

Strategic Measures to Prevent Short Cargo During Coal Loading and Unloading Operations: A Case Study

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ABSTRACT

Short cargo refers to a condition in which the quantity of cargo unloaded does not match the amount loaded or specified in the stowage plan. This discrepancy poses a significant challenge for shipping companies, as it not only leads to financial losses but also damages their reputation. This study aims to analyze the causes, impacts, and prevention strategies of short cargo incidents during the coal loading and unloading process at a shipping company. A qualitative research method with a case study approach was employed. Data were collected through interviews, observations, and document analysis, with key informants including the Operations Manager, the shipping agent, and the ship's master. Fault Tree Analysis (FTA) was used to identify the root causes of the problem. The findings indicate that the primary factors contributing to short cargo are adverse weather conditions, human error, criminal activities, and equipment malfunctions during loading and unloading operations. The consequences of short cargo extend beyond financial losses to include reputational damage and a decline in customer trust. To mitigate these risks, the company has implemented various preventive strategies, such as enhancing supervision during operations, using more efficient loading and unloading equipment, providing training for crew members and stevedores, and strengthening coordination among relevant stakeholders. With these measures in place, the company aims to reduce the occurrence of short cargo and improve the effectiveness and efficiency of its coal handling operations.



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1. INTRODUCTION

Short cargo is a condition in which the amount of cargo loaded at the port of loading, unloaded at the port of discharge, or transferred to a larger ship (transshipment) does not match the amount stated in the stowage plan or loading documents. The causes of short cargo include communication with stevedores (TKBM), weather, natural disasters, ship seaworthiness, human error, and a lack of crew skills (Niken, 2023). Draught survey evaluations of coal shipments have also linked cargo losses between barges and vessels to weather, spillage, theft, and measurement errors (Yusuf et al., 2019).

Short cargo causes the amount of coal received at the final destination or unloading site to be less than the amount recorded during loading or the agreed amount. In the event of short cargo, the carrier is responsible for the cargo. Under Article 468 of the Indonesian Commercial

Code (KUHD) and the Hague-Visby Rules, the carrier is responsible for the cargo from the time it is loaded onto the ship until it is unloaded at the port of destination, and is obliged to load, stow, and discharge the goods properly (Posende, 2020). Studies of coal transshipment show that shortages frequently arise during transfer between barges and mother vessels (Rijal et al., 2023; Susanto et al., 2023).

This research was conducted at a sea transportation company located in South Jakarta. In this company, short cargo, namely a reduction in coal cargo, occurred on one of its routes, at Muara Berau, Samarinda, East Kalimantan. A reduced cargo results in losses for the carrier because the owner of the goods has paid freight in accordance with the cargo stated in the stowage plan, and the shipper or cargo owner may consider the carrier to have failed in its responsibility. The carrier is obliged to ensure that the cargo transported from the port of loading to the port of discharge remains intact and in accordance with the loading documents and the agreement between the parties. The resulting losses affect not only the company's finances but also its reputation, because they can damage the trust of the shipper or the owner of the goods. If loss, damage, or delay occurs, the owner of the goods can file a claim against the carrier (Gusti et al., 2019).

Therefore, knowledge of strategies to prevent short cargo, especially of coal, is important for shipping companies, ship crews, stevedores (TKBM), port operators, and the company's operational division. Likewise, supervision of the loading and unloading process and of any factors that can cause short coal cargo is needed to support the effectiveness and efficiency of coal loading and unloading. Accordingly, this study aims to analyze the causes and impacts of short cargo during coal loading and unloading at a sea transportation company and the strategies applied by the company to prevent it.

2. METHODS

According to Sugiyono (2020), the qualitative descriptive approach is research based on the philosophy of postpositivism, used to study natural objects in which the researcher acts as the key instrument. In this study, the researchers used a qualitative descriptive approach with a case study design to describe and obtain an overview of short cargo problems during coal loading and unloading at a sea transportation company, using triangulated data collection techniques that combine several methods.

