



Lloyd's Register  
Foundation

# Insight report on safety in the passenger ferry industry

A global safety challenge



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# About the Lloyd's Register Foundation

## Our vision

Our vision is to be known worldwide as a leading supporter of engineering-related research, training and education, which makes a real difference in improving the safety of the critical infrastructure on which modern society relies. In support of this, we promote scientific excellence and act as a catalyst working with others to achieve maximum impact.

## The Lloyd's Register Foundation charitable mission

- To secure for the benefit of the community high technical standards of design, manufacture, construction, maintenance, operation and performance for the purpose of enhancing the safety of life and property at sea, on land and in the air.
- The advancement of public education including within the transportation industries and any other engineering and technological disciplines.

## About the Lloyd's Register Foundation Report Series

The aim of this Report Series is to openly disseminate information about the work that is being supported by the Lloyd's Register Foundation. It is hoped that these reports will provide insights for the research community and also inform wider debate in society about the engineering safety-related challenges being investigated by the Foundation.

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# Executive summary

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The global passenger ferry industry has averaged more than 1,000 fatalities per year since the 1960s, with the great majority occurring on domestic voyages in Asia and Africa.

From 1966 to 2015 there were 750 recorded fatal accidents involving passenger vessels, resulting in 59,600 fatalities<sup>1</sup>. Ninety-three per cent of ferry accidents occurred during domestic voyages, with 90% of fatalities occurring in just 20 countries and 76% in 10.

The Lloyd's Register Foundation identified passenger ferry safety as a challenge in its Insight report on global safety challenges<sup>2</sup>, in 2017. Since then The Foundation has investigated further to better understand the issue. It has drawn on expert knowledge and opinion to determine what activity is already underway to improve safety, what is further needed, and to explore if there is a unique role for The Foundation in line with its charitable mission.

The investigation has focused on establishing or confirming:

- the countries or locations where the most fatalities are occurring
- the predominant causes of accidents in these countries
- the practical measure(s) which could save the most lives.

This Insight report on safety in the passenger ferry industry presents the following key findings:

- The highest numbers of fatalities have occurred in the Philippines, Bangladesh, and Indonesia.
- Globally, the causes of ferry accidents are related to the economic status, value placed on life and social outlook of the operators and passengers in the countries where the incidents occurred.

In countries enjoying relatively favourable economies, causes include:

- failure to enforce existing regulations
- suboptimal vessel design (including bridge, and other location, ergonomics)
- suboptimal technology informing captains and crews of real-time vessel status
- incomplete or less than best-practice safety training
- suboptimal emergency equipment, for example lack of equipment making it possible to pinpoint vessel location at any time
- suboptimal safety culture producing dangerous behaviours and decisions.



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In countries with less favourable economies, the causes are different, including:

- lack of any form of enforceable regulation or complete failure to enforce existing regulations
  - very poor vessel design and / or construction, leading to small vessels which are unseaworthy
  - inadequate or totally absent vessel maintenance
  - inadequate weather information or, more often, failure to heed weather warnings
  - absence of crew training.
- A non-profit, ferry-operator funded organisation dedicated to improving ferry safety should be established. The initial operational area will be the three countries experiencing the most fatalities, but the long-term intention is to offer safety services globally. The initial step in each location where the organisation operates will be to identify the specific local situation and scope of activity.

Partnerships with like-minded organisations and local representation will be crucial to success. Connections will be made with key stakeholders such as owners, governments, the International Maritime Organization (IMO), International Labour Organization (ILO), flag authorities, IACS (International Association of Classification Societies), crew unions and the general public.

- The network of safety experts who contributed to the work should be supported and expanded. This will be facilitated by the establishment of a platform from which they can share expertise, experience, knowledge and good practice and engage with policy makers, industry and the wider public on safety issues in the industry.

# Foreword

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When we published the Insight report on global safety challenges<sup>2</sup> we identified 12 topics that affect the lives and property of people internationally in both the present and the emerging future. Identifying these themes was the first step of a journey for us. Now we are gaining a better understanding of these challenges, including who is active in addressing them and ultimately if there is a role for the Foundation to do something unique that enhances safety.

In this report we focus on the global safety challenge in the passenger ferry industry. In developed countries, many of us look forward to vacations including enjoyable journeys on well-equipped and safe ferries without concern for our family's wellbeing. But this is not the case in all regions. Fatality statistics in developing countries are unreliable, however annual global fatality estimates over the past 50 years have exceeded 1,000. Most of the fatalities occur in Asia and Africa, where overcrowded, poorly maintained ferries without proper safety equipment are common. Crew training and basic seamanship practices are also lacking in many instances.

