The Impending Effects of Shipping Phenomenal Undertaking on Shipboard Safety: Sleep Problem as Moderator

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Throughout maritime history, disasters have led to the loss of many human lives, environmental pollution, and property loss. The historic sinking of the iconic Titanic on 14 April 1912 had prompted massive change and enhancement in shipping regulations. Nonetheless, the shipping industry still encounters similar incidents. This study aims at empirically examining the effects of Work-Family Conflict (WFC), Quality Regulatory Activity (QRA), Ship Owner Efficiency Demand (SOED), and Sleep Problem (SP) towards Shipboard Safety (SS). A theoretical model was adopted to measure the relationship between the variables considered. A structured self-administrated questionnaire was developed and disseminated to seafarers via the Human Resources department of various shipping companies and social media outlets. Quantitative analysis and a five-point Likert scale were utilized to quantify the respondents' feedback. A total of 314 useable seafarers' responses from 12 countries provided intrinsic value from the perspectives of cultural and race adaptation towards safety behaviour. The data were subjected to the reliability, explanatory factor, normality, correlation, and regression analysis, to determine the validity, relationship, strength, and effects of the constructs in the research objectives. The research attested the conceptualised model and pedagogic QRA and SOED positive effects on shipboard safety, whilst WFC and the moderating tool - SP, found not moderated WFC, neither influencing shipboard safety. This research has proposed a new phenomenon that prompts shipboard safety, predicted to contribute towards the industry from different views of safety-related elements, and provide valuable insight for shipping companies, authorities, and maritime organisations.

KEYWORDS

~ Seaworthiness
~ ISM code
~ Paris MoU
~ Seafarers
~ Biological clock

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1. INTRODUCTION

The shipping industry carries 90% of cargoes in the world. Without shipping, transportation of raw material like grains, e.g., wheat, barley, and corn, or finished product, e.g., electronic goods, cars, and clothes, or oil and chemical products across the oceans and continents would not be possible. As of January 2018, the International Chamber of Shipping (ICS-Global seafarers, 2018) reported 53,732 ships were trading worldwide and manned with an estimated 1,647,500 seafarers. According to the European Maritime Safety Agency (EMSA) 2020 review, there were 3,062 casualties and accidents involving 3,350 ships reported in 2019, involving 63 serious casualties, 60 fatalities, 948 injuries, and 21 lost ships.

In response to the disaster, regulatory and legislative bodies, such as International Maritime Organisation (IMO), Classification Society (RO), International Association Classification Society (IACS), Flag administration and shipping association, e.g., EMSA and ICS, have collaborated to revise the pertinent requirement to enhance safety at sea. A joint Concentrated Inspection Campaign (CIC), i.e., Paris MoU and Tokyo MoU, were formed to eliminate substandard ship and ensure the ship meet the international safety, security and environment standard set up by the international maritime conventions. Despite numerous efforts that have been made by relevant stakeholders, the rate at which the ship accident happens is still worrying. This research was undertaken to empirically examine the effects of Work-Family Conflict (WFC), Quality Regulatory Activity (QRA), Ship Owner Efficiency Demand SOED), and Sleep Problem (SP) on shipboard safety (SS).

In shipping, seafarers are required to sign a contract of employment and serve on board for a certain period depending on the company that they work with. Prolonged absence from the lives of the family creates work-family conflict which affects attitude and comportment. The design and build of a ship must be carried out in compliance with the exhaustive rules and regulations set by the conventions. Upon completion, the ship is considered to comply with all applicable requirements. In ensuring the ship's continued compliance with the requirements, inspection and examination on the ship shall be performed by the authority such as Classification Society, Port State Control (PSC), and Flag State Control (FSC).

The ship is managed by the shipowner or the ship manager who supervises the operations, maintenance, and markets of the ship. The ship is bound by a tight schedule to meet the charterer contract requirement, port allocation, cargo readiness, etc. The demand from the shipowner influences the shipboard management in terms of safety rules and requirements. The seafarer is required to perform the mandatory eight working hours a day. Besides, they are also required to work overtime due to limited resources on board, which involves the extra work that is required for maintenance and upkeeping of the ship.

2. THE CONCEPT OF THE SHIPPING INDUSTRY

Shipping is the main means of transportation of cargo between countries across the globe. According to ICS, approximately 11 billion tons of goods are transported by ship each year, representing an impressive 1.5 tons of goods per person based on the current global population. As of 2019, the total value of the annual world shipping trade has exceeded 14 trillion US dollars.

The shipping industry transports crude oil, iron ore, and million tons of grain. Transportation of these goods is not possible by road, rail, or air, which drives the demand for the shipowner to build a big and complex ship that is more economical than those run on fuel burnt in the propulsion engine. However, many shipowners keep a minimum number of seafarers on the ship to reduce their operational costs.

2.1. The Seafarers

Seafarers are considered to be a highly stressful and high-risk profession in terms of physical and mental exhaustion. Seafarers are subject to numerous psychosocial and physical stressors, encompassing high leadership responsibilities, under-qualified subordinate crew members, separation from family, loneliness, cross-cultural communication, fatigue and sleep deprivation, recreation scarcity, workplace noise, ship movement, vibration, and heat (Oldenburg and Jensen, 2012; Carotenuto et al., 2013; M. Oldenburg et al., 2013; Jepsen et al., 2015; Bal BeşİkÇİ et al., 2016). Seafarers must serve on board for several months, which means they have to endure the absence from home and society. Many pieces of the relavant literature have identified separation from family and parents as the most prominent stressor for seafarers (Oldenburg et al., 2009), and loneliness on board the vessel to be associated with separation from family and parents (Carotenuto et al., 2013).