The research was conducted at a sea transportation company located in Jakarta while the researcher carried out an internship (work practice) at the company from August 2023 to July 2024. Semi-structured interviews were conducted with the Operations Manager, the agent, and

the ship's master. Observations covered ship loading and unloading documents, reports related to short cargo, and actions that can cause short cargo, including discussions during weekly meetings. The researcher also collected documents for analysis, such as minutes related to short cargo (cargo burning, cargo theft, and cargo spillage during loading and unloading or on the way to the unloading site) and photographs of the crew handling cargo fires, the cargo before and after theft, burning cargo, and cargo spills during loading and unloading.

The data were analyzed using Fault Tree Analysis (FTA). FTA is a data analysis technique used to identify the risks that contribute to a failure (Ariyanty, 2021). It identifies the relationships between causal factors and displays them as a fault tree, using a top-down approach that begins with an undesirable top event and then details its causes down to the root causes. FTA has been widely applied to analyze failures in maritime and port operations (Budiyanto & Fernanda, 2020; Knežević et al., 2020). The fault tree in this study was constructed from interviews with the parties involved in coal loading and unloading and from direct observations of the process in the field.

Data validity was ensured through triangulation, by comparing the interview results with the researchers' observations and with the documents collected, including minutes and loading and unloading documents.

3. RESULTS AND DISCUSSION

Based on the interviews, observations, and documentation studies, the results are presented in three parts: the factors causing short cargo, the impacts of short cargo, and the company's efforts to prevent it.

3.1. Factors Causing Short Cargo in the Coal Loading and Unloading Process

To compile the fault tree, the researcher conducted observations, documentation studies, and interviews with the Operations Manager, the agent, and the ship's master. The factors that cause short cargo during coal loading and unloading were then arranged as components of a fault tree model. Figure 1 shows the root causes of short cargo identified using the FTA method.