At first we considered it a tragic coincidence that after months of work related to this important safety challenge, within days of publication a ferry sank in Indonesia due to overcrowding, with approximately 200 souls either lost or missing. Both the location and cause of this latest terrible incident serve to validate the information and opinions reported here. And, upon reflection of the global frequency, locations, and causes of ferry fatalities, it is not a coincidence at all.

This insight report makes a valuable contribution to understanding the safety challenges in the passenger ferry industry. It takes a closer look at where accidents are occurring, why they happen and what steps the Foundation can take to reduce the lives lost in this global industry... because life matters.

This insight report makes a valuable contribution to understanding the safety challenges in the passenger ferry industry.

Professor Richard Clegg  
Foundation Chief Executive  
Lloyd's Register Foundation



# Background

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The Lloyd's Register Foundation (the Foundation) is a charity and owner of the 258-year old Lloyd's Register Group Limited (LR). LR is a leading global provider of engineering and technology-centric professional services to clients in a range of sectors, primarily in energy and maritime, but also in food, healthcare and manufacturing.

The Foundation's Insight report on global safety challenges<sup>2</sup>, published in 2017, included the following text related to safety in the passenger ferry industry:

"From 2002-2016, there were 163 reported passenger ferry accidents, causing over 17,000 deaths<sup>3,4</sup>. Twenty-five percent of all passenger ferry accidents happened in Bangladesh, 16% in Indonesia, 11% in the Philippines, 6% in China and 42% in the rest of the world<sup>3</sup>. The Southeast Asia region has the worst fatality rates in the shipping industry.

From 2002-2016, there were 163 reported passenger ferry accidents, causing over 17,000 deaths.

Many respondents stated that lack of standards and regulation, or lack of their implementation, along with lack of investment in safety practices, leads to unsafe design and dangerous practices on board passenger ferries. Loss of life on passenger ferries in Southeast Asia and South Asia is particularly serious and occurs due to overcrowding, lack of standards implemented on size and type of cargo, the use of inappropriate boats not designed to carry passengers, inappropriate (cheap) design, human factors and misjudgement of weather conditions.

Risks to the safety of passenger ferries are of global concern given both the broad geographical spread of accidents and the potential for large-scale loss of life. Following the sinking of the RMS *Titanic*, the UK official enquiry made 24 safety recommendations, of which just 12 have been implemented. The sinking of the *Costa Concordia* off the coast of Italy in 2012 (killing 32 people) pushed the IMO to implement the twelfth recommendation, exactly 100 years after the *Titanic* sank<sup>5</sup>."





Focusing on safety in the ferry industry, the Foundation has conducted a desk study and consultation to establish:

- the countries (or locations) where the most fatalities are occurring
- the predominant accident causes in these countries
- the practical measure(s) which would save the most lives.

This Insight report on safety in the passenger ferry industry gives the findings of this work. The Foundation consulted broadly with organisations having direct experience with ferry industry challenges, including a two-day workshop held in London in March 2018 bringing together international experts to address the above three questions.

This insight report reflects the experience and insights of those that participated in the consultation process and the Foundation is grateful to all that have contributed.



Following the sinking of the RMS *Titanic*, the UK official enquiry made 24 safety recommendations, of which just 12 have been implemented.

By Willy Stöwer [died 31 May 1931 [Public domain]], via Wikimedia Commons

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Worldwide Ferry Safety Association

# Ferry safety: an overview

Historical information describing global ferry accident locations, causes, and other information is publicly available. The Baird/Australian National Centre for Oceanic Research and Security (ANCORS)<sup>6</sup> database, categorising global incidents occurring over the past half century, has been used to generate the charts in this section.

From 1966 to 2015 there were 750 recorded fatal accidents involving passenger ferries, resulting in 59,600 known fatalities. Ninety-three per cent of ferry accidents occurred during domestic voyages, with 90% of fatalities occurring in just 20 (mostly developing) countries and 76% in the ten worst countries. Countries experiencing the most fatalities were the Philippines, Bangladesh and Indonesia.

## Overall trend in global ferry fatalities

Despite a short-term improvement from 2011-2017, the statistical significance of which is currently unknown, the overall fatality trend is a steady increase over a 50-year period (see figure 1). The large spikes in 1987 and 2011 were primarily due to the 1987 sinking of the *Doña Paz* in the Philippines with a loss of 4,386 lives, and the 2011 sinking of the *Spice Islander 1* in Tanzania with a loss of 2,976 lives.

