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Review Article

Enhancing maritime safety: A comprehensive review of challenges and opportunities in the domestic ferry sector

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Abstract

The domestic ferry sector is uniquely distinctive owing to its challenging navigation conditions and vulnerable accident records that have evoked endless calls for improving maritime safety. The recent adoption of IMO model safety regulations offers viable options for the Member States to standardize incorporation into national law. The operations of domestic ferries range from very large vessels with freight to small craft, which are often the only transport means for a large population of commuters in the developing world. The flexibility of domestic ferries is appealing; on the other hand, their operations are a challenge to handle, raising the need to identify those challenges that are incompatible with smooth operations and business opportunities. The maritime industry, specifically regarding domestic ferry operations, confronts multilayered challenges with direct implications on accident prevention and operational safety that necessitate a thorough analysis for a comprehensive understanding. This study explores five categories, namely, operations, technology and innovations, the human element, policy and regulation, and economics, recognized as pivotal to improving maritime safety. Our content analysis identifies the comprehensive taxonomies, that explain the current challenges and practical opportunities faced by the sector and which are notably lacking, urging efficient tenacity to ensure sustainable domestic ferry operations. The primary objective was to enhance safety standards, promoting sustainable shipping for all stakeholders involved. This study has identified 28 challenges and 90 opportunities, providing a significant pathway for sustainable decision-making that also adds value to the safety of the stakeholders. This study is expected to explore novel and fertile future research areas to promote scholarly discussion in the domestic ferry sector.

1. Introduction

The role of the passenger ferry and the potential for economic activities have been discussed in the literature (Greig & Mcquaid, 2005; Kotowska, 2015; Mendas, 2015), including how domestic ferries (DF) support modal transport and provide lifeline services to communities living in remote areas unconnected to any transport network (Kabran & Eguavoen, 2019; Nurwahyudy, 2014). Despite a substantial decline in the international ferry sector due to the recent mayhem of the COVID-19 pandemic, the DF sector has proven resilient, ensuring sustainable operations (Baird, 2000; UNCTAD, 2020). Hence, there has been supported continuous safe operations and boosted local tourism and other economic activities (Lee & Leung 2021; Nautilus International, 2020). Thus,

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coastal ferries are considered a well-organized mode of transportation in various social, economic, and environmental respects (Yen et al., 2018).

Understanding the diverse operations of domestic ferries necessitates a comprehensive view of the three primary ferry services outlined by Bruzzone (Bruzzone, 2012). These include three types of ferry services (a) water taxis- small watercraft that serve short cross-waterways, operate on demand, and do not follow fixed routes; (b) passenger ferries- larger vessels, possessing more speed and passenger capacity than water taxis, that operate on a fixed route with a time-based schedule, and (c) automobile ferries- commonly known as ro-ro ferries, which transport passengers as well as vehicles, generally used on longer routes with fixed schedules. Moreover, ferry services are served in several ways, either through state-owned operations or via private stakeholder operators (Baird, 2012).

Water-borne transportation is attaining significance as a viable solution to combat the escalating pollution and congestion challenges in cities, also seamlessly integrating into the multimodal transport network (Cheemakurthy & Garme, 2022). There is an ongoing discussion regarding the extent to which prominence advancement in ship design, regulation, technology, and risk management systems have contributed to a 70 % drop in shipping accidents and losses over the past decade (Allianz Global, 2021). Nevertheless, DF accidents are not rare, and have the potential to involve a large number of causalities (Fenstad et al., 2016) and catastrophic consequences that can be overwhelming to society. The tragedies of Doña Paz (Philippines, 1987), Al Salam Boccaccio (Red Sea, 2001), Prince Ashika (Tonga, 2009), and Sewol (South Korea, 2014) have traumatized areas the world over, with massive socioeconomic impacts. Though in comparison with other marine shipping sectors, DF covers short voyages, it is more vulnerable, due to the complexity of its operations, low capability to tackle emergencies, and inadequate infrastructure (ESCAP, 2016; Kim et al., 2016; Wang & Yang, 2018). Consequently, a single incident can lead to catastrophic consequences, emphasizing the imperative for the DF sector to prioritize sustainability and maritime safety.

This situation underscores the need for sustainable and safety-oriented DF operations. The International Maritime Organization (IMO) is central to maritime safety (IMO, 2021), and the SOLAS regulations do not extend to ferries engaged in domestic voyages (Jon Ingleton, 2020). Consequently, these vessels are often referred to as non-SOLAS, or non-convention, vessels. Operating on domestic or inland routes, they are exempt from SOLAS compliance (Sakalayen, 2006), presenting unique challenges, particularly in developing countries, where 97 % of known ferry fatalities occur in domestic operations (Golden & Weisbrod, 2016). This contrast highlights the pressing need for concerted efforts to enhance maritime safety in the DF sector.

While the IMO primarily focuses on international shipping safety, it recognizes the importance of extending its focus to non-convention vessels like domestic ferries (IMO, 2021). The complexity of DF operations magnifies the significance of addressing their safety. DF operations are exposed to vulnerabilities due to environmental conditions and complex traffic (Huang et al., 2013). Moreover, the size and type of vessels undertaking DF operations vary widely, adding another layer of complexity to the safety landscape (Wisdom & Kamanga, 2002). Often, in developing countries, these vessels are not properly registered or named, leaving a grey area in terms of maritime safety, especially in preventing accidents (Li & Wonham, 2001). Therefore, it becomes imperative to address or align DF with international safety standards, fostering a safer maritime environment.

To address this gap, the recent adoption of "Model Regulations on Domestic Ferry Safety" offers standardized provisions (IMO, 2022; Kitada & Ölçer, 2020). However, the variations in local conditions necessitate continuous attention, highlighting the need for tailored regulatory frameworks. Similarly, the absence of a universally agreed-upon definition does not articulate clarity, particularly since DF vessels are not subject to the same stringent design and operational requirements as SOLAS convention vessels. **Table 1** displays examples of definitions from various organizations. Notably, in the author's opinion, the existing definitions often lack specificity regarding critical elements, such as passenger capacity and regular operational intervals. This lack of definitional standardization not

only creates challenges for the effective study of DF, but also deters the development of comprehensive safety measures within the maritime domain. To bridge this definitional gap, the following proposed definition may contribute to a clear understanding of DF: "*a vessel of any size or type primarily engaged in the transportation of passengers within the boundaries or limits of the country's national waters. It may also include vessels designed for the transport of specific goods, such as automobiles, in addition to passengers*''. This proposed definition encapsulates the essence of DF, and emphasizes its role in national transportation networks, while addressing the need for clarity amidst the varying definitions.

Table 1 Domestic ferry definitions.

Definition	Reference
'A domestic ferry means a vessel that is entitled to fly the Canadian flag, carries passengers on a regular schedule, and operates on a set route'	(Marine Transport Security, 2009)
'Any vessel operates across a body of water on a frequent and regular basis, which varies from small boats carrying passengers to large ships not only carrying passengers, but also vehicles and cargo', etc.	(Interferry, 2023)
'A boat or ship for taking passengers and often vehicles across an area of water, especially as a regular service'	(Cambridge Dictionary, 2023)
"A vessel (1) operates in other than ocean or coastwise, service; (2) has provisions only for passengers or vehicles or railroad cars; (3) used on a short run on a regular schedule between two points over the most direct water route"	(USCG, 2023)

Source: Own compilation

The primary aim of this study is to explore and address the challenges faced by the domestic ferry sector and identify opportunities for improvement. Organized around five key categories-operations, technology and innovations, the human element, policy and regulation, and economics-the study conducts a systematic literature review to summarize key findings. These include inadequate regulatory frameworks, governance and oversight challenges, the lack of standardization, the importance of capacity building and training, the need for adaptability, and the role of public awareness and international collaboration.

The overarching objective is to enhance safety standards and promote sustainable shipping for all stakeholders involved. The research questions- **RQ1**: *The rationale*; What are the primary challenges obstructing substantial improvements in maritime safety within the DF sector? **RQ2**: *The object*; What potential opportunities and viable solutions exist to address the identified challenges? **RQ3**: *The subject*; How can the findings aid maritime decision-makers in enhancing safety within the DF sector?- are designed to align with the study's aim and objectives, focusing on challenges, opportunities, and the potential impact on maritime decision-makers in enhancing safety within the DF sector.

While the introduction has set a comprehensive background for this study and explained its relevance to the DF sector, the next section covers the "Materials and methods," along with a detailed discussion on the literature review, building the groundwork for understanding challenges and opportunities.

2. Materials and methods

2.1 Systematic Literature Review (SLR)

The SLR method is chosen for its impartiality. It begins by selecting appropriate keywords for gathering relevant literature from credible sources, using predefined inclusion and exclusion

criteria. Key findings and data from academic studies are analyzed and synthesized, following guidelines from Snyder (2019) and Tranfield et al. (2003). Qualitative content analysis, as suggested by Mayring (2000), fortifies the review's robustness, adopting a four-step process: material collection, descriptive analysis, category selection, and data evaluation, following recommendations from Seuring and Gold (2012). This approach ensures replicability and facilitates updates for future researchers. **Figure 1** illustrates the SLR process.

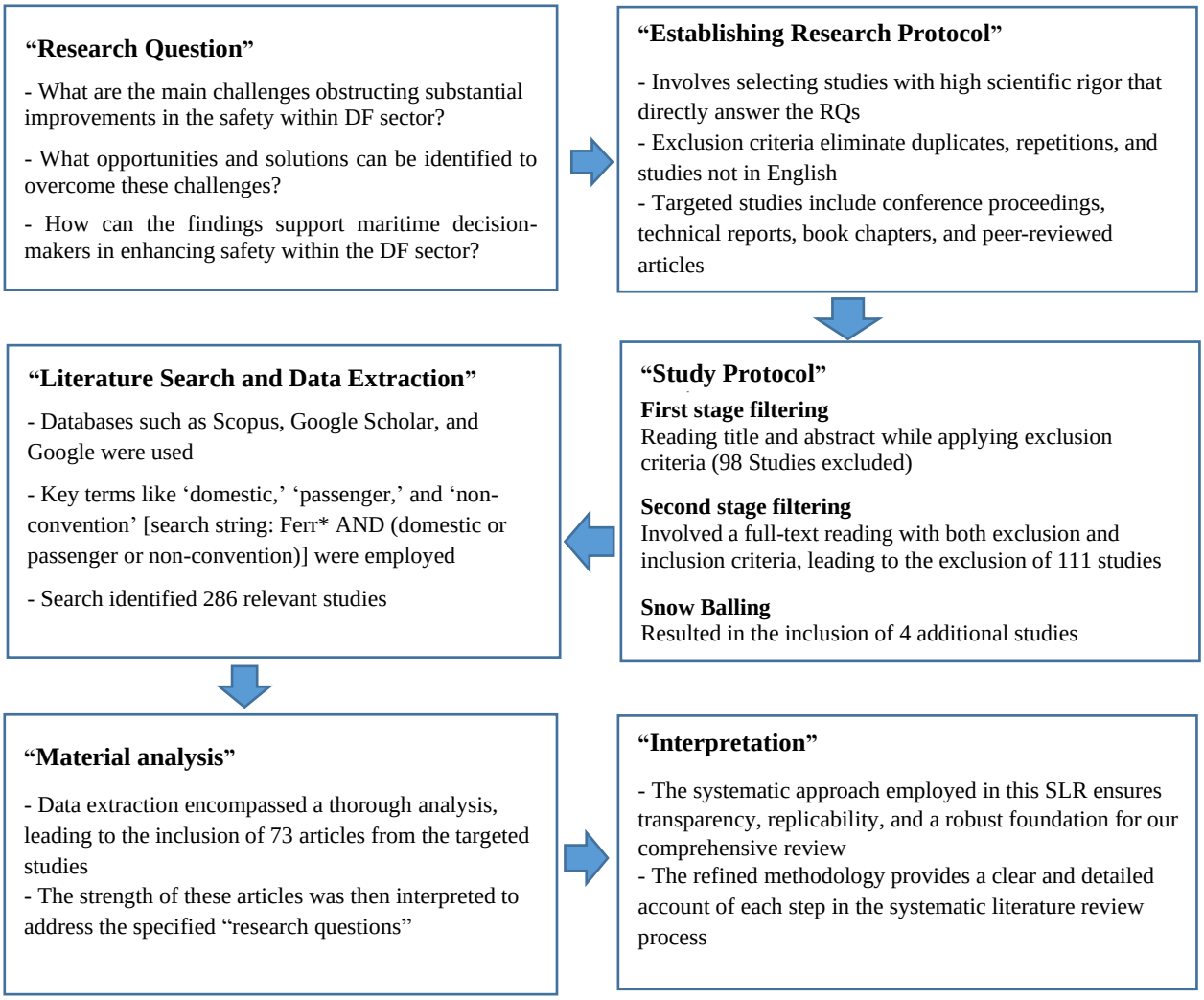

Figure 1 Iterative article selection process.
Source: Own illustration, based on Tranfield et al. (2003)

2.2 Material collection

In the initial phase, relevant materials were systematically collected by conducting a comprehensive search across esteemed databases such as Scopus, Google Scholar, and Google. Our search strategy, employing key terms like 'domestic,' 'passenger,' and 'non-convention' [search string: Ferr* AND (domestic or passenger or non-convention)], is tailored to focus on literature reviews and technical reports. This deliberate approach confines the search to English-language journal articles, without specifying a publication period. To enrich the diversity of our dataset, we intentionally included studies conducted by postgraduate students at the World Maritime University (WMU), Sweden, which is a leading institution specializing in maritime education and research. The inclusion ensured a multi-faceted perspective, with students typically pursuing Masters and PhD degrees in maritime-related disciplines. Their contributions bring valuable insights from their

professional maritime authority backgrounds and academic training. This selection criteria aimed to enhance the comprehensiveness and depth of our review. Subsequent stages involved coding and categorization, unveiling emerging thematic clusters, and resulting in the inclusion of a total of 286 studies in our comprehensive review.

