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Contents

The Effect of Safety Philosophical Factors on Risk Management

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المستخلص:
نظرا لأن الغاز الطبيعي المسال يعتبر أحد أنظف أنواع الوقود الأحفوري، فإن الهدف الأساسي من هذه الدراسة هو جمع البيانات المتعلقة بتزويد الغاز الطبيعي المسال كوقود في الصناعة البحرية. الغرض من البحث الحالي هو النظر في العوامل الفلسفية للسلامة وكيف يمكن أن تؤثر على إدارة المخاطر. للتحقيق في هذه العلاقة، يتم جمع البيانات الكمية من الاستبيانات التي يتم توزيعها على ٢٠٠ بحار. وأخيرا، أظهرت نتائج تحليل الارتباط وجود علاقة مهمة بين العوامل الفلسفية للسلامة وإدارة المخاطر، بينما أظهر تحليل الانحدار تأثيرا إيجابيا كبيرا لعوامل السلامة الفلسفية على إدارة المخاطر.

Abstract
Since Liquefied Natural Gas (LNG) is regarded as one of the cleanest fossil fuels, the primary goal of this study is to collect data concerning the bunkering of LNG in Maritime Industry. The purpose of the current research is to look into Safety Philosophical Factors and how it could affect risk management. To investigate this relationship, quantitative data are collected from questionnaires that are distributed among 200 seafarers. Finally, the findings of correlation analysis showed a significant relationship between safety philosophical factors and risk management, while the regression analysis showed a positive significant impact of safety philosophical factors on risk management.

Keywords: Liquefied Natural Gas, Safety Philosophical Factors, Risk Management

1. Introduction

The condition of being protected from danger, harm, or injury is commonly defined as safety. Safety is a necessary daily resource for individuals and communities to achieve their goals. There are numerous definitions of safety depending on the context, and the field in which it occurs. The importance of safety has changed dramatically in the last few decades of the 20th century, as the idea of safety has changed with time. Because of developments in marine commerce and the global environment at the end of the twentieth century, much emphasis was placed on the perception of maritime and navigational safety (Formela et al., 2019).
Functional safety is a notion that applies to all industries. It is essential for the deployment of complex technologies employed in safety-related systems. It ensures that the safety-related systems will provide the essential risk reduction to assure the equipment's safety. But first, consider the concept of security: Freedom from an unreasonably high risk of bodily harm or

health damage as a result of property or environmental degradation, either directly or indirectly (International Electrotechnical Commission, 2000). Safety at sea is related to navigational safety, emission reduction, people's safety in emergency circumstances, and ship technological and operational safety (Formela et al., 2019).

On modern, technologically advanced ships, the safety of the sailors is crucial. Operating in fast changing operational, economic, social, political, and international situations are the shipping industry as a whole and the maritime sector. Because of the increased operational complexity, sailors must have the necessary skills and training to handle challenges. Also, because of the complexity, decision-makers are concentrating more on training safety (Markopoulos et al., 2020).

The current study puts its main focus on testing the relationship between Safety Philosophical Factors and Risk Management in Maritime Field. Although LNG starts to be significantly adopted in Maritime industry, LNG has number of challenges and dangers that could occur. LNG is a cryogenic liquid that is held at close to atmospheric pressure. When released, there is a risk of fire, Boiling Liquid Expanding Vapor Explosion (BLEVE), cryogenic burns, metallic part shattering, and asphyxiation. In severe situations, in addition to the direct harmful consequences of exposure to those nearby, fire or structural failure could result in the destruction of the vessel, with major loss of life to those nearby. If the vessel is alongside at the time, this may include those on shore (Stokes et al., 2013).

Therefore, it is important to provide suitable trainings that help seafarers to know how to deal with LNG bunkering and avoid its challenges in order to succeed in manage the risks that could happen as a result of using LNG. Accordingly, this paper is divided into six sections, which are; introduction, aim and objectives, literature review, methodology, analysis and findings, conclusion and recommendations.

2. Research Aim and Objectives

The current research purposes examining the relationship between Safety Philosophical Factors and Risk Management while bunkering Liquefied Natural Gas inside the field of maritime. Accordingly, one main objective is developed, which is;

- To identify Safety Philosophical Factors achieving Risk Management in Liquefied Natural Gas bunkering in maritime industry.