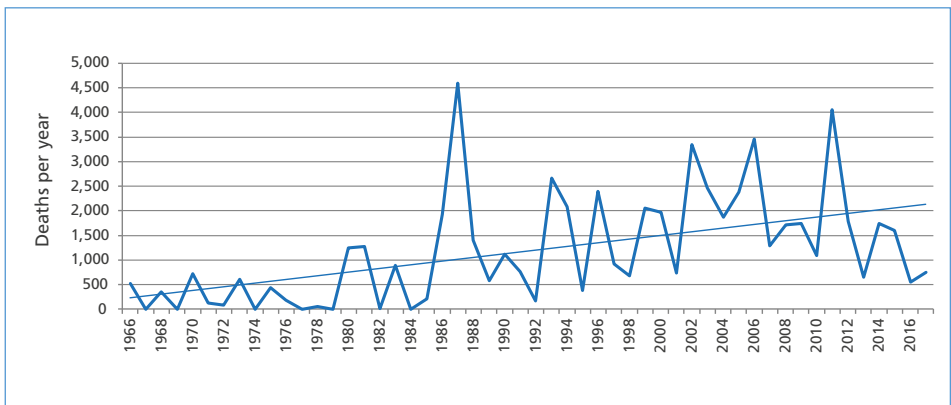


Figure 1: Global trend in ferry fatalities<sup>6</sup>



## Case study: Doña Paz, the Philippines, December 1987<sup>7,8</sup>

### Overcrowding, safety equipment, poor bridge monitoring, unseaworthy vessels, lack of crew certification

The MV *Doña Paz* caught fire and sank after colliding with the oil tanker MT *Vector* while on a voyage between Leyte Island and the Philippine capital of Manilla on 20 December 1987<sup>9</sup>, with the loss of 4,386 lives<sup>6</sup>. It remains the deadliest peacetime marine disaster in history. The *Doña Paz* had previously been gutted by fire in 1979 and declared a total loss but was later refurbished and returned to service.

Overcrowding played a significant role in the fatality numbers, as the *Doña Paz's* capacity was stated by the owners to be 1,424. Furthermore, more than 2,000 passengers were not listed on the manifest. There were no radio facilities on board and lifejackets remained in lockers. Only one apprentice crewman was monitoring the bridge at the time of the collision. Considerable blame was also directed toward the *Vector*, which was found to be unseaworthy and operating without a qualified master.

Oil spilled from the *Vector* and ignited, causing the sea around the ships to catch fire. Passengers and crew were forced to jump into flaming, shark infested waters. Eight hours passed before authorities learned of the incident, and another eight before search and rescue operations commenced; only 24 survivors were rescued by a passing ship.

### Broader impact

The Philippine president described the event as “a national tragedy of harrowing proportions”, and messages of condolence were received from the Pope, Japanese Prime Minister, and Queen Elizabeth II. The owners announced that insurance had been in place and each survivor would receive USD 472.

Eventually, the official Board of Marine Inquiry<sup>10</sup> cleared the *Doña Paz's* owners of fault. The *Vector's* owners were required to indemnify the victims. Some subsequent individual claims brought against both ships' owners resulted in even families of victims who were not listed on the official manifest receiving some compensation.

## Case study: Spice Islander 1 – Zanzibar, Tanzania, September 2011<sup>11</sup>

### Overcrowding

Information on this incident, like others occurring in developing regions, is limited<sup>12,13,14</sup>. However, it is known that the MV *Spice Islander 1* lost engine power, capsized and sank off the coast of Zanzibar while on a voyage between two islands on 10 September 2011, with an estimated loss of as many as 2,976<sup>6</sup> lives.

Overcrowding was a significant cause of the disaster as the ship's official capacity was 45 crew and 645 passengers. Around 620 persons were rescued by other ferries; at least 40 of the survivors suffered serious injuries.

While the Zanzibar government announced<sup>15</sup> it would punish those found responsible for the tragedy, another ferry sailing the same route, the MV *Skagit*, sank eight months later with an estimated loss of 293 lives.



## Locations of most fatalities

Figure 2 shows the relative number of fatalities, by continent, over the past 50 years<sup>6</sup>. The vast majority of deaths occur in Asia and Africa. Figure 3 shows the 10 countries suffering the most fatalities. Available data and expert opinion confirm Bangladesh, Indonesia, and the Philippines (BIP) as the countries experiencing the most fatalities, more than 27,000 over the past 50 years, an average of about 540 per year. Consistent with the Foundation's philosophy of maximising impact, it was decided to direct attention to those three countries in the first instance.