2.3 Development stage

In the third stage of our research methodology, focused was placed on category selection, which formed the structural foundation for collecting and analyzing material. The categorization method was inspired by the work in an SLR of maritime cleaner logistics and supply chains (Alamoush et al., 2022; Vakili et al., 2022), but was adapted to the specific context, namely, maritime safety in the DF sector. This process involved three crucial steps- category building, testing, and continuous revisiting- as data was compared (Mayring, 2000; Seuring & Gold, 2012; Tranfield et al., 2003). This involved three crucial steps: category building, testing, and continuous revisiting. The lack of a comprehensive taxonomy for the DF sector's safety landscape led to identification of primary challenges and solutions. The chosen five broad categories- Operations, Technology and Innovation, the Human Element, Policy and Regulation, and Economics- aligned with the complex nature of the DF sector.

2.3.1 Broad classification of domestic ferry challenges

Identifying and categorizing challenges is a fundamental step, with an SLR used to systematically review academic journals, reports, and relevant sources. A total of 73 articles were included, with the five broad categories chosen reflecting the complex nature of the DF sector and its impact on maritime safety. **Figure 2** presents 28 identified challenges encountered in the DF sector, characterized under five broad categories.

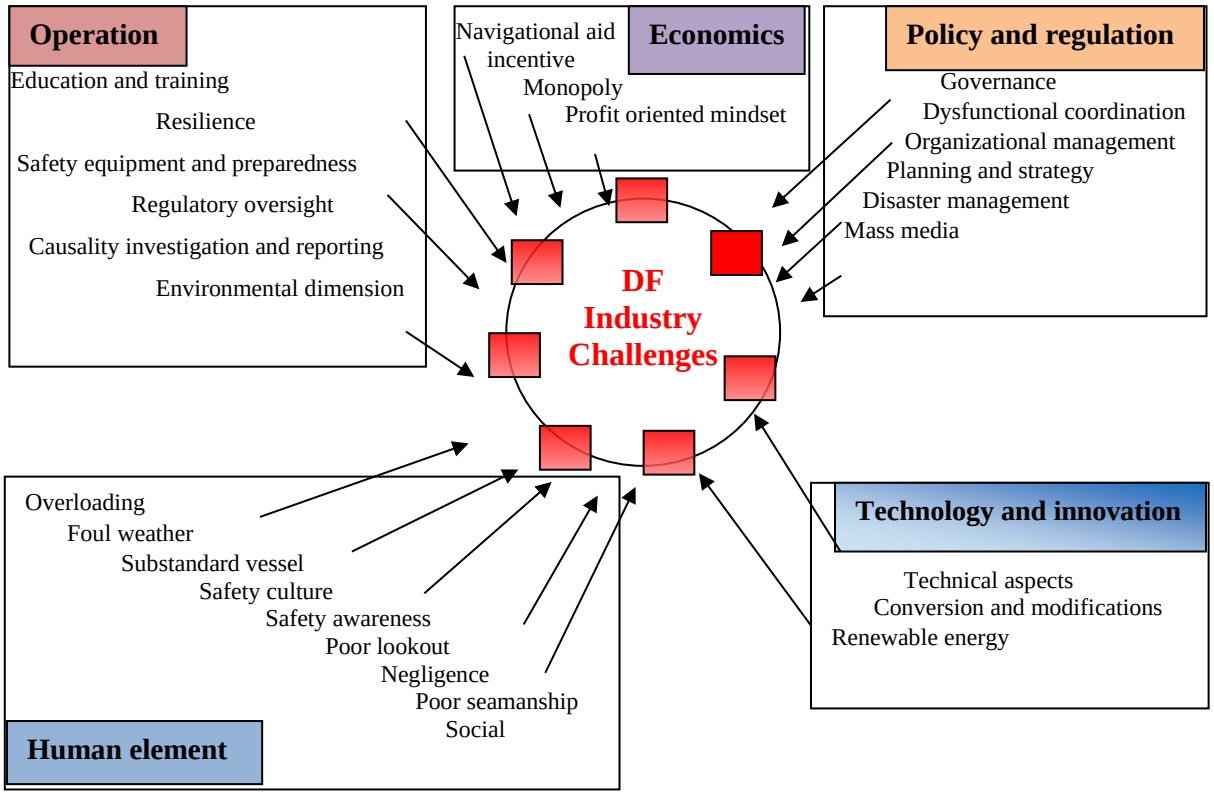

Figure 2 Classification of DF sector challenges in five categories.
Source: Own compilation

2.4 Data evaluation

In the final stage of the methodology, data evaluation was conducted with a focus on the previously mentioned categories. This process enhanced the visualization of the findings (Jaakkola, 2020). To ensure transparency and rigor in the data collection, category selection, content analysis, and material evaluation, other researchers were engaged, and the inter-rater agreement technique, was utilized, which involves discursive alignment of interpretation (Seuring & Gold, 2012; Seuring & Müller, 2008).

3. Results of systematic literature review

This subsection briefly summarizes the features and characteristics of the included studies. The basic body of the literature comprised 73 studies. The distribution of the studies about DF per year is displayed in **Figure 3**. Notably, DF studies have increased significantly over the years, particularly from 2018 onwards.

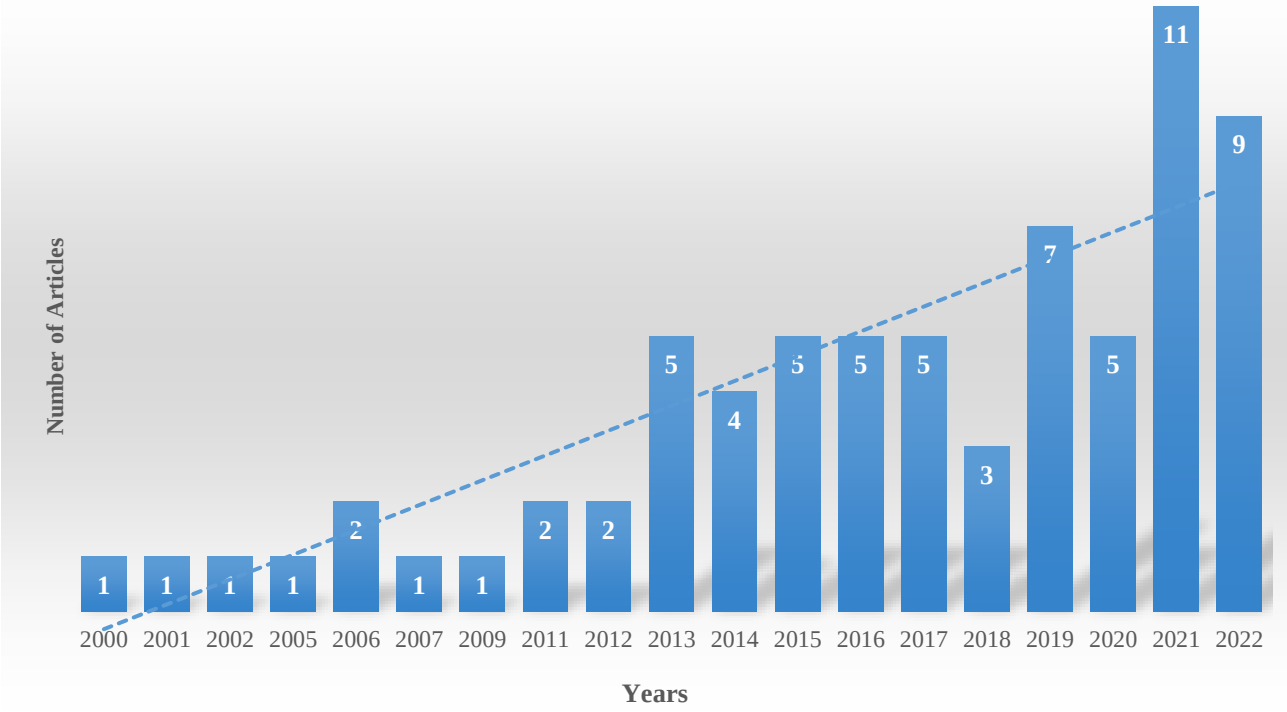

Figure 3 Frequency distribution of studies about DF per year, based on analysis of 73 articles. Source: Own compilation, from literature review

In terms of regional coverage of the studies, as depicted in **Figure 4**, the largest concentration of studies was observed in East Asia (48 %), followed by the EU (23 %), Africa (16 %), and the rest of the world (about 13 %). This tilt is largely influenced by the presence of developing countries in East Asia, fueling research interest in the DF sector within the region. It is important to note, however, that a higher percentage of studies in Asia does not automatically ensure uniform quality and depth. The diverse nature of these studies, with some focusing on specific aspects of the DF sector, emphasizes the need for a more comprehensive and interdisciplinary research approach. The quest to address the root causes of fatalities in the DF sector requires not only quantity, but also a nuanced exploration of operational, human, and environmental factors. Recognizing the variability in research methodologies employed in these studies is essential, as it prompts a call for advancing both the quantity and quality of research to effectively tackle safety challenges within the DF sector.

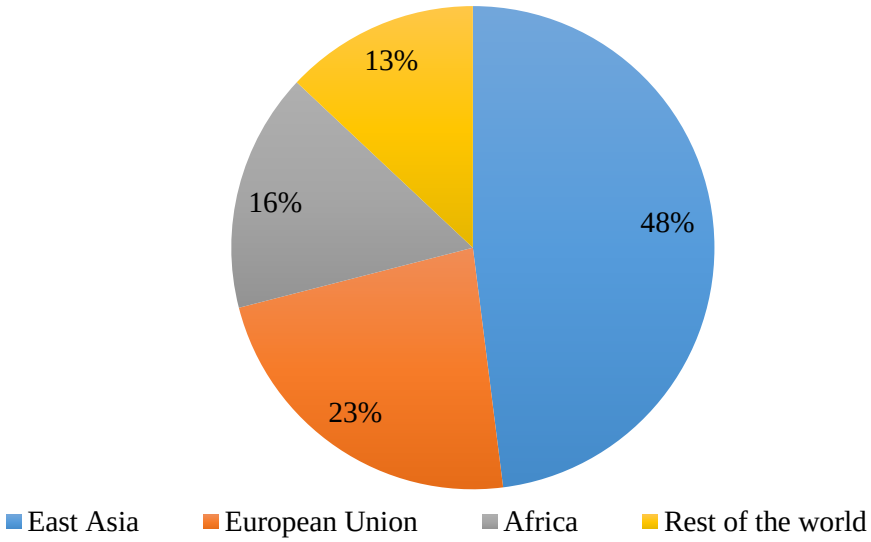

Figure 4 Percentage distribution of studies by region.
Source: Own compilation

4. Discussion

This section undertakes a scholarly examination of challenges within the DF sector, systematically categorized across five foundational categories: Operations, the Human Element, Policy and Regulation, Technology and Innovation, and Economics. The identification of 28 challenges, illustrated in **Figure 2**, is the result of a rigorous analysis that meticulously considered the complex interconnections among them (section 2 refers to this). The discernment of these interconnections is grounded in qualitative content analysis, ensuring a scholarly and transparent approach to understanding the complex relationships embedded within the DF sector's challenges. As each category is navigated through, it becomes apparent that challenges are not isolated entities, but are interconnected, reflecting the multifaceted nature of the maritime safety landscape. By unveiling these interconnections, this discussion aims to contribute to a distinct understanding of the intertwined challenges that necessitate a holistic and integrated approach for effective mitigation.