3. Literature Review

This section consists of two sub-sections, where it discusses previous literature that had investigated the same topic.

3.1 Safety Factors and Risk Management

Many sorts of safety have been the genesis for early civilizations (Egypt, Greece, and China) to exist, so these civilizations did not create the concept by themselves as it was formed naturally from their daily lives. Nevertheless, there may be more to the relationship between risk and safety than a simple linguistic change. Thus, safety can be viewed as a component of overall risk management. Although the security risk management may be perceived as an expense against the operation, it also represents a substantial threat if not handled carefully (Mokhtari et al., 2021).

Maritime transportation is characterized by its higher danger level than air transportation, but it is close to rail transportation's level of safety and far greater than road transportation's level of safety. Accident risk and, more specifically, the involvement of the human component in these risks are critical considerations in this scenario. Indeed, human error appears to be the major cause of maritime catastrophes. Accordingly, the risks come initially from human factors that could be represented in; (Berg, 2013)

- Elements that reduce performance (tired, stress, and health issues)
- Organizational features (safety training, team management and safety culture)
- Insufficient technical and cognitive capacities
- Insufficient interpersonal competencies (problems in understanding a shared language and communication challenges)

It is important to refer that, safety culture and training are still suffering from some gaps in Maritime industry. Therefore, the marine industry's safety culture and training need to be given more attention and growth. The importance of safety training, safety culture, and competency evaluation must be increased (Berg, 2013). Frequent training, continuing awareness of cultural change, and an ongoing process of continuous development are all necessary for maintaining safety culture (Goldberg 2013).

As can be seen from the above, risk is mostly dependent on human errors; as a result, risk management could be enhanced by focusing on people (seafarers, masters and officers) through applying safety training and safety procedures. The IMO, like other regulatory authorities, distinguishes between safety and security. In this sense, safety refers to protection against the danger of injury caused by unintentional events such as accidents, whereas security refers to protection from purposeful occurrences (Joseph and Dalaklis, 2021). The International Atomic Energy Agency (IAEA) contends that handling safety and security frequently occurs concurrently. Regardless of intent, businesses will deal with the ramifications of an occurrence in the same way. For example, if there is a power outage on board, regardless of the source, the crew will respond in the same way by ensuring that the situation does not threaten the ship's safety or security (for example; drift into the path of another ship) (Hopcraft, 2021).

Because seafarers' activities directly affect the safety and security of a ship's systems, they must be provided with the necessary digital competences to make educated decisions concerning such systems. IMO has long stressed the link between the human factor and maritime safety and security. IMO explicitly recognized the link between training and ship safety in 1993. Taking this a step further, the IMO contends that safety and security are dependent on a plethora of complicated interacting elements, such as training, talent, and experience (Hopcraft, 2021).

As previously said, safety and security frequently have conflicting priorities; nonetheless, as businesses attempt to improve one, they accidentally advance the other. Both the IAEA and the IMO have called for the concurrent development of a safety and security culture that promotes holistic risk management. The IMO contends that a safety culture is an essential component of a company's safety management system (SMS) (Hopcraft, 2021). According to the IMO, this should also entail the establishment of a just culture in which organizations acknowledge that accidents can occur and that these provide a chance to learn what improvements are required to fix flaws in the current safety management system (Hopcraft et al., 2023). The creation of an organizational culture that considers both safety and security enables a company to assess the risks it faces and determine the actions needed to mitigate that risk (Hopcraft, 2021).

In terms of risk management, the IMO specifically highlighted the importance of improving operations of marine safety following many high-profile safety-related accidents. The IMO approved a number of regulations demanding stricter safety management systems aboard ships to that end (IMO, 1988).

The Safety of Life at Sea (SOLAS) convention emerged and incorporated the ISM Code as a requirement. The ISM Code was developed to make sure that all governments and businesses apply risk management strategies that increase the safety of mariners. Together with these guidelines, industry participants began to create risk management frameworks. These aided individuals in understanding, visualizing, and meeting new safety criteria in day-to-day operations (Hopcraft et al., 2023).