2.2. The Shipboard Management

The shipping industry consists of various types of ships used to transport different types of cargoes, i.e., an oil tanker is used to carry crude oil, the chemical carrier carries chemical products, container ship carries containerized cargo, bulk-carrier carries bulk cargoes like grains and steel, RO-RO ship carries vehicle, the cruiser or passenger ship carries passengers and many other items designed for the intended purpose.

The shipboard management consists of the deck department, i.e., taking care of navigational, cargo, and deck maintenance, and the engine department, i.e., s taking care of the main propulsion engine, and other machinery maintenance to ensure the safety of the ship at sea. Another department includes the catering which prepares food for the crews. The shipboard management is led by The Master or Captain who has full authority to make decisions, particularly regarding safety.

The recruitment of seafarers is unique as compared to that of shore jobs. Seafarers are required to sail with the ship from the port of embarkation until the contract is completed. While onboard, seafarers are out of communication with their families and parents. The current trend shows that social media have become the most used means of communication by people, whereby the majority spend more than three hours per day engaging in activities related to social media (https://kommandotech.com/statistics/how-much-time-does-the-average-person-spend-on-their-phone/). Inaccessibility to social media in the middle of the sea has been a challenge for the seafarers working in this industry.

2.3. The Regulatory and Legislation

The ship is designed and built according to certain rules and requirements to ensure that the ship is safe when encountering environmental disasters such as typhoons, strong wind, and big waves en route from one port to another. The ship is typically equipped with Life Saving Appliances (LSA) and Fire Fighting Appliances (FFA) equipment whose purpose is safety and combatting fires, respectively.

Upon completion of ship construction, trading certificates will be issued to allow the ship to sail into the water of the countries that are signatories to the convention and codes. To maintain certification, verification by the regulatory authorities, i.e., a classification surveyor is required. Besides, authorities such as PSC and FSC, and other interested parties may also perform their investigation when the ship is called to their port and country's water.

The above inspection is carried out to ensure that the ship complies with the regulation at all times and that the LSA and FFA are maintained and ready for immediate use. The ship that is not in compliance with certain requirements will be asked to rectify the issue as soon as possible and the authority has the right to detain the ship should the major non-compliance is found during the inspection. The stringent inspection by the regulatory authorities demonstrates the thorough inspection carried out to ensure the safety and compliance of the ship with the requirement.

2.4. The Shipowner or Ship Manager

The ship is managed by the shipowner or ship manager. While the ship is on charter, they are bound by the contract with the charter parties. The shipowner and manager are responsible to ensure that the ship is properly maintained and safe to operate. However, on many occasions, the shipowner and managers have made meeting the charterer contract their priority to avoid delay, i.e., to keep departure and arrival on schedule and avoid charterer claim. In meeting the charterer contract, the shipowner and manager will give instructions to the shipboard management, whereby in extreme cases, some would even compromise safety to keep the vessel on schedule.

3. CONCEPTUAL MODEL DEVELOPMENT AND LITERATURE GAP

A review of the previous study on shipboard safety was performed to identify the gap.(Rabenu et al., 2017) studied the organisation justice concerning work-family conflict, which has revealed that the organization justice affects work-family conflict. (Charkhabi et al., 2016) studied the effects of work-family conflict on the mental and physical health of hospital employees, the findings demonstrating that the work-family conflict has greatly caused physical and psychological strains among the employees. (Obrenovic et al., 2020) explored the association between work-family conflict and job performance among employees in the oil and gas industry in Bahrain, which showed that job performance is directly related to work-family conflict and is the determining factor to organisational success. (An et al., 2020) studied the degree of association between seafarers' performance and work-family conflict, job stress, and job satisfaction, which demonstrated that work-family conflict, job stress, and job satisfaction are the significant predictors in the assessment of seafarers' performance.

(Fenstad et al., 2016) looked into the influence of quality of regulatory activity on the ferry industry in Norway, the results revealing that stringent inspection by regulators can improve shipboard safety. (Heij and Knapp, 2018) reviewed the five-year global data on inspection outcomes comprising 130,000 vessels. The result indicated that the repetitive deficiencies on the ship increase the probability of future accidents. (Heij and Knapp, 2019), in a review of worldwide data from numerous sources of PSC inspection from 2010 to 2014 involving 105,585 vessels, suggested that selection of vessel by PSC should consider past accident history instead of just focusing on detention risk. This is because the vessels with a high rate of accidents and detention have a high potential to get involved in a serious accident in future.

(Cariou et al., 2008) reviewed previous records of studies done on the relation between inspection frequency and shipboard safety. The review confirmed that the frequency of inspection could reduce the non-compliance of the ship with applicable requirements. (Fenstad et al., 2016) investigated the involvement of shipowners in the ferry industry in Norway, whose result suggested that active involvement of shipowners improves the safety of the ship. (Jiang et al., 2020) analysed the effects of the shipping schedule, revealing that the schedule affects the operational cost, sailing speed, time of arrival, also incurring penalty.