Beyond the identification of challenges, the study extends its scope to opportunities, totaling 90 across the five categories. Presented in a structured tabular format, these enablers serve as a strategic guide for stakeholders, providing a comprehensive pathway to inform decision-making processes geared towards enhancing maritime safety. This scholarly endeavor, characterized by its methodological rigor and academic precision, seeks to enrich the scholarly discourse on the challenges and opportunities within the DF sector. This discussion aspires to not only deepen the academic understanding of maritime safety, but also set the stage for future interdisciplinary research and practical interventions.

4.1 Operations

Aligned with the study's scope, this section dissects DF operations, identifying key challenges. These challenges are categorized as a focused exploration, adhering to academic rigor, and setting the stage for in-depth discussions. The challenges with DF operations identified in the study are aggregated into sub-categories, as follows:

4.1.1 Education and training

Safety training and education have a positive impact on improving crew safety management and knowledge (Herno Della et al., 2020). However, in developing countries, formal training facilities

are very limited and expensive; mostly crew and shore staff are unable to attain quality knowledge, which presents challenges for safe operations onboard and efficient accident investigation skills (Onsongo, 2017). Poor safety education and insufficient technical knowledge give rise to careless actions by crew, hence, causing several defects and non-compliance with rules (Huang, 2015; Kang, 2017). This attitude also encourages habits that a master or crew practice for over a year without any problem; certainly, at the time of any incident, these actions ultimately risk the lives of passengers (Atika, 2021). Additionally, fewer emphases on passenger safety awareness and life jacket drills compromise passenger safety (Lu & Tseng, 2012). Eventually, the non-existence of a training program that covers contingency planning, emergency preparedness drills, correct use of firefighting gears, stability in an emergency, and electrical knowledge ultimately promotes untrained crew and risks the vessel and human lives (Adiputra, 2020; Jiang, 2016; Sheilla, 2019).

4.1.2 Resilience

The Sewol ferry accident exhibited the blame culture that prevented moving of the focus from what went wrong and what was supposed to work. In the ferry sector, such a shift of focus, in order to have a proactive future orientation that might aid learning, is challenging. That would assist the core ideas of a high-reliability organization, such as mindfulness, commonly known as resilience engineering (Kee et al., 2017). Størkersen, in a study, identified that organizations, because of the tightness of schedules and competitiveness, display limited and low resilience to prevent unwanted events; therefore, emergency preparedness plans are difficult to practice during operations, especially fire drills, and are also affected due to short manning (Størkersen & Johansen, 2013). The Eastern Star [†] incident in China further accentuates the severe role of resilience, revealing crew underestimation of storm severity, delayed navigation stoppage, lax shipbuilding inspections, and profit-driven actions affecting safety (Wang et al., 2019).

4.1.3 Safety equipment and preparedness

To enhance safety in the backdrop of DF, vessels must adhere to a set of stringent safety measures, encompassing adequate safety equipment, compliance with regulatory policies, and a robust emergency response plan (Lu & Tseng, 2012). Deficiencies in safety apparatus, like inadequate fire protection and emergency drills, pose challenges, highlighted by collision and grounding safety assessments. The study by Thawillarp et al. (2014) on a ferry boat accident in Thailand[‡], in 2013, stresses the significance of safety equipment and preparedness. The findings reveal issues like insufficient buoyancy aids and communication breakdowns during emergencies (Gwaday, 2019; Raduan et al., 2017; Thawillarp et al., 2014). Moreover, the ability of the crew to utilize rescue communication systems and navigate survival procedures, such as locating lifeboats under stressful circumstances, remains a noteworthy challenge. The tragic incident involving the Sewol ferry underlines the gravity of this issue, where inadequate communication and response systems resulted in misperception and chaos during the disaster (Ha, 2017). Zhang et al. stated that, even in cases where ferries pass safety inspections, operational shortcomings become apparent during emergencies, exemplified by the Sewol ferry tragedy, where only one lifeboat was operational at the time of the accident. Further investigation revealed that the roles and responsibilities of maritime managers, often confined to onshore activities, exacerbated the situation (Zhang & Wang 2015). These identified challenges underscore the pressing need for a comprehensive re-evaluation of safety procedures, stressing the significance of regulatory compliance, crew training, and robust crisis management

[†] On June 1, 2015, the Eastern Star, a large-scale travel ship owned by Chongqing Eastern Steamship Company, capsized in the Jianli waters of the Yangtze River during a severe storm, resulting in 442 deaths- the most serious maritime accident since 1949. See Wang et al. (2019) for a detailed analysis of the Eastern Star incident

[‡] News clip from The Guardian, [3 Nov 2013], reporting on an overcrowded tourist ferry incident near Pattaya, Thailand, where six people lost their lives, including two Russians and a Chinese. The remaining approximately 200 passengers were successfully rescued

strategies to ensure the safety and well-being of passengers and crew members in the dynamic domain of DF operations.

4.1.4 Regulatory oversight

In light of the broader maritime regulatory framework, it is important to emphasize that regulatory oversight plays a pivotal role in ensuring the safety of passenger vessel operations. The lack of effective oversight by regulatory authorities, as highlighted by Onsongo (2017), to monitor the accuracy and integrity of the safety regime can lead to unsafe acts or practices within the sector. While safety remained the priority, deficient enforcement by the local authority, and non-compliance by ship operators with established safety regulations, increased the total number of fatalities (Abdul et al., 2014). Many DF accident findings revealed the absence of a suitable inspection and audit regime. This gap makes it difficult to detect inadequate equipment and safety measures, thereby posing a considerable threat to the safety of ferry operations (Adiputra, 2020; Jiang, 2016). Moreover, law enforcement inspectors generally lack the requisite skills to effectively evaluate whether ferry operations are safe or unsafe, which requires trained and qualified proficiency (Munyangeyo, 2021; Onsongo, 2017). The challenges are exacerbated by fragmented information, outdated checklists that fail to comprehensively cover all necessary documents and emergency equipment, and insufficient control mechanisms to counter-check inspection records, leading to oversights in the inspection process (Abiodun, 2021; Atika, 2021; Ronnie & Ong, 2021). Generally, operational irregularities of ferry terminals provide an opportunity, especially at night, for vessel owners to exploit the system and operate substandard vessels, further jeopardizing passenger safety (Abiodun, 2021).

4.1.5 Causality investigation or reporting

The integrity of maritime safety often stands at risk due to an inefficiency in scientific accident investigation capabilities among staff, resulting in a lack of substantial changes or knowledge acquisition following a DF accident (Munyangeyo, 2021; Onsongo, 2017). This inadequacy is further aggravated by a failure to promptly submit accident data and disseminate lessons learned to discern evolving trends in DF operations. Unlike the aviation sector, which has systematically gathered information on human factors since the 1970s (Schröder-Hinrichs et al., 2012), the maritime sector faced delays in addressing human and organizational factors, initiating discussions only after the capsizing of the Herald of Free Enterprise in 1987 (Department of Transport, 1987). Similarly, domestic ferry safety remains obscured by the lack of international attention and a common approach among interested States (Nurwahyudy, 2014). Thus, the lack of systematic analysis and global sharing of maritime accidents diminishes the industry's ability to gain international attention. Consequently, the deficit in international attention compromises vital aspects such as crew training, proficient emergency response, and the integration of advanced safety protocols (Heryandri, 2018; Nurwahyudy, 2014; Onsongo, 2017; Sakalayen, 2006). These deficiencies hamper the effective formulation of safety procedures.

4.1.6 Environmental dimension

Within the environmental dimension, the challenges that contributed to the accidents included elements such as strong winds, visibility, fog, waves, strong currents, and a complex water environment, including the navigation environment risk factor (referring to the risk caused by the natural environment) (Deng et al., 2022; Huang, 2015). Navigating through such environmental challenges poses significant threats to maritime safety, impeding the smooth and secure operations of DF services. Adverse weather conditions and rough seas constitute predictable risks, with wind and waves alone accounting for a substantial 55 % of impacts on marine and inland accidents (Deng et al., 2022; Montewka et al., 2022; Onsongo, 2017).

In the context of maritime safety, DF operations play a vital role, but their growth has raised concerns about energy consumption and air pollution. Member States are now striving to adopt

environmentally conscious solutions in line with IMO directions for the ferry sector (Kocaman, 2020). However, this transition towards environmental responsibility also presents challenges. The shift from fuel oil to natural gas, while environmentally beneficial, necessitates careful navigation to ensure that safety remains paramount. The need to navigate safely amidst these changes in fuel sources and their associated challenges is a significant obstacle (Liwagon et al., 2015; López-Aparicio et al., 2017). Environmental challenges underscore the necessity for a nuanced approach in DF operations, emphasizing the importance of balancing sustainability and safety. While strides are being made to mitigate the impact on the environment, it is crucial to address these challenges effectively to ensure maritime safety. The DF sector must continuously innovate to adapt to these changes, prioritizing the safety of passengers and crew without compromising environmental responsibility. Striking this balance effectively remains a key objective, ensuring the safety of all stakeholders despite the challenges posed by the evolving maritime landscape. The opportunities associated with the DF for the operations faced by academia are elaborated on in **Table 2**.

Table 2 Opportunities for operations.

Areas	Opportunities
Education and Training	• Targeted-oriented training based on lessons learned may be accomplished by the engaging owner, operator, administrative staff, crew operators, etc. • Pre-departure safety drills for passengers similar to the aviation industry may be promoted • Training education on emergency preparedness drills, emergency handling, and contingency planning may be designed • Academia may develop safety management course-related training materials for companies to promote safety
Resilience	• Seamanship is the key feature of safety and acts as an imperative layer of resilience • A shift of focus on resilience may provide a way to transition from retrospective to proactive safety
Safety equipment and preparedness	• All stakeholders are necessary to participate in disaster response to minimize impact • National disaster response should include disaster preparedness and disaster recovery • Emergency communication and SAR equipment skills may be made part of crew training
Regulatory Oversight	• Small craft inspection can reduce the risk of accident • Centralized data records accessible to enforcement officers and shore authorities can improve the inspection regime and reduce substandard ferry operations • Annual inspection seaworthiness stickers may be displayed n prominent places • Wooden and fiberglass boats need to be inspected before every tourist season, irrespective of the annual inspection
Causality Investigation or Reporting	• Owners must formulate policies under which every incident may be investigated, as well as contribute through company education to lessons learned • Lessons learned can be used to revise regulations, as well as make live documents • Causality investigation data may also be used to broaden the analysis and enable the identification of risks • Companies should encourage a reporting culture, an informed culture, and a flexible culture for crew to learn • An effective reporting system needs to be created to facilitate efficient SAR
Environmental Dimension	• Strong safety concerns, policies, and regulations, with a culture of timely caution, can prevent accidents under the influence of the environmental dimension • Dialogue on safety issues with crew may be encouraged in place of regular safety meetings • The use of LNG and alternative fuels can reduce further emissions • Electrification improves noise reduction, maneuverability, and vibration, enabling zero-emission energy solutions

Source: (Balestra & Schjølberg, 2021; Sheilla, 2019; Ha, 2017; Onsongo, 2017; Ronnie & Ong, 2021; Kee et al., 2017; Sakalayen, 2006; Størkersen & Johansen, 2013; Siyu et al., 2019; Jiang, 2016; Britz, 2014; Vlado et al., 2009; López-Aparicio et al., 2017; Kee et al., 2017)

4.2 Human element

The human elements is the cornerstone influencing the ability to navigate a range of challenges within the multifaceted environment of ferry operations (Faturachman & Mustafa, 2012b;

Suleiman, 2016). In this context, we delve into an in-depth discussion regarding the array of challenges related to the human element that profoundly impact the safety of DF operations.