One risk management strategy that focuses on adding many layers of mitigations is Reason's Swiss Cheese Model (Reason, 2016). These safeguards can take the shape of hardware, software, or rules and processes. These layers contain defects (holes). A successful SMS will prevent those holes from aligning. Due to its ease of understanding, this risk perspective has been widely used since it was first introduced. As a consequence, the researchers utilize this model to illustrate a shortcoming in current risk management practices. Figure 1 shows this Model (Hopcraft et al., 2023).

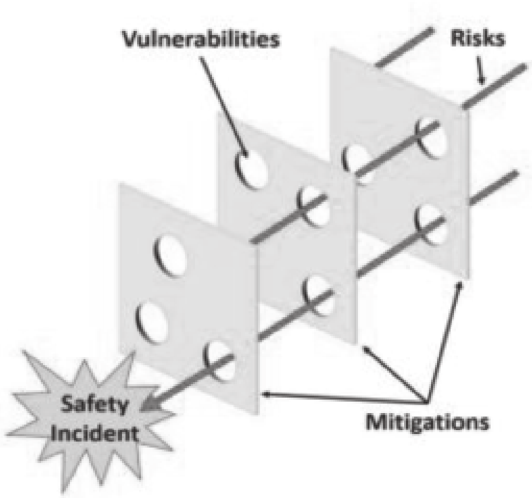

Figure 1: Reason's Swiss Cheese Model
Source: Hopcraft et al., (2023)

Yet, like with loss-of-life incidents, operational safety is dependent on human-machine interactions, which is referred to as a socio-technical system. A system's performance is determined by the optimization of both technical and social elements. Yet, dangers might arise inside the system as a result of poorly ordered or poorly managed interactions between various pieces. Accordingly, safety must also be ensured within the devices themselves. The Swiss Cheese Model is illustrated in Figure 2 to represent essential features used in the safety of socio-technical systems (ships). Four layers are included; the governance layer, which represents the laws and regulations that must be followed. The management layer is the internal practices that direct the company's core risk profile. The technical layer consists of technological and, in many cases, digital safety management and mitigation tools. The human element is the fourth layer, and it is responsible for operating within the safety boundaries (Hopcraft et al., 2023).

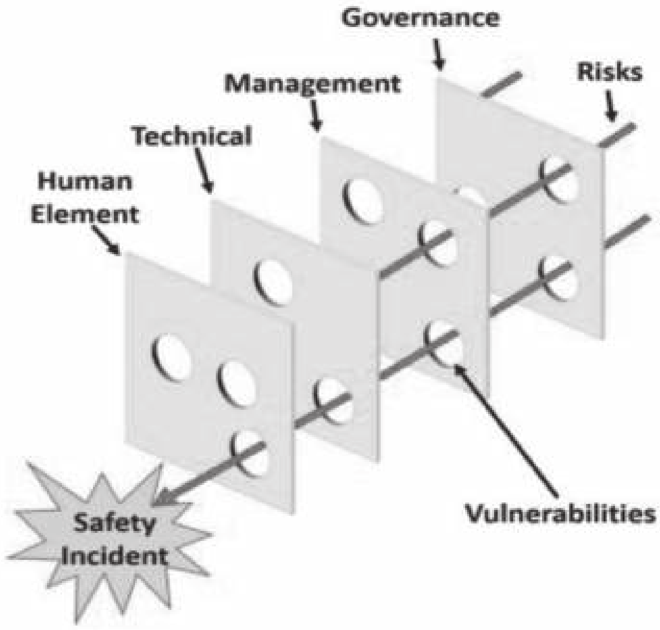

Figure 2: Swiss Cheese Model utilizes in the safety of ships
Source: Hopcraft et al., (2023)

The purpose of this current study is to examine the connection between risk management and safety philosophical factor. Because of environmental protection legislation regarding emission limitations and LNG's cost-effectiveness, the LNG usage as a fuel in marine operations is expanding. IMO is concerned about LNG usage and other low-flashpoint fuels as gaseous fuels on ships. The Maritime Safety Committee approved modifications to the 1978 International Convention on Standards of Training, Certification, and Watchkeeping (STCW) for Seafarers regarding the necessary minimum standards for masters, officers, and other crew members on ships within light of the IGF, and the Gases or Other Low-Flashpoint Fuels (IGF) safety code was put into effect. The STCW revisions include requirements for crew members working on ships subject to the International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels to complete basic and advanced training (Zincir and Dere, 2015).

