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Analysis of Factors Causing Delays in MCT Sealing Block Handi Block HB40 Material Distribution for Offshore Fabrication Using Fishbone Diagram

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Abstract: *Material distribution delays can disrupt offshore fabrication because production activities depend on the timely availability of specialized materials. This study aims to identify the root causes of delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials using Root Cause Analysis (RCA) through the Fishbone Diagram. A descriptive qualitative case study approach was employed. Data were collected through direct observations of material planning, procurement, shipment, monitoring, and receiving processes, supported by document reviews and relevant literature. The analysis included problem identification, cause classification, Fishbone Diagram development, and interpretation of causal relationships. The results indicate that distribution delays are influenced by five interrelated factors: Man (People), Method, Material, Machine/Facilities, and Environment. The major causes include inadequate coordination, insufficient integration between distribution planning and fabrication schedules, uncertain supplier lead times, limited shipment tracking, and weather and multimodal transportation constraints. The Fishbone Diagram demonstrates that distribution delays result from the interaction of these factors rather than a single dominant cause. The findings provide a systematic framework for improving offshore material distribution by strengthening cross-functional coordination, integrating planning with fabrication schedules, improving supplier lead-time management, and enhancing shipment monitoring systems.*

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INTRODUCTION

Delays in material distribution remain one of the most critical operational problems affecting manufacturing and project-based industries because they directly influence production continuity, resource utilization, and project schedule performance. Materials must be available in the required quantities, specifications, and timeframes to ensure uninterrupted production activities. Any discrepancy between planned and actual material delivery schedules may generate idle time, reduce equipment utilization, delay subsequent work activities, and increase operational costs. These consequences become even more significant in offshore fabrication projects, where procurement, warehousing, transportation, production, inspection, and installation activities operate within a highly integrated and interdependent supply chain. Disruptions occurring at any stage of material distribution may propagate throughout the fabrication sequence and ultimately affect project completion. Sjögren et al. (2014) explained that offshore manufacturing and installation activities are characterized by high technical and operational complexity, while Liu et al. (2016) identified off-site fabrication and multimodal transportation as essential components of modular construction systems. These findings indicate that material distribution should be regarded not merely as a logistics function but as a critical

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determinant of offshore project performance. In this study, the material under investigation is the MCT Sealing Block Type Handi Block HB40, which directly supports offshore fabrication activities. Therefore, understanding the factors causing delays in its distribution is essential for improving operational reliability and project execution.

Project delays may originate from numerous operational activities, including procurement, planning, production, and material distribution. Abrinaldi and Nurcahyo (2022) analyzed factors contributing to delays in railway infrastructure construction projects, whereas Pratama and Islami (2023) investigated delays in railway manufacturing using the Fishbone Diagram. Similarly, Putra et al. (2016) evaluated delay factors in jacket structure projects, Muhadi and Yudoko (2021) performed root cause analysis for delays in the BGC–TEG project, and Rahim et al. (2024) identified the root causes of project delays using a case study approach. These studies consistently demonstrate that project delays arise from multiple interrelated causes, including inadequate planning, ineffective execution, resource limitations, material shortages, insufficient coordination, and changing operational conditions. However, most previous studies were conducted within construction, manufacturing, or general project management environments. Limited attention has been devoted to offshore fabrication projects, where material distribution is influenced by unique logistical constraints, restricted site accessibility, complex operational coordination, and highly interdependent production activities. Consequently, findings obtained from previous industrial contexts cannot be directly generalized to offshore material distribution, indicating the need for a context-specific investigation.

Material management plays a fundamental role in controlling project schedules and ensuring production continuity. Kar and Jha (2021) investigated construction material lead times and emphasized that lead-time management should be integrated into project planning because delays in material arrival directly restrict project execution. Khursheed et al. (2024) examined project delays and cost overruns associated with material-related issues. Harlan (2023) utilized the Cause-and-Effect Diagram to improve procurement delays, while Prakoso and Rinawati (2019) employed Failure Mode and Effects Analysis (FMEA) to identify the causes of procurement delays. Furthermore, Wulandari and Murdapa (2025) applied the Precedence Diagram Method (PDM) and Root Cause Analysis (RCA) to improve spare-part procurement projects. Collectively, these studies demonstrate that procurement planning, material lead time, information availability, schedule synchronization, and interdepartmental coordination collectively determine distribution performance. Nevertheless, previous research has primarily focused on procurement or scheduling activities rather than examining how these interconnected processes influence material distribution within offshore fabrication environments.

Material distribution is also closely associated with an organization's capability to minimize operational waste while maintaining uninterrupted material flow. Siregar and Ayu (2019) implemented Lean Distribution to reduce delays in dairy product deliveries, whereas Vikaliana and Arizqi (2023) investigated delays in finished-product distribution within manufacturing companies. Al Gusta et al. (2026) analyzed waste in industrial hose distribution processes, and Cahyani et al. (2024) examined logistics optimization to improve operational efficiency. Nasution et al. (2021) evaluated factors contributing to delays in ready-mix concrete distribution, while Tirtaningrum and Ernawati (2023) applied the Six Sigma approach to shipment delays. These studies indicate that material distribution should be considered an integrated sequence of planning, preparation, inspection, handling, transportation, and receiving activities. Disruptions occurring at any stage may generate waiting time,

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repeated handling, unnecessary movement, and schedule deviations. However, these studies were predominantly conducted in conventional manufacturing and construction sectors. The operational characteristics of offshore fabrication, particularly for specialized materials such as MCT Sealing Block Type Handi Block HB40, remain insufficiently explored. Therefore, a dedicated investigation is required to understand how operational bottlenecks emerge within this specialized distribution process.