4.2.1 Overloading

Overloading, a prevalent issue in DF operations, significantly reduces a vessel's freeboard[§] (Weisbrod, 2012), making it more susceptible to waves and instability. This dangerous practice leads to a heightened risk of capsizing, resulting in tragic consequences like passenger fatalities (Faturachman & Mustafa, 2012a; Munyangeyo, 2021). It is a direct cause of approximately 90 % of maritime accidents (Faturachman & Mustafa, 2012b; Munyangeyo, 2021). Efforts to ensure stability through safe design can be compromised by overcrowding, particularly on upper decks, which lowers the meta-centric height (Kocaman, 2020; Lawson & Weisbrod, 2005). This challenge is particularly prevalent in developing countries, where operators commonly overload vessels, especially on remote islands where passengers and cargo are transported on smaller boats (Suleiman, 2016; Vitus, 2015). In some cases, the exploitation of artificially low ticket prices by ferry operators is coupled with deliberate overloading of passengers and freight to cover the operational costs and earn a huge profit (Abiodun, 2021; Onsongo, 2017). This practice, while violating known carrying limits, remains unchecked by responsible ferry operators. Moreover, passenger details during embarkation in such conditions are often not recorded, complicating disaster response and recovery efforts (Golden & Weisbrod, 2016). This issue was remarkably evident in ferry disasters, demonstrated by incidents like MV Bukoba, MV Le Joola, and the Sewol tragedy, where overloading played a critical role, emphasizing the urgent need for regulation and oversight in DF operations (Aisha, 2011; Jiang, 2016; Sakalayen, 2006). The deficiency of human factors for non-convention ferry safety is a major challenge in developing countries, as illustrated by accidents such as the Bukoba ferry[**] in Tanzania, indicating poor patterns of crew training and risk judgment (Aisha, 2011; Sakalayen, 2006). These incidents emphasize the broader global challenges in maritime safety, necessitating comprehensive measures to address policy and governance issues.

4.2.2 Overlooking foul weather

In the realm of DF operations, foul weather emerges as an unpredictable and significant threat, particularly during rainy seasons or monsoon flooding. The onset of heavy winds, often resulting in water tornadoes known as down drafts and water spouts, poses severe risks to safe ferry operations, especially ro-ro services (Heryandri, 2018; Weisbrod, 2012). These environmental challenges substantially elevate the risk of vessels capsizing and tragically, the loss of both human lives and property. Alarmingly, approximately 50 % of ferry accidents can be partially attributed to foul weather conditions (Golden & Weisbrod, 2016; Kocaman, 2020; Siyu et al., 2019). The relationship between foul weather and ferry accidents is undeniable, exacerbated by factors like tight competition, limited time for berth allocation, and the demand to maintain schedules for continuous ferry services even during inclement weather (Nurwahyudy, 2014; Suleiman, 2016). One of the critical aspects contributing to these accidents is the rush to adhere to timetables despite foul weather conditions, often leading to fatalities (Atika, 2021; Gwaday, 2019). Secondly, there is a concerning tendency to either ignore, or not timely receive, weather alerts based on habits and past experiences. Improper stowage of cargo is another element of danger, creating a top-heavy imbalance that, combined with foul weather, significantly elevates the risk of vessel listing or capsizing (Lawson & Weisbrod, 2005; Onsongo, 2017).

[§] The distance between the waterline and the main deck or weather deck of a ship or between the level of the water and the upper edge of the side of a small boat, Merriam-Webster (2023), freeboard. https://www.merriam-webster.com/dictionary/freeboard

[**] In 1996, the sinking of the M/V Bukoba claimed up to 1,000 lives. Over 500 people were trapped inside the steel hull as the ship capsized in calm waters, around 10 km Northwest of Mwanza, Tanzania.

4.2.3 Substandard vessels

The use of substandard or inadequately seaworthy vessels is a prevalent and concerning challenge in many developing regions within the DF sector. The catastrophic sinking of MV Pinak-6[††] in Bangladesh, vividly illustrates the consequences associated with substandard vessel operations (Rashid & Islam, 2017). These vessels often lack necessary fit-to-operate certificates (Lawson & Weisbrod, 2005) and may have compromised structural integrity, leading to an increased risk of technical failures and accidents (Golden & Weisbrod, 2016; Siyu et al., 2019). The absence of proper safety control and insufficient safety equipment inspections further worsen the seaworthiness of these vessels (Suleiman, 2016). Frequently, private operators in syndicated businesses are behind the operation of these substandard vessels, sometimes even utilizing influence or pressure tactics to limit new, safer, vessel operators (Sakalayen, 2006). Additionally, modifications made to traditional boats for commercialization purposes often undermine their original safety features, presenting a significant risk to maritime safety (Atika, 2021; Prasetiawan et al., 2021).

4.2.4 Safety culture

In the contemporary era of safety, often referred to as the 'third age of safety,' emphasis has shifted from technological solutions (first safety age) and organizational measures (second safety age) to a focus on human behavior and safety culture (Erik, 2014). Researchers have tied safety culture to fundamental assumptions and awareness of how safety issues are generally handled, especially in developing countries, where inadequate record-keeping and weak safety management undermine safety precautions (Golden & Weisbrod, 2016; Heryandri, 2018); however, the absence of a culture that prioritizes timely caution, strong regulation, and safety consciousness, potentially preventing maritime accidents even in adverse weather conditions , poses a significant challenge aboard vessels (Adiputra, 2020; Onsongo, 2017). Ferry operators must prioritize the development of a robust safety culture to enhance safety behavior among organizations and crews (Herno Della et al., 2020). Notably, investigations into DF accidents have exposed how a weak safety culture among operators contributes to compromised watertight hull integrity and unsafe vessel design, ultimately amplifying managerial inefficiency and manpower incompetence (Ronnie & Ong 2021; Vitus, 2015). This lack of focus on safety culture not only affects operational efficiency, but can also lead to structural vulnerabilities in vessels. Additionally, beyond the operators, a lack of safety culture is prevalent among a considerable portion of the island and coastal community travelers, significantly increasing the occurrence of accidents or near-miss incidents (Gwaday, 2019; Jiang, 2016).

4.2.5 Safety awareness

Safety awareness is a linchpin in fostering responsible behavior, sound decision-making, and professional ethics within the maritime domain (Huang, 2015). This heightened sense of safety consciousness serves as a deterrent against unsafe acts, violations, and potential disasters (Onsongo, 2017). However, a crucial challenge arises from decision-makers, responsible for vessel design, crew management, cargo arrangement, and overall safe vessel operations, being either unaware or dismissive of the far-reaching impact their decisions can have on safety systems (Kim et al., 2016). Often, these decision-makers are oblivious to the true cost and economic consequences of accidents, highlighting a critical gap in safety awareness at the management level. A hard example is the tragic Sewol ferry accident, where a lack of safety awareness within the management significantly contributed to the disaster (Raduan et al., 2017; Zhang & Wang, 2015). Moreover, a considerable challenge lies in the inadequate awareness of safety equipment, including life jackets, among passengers and the general public (Abiodun, 2021; Kee et al., 2017; Suleiman, 2016).

[††] MV Pinak-6 sank in the Padma River near Mawa Ghat on August 4, 2014, carrying over 200 passengers, far beyond its capacity of 85, with an expired fitness certificate.

4.2.6 Poor lookout

Maintaining a proper lookout is a fundamental prerequisite for effective watchkeeping. Inadequate vigilance can lead to critical errors in judgment, non-compliance with regulations, lack of coordination between the pilot and bridge crew, and insufficient technical knowledge, particularly regarding radar operation. These human errors significantly contribute to ferry boat accidents (Abiodun, 2021; Berg et al., 2013; Suleiman, 2016). The effectiveness of proper lookout is significantly compromised by various external factors such as fog, foul weather, low visibility, and adverse environmental conditions like rough seas, high tides, and gusty winds. These conditions substantially heighten the risk of collisions (Faturachman & Mustafa, 2012b; Siyu et al., 2019). When visibility is drastically reduced, as in poor weather conditions, the role of a lookout becomes even more challenging. In such scenarios, coupled with poor bridge management, fatigue, weak eyesight, and electronic distractions, lookout responsibilities become a contributing factor in approximately 22 % of accidents (Baird, 2018; Faturachman & Mustafa, 2012b). The tragic incident involving the MV Doña Paz[‡‡] serves as a miserable reminder of the catastrophic consequences that result from a lack of proper lookout, particularly on the tanker deck (Perez et al., 2011). These challenges underscore the critical importance of maintaining a diligent lookout to ensure maritime safety.

4.2.7 Negligence

Negligence poses a significant threat to maritime safety, often overshadowing the imperative of 'safety first' in the shipping sector, particularly at the operational level (Schröder-Hinrichs et al., 2012). Safety remains a watchdog for passenger ferry services, but the negligence of crews often leads to accidents (Herno Della et al., 2020). In developing countries, negligence emerges as the third most significant contributing factor, responsible for approximately 40 % of marine and inland accidents. These incidents are marked by delayed actions and a concerning lack of safety awareness (Baird, 2018; Deng et al., 2022; LRF, 2018). The spectrum of crew negligence encompasses critical dimensions such as situational awareness, organizational mismanagement, structural deficiencies, oversight in pre-departure safety checks, overloading, inadequate adherence to safety standards, and lapses in ballast management (Aisha, 2011; Chae et al., 2021; Ha, 2017; Nurwahyudy, 2014).

4.2.8 Poor seamanship

Seamanship can be defined as the "art or practice of managing a ship or boat at sea; the skill of a good seaman"; among other major fatal challenges, poor seamanship is also a leading factor (Baird, 2018). Accident investigations have consistently underscored the pivotal role of seamanship. The lack of seamanship knowledge among crew members can escalate seemingly minor tasks into perilous situations. Instances include inadequate lashing of vehicles or cargo and improper securing of cargo. Factors such as the pressure for quick turnovers and limited time at the berth, often stemming from a company's profit-oriented policies, compound the complexity of maintaining sound seamanship practices (Kee et al., 2017; Nurwahyudy, 2014; Størkersen & Johansen, 2013). Kee et al. (2017), appropriately emphasize that deficiencies in seamanship are often attributable to multiple factors. These include a lack of comprehensive training, the precarious positions of crew members, low salaries, and shifts in a company's priorities, often leaning more towards financial gains than towards the safety of passengers and operations.

4.2.9 Social dimension

Ferry operations play a vital role in maintaining efficient transportation systems and exert significant influence on the overall well-being, social dynamics, and environmental health of communities (Ave, 2007). Particularly in developing countries, DF offers essential social support by

[‡‡] The MV Doña Paz sank on December 20, 1987, in the Philippines, resulting in the tragic loss of over 4,000 lives. The ship, overloaded beyond its declared capacity, departed from Tacloban City in Samar to Manila. See the study of Perez et al. (2011) for detailed insights into the factors contributing to this maritime disaster

integrating the nation and facilitating economic activities for commuters. However, ensuring safe operations necessitates a focus on improving crew conditions, due to the repetitive and regular nature of their work (Nurwahyudy, 2014). Sakalayen argued that, unfortunately, in the 21st century, some ferry owners prioritize revenue over human lives, allowing overcrowding and overloading, which significantly heightens the risk of accidents (Sakalayen, 2006). This jeopardizes the social fabric of the community, causing immense suffering for families and peers. Tragic incidents result in sudden disruptions for families, especially with the loss of breadwinners. Additionally, inadequate insurance coverage poses a significant social protection challenge for passengers, leaving them vulnerable to risks (Oo, 2019; Vitus, 2015). The far-reaching aftermath of accidents like the Sewol disaster is profoundly distressing. A survey revealed that 41.4 % of victims considered suicide, 67 % of victims quit their jobs, and 73 % faced severe disruptions in their social relations (Lee et al., 2022; Yen et al., 2018).

Table 3 Opportunities for the human element.