Several research are being conducted to reduce shipboard emissions as emission limitations and energy efficiency rules become more stringent. These investigations could be the main engine following treatment procedures, such as filtering and cleaning equipment, that aim to eliminate dangerous combustion products. Prevention studies prior to the combustion process, on the other hand, can be another sort of emission abatement study. Alternative fuel use at ship main engine and diesel generators is one of the prevention studies before the combustion process (Calleya et al., 2011).

Current technological developments and international maritime legislation highlight the importance of training engine officers and ratings who will work on LNG-fueled ships. Training methods for STCW involve simulator training, training programs, in-service training, and training on ships as per STCW 2010. In addition to theoretical training and aboard experience, simulator training aids learning and provides learners with practical experience (Zincir and Dere, 2015).

3.2 Challenges in Maritime Industry while using Liquefied Natural Gas

LNG is a developed natural gas transportation technique that is used to transport it across oceans over great distances. LNG is the finest option for transporting natural gas across long distances, particularly those more than 2000 kilometres. LNG is created by cooling natural gas to 162 degrees Celsius at atmospheric pressure. Because one cubic metre of LNG includes around 625 cubic metres of natural gas, LNG has a substantially higher energy density than natural gas. Furthermore, because LNG is colourless, non-toxic, odourless, and noncorrosive, it is widely used in a variety of sectors. Because methane is the most abundant component of LNG, it emits extremely few greenhouse gases and nitrogen oxides, and nearly no sulphur oxides when evaporated and burned (He et al., 2019). Therefore, LNG is one of the cleanest resources of energy (Lowell et al., 2013).

When LNG spills on the ground or in water, it instantly vaporises and leaves no traces. If LNG spills over water, it has no negative impact on waterways (Dodge, 2014). Although LNG has all these advantages, it is only used by 668 LNG-fueled ships in operation, and construction on 76 additional buildings is ongoing (Zincir and Dere, 2015).

Previous studies have investigated the adoption of LNG and linking it to risk management in the maritime industry. Stokes et al. (2013) sought to establish the needs for maximizing safety in LNG bunkering operations, as well as to comprehend how to assess the skill gap between crew and port staff in order to eliminate human factor risks in LNG. It was concluded that changes in technology, procedures, and processes will necessitate a review of the abilities required to operate the new LNG operations concurrently safely and efficiently. It is worth noting some of the additional advantages of ensuring worker capabilities in this manner. It can considerably reduce the risk of human mistakes, offering additional protection to the LNG bunkering systems on board and on shore, as well as the vessel as a whole, lowering the likelihood of a serious event. Additionally, wider benefits may be realised as skilled employees are less likely incur workplace health and safety risks originating from human error.

A statistical method for determining the safe exclusion zone surrounding LNG bunkering facilities was provided by Jeong et al. (2017) using a specially developed computer programme and quantitative risk assessment. The conclusion demonstrates that, for a variety of reasons, IMO member states have not yet developed their own clear standards for safety exclusion zones in LNG bunkering.

In their 2018 study, Ovidi et al. focused on LNG safety as they approached a bunkering terminal through port channels in an industrial region. The risk level associated with the ship approaching the harbour was measured using a risk matrix technique. A case study of industrial relevance was used to demonstrate the tool's capability for assisting risk-based decision making. The findings of the investigation showed that LNG carrier access creates a significant risk level for industrial and civic installations near the channel.

With a focus on LNG technology, Iannaccone et al. (2018) examined the safety of onshore bunkering options for systems of maritime fuel. The results show that traditional IFO bunkering is fundamentally safer than LNG and enable the accurate determination of crucial process units and operations. In order to ensure the long-term growth of the LNG supply chain for marine applications, safety concerns must be weighed against environmental advantages.

Hongjun et al. (2018) proposed that LNG leaks could occur during pontoon bunkering operations in China. It is decided that the pontoon equipped with IMO Type C tanks, as well as suitable berthing/unberthing and safety systems, has been demonstrated safe and reliable by practices. It is also estimated that about 30 such upgraded LNG bunkering pontoons with a fuelling capacity of 500 m^3 will be required on the Yangtze and Pearl Rivers by 2025. Ultimately, practices have validated the pontoon's safety and dependability, and its fourth version has been developed.