Year and Authors	Date and Sample	Independent (IV) and dependent (DV) variables	Key findings
Rabenu, Tziner and Sharoni, 2017	Data collected from 120 Israeli-Arab respondents.	IV: Organisation justice. DV: Work-family conflict.	Organisational justice at work affects work-family conflict.
Charkhabi et al., 2016	Data collected via structured self-reported surveys from 311 nurses employed in 6 hospitals in the southwest of Iran.	IV: Work-family conflict. DV: Mental health; physical health.	WFC has greatly caused physical and psychological strain.
Obrenovic *et al.*, 2020	Data collected from 277 employees of international manufacturing and service companies in the oil and gas industry in Bahrain.	IV: Work-family conflict. DV: Job performance.	Work-family conflict affects job performance and is a crucial aspect to ensure organisational success.
An *et al.*, 2020	Data collected from 337 seafarers on a merchant ship at the Yangshan Port, Shanghai, China.	IV: Work-family conflict; job stress; job satisfaction. DV: Seafarer performance.	Work-family conflict, job stress, and job satisfaction are significant predictors in the assessment of seafarers' performance.
Fenstad, Dahl and Kongsvik, 2016	Data collected from 244 seafarers working on passenger ferries operating in Norway.	IV: Quality of regulatory activities. DV: Shipboard safety.	Stringent inspection by regulators can be effective to improve the safety of the ship.
Heij and Knapp, 2018	PSC global data from Jan 2010 - June 2015) covering about 130,000 vessels.	Bad inspection outcomes and repetitive deficiencies increase the probability of future accidents.	The risk of future shipping accidents increases for vessels with bad inspection outcomes as compared to those with good outcomes.
Heij & Knapp, 2019	Worldwide data from numerous sources of PSC inspection from 2010 – 2014 involving 21,117 vessels per year.	Selection of vessel via PSC inspection should consider past accident history and not focus on detention risk only.	The selection of vessels by PSC could be improved by incorporating incident and detention risks. A vessel with high accident and detention risks has a high potential to get involved in a serious and very serious accident in the future.
Cariou, Mejia and Wolff, 2008	Data collected from Swedish Maritime Administration between 1996–2001. Total 4080 cases.	IV: Vessel characteristic. DV: Duration between two successive inspections.	Vessel deficiency was reduced during subsequent inspections as compared to the previous ones.

Fenstad, Dahl and Kongsvik, 2016	Data collected from 244 seafarers working on passenger ferries operating in the Norwegian port.	IV: Demand for efficient management by the shipowner. DV: Shipboard safety.	Active involvement of shipowners can be effective for the improvement of safety.
Jiang et al., 2020	The study of container liner trading near-sea shipping route China-Vietnam-Indonesia. (Port rotation: Ningbo - Shanghai - Xiame -Shekou – Hochiminh -Jakarta - Semarang -Surabaya - Makassar -Ningbo)	Variables: Sailing speed; the number of ships deployed; ship's arrival time; period of a round-trip journey; arrival time of ship at the port of call in the first week; total shipping from loading port to the discharging port.	The shipping schedule affects the operational cost, sailing speed, ship's arrival time, and penalty.

Table 1. Empirical research in WFC, QRA, SOED, SP, and SS: A Summary.

Assessment of the research gap was carried out by consolidating parameters and synthesising historical studies. Previous pedagogical research has covered WFC concerning organization success, sleep issues, fatigue, and job performance. No study has been performed to measure WFC concerning shipboard safety. A very limited number of studies related to QRA and SOED are available for reference.

The present study has incorporated the element of WFC, QRA, SOED, and SP to measure their influence on shipboard safety. The research conducted covers various types of vessels, worldwide trading patterns, across diverse nationalities. The broad scope of research provides valuable and genuine results. The impact of WFC and SP measured in this study, concerning the long absence from family and parents, was expected to be more significant, with consideration of the different nationalities of the seafarers. Addressing QRA and SOED for the vessel trading worldwide is challenging as the ship is subjected to inspection by various authorities from different countries and keeping up with the shipping schedule can be difficult due to the environment act.

4. LITERATURE REVIEW

4.1. Work-Family Conflict

Balancing between demands from work and family has been a major issue in the maritime industry. The industry has suffered a global shortage of seafarers as only a handful of people are willing to work off-shore due to the potential WFC, despite the prospect of good pay (ICS - Global shortage of seafarers). (Greenhaus and Beutell, 1985) defined the WFC as an inter-role conflict, whereby the pressure from work and family conflict with each other in many ways. Consequently, performing the job at work becomes more difficult as it clashes with demands at home. For seafarers, the effects of such conflict are worsened because they cannot return home, regardless of the magnitude of the pressure that they have to endure.

WFC are divided into 3 categories (Dewe and Cooper, 2020). (1) Time-based conflict, where time expended in one domain precludes time spent in the other in such a way that it depletes energy and creates stress. In the case of seafarers, they have to spend numerous months onboard which will deplete their energy and create stress. (2) Strain-based conflict, where the stress in one role affects performance in another role. Being parents, seafarers have to juggle multiple family responsibilities that can create a considerable amount of psychological strain, whose magnitude may be further amplified at work (3) Behaviour-based conflict, which refers to incompatibility between various desirable behaviour patterns in the two competing domains. As an individual, the seafarer may be expected to be ambitious and task-oriented at work, which is contrary to their character at home, which is expected to be loving, supportive, and accommodating to the family.

Ahmad A, in his research, underscored the role of WFC in decreasing and lowering job performance (Ahmad, 2008; Wang et al., 2019), identified that WFC was associated with job performance, as supported by (Karatepe, 2013), who reported the indirect effect of WFC on job performance. Role theory, originating from Robert Merton (Merton, 1957), refers to psychological factors associated with their loved ones, which describes that when WFC intensifies, the pressure of the consequences leads to dissipation in individual's energy and distraction. The pressure caused by the role will be detrimental to the outcomes of work. In summary, we have arrived at the following hypothesis:

Hypothesis 1 – There is a negative relationship between WFC and shipboard safety. The increase in WFC level will decrease shipboard safety.

4.2. Quality of Regulatory Activity

An assessment regarding compliance with the rules and regulations and structural seaworthiness of a ship is periodically carried out by the authority, e.g., classification surveyor, PSC, FSC, and other interested parties, to ensure that the ship is fit to trade, and trading certificates are valid to allow them to sail. According to (Heij and Knapp, 2018), any deficiencies or noncompliance discovered during the PSC inspection have the predictive power for the risk of a future accident. The assumption can be expanded to other forms of inspection, such as those carried out by a class surveyor, FSC, and other authorities. (Heij & Knapp, 2019) in their analysis found that vessels with high accident and detention risks are typically prone to serious and very serious accidents in the future. (Fenstad et al., 2016) asserted that stringent inspection by regulators can be an effective way of improving safety aboard the ship.