Various analytical approaches have been developed to identify the causes of operational and project-related problems. Al Ghaithi et al. (2017) employed the Ishikawa Diagram to investigate Engineering, Procurement, and Construction (EPC) project delays, whereas Pratama and Islami (2023) utilized the Fishbone Diagram in railway manufacturing projects. Kvitschal (2022) discussed practical analytical tools for identifying operational problems, while Hariastuti et al. (2025) applied the DMAIC framework to analyze cement distribution delays. Akbar (2024) implemented Lean Six Sigma to minimize shipment delays in the cement industry. Although these approaches differ in methodology, they share the common objective of systematically identifying the root causes of operational problems. Compared with other techniques, the Fishbone Diagram provides a simple yet comprehensive framework for classifying potential causes into logical categories while illustrating the relationships between the primary problem and its contributing factors. Although it does not quantitatively prioritize causal factors, the Fishbone Diagram is highly suitable for exploratory investigations that seek to systematically identify the underlying causes of operational problems. Unlike previous studies that generally investigated project delays within broader industrial contexts, this research specifically applies the Fishbone Diagram to analyze delays in the distribution of MCT Sealing Block Type Handi Block HB40 within offshore fabrication, thereby addressing a specialized operational context that has received limited attention in previous studies.

Beyond technical processes, project performance is also influenced by coordination quality and information management. Erwindo and Sukarma (2025) highlighted the importance of Concurrent Engineering and Business Process Reengineering in offshore drilling projects, emphasizing integrated planning and cross-functional decision-making. Hermawanto and Ratnamurni (2024) discussed Customer Relationship Management (CRM) as an important mechanism for improving organizational information management, while Sari et al. (2024) demonstrated that administrative completeness and interdepartmental coordination significantly affect logistics performance within shipping operations. These findings indicate that accurate information regarding demand, schedules, shipment status, material availability, and document readiness is essential for maintaining effective material distribution. In offshore fabrication projects, inconsistencies in information exchange among departments may delay material preparation, disrupt delivery priorities, and reduce production efficiency. Consequently, analyzing distribution delays requires consideration of both physical logistics activities and organizational coordination processes. The Fishbone Diagram provides an appropriate analytical framework for integrating these technical and managerial dimensions into a comprehensive root cause analysis.

Although previous studies have investigated delays in procurement, production, transportation, distribution, and project execution, research specifically addressing the distribution of MCT Sealing Block Type Handi Block HB40 within offshore fabrication remains limited. Existing studies have predominantly focused on construction projects, railway systems, cement industries, ready-mix concrete, dairy products, industrial hose distribution, shipping agencies, and jacket fabrication, whose

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operational characteristics differ substantially from those of offshore fabrication. This limitation constitutes the primary research gap addressed in the present study. Accordingly, the novelty of this research lies in applying the Fishbone Diagram to investigate the root causes of delays in distributing a specialized offshore fabrication material while considering the interaction among human, method, material, facility, environmental, and coordination factors within an integrated offshore operational system. Therefore, this study aims to identify and analyze the factors causing delays in the distribution of MCT Sealing Block Type Handi Block HB40 during offshore fabrication and to systematically describe their cause-and-effect relationships based on actual operational conditions. Practically, the findings are expected to support companies in determining priority areas for improving material distribution performance and reducing operational delays. Academically, this study contributes to extending the application of the Fishbone Diagram within the specialized context of offshore fabrication material distribution, thereby enriching the literature on material management and operational improvement in offshore projects.

RESEARCH METHOD

Research Design

This study employed a descriptive qualitative approach using a single-case study design. The qualitative case study was selected because the research aimed to identify, classify, and explain the factors causing delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials during offshore fabrication activities. Rather than examining statistical relationships among variables, the study focused on understanding the operational conditions underlying material distribution delays through empirical evidence obtained from the research setting. This approach enables an in-depth exploration of complex operational problems within their real-life context and facilitates the identification of interrelated causal factors affecting the material distribution process.

The primary analytical method adopted in this research was Root Cause Analysis (RCA) using the Fishbone Diagram (Ishikawa Diagram). This method was selected because it systematically identifies and classifies multiple contributing factors associated with a specific operational problem into logical categories. Previous studies have demonstrated the effectiveness of the Fishbone Diagram in investigating operational and project delays, including Engineering, Procurement, and Construction (EPC) projects (Al Ghaithi et al., 2017) and railway manufacturing projects (Pratama & Islami, 2023). In the present study, the Fishbone Diagram was employed as a qualitative analytical framework to identify and classify the root causes of material distribution delays without altering the characteristics of the observed operational process. Since the objective of this research was to explore the causes of delays rather than prioritize their relative importance, quantitative prioritization methods such as Failure Mode and Effects Analysis (FMEA) or Pareto Analysis were not incorporated into the analytical framework.

Research Location and Period

The research was conducted during offshore fabrication activities at [Company Name], located in [Research Location]. The research location was purposively selected because it represents the operational environment where the distribution process of MCT Sealing Block Type Handi Block HB40 materials is performed and where material distribution delays had been identified during project execution.