Jeong et al. (2018) was carried out to evaluate potential dangers connected with LNG bunkering. In the LNG bunkering process, a unique method for developing practical safety exclusion zones was provided. The investigation disproved the presumption that current probabilistic risk assessment practice focused entirely on population independent analysis because the size of safety exclusion zones appeared to be set up in an unfeasibly wide manner. Instead, it was shown that the suggested method—which included both population-dependent and independent assessments—was effective at more accurately identifying the zones.

Aneziris et al. (2020) gave an in-depth literature study on LNG port safety and risk assessment. 23 articles in English were collected and analyzed, where they included the period between 2008-2018. The evaluation showed gaps in science and harmonisation, while safety and hazard zones required greater research and analysis.

3.3 Research Gap

According to the above literature review, it is noticed that previous studies focuses on LNG and tries to identify the challenges related to LNG and how can risk management control and avoid these challenges. On the other hand, previous studies did not focus on factors that may affect risk management related to LNG bunkering. Therefore, the current study aims to overcome this gap through examining the impact of safety philosophical factors on risk management.

4. Research Methodology

Research methodology is a process a researcher uses to conduct his research in a methodical way, gathering a variety of ideas, thoughts, theories, and concepts to apply to a certain study topic (Matthews, 2014). Research methodology's main objective is to produce accurate and trustworthy data on the subject area with regard to future-looking procedures (Ørngreen and Levinsen 2017). The current study applied positivism philosophy and deductive approach aiming to reach the study aim. Qualitative data are collected through questionnaires, where a non-random technique of convenience sampling is used, and the final data consisted of 200 seafarers who are working at the energy sector companies.

As, the current study aims to examine the effect of Safety Philosophical Factors on the Risk Management while using LNG, the research framework could be shown as follows;

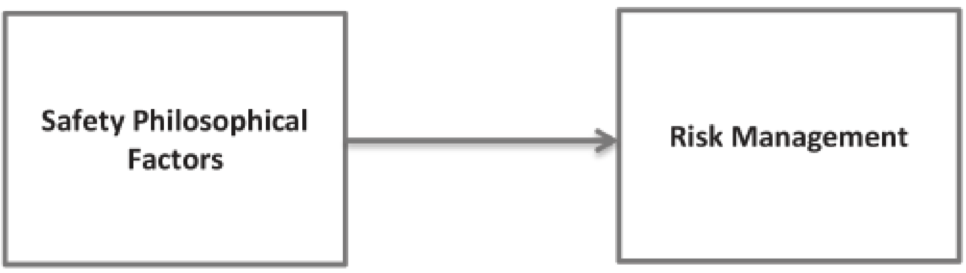

Figure 3: Research Framework

From the framework, the hypothesis of the research is developed, which indicated that;

H: There is a significant relationship between safety philosophical factors and risk management

The research hypothesis is analyzed through using correlation and regression analysis, where data are collected from questionnaires. Table (1) shows the statements used in the questionnaires.

Table 1: Research Variables Measurement

Variables	Measurement	References
Safety Philosophical Factors	The organization's safety policy is established, and its principles are shared by all members.	Fan et al. (2022)
	Safety duties and responsibilities are well defined.	
	Errors are reported with no consequences or punishments.	
	Vertical/horizontal communications on safety are emphasized. (Vertical is between levels of an organizational hierarchy. Horizontal is between individuals or units at the same hierarchy.)	
	Management is dedicated to safe procedures.	
	The safety management system's audits are adequately executed.	
	The organization's risk assessment is effective.	
	The organization has a well-developed safety checklist for simultaneous LNG bunkering activities.	
	The organization's emergency procedures and policies are adequately designed.	
	Clear mission statements are extensively shown at work.	
	As part of the training program, specialized training and education are delivered on a regular basis.	
	Near misses and incident/accident reports teach employees valuable lessons.	
	Employees are well educated on the company's safety policies.	
	Staff training includes learning and improving contentious safety.	

