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Risk Characteristics and Response Strategies for Marine Pollution Due To Container Ship Accidents at PT IPC Terminal Petikemas

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Abstract: Export-import and international trade activities require the role of container ships and ports. Shipping and port activities that do not meet standards can cause marine pollution and ship accidents. The number of incidents of pollution brought on by container ship accidents rises as a result of mechanical issues like inclement weather and human mistake as well as the continued decline in container accidents. This research is literature study or literature review research. This research uses a systematic literature review approach regarding the application of risk characteristics and response strategies in cases of container ship pollution and accidents. By implementing a risk characteristics program and response strategies that are carried out regularly, accidents that occur on container ships can be minimized. By conducting a comprehensive review of marine pollution and implementing a risk characteristics program and response strategy, its effectiveness can be proven to reduce the level of marine pollution and ship accidents.

Keyword: Pollution, Risk, Accident, Strategy

INTRODUCTION

One of the environmental issues currently occurring is marine pollution caused by ship activities in Indonesian waters and ship accidents. Ship accidents can cause wider pollution in the surrounding seas due to heavy metals, plastic fibers, fuel leaks and hazardous substances. Accidents involving containers have the potential to harm entire marine environments and threaten human health as they spread the food chain. The risks posed by container accidents are often ignored, resulting in marine pollution and accident rates increasing.

Human suffering, inclement weather, and mechanical failure are the main causes of container accidents. An engine or rudder failure or other mechanical issue results in a failure of the ship as a whole. Mechanical failure is the root cause of crashes, drifting, and stranding. A thorough analysis of Peru's mechanical container fleet was conducted under strong time limitations to understand the fundamental circumstances of ship operation and solve the issue

of container ship mechanism failure in order to address container ship incidents connected to mechanical failure.

According to previous research, Youjia Zou with an article entitled "Impacts of different characteristics of marine biofouling on ship resistance" research results state that fields such as ecotoxicology, aquatic biology, oceanography, environmental science, biochemistry and engineering have been involved in this effort. However, further involvement of engineering and humanities disciplines is needed for proactive efforts in mitigating marine pollution.

According to Massimiliano Marino's previous research with the title "Database Analysis of Ship Accidents in Port Areas". The research results state that the database can be used as a basis for maritime risk assessment methods and for calibration of real-time ship collision avoidance scenarios.

Therefore, we decided to conduct research "Risk Characteristics and Response Strategies for Marine Pollution Due to Container Ship Accidents". This study focuses on the risk elements and prevention strategies for marine pollution brought on by container ship mishaps.

Literature review

1. Risk Characteristics

According to Hanafi (2006: 1), the definition of risk is danger, result or consequence that can occur as a result of an ongoing process or future event. According to the Committee of Sponsoring Organizations of The Treadway Commission, Enterprise Risk Management (COSO ERM) 2004, the definition of risk is the possibility of an event occurring that can affect the achievement of organizational goals. According to Kountur (2004), risk is an uncertain situation faced by a person or company that can have a detrimental impact.

Meanwhile, Hillson (2001) in Rizqiah (2017) stated that risk has a double meaning, namely risks with positive effects which are called opportunities, and risks which have negative effects which are usually called threats. So, the author draws the conclusion that risk characteristics are the basic values for shaping a person's personality to increase success when acting in the presence of danger or threats that may occur while achieving goals.

2. Container Ship Accidents

In both domestic and global transportation networks, container ships are a key factor, because container ships are one of the most efficient modes of transportation for transporting large amounts of cargo. Additionally, during the past 10 years, container ship numbers, capacities, and speeds have all greatly grown. To boost ship capacity and save transportation costs, more containers are being stacked on deck. Even though every ship must comply with classification regulations and applicable laws and regulations for ship and cargo safety, based on accident data, this issue has led to an upsurge in container ship mishaps, particularly those involving fallen containers and onboard fires. Ship accidents consist of several types, including collisions, equipment failure, explosions, fires, leaks, grounding, capsizing and sinking.

