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Analysis of Cargo Handling Procedures Implementation to Minimize Cargo Shrinkage on SC Majestic LXII Vessel

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Abstract: In distributing fuel oil in Indonesia, of course it requires a large mode of transportation that can distribute fuel oil in large quantities. One of these modes of transportation is sea transportation. Tankers are made to be able to carry liquid cargo which has sensitive properties and requires special treatment. Starting from loading, holding, loading on the ship, handling cargo on board and when unloading. The fact that researchers discovered on the SC Majestic XLII ship was that after unloading at Daesan port, Korea on January 21 2022, there was a Cargo Loss on the Naphtha cargo. The results of the load calculation after unloading are different from the calculation results after loading. Where the calculation results after the ship was unloaded, the land figure was 82,246,807 Barrels, while the calculation results at the loading port according to the Bill of Lading (a document that states the quantity of tanker cargo intended for the recipient party) was 82,400,783 barrels, the ship experienced a Cargo Loss the R4 figure (the difference in cargo from the reject port tank to the arrival port tank) is 153,976 barrels or 0.186%. This research is qualitative research with a descriptive approach. It is hoped that the research results can be compiled become a reference for the development of knowledge regarding the application of loading and unloading procedures to reduce cargo shrinkage.

Keyword: Loading, Discharging, Cargoloss, Tanker, Naphtha

INTRODUCTION

As a crucial aspect of the transportation industry, the movement of goods represents one of the largest contributions of maritime transport to the global economy (Tulus Irpan H. S. et al., 2016)Compared to air and land transportation, maritime transport offers the lowest cost contribution, making its impact even more significant. Additionally, when considering alternative modes of transport, shipping allows for a much larger volume of goods to be moved at once. Due to its high carrying capacity and the lack of alternative means of transportation with similar capabilities, maritime transport remains the most efficient and cost-effective method for transferring goods between locations or countries.

Tanker vessels are specifically designed to transport sensitive liquid materials that require special handling. Managing cargo on board, including the processes of loading, securing, and unloading, demands careful and precise procedures (Ilham Pratama et al., 2018). Any mishandling of cargo, particularly instances of cargo loss or shrinkage during loading and unloading operations, is unacceptable, as it can result in significant financial losses and potential liabilities. Incidents such as leaks (leading to marine pollution), transportation fraud, or smuggling are often suspected when cargo shrinkage occurs on tankers, although it can be difficult to determine the exact cause. Nevertheless, human error remains the leading factor behind many of the losses encountered aboard ships (Jamil et al., 2023).

To ensure smooth loading and unloading operations without delays or financial loss, ship officers and crew must strictly adhere to established procedures. This includes the ability to monitor, implement, maintain, and operate all necessary equipment properly. In the oil distribution sector, involvement in cargo operations is unavoidable. However, these operations do not always proceed as expected; one of the main challenges faced by tanker vessels is cargo shrinkage, also known as cargo loss. Therefore, to prevent or at least minimize the frequency of cargo loss, ship crews must be well-trained and competent in applying cargo handling and loss control procedures.

On January 21, 2022, at Daesan Port in South Korea, after the unloading process, the crew aboard the SC Majestic LXII discovered a cargo loss involving the shipment of naphtha. Post-discharge calculations showed a significant discrepancy compared to the figures recorded after loading. According to the Bill of Lading — the official document stating the quantity of cargo designated for the consignee — the loading port recorded 82,400.783 barrels. However, after unloading, the measured quantity was only 82,246.807 barrels. Consequently, the vessel experienced a cargo loss, with the R4 value (the cargo difference between the reject port tank and the arrival port tank) amounting to 153.976 barrels or approximately 0.186%. This loss exceeded Pertamina's allowable shrinkage tolerance, which is set at only 0.15%. To fully understand the causes of cargo loss, it is essential for prospective officers to have solid knowledge and understanding of cargo measurement and calculation methods within ship compartments. Mastery of these techniques is crucial to minimizing cargo loss, maintaining operational integrity, and preventing disputes between ship and shore parties.

This study aims to investigate the unloading practices at the discharge port to minimize naphtha shrinkage aboard the SC Majestic LXII tanker. It seeks to understand why cargo shrinkage frequently occurs and identify the challenges that must be addressed to reduce naphtha losses on the SC Majestic LXII. According to research by Sitepu & Rangga (2022), there is currently no standard method for cargo calculation that guarantees absolute accuracy. Standardization in measurement practices could greatly assist in ensuring consistent and reliable cargo estimations. This research focuses specifically on the cargo unloading operations conducted aboard the SC Majestic LXII and their role in minimizing cargo shrinkage.