Variables	Measurement	References
	Safety training and education are provided based on the degree of personnel.	
Risk Management	Uncertainty is seen as a significant challenge in our organization.	Ndubisi and Agarwal (2014) Szambelan and Jiang (2019)
	Our team promotes opportunity for success rather than possibilities for failure	
	Our team has a strong preference towards high-risk ventures with a high probability of success.	
	Because of the environment nature, our team feels that bold, broad-reaching actions are required to fulfil our organization's goals.	
	Our organization often takes a strong, proactive stance to increase the likelihood of capitalizing on prospective opportunities, when there is uncertainty.	

5. Research Analysis and Discussion

The empirical analysis is shown in this section, where it includes five sub-sections;

5.1 Data Testing using Validity and Reliability for the Research Variables

Validity analysis implies the degree to which an instrument assesses what is supposed to quantify efficiently and properly. The extracted average variance (AVE) represents the average community for the hidden factor (should be ≥50%). Furthermore, the size of the factor loadings (FL) of the measures on their respective constructs (which should be ≥0.4), can be used to assess item reliability (Bell et al., 2018). Likert Scale 5 has been used for the questionnaire (1 – strongly disagree, 2 – disagree, 3 – not sure, 4 – agree, 5 – strongly agree), Reliability analysis relates to the amount of consistency of the scale used to assess the stated construct. Cronbach's Alpha was chosen as the most often used trial measure of reliability (should be 0.7) (Fuentes-Huerta et al., 2018).

This section tests the validity and reliability of the research variables. It was found that from the analysis results at Table (2) that all the fifteen statements of the safety philosophical factors are valid, as the factor loadings of the 15 statements are greater than 0.4. In addition, the result of AVE was 63.315%. Regarding the reliability test, it is observed that the Cronbach Alpha of the statements is 0.958, which means that the statements are reliable to form this construct.

Regarding the validity and reliability of the dependent variable, Table (2) shows that the factor loading of the five statements are 0.741, 0.625, 0.587, 0.626 and 0.672 respectively. In addition, the result of AVE was 65.013%, therefore, all the five statements of the risk management are valid. It could also be noticed that the Cronbach Alpha is 0.861, which means that the assigned statements are reliable to form this construct.

Table 2 Validity and Reliability of the Variables

Items	FL	AVE	Cronbach's Alpha
SP1	.614	63.315%	.958
SP2	.604		
SP3	.591		
SP4	.603		
SP5	.715		
SP6	.641		
SP7	.621		
SP8	.625		
SP9	.627		
SP10	.693		
SP11	.563		
SP12	.683		
SP13	.671		
SP14	.638		
SP15	.608		
R1	.741	65.013%	.861
R2	.625		
R3	.587		
R4	.626		
R5	.672		

5.2 Descriptive Analysis for the Research Variable

The descriptive analysis shows that the mean values of the safety philosophical factors and risk management equal 4.9050 and 4.8950 with a standard deviation of 0.29395 and 0.30732, while the minimum andmaximum values are 4.00 and 5.00. and 4.00 and 5.00 respectively.

Table 3 Descriptive Analysis

	N	Minimum	Maximum	Mean	Std. Deviation
Safety Philosophical Factors	200	4.00	5.00	4.9050	.29395
Risk Management	200	4.00	5.00	4.8950	.30732

5.3 Normality Test

Normality is one of the assumptions that must be checked in order to evaluate whether or not a data collection is normal. Table 4 shows the formal testing using the Kolmogorov-Smirnov test. As the related P-values are less than 0.05, it is clear that the research variables are not regularly distributed.

Table 4: Formal Testing of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	P-value	Statistic	df	P-value
Safety Philosophical Factors	.532	200	.000	.332	200	.000
Risk Management	.529	200	.000	.352	200	.000

5.4 Testing Regression Assumptions

Regressions assumptions are tested through autocorrelation and heteroscedasticity.

Autocorrelation: It is another important assumption of the ordinary least squares' method in which means that the errors present in the model have relationship between each other. A Durbin-Watson (D-W) test is used because it is one of the statistical tests used to compare the null hypothesis (there is no autocorrelation to others that are autocorrelated). The results indicated that the model test equals 2.130, which shows that the no autocorrelation is supported.

Durbin-Watson Value = 2.130

Heteroscedasticity Assumption: It is the problem of having inconstant variance in the model assigned. The scatter plot of the standardized residuals against the unstandardized predicted values is used, where the results show heteroscedastic relationships between the variables.