Areas	Opportunities
Overloading	• Pre-check inspections may be increased pre-voyage • Monitor the loading limits through the sensors • Install weight-sensing systems on elevators to prevent overloading • Employ a business model enabling advance ticketing, offering guaranteed seats • Overloading or overcrowding issues may be addressed with the IMO model regulation • Tickets may be crossed for the exact counting of passengers
Overlooking Foul Weather	• Implement an affordable, real-time weather reporting system • Vessels may be built or modified to be more resistant according to the local weather conditions • Conduct awareness campaigns on marine weather forecasting importance • Encourage marine VHF/ HF installation radio for updated weather broadcasts • Adopt mobile-based storm alerts using SMS or relevant technology
Substandard Vessels	• Grant permits to seaworthy vessels through local authorities with accessible database information • Centralized data information with all inspectors for counter checks to be in place • Organizations involved with construction, design, maintenance, certifications, and regulatory authority should exchange information • Provide additional safety equipment, such as LSA, AIS, flares, EPIRBs, etc. • Conduct frequent or surprise inspections to ensure safety equipment compliance
Safety Culture	• Promote an informed and flexible safety culture with a focus on learning and reporting • Cultivate a close-knit safety culture involving crew and administrations to enhance safety awareness • Create an environment encouraging strong employee involvement in safety practices • Shift the awareness and education approach to value human life instead of economics • Operators should monitor and adopt updated safety compliance
Safety Awareness	• Operators may conduct safety drills after boarding, demonstrating rescue equipment, pointing out emergency exits, and delivering safety instructions • Crew competence and emergency response behavior may be focused on • Emphasis to be given on behavior modification instead of technical improvement • Owners should take responsibility and ensure that crew is aware of vessel and passenger safety policies • Victims' families may be engaged to tell their ordeals and how accidents can affect communities • The partnership of educational institutes and media is encouraged
Poor Lookout	• Better management, coordination, leadership, and discipline may be instituted • Training packages may include the importance of proper lookout
Negligence	• Crew may be educated about the importance of safety measures and policy regulations
Poor Seamanship	• Companies' management may prioritize seamanship knowledge with training and education • Seaman practices, such as pre-safety checks, safety lash checks, etc., may be implemented
Social Dimension	• Health safety environment meetings with crew to debate safety issues being formed • Governments may ensure the social protection of ferry passengers by introducing insurance • A transparent system and accountability may be ensured for any incident investigation

Source: (Kocaman, 2020; Prasetiawan et al., 2021; Golden & Weisbrod, 2016; Weisbrod, 2012; Abdul et al., 2014; Onsongo, 2017; Munyangeyo, 2021; Gwaday, 2019; Ronnie & Ong, 2021; Britz, 2014; Baird, 2018; Suleiman, 2016; Herno Della et al., 2020; Kee et al., 2017; Størkersen & Johansen, 2013; Lu & Tseng, 2012; Raduan et al., 2017)

The opportunities under the umbrella of human element, and which are argued about by academia in the search for plausible solutions, are illustrated in **Table 3**.

4.3 Policy and regulation

Policies and regulations are essential in guiding maritime organizations toward safe operations. However, in the competitive ferry sector, diverse functionalities in handling freight and passengers often pose safety challenges. Strengthening policy standards and regulatory frameworks is crucial for secure navigation and overall safety in the sector (Lu & Tseng, 2012; Wisdom & Kamanga, 2002). The challenges faced in the category of policy and regulations by academia are discussed as follows.

4.3.1 Governance

Effective governance in the DF sector is paramount for ensuring safe operations. However, this poses significant challenges. The development and implementation of policies that prioritize safety necessitate active involvement from operators, academia, and passengers (Lu & Tseng, 2012). Maritime governance refers to the relationships that direct, influence, and regulate shipping activities, aiming to address societal challenges and opportunities and establish a normative framework for these activities (Bjerkan et al., 2019). DF operations, covering areas such as registration, construction, safety equipment, route scheduling, maintenance, manning, and survey, are subject to national regulation. Unfortunately, in several developing IMO Member States, these regulations face challenges due to resource scarcity, inadequate management, and a lack of requisite expertise (Baten, 2022; Lu & Tseng, 2012; Onsongo, 2017). The Sewol disaster serves as a poignant example, alongside the Le Joola ferry[§§] tragedy in Senegal, where over 1,800 passengers perished, making it the second-worst maritime disaster of the modern era and the highest death toll of any African maritime sinking (Rothe et al., 2006). Despite passing safety inspections before these accidents, both incidents revealed critical governance shortcomings (Wang et al., 2020). This necessitates essentially strengthening governance structures and practices to enhance safety in the DF sector.

4.3.2 Dysfunctional coordination

Effective coordination within a maritime organization is a fundamental necessity, especially in the context of DF operations. Dysfunction in coordination across various departments within a multi-layered organization can lead to a manifold of challenges and, ultimately, accidents, particularly in adverse weather conditions (Ahsan & Panday, 2013; Raduan et al., 2017). In critical situations such as fires or capsizing incidents, seamless coordination becomes paramount; any lack thereof can result in distractions, confusion, and a display of inadequate training during emergency response measures (Nurwahyudy, 2014). Notably, inadequate coordination was a contributing factor in the tragic case of the Sewol ferry, impacting decision-making processes (Kim et al., 2016). Additionally, this breakdown in coordination posed limitations on the ability to utilize high-tech devices and underwater cameras, causing frustration among both divers and the victims' families (Ha, 2017). Therefore, dysfunction in coordination within maritime organizations is a significant challenge, posing a serious threat to safety during DF operations.

4.3.3 Safety management

Safety management within the maritime domain is a critical facet of organizational oversight (Kristiansen, 2005), encompassing systematic and safety-focused management of both physical and human resources. However, within the DF sector, the lack of consistent and vigilant monitoring of safety aspects has resulted in deficient safety supervision and management (Atika, 2021). While ro-

[§§] MV Le Joola, a Senegalese government-owned ro-ro ferry, capsized off the Gambia's coast on September 26, 2002, resulting in 1,863 deaths and 64 survivors- the third-worst non-military disaster in maritime history. See Rothe et al. (2006) for a detailed analysis of the MV Le Joola incident.

ro transportation is efficient in driving economic activities, it requires a heightened focus on ship safety management due to its unique design and operational challenges (Huang, 2015). Ineffective safety management significantly increases the risk of accidents, as evident in cases involving the mishandling of dangerous cargoes during fire investigations on ro-ro ferries (Nurwahyudy, 2014).

Moreover, the lack of adequate feedback channels for reporting safety-critical information to maritime authorities exacerbates the potential for accidents. The Sewol ferry incident serves as an example, where critical safety actions were not effectively monitored and reported (Jiang, 2016). Additionally, the maritime community was deeply impacted by the MV Samina[***] incident in Greek waters, a tragic event that claimed the lives of 80 passengers and crewmembers. A collision with a rocky islet, coupled with left open, normally watertight, doors, exemplified lapses in safety management, highlighting the urgent need for comprehensive safety measures in the DF sector (Papanikolaou et al., 2004). Typically, ensuring adherence to safety standards is delegated to operators who often prioritize maximizing commercial interests over safety procedures (Aisha, 2011). Ferry operations, characterized by tight and regular schedules, tend to normalize work routines, reducing the reliance on procedural guidelines and increasing the likelihood of violations. A study revealed that 67 % of employees did not consistently follow procedures, highlighting challenges in onshore and ship-borne supervision (Bye & Aalberg, 2020; Heryandri, 2018). As modern ships incorporate a multitude of complex components- ranging from electrical and mechanical systems to hydraulic and electronic elements- the potential for safety chain disruptions amplifies, emphasizing safety management challenges within the maritime industry (González-Almeida & Padrón-Martín, 2019).

4.3.4 Planning and strategy

A key element in enhancing safety within the DF sector lies in meticulous planning and strategic approaches, augmented by comprehensive information dissemination and training. This principle is accentuated by the predominant belief in the significance of adhering to procedures and the effectiveness of procedural compliance. Essentially, safety can be optimally achieved by ensuring that 'Work-As-Done' aligns seamlessly with 'Work-As-Imagined' (Erik, 2014). Unfortunately, the lack of robust planning and strategy formulation represents a primary challenge in decision-making, significantly constraining a crew's ability to perform optimally. Nevertheless, proactive planning by ferry operators can substantially mitigate these challenges (Heryandri, 2018; Nurwahyudy, 2014). The confined and dynamic environment of a vessel demands proactive planning and strategic thinking, especially during emergencies. Inadequate strategies for this exclusive setting can compromise safety measures and emergency response, making it a serious challenge (Wang et al., 2021). Therefore, addressing these challenges is paramount for fostering a safer DF environment.

4.3.5 Disaster management

Ferry disasters, as emphasized by Yen et al. (2018) not only pose direct threats to human lives and ferry assets, but also lead to a significant decrease in operational efficiency, demonstrating the broad-reaching implications of such events. Investigations into DF accidents underscore a critical challenge in disaster response-insufficient participation from all stakeholders. This limitation hinders effective disaster impact minimization and management (Ha, 2017). Disaster management complexities are exacerbated in developing countries due to various factors. These include delayed and unclear information, challenging disaster coordination, limited communication equipment, inadequate radio/ mobile network coverage, and adverse weather conditions, rendering disaster response more complex (Gwaday, 2019; Heryandri, 2018). Another challenge lies in the timely reception of distress information and signals by search and rescue (SAR) coordinators, the absence

[***] On September 26, 2003, the Greek ro-ro passenger ferry Express Samina sank near Paros, Greece, on its third anniversary. See Papanikolaou et al. (2004) for a detailed analysis of the MV Samina incident.

of which results in the obstructing of swift and effective disaster management (Golden & Weisbrod, 2016).

4.3.6 Mass media

A notable challenge is the inadequacy of focused media coverage on accidents in the DF sector. Often, these incidents receive insufficient attention, limiting the dissemination of crucial safety-related information and the comprehension of ferry operation risks (Golden & Weisbrod, 2016). Maritime accidents typically receive initial media coverage, but follow-up reporting, which includes identifying responsible parties and conducting thorough investigations, is often lacking, hindering a comprehensive understanding of the event (Sakalayen, 2006). Media professionals frequently lack technical knowledge about safety protocols and operational intricacies in DF services, which affects their ability to provide detailed and accurate reports on root causes and necessary safety measures (Ha, 2017). Media coverage, especially live broadcasting and extensive sharing on social platforms, of DF accidents can have a profound psychological impact on commuters and stakeholders. Repeated exposure to distressing scenes and tragic events through the media can lead to heightened anxiety, stress, and negative emotions within the community, particularly affecting those directly associated with ferry services (Woo et al., 2015). Addressing these media challenges, with a specific focus on the DF sector, is vital for improving safety communication, accurate reporting, and fostering a better understanding of safety measures among the public and stakeholders involved in DF operations.

Table 4 Opportunities for policy and regulation.

Areas	Opportunities
Governance	• Ferry governors may keep communications with all ferry operators, owners, academia, etc., for formulating any maritime safety policy • Taskforces may be formulated to ensure compliance with rules and regulation • Maritime authorities should have strong governance to ban non-compliance ferries
Dysfunctional Coordination	• Besides ferry crew, corporate culture and behavior may be changed to have increased coordination • Instead of time-based meetings, hosting regular interactions in the form of emerging crew trends may be undertaken • Maritime administration may work hand in hand with ferry operators and owners to ensure the safe implementation of regulations for developing safety rather than making profits
Organizational management	• Organizational management may be standardized with maritime safety requirements • The required human resources, such as naval architects and marine engineers, on equal footing may be recruited for improved management
Safety Management	• Successful feedback channels to report and process safety critical information to maritime authorities may be established to improve safety management • Maritime safety may take priority and profit pursuit may be balanced with safety management • Crew and staff knowledge-based skills development for the maintenance of the high quality of safety through training needs to be promoted
Planning and Strategy	• Risks of human error can be reduced by conducting early planning and strategy • Effective planning and schedule management can reduce the collision risk in a busy harbor • One of the costless and easy methods for reducing accident probabilities is proposed as *schedule management*
Disaster Management	• All stakeholders should participate in the planning phase for the coordinated implementation of disaster response • Focus may be accorded to the disaster prevention measures along with disaster response • An effective emergency reporting system needs to be developed to facilitate SAR
Mass Media	• Mass media need to set up guidelines in a professional manner to cover the whole range of disaster management • Mass media need to participate an efficient part in promoting maritime safety awareness to the local community

Source: (Heryandri, 2018; Lu & Tseng, 2012; Abiodun, 2021; Sakalayen, 2006; Jiang, 2016; Wisdom & Kamanga, 2002; Korçak & Balas, 2020; Ha, 2017; Onsongo, 2017)

The opportunities for plausible solutions faced by academia in the light of policy and regulations are displayed in **Table 4** for further improvement.