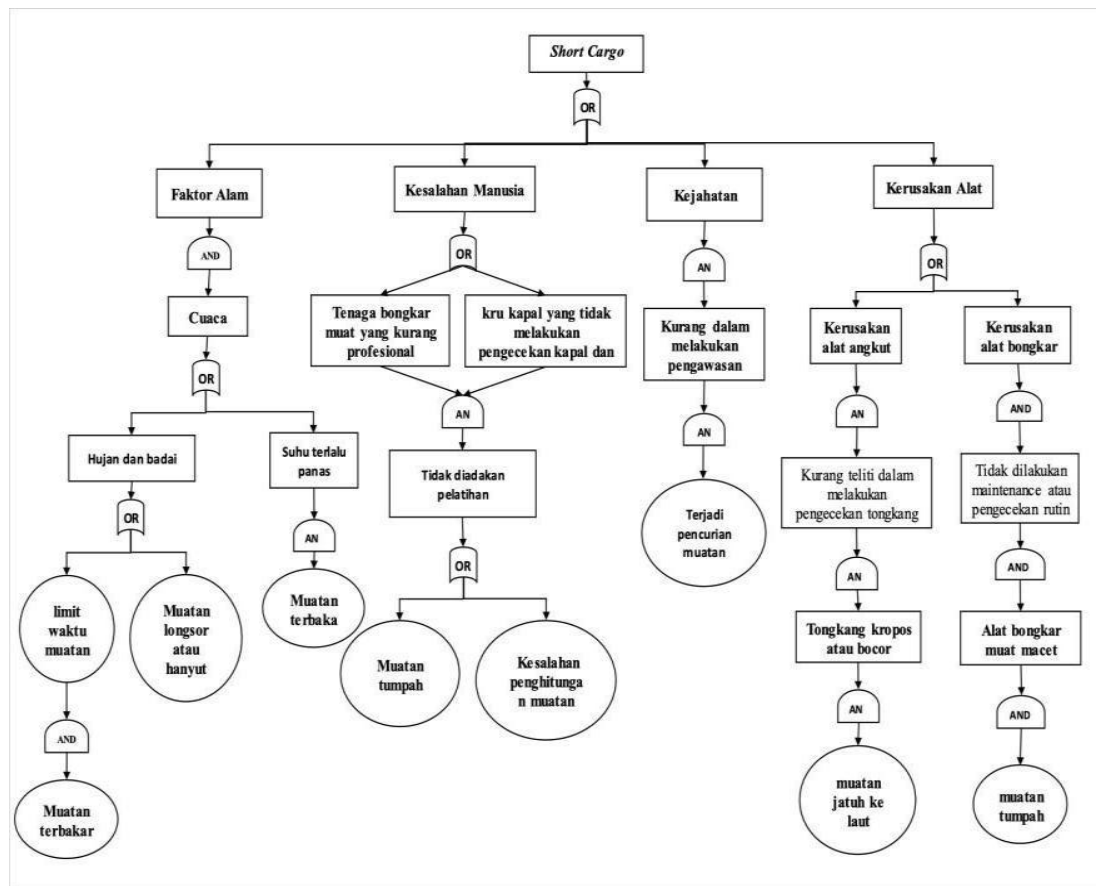


Figure 1. Fault tree analysis (FTA) diagram

The FTA diagram in Figure 1 shows that short cargo during coal loading and unloading is caused by four groups of factors: natural factors (weather), human error, crime, and equipment damage.

a. Natural factors (weather)

1) Rain and storms. The Operations Manager stated that one impact of bad weather is heavy rain that causes coal to slide and flow into the drainage channels of the barge. The agent added that bad weather, especially large waves, is often the main cause of short cargo, because the waves make barges roll so that part of the coal falls into the sea. The master added that the limited durability of coal cargo also affects short cargo: coal can generally be held for about 10 days, after which hot spots, smoke, and even fire may appear. If bad weather forces the ship to shelter or stop, the loading and unloading time becomes longer and the risk of the coal burning on its own increases.

2) Hot weather. Excessively high temperatures can cause self-combustion, so that the amount of coal is reduced when it arrives at its destination. The Operations Manager stated that, in addition to heavy rain, hot weather can trigger self-combustion of coal, especially coal with a high sulfur content. The agent added that an overly long loading and unloading time increases

the risk of the cargo burning, and the master stated that coal that was safe during loading began to burn during the voyage when hot weather aggravated the situation. Figure 2 shows a barge carrying coal on which smoke emerged from the cargo, indicating the potential for fire due to spontaneous oxidation that was not properly managed.



Figure 2. Coal cargo fire

Spontaneous combustion (swabakar) is a phenomenon in which coal burns on its own without an external trigger, due to an oxidation reaction between coal and oxygen that produces heat. If this heat is not properly dissipated, the temperature of the coal rises until it reaches the ignition point (Yolanda et al., 2024). The factors affecting the self-combustion potential of coal include coal quality, since low-rank coal such as sub-bituminous coal has a higher volatile matter content; sulfur content, especially in the form of pyrite, whose oxidation produces additional heat; and moisture content, which under certain conditions can accelerate oxidation (Jepriansyah et al., 2023; Wahidah et al., 2022). The international code for solid bulk cargoes likewise classifies coal as a cargo that may self-heat and requires temperature monitoring during carriage (International Maritime Organization, 2020).

The documentation of short cargo caused by weather is shown in Figure 3, a report stating that the cargo on one of the barges was smoking and burning during loading and unloading, which caused the short cargo. Such minutes can also be used as material for evaluating and improving safety procedures to prevent similar incidents in the future.

BERITA ACARA

Pada hari ini, Selasa tanggal 08 Oktober 2024 pukul 08.00 - 08.30 WIB telah dilakukan Draught Survey BG. Azamara 3060 dengan hasil 8.393,518 MT dan Short BL +/- 116,742. Dari hasil short tersebut dikarenakan cargo BG. Azamara 3060 dalam kondisi berasap dan terbakar saat bongkar. Adapun langkah yang dilakukan untuk kelancaran pembongkaran maka dilakukan pemadaman cargo BG. Azamara 3060.

