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A Ship Maintenance Risk Management Framework

Ali Alshehhi
Faculty of Management and Economics Universiti Pendidikan
Sultan Idris Kuala Lampur, Malaysia

***Abstract* – The UAE's ship maintenance industry is essential to support economic growth through uninterrupted logistics. Ship maintenance ensures that the vessels are always in good condition to avoid delays that might arise due to accidents or breakdowns. Despite the significance, the industry faces a challenge due to the risks involved in maintenance projects leading to delays, high costs and reduced vessel life due to poor quality work. Risks in ship maintenance have persisted with growing models and frameworks to support prevention and mitigation. The current ship maintenance frameworks in the UAE are inadequate. There is a lack of knowledge on the nature of risks and their impact on management within the UAE ship maintenance companies. UAE ship maintenance project managers and teams also lack adequate frameworks they can use to design risk management practices. This proposal suggests developing an alternative and robust risk management framework for ship maintenance projects in the UAE. The exploratory study used the Ship Building company team that maintenance ships to explore current strategies and gaps in managing risks by interviewing 20 members. A thematic analysis led to the development of themes leading to a risk management framework. The results of this study identified various types of risks that occur in ship building companies including materials-related, operational, project management, and resource risks. These risks occur due to many reasons, including machinery breakdowns during operations, limited capital, technology issues, strategic management errors, natural disasters, accidents unsafe or negligence by the workforce, improper housekeeping, and lousy planning or execution of plans, among other causes. The study recommends strategies to address the risks based on the engagement of stakeholders and using risk-based approaches. The risk management framework in this study entails identifying, assessing, analyzing, and finding mitigation measures. Results will inform the body of knowledge through a theory, and risks management framework, explaining the relationship between risk causation factors within ship maintenance companies. The findings will also provide ship-building companies with a better framework for risk management leading to educed risks and improved outcomes such as cost and time estimates.**

***Keywords* – Risk Management, Framework, Ship Maintenance.**

I. INTRODUCTION

Risk management is increasingly attracting companies and managers as an essential measure of delivering projects within schedule, budget, environmental and human safety, and ensuring quality products. In ship maintenance companies and projects, the value of comprehensive risk management is immeasurable (Zagan et al., 2021). Globalization and competition across nations in trade and security have increased the production of vessels, increasing the demand for ship repair and maintenance (Zhimeng et al., 2021). Shipyards are becoming overpopulated with construction and maintenance work. Statistics show a delay of 40% in ship repair and maintenance in Indonesia every year.

The deferment extends to other countries, such as the US, with the inability to meet the deadline for over 64% of naval vessel maintenance work (Eckstein, 2022). Additionally, repair and maintenance work is one of the vital activities in the shipping industry because of the high costs and time. As a result, risk management has become an avoidable and essential part of maintenance work to address the delays and costs within the industry. In the UAE, maintenance firms cannot ignore adequate risk management because the nation's reliance on oil needs transportation and government vision to make the country a global economic hub.

II. LITERATURE REVIEW

1. Concept of Risk in Maintenance Projects

Scholars differ in their definition of risk but agree on some features. Soliman (2018) defined risk as the possibility of problems and complications that affect project completion and goal achievement. Kozień (2020) described risk as a quantifiable uncertainty in all organizational activities and actions. Maletič et al. (2020) explore the International Organization for Standardization (ISO) definition of risk that it has shifted focus from the probability of an event to the possibility of an effect. The author adds that a risk qualifies if the factors can impact resources, processes, and activities within any organization (Maletič et al., 2020).

The three definitions emphasize the effect of risk. The impact of a risk is essential in management because it defines the losses an organization makes, including time and budget. In ship maintenance, the effect of risk informs the progressive nature of other risks. The maintenance team uses the effect to identify possible risks (Rahimian, 2020). Risks in ship maintenance projects result from interactions between many variables. A single risk in the projects is a variable that causes other risks. For example, a delay risk contributes to budget and labor crises. As a result, defining risks through their effects offers a critical starting point within the identification and analysis process to inform an effective management model.

II. TYPES OF RISKS IN MAINTENANCE PROJECTS

Ship maintenance attracts unique risks due to the flexibility of the project and related work and the working conditions. Defining the various types of risks is critical to understanding their management challenges.