Special mention should be made of the Pacific Islands<sup>16</sup> in consideration of their high fatality rate and similarities to BIP in economy, culture, geography, climate, and accident causes. The Islands’ regulators understand the need to address local ferry safety. However, in terms of total fatality numbers, the Pacific Islands lag far behind the 10 countries shown in figure 3.

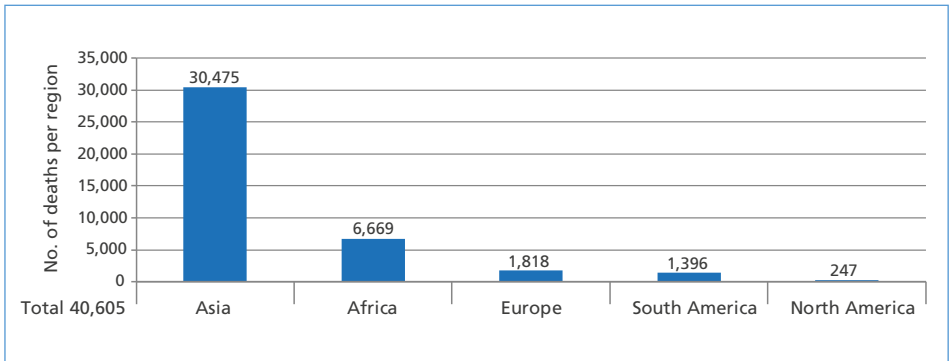


Figure 2: Regional ferry fatality comparison<sup>6</sup>

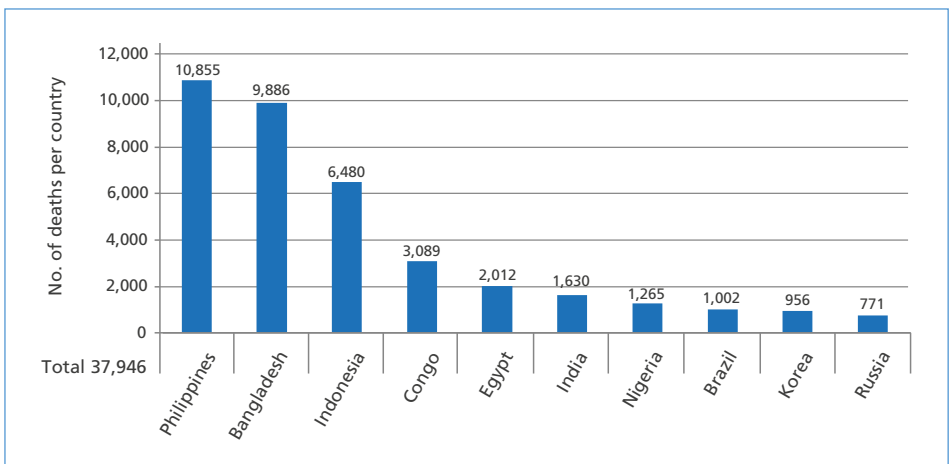


Figure 3: Ten countries having the most ferry fatalities from 1966 to 2017<sup>6</sup>

# Causes of ferry accidents

There are a wide range of safety issues associated with ferries across diverse geographies. A full description of these, along with suggested measures to address them, is given in appendix B on page 24.

A summary of accident causes in Bangladesh, Indonesia and the Philippines (BIP), derived from the Baird/ANCORS database<sup>5</sup>, is shown in figure 4.

The main themes that emerge as key causes of ferry accidents in BIP countries are:

- incomplete training leading to poor seamanship and other incompetence
- unseaworthy vessels and inadequate safety / automatic identification system (AIS) equipment
- overcrowding
- human / social issues
- inadequate search and rescue capability
- regulatory issues.

Each of these is discussed in more detail overleaf.