The quality of inspection performed by the authority also determines the level of compliance with the rules and regulations, which positively influences the level of shipboard safety. Stringent inspection reveals noncompliance, and any rectification works in detail, which can effectively increase the level of safety. Therefore, we have also concluded the following:

Hypothesis 2 – There is a positive relationship between QRA and shipboard safety. The increase in QRA level will increase shipboard safety.

4.3. Demand for Efficient Operation by the Shipowner

The International Safety Management Code (ISM Code) requires the shipowner and shipping company to ensure the ship they operate is safe. (Karakasnaki et al., 2018) studied two dimensions in the safety management system (SMS)—seafarers and company—which revealed that efficiency in SMS reduces the probability of an accident at the highest level. Effective SMS allows for the identification and management of potential risks. Therefore, the company must continuously improve the skills of both personnel working onshore and onboard ships. (Fenstad et al., 2016) asserted that variation in the balance between efficiency and shipboard safety achieved by different shipowners may result in varying consequences for the respective crews.

In the shipping business, the shipowner is bound by the tight ship schedule, cargo readiness, port spaces allocation, and voyages restriction. The ship's estimated time of arrival and estimated time of departure at/from the port are mostly affected by external factors beyond control. (Perera and Soares, 2017) reported the speed of the ship to be affected by voluntary and involuntary factors during adverse weather that occurred along their routes. According to (Perera and Mo, 2016), the speed of the ship is governed through the control of nitrogen oxide and carbon dioxide emission as required by IMO as part of the effort to reduce air pollution. Inability to meet the schedule affects vessel operating cost, increases total shipping time, which may be subject to penalty (Jiang et al., 2020). Demand for efficiency by the shipowner creates work pressure on the seafarers.

Shipboard management is forced to deviate from the safety rules to catch up with the schedule, which in turn directly influences shipboard safety. In this regard, we hypothesise that:

Hypothesis 3 - There is a negative relationship between SOED and shipboard safety. The increase in SOED level will decrease shipboard safety.

4.4. Sleep Problem

National Sleep Foundation (NSF) has concluded that an individual's health and well-being are improved with sufficient sleep; as an adult, seafarers should get 7-9 hours of sleep at night for them to perform efficiently at work (Hirshkowitz et al., 2015). The maritime industry typically operates 24/7, which requires seafarers to work day and night, and at times, they have to work at odd hours during which the body should be rested instead—causing adverse effects on the health of seafarers. Seafarers working on night watch suffer from sleep disturbances and chronic fatigue more often than workers working on regular hours as they have to work against the biological clocks.

(Van Leeuwen et al., 2020) laid out an onboard watchkeeping system, which consists of two or three watch systems and the theoretical amount of sleep that the seafarers get. It was found out that the three-watch system, the 4-on-4-off shift provides longer sleep hours for the seafarers than the two-watch system. While a watch system with a 12-on-12-off schedule allows for long hours of rest and recuperation, the system requires long hours of watching which increases the likelihood of seafarers falling asleep during the watch. (Andrei et al., 2020) in a study on chronic fatigue among the seafarers demonstrated that acute fatigue was the driver for sleep problems among the seafarers. Canadian Centre of Occupational Health and Safety (CCOHS) defined fatigue as the state of feeling very tired, weary, or sleepy, resulting from insufficient sleep, prolonged mental or physical work, or extended period of stress or anxiety. Fatigue can be described as either acute or chronic. Acute fatigue is the result of short-term sleep loss or a short period of heavy physical or mental work, whereas chronic fatigue is a syndrome related to the state of tiredness that is not relieved by rest.

Fatigue often results in reduced situational awareness, planning deficits, inability to adopt new information (Sneddon et al., 2013), difficulties in focusing attention (Van Der Linden and Eling, 2006), reduced attention and vigilance reaction time, i.e., both in speed and thought, loss of memory or the ability to recall details, and failure to respond to changes in surroundings or information provided. These symptoms can translate into performance impairment, inability to stay awake and willing, increased tendency to take risks, and increased accidents in the maritime industry. Therefore, we hypothesised the following:

Hypothesis 4 - The relationship between WFC and shipboard safety is moderated by sleep problems in a way that the greater the SP, the higher the level of WFC and the poorer the shipboard safety.

4.5. Shipboard Safety

Shipboard safety can be broadly defined as an issue comprising safety culture, awareness, attitude, and shared values within the shipboard community. (Lu et al., 2016) discovered cultural dimension among seafarers which influences the shipboard safety, whereby the national culture was found to be one of the critical factors affecting seafarers' safety behaviours. The fact that the frequency of accidents has been increasing at a worrying rate signifies that the level of shipboard safety has not significantly improved over the years (Eleftheria et al., 2016). Human elements are still the forefront factor in ship accidents (Akhtar and Bouwer Utne, 2015), while poor handling of navigation equipment and poor decision-making during emergencies have contributed towards the majority of ship accidents (Graziano et al., 2016).

In this research, shipboard safety is referred to by two elements: personal incidents such as personal injury, illness, stress, suicide; ship accidents such as collision, grounding, and contact. Shipboard safety solely relies on the management onboard led by the Master, who is responsible to cultivate the safety culture onboard. Personal safety relates to how seafarers view safety and how seriously they adhere to safety requirements. Ship safety is mostly related to unintentional causes, such as the breakdown of main propulsion, loss of manoeuvrability, fire, flooding, or external factors such as typhoons, big waves, and other environmental disasters.

(Sotiralis et al., 2016) revealed that human factors contribute towards the majority of ship accidents and navigation officers or Officer On Watch (OOW), who are responsible for navigating the ship, have been identified as the main human factor as compared with seafarers from other positions onboard.