4.4 Technology and innovation

In the ever-evolving landscape of maritime safety, the role of technology and innovation cannot be overstated. This section delves into the pivotal role of technology and the innovative frontier, shedding light on the challenges and opportunities that significantly impact the safety fabric of DF operations:

4.4.1 Technical factors

Several researchers have meticulously investigated the technical underpinnings that contribute to challenges within the passenger ferry domain. A comprehensive analysis reveals a spectrum of decisive technical components implicated in safety concerns, including propulsion systems, radar, steering mechanisms, associated couplings, fuel systems, engines, VHF communication, GPS systems, hydraulic systems, and power supply. Failures in any of these essential technical aspects significantly deteriorate the risks of vessel damage and amplify the potential for fatalities (Siyu et al., 2019; Suleiman, 2016). Furthermore, these technical challenges are exacerbated by inaccuracies in ship design and suboptimal maintenance practices, often resulting in accidents such as collisions and fires. Rectifying these deficiencies and advancing design and maintenance protocols is imperative to mitigate accidents and elevate safety standards (Faturachman & Mustafa, 2012b). In various developing countries, the majority of older and second-hand ferries compound these challenges. A significant portion of ships in such regions lack modern technical advancements and suffer from inadequate structural integrity. Addressing these technological deficiencies is pivotal for strengthening safety measures within the DF sector, especially in regions heavily reliant on outdated vessel models (Golden & Weisbrod, 2016).

4.4.2 Conversion and modification

Poor modifications and maintenance practices within the DF sector present significant operational challenges and emphasize issues with regulatory oversight (Sakalayen, 2006). Often driven by profit motives, vessel owners tend to augment passenger and cargo capacities, inadvertently disrupting the vessel's draught, resistance, and displacement dynamics, resulting in an important reduction of metacenter height and integrity (Baird, 2018; Vassalos et al., 2015). The author's perspective is that these profit-driven modifications increase the likelihood of accidents by compromising the vessel's original design and stability. Accident investigations have highlighted cases where the vessel's construction did not align with the sea and physical conditions due to improper modifications, consequently increasing the probability of accidents (Adiputra, 2020; Nurwahyudy, 2014). In many developing countries, a diverse range of challenges during modifications, such as the installation of land engines, the adding of decks, the lack of available naval architects, the absence of ship stability diagrams, and falsified documentation, contribute significantly to accidents (Baird, 2018; Jiang, 2016; Lu & Tseng, 2012; Weisbrod, 2012).

4.4.3 Renewable energy

The transition to renewable energy sources is not only a step towards environmental sustainability but also a fundamental safety concern in the DF sector. The adaptation of a reliable and environmentally sustainable ferry system is a critical concern for countries aiming for a sustainable future. While ferries inherently produce a lower environmental impact compared to other transportation sectors, highly developed nations are increasingly encouraging the water transportation sector, both passenger and freight, to adopt sustainable solutions (Lawson & Weisbrod, 2005). A notable example is Norway, where the DF sector is actively embracing electrification as an innovative system, requiring collaborative efforts and mutual trust among stakeholders to significantly reduce

greenhouse gas emissions within the maritime sector (Balestra & Schjølberg, 2021). However, transitioning to alternative energy sources, particularly low-emission fuels, remains a major challenge for developing countries (Al-falahi et al., 2019). Despite the global sustainability push, maritime transport and, specifically, safety considerations in this transition have not received the necessary focus, underlining the need for an integrated approach that prioritizes safety while striving for sustainability (Sæther & Moe, 2021).

The viable opportunities for an effective solution to mitigate DF accidents in the future faced by academia in the light of technology and innovation are displayed in **Table 5**.

Table 5 Opportunities for technology and innovation.

Areas	Opportunities
Technical Factors	• The use of a combination of ashore supply and alternative fuels can reduce emissions by up to 23 % (NO_x) and 17 % (CO_2) • Necessary preparation for preparing relevant rules on the electrification of ferries may be instituted by maritime authorities
Conversion and Modification	• Strategies need to be developed for the strict implementation of established standards relating to vessel conversion and modification • In developing countries, the sites for ship modification or launch may be controlled • The use of electronic records can improve the certifications and permits for modification by regulators for effective tracking • All stakeholders concerned with construction, design, maintenance, classification societies, and regulatory authorities may adopt a transparent and strict liability regime
Renewable Energy	• The ferry sector needs to explore the use of alternative fuels for a sustainable green solution

Source: (Onsongo, 2017; López-Aparicio et al., 2017; Hong et al., 2021; Britz, 2014; Weisbrod, 2012; Sæther & Moe, 2021; Sakalayen, 2006)

4.5 Economics

Economic vitality and sustainability in the domain of DF transportation are linked with multiple challenges. These challenges, ranging from monopolistic practices to profit-centric mindsets, significantly impact not only the financial aspects, but also the safety, regulation, and overall well-being of passengers, crews, and the maritime industry as a whole. In this section, we delve into the distinct economic challenges that underlie the operations and safety within the DF sector.

4.5.1 Navigational aids

Navigational aids carry a significant role in limiting maritime risk; the shapes, types, and sizes of navigational aids depend on the purpose and region. These are radar reflectors, navigational or channel buoys, directional cardinal, fog signals, etc. (Kocaman, 2020). ‘Aids to navigation’ refers to off-ship devices and systems designed to enhance maritime navigation’s safety and efficiency (Monje, 2013; Wisdom & Kamanga, 2002). Accidents such as collisions and groundings, contributing to 22 % of all maritime mishaps, often relate to navigational challenges (Golden & Weisbrod, 2016). The absence of tug assistance and functional navigational aids, particularly lit buoys within traffic separation schemes, poses a substantial threat to DF operations (Ronnie & Ong, 2021). Moreover, night operations prove another challenge, as aids to navigation are not visible to the operators (Abiodun, 2021). In many developing countries, shortage or misplacement of aids to navigation, outdated charts, improper use of compasses, radars, communication equipment, and sound signals

significantly contribute to DF accidents (Kang, 2017; Nurwahyudy, 2014). The implication of addressing these challenges for enhanced DF safety cannot be understated.

4.5.2 Incentives

Incentives and cost-cutting initiatives implemented by ferry owners often lead to perilous circumstances for both passengers and vessels, a trend particularly prominent in developing countries (Baird, 2018; Weisbrod, 2012). This focus on financial gains over safety was tragically exhibited in the Sewol incident (Jiang, 2016). Furthermore, the lack of insurance for passengers endangers the victim's state of affairs, emphasizing a vital safety concern. This also has an impact on the government in supporting vulnerable victims when insurance is not made, further underscoring the necessity for safety-focused policies and practices (Oo, 2019). Therefore, the arrangement for an incentive of public insurance can make ferry passengers more attractive and strengthen safety measures. On the other hand, in addressing environmental concerns and aiming for sustainable practices, countries like Norway are pioneering efforts by providing various incentives and implementing mild policies to encourage a sustainable shift in the DF sector (Bjerkan et al., 2019). These strategies aim to alleviate high operational costs and reduce air emissions, eventually contributing to enhanced safety and sustainability within the sector (Kocaman, 2020).

4.5.3 Monopolies

Countries comprising numerous islands or remote areas have contended with the influence of private operators, particularly the operation of substandard vessels, presenting a significant challenge to maritime safety. The lack of supervision and assessment of vessel fitness aggravates this concern, contributing to a deteriorated safety landscape within the sector. An alarming aspect of this challenge lies in the monopolistic practices of ferry owners, who restrict new entrants from establishing services with improved vessels, further impeding advancements in maritime safety (Sakalayen, 2006). Additionally, the monopoly of ferry owners manifests in inadequate maintenance of ticketing systems and passenger documentation, driven by motives to maximize passenger and cargo loads, presenting a vibrant safety concern (Suleiman, 2016). This monopolistic control extends to developing countries, where ferry owners exploit their position by engaging in strikes, leveraging the entire system to press for illegal demands and avoid strict regulatory enforcement, thus undermining safety procedures (Sakalayen, 2006; Suleiman, 2016). The monopoly challenge, therefore, significantly impacts safety practices, necessitating comprehensive measures and reforms to promote fair competition and prioritize safety over economic interests, ultimately ensuring safer DF operations.

4.5.4 Profit-oriented mindset

The profit-driven mindset in the DF sector heightens safety challenges, undermining maritime security. Several DF accidents can be linked to factors like unreliable safety inspections, limited safety awareness, inadequate equipment, and delayed maintenance- all driven by profit motives (Suleiman, 2016). In many developing countries, low ticket prices foster cutthroat competition, encouraging vessel overloading (Lawson & Weisbrod, 2005). This alarming drive to increase profit margins prompts owners to overload both passengers and cargo, deliberately disregarding maritime safety and the welfare of those onboard (Abdul et al., 2014). Consequently, this profit-oriented culture not only compromises safety, but also instigates a dire lack of respect for stringent regulation, safety procedures, and the value of human lives within the industry (Golden & Weisbrod, 2016). Company management often prioritizes profits over crew training, leading to the employment of untrained crew members on low wages or contract terms, further jeopardizing safety (Kee et al., 2017). Addressing this profit-oriented mindset is critical in establishing a vigorous safety culture within the DF sector, demanding a paradigm shift that values safety and regulations over monetary gains, ensuring a safer maritime environment for all.

The non-exhaustive list of the opportunities for the economic domain is shown in **Table 6**.

Table 6 Opportunities for the economic domain.

Areas	Opportunities
Navigational aids	• To mitigate accidents, efforts may be taken to improve ship-borne and shore-based aids for navigation • AIS devices on every passenger's vessel may be introduced • Enforcing safe distance regulations, particularly during adverse weather conditions with high waves that can obscure operators' vision • Exploring the formulation of a navigational act that includes provisions for aids to navigation to enhance navigational safety
Incentive	• Maritime authorities may introduce incentives for passengers to have insurance that may reduce the burden on the government in the case of an accident
Monopoly	• Control of the ticketing system may reduce the owner's monopoly to maximize the profit
Profit oriented mindset	• Serious penalties may be instituted on companies for giving priority to profit over safety • Balancing operational and maintenance costs, including creating attractive terminals aligned with the community's vision, providing seamless multimodal transport connections, and ensuring quality service to enhance profitability

Source: (Bruzzone, 2012; Wisdom & Kamanga, 2002; Vlado et al., 2009; Abiodun, 2021; Sakalayen, 2006; Oo, 2019; Suleiman, 2016)

5. Key findings

The key findings identified during the systematic literature review are summarized below:

- Inadequate regulatory framework: Many developing countries lack a robust regulatory framework specifically tailored to the DF sector. This deficiency results in a regulatory gap where DF may not be subject to the same stringent safety standards as international vessels. Such regulatory gaps hinder the establishment of clear safety guidelines and standards.
- Effective governance and oversight: A strong governance structure ensures proper oversight and adherence to safety policies. It involves delineating roles, responsibilities, and accountabilities across all stakeholders- from operators to regulatory authorities.
- Lack of standardization: There is a lack of standardization in defining and categorizing DF, which makes it challenging to develop uniform safety regulations. Without standardized definitions and classification, it becomes difficult to implement comprehensive safety measures.
- Capacity building and training: Both governance structures and industry stakeholders should promote continuous capacity building and training programs. These initiatives enhance the skills and knowledge of the workforce, resulting in a safety-conscious culture within the DF sector.
- Adaptability and updating: Policies and governance frameworks must be adaptive to changing dynamics, technological advancements, and emerging risks. Regular updates ensure that safety measures remain relevant and effective.
- Public awareness and involvement: Engaging the public through awareness campaigns and involvement in safety initiatives can reinforce adherence to safety regulations and foster a sense of collective responsibility.
- International collaboration: Collaborating with international maritime bodies and adopting globally recognized safety standards further enhances the effectiveness of policies and governance in ensuring safety.

6. Conclusion

In conclusion, this study provides a thorough examination of the challenges faced by the DF sector, aiming to contribute a solid foundation of knowledge and offer valuable insights for enhancing maritime safety. Through an exhaustive review of academic peer-reviewed literature, industry technical reports, and academic search engines, the challenges have been identified and placed into distinct categories, including operations, technology and innovations, the human element, policy and regulation, and economics. The systematic literature review has revealed a concerning disparity between the identification of challenges and the availability of viable solutions in the existing research

landscape. To address this, the study serves as a unified repository, consolidating challenges and potential solutions. By classifying these challenges under broad categories, a holistic view is presented that aids decision-makers in understanding the multifaceted nature of the issues faced in the DF sector.