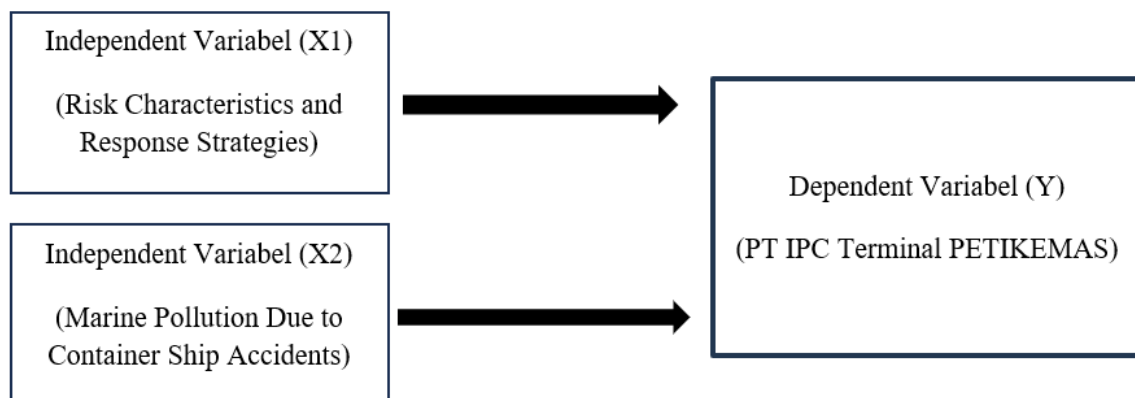


Figure 1. Variabel

Information:

- X₁ = Risk Characteristics and Response Strategies (X₁)
X₂ = Marine Pollution Due to Container Ship Accidents (X₂)
Y = PT IPC Terminal PETIKEMAS (Y)

Based on the explanation of the conceptual description and theoretical framework above, hypotheses that can be proposed in this study are as follows:

- a. There is an Influence on the Application of Risk Characteristics and Response Strategies to Marine Pollution Intentions.
- b. There is an Effect of Application Risk characteristics and response strategies to accident rates on container ships.

METHOD

The research method used is the Literature review method. The literature review method is a form of research by searching existing research and literature. Research was carried out by reviewing the literature to obtain references appropriate to the research topic. This method is used to carry out critical studies, ideas, findings, and knowledge to draw theoretical conclusions to be used as a reference in further research.

This literature review method will be summarized in a descriptive analysis according to the researcher's needs based on the findings in each piece of literature obtained. The results of the study are arranged in such a way and presented to readers in a form that is easy to understand.

Literature Search Strategy

This research uses a literature search strategy through online media which includes searches on Google Scholar, PubMed, Researchgate, Elsevier, NCBI. The following is the address of the search site that will be used by researchers in conducting literature reviews:

Site Name:

- a. Google Scholar : <https://scholar.google.co.id/>
- b. Elsevier : <https://www.elsevier.com>
- c. Research Gate : <https://www.researchgate.net>
- d. PubMed : <https://pubmed.ncbi.nlm.nih.gov>

Keywords that will be used as alternative searches are keywords that are adapted to the research title, namely strategy, risk, pollution, accidents.

Inclusion Criteria

The literature used as data for this Literature Review research is as follows:

- a. Research published in journals from 2019 to 2023 (last 5 years)
- b. Research published in Indonesian and English
- c. Research involving strategies and characteristics of marine pollution and ship accidents
- d. Research results are published with full access (full text) from sites that have been used as sources of literature data

Exclusion Criteria

- a. Research journals published before 2018
- b. Research journals whose research results are published on a limited basis (not full text) or for a fee

Data Synthesis

The research data that has been collected will be curated or collected according to the research method and will be summarized narratively based on groups of research results. After the research curation process and research grouping according to the inclusion criteria and methods used. Researchers will summarize and collect research description data in tabular form.

The research description table will describe the summary results of all research containing the researcher, year of publication, journal that published it, title of the research article, and a summary of the research results. The summary results in table form will later be examined more clearly about the research methods, research process, and research results obtained from the full text research article.

After a clearer and more in-depth study, the researcher will carry out coding and analysis of the similarities and differences of each journal which will later be collected and draw conclusions on the research synthesis and will be discussed in the discussion.

RESULTS AND DISCUSSION

This research uses the PICOS framework method to search for articles by selecting and collecting articles based on five components of suitability to the research topic. These components are as follows:

- a. Population, namely the population or subject that is targeted is the company PT IPC Terminal Petikemas
- b. Intervention is an intervention in the form of applying risk characteristics and response strategies to marine pollution due to container ship accidents
- c. Comparative is a comparison which in this case compares with other interventions or conditions before and after the implementation of response characteristics and strategies to minimize pollution and accidents.
- d. Outcomes are the results obtained from interventions in the form of reducing cases of container ship accidents and marine pollution as well as other factors such as increasing port mobility activities
- e. Study Design is a research method and design that focuses on intervention research design.

Research articles are curated and collected by researchers from various sources using keywords in searches for each site. Searches were carried out using the following keywords:

- a. The keyword for risk characteristics is characteristics or risk
- b. The keyword for response strategy is safety strategy or prevention or response response
- c. The keyword for pollution is marine pollution or pollution
- d. The keyword for accident is ship accident or ship collision

After searching for articles, articles were collected to be studied and analyzed using the PICOS framework method and presented in the form of a descriptive review of literature analysis.