5. CONCEPTUAL MODEL AND THEORY

The behaviour and attitude of seafarers are the main domains contributing towards the safety acceptance onboard. Theory of Reason Action (Fishbein and Ajzen, 1975) explains the relationship between attitude and behaviour in human action, which is defined as the prediction of individual attitude towards behavioural intentions and that decision to engage in a particular behaviour is based on the expected outcomes. The theory of planned behaviour (Ajzen, 1991) provides the framework to deal with the complexity of attitude, subjective norms, and perceived control of human social behaviour. The development of a research model was adopted from these theories and found suitable to explain the seafarer's actions towards shipboard safety and the predicted outcomes from the regulatory inspection, as well as demand from shipowners. Attribution theory (Weiner, 2010) investigates human behaviour based on the actions undertaken by an individual, which complements the above theories in terms of the seafarer's control over their behaviour and situations and establish the validity of their perceptions. Role theory (Merton, 1957) on psychological factors measures the influence of sleep problems as a moderating factor in work-family conflict.

The variables and conceptual framework are derived from an extensive review of previous literature related to the shipping industry. Three independent variables, i.e., the Work-Family Conflict (WFC), Quality Regulatory Activity (QRA) and Shipowner Efficiency Demand (SOED), one moderating variable, i.e., Sleep Problem (SP), and one dependent variable, i.e., Shipboard Safety (SS), have been identified in this study. A theoretical model (Harris and Harris, 1964) was embraced to measure the relationship among the variables. The model explains how shipboard safety is influenced by the following factors: the way that individuals or groups act and collaborate in their daily routine; how shipowners balance between safety & efficiency; and how regulators adopt different inspection strategies and implementation rules to increase the safety level.

Variables	Source	Significant
WFC	An et al., 2020 Impact of Work-Family Conflict, Job Stress and Job Satisfaction on Seafarer Performance.	The research discussed the relationship between WFC and seafarers' job stress, job satisfaction, and job performance. The concept was adopted in this study and expanded to examine the relationship between WFC and shipboard safety.

QRA & SOED	Fenstad et al., 2016 Shipboard safety: exploring organisational and regulatory factors. Maritime Policy & Management.	The research discussed the QRA & SOED in the Norwegian small ferry industry and Norwegian authority inspection. The concept was adopted to study the international trade vessel and authority inspection by RO, PSC, and FSC worldwide.
SP	Andrei et al., 2020 How demands and resources impact chronic fatigue in the maritime industry. The mediating effect of acute fatigue, sleep quality, and recovery.	The research discussed the seafarer's fatigue issue. The concept was adopted to study the seafarer's sleep issue and sleep latency concerning WFC in the worldwide trade vessel.
SS	Fenstad et al., 2016 Shipboard safety: exploring organisational and regulatory factors. Maritime Policy & Management.	The research discussed shipboard safety in the Norwegian small ferry industry that trades in the short distance between the cities. The concept was adopted to apply in the international trade vessels which are faced with great challenges in upholding safety due to operational and trading patterns that are influenced by both internal and external factors.