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The study was carried out from [Month–Month, Year]. The research activities consisted of preliminary observations, preparation of research instruments, field observations, document collection, literature review, validation of collected data, development of the Fishbone Diagram, interpretation of analytical findings, and formulation of improvement recommendations.

Research Object and Unit of Analysis

The object of this study was the distribution process of MCT Sealing Block Type Handi Block HB40 materials used in offshore fabrication projects. The unit of analysis comprised the entire material distribution process, beginning with material requirement planning, warehouse preparation, delivery scheduling, transportation activities, material dispatch, and ending with material receipt at the fabrication area. The analysis focused on operational conditions that generated discrepancies between planned distribution schedules and actual material availability.

This research employed a single-case study design; therefore, statistical population and sampling procedures were not applied. The investigated case was purposively selected because the observed material distribution delays directly affected fabrication continuity and project schedule performance. Consequently, the selected case was considered appropriate for investigating the operational factors contributing to material distribution delays in offshore fabrication.

Data Sources

The study utilized both primary and secondary data.

Primary data were obtained through direct observations of the material distribution process and field investigations of operational activities associated with material distribution delays.

Secondary data consisted of company operational documents, including material requirement schedules, material request forms, warehouse records, delivery schedules, material receiving reports, distribution logs, and other documents related to material management. Relevant scientific literature concerning project delays, procurement management, logistics distribution, offshore fabrication, material lead time, and Fishbone Diagram applications was also reviewed to support the interpretation of analytical findings.

Data Collection Techniques

Observation

Direct observations were conducted throughout the material distribution process to understand operational workflows, identify process deviations, and record activities associated with distribution delays. During observations, the researcher documented discrepancies between planned and actual delivery schedules, material readiness, coordination activities among departments, transportation conditions, and operational interruptions affecting distribution performance.

Document Review

Supporting operational documents were reviewed to verify field observations and provide objective evidence regarding material distribution performance. The reviewed documents included material planning schedules, delivery schedules, warehouse records, material request forms, material receiving reports, and distribution records generated during offshore fabrication activities.

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Literature Review

A literature review was conducted to establish the theoretical foundation of the study and support the interpretation of the identified causal factors. The reviewed literature covered topics related to project delays, material procurement, logistics management, offshore fabrication, material lead time, Root Cause Analysis, and Fishbone Diagram applications.

Research Participants and Stakeholders

The research involved stakeholders directly associated with the material distribution process. These included personnel responsible for warehouse operations, material control, procurement, logistics, production planning, and project supervision. Their operational responsibilities provided valuable information regarding distribution procedures, coordination mechanisms, and operational constraints encountered during material delivery.

The involvement of multiple functional units enabled cross-validation of field observations and facilitated a comprehensive understanding of the operational factors contributing to material distribution delays.

Research Instruments

Two research instruments were employed during data collection.

The first instrument was an observation checklist used to systematically document each stage of the material distribution process, operational deviations, coordination activities, and delay events observed during field investigations.

The second instrument was a cause identification matrix developed to organize and classify all identified causal factors according to the five categories of the Fishbone Diagram. This matrix facilitated systematic grouping of empirical findings before constructing the final Fishbone Diagram.

Data Validation

The credibility of the research findings was established through source triangulation, method triangulation, and member validation.

Source triangulation was conducted by comparing information obtained from field observations, operational documents, and relevant scientific literature.

Method triangulation involved comparing evidence generated from direct observations with documentary records to ensure consistency among different sources of information.

Furthermore, the identified causal factors and their classifications were reviewed with operational personnel familiar with the material distribution process to confirm that the Fishbone Diagram accurately represented actual field conditions. These validation procedures were intended to minimize researcher subjectivity and enhance the credibility, dependability, and confirmability of the research findings.

Research Procedure

The research procedure consisted of seven sequential stages:

1. Identification of the research problem related to material distribution delays.
2. Preliminary observation of the material distribution process.
3. Collection of primary and secondary data.

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4. Verification and validation of empirical findings.
5. Identification and classification of causal factors.
6. Development of the Fishbone Diagram.
7. Interpretation of analytical findings and preparation of improvement recommendations.

The overall research procedure is illustrated in Figure 1, which presents the sequence of activities from problem identification to the formulation of recommendations. This systematic procedure ensures that each identified causal factor can be traced back to empirical evidence collected during the research process.

Data Analysis Technique

The data analysis consisted of four sequential stages.

The first stage involved identifying the primary problem, namely delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials during offshore fabrication.

The second stage involved data reduction by retaining only information directly related to the material distribution process while excluding information irrelevant to the research objectives.

The third stage consisted of systematically classifying the identified causes into the five categories of the Fishbone Diagram: Man (People), Method, Material, Machine/Facilities, and Environment. The Man category included factors associated with coordination, communication, competency, and work execution. The Method category comprised planning, operational procedures, and distribution management practices. The Material category addressed material availability, procurement lead time, and material readiness. The Machine/Facilities category included transportation facilities, warehouse equipment, and supporting information systems. The Environment category represented external operational conditions affecting the distribution process.

The final stage involved constructing the Fishbone Diagram and interpreting the logical relationships among the identified causes. Each causal factor was evaluated based on its consistency with field observations, documentary evidence, and relevant literature. In accordance with the research objectives, the Fishbone Diagram was employed exclusively as a qualitative mapping tool for identifying and classifying root causes rather than as a quantitative prioritization method. Future studies may complement this analysis by incorporating techniques such as Failure Mode and Effects Analysis (FMEA) or Pareto Analysis to prioritize improvement initiatives.