Article Description

A total of 50 articles were collected and analyzed from several international journal search sites. The research articles collected range from 2019 to the most recent year 2023. The research articles collected were then synthesized using the PICOS method and summarized in a synthesis table.

Table 1. Article Description

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
<p>A study on characteristics of microplastic in wastewater of South Korea: Identification, quantification, and fate of microplastics during treatment process, Tae-Gwan Lee, Haerul Hidayaturrehman, 2019 Source = Sciencedirect</p>	<p>Characteristics of microplastic</p>	<p>Wastewater is treated through screening, settling, activated sludge, coagulation, ozonation, and filtration before being discharged into the Nakdong River and Geumho River.</p>	<p>Microplastics, especially in granular form, are commonly found in wastewater and despite high removal efficiency, some still end up in rivers.</p>	<p>Microplastics, wastewater treatment plants, coagulation, ozone, membrane disc filters, rapid sand filtration.</p>
<p>Assessment for oil spill chemicals: Current knowledge, data gaps, and uncertainties addressing human physical health risk, Alesia Ferguson, Helena Solo-Gabriele, Kristina Mena, 2020 Source = Science Direct</p>	<p>Oil spill chemicals</p>	<p>Contaminant exposure assessments are conducted directly and indirectly; direct methods measure actual exposure and dose through monitors, skin patches, or food analysis.</p>	<p>Building a predictive platform to assess the health impacts of oil spills based on the distribution of chemical concentrations, human activities, and the toxicity of chemicals in the oil.</p>	<p>Risk assessment oil spill chemicals (oscs) Human exposures to oscsfate and transport of oil spill chemicalsoil spill management</p>
<p>Initial environmental risk assessment of hazardous and noxious substances (HNS) spill accidents to mitigate its damage, Young-Ryun Kima, Moonjin Leeb, Jung-Yeul Jungb, Tae-Woo Kim, Daejoong Kim, 2019 Source = Science Direct</p>	<p>Risk assessment of hazardous and noxious substances</p>	<p>Environmental risk assessment and monitoring after HNS spill accidents have been recognized as the most effective methods to reduce environmental damages and to help in preparation of the contingency plan</p>	<p>The results of the study showed that HNS is highly soluble and harmful to marine organisms at the lowest tides, and the developed method can be used for risk assessment of HNS spills in the future.</p>	<p>Exposure assessment, HNS initial environmental risk assessment, marine ecosystem, spill accident, toxicity assessment</p>
<p>Increasing Understanding of Legal Responsibilities in Ship Accidents at Sinar Bahari Palembang Shipping Vocational School, Adrian Nugraha, Muhammad Syaifuddin, Akhmad Idris, Dedeng Dedeng, 2023 Source = Google Scholar</p>	<p>Legal Responsibilities in Ship Accidents</p>	<p>An increase in understanding was held in community service activities regarding legal responsibility in ship accidents, especially for educators and prospective sailors who are educated at Maritime Vocational Schools (SMK Pelayaran).</p>	<p>After this legal outreach activity, the participants' understanding of community service significantly increased. The implementation of this legal outreach went well and optimally.</p>	<p>Maritime security and safety, Ship accident, Law enforcement, Legal responsibility</p>
<p>Limitation of Harbormaster Responsibility in Ship Accidents, Handar Subhandi Bakhtiar, Abbas, Rafika Nur, 2021 Source = Reaserchgate</p>	<p>Responsibility in Ship Accidents</p>	<p>Maritime transportation requires operational support, port facilities, and safety assurance, but some port support facilities are still inadequate.</p>	<p>The research results show that the harbormaster is not fully responsible for ship accidents after the ship has sailed, because the responsibility shifts to the captain according to the results of the inspection and legal provisions.</p>	<p>Harbormaster responsibility, The Safety and Security of Shipping, Ship accidents</p>
<p>A Concept Study on Design Alternatives for Minimizing Accident Consequences in Maritime Autonomous Surface Ships, Gyeong Joong Lee, Dongkon Lee, Jin Choi, 2023 Source = Reaserchgate</p>	<p>Design Alternatives for Minimizing Accident Consequences</p>	<p>MASS design and technology alternatives were developed to reduce the impact of accidents, including a floor HVAC system and a verified accident response prototype.</p>	<p>MASS accident response procedures can be refined through risk assessment and ORCC, and a prototype automated response system has been successfully developed and verified.</p>	<p>Autonomous ships, Maritime Autonomous Surface Ships (MASS), International Maritime Organization (IMO), accident-avoidance technologies, emergency response</p>