Table 2. An empirical study on the research construct development

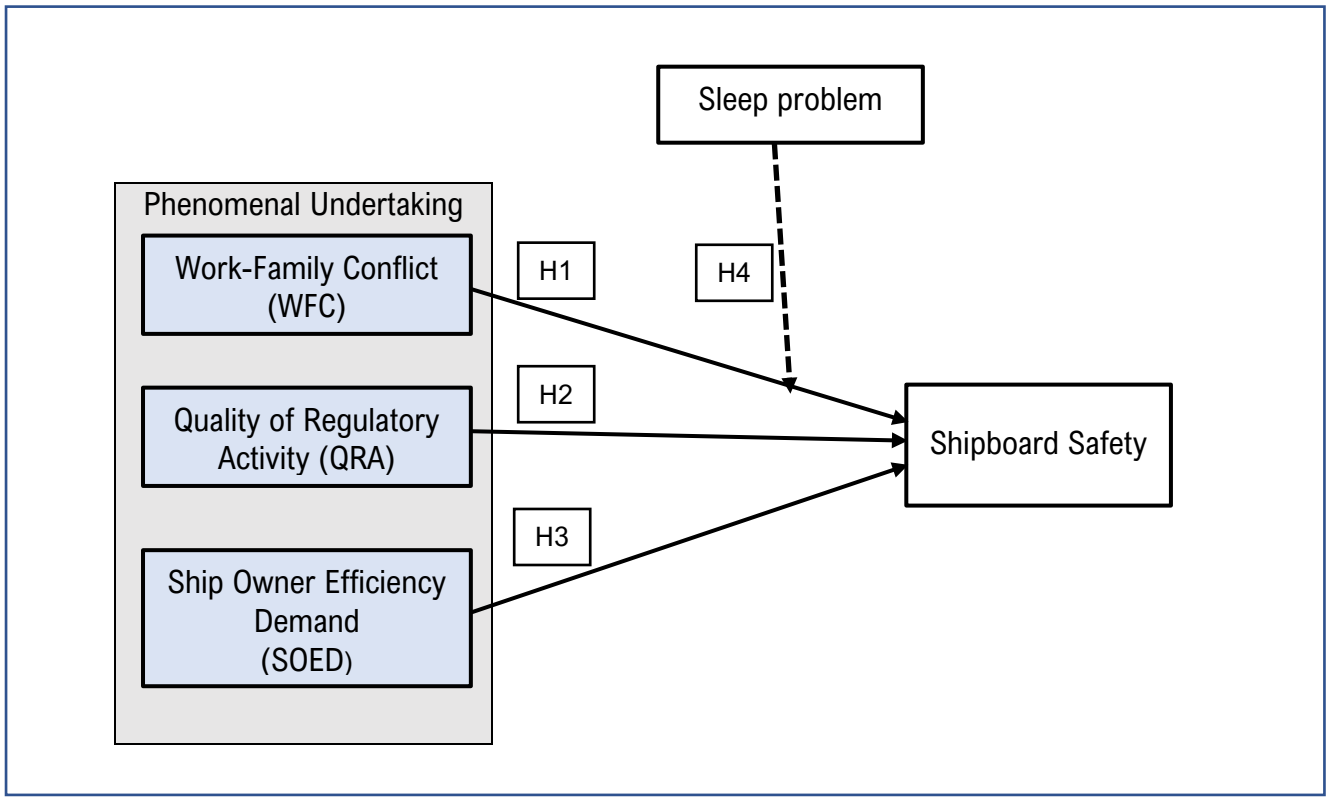

Figure 1. Conceptual Framework

6. METHODOLOGY

6.1. Questionnaire Development

The questionnaire has been designed by adapting those of existing literature, combined with those developed by the researcher of the present study to make up for the inadequate questions available to address the variables. The measurement of WFC consists of four items adapted from (Matthews et al., 2010; An et al., 2020), whereby the four items have been developed with Cronbach's alpha value of 0.868. For QRA, two items from (Fenstad et al., 2016) and four items have been developed with Cronbach's alpha value of 0.931. For SOED, four items have been adapted from (Fenstad et al., 2016) and two items with Cronbach's alpha value of 0.850. For SP, three items have been adapted from (Andrei et al., 2020) and three items with Cronbach's alpha value of 0.769. For SS, two items have been adapted from (Fenstad et al., 2016) and five items have been developed based on Cronbach's alpha value of 0.859. A total of 41 questionnaires have been developed with consideration of equal measurement, non-sophisticated language, ambiguity, double barrel, redundant and negative wording. Eight (8) questions have been deleted due to low loading factors. Table 3 illustrates the characteristics of the questionnaire.

6.2. Sampling and Survey Technique

A quantitative, non-probability and persuasive sampling method has been adopted, involving the collection of data from targeted respondents among seafarers, globally. E-forms of the questionnaire have been disseminated to seafarers via HR of various shipping companies and social media. Demographic factors have been included to scrutinise the impact of demographics on shipboard safety.

Sample size determination has been concluded based on the sampling size proposed by (Dillman, 2007), and (Salant and Dillman, 1996), which has been confirmed by Roasoft software. The parameters have been capped at 95% confidence level, 80/20 split for distribution, and ±5% margin of sampling error. Theoretically, the result should be skewed towards the expected direction that is in line with the predicted outcomes of the constructed questionnaire. The sample size computation was carried out based on the worldwide seafarer population, i.e., 1,647,500 (ICS Report, 2018), with a sample size of 246. Likert 5-point scales ranging from "1- Totally Disagree", "2- Disagree", "3- Neutral", "4- Agree", to "5- Totally Agree" have been used to evaluate the variables.

Variables	Item	Source
Work-Family Conflict	You feel like you miss your family after a certain period at sea. You could not wait to sign off from the ship.	An et al., 2020
	You constantly view your family photo, videos and read your WhatsApp chat when you miss them.	Developed
	You divert your thinking of your family by working hard when you miss them. You keep thinking about the moments with your family when you were onshore with them.	An et al., 2020

	You would try to go home to visit your parents when your ship's port of call is your home port. You have planned for what to do with your family after you sign off from the ship. You would make as many calls as you could while the ship is at the port or write as many texts as possible when you have internet coverage.	Developed
Quality of Regulatory Activity	Inspection by PSC and FSC will upgrade seafarers' working and living conditions onboard. Inspection by PSC and FSC motivates the shipping industry to take responsibility for the safety onboard.	Fenstad et al., 2016
	Inspection by the class surveyor will assist the shipowner in identifying any noncompliance with regulations. The experience and skill of the class surveyor contribute to ensuring the shipboard compliance with the rules and requirements. The inspection carried out by the port state control will increase awareness of the seafarers about safety onboard. The stringent inspection performed by the class surveyor will reduce the ship's detention risk.	Developed
Ship Owner's Efficiency Demands	The shipowner compromises on safety to cut operational costs. The shipowner compromises on safety to keep the shipping schedule. The shipowners' demand for efficient operation sometimes forces the seafarers to violate safety procedures. If I follow safety procedures, the company will not reward me.	Fenstad et al., 2016
	Ad-hoc instruction from shipowners to meet the demand from charterers will influence shipboard safety. The shipowner's decision to employ seafarers with less experience to reduce operational costs will influence shipboard safety.	Developed
Sleep Problem	As I have to work overtime, I can only sleep few hours a day. Seafarers on watch rotation often have short sleep duration as compared with those working in usual hours. I cannot sleep when I think of my family.	Andrei et al., 2020)
	When I am feeling homesick, my mind becomes imbalanced which leads to sleep problems. The time difference between the country where my ship is trading (against my biological clock), and my country of origin makes it hard for me to have quality sleep. Ship with short voyages reduces seafarers' sleep time as compared to ship with long voyages.	Developed

	I am happy with the safety level of the ship that I work in.	Fenstad et al., 2016
	I agree that the training conducted onboard will assist seafarers to work safely.	
Shipboard Safety	I agree that drills performed on board will increase the level of shipboard safety.	Developed
	I agree that any "shortcuts" performed to meet the ship operational demand will influence shipboard safety.	
	I agree that consumption of alcohol over the prescribed limit will influence shipboard safety.	
	I agree that factors such as the breakdown of the main engine, typhoons, narrow channels, and busy traffic will increase the risk of shipping collisions.	
	I agree that the Bridge Navigation Bridge Alarm System (BNWAS) fitted onboard increases shipboard safety.	