Analytical Validity

The validity of the analytical results was maintained through continuous verification of the relationships among the identified problem, empirical findings, and the causal categories represented in the Fishbone Diagram. Each identified cause was carefully reviewed to prevent overlapping classifications and ensure logical consistency among all causal categories.

Furthermore, every stage of the analytical process was systematically documented using the observation checklist, cause identification matrix, and supporting operational documents, enabling complete traceability of analytical decisions and research findings. This analytical procedure follows the principles of systematic, transparent, and traceable root cause analysis described by Kvitschal (2022), thereby strengthening the credibility and reliability of the study.

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RESULTS AND DISCUSSION

Empirical Findings

The empirical findings were derived from direct field observations conducted throughout the distribution process of MCT Sealing Block Type Handi Block HB40 materials during offshore fabrication activities. The observations covered the complete material distribution workflow, including material requirement planning, procurement coordination, warehouse preparation, shipment scheduling, transportation, shipment monitoring, and material receipt at the fabrication site. Rather than identifying a single operational failure, the observations revealed that distribution delays resulted from a series of interconnected disruptions occurring across multiple stages of the logistics process.

The qualitative analysis identified five principal categories of factors contributing to material distribution delays, namely Man (People), Method, Material, Machine/Facilities, and Environment. These categories were established through Root Cause Analysis (RCA) using the Fishbone Diagram, which enabled the systematic classification of operational issues observed during field investigations. Since the study adopted a qualitative case study approach, the objective of the analysis was to explain the causal relationships underlying the observed delays rather than to quantify the magnitude or statistical significance of each factor. Consequently, no frequency analysis, weighting procedure, or ranking technique was applied to determine the dominant cause of distribution delays.

The empirical observations indicate that material distribution delays should be interpreted as systemic operational problems rather than isolated transportation issues. Several disruptions originated before shipment activities commenced, particularly during planning, coordination, and material preparation. Changes in supplier lead time, material readiness, or fabrication priorities were not consistently communicated among procurement, warehouse, logistics, transportation providers, and fabrication personnel. As a result, distribution schedules were frequently implemented based on outdated operational information, reducing the organization's ability to synchronize material availability with fabrication requirements.

The observations further demonstrate that the identified causal factors are highly interrelated. Weak coordination among stakeholders affected planning accuracy, while inadequate planning influenced material readiness and shipment scheduling. Limited shipment monitoring reduced the visibility of transportation progress, making it difficult to identify schedule deviations before they affected fabrication activities. External conditions, including weather variability and multimodal transportation, further increased operational uncertainty throughout the distribution process. These interactions suggest that delays cannot be attributed to a single organizational function but rather emerge from the cumulative effect of interconnected operational processes.

Table 1 summarizes the qualitative empirical findings obtained during field observations. The table illustrates how each identified category contributed to specific process disruptions and operational consequences affecting the continuity of offshore material distribution.

Table 1. Qualitative Empirical Findings on the Causes of Material Distribution Delays

Category	Observation Findings	Indication of Process Disruption	Direct Impact on Distribution
Man (People)	Interdepartmental coordination is not consistently maintained.	Information regarding material requirements, readiness, and shipment status is not communicated simultaneously among relevant parties.	Delays in decisions related to material preparation and receiving.

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Man (People)	Communication regarding shipment status changes is delayed.	Schedule changes are not immediately addressed by responsible personnel.	Fabrication schedules cannot be adjusted promptly.
Method	Distribution planning is not fully integrated with fabrication requirements.	Delivery schedules are prepared without adequate synchronization with the fabrication sequence.	Materials are unavailable when required during production activities.
Method	Distribution control and monitoring are not systematically implemented.	Schedule deviations are identified only after shipment has commenced.	Corrective actions are initiated too late.
Material	Supplier lead times cannot always be accurately predicted.	Material availability differs from the original schedule.	Delivery schedules are shifted from the planned timeline.
Material	Handi Block HB40 materials are unavailable according to production requirements.	Materials are unavailable when shipment preparation begins.	Waiting time occurs before distribution can proceed.
Machine/Facilities	Shipment tracking capabilities remain limited.	Shipment location and progress cannot be adequately monitored.	Distribution delays are difficult to detect at an early stage.
Machine/Facilities	Shipment status information is not integrated.	Distribution data are dispersed across multiple communication channels or responsible parties.	Distribution process visibility is reduced.
Environment	Weather conditions affect transportation activities.	Transit time and material handling may vary depending on weather conditions.	Planned arrival schedules become difficult to maintain.
Environment	Distribution involves multimodal transportation.	Transfers between transportation modes introduce additional coordination points and waiting time.	Variability in delivery time increases.

Source: Research observations and qualitative data classification.

Interpretation of Empirical Findings

The empirical findings presented in Table 1 indicate that delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials are not generated by a single operational deficiency but by the interaction of organizational, procedural, logistical, and environmental factors throughout the distribution process. Each category contributes differently to operational performance while simultaneously influencing the effectiveness of other distribution activities. This finding highlights the systemic nature of offshore material distribution, where disruptions occurring in one operational stage frequently propagate to subsequent stages.