Figure 3. Excerpt of the minutes of a burning cargo

The loading draft survey document (Figure 4) records a net displacement of 1,286.603 MT before loading and 9,796.863 MT after loading, so the cargo loaded according to the draft survey was 8,510.260 MT. The unloading draft survey document (Figure 5) records 8,393.518 MT of coal discharged, a difference of 116.742 MT, or approximately 1.37% of the loaded cargo, and notes self-combustion of the cargo.

• Others		MT/LT	MT/LT
16. Net Displacement	1.286.603	MT/LT	MT/LT
17. Cargo loaded / discharged	8.510.260	MT/LT	MT/LT
Remarks & Sea State:			
Acknowledged by TB. LIBERTY 23 Master: <i>[Signature]</i> Master/Chief Officer: <i>[Signature]</i>			
<i>Desa KBL CILACAP</i> <i>PT. Sucolindo</i> <i>Surveyor/Draughtsman</i>			

**) Pilih satuan ukuran dan berat yang sesuai (coret yang tidak sesuai)*

Figure 4. Excerpt of the loading draft survey document

• Others		MT/LT	MT/LT
16. Net Displacement	7.721.323	MT/LT	MT/LT
17. Cargo loaded / discharged *)	8.393.518	MT/LT	MT/LT
Remarks & Sea State: <i>SELF COMBUSTION</i>			
Acknowledged by TB. LIBERTY 23 Master: <i>[Signature]</i> Master/Chief Officer: <i>[Signature]</i>			
<i>Desa KBL CILACAP</i> <i>PT. Sucolindo</i> <i>Surveyor/Draughtsman</i>			

**) Pilih satuan ukuran dan berat yang sesuai (coret yang tidak sesuai)*

Figure 5. Excerpt of the unloading draft survey document

b. Human error

Human error in the coal loading and unloading process is also one of the main causes of short cargo. The Operations Manager stated that one of the internal factors is a lack of supervision by the ship's crew or master, who should be responsible for the loading and unloading process on board. Similar findings on operator and handling errors have been reported in studies of coal losses during barging and transshipment (Nurjanah et al., 2023; Rijal et al., 2023).

1) Unskilled loading and unloading personnel. If loading and unloading personnel, whether crew members or external workers, lack competence, errors may occur in moving the cargo, causing coal to spill or the cargo to be miscalculated.

2) Crew members who do not check the barge and draft. Barge checks and draft surveys that are not carried out properly can cause discrepancies between the recorded and actual cargo amounts. The Operations Manager stated that before loading, the master must know the physical condition of the barge thoroughly, and that the watch officers, crew, and helmsmen must check the condition of the barge, especially its draft. This inspection is

important to find any residual cargo or leaks so that cleaning or repairs can be carried out before loading begins. Without such checks, the amount of cargo will not match because of barge leakage or residual cargo resulting from inadequate cleaning.

c. Crime

The loss of coal cargo can also be caused by criminal acts such as theft. The Operations Manager stated that one of the external factors causing short cargo is cargo theft, and that the waters around Samarinda are highly prone to theft, causing losses for both the carrier and the shipper. Theft occurs when the barge crosses vulnerable waters: the perpetrators approach the barge with a small boat and take part of the coal cargo. Figure 6 shows a barge carrying coal on which there are indications of a reduction in the cargo. Theft has also been identified as a cause of coal cargo losses in draught survey evaluations (Yusuf et al., 2019).