Based on the realities observed, it is clear that cargo operations, particularly unloading, face numerous challenges, including cargo loss. Therefore, the researcher was motivated to address this issue through a study entitled "Analysis of Cargo Handling Procedures Implementation to Minimize Cargo Shrinkage on the SC Majestic LXII Vessel."

METHOD

This research employs a qualitative method with an exploratory approach, using a fishbone diagram for analysis. Non-probability sampling was applied, specifically utilizing purposive sampling as the sampling technique (DEWI, 2022). Additionally, the study adopted a "snowball sampling" method, where a small initial group of data sources gradually expanded. In this approach, individuals directly involved and considered to have the most comprehensive knowledge about the events being studied were observed and their data recorded. The study relied on two types of data sources based on the techniques used to obtain the information: primary data and secondary data. Primary data was collected through direct observation of information related to the cargo shrinkage of naphtha on the SC Majestic LXII vessel. Meanwhile, secondary data was gathered from pre-existing information, typically in the form of publications or continuous reports obtained from the company. These secondary sources were also retrieved from data archives available aboard the SC Majestic LXII. The research utilized a qualitative approach with data collection techniques that included direct observation, Focus Group Discussions (FGD), and documentation analysis.

Data Analysis Method

1. Focus Group Discussion (FGD) Analysis

The FGD involved five key informants who discussed the issue of naphtha cargo shrinkage aboard the SC Majestic LXII and identified strategies to minimize the loss.

2. Fishbone Analysis

A fishbone (Ishikawa) diagram was used to analyze the root causes of cargo shrinkage comprehensively by mapping the contributing factors in a visual "fishbone" structure.

Data Validation (Triangulation)

Credibility

1. Extended Observation, Field observations were prolonged to strengthen the data's depth and reliability.
2. Enhanced Accuracy, Data was systematically recorded and cross-checked with relevant references.
3. Triangulation:
   a. Source Triangulation: Data was collected from multiple sources, including the captain, chief officer, pumpman, helmsman, and loading master.
   b. Technique Triangulation: Various methods such as interviews, direct observations, and documentation were employed.
   c. Time Triangulation: Data collection was conducted at different times (morning and afternoon) to ensure consistency.
4. Use of Supporting References, the findings were backed by authentic photographs and official documents.
5. Member Checking, Validation was performed by confirming the results directly with the informants.

Transferability

Assessed the extent to which the findings could be applied to similar contexts while maintaining relevance across different social conditions.

Dependability

Ensured data consistency through independent auditing of the entire research process, from problem identification to final reporting.

Confirmability

Maintained the objectivity of the data by ensuring that the findings reflected actual field conditions, free from researcher bias.

RESULTS AND DISCUSSION

This study identifies the factors contributing to cargo loss aboard the tanker vessel SC MAJESTIC LXII. Data was collected through direct observation, documentation, and Focus Group Discussions (FGD) with the ship's crew. The results were analyzed using a fishbone diagram to visually map out the contributing factors. Based on the analysis, several main causes of cargo loss were identified and are described in detail below:

1. Measurement Errors

Measurement inaccuracies of naphtha cargo occurred due to discrepancies between the use of tank tables and ASTM tables. These differences led to inconsistencies between the Gross Observed Volume (GOV) and the Gross Standard Volume (GSV) in each tank. Incorrect application of corrections for factors such as heel, trim, and temperature variations further impacted the volume calculations. These errors were exacerbated by:

a. Lack of Maintenance on Measuring Equipment: Poorly maintained equipment, such as UTI-MMC devices with low battery levels, missing wipers, and unavailable gaskets on board, compromised measurement accuracy. This forced the crew to use inadequate tools, leading to miscalculations.
b. Insufficient Supervision: Accurate measurement and record-keeping are critical. A lack of oversight by the Chief Officer during the gauging process increased the risk of human error and unnoticed negligence.

2. Inappropriate Measurement Methods

The use of unsuitable measurement methods also contributed to cargo loss. Applying ASTM tables without adjustments for the vessel's actual conditions—such as extreme temperature or pressure variations or different cargo types—resulted in inaccurate readings. Moreover, physical conditions like tank corrosion or sediment buildup inside the tanks further skewed measurements. Thus, precise cargo measurement must be adapted to the vessel's specific conditions.

3. Non-Compliance with Procedures

Deviations from proper gauging procedures, such as failure to conduct rechecks of tank compartments after cargo transfer, increased the risk of cargo loss. Rechecking ensures that no residual cargo remains and that the recorded volumes are accurate. Skipping this step often led to errors in cargo volume recording and reporting.