The Man (People) category primarily affects communication and coordination among procurement, warehouse, logistics, transportation providers, and fabrication teams. Inadequate information sharing delays operational decision-making, particularly when changes in material readiness or shipment schedules are not

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communicated simultaneously across departments. Consequently, fabrication teams experience difficulties in adjusting production schedules to accommodate changing material availability.

The Method category reflects weaknesses in planning integration and operational control. Distribution schedules were prepared independently from fabrication progress, reducing synchronization between material delivery and production requirements. Furthermore, schedule deviations were generally identified only after shipment activities had commenced, limiting opportunities for preventive corrective actions.

Within the Material category, supplier lead-time uncertainty and inconsistencies in material readiness directly affected shipment preparation. Delays occurring during procurement propagated throughout the distribution chain because transportation schedules depended on the availability of Handi Block HB40 materials. These findings demonstrate that procurement performance cannot be separated from logistics planning in offshore fabrication projects.

The Machine/Facilities category highlights limitations in shipment monitoring and information integration. The absence of comprehensive tracking capabilities reduced shipment visibility and delayed the identification of transportation problems. Consequently, logistics personnel frequently adopted reactive responses rather than preventive operational control.

Finally, the Environment category illustrates the influence of external operational conditions, particularly weather variability and multimodal transportation. Although these factors cannot be directly controlled, their impacts become more significant when organizational coordination, planning, and information systems are insufficiently integrated.

Overall, the empirical findings demonstrate that improving material distribution performance requires a comprehensive systems approach rather than isolated improvements within individual operational functions. These observations provide the analytical foundation for the subsequent Fishbone Analysis, which systematically examines the causal relationships among the five identified categories and explains how their interactions contribute to delays in offshore material distribution.

Fishbone Analysis

To systematically identify the underlying causes of delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials, the empirical findings were analyzed using the Fishbone Diagram (Ishikawa Diagram). This Root Cause Analysis (RCA) tool classifies operational problems into several interrelated categories, enabling a comprehensive understanding of how multiple organizational and operational factors collectively contribute to distribution delays. Based on field observations, five principal categories were identified: Man (People), Method, Material, Machine/Facilities, and Environment.

Unlike quantitative prioritization techniques, the Fishbone Diagram does not determine the statistical significance of individual factors. Instead, it provides a structured framework for visualizing the causal relationships among operational issues observed throughout the material distribution process. The following sections discuss each category in detail.

Man (People)

The Man (People) category highlights the importance of effective communication and coordination among all stakeholders involved in offshore material distribution. Field observations revealed that procurement personnel, warehouse operators, logistics coordinators, transportation providers, and fabrication supervisors did not consistently exchange operational information in a timely manner. Information regarding material readiness, shipment schedules, and delivery status was frequently communicated sequentially rather than simultaneously, delaying operational decision-making.

This condition reduced the ability of fabrication teams to adjust production schedules whenever changes occurred in procurement or transportation activities. Consequently, waiting time increased because fabrication activities depended directly on the availability of MCT Sealing Block Type Handi Block HB40 materials.

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These findings support the observations of Harlan (2023), who identified procurement coordination as one of the principal determinants of project material availability. Likewise, Prakoso and Rinawati (2019) reported that ineffective communication among organizational units contributes significantly to project delays. The present study extends these findings by demonstrating that communication challenges become more critical in offshore fabrication projects due to the involvement of multiple organizations operating across geographically separated locations.

From an operational perspective, strengthening integrated communication mechanisms would improve synchronization between procurement, logistics, warehousing, transportation, and fabrication activities, thereby reducing unnecessary waiting time and enhancing material distribution reliability.

Method

The Method category represents deficiencies in planning procedures and operational control throughout the distribution process. Field observations indicate that distribution schedules were not consistently synchronized with fabrication requirements. Material deliveries were frequently planned according to predetermined schedules without incorporating changes in supplier lead times or fabrication priorities.

Furthermore, shipment monitoring remained largely reactive. Schedule deviations were generally identified only after transportation had commenced or when materials failed to arrive according to plan. Consequently, corrective actions were implemented after operational disruptions had already affected fabrication activities.

These findings are consistent with Abrinaldi and Nurcahyo (2022), who identified planning integration as a key determinant of project performance. Similarly, Muhadi and Yudoko (2021) emphasized that Root Cause Analysis should investigate weaknesses in organizational procedures rather than focusing solely on operational symptoms.

The present study demonstrates that distribution planning in offshore fabrication should operate as a dynamic process capable of continuously adapting to operational changes. Integrating procurement information, fabrication schedules, and logistics planning would improve schedule reliability and reduce the likelihood of downstream operational disruptions.

Material

The Material category represents operational conditions related to supplier performance, material availability, and procurement readiness. Field observations showed that supplier lead times were occasionally inconsistent with planned procurement schedules, causing Handi Block HB40 materials to be unavailable when shipment preparation was scheduled. Consequently, logistics personnel were required to postpone deliveries, resulting in delays throughout the fabrication process.

The findings indicate that supplier lead time should not be regarded merely as procurement information but rather as an operational parameter that directly influences logistics planning. Delays occurring during procurement propagated throughout warehouse preparation, transportation scheduling, and fabrication execution because distribution activities depended entirely on material readiness.