Table 3. Characteristics of the questionnaire

6.3. Factor Analysis and Reliability Test

Exploratory Factor Analysis (EFA) has been performed on 33 items of variables to summarise a large number of constructs to the smallest number of hypothetical constructs that parsimoniously explain the covariation observed among a set of measured variables and to identify common factors that explain the order and structure among measured variables (Abdullah *et al.*, 2020; Wan Abdullah, Zainudin and Mohamad Ishak, 2018). Three (3) EFA tests have been performed, namely the Suitability test, i.e., Kaiser Mayor Olkin (KMO) (Kaiser, 1970) and Bartlett (BURT, 1952), Extraction Test, i.e., Principle Component Analysis (PCA) (Williams et al., 2012), the combination of Kaiser's criteria (Kasier, 1960) and Scree test (Cattell, 1966) and Rotation Test, i.e., Direct Oblimin (Coakes, 2010). The reliability and consistency of the questionnaire have been assessed by using Cronbach's alpha (Cronbach, 1951). Eigenvalues, which represent the sum of the squares of loading variables on a specific factor, are considered significant when the eigenvalue is equal to or exceeds 1.0, and the factor loading value of 0.4 or more will be set as a threshold (Watkins, 2018). The KMO value that is greater than 0.6 and the Bartlett test ($p<0.05$) indicate suitability of the factor used for the data (Tabachnick et. al., 2007). The analysis result is summarised in table 4.

Variable	Factor	EFA				Reliability		
		Factor loading	Kaiser Mayer-Olkin (KMO >0.6)	Eigen Value (≥ 1)	Bartlett test (p <0.5)	Cronbach's Alpha (>0.7)	Mean	Standard Deviation
WFC1	Factor 1: Work-Family Conflict	0.761	0.818	4.467	.000	0.868	4.38	0.609
WFC2		0.652					3.94	0.982
WFC3		0.886					4.03	0.782
WFC4		0.802					3.75	1.078
WFC5		0.840					3.88	0.833
WFC6		0.547					3.34	1.096
WFC7		0.734					4.38	0.554
WFC8		0.724					4.00	0.984

QRA1	Factor 2: Quality Regulatory Activity	0.863	0.878	4.523	.000	0.931	4.19	0.693
QRA2		0.852					4.22	0.608
QRA3		0.912					4.31	0.535
QRA4		0.895					4.28	0.581
QRA5		0.799					4.22	0.659
QRA6		0.884					4.06	0.716
SOED 1	Factor 3: Ship Owner Efficiency Demand	0.866	0.706	3.479	.000	0.850	3.16	1.167
SOED 2		0.877					3.06	1.162
SOED 3		0.645					3.06	1.294
SOED 4		0.748					3.19	1.120
SOED 5		0.711					3.60	1.096
SOED 6		0.691					3.72	1.114
SP1	Factor 4: Sleep Problem	0.608	0.693	2.797	.000	0.769	3.28	0.958
SP2		0.697					3.88	0.942
SP3		0.876					3.38	1.212
SP4		0.678					3.41	1.073
SP5		0.680					3.25	0.880
SP6		0.502					4.13	0.793
SS1	Factor 5: Shipboard Safety	0.731	0.746	4.047	.000	0.859	3.97	0.782
SS2		0.886					4.25	0.568
SS3		0.878					4.16	0.677
SS4		0.762					4.28	0.850
SS5		0.783					4.44	0.840
SS6		0.503					4.25	0.880
SS7		0.715					4.16	0.884

Table 4. Explanatory Factor Analysis and Reliability

Data collected as per table 5 shows that there were 221 Malaysian and 94 non-Malaysian who participated in the research. Further, 259 respondents were working on the ship trading worldwide, the criteria providing an adequate impact in the research findings as the ships trading worldwide are very likely to encounter various environmental disasters, inspections by various authorities and joined by seafarers of different nationalities, which often presents challenges in terms of cultural barriers, all of which could influence safety practices and harmonisation onboard.

Category	Sub-category	Frequency	Percent (%)
Gender	Male	307	98.0
	Female	7	2.0
Total			100
Marital Status	Single	71	23
	Married	243	77
Total			100
Age (years)	Cadet – 20	4	1.3
	21 – 30	81	25.8
	31 – 40	137	43.6
	41 – 50	65	20.7
	51 – 60	22	7.0
	61 and above	5	1.6
Total			100

Nationality	Malaysian	221	70.4
	Non-Malaysian Australian - 2, Bangladeshi - 5, Brazillian -1, Filipino-18, Indian-44, Indonesian-7, Myanmar-3, Singaporean-3, South African – 4, Yemenian-3, Ukranian – 4	94	29.6
Total			100
Trading Areas	Foreign going	259	82.5
	Near coastal	51	16.2
	Domestic	4	1.3
Total			100
Department	Deck	135	43.0
	Engine	168	53.5
	Catering	11	3.5
Total			100
Working experience (years)	1 – 5	53	16.9
	6 – 10	79	25.2
	11 – 15	67	21.3
	16 – 20	46	14.6
	21 - 25	44	14.0
	26 and above	25	8.00
Total			100

Table 5. Demographic data of respondents (N = 314)

7. RESULT

The data has been subjected to normality test, skewness and kurtosis Z scores found within range for large sample size are normal. The Q-Q plots indicate that the data has been normal and distributed along the straight line. The histogram shows a mixed bell-shaped pattern with the majority considered normal. The box plot indicates that there has been no outlier and the data has been found to be normal, which is contrary to the result of the Kolmogorov-Smirnov (K-S) test which showed that the data was not normal. According to (Ghasemi and Zahediasl, 2012; Altman and Bland, 1995), for a large sample size of 100 or more, violation of normality is not a major issue, thus giving strong justification to perform parametric statistical analysis.

Table 6 shows the result of the statistic correlation matrix which indicates no multicollinearity problem for the constructs as the values have remained below the critical level of 0.9 (Hair et al., 2006). Table 7 represents multiple regression analysis with shipboard safety as a dependent variable.