However, a significant gap exists in the research landscape, particularly in the scattered nature of existing solutions. Simultaneously, the lack of standardized maritime regulations hinders the implementation of comprehensive safety measures. This study urges focused research and actionable solutions to bridge this divide. The need for a comprehensive approach is emphasized, delving into the underlying attributes of challenges, including governance structures and institutional settings that encompass delineating roles, responsibilities, and accountabilities across all stakeholders- from operators to regulatory authorities. It is crucial to assess these challenges against social, environmental, and economic dimensions, in addition to exploring cost-effective and sustainable measures, such as integrating renewable energy sources.

The findings of this study bear wide-ranging implications for stakeholders in the DF sector, including managers and decision-makers. By integrating the newly adopted IMO model safety regulations and leveraging the insights garnered from this research, stakeholders can steer the sector towards a safer and more efficient future. In essence, this study endeavors to catalyze further research, encouraging a collaborative effort to enhance maritime safety in the DF sector. It is hoped that this research inspires a deeper exploration of potential solutions and fosters a proactive approach to tackle the identified challenges effectively.

References

Abdul, N. S. F. R., Saharuddin, A. H., & Hamidah, Z. R. (2014). An innovation approach for improving borneo inland passenger water transport safety level: Overload problem. *International Journal of Business Tourism and Applied Sciences, 1*(1), 129-139.

Abiodun, S. (2021). Safety and security of ferry passengers' Lives at Night at Ebute Ero, Marina and Mekuen, Lagos State. *International Journal of Research Publication and Reviews, 2*(9), 1188-1193.

Adiputra, I. K. H. P. (2020). *Analysis domestic ferry safety in Indonesia*. World Maritime University.

Ahsan, A. H. M. K., & Panday, P. K. (2013). Problems of coordination in field administration in Bangladesh: Does informal communication matter? *International Journal of Public Administration, 36*(8), 588-599. https://doi.org/10.1080/01900692.2013.772626

Aisha, N. (2011). *Maritime safety on Lake Victoria: Analysis of the legal and regulatory framework*. University of Oslo.

Alamoush, A. S., Aykut, I. Ö., & Fabio, B. (2022). Ports' role in shipping decarbonisation: A common port incentive scheme for shipping greenhouse gas emissions reduction. *Cleaner Logistics and Supply Chain, 3,* 100021. https://doi.org/10.1016/j.clscn.2021.100021

Al-Falahi, M. D. A., Shantha, D. G. J., Hossein, E., Craig, B., & Udaya, M. (2019). *Diesel, hybrid or fully electric ferry: A method for operating cost analysis and battery size optimisation* (pp. 1-9). In Proceedings of the 9th International Conference on Power and Energy Systems. University of Southern Queensland, New Zealand. https://doi.org/10.1109/ICPES47639.2019.9105602

Allianz Global. (2021). *Safety & Shipping.* AGCS.

Atika, A. I. (2021). *Ship accident analysis in Toba Lake* (pp. 17-34). In Atika, A. I. (Ed.). IWPOSPA Excellent Human Resource for the Sustainable Safety of Inland Water and Ferries Transport in New Normal Era-International Webinar. KnE Social Sciences. https://doi.org/10.18502/kss.v5i1.8267

Ave, W. W. (2007). Economic impact analysis of ferry operations in Wisconsin. *Word Journal of the International Linguistic Association, 250*(608), 17.

Baird, A. J. (2000). The Japan coastal ferry system. *Maritime Policy and Management, 27*(1), 3-16. https://doi.org/10.1080/030888300286644

Baird, A. J. (2012). Comparing the efficiency of public and private ferry services on the Pentland Firth between Mainland Scotland and the Orkney Islands. *Research in Transportation Business and Management, 4*, 79-89. https://doi.org/10.1016/j.rtbm.2012.06.001

Baird, N. (2018). *Fatal ferry accidents, their causes and how to prevent them*. University of Wollongong.

Balestra, L., & Schjølberg, I. (2021). Modelling and simulation of a zero-emission hybrid power plant for a domestic ferry. *International Journal of Hydrogen Energy, 46*(18), 15. https://doi.org/10.1016/j.ijhydene.2020.12.187

Baten, A. S. M. A. (2022). A stronger safety regime is vital to ensure safer passengers' movement at Inland Water Transportation Sector of Riverine-Bangladesh. *Journal, Bimrad, 3*(1), 38-55.

Berg, N., Jenni, S., & Jouni, L. (2013). *The impact of ship crews on maritime safety*. Vol. 86. Turku: Merenkulkualan Koulutus-JA Tutkimuskeskus.

Bjerkan, K. Y., Hampus, K., Rebecka S. S., Sigrid, D., & Solveig, M. (2019). Governance in maritime passenger transport: Green public procurement of ferry services. *World Electric Vehicle Journal, 10*(4), 74. https://doi.org/10.3390/wevj10040074

Britz, A. C. (2014). *Messing around in Boats Safe Management of South African Pleasure Vessels: A review of the South African Shipping Legislation Applicable to small pleasure vessels operating at sea and the application of this Regime to South Africa's Inland Boaters*. University of Cape Town.

Bruzzone, A. (2012). *Guidelines for ferry transportation services*. Washington, DC. https://doi.org/10.17226/14644

Bye, R. J., & Asbjørn, L. A. (2020). Why do they violate the procedures? An exploratory study within the maritime transportation industry. *Safety Science, 123*, 104538. https://doi.org/10.1016/j.ssci.2019.104538

Cambridge Dictionary. (2023). *FERRY | Meaning in the Cambridge English Dictionary*. Retrieved from https://dictionary.cambridge.org/dictionary/english/ferry

Chae, C. J., Kyung, H. K., & Suk, Y. K. (2021). Limiting ship accidents by identifying their causes and determining barriers to application of preventive measures. *Journal of Marine Science and Engineering, 9*(3), 302. https://doi.org/10.3390/jmse9030302

Cheemakurthy, H., & Garme, K. (2022). Fuzzy AHP-based design performance index for evaluation of ferries. *Sustainability, 14*(6), 3680. https://doi.org/10.3390/su14063680

Deng, J., Shaoyong, L., Cheng, X., & Kezhong, L. (2022). Risk coupling characteristics of maritime accidents in Chinese Inland and Coastal Waters Based on N-K Model. *Journal of Marine Science and Engineering, 10*(1), 4. https://doi.org/10.3390/jmse10010004

Department of Transport. (1987). *Formal investigation report: MV herald of free enterprise*. London, UK.

Erik, H. (2014). *Safety-I and Safety-II the past and future of safety management*. 1st ed. Surrey: Ashgate Publishing Company.

ESCAP. (2016). *Study on the improvement of maritime transport safety in the escap region*. ESCAP 85. Retrieved from https://www.unescap.org/sites/default/files/Report on Improving Maritime Transport Safety in the ESCAP region %28FNL%29_19 July 2017_0.pdf

Faturachman, D., & Shariman, M. (2012a). *Sea transportation accident analysis in Indonesia* (pp. 616-621). Asia Pacific Business Innovation and Technology Management. Elsevier B.V. https://doi.org/10.1016/j.sbspro.2012.03.239

Faturachman, D., & Shariman, M. (2012b). *Trend analysis of ship accidents in Indonesia* (pp. 1-6). UMP Istitutional Repository.

Fenstad, J., Øyvind, D., & Trond, K. (2016). Shipboard safety: Exploring organizational and

regulatory factors. *Maritime Policy & Management, 43*(5), 552-568. https://doi.org/10.1080/03088839.2016.1154993

Golden, A., & Weisbrod, R. (2016). Trends , causal analysis , and recommendations from 14 years of ferry accidents. *Journal of Public Transport, 19*(1), 17-27. https://doi.org/10.5038/2375-0901.19.1.2

González-Almeida, A. J., & Padrón-Martín, F. (2019). Accidentability as change factor in safety policies of cruises and passenger ships. *Journal of Maritime Research, 16*(2), 28-36.

Greig, M., & Ronald, W. M. (2005). *The impact of ferry services on an Island Economy* (pp. 1-25). In Proceedings of the ERSA Conference. Edinburgh: European Regional Science Association.

Gwaday, M. K. (2019). *A study of maritime SAR and safety of small vessels: A regional perspective with focus on Papua New Guinea*. World Maritime University, Sweden.

Ha, K. M. (2017). A lesson learned from the ferry sewol sinking in South Korea in 2014. *International Journal of Emergency Management, 13*(3), 210-215. https://doi.org/10.1504/IJEM.2017.085002

Herno, D., Rhaptyalyani, T. C. L., & Kuo, C. S. (2020). The study of safety behavior in ferry transport. *Safety Science, 131*, 12. https://doi.org/10.1016/j.ssci.2020.104912

Heryandri, K. (2018). The importance of Ferry Ro-Ro transportation in Indonesia and its contrary to the lack of attention on Ferry Ro-Ro Safety, which cause high rate of accidents and fatalities. *Advances in Transportation and Logistics Research, 1*, 641-651. https://doi.org/10.25292/atlr.v1i1.69

Hong, J. P., Young-Shik, K., Hyung-Won, S., Hee-Jin, K., Yunho, K., Gyu, B. K., & Seongpil, C. (2021). Study on a fully electrified car ferry design powered by removable battery systems considering domestic coastal environment. *Journal of Ocean Engineering and Technology, 35*, 1-12. https://doi.org/10.26748/KSOE.2020.061

Huang, D. Z., Hao, H., & Li, Y. Z. (2013). Spatial analysis of maritime accidents using the geographic information system. *Transportation Research Record, 2326*(1), 39-44. https://doi.org/10.3141/2326-06

Huang, L. (2015). *Study on Ro-Ro passenger ship safety management in Qiongzhou study*. World Maritime University, Sweden.

IMO. (2021). *Safety of Ro-Ro ferries*. Retrieved from https://www.imo.org/es/OurWork/Safety/Paginas/RO-ROFerries.aspx

IMO. (2022). *Resolution MSC.518(105) - Model regulations on domestic ferry safety*. International Maritime Organization.

Interferry. (2023). *Ferry industry facts: Interferry*. Retrieved from https://interferry.com/ferry-industry-facts

Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review, 10*(1-2), 18-26. https://doi.org/10.1007/s13162-020-00161-0

Jiang, Y. (2016). *An application of accimap to identify and analyse the causes of the Eastern Star and Sewol Casualties*. World Maritime University, Malmö.

Jon, I. (2020). *Sustained focus on domestic ferry safety*. Cruise & Ferry. Retrieved from https://www.cruiseandferry.net/articles/sustained-focus-on-domestic-ferry-safety-1

Kabran, E. G., & Eguavoen, I. (2019). *Ferry transportation in Abidijan: Establishment, operation and sustainability of a paratransit system*. ZEF Working Paper 179 University of Bonn.

Kang, S. (2017). *Application of HFACS: The human factors analysis and classification system) to the Korean domestic passenger ship accidents*. World Maritime University, Sweden.