These observations are consistent with Kar and Jha (2021), who explained that supplier lead time significantly influences project performance through its effect on downstream operational activities. Likewise, Khursheed et al. (2024) identified material availability as one of the major contributors to project schedule overruns. However, the present study extends previous findings by demonstrating that supplier uncertainty becomes particularly critical in offshore fabrication because specialized materials cannot easily be substituted or rescheduled.

The findings suggest that supplier performance monitoring should be integrated into distribution planning to enable proactive adjustments before shipment activities begin, thereby improving operational continuity.

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Machine/Facilities

The Machine/Facilities category refers to the infrastructure supporting shipment monitoring and logistics information management rather than production equipment. Field observations revealed that existing shipment tracking capabilities provided limited visibility regarding shipment location, transportation progress, and estimated arrival times. Distribution information remained fragmented across different organizational units, reducing the effectiveness of logistics coordination.

As a result, schedule deviations frequently became apparent only after materials failed to arrive according to the planned timeline. This reactive monitoring approach limited the organization's ability to implement preventive corrective actions before fabrication activities were affected.

These findings support Liu et al. (2016), who emphasized that construction projects involving off-site fabrication require integrated logistics information systems. Similarly, Cahyani et al. (2024) highlighted the importance of information visibility in improving logistics efficiency and operational responsiveness.

Compared with previous studies, this research demonstrates that shipment monitoring plays an even more strategic role in offshore fabrication because material distribution involves multiple transportation modes and geographically dispersed operational locations. Therefore, logistics information systems should function not merely as shipment tracking tools but also as decision-support systems capable of facilitating coordination among procurement, logistics, warehouse, and fabrication departments.

Environment

The Environment category encompasses external operational conditions affecting transportation performance, particularly weather variability and multimodal transportation complexity. Although these factors are beyond direct organizational control, their operational consequences depend largely on the effectiveness of planning and coordination implemented by the organization.

Field observations indicate that adverse weather conditions influence transportation schedules, cargo handling activities, and overall transit duration. Furthermore, multimodal transportation introduces multiple transfer points requiring coordination among transportation providers, port facilities, warehouse operators, and fabrication personnel. Each transfer stage increases operational uncertainty and creates additional opportunities for schedule deviations.

These findings support Sjögren et al. (2014), who emphasized that offshore construction projects operate under considerable environmental uncertainty. Likewise, Putra et al. (2016) demonstrated that external logistical constraints significantly influence offshore project performance. Sari et al. (2024) further reported that administrative coordination and transportation management strongly affect logistics reliability within maritime operations.

The present study indicates that environmental uncertainty should not be viewed solely as an unavoidable external risk. Instead, its impact can be mitigated through proactive transportation planning, continuous shipment monitoring, and effective coordination among all stakeholders participating in offshore logistics activities.

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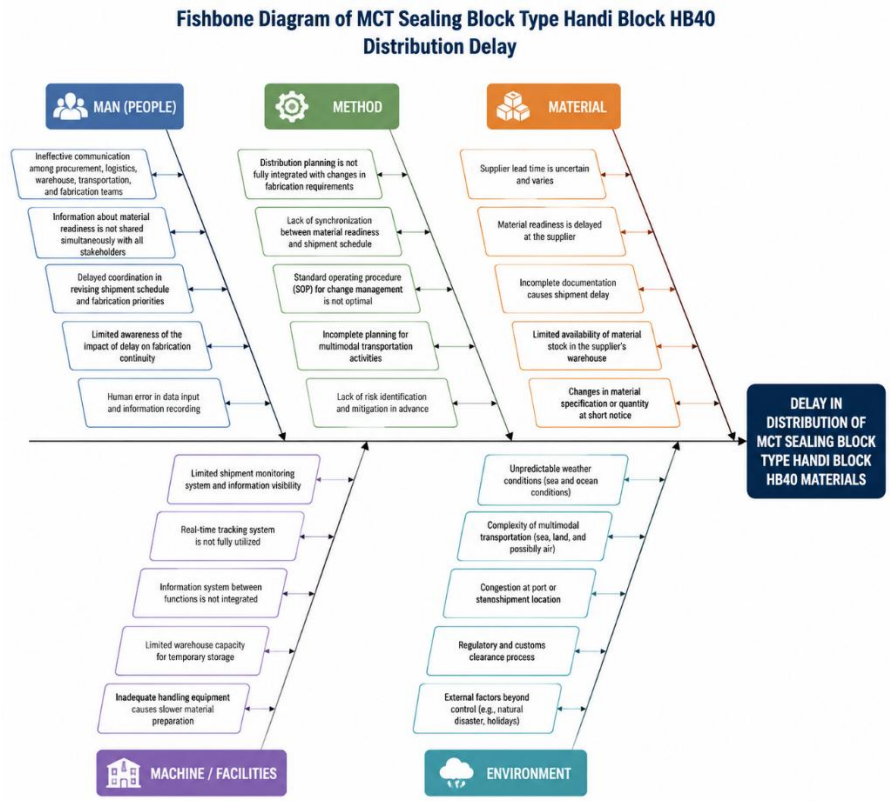

Figure 1. Fishbone Diagram of MCT Sealing Block Type Handi Block HB40 Distribution Delay
Source: Developed from field observations and Root Cause Analysis using the Fishbone Diagram.

Interpretation of the Fishbone Diagram

The Fishbone Diagram demonstrates that delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials are generated by the interaction of multiple organizational and operational factors rather than by a single dominant cause. The five identified categories collectively influence the effectiveness of material planning, procurement, transportation, shipment monitoring, and fabrication scheduling.