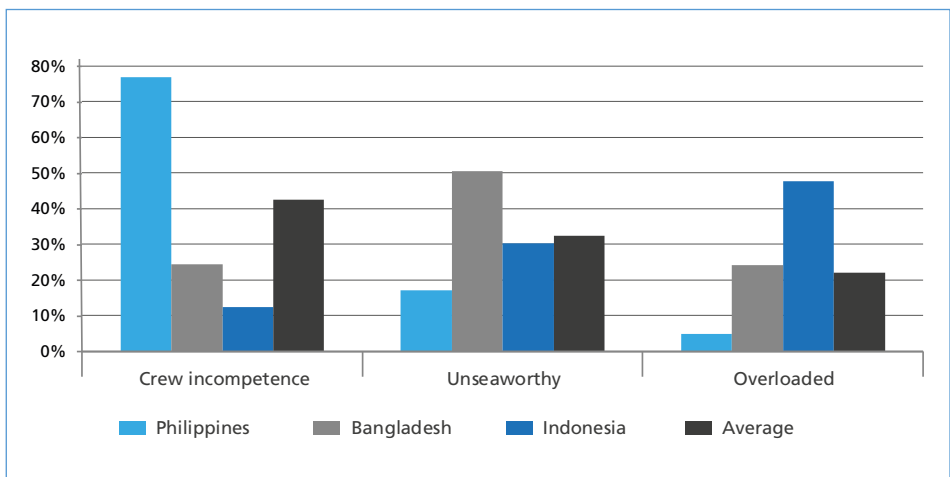


Figure 4: Suggested root causes of ferry fatalities in BIP, by country<sup>6</sup>





## Case study: Scandinavian Star, Norway – Denmark, April 1990<sup>17,18</sup>

### Crew training, safety equipment

The MS *Scandinavian Star* was set on fire while on a voyage between Oslo, Norway and Frederikshavn, Denmark on 7 April 1990, resulting in the deaths of 159 of the estimated 480 passengers<sup>19</sup>. The vessel had also experienced fires in 1985 and 1988<sup>20</sup>.

Fire was first detected by a passenger at about 02:00 local time and spread to multiple decks through stairwells acting as chimneys. A flammable decorative wall covering produced toxic hydrogen cyanide and carbon monoxide gases when ignited. The arrangements and crew actions onboard led to smoke being directed to passenger cabins via door vents, leading to rapid unconsciousness and death of the occupants. The captain and crew abandoned ship before all passengers had been evacuated and the vessel was towed ashore in Sweden.

Insufficient safety training likely contributed to the number of fatalities, as the crew had been given just 10 days to learn new responsibilities following the vessel's conversion from a casino ship. Experts suggested six to eight weeks as the normal time required for such training<sup>21</sup>. Language difficulties may also have contributed, as numerous crew members did not speak or understand Norwegian, Danish, or English. Safety equipment deficiencies were also noted, specifically defective fire doors.

The issues related to fire protection and passenger evacuation raised by the disaster led to a comprehensive amendment of the International Maritime Organization's International Convention for the Safety of Life at Sea (SOLAS) in 1992.



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museet (<https://digitaltmuseum.se/02115447730>) [CC BY-SA  
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## Incomplete training leading to poor seamanship and other incompetence

Insufficient training or incompetence of captains and crews is considered to be the most significant overall accident cause in BIP. In the Philippines, crew incompetence was considered<sup>1</sup> to have led to the greatest proportion (77%) of fatalities, with the result dominated by a single event, the *Doña Paz* sinking, which accounted for 40% of the lives lost. In Bangladesh, 24% of fatalities were caused by poor crew competence.

In addition to the incompetence of ships' operating personnel, the lack of flag administrations' and other professional regulating bodies' awareness of the specific issues affecting safety in BIP is also considered to be a problem.

In fact, inadequate training is frequently reported as a cause of ferry accidents across the globe.

## Unseaworthy vessels and inadequate safety / AIS equipment

Vessel unseaworthiness was confirmed as a significant causal factor. In BIP, where small vessels (for example motor bancas) carry many citizens, there are multiple root causes of unseaworthiness, including:

- original inappropriate design and / or construction due to incompetence or negligence
- poor survey by government agencies or classification societies
- poor maintenance
- degradation (usually corrosion), and
- the utilisation of elderly, second hand conventional Ro-Pax (roll-on / roll-off passenger) ferries purchased from wealthier nations. Since 2000, 32% of fatalities have occurred on these old Ro-Pax vessels.

Fifty-one per cent of fatalities in Bangladesh, 30% in Indonesia and 17% in the Philippines were considered to have been caused by unseaworthy vessels<sup>1</sup>. Vessel unseaworthiness, leading to capsizing, is a significant cause of global vessel losses and fatalities<sup>22</sup>.