Figure 6. Reduced coal cargo

d. Equipment damage

Damage to loading and unloading equipment is another cause of short cargo. Damage to equipment such as grab cranes, conveyors, and hoppers can suspend loading and unloading, so that the coal remains longer in the barge, oxidizes, and may undergo self-combustion (Suryadi & Setyawan, 2023). In addition, if a grab crane cannot close tightly during loading or unloading, coal may spill into the sea or onto the deck of the mother vessel, as also found in studies of losses caused by unloading equipment (Pratama et al., 2024; Rijal et al., 2023). Figure 7 shows a grab hanging in a slightly open position, whereas it should be tightly closed to prevent the cargo from spilling during transfer, and Figure 8 shows the deck of the mother vessel covered with spilled coal as a result.



Figure 7. Grab not fully closed



Figure 8. Coal spill on the mother vessel deck

3.2. Impacts of Short Cargo During Coal Loading and Unloading

The Operations Manager stated that a large amount of short cargo leads to compensation claims from customers due to the loss of goods or discrepancies in the amount of cargo. In addition, the company must incur additional costs for investigations, audits, and reshipments. Another impact is a decrease in customer confidence, because the company is considered unable to handle cargo properly.

A shortage of coal in the distribution process can have a significant operational impact. When the amount of coal unloaded is insufficient, the company is forced to make additional deliveries to make up for the shortage, which disrupts supply chain and operational activities and reduces overall productivity. A lack of cargo can cause distribution delays, increased costs, and reduced customer trust in the company (Rifaitulloh, 2021). Operational efficiency in the coal industry is also greatly influenced by the timeliness of loading, unloading, and shipping,

so disruptions such as equipment breakdowns and cargo shortages can delay the delivery schedule and lead to demurrage charges (Suryadi & Setyawan, 2023).

Companies must also incur additional costs to deal with short cargo, including reshipment costs and additional labor for checking and reloading to cover the difference in cargo, and in some cases must pay deadfreight to fulfil the contract (Rijal et al., 2023). These costs reduce the company's profits. Reduced quantities of goods during delivery can also lead to customer dissatisfaction, decreased orders, and decreased revenue, as coal losses translate directly into financial losses (Nurjanah et al., 2023).

Another impact of short cargo is that companies that are less able to manage cargo properly are often considered incompetent by customers, business partners, and investors. As a result, the company's image in the shipping market can decline drastically, reducing its competitiveness compared with other shipping companies that have better cargo management systems. In the long run, a bad reputation not only causes the loss of customers but can also hinder efforts to attract new investors. Thus, short cargo in coal distribution affects not only operations but also the company's finances and business continuity, so companies need strategies to minimize its occurrence (Kevin, 2021).

3.3. Efforts Made by the Company to Minimize Short Coal Cargo

Based on the FTA diagram, the company's efforts to minimize short cargo address the four main factors: weather, human error, crime, and equipment damage.

To address weather factors, which can cause coal spills, coal slides, coal falling into the sea, and self-combustion, the company has taken several measures. First, the piles of coal are kept at a distance of approximately 70 centimeters to one meter from the side of the barge, so that coal is not thrown out or does not fall into the sea when the barge rolls. Second, the company ensures that the barge is not porous and the sides have no holes, so that rainwater does not wash the coal out through the holes. Third, the drainage channels are kept from being too wide so that cargo is not lost into the sea. Fourth, to prevent self-combustion, the coal is treated by spraying a liquid chemical (Jepriansyah et al., 2023).

To minimize short cargo caused by human error, the company ensures that the crew can read the draft and calculate the cargo, reminds the crew to check the condition of the barge, and requires continuous monitoring during loading and unloading. In addition, the crew is briefed every month when the ship calls at the port. Based on the researcher's observations, the Operations Manager briefed the crew in the ship's control room to ensure that all crew members understand safety procedures and measures to prevent short cargo caused by weather, theft,

operational errors, or equipment malfunctions. This routine briefing aims to increase the crew's awareness of and responsibility for securing the cargo.

To minimize short cargo caused by crime, namely cargo theft, the company hires a security party to escort the cargo during the voyage. This effort is not cheap: each escort costs the company Rp 5,000,000 to Rp 10,000,000.