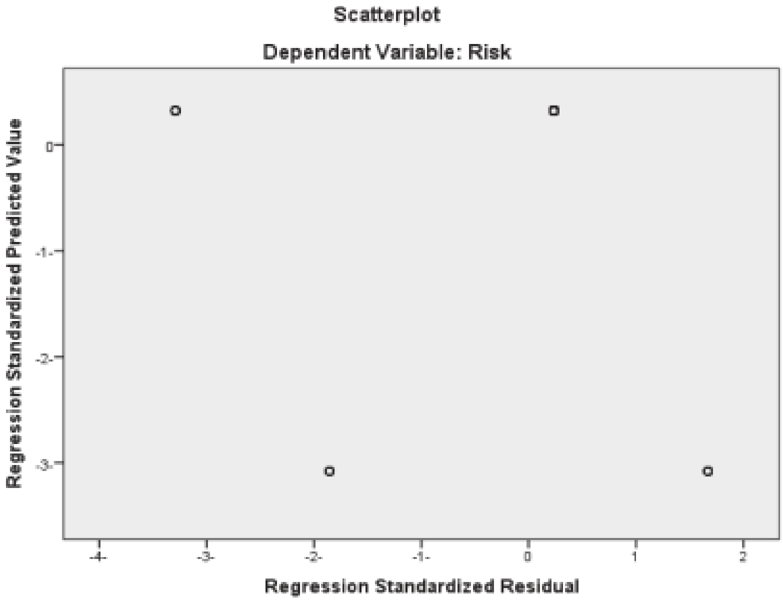

Figure 4: Scatter Plot for Heteroscedasticity

5.5 Testing the Research Hypotheses

This section introduces the correlation and regression analysis, where the non-parametric test of Spearman correlation is applied. The correlation matrix shows that Safety Philosophical Factors has a positive significant relationship withRisk Management as P-Value= 0.000 and r= 0.390.

Table 6 Correlation Matrix between Safety Philosophical Factors and Risk Management

			Safety Philosophical Factors	Risk Management
Spearman's rho	Safety Philosophical Factors	Coefficient	1.000	.
		2-tailed Sig.	.	.
		N	200	200
	Risk Management	Coefficient	.390	1.000
		2-tailed	.000	.
		N	200	200

The regression model in Table (7) illustrates that there is a positive significant influence of Safety Philosophical Factors and Risk Management, as the coefficient =0.407 with a significance= 0.000. Furthermore, the R square is 0.152, indicating that the model can explain 15.2% of the variation in Risk Management, which means that safety philosophical factors affects risk management by only 15.2%, by that there are independents factors that may affect risk management other than the current independent such as; digital transformation, and supply chain management.

Table 7 Regression Model for Safety Philosophical Factors on Risk Management

Model		Unstandardized Coefficients		Std. Coefficients	t	Significance	R Square	P Value
		B	Std. Error	Beta				
1	(Constant)	2.897	.336		8.615	.000	0.152	0.000
	Safety Philosophica l Factors	.407	.068	.390	5.954	.000		

6. <u>Results</u>

From the above analysis, the correlation and regression analysis proved that safety philosophical factors have positive significant influence on risk management regarding LNG bunkering. The concluded results are expected as safety factors are expected to enhance the risk management in maritime industry.

7. <u>Conclusions, Recommendation and Limitation</u>

In the context of maritime transport, the current study focusing on investigating the impact of the safety philosophical factors on the Risk Management for the ships that use Liquefied Natural Gas. Accordingly, one main hypothesis is developed and the analysis shows a positive significant impact of safety political factors on risk management. The current study proved that the safety factors and procedures that the seafarers follow represents main factors that reduce risks related to LNG usage.

Decision-makers can be advised based on the findings to ensure the existence of all safety measures and address any issues found to prevent any accidents related to the use of LNG. Additionally, it is suggested that seafarers receive regular training on how to cope with LNG.

Finally, it is important to refer that the current research has some limitations. These limitations are related to the time period, the used population and the used sample. According to these limitations, the research suggests making future research that included a longer period of time and wider sample. Another limitation is related to the research variables, the current study recommends testing other independent variables that may affect the risk management.

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