Missing, inappropriate or inadequate life-saving and onboard fire-fighting appliances are significant contributors to fatalities. There is widespread anecdotal evidence of captain, crew and passengers not having access to or refusing to use life jackets, immersion suits, or similar personal floatation devices. This is particularly tragic in warm weather areas where relatively long-term survival in the sea is possible.



Lifeboats and life-rafts, their deployment systems, and other escape systems have, in general, been designed for large ships operating in the North Atlantic. They are often not practical for use on the much smaller vessels which make up most of the ferry traffic in BIP.

Lifeboats typically found in BIP were considered too heavy and complicated to launch, and require too much maintenance for use in the region.

Fire-fighting systems and elaborate automatic detection and initiation equipment installed in some vessels in BIP are believed to have been designed for more sophisticated vessels, and may not be appropriate for use in the region.



## Overcrowding

Overcrowding is a significant cause of fatalities, particularly in Bangladesh (24% of total fatalities) and Indonesia (48%). Baird<sup>23</sup> commented, "Overloading has been and remains the major cause of the fatalities that arise from passenger vessel accidents".

Overcrowding leading to capsizing as a significant cause of global vessel losses and fatalities<sup>22</sup>.

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## Human and social issues

The general public's lack of awareness of the issues causing ferry fatalities in BIP is also considered to contribute significantly to the fatality numbers. If passengers were more aware of the contribution of overcrowding to loss of stability and subsequent capsizing, they might be less likely to board overcrowded vessels.

Human error leading to capsizing as a significant cause of global vessel losses and fatalities<sup>24</sup>. Many of the above causal factors are symptoms rather than causes, resulting from human decisions and interactions. Ultimately human beings making decisions and engaging in inappropriate action are the underlying causes of the problems<sup>25</sup>.

In the Philippines and Bangladesh, group behaviour is particularly important<sup>25</sup>, where people and cultures tend to lean towards majority behaviour. Public awareness campaigns and engagement with business owners are considered to be important focus areas in producing positive results.

## Inadequate search and rescue (SAR) capability

The Philippines and Indonesia have substantial coast guard organisations, but their rate of successful rescues is not high. SAR services in Bangladesh are practically nonexistent<sup>23</sup>.

Considerable attention and significant government and charity money has been directed toward SAR issues in wealthy countries, but acute problems exist in poorer nations which have not had access to similar investment<sup>23</sup>. Research has been conducted to highlight SAR failures in poorer countries<sup>4</sup>. Specific issues leading to SAR difficulties include the large rescue area, inadequate rescue and salvage equipment, dangerous weather and sea state conditions, incomplete passenger manifests and lack of communication equipment with which to send distress signals.

## Regulatory issues

Some experts reject the significance of a relationship between regulation and ferry fatalities in BIP. However, inadequate regulations or failure to enforce existing regulations, particularly leading to vessel unseaworthiness<sup>1,26,27,28,29</sup>, is a factor in some ferry fatalities in BIP.



## Case study – Sewol, Korea, April 2014<sup>30</sup>

### Poor seamanship, stability, overloading

The MV *Sewol* capsized and sank while on a voyage between Incheon and Jeju Island, South Korea on 16 April 2014 with the loss of 304 lives, mostly secondary students on a school trip<sup>31,32,33</sup>. The 172 survivors were rescued by fishing boats and other commercial vessels shortly after the event. The captain and three crew members were charged with murder, and the ship operator's owner was indicted and later committed suicide. The school's vice principal, who had organised the trip, also committed suicide.

The direct cause of the capsizing was an unreasonably sudden turn to starboard<sup>34</sup>, which caused cargo to shift to port and the ship to list and become unmanageable. The ship's automatic identification system was used to confirm the sudden turn.

Cargo overloading was also a contributing factor. More than three times the listed maximum weight of cargo was being carried<sup>35</sup>. According to the *Sewol's* off-duty captain, the owners had ignored previous warnings related to overloading. Another stability-related cause was the carriage of only 580 tons of ballast water, compared to the recommended 2,030 tons. Ballast water had been removed to make room for additional cargo.

Regulatory changes were eventually made because of the tragedy, with the Ministry of Public Safety and Security being founded and taking over the Korean Coast Guard's responsibilities in November 2014<sup>36</sup>.

### Broader impact

There was an enormous reaction to the incident in South Korea, ranging from public anger about the lax regulatory environment contributing to safety violations, criticism of rescue operations, and a drop in the South Korean president's approval rating from 71% to 40% within weeks of the disaster.