4. Volatility of Naphtha

Naphtha is a highly volatile substance, and fluctuations in temperature or pressure can cause significant amounts to evaporate into the atmosphere, resulting in cargo loss. This evaporation accelerates under poorly controlled conditions. Furthermore, naphtha's volatility also increases the risk of fire or explosion, complicating the safe handling and storage of the cargo.

5. Temperature Effects

Elevated temperatures can accelerate the evaporation of naphtha, reducing the recorded cargo volume. Unstable temperatures inside the tanks or external temperature changes exacerbate this condition, leading to greater cargo loss.

6. Weather Effects

Extreme weather changes such as strong winds, heavy rain, or temperature fluctuations can impact tank temperature and pressure, speeding up the evaporation rate. Unstable weather conditions cause inconsistent internal environments, further increasing the risk of cargo loss.

7. Equipment Malfunctions

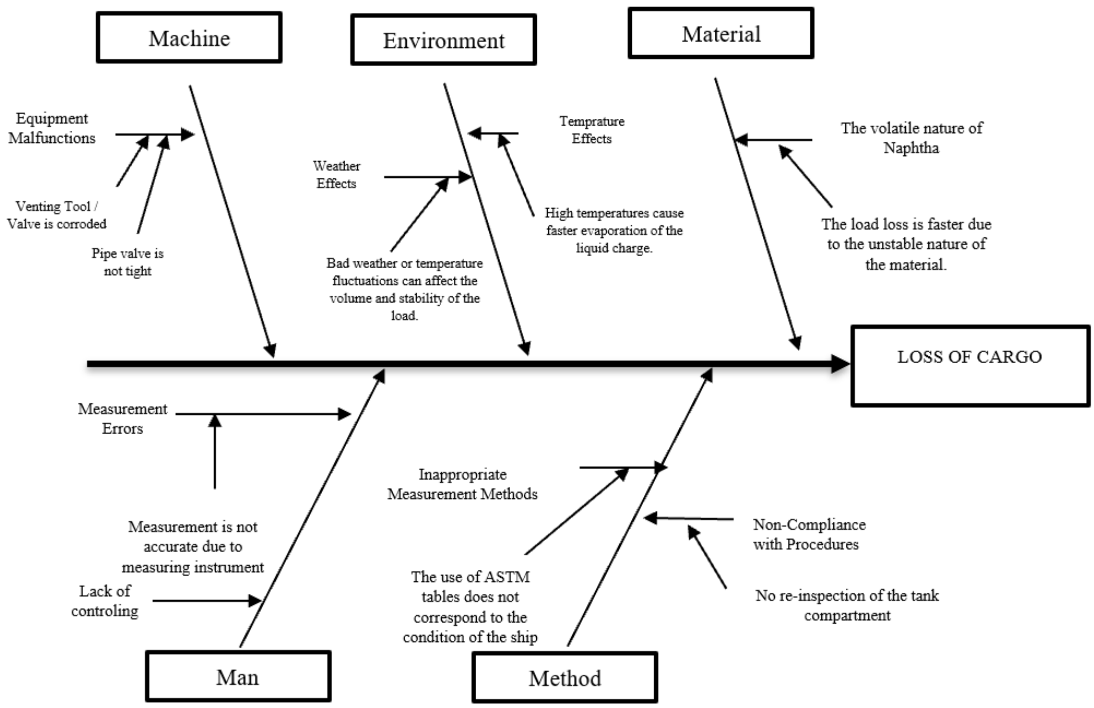
Damage to equipment used for measuring, loading, and storing cargo also affects the accuracy of cargo measurement and handling. Several issues were identified:

a) Damage to Venting/Valve Equipment: Malfunctions in venting systems and valves caused improper pressure control inside the tank, worsening the evaporation of cargo and increasing cargo loss.

b) Leaky Pipe Valves: Valves that failed to seal properly resulted in fluid leaks, especially with volatile substances like naphtha. This leakage accelerated evaporation and caused significant cargo loss.

From the observations and interviews, the researcher identified the schemes used to minimize cargo loss of naphtha on the SC MAJESTIC LXII, the efforts that must be taken to further reduce cargo loss on board, and the factors contributing to cargo loss on the SC MAJESTIC LXII tanker. The collected data was then processed using the fishbone analysis method.

The researcher selected the fishbone analysis method because it is highly suitable for identifying the causes or underlying factors of a problem. The use of fishbone analysis aims to provide a detailed breakdown. The factors identified are categorized into Manpower, Methods, Materials, Environment, and Machinery, adapted to the findings observed during activities on board the SC MAJESTIC LXII tanker. These factors were later illustrated in a fishbone diagram.