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
Ship accident prevention under organizational influences on the ship operation by using gap analysis, Dwi Antoro, Bambang Eka W, Antoni Arif Priadi, 2019 Source = Knowledge E	Ship accident prevention under organizational influences	This research follows up on the HFACS study which showed that ship accidents were primarily caused by organizational factors, with a focus on measuring gaps in these factors.	The research findings emphasize the need for prevention and mitigation by all parties involved in ship operations, as well as the need for further, more in-depth research.	Ship accident, human errors, classification system, gap analysis
Operational risk identification of maritime surface autonomous ship: A network analysis approach, Xue Li, Poong Oh, Yusheng Zhou, Kum Fai Yuen, 2023 Source = Science Direct	Operational risk identification	This study aims to identify and analyze MASS operational risks using network modeling and network metrics to support safe operations.	This study introduces a network theory-based risk framework that identifies 32 risks and 80 cause-and-effect relationships to support MASS risk analysis and assessment.	Maritime autonomous surface ship network analysis causal relationships risk identification
Process, methods and tools for ship damage stability and flooding risk assessment Dracos Vassalos, *, Donald Paterson, Francesco Mauro a, M.P. Mujeeb-Ahmed, Evangelos Boulougouris, 2022 Source = Science Direct	Ship damage stability and flooding risk assessment	This study discusses the basic concepts for accurately assessing flooding risk on passenger ships.	Upaya masa depan diarahkan pada regulasi IMO berbasis risiko untuk meningkatkan keselamatan kapal melalui mitigasi risiko banjir dan stabilitas kerosaka	Damage stability, Survival, Statistical methods, Direct methods, Evacuation, Flood risk
A general method to combine environmental and life-safety consequences of Arctic ship accidents, Thomas Browne, *, Rocky Taylor, Brian Veitch, Inari Helle, Tuuli Parviainen, Faisal Khan, Doug Smith, 2022 Source = Science Direct	Environmental and life-safety consequences	This study develops a risk aggregation method to combine the ecological, socio-economic, and life safety impacts of ship accidents in the Arctic.	The research results show that the severity of Arctic ship accidents is influenced by the type of ship and location, so that further development of mitigation models and risk assessments is needed.	Arctic shipping, risk aggregation, consequence modeling, life safety, socio-economic consequences, ecological consequences
Determining the critical risk factors for predicting the severity of ship collision accidents using a data-driven approach, He Lan, Xiaoxue Ma, Weiliang Qiao, Wanyi Deng, 2023 Source = Science Direct	Predicting the severity of ship collision accidents	This paper proposes a data-driven approach using ARM, CN, and RF to analyze risk factors and predict the severity of ship collisions.	The research results show that poor team communication is a major factor in the severity of ship collisions and can be the basis for developing safety strategies.	Risk factor, severity of ship collisions, maritime accident
"Factor assessment of hazardous cargo ship berthing accidents using an ordered logit regression model", Rafi Ullah Khan, 2023. Source = Science Direct	Hazardous cargo ship berthing accidents	This study analyzed 348 hazardous cargo ship accidents at dock using ordered logit regression to reduce the risk and severity of accidents.	The research results show that human factors, weather, tugboats, and port safety systems have a major influence on the severity of dangerous cargo ship berthing accidents.	Ship berthing, hazardous cargo, accident factors, ordered logit regression, port safety
"Analysis on a database of ship accidents in port areas", Massimiliano Marino, 2023. Source = Science Direct	Database of ship accidents in port areas	Risk assessment methods help decision makers understand the characteristics and causes of ship accidents to improve future mitigation strategies.	The database can be used as a basis for maritime risk assessment methods and for calibration of real-time ship collision avoidance scenarios.	Maritime safety, risk assessment, safe navigation, collision avoidance