The official report from the Korean government's National Intelligence Service emphasised controlling public protest rather than assigning responsibility. Following intense public pressure, in 2017 the wreck was raised and transported to a shipyard in Mokpo for further study. The sinking contributed to the downfall of the South Korean president who eventually lost her presidency in March 2017.

## Areas for action: improving safety

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Individual root fatality causes are diverse, both within and between countries. Many of the root causes could be considered to fall within the general category of human factors. Producing a significant, consistent and long-lasting improvement by attempting to solve each problem individually is not an effective or practically manageable approach.

Based upon consultation, the favoured approach is to establish a non-profit, and at least partially ferry-operator funded organisation dedicated to improving safety in the industry. The organisation's initial scope would be the development of a framework of practical, holistic solutions to various combinations of the identified problem areas.

There is a need to conduct studies to confirm, within each geographical or cultural operational region, the specific local problem areas and solutions, and to tailor the scope accordingly. Based on the relative fatality numbers, the Philippines should be the initial focus country, followed by Bangladesh and Indonesia, before a global expansion as appropriate.

Some organisational characteristics and philosophies for the non-profit organisation are as follows:

- The team would initially be relatively small, 5-10 employees.
- Connection with and buy-in from the following stakeholders is critical:
  - ferry owners
  - government representatives
  - International Maritime Organization
  - International Labour Organization
  - flag state authorities
  - classification societies and the International Association of Classification Societies (IACS)
  - workers' unions (representing captains and crew)
  - general public.
- In cases where ferries are operated by relatively larger companies, the likelihood of success in improving safety will be enhanced by fully appreciating the intense commercial pressures they typically face, including those imposed by both creditors and customers. All owners have become increasingly aware of the ramifications of major accidents, including indirect financial losses associated with corporate reputational damage.



- A public awareness campaign is considered essential – for example to ensure prospective passengers are more aware of the risks of boarding overcrowded, unseaworthy, or otherwise unsuitable vessels. Videos in passenger terminals have been proposed as a convenient and effective way of achieving this.
- A structured and widely publicised safety ratings system for all ferries is proposed, covering all safety issues and visible on multiple modern popular media and social network platforms. Similar systems have proven very effective in other service industries, particularly the hotel business.



# Conclusions and recommendations

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## Conclusions

Passenger ferry fatality figures are high in countries with poor economic circumstances, in particular Bangladesh, Indonesia and the Philippines (BIP), where approximately 27,000, or nearly 45%, of the industry's annual deaths have occurred in the last half century.

While efforts to continuously improve passenger and crew safety in the developed world will no doubt improve safety further, the greatest impact in terms of lives saved is achievable in countries such as BIP. Improvements in developed countries are primarily directed toward stricter enforcement of regulations and highly technological enhancements for large ships. With a few exceptions, it is recognised that an approach based on these two measures in isolation would be less effective in BIP, where many ferries are extremely overcrowded, operated by essentially untrained crews and whose captains' feel obligated to sail in poor weather as a matter of routine.

Passenger ferry fatality figures are high in countries with poor economic circumstances, in particular Bangladesh, Indonesia and the Philippines.

## Industry recommendations

To maximise lives saved, a non-profit, ferry-operator funded, organisation dedicated to improving safety should be established. The organisation's primary mission will be to establish a framework of practical solutions to address those combinations of causal factors most prominent in each region where it operates. Potential solutions are mentioned in the body and appendix B of this report.

The Philippines' position of having had the most average annual fatalities highlights why this should be the first focus country. Expansion to Bangladesh and Indonesia, and then globally, should follow.





## Foundation recommendations

### Global ferry safety community

Through the development of this insight report the Foundation has established a group of experts who have shared their experiences, knowledge and good practice for wider benefit. There is clear value in maintaining and expanding this group to create a platform for sharing information and engaging with policy makers, industry and the wider public.

### Improving ferry safety data

The Foundation is currently exploring how data can be used to identify safety challenges and to track trends. The availability of ferry safety data around the world is variable and could be an area for the Foundation to investigate further.

### Ferry safety organisation

The Foundation is well positioned to support a ferry safety organisation whose purpose is to create measurable change within countries where programmes are run.

Foundation support could be used to convene stakeholders, establish impact measures and attract support to conduct a trial in the Philippines.