Constructs	1	2	3	4	5
Mean	4.172	4.133	3.321	3.630	4.364
Standard Deviation	0.590	0.743	0.933	0.786	0.552
Work-Family Conflict	1.00				
Quality Regulatory Activity	.280**	1.00			
Ship Owner Efficiency Demand	.299**	-.032	1.00		
Sleep Problem	.529**	.014	.442**	1.00	
Shipboard Safety	.284**	.456**	-.042	.101*	1.00

Note: * p<.05 (one-tailed). **p<.01(one-tailed)

Table 6. Pearson Correlation analysis between constructs (N = 314)

Predictor Variables	Shipboard Safety	
	ß	T
Main Effects		
Quality Regulatory Activity	0.403	7.687***
Work-Family Conflict	0.177	2.864***
Ship Owner Efficiency Demand	-0.103	- 1.861 †
Sleep Problem	0.048	0.759
Interaction Effects		
Work-Family Conflict x Sleep Problem	0.102	1.860†
R^2 = .242		
Adjusted R^2 = .235		

Note: †p<.10. *p<.05. **P<.01. ***p<.001

Table 7. Result of Regression Analysis

Hypothesis 1 predicts a negative relationship between WFC and shipboard safety, whereby the increase in WFC will decrease the shipboard safety. The results indicate that WFC positively influences shipboard safety (ß = 0.177, p < 0.1), which is contrary to the proposed hypothesis. Therefore, H1 has been refuted.

Hypothesis 2 anticipates a positive relationship between QRA and shipboard safety, whereby the increase in QRA will increase shipboard safety. The results indicate that QRA positively influences shipboard safety, which relationship has been found significant (ß = 0.403, p < 0.1). Thereby H2 has been supported.

Hypothesis 3 assumes a negative relationship between SOED and shipboard safety, whereby the increase in SOED will decrease shipboard safety. The analysis reveals that SOED negatively affects shipboard safety at a significant level (ß = - 0.103, p < 0.1). Therefore, H3 has been supported.

Hypothesis 4 anticipates a relationship between WFC and shipboard safety, which is moderated by SP. The greater the SP, the higher the level of WFC and the poorer the shipboard safety. The result indicates that the interaction between SP and WFC positively influences shipboard safety (ß = 0.102, p < 0.1), which is contrary to the proposed hypothesis. Thus, H4 has been refuted.

8. DISCUSSION

This research has contributed new knowledge to the existing literature, wose findings related to the elements in the study had never been reported before. This research has also expanded the theory of reasoned action which suggests that a decision is made based on the expected outcome, as well as the theory of planned behaviour, which investigates the complexity of attitude in human behaviour. In this study, the role theory on psychology has demonstrated how seafarers adapt to psychological conflict during their tenure onboard a ship.

The study has revealed that marital status is not the prime factor that drives an individual to work as a seafarer, as it can be seen that the majority of respondents are married (77%) and continue sailing until the age of more than 55 years. The fact that the ship that they are working on trades internationally (82.5%) means that they are far away from their country of origin. Although work-family conflict exists and has a strong impact on shipboard safety, it does not influence or contribute towards shipboard safety. The possible reasons include the implementation of safety awareness or safety campaigns on the ship and the stringent requirement from national and international bodies, which might have forced the seafarers to adhere to the highest level of safety measures. In this regard, the intensity of work-family conflict may have been addressed by the safety practices on board to avoid the ship from being detained at the port or refused from loading and discharging the cargoes. On another note, the technology onboard, such as an internet facility that connects seafarers with their loved ones may also help in reducing work-family conflict.

An analysis has been conducted on the influence of the quality of regulatory activity, such as ship inspection by the classification society, PSC, and FSC on shipboard safety. The findings show that the quality of inspection and the experience of the responsible inspector contribute towards an increase in the level of safety onboard. The result supports the previous study on the relationship between the quality of regulatory activity and safety climates (Fenstad et al., 2016), which was conducted for the ferry industry in Norway.

Demand for efficiency by shipboard management has been found to influence shipboard safety. Notably, the delay in the shipping schedule would have a significant impact on the reputation of the shipping company, which may be subject to fines and claims in the worst-case scenario. However, safety should not be compromised and justification must be given to explain the cause of the delay.

The research has also examined the sleep problem among the seafarers concerning their hectic ship operations, limited resources, and the fact that they are being away from family. The result indicates that the seafarers have been confronted with sleep issues while onboard, as reported by a previous study (Van Leeuwen et al., 2020). Sleep problems have been shown to have a strong impact on the work-family conflict, and no evidence has been found to show that it moderates work-family conflict to influence shipboard safety. The reason could be the same as discussed above.

9. LIMITATIONS

The research has been conducted using a quantitative method, limited by the number of questionnaires. This method does not provide a two-way discussion on the subject and it is difficult to represent the situation in the form of a questionnaire, which is why in this case the qualitative methods may be a more suitable approach. The questionnaire has been distributed via HR of shipping companies during the pandemic, where job security is crucial, and therefore, there was a potential of biased feedback which could influence the result, despite keeping the statement collection anonymous.

10. CONCLUSION AND RECOMMENDATION

The shipping industry is needed to transport cargo worldwide. Regardless of how much resistance and challenges the seafarer and the industry have to face, nothing could substitute the industry. To safeguard all stakeholders, conducting studies to identify and eliminate the root causes through applicable means, i.e., engineering design, operational activity, enforcement of regulation, and more, are considered to be necessary.

Although this study has made a new contribution towards the industry, and the proposed model has demonstrated a good fit for data from the seafarers worldwide, enhancement is needed to further expand the area of study. Thus an in-depth investigation into the elemenst from different angles and views is highly recommended. The set of questionnaires shared in this article can be used as a reference in designing a new experiment in the future.

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CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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