The analysis indicates that Man and Method categories primarily affect planning quality through communication effectiveness and operational coordination. Weak coordination subsequently influences procurement activities and shipment scheduling, creating inconsistencies between material availability and fabrication requirements. Material factors determine whether logistics activities can commence according to schedule, while Machine/Facilities influence the organization's ability to detect operational deviations during transportation. Finally, Environment amplifies uncertainty through weather conditions and multimodal logistics complexity.

Overall, the Fishbone Diagram reveals that distribution delays should be interpreted as systemic operational failures arising from interactions among planning, communication, logistics execution, and external environmental conditions. Accordingly, improving only one operational component would not substantially enhance distribution performance unless accompanied by integrated improvements across the entire material management system.

The application of the Fishbone Diagram is consistent with previous studies by Al Ghaithi et al. (2017) and Pratama and Islami (2023), who demonstrated its effectiveness in identifying the root causes of operational delays. However, this study contributes additional knowledge by showing that, within offshore fabrication projects, Root Cause Analysis provides a comprehensive framework for understanding the complex interactions among procurement, warehousing, logistics, transportation, and fabrication activities. These findings establish

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the foundation for the subsequent discussion, which examines the theoretical implications and practical contributions of the identified causal relationships to offshore material distribution management.

Discussion

Comparison with Previous Studies

The present study demonstrates that delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials are generated through the interaction of multiple operational factors rather than by a single isolated cause. The empirical findings indicate that communication effectiveness, planning integration, material readiness, logistics monitoring, and environmental uncertainty collectively influence the continuity of offshore material distribution. This systems-oriented perspective is consistent with previous studies emphasizing that project delays generally originate from the interaction of organizational and operational processes instead of individual technical failures.

The findings concerning the Man (People) category support the work of Harlan (2023) and Prakoso and Rinawati (2019), who identified ineffective coordination between procurement and project implementation teams as a major contributor to material-related delays. However, the present study extends these findings by demonstrating that coordination challenges in offshore fabrication involve a broader network of stakeholders, including procurement, logistics, warehousing, transportation providers, suppliers, and fabrication teams. Consequently, communication effectiveness becomes increasingly important because operational decisions made by one organizational unit immediately affect subsequent distribution activities.

Similarly, the results concerning the Method category are consistent with Abrinaldi and Nurcahyo (2022), who reported that inadequate planning integration contributes significantly to project delays. The present findings further demonstrate that distribution planning should not function as an independent administrative activity but rather as an integrated component of fabrication planning. Distribution schedules require continuous adjustment according to changes in procurement status, supplier lead time, and fabrication priorities to maintain operational continuity.

Regarding the Material category, the findings confirm previous research by Kar and Jha (2021) and Khursheed et al. (2024), who emphasized the influence of supplier lead time on project performance. Nevertheless, this study demonstrates that supplier uncertainty becomes particularly critical within offshore fabrication because specialized materials such as Handi Block HB40 cannot easily be substituted or delivered through alternative supply channels. Consequently, procurement performance directly determines logistics performance and fabrication continuity.

The findings concerning Machine/Facilities are also consistent with Liu et al. (2016) and Cahyani et al. (2024), who highlighted the importance of integrated logistics information systems in supporting construction projects involving off-site fabrication. However, the present study provides additional evidence that shipment visibility becomes more strategic within offshore projects because material transportation involves geographically separated operational locations and multiple transportation modes. Therefore, information integration serves not only administrative purposes but also supports operational decision-making.

Finally, the influence of Environment corroborates previous observations by Sjögren et al. (2014) and Putra et al. (2016) regarding the effect of environmental uncertainty on offshore projects. Nevertheless, the findings suggest that environmental conditions should not be interpreted solely as uncontrollable external risks. Instead, their operational impact depends substantially on organizational preparedness, including proactive planning, integrated monitoring, and effective coordination among logistics stakeholders.

Overall, the comparison with previous studies demonstrates that the findings of this research are theoretically consistent with existing Root Cause Analysis literature while providing additional empirical evidence regarding the complexity of material distribution management within offshore fabrication projects.

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Offshore Characteristics

One of the principal contributions of this study lies in its focus on the distinctive operational characteristics of offshore fabrication projects. Unlike conventional manufacturing or building construction, offshore fabrication requires continuous synchronization among procurement activities, logistics operations, warehouse management, transportation providers, fabrication teams, and offshore installation schedules. The success of each operational stage depends heavily on the timely completion of preceding activities, making the entire distribution process highly interdependent.

Another distinguishing characteristic involves the extensive use of multimodal transportation. Materials commonly pass through several logistics stages, including supplier facilities, land transportation, port operations, marine transportation, and fabrication yards before reaching the final installation location. Each transition introduces additional handling activities, administrative procedures, and coordination requirements that increase operational complexity and the potential for delays.

Furthermore, offshore fabrication projects operate under strict production sequencing because many components are engineered specifically for designated installation locations. MCT Sealing Block Type Handi Block HB40 represents one such specialized material whose delayed availability may immediately interrupt fabrication activities because suitable substitutes are generally unavailable. Consequently, distribution reliability becomes equally important as production capability in maintaining project continuity.