To minimize short cargo caused by equipment damage, the company carries out routine maintenance and periodic checks of the loading and unloading equipment to ensure that all equipment functions properly before use (Karatuğ et al., 2023), and performs real-time monitoring and recording of the condition of the equipment and the volume of cargo moved to prevent losses due to undetected spills.

In addition, the operations department holds weekly meetings to evaluate operational activities, identify obstacles, and find solutions to problems, especially short cargo. These meetings serve as a communication forum between the parties within the company so that coordination between teams runs well. As a follow-up, the company implements several additional strategies to increase the effectiveness of the coal loading and unloading system:

- a) More systematic cargo planning: the company ensures that the coal piles conform to the stowage plan, and evaluates the height of the coal piles and their distance from the side of the barge to reduce the risk of slides or coal falling into the sea.
- b) Supervision and verification of deliveries: the crew must understand the draft and calculate the cargo carefully, check the condition of the barge for leaks or damage before loading, and supervise loading and unloading directly so that any problems are detected immediately.
- c) Maintaining the quality and consistency of loading: each stage of loading and unloading is monitored to ensure that the volume of cargo sent corresponds to the volume received, and the barge drainage system is kept from being too wide.
- d) Improving the monitoring system: the loading and unloading process is monitored in real time, and the cargo moved is recorded regularly to identify suspicious shrinkage early.
- e) Monitoring cargo condition and security: a security party escorts shipments on routes prone to theft, and the coal is treated by spraying a chemical liquid to reduce the potential for self-combustion.
- f) Briefing the crew on safety procedures and short cargo prevention, including the importance of checking barge conditions and monitoring the loading and unloading process.

4. CONCLUSION

Based on the results of the research on strategies to prevent short cargo during coal loading and unloading, it is concluded that short cargo is caused by several factors. Natural or weather factors include heavy rain, which can cause coal slides and cargo falling into the sea, and hot weather, which can trigger self-combustion (swabakar). Human error is also a factor, as a lack of control by the ship's crew and unskilled loading and unloading personnel often cause errors during loading. Coal theft frequently causes short cargo, especially in vulnerable waters such as the Samarinda shipping channel. In addition, loading and unloading equipment, such as grab cranes that do not close tightly, can cause coal to spill or fall into the sea. Among these, weather-related factors, including self-combustion aggravated by hot weather and prolonged loading and unloading, were emphasized by all three informants and are documented in the short cargo minutes and draft survey reports.

The impacts of short cargo on the company are financial and operational. Financial losses arise from additional reshipment costs, loading and unloading labor costs, and related expenses, while repeated incidents can cause the cargo owner to lose trust in the company and damage its reputation. Operationally, short cargo can cause delivery delays and disrupt the fulfilment of customer needs.

To minimize short cargo, the company ensures proper loading procedures and treats the coal to reduce self-combustion, improves crew competence through regular briefings and barge checks before loading, hires security escorts to reduce the risk of theft, carries out periodic maintenance and checks of loading and unloading equipment, and holds weekly meetings to evaluate obstacles and find solutions to improve operational efficiency.

5. DECLARATIONS

Author contributions: L.I.S.: Conceptualization, Methodology, Supervision, Writing – review & editing; J.B.: Validation, Formal analysis, Writing – review & editing; R.H.: Investigation, Data curation, Visualization, Writing – original draft. All three authors read and endorsed the final manuscript.

Conflict of interest: The authors declare that no competing interests exist in relation to this article.

AI usage statement: The fault tree, data interpretation, and text of this article were produced by the authors; no generative AI tools were used.

Ethical approval: The Operations Manager, the agent, and the ship's master agreed to be interviewed. To protect confidentiality, the company is not named, and the minutes, draft survey documents, and photographs are shown only as excerpts that do not reveal commercial details.

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Data availability: Because the short cargo minutes and draft survey reports are confidential company documents, they cannot be shared publicly; interview notes may be obtained from the corresponding author on reasonable request.

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