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
"Study on the prediction model of accidents and incidents of cruise ship operation based on machine learning", Zhaoqian Su, 2022. Source = Science Direct	Prediction model of accidents and incidents of cruise ship operation	Machine learning was used to build an ensemble learning model to predict accidents and incidents during cruise ship operations.	The proposed improvement model shows the best predictive performance compared with other models in this study. Prevent accidents from occurring	Cruise ship operations, accidents and incidents, machine learning, ensemble learning
"Knowledge graph construction based on ship collision accident reports to improve maritime traffic safety", Langxiong Gan, 2023. Source = Science Direct	Knowledge graph construction based on ship collision accident reports	A new knowledge graph construction approach to explore ship collision accidents is proposed, aiming to show the correlation among important factors of the accidents.	The research results show that the proposed approach is effective in revealing accident relationships and accelerating maritime investigations.	Ship collision accident, knowledge graph (scakg), ontology module, ship accident reports, maritime traffic safety, natural language processing
"A general method to combine environmental and life-safety consequences of Arctic ship accidents", Thomas Browne, 2022. Source = Science Direct	Environmental and life-safety consequences of Arctic ship accidents	This method combines ecological, socio-economic and life safety impacts in the form of total costs resulting from a ship accident scenario.	This study evaluates and compares the severity of various ship accident scenarios in the Canadian Arctic.	Arctic shipping, risk aggregation, consequence modeling, life safety, socio-economic consequences, ecological consequences.
"A framework for onboard assessment and monitoring of flooding risk due to open watertight doors for passenger ships", Pekka Ruponen, 2022. Source = Science Direct	A framework for onboard assessment and monitoring of flooding risk	Active monitoring of flooding risk can increase the crew's situation. Awareness of the effect of open wtds on the flooding risk, thus positively influencing the safety culture onboard the ship.	This method aims to improve the operation and design of safer ships and is ready to be tested through prototypes on real ships.	Maritime risks and safety, watertight doors, vulnerability to flooding, vulnerability to accidents
"Accident susceptibility index for a passenger ship-a framework and case study", Jakub Montewka, 2022. Source = Science Direct	Passenger ship-a framework	A direct approach based on human performance principles is used to evaluate the vulnerability of ship accidents in marine and coastal navigation.	This method can be used as decision support to assess ship accident risks, increase crew awareness, and analyze navigation safety based on historical data.	Accident susceptibility, safety of transportation, maritime risk and safety, waterways complexity, traffic complexity, human reliability, human performance
"A methodology to assess the causation relationship of seafarersunsafe acts for ship grounding accidents based on Bayesian SEM", Lan He, 2022. Source = Researchgate	Relationship of seafarersunsafe acts for ship grounding accidents based on Bayesian SEM	This methodology combines Grounded Theory, HFACS, and Bayesian SEM to analyze the causes of unsafe acts that trigger ship grounding accidents.	The results of the study show that organizational influence plays a major role in unsafe acts by seafarers, with the prerequisites for unsafe acts as the main direct factor.	Unsafe acts, Maritime accidents, HFACS, Bayesian approach, SEM
The Impacts of Risk Level Based on PSC Inspection Deficiencies on Ship Accident Consequences., Lixian Fan, 2020 Source = Science Direct	PSC Inspection Deficiencies on Ship Accident	This study builds a Bayesian network model to analyze the influence of various factors on the risk and consequences of ship accidents.	The model results help identify the main ship risk factors, the relationship of risk to accident consequences, and the effectiveness of PSC inspections.	Bayesian network, Hidden variable, Risk level, PSC inspection level, Accident consequences

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
"Analysis of the influence of human errors on the occurrence of coastal ship accidents in different wave conditions using Bayesian Belief Networks", Pedro Antão, 2019. Source = Science Direct	Uman errors on the occurrence of coastal ship accidents	A Bayesian Belief Network model was developed using maritime accident variables and wave conditions based on Portuguese Maritime Authority data.	The results of the study showed that fishing vessel crews had high risk acceptance, while recreational vessel crews had low risk perception.	Bayesian Belief, Networks Maritime accidents, Human factors, Significant wave height
"Research on risk, safety, and reliability of autonomous ships: A bibliometric review", Meriam Chaal, 2023. Source = Science Direct	Risk, safety, and reliability of autonomous ships	This bibliometric review discusses research trends in autonomous ship risk, safety, and reliability, including the development of the MASS collision avoidance algorithm.	Will support the government, industry, and Academia in identifying the key information about bibliometrics and research trends on the topic of autonomous ship safety and reliability.	Mass, literature review, policy making, safety cyber, security, reliability
"Object detection method for ship safety plans using deep learning", Min-Chul Kong, 2022. Source = Science Direct	Ship safety plans using deep learning	A deep learning-based object detection method is proposed to extract the number and location of objects in the ship safety plan.	Consequently, an average recall of 0.85 was achieved, confirming the effectiveness of the proposed method	Deep learning, symbol detection, object detection, ship safety plan
"A quantitative effectiveness analysis to improve the safety management system (SMS) implementation on-board ship", Esma Uflaz, 2022. Source = Science Direct	The safety management system (SMS) implementation on-board ship	The fuzzy BWM method is used for assessment, with improvements on expert impact-based aggregation and consistency analysis, although it is not yet common in maritime transport.	The research results show that the implementation of the ISM Code improves safety culture and supports the improvement of ship safety management systems.	Ship safety plan, SMS, Safety Cyber, ISM code
"A method to assess safety and comfort for different ship types in a region of interest", Tomaso Gaggero, 2022. Source = Science Direct	Safety and comfort for different ship types	A statistical approach based on AIS data, strip theory, and historical meteorological data is used to establish the safety and comfort thresholds for ship navigation in the Mediterranean Sea.	The worldwide increase in ship traffic poses a series of challenges for the designer, the crew and the authorities involved in ship traffic management.	Ais,safety and comfort indexes, mediterranean sea, ship and route indentification
"A Decision-Based System for Controlling Safety of a Damaged Ship", Mirosław Gerigk, 2023. Source = Science Direct	Controlling Safety of a Damaged Ship	This method uses the concept of survivability probability by considering the shape of the ship, compartments, cargo, loading conditions, damage scenarios, as well as stability and the dynamic effects of flooding.	This method allows for risk assessment in accordance with IMO regulations, with alternative procedures for special vessels, and supports the development of a ship safety assessment system in critical conditions.	Ship safety, probabilistic concept, damage stability, survivability
"Review of ship safety domains: Models and applications", Rafal Szlapczynski, 2017. Source = Science Direct	Ship safety domains	A systematic and critical review of the newer ship domain models and related research	collision avoidance and traffic engineering	Ship domain, collision avoidance, collision risk, maritime traffic engineering