Kee, D., Gyuchan, T. J., Patrick, W., & Roger, H. (2017). A systemic analysis of South Korea Sewol ferry accident: Striking a balance between learning and accountability. *Applied Ergonomics, 59*, 13. https://doi.org/10.1016/j.apergo.2016.07.014

Kim, T. E., Salman, N., & Kjell, I. Ø. (2016). A STAMP-based causal analysis of the Korean Sewol

ferry accident. *Safety Science, 83*, 93-101. https://doi.org/10.1016/j.ssci.2015.11.014
Kitada, M., Ölçer, A. (2020). *A contemporary outlook on human element in energy efficient seaborne transportation* (pp. 149-154). In Proceedings of the 16th Annual General Assembly and Conference of the International Association of Maritime Universities. Opatija, Croatia: University of Rijeka Faculty of Maritime Studies Rijeka.
Kocaman, F. (2020). *Effects of risk management practices for prevention of ferry accidents*. Piri Reis University.
Korçak, M., & Balas, C. E. (2020). Reducing the probability for the collision of ships by changing the passage schedule in Istanbul Strait. *International Journal of Disaster Risk Reduction, 48*, 101593. https://doi.org/10.1016/j.ijdrr.2020.101593
Kotowska, I. (2015). The role of ferry and Ro-Ro shipping in sustainable development of transport. *Review of Economic Perspective, 15*(1), 35-48. https://doi.org/10.1515/revecp-2015-0010
Kristiansen, S. (2005). *Maritime transportion safety management and risk analysis*. 1st ed. Oxford: Elsevier Butterworth-Heinemann.
Lawson, C., & Weisbrod, R. (2005). Ferry transport: The realm of responsibility for ferry disasters in developing nations. *Journal of Public Transport, 8*(4), 17-31. https://doi.org/10.5038/2375-0901.8.4.2
Lee, H. Y., & Leung, K. Y. K. (2021). Island Ferry Travel during COVID-19: Charting the recovery of local tourism in Hong Kong. *Current Issues in Tourism, 25*(1), 76-93. https://doi.org/10.1080/13683500.2021.1911964
Lee, J. E., Seol, A. K., Eugene, S., & Sang, I. R. (2022). Disaster resilience differs between survivors and Victims' Families: A semantic network analysis. *Social Sciences, 11*(3), 16. https://doi.org/10.3390/socsci11030117
Li, K. X., & Wonham, J. (2001). Maritime legislation: New areas for safety of life at sea. *Maritime Policy and Management, 28*(3), 225-234. https://doi.org/10.1080/03088830110048880
Liwagon, C. M., Alvin, L. B., Deofre, A. M., Eleazer, J. J. G., Jeffrey, G. L. S., Mark, D. J. B., Roman, M. B., Arturo, A. G., Marie, C. R. E., Liwagon, C. M., Balongoy, A., Maraviles, D. A., Gavenia, E. J. J., Sulay, J. L. G., Basalo, M. J. D., Balungag, R. M., Genon, A. A., & Enguito, M. R. C. (2015). Assessment of Ro-Ro transportation services in ozamiz city, Philippines. *Philippines Journal of Multidisciplinary Studies, 4*(2), 77-105.
López-Aparicio, S., Dag, T., Nguyen, T., & Heidi, N. (2017). Shipping emissions in a Nordic Port: Assessment of mitigation strategies. *Transportation Research Part D: Transport and Environment, 53*(2017), 205-216. https://doi.org/10.1016/j.trd.2017.04.021
LRF. (2018). *Insight report on safety in the passenger ferry industry*. Lloyd's Register Foundation.
Lu, C. S., & Tseng, P. H. (2012). Identifying crucial safety assessment criteria for passenger ferry services. *Safety Science, 50*(7), 1462-1471. https://doi.org/10.1016/j.ssci.2012.01.019
Marine Transport Security. (2009). *Domestic ferries security regulations*. Retrieved from https://laws-lois.justice.gc.ca/eng/regulations/SOR-2009-321/page-1.html
Mayring, P. (2000). Qualitative Content Analysis. *Forum Qualitative Sozialforschung Forum: Qualitative Social Research, 1*(2), 20. https://doi.org/10.17169/fqs-1.2.1089
Mendas, Z. (2015). Tracing socio-economic impact of ferry provision in Zadar Island Archipelago. *Journal of Marine and Island Cultures, 4*(1), 10-26. https://doi.org/10.1016/j.imic.2015.06.002
Monje, T. G. R. (2013). *Maritime enforcement in the Philippines: Issues and challenges*. University of Wollongong Australia.
Montewka, J., Teemu, M., Pekka, R., Markus, T., Mateusz, G., & Spyros, H. (2022). Accident susceptibility index for a passenger ship-a framework and case study. *Reliability Engineering and System Safety, 218*, 108-145. https://doi.org/10.1016/j.ress.2021.108145
Munyangeyo, A. (2021). *Assessment and proposals for improved transportation safety on Congo River*. Western Norway University of Applied Sciences.

Nautilus International. (2020). *Keeping the lifelines open: What It's like to work on essential Island Ferry Services during the Covid-19 pandemic*. Nautilus International. Retrieved from https://www.nautilusint.org/en/news-insight/telegraph/keeping-the-lifelines-open-what-its-like-to-work-on-essential-island-ferry-services-during-the-covid-19-pandemic

Nurwahyudy, A. (2014). *Contemporary issues in domestic Ro-Ro passenger ferry operation in developing countries: Identification of safety issues in domestic ferry operation based on accident investigation reports on ferry involved accidents in Indonesian Waters, 2003-2013*. World Maritime University, Sweden.

Onsongo, S. K. (2017). *Analysis of the domestic passenger ferry safety in Kenya*. World Maritime University.

Oo, T. Z. (2019). *A study on customers' perception of Inland water ferry transpotation in Yangon Region*. Yangon University of Economics, Myanmar.

Papanikolaou, A., Spanos, D., Boulougouris, E., Eliopoulou, E., & Alissafaki, A. (2004). Investigation into the sinking of the Ro-Ro passenger ferry express Samina. *International Shipbuilding Progress, 51*, 26.

Perez, A. R., Carl, A., Antonio, T., & Rafael, J. C. (2011). The sinking of the MV Doña Paz - A critique on maritime disaster preparedness in the Philippines: An analysis of the event. *Acta Medica Philippina, 45*, 1-5.

Prasetiawan, A., Zainuri, M., Winarno, & Wijayanto, D. (2021). Integration of traditional shipping in the marine toll of Indonesia: Determining the priority and management strategy. *IOP Conference Series: Earth and Environmental Science, 750*(1), 012051. https://doi.org/10.1088/1755-1315/750/1/012051

Raduan, S., Rabiah, A. J. D., Kamu, A., & Hassan, D. (2017). Passengers perception on safety level of ferry transport: A case study in Labuan Island, Malaysia. *Journal of Advanced Research in Social and Behavioural Sciences, 1*(2017), 7-17.

Rashid, C. K., & Major, M. R. I. (2017). *Reasons and remedies of inland passenger vessels accidents in Bangladesh* (p. 9). In Proceedings of the 1st International Conference on Mechanical Engineering and Applied Science. AIP Publishing. https://doi.org/10.1063/1.5018554

Ronnie, J. T., & Ong, J. (2021). *An analysis of domestic ferry safety and the pre-departure inspection enforcement in the Philippines inspection enforcement in the Philippines*. World Maritime University, Sweden.

Rothe, D., Stephen, M., & Christopher, W. M. (2006). Crime on the high seas: Crimes of globalization and the sinking of the Senegalese Ferry Le Joola. *Critical Criminology, 14*, 159-180. https://doi.org/10.1007/s10612-006-9003-3

Sæther, S. R., & Espen, M. (2021). A green maritime shift: Lessons from the electrification of ferries in Norway. *Energy Research and Social Science, 81*, 11. https://doi.org/10.1016/j.erss.2021.102282

Sakalayen, Q. M. H. (2006). *Non-conventional ferry safety and the potentiality of inland waterways for multimodal transportation: A comparative analysis for the betterment of Bangladesh's Situation*. World Maritime University, Malmo Sweden.

Schröder-Hinrichs, J. U., Michael, B., & Erik, H. (2012). From Titanic to Costa Concordia: A century of lessons not learned. *WMU Journal of Maritime Affairs, 11*(2), 151-167. https://doi.org/10.1007/s13437-012-0032-3

Seuring, S., & Gold, S. (2012). Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management, 17*(5), 544-555. https://doi.org/10.1108/13598541211258609

Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production, 16*(15), 12. https://doi.org/10.1016/j.jclepro.2008.04.020

Sheilla, A. (2019). *The legal framework governing maritime administration in Uganda*. Kampala International University, Uganda.

Siyu, X., Hao, H., & Roberta, W. (2019). Development of a worldwide ferry safety database utilizing relational database approach. *Journal of Transportation Safety and Security, 11*(4), 353-376. https://doi.org/10.1080/19439962.2017.1402838

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333-339. https://doi.org/10.1016/j.jbusres.2019.07.039

Størkersen, K. V., & Johansen, J. P. (2013). *No swans in sight-analyzing the resilience in norwegian water passenger transport* (pp. 1619-1626). In Proceedings of the European Safety and Reliability Conference. Amsterdam, Netherland. https://doi.org/10.1201/b15938-244

Suleiman, M. (2016). Pragmatic analysis of safety and security in Tanzania maritime logistics: Evidence from Zanzibar Passenger Ferry Boat, Tanzania. *International Journal of Economics, Commerce and Management United Kingdom, IV*(7), 14.

Thawillarp, S., Waiyanate, N., Chen, L., Srichang, N., Gerdmongkolgan, S., Akechalermkiat, S., & Ritthidej, P. (2014). *Ferry boat injuries and deaths in Pattaya, November 2013; Its' Time for Thailand to Reclaim Its Safe and Smile Traveling*. Vol. 7. Pattaya, Thailand. https://doi.org/10.59096/osir.v7i4.263283

Tranfield, D., David, D., & Palminder, S. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management, 14*(3), 207-222. https://doi.org/10.1111/1467-8551.00375

UNCTAD. (2020). *Impact of the pandemic on trade and development*. UNCTAD, New York, USA: United Nations Publications.

USCG. (2023). *175.400 - Search results | Govinfo. 46 code of federal regulations 175.400*. Retrieved from https://www.govinfo.gov/app/search/%7B%22query%22%3A%22175.400%22%2C%22offset%22%3A0%7D

Vakili, S., Aykut, I. Ö., Alessandro, S., Fabio, B., & Anh, T. H. (2022). Energy-related clean and green framework for shipbuilding community towards zero-emissions: A strategic analysis from concept to case study. *International Journal of Energy Research, 46*(14), 20624-20649. https://doi.org/10.1002/er.7649

Vassalos, D., Sokratis, S., & Evangelos, B. (2015). *Stability upgrade of a typical Philippine ferry* (pp. 521-527). In Proceedings of the 12th International Conference on the Stability of Ships and Ocean Vehicles. Glasgow, Scotland: University of Strathclyde.

Vitus, U. (2015). Boat accidents in Nigeria: General trends and risk factors (June 2006-May 2015). *Journal of Advanced Research in Humanities and Social Sciences, 2*(3-4), 1-9.

Vlado, F., Marko, N., & Lovro, M. (2009). Safety analysis of passenger ships in domestic voyages. *Pomorstvo, 23*(2), 539-555.

Wang, L., & Yang, Z. (2018). Bayesian network modelling and analysis of accident severity in waterborne transportation: A case study in China. *Reliability Engineering and System Safety*, 180, 277-289. https://doi.org/10.1016/j.ress.2018.07.021

Wang, X., Boling, Z., Xu, Z., Lulu, W., & Ruipeng, T. (2020). Exploring the underlying causes of Chinese Eastern Star, Korean Sewol, and Thai phoenix ferry accidents by employing the HFACS-MA. *International Journal of Environmental Researchand Public Health, 17*(11), 4114. https://doi.org/10.3390/ijerph17114114

Wang, X., Zhengjiang, L., Jin, W., Sean, L., Zhiwei, Z., & Liang, C. (2021). Passengers' safety awareness and perception of wayfinding tools in a Ro-Ro passenger ship during an emergency evacuation. *Safety Science, 137*, 105189. https://doi.org/10.1016/j.ssci.2021.105189

Wang, Y., Enrico, Z., Xiaoyang, W., Di, Z., & Bing, W. (2019). A resilience perspective on water

transport systems: The case of Eastern Star. *International Journal of Disaster Risk Reduction, 33,* 343-354. https://doi.org/10.1016/j.ijdrr.2018.10.019

Weisbrod, R. (2012). Maritime transport technology for the other 90% of us. *Transportation Research Record, 2273*(1), 128-135. https://doi.org/10.3141/2273-16

Wisdom, T., & Kamanga, T. (2002). *Development and implementation of uniform safety standards for inland waterways vessels and non-convention craft in Africa: The case of the Southern African Development Community (SADC)*. World Maritime University, Sweden.

Woo, H., Youngtae, C., Eunyoung, S., Kihwang, L., & Gilyoung, S. (2015). Public Trauma after the Sewol ferry disaster: The role of social media in understanding the public mood. *International Journal of Environmental Research and Public Health, 12*(9), 10974-10983. https://doi.org/10.3390/ijerph120910974

Yen, T. P., Park, S. H., & Yeo, G. T. (2018). The impact of ferry disasters on operational efficiency of the South Korean Coastal Ferry Industry: A DEA-window analysis. *The Asian Journal of Shipping and Logistics, 34*(3), 248-255. https://doi.org/10.1016/j.ajsl.2018.09.009

Zhang, S., & Wang, J. (2015). Analysis of South Korea Sewol Sunken ferry accident based on behavioral safety. *Journal of Coastal Research, 73,* 611-613. https://doi.org/10.2112/SI73-106.1