The empirical findings indicate that these offshore characteristics amplify the consequences of deficiencies in communication, planning, information management, and procurement coordination. Operational problems that may produce relatively minor consequences within conventional logistics systems become substantially more significant within offshore environments because opportunities for corrective intervention are considerably more limited once transportation activities have commenced.

Research Contribution

This study contributes to the literature on offshore logistics and material management in three important ways.

First, the research provides a systematic qualitative framework for identifying the root causes of material distribution delays using the Fishbone Diagram within the context of offshore fabrication. While previous studies have applied Root Cause Analysis to construction and manufacturing projects, relatively few have specifically examined offshore material distribution involving specialized fabrication materials.

Second, the findings demonstrate that distribution delays should be interpreted as systemic operational problems resulting from interactions among organizational coordination, planning procedures, procurement performance, logistics monitoring, and environmental uncertainty. This systems perspective extends previous Root Cause Analysis studies that primarily focused on identifying individual causal factors without examining their interrelationships throughout the logistics process.

Third, the study provides practical evidence that improving offshore material distribution requires integrated process management rather than isolated improvements within individual departments. The findings emphasize that procurement, logistics, warehousing, transportation, and fabrication planning should operate as interconnected components of a single operational system. This integrated perspective offers useful guidance for organizations seeking to improve logistics reliability and production continuity within offshore fabrication environments.

Practical Implications

The findings of this study have several practical implications for organizations involved in offshore fabrication and material distribution.

First, organizations should strengthen cross-functional coordination among procurement, logistics, warehouse operations, transportation providers, and fabrication departments through integrated communication

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mechanisms. Timely dissemination of operational information would improve planning accuracy and reduce delays resulting from inconsistent decision-making.

Second, distribution planning should be dynamically integrated with fabrication schedules. Rather than relying on predetermined delivery schedules, logistics planning should continuously incorporate changes in supplier lead time, material availability, and production priorities to ensure synchronization between material flow and fabrication requirements.

Third, organizations should improve shipment visibility by implementing integrated logistics information systems capable of providing real-time tracking and centralized monitoring of material movement. Such systems would facilitate earlier detection of schedule deviations and enable preventive corrective actions before operational disruptions affect fabrication activities.

Finally, organizations should incorporate environmental risk considerations into routine logistics planning. Weather forecasts, transportation availability, and multimodal coordination should be evaluated continuously to improve schedule reliability and minimize operational uncertainty throughout offshore material distribution.

Collectively, these recommendations support the development of a more integrated and resilient material distribution system capable of maintaining production continuity within offshore fabrication projects.

Research Limitations

Several limitations should be considered when interpreting the findings of this study.

First, the research employed a qualitative single-case study design focusing exclusively on the distribution of MCT Sealing Block Type Handi Block HB40 materials within one offshore fabrication project. Consequently, the findings should be interpreted within the specific operational context investigated and may not be directly generalizable to other industries or project environments.

Second, the study utilized the Fishbone Diagram as a qualitative Root Cause Analysis tool. Accordingly, the analysis was intended to identify and classify causal relationships rather than quantify the relative importance of individual factors. No statistical analysis, weighting procedure, or risk prioritization technique was applied to determine the dominant contributor to distribution delays.

Third, the empirical evidence was derived primarily from field observations, supporting operational documents, and literature review. Although source triangulation and method triangulation were implemented to enhance research credibility, additional evidence obtained through interviews, quantitative operational data, or longitudinal observations could provide a more comprehensive understanding of the identified causal relationships.

Future research is therefore encouraged to integrate qualitative Root Cause Analysis with quantitative decision-support methods, such as Failure Mode and Effects Analysis (FMEA), the Analytic Hierarchy Process (AHP), or Bayesian Network Analysis, to prioritize critical causal factors and evaluate the effectiveness of alternative improvement strategies. Such approaches would complement the qualitative framework developed in this study and contribute to more comprehensive decision-making for offshore material distribution management.

CONCLUSION

This study investigated the factors contributing to delays in the distribution of MCT Sealing Block Type Handi Block HB40 materials during offshore fabrication using Root Cause Analysis (RCA) through the Fishbone Diagram. The findings indicate that material distribution delays are not caused by a single operational deficiency but result from the interaction of five interrelated categories of factors: Man (People), Method, Material, Machine/Facilities, and Environment. Weak interdepartmental coordination, insufficient integration between distribution planning and fabrication schedules, uncertainty in supplier lead times, limited shipment monitoring capabilities, and external

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environmental conditions collectively influence the continuity and reliability of the material distribution process.

The application of the Fishbone Diagram proved effective in systematically identifying and organizing the root causes of distribution delays, providing a comprehensive understanding of how organizational, procedural, logistical, and environmental factors interact throughout the distribution workflow. From a theoretical perspective, this study extends the application of Root Cause Analysis to specialized material distribution within offshore fabrication, emphasizing the importance of a systems approach to logistics management. From a practical perspective, the findings suggest that organizations should strengthen cross-functional coordination, improve synchronization between distribution planning and fabrication activities, enhance supplier lead-time management, implement integrated shipment monitoring systems, and proactively manage environmental risks to improve distribution reliability. Although this study is limited by its qualitative single-case design, it provides a valuable foundation for future research integrating qualitative Root Cause Analysis with quantitative methods, such as Failure Mode and Effects Analysis (FMEA), to prioritize critical causal factors and evaluate the effectiveness of improvement strategies in offshore fabrication projects.

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