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
<p>"Statistical analysis of ship accidents and review of safety level", Eleftheria Eliopoulou, 2016. Source = Science Direct</p>	<p>Ship accidents and review of safety level</p>	<p>PLL statistics are greatly affected by individual disastrous accidents that (if they happen) decisively Determine the statistical values.</p>	<p>This study quantitatively assesses the safety risks of the world fleet and shows an increased risk of accidents for several types of vessels.</p>	<p>Maritime safety. Risk assessment. Ship accident statistics. Safety level Formal. Safety Assessment. Maritime regulations</p>
<p>"Portservice attributes for ship navigation safety", Wen-Kai K. Hsu, 2012. Source = Science Direct</p>	<p>Ship navigation safety</p>	<p>A fuzzy AHP model with a Dissatisfaction Attitude (DA) index was employed to identify the Attributes from the shipmastersperspective, by which the port Authorities can make policies to improve their service quality.</p>	<p>This study identified 19 port service attributes that affect navigation safety, with priority given to communication competency and traffic control at the Port of Kaohsiung.</p>	<p>Ship navigation, Safety Port, Fuzzy AHP</p>
<p>"Application of artificial intelligence in the process of supporting the ship owner's decision in the management of ship machinery crew in the aspect of shipping safety", Zbigniew Łosiewicz, 2019. Source = Science Direct</p>	<p>Management of ship machinery crew in the aspect of shipping safety</p>	<p>The application of an expert system which is designed to support a ship owner in managing shipsmachine crews in the aspect of shipping safety.</p>	<p>a. Appropriate selection and recruitment of crews for actual ships based on application system b. Support for operators with lower qualifications in operating, controlling and diagnostics of engines and ship equipment.</p>	<p>Artificial intelligence, expert system decision, support management of ship crew</p>
<p>"Origins of ship safety requirements formulated by International Maritime Organization", Wieslaw TARELKO, 2018. Source = Science Direct</p>	<p>Ship safety</p>	<p>Development of safety technical requirements for ships is presented based on experience of the author as a chairperson of Polish department for subcommittee of ship and equipment design (de) of international maritime organization.</p>	<p>The number of collisions between ships has been greatly reduced in areas where the imo approved traffic Separation schemes have been introduced and oil pollution of the sea is less of a threat now than it was 30 years ago.</p>	<p>Requirements, origination, ship</p>
<p>"Modeling chronic oil pollution from ships", S. Liubartseva, 2023. Source = Science Direct</p>	<p>Chronic oil pollution</p>	<p>The current MEDSLIK-II version focuses on short-term forecasting of oil transport and fates. An upgrade of the model is needed to account for biodegradation and photooxidation of oil, which become effective after more than 10 days</p>	<p>Unstructured grid technologies will improve hazard mapping in the extremely rugged coastal geometry of the Adriatic that includes more than 1000 islands and fine-scale transitional water/coastal systems: lagoons, bays, estuaries, fjords</p>	<p>Operational oil pollution, MEDSLIK-II oil spill model, EMO, Dnet-derived vessel densities, Hazard maps, Adriatic Sea, Territorial waters of Italy and Croatia</p>
<p>"Trends in marine pollution mitigation technologies: Scientometric analysis of published literature (1990-2022)", Damsara Anthony, 2023. Source = Science Direct</p>	<p>Marine pollution mitigation technologies</p>	<p>Marine pollution mitigation needs to be enhanced through the application of technologies such as cloud, AI, and machine learning.</p>	<p>Marine pollution mitigation efforts involve various disciplines, but still require greater contributions from engineering and the humanities.</p>	<p>Marine pollution, AI, indexing databases, Web of Science, Dimensions.</p>