Source: Research Results

Figure 1. Fishbone Analysis

The diagram illustrates how the implementation of loading and unloading procedures helps reduce cargo loss on the SC Majestic LXII. From the fishbone diagram, several factors were identified, including Man, Method, Material, Environment, and Machine.

The issues of cargo loss during the transport of naphtha are caused by five main factors:

1. Man

Lack of supervision and errors in the use of measurement tools lead to inaccurate cargo volume data, resulting in cargo loss and financial losses.

2. Method

Inaccurate application of measurement methods, such as the use of the ASTM table that does not match the ship's conditions, and insufficient rechecking of tanks, causes inaccuracies in cargo data.

3. Machine

Damage to ship spare parts, including venting equipment and leaky pipe valves, leads to cargo leaks and increases the risk of evaporation of liquid materials.

4. Environment

Changes in temperature and extreme weather conditions accelerate the evaporation of naphtha, affecting the volume and stability of the cargo in the tanks.

5. Material

The natural volatility of naphtha speeds up cargo loss through evaporation, causing a discrepancy between the recorded and actual cargo volume.

What Scheme is Used to Minimize Naphtha Cargo Loss on the SC Majestic LXII?

Source: Research Results

Figure 2. Scheme to Minimize the Cargo Loss

To minimize naphtha cargo loss on the SC Majestic LXII, a systematic approach combining technical and procedural measures can be applied. Here is the scheme that can be implemented:

1. Accurate Measurement and Monitoring

The use of digital measuring devices like flowmeters and the SAAB radar, which are regularly calibrated, is crucial to ensure the accuracy of cargo measurements. An automatic measurement system that records data in real-time helps reduce human error and improves operational efficiency. Routine calibration ensures that measuring tools remain in optimal condition, preventing errors in cargo volume calculations.

2. Temperature Control and Evaporation Management

Since naphtha is highly volatile, controlling the temperature is critical. The use of real-time temperature sensors and temperature control systems within the tanks helps maintain stable temperatures, preventing excessive evaporation. Controlled ventilation also assists in reducing cargo loss due to evaporation.

3. Efficient Loading and Unloading Procedures

Specialized training for the crew in identifying and addressing potential leaks or spills during loading and unloading is essential. The use of well-maintained, appropriate equipment and careful unloading procedures can minimize cargo loss due to spills or excessive evaporation.

4. Enhanced Crew Training

Regular training and emergency situation simulations for the crew improve their ability to respond quickly to potential issues such as leaks or errors during loading. Enhancing operational knowledge also ensures that the crew uses the equipment correctly and efficiently.

5. Improved Tank Emptying Procedures

Advanced technology like automatic cleaning systems ensures that almost all remaining liquid in the tanks or pipes can be removed. Optimized final pumping procedures, such as using vacuum pumps, reduce residues and ensure no liquid is left behind.

6. Improved Coordination Between Ports/Terminals

Implementing standard measurement procedures agreed upon by all ports and improving communication between terminal personnel ensures smooth and safe loading and unloading activities. A transparent reporting system also ensures that cargo-related data is accurately recorded and accountable.

7. Routine Audits and Monitoring

Conducting regular audits of all loading and unloading equipment and continuously monitoring the entire process with digital tracking devices helps detect potential problems early. Evaluating procedures and equipment used is also important to improve efficiency and reduce cargo losses.

Efforts to Minimize Naphtha Cargo Loss on Tanker SC MAJESTIC LXII

To reduce cargo loss during the transportation of naphtha, several strategic measures must be consistently implemented:

1. **Accuracy in Calculations Using Calibration and ASTM Tables**

The calculation process of the cargo volume using tank calibration tables and ASTM tables must be carried out with a high level of precision. This ensures alignment between the ship figure and the shore figure, minimizing potential discrepancies that could lead to cargo loss.

2. Repeated Liquid Level Measurements (Average Finding Measurement)

To avoid measurement errors caused by rough sea conditions, the liquid level inside the tanks must be measured five times. Additionally, an official record documenting adverse weather conditions must be prepared and signed by the relevant parties. If any discrepancies exceeding the tolerance limit occur, all findings must be recorded in the Compartment Log Sheet to facilitate further verification.

3. Maintenance of Measuring Equipment and Cargo Handling Facilities

Cargo handling equipment such as tanks, pumps, and pipelines must undergo regular maintenance to prevent leaks or evaporation. The ship's crew is required to inspect the tank shell conditions and promptly report any detected damages for immediate repair to ensure the safety of the cargo.