Schedule Risk

Schedule risk has received considerable coverage in the literature, implying its significance in ship maintenance projects. Zhimeng et al. (2021) define schedule risk as a threat to completing maintenance work within the stipulated time. The author also argues that schedule risk can be the danger of wasting too much time on maintenance work (Zhimeng et al., 2021). Time wastage attracts attention in ship maintenance work because of the associated costs in the yard and losses in downtime. Zhimeng et al. (2021) observe that schedule risk is one of the two major threats that keep propping naval ship maintenance. Delays in naval ship maintenance are essential because of the vessel's role in the security of a nation. In 2022, the US Navy estimated that only 36% of ship repairs would complete on time (Eckstein, 2022). As a result, the naval context might rate delay risk above others because of its impact. Badrus Zaman et al. (2019) also identified delay as a significant risk in vessel maintenance, and focused on a non-naval context, a case of PT. Adiluhung Sarana Sega shipyard in Indonesia. In Surabaya, deferment of ship repair stood at 25% in 2015. Studies on diverse shipyards show that the danger of delays and time wastage is prevalent in maintenance projects.

Accident Risk

Accident risk is the probability of unwanted and unexpected occurrences that can lead to equipment damage and people injury. Accidents can occur due to worker inexperience, carelessness, and inadequate training on safety. Other ship maintenance yard accidents result from strikes against materials, explosions, fire, and electric shock (Badrus Zaman et al., 2022). According to Zaman et al. (2023), accident risk in ship maintenance is more likely and with high impact than in other industries because of the hazardous nature of the yard. The activities include replating, electric and general work, and propeller inspection in a limited time, space, and hybrid working environment. A shipyard also attracts hazardous work because of the complex activities on the vessel.

Resource Risk

Zhimeng et al. (2021) observe that resource risk in ship repair includes financial scheduling, equipment, and personnel. The risks involve the demand for more resources, including labor, equipment, and finances above the scheduled or budgeted one. A resource risk in ship maintenance is essential because of the impact of delays and changes in plans to accommodate the limited budget (Sears, 2021). In one of the ship maintenance simulations, Zhimeng et al. (2021) found that resource risk and its impact increased with delay risk, as Figure 2.1 shows. The figure shows the magnitude of personnel, equipment, and facility risk on the Y axis and scheduling duration in hours on the X axis. Zhimeng et al. (2021) use the graph to demonstrate that resource risk is a progressive threat from delay. Inappropriate time estimates can make the allocated resource inadequate as the labor and other costs rise.

III. RISK ANALYSIS

Zhimeng et al. (2021) solve the problem of concluding the relationship loop and documenting possible risks through likelihood analysis. The risk analysis stage involves quantifying a risk's impact on the project targets, such as resources and schedule. Zhimeng et al. (2021) propose assigning the magnitude of an effect a number between 0 and 1. The rating shows how the variable factors contribute to the initial and subsequent risks. A maintenance team can conclude possible progressive risks by analyzing the extent to which a given threat will inform the other. The analysis guides where to stop on the analysis list by identifying when the magnitude of the risks reduces below a level that can justify further prediction.

III. METHODOLOGY

The primary paradigms in research are positivism, realism, pragmatism, and interpretivism, according to Saunders Lewis, and Thornhill (2019).

The analysis of different assumptions and philosophies demonstrates that interpretivism was appropriate for the study. Interpretivism recognizes human interests in understanding the world. This philosophy argues that social actors do not differ from the phenomenon and shape knowledge about it (Saunders et al., 2019). People engage in phenomena to develop reality through experience and conscious interaction (Turyahikayo, 2021). As a result, interpretivism holds a subjectivist view of the world. Interpretivism meets subjectivism ontological, epistemological, and axiological assumptions appropriate to the study. The philosophy assumes that reality is internal and multiple because it depends on personal views and engagement with the world. Interpretivism also acknowledges the role of social actors in developing knowledge about reality. As a result, a researcher's contribution is significant in organizing people's diverse opinions about a phenomenon.

A study on risk management in ship maintenance requires an exchange and flexible method because team members create and hold knowledge about the phenomenon. The stakeholders in ship maintenance projects interact with the work and risks. As a result, the stakeholders hold opinions about risk management factors within ship maintenance projects. A qualitative method engage the stakeholders to provide views on their realities about risk management

factors. The method allows the researcher to engage the stakeholders in an interactive forum to create the truth about risk management factors and, later, a framework.

IV. FINDINGS

Thematic analysis of interview data yielded some clustering of themes, and sub-themes as well relating with the study research objectives. These are the themes that bring a repetitive set of patterns, perceptions and difficulties that were experienced during the ship maintenance operations within the context of Ship Building Company. All the themes offer an inclusive picture of the way the risks come up, how they are handled in a realist sense and areas that lack which have to be filled by the development of a more developed risk management system.

Table I: Risk Drivers

Risk Drivers	
Environment	Adverse weather/climate variability, Natural disasters
Upstream Supply Chain and Process	Safety Hazards, pollution/contamination
Organizational structure	Quality of suppliers

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