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
"Above management: Scale development and empirical testing for public opinion monitoring of marine pollution", Jihong Chen, 2023 Source = Science Direct	Scale development	The research defines the implications of public opinion monitoring regarding marine pollution based on previous literature and experience, using empathy theory as an entry point.	This research develops a public opinion monitoring instrument for marine pollution to reduce the crisis of trust and maintain social environmental stability.	Above management, public opinion monitoring, Empathy theory, public engagement
"Impacts of different characteristics of marine biofouling on ship resistance", Youjia Zou, 2023. Source = Science Direct	Different characteristics of marine biofouling	A novel numerical model which enables more precise estimates of the contribution of each single component involving in the marine biofouling.	The simulation results show that the modified model is more accurate in predicting ship resistance and is consistent with the measurement data.	Ship hull roughness, marine biofouling, additional ship resistance, green navigation
"Relationship among marine pollution, outdoor activities, and climate change: Fresh evidence from panel threshold regression analysis from coastal regions of China", Guanghui Hou, 2023. Source = Science Direct	Fresh evidence from panel threshold regression	Utilizes a panel threshold model to examine the non-linear effects of marine patents and per capita gross ocean product on marine pollution	Advances in marine technology are increasingly important to reduce marine pollution, with the identification of areas and great attention to the development of the marine economy.	Environmental research
"Indonesian policy and research toward 70% reduction of marine plastic pollution by 2025", Zainal Arifin, 2023. Source = Science Direct	Reduction of marine plastic pollution	This study uses a panel threshold model to analyze the nonlinear effects of marine patents and GDP per capita on marine pollution in coastal areas.	Analysis shows that marine patents have a significant impact on pollution, underscoring the importance of technology in reducing marine pollution and developing the marine economy.	Marine Policy
"Identifying factors influencing total-loss marine accidents in the world: Analysis and evaluation based on ship types and sea regions", Jihong Chen, 2019. Source = Science Direct	Total-loss marine accidents in the world	To use Human Factors Analysis and Classification System (HFACS) to identify and prevent human errors in marine accidents.	Based on the TOPSIS model with enhanced entropy weighting, the results show that in both models, both in terms of ship type and sea area, the main influencing factors are sinking, grounding, and fire/explosion.	Maritime accidents with total loss, Entropy weight increase, Maritime safety options, Maritime risks
"Societal risk acceptance criteria of the global general cargo ships", Jinhui Wang, 2022. Source = Science Direct	Societal risk acceptance criteria	This study evaluates and updates the IMO SRAC for cargo ships using GISIS accident data (2005–2019).	The results illustrate that the SRAC established in this study for general cargo ship fatality accidents are found stricter than that by IMO presented in 2000.	General cargo ship, Risk acceptance criteria, Societal risk–N curve, ALARP principle
"Scientific awareness of marine accidents in Europe: A bibliometric and correspondence analysis", S.M. Esad Demirici, 2023. Source = Science Direct	Marine accidents in Europe	This study uses bibliometric and correspondence analysis to classify and analyze maritime accidents based on their severity and consequences.	Collaboration between researchers, stakeholders, and policymakers is needed to improve maritime safety and protect the marine environment.	Key risk, Marine accidents