4. Provision of Adequate Spare Parts for Measuring Equipment

To maintain the accuracy of cargo measurements, the vessel must be equipped with standard measuring tools that are regularly calibrated and have available backups, including steel measuring tapes, brass bob weights, sounding rods, thermometers, water-finding pastes, and hydrometers. All measuring instruments must meet the standards set by independent certification bodies and should be reverified during major dockings (special surveys) to ensure their reliability.

Factors Causing Cargo Loss on Tanker SC MAJESTIC LXII

Cargo loss on the SC MAJESTIC LXII tanker is caused by several interrelated key factors, including:

1. Lack of Accuracy in Cargo Calculation

Precision in cargo calculations is crucial to ensure the accuracy of the amount of cargo loaded and discharged. In the case of SC MAJESTIC LXII, shrinkage occurred due to deficiencies in operational infrastructure and equipment, such as leakage in the cargo pump located in the pump room, deteriorated or overly tightened PV (Pressure Vacuum) valves, and loosened tank shells. The failure to detect and promptly repair these damages led to gradual cargo leakage during the voyage or cargo handling operations. Therefore, regular monitoring and thorough inspections of the ship's infrastructure are essential to prevent cargo loss.

2. Use of Non-Standard Measuring Equipment

The accuracy of cargo measurements heavily depends on the standardization of the measuring instruments used. Onboard SC MAJESTIC LXII, it was found that the measuring equipment utilized during loading and unloading operations did not meet established standards. This lack of calibration contributed to errors in recording cargo volumes both during tank filling and emptying stages. Moreover, the use of improperly calibrated tools heightened the risk of discrepancies between ship and shore figures, potentially leading to disputes between parties involved and causing significant financial losses for the company.

3. Limited Availability of Measuring Equipment Spare Parts on Board

The availability of adequate spare parts for measuring equipment is crucial for ensuring smooth cargo measurement operations. On SC MAJESTIC LXII, limited spare parts created obstacles during cargo measurement and calculation procedures. Several factors further complicated this challenge, including:

a) Variety of Measuring Equipment: Differences in specifications, accuracy levels, and measurement methods among devices resulted in inconsistent data, making validation difficult.
b) Calibration Uncertainty for Compartments: Each vessel has unique designs and characteristics, requiring specific calibrations. Without regular updates, measurement results can become inaccurate, increasing the risk of disputes.
c) Lack of Standardized Measurement Procedures: Variations in operational systems and standards across supply chain participants worsened data inconsistencies. Although necessary, achieving standardization demands significant investment in new equipment, training, and regulatory harmonization.
d) Outdated Cargo Handling Facilities: Aging infrastructure incompatible with modern technologies slowed down loading and unloading operations, heightened the risk of cargo loss, and extended operational times.

Thus, a comprehensive approach is necessary to mitigate cargo loss risks, including improving infrastructure and facilities, using standardized and calibrated measuring tools, ensuring sufficient spare parts availability, and modernizing supporting cargo handling systems.

CONCLUSION

Based on the discussion, it can be concluded that minimizing cargo loss of Naphtha on the SC Majestic LXII requires a comprehensive and systematic approach, focusing on both technical improvements and procedural enhancements. Key measures include the use of more accurate measuring instruments, the implementation of advanced temperature monitoring systems, and the application of more efficient cargo loading and unloading procedures. Additionally, regular crew training, the adoption of improved tank emptying technologies, stronger coordination between ports, as well as routine audits and monitoring, are crucial elements in preventing leakage and shrinkage of cargo.

The main causes of Naphtha cargo loss are attributed to a lack of accuracy in cargo calculation and measurement, the use of non-standard measuring instruments, and insufficient availability of spare parts onboard. These issues are further exacerbated by miscalculations between shore and ship figures, evaporation during transit, outdated cargo handling infrastructure, and leakages in the equipment. Therefore, it is essential to improve the quality of measuring tools, apply proper calibration practices, modernize cargo handling facilities, and ensure the availability of adequate spare parts.

Moreover, to enhance the accuracy of cargo calculations, careful use of calibration tables and ASTM tables, along with repeated liquid level measurements—particularly under unstable sea conditions—is highly necessary. Regular maintenance of measuring devices and cargo handling equipment is also key to ensuring smooth operations and preventing losses due to equipment failure. Through the adoption of more thorough and systematic procedures, it is expected that cargo calculation processes will become more accurate and efficient, significantly reducing the potential for cargo loss.

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