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
"Operational adaptation of ports with maritime autonomous surface ships", Ismail Kurt, 2024. Source = Science Direct	Maritime autonomous surface ships	The development of autonomous interoperability with ports where a ship spends a significant part of its life cycle will accelerate the widespread use of autonomous ships.	The discrete choice modelling methods are considered as the most appropriate methodologies to perform such stakeholder perspective analysis in detail.	Autonomous shipping, autonomous cargo ships, port operations interoperability, autonomous ship-port interface
"Evaluation of ship operational effect based on long-term encountered sea states using wave hindcast combined with storm avoidance model", Rei Miratsu, 2022. Source = Science Direct	Long-term encountered sea states using wave hindcast combined	This study reconstructs 25 years of ocean conditions in the North Atlantic using AIS data and merchant ship storm avoidance models.	The operational effects of the ship are analyzed from the differences in natural sea conditions and those encountered by the ship, to assess their impact on roll, pitch, VBM and hydrodynamic pressure over the design life.	AIS, Ship Operational
"Roles and challenges of seafarers for implementation of energy efficiency operational measures onboard ships", Mohammud Hanif Dewan, 2023. Source = Science Direct	Efficiency operational measures onboard ships	The study recommends improvements to working conditions, training, incentives, and technology to reduce workload and increase compliance with standards.	This supports safe and efficient shipping operations and contributes to reducing the impacts of climate change.	Energy efficiency, Eedi, Seemp, Eexi, Cii, Marpol appendix vi listener challenge
"Preparation of in-service measurement data for ship operation and performance analysis", Øyvind Øksnes Dalheim, 2020. Source = Science Direct	Data for ship operation and performance	This study presents a method for analyzing ship operational data that includes spike removal, outlier detection, and time series data extraction.	The final result is a data set free from disturbances, distortions and undesired physical effects, that can be used to improve the quality of a ship operation and performance analysis.	Data preparation, data pre-processing, outlier detection, synchronization, steady state detection, data extraction
"Ship choice and shore-power service assessment for inland river container shipping networks", Zhijia Tan, 2021. Source = Science Direct	Shore-power service	This study uses a network-based model to analyze the choice of container ships to shore power and evaluate its efficiency at inland river ports.	This method analyzes the impact of emission policies and electricity subsidies on ports by considering ship choice behavior.	Shore power, Inland waterway transportation, Container shipping, Emission control, Automatic identification system
"Modelling the operational effects of deploying and retrieving a fleet of uninhabited vehicles on the design of dedicated naval surface ships", N. Kouriampalis, 2021. Source = Science Direct	A fleet of uninhabited vehicles	QT tools help analyze USV fleet tasks and support mission space design as a critical element of USV carriers.	This showed operating such a fleet of uninhabited vehicles resulted in large and costly naval vessels.	UXV, fleet aircraft carrier, design, launch and recovery, operational analysis.
"Effective Training of Seafarers on Energy Efficient Operations of Ships in the Maritime Industry", Mohammud Hanif Dewan, 2023. Source = Science Direct	Seafarers on Energy	This study shows that on-board and simulator-based training are most effective for improving the energy efficiency of ship operations.	This study shows that seafarers understand and support EE policies and the need for technical training for their implementation on board ships.	Energy Efficient Operations of Ships, EEDI, SEEMP, EEOS, EEXI, CII, Maritime Industry, MARPOL

Article Description Title, Researcher, Year of Publication and Source	Variabel	Research methods	Results	Object
"Evaluation of the risk of pollution caused by ship operations through bow-tie-based fuzzy Bayesian network", Ozan Bayazit, 2023. Source = Science Direct	Pollution caused by ship operations	The probabilities of each ship's operations that cause marine pollution are computed by the Fuzzy Bayesian Network approach	The study will be beneficial for the practitioners of safety and environmental management in maritime transportation to make decisions practically and strategically.	Pollution marine, fuzzy bayesian network

Based on the synthesis table of the articles collected, it can be summarized that there are articles with prospective methods and randomized control trials. The research method used was systematic literature reviews, this study will locate, assess, and interpret research findings pertaining to research questions, subjects, or phenomena of interest utilizing the SLR (Systematic Literature Review) approach.

Discussion

Based on the journals that we have analyzed, it is proven that the application of risk characteristics and response strategies can help to minimize marine pollution due to container ship accidents by developing efficient emergency response plans and involving the latest technology to prevent and handle ship accidents.

Risk characteristics and response strategies are interventions to minimize cases of marine pollution and ship accidents. This program usually takes the form of regular inspections and reviews of the ship's space, permits and sailing safety standards. This intervention is often used for problems in accident cases such as on container ships.

The results of the analysis and literature study show that the application of risk characteristics and response strategies on container ships has sufficient effectiveness in reducing cases of marine pollution and ship accidents. Research from articles collected in this literature study shows that measurements using the systematic literature review method have significant effects.

Analysis of research articles collected using different methods, prospective and randomized trials shows results that tend to be the same as research and shows that although the application of risk characteristics and response strategies has good effectiveness in cases of environmental pollution and ship accidents, further research still needs to be done. related to safety management at the international level.

Although the articles reviewed obtained consistent results regarding risk characteristics and response strategies to marine pollution due to container ship accidents, there are several factors or variables that need to be taken into consideration when used as criteria for further research. As in consideration of safety facilities and other factors are also the causes of container ship accidents themselves.

CONCLUSION

Based on the results of the review and analysis of research literature, it can be concluded that:

1. By implementing a risk characteristics program and response strategies that are carried out regularly, accidents that occur on container ships can be minimized.
2. By conducting a comprehensive review of marine pollution and implementing a risk characteristics program and response strategy, its effectiveness can be proven to reduce the level of marine pollution and ship accidents.
3. Through this research, we can find out the impact of implementing response strategies and risk characteristics on accidents and marine pollution on container ships.

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