## Appendix A: Glossary

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AIS	Automatic identification system
ANCORS	Australian National Centre for Oceanic Research and Security
BIP	Bangladesh, Indonesia, and the Philippines
CHIRP	Confidential hazardous incident reporting programme
IACS	International Association of Classification Societies
IMO	International Maritime Organization
KRISO	Korea Research Institute of Ships and Ocean Engineering
MIMUN	Marine Institute, Memorial University of Newfoundland
MS/MV	Motor ship/motor vessel
MT	Motor tanker
RMS	Royal Mail ship
SAR	Search and rescue
SOLAS	International convention for the safety of life at sea
WFSA	Worldwide Ferry Safety Association



# Appendix B: Collation of causes of and solutions to fatalities proposed by industry experts

## Causes

Prior to the workshop, attendees suggested significant causes of ferry fatalities based on their individual experience. These are described in this section, grouped into several main categories. A tabulation of results appears at the end of this section, on page 28.

The types of proposed causes differ depending on the economic circumstance of the accident location. In the developed world, insufficient adherence to regulations was often identified as a causal factor. In the developing world, lack of even the most basic safety equipment, lack of existence of or adherence to weather information and unseaworthiness were often mentioned. Immature safety culture was mentioned frequently in all areas.

### Insufficient training or competence

CHIRP Maritime (UK)<sup>37</sup> identified lack of sufficient competence as the third most important causal factor in Bangladesh, Indonesia and the Philippines (BIP).

Solent University - The Warsash School of Maritime Science and Engineering (SU)<sup>38</sup> identified insufficient experiential knowledge as a significant causal factor in BIP.

LR<sup>28</sup> suggested insufficient training as a causal factor globally.

MIMUN (Marine institute, Memorial University of Newfoundland)<sup>27</sup> identified insufficient nationally and internationally recognised training and education as a significant causal factor in BIP, specifically insufficient access to education and lack of awareness of risk and safety culture.

Evercat Asia<sup>29</sup> identified insufficient competence as a causal factor in the Philippines.

Interferry<sup>39</sup> identified inadequate training as a causal factor in Bangladesh and Indonesia.

### Poor seamanship (including poor lookout activities)

The Worldwide Ferry Safety Association (WFSA)<sup>22</sup> identified insufficient vision during night-time operations as a significant causal factor in Bangladesh.

MIMUN<sup>27</sup> noted the same (night vision) problem in the Philippines and Indonesia. It also mentioned the following seamanship issues in ferry collisions in Bangladesh:

- inadequate knowledge
- poor views from the navigation bridge
- lack of captain / crew certification on inland passenger vessels.

ANCORS<sup>1</sup> (Australian National Centre for Oceanic Research and Security) recognised poor lookout practices as the second most important contributor to fatalities in the Philippines and Bangladesh.

ANCORS<sup>1</sup> recognised negligence as the third most important contributor to ferry fatalities in the Philippines and Indonesia.

### **Unseaworthy / poorly designed / suboptimal vessels and equipment**

The WFSA<sup>22</sup> identified poor vessel quality as a causal factor in Bangladesh and the Philippines. It also mentioned a well-documented fire problem with open deck Ro-Pax ferries in Indonesia.

ANCORS<sup>1</sup> recognised unseaworthiness as the number one cause of fatalities in BIP.

CHIRP Maritime (UK)<sup>37</sup> identified poor vessel design as the number two cause of fatalities in BIP.

Nesta (UK)<sup>26</sup> identified unsafe design and the use of inappropriate (for their intended use) boats as significant causal factors in BIP.

Evercat Asia<sup>29</sup> also identified unsafe design and the use of inappropriate boats (specifically river boats with questionable stability characteristics being used in coastal waters) as significant causal factors in the Philippines.





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## Lack of safety or automatic identification equipment

Nesta (UK)<sup>26</sup> identified lack of investment in safety equipment and practices as a significant causal factor in BIP.

Interferry<sup>39</sup> recognised the less than ideal emergency response capability and access to safety equipment in Bangladesh and Indonesia.

Interferry<sup>39</sup> described work which showed that when referencing density of automatic identification system (AIS) coverage and accident frequency, the worst safety records correlate with the lack of AIS data.

WFSA<sup>24</sup> confirmed the Interferry view on AIS system coverage, and provided data (specifically for BIP) comparing total accidents to accidents 'with AIS' from November 2009 to January 2018. There were 31 total accidents, but only two 'with AIS'.

## Overcrowding

The WFSA<sup>22</sup> identified overcrowding as a causal factor in Bangladesh.

ANCORS<sup>1</sup> recognised overcrowding as the third most important contributor to fatalities in Bangladesh.

MIMUN<sup>27</sup> recognised overloading or overcrowding as an issue in BIP, mentioning an under-capacity to handle large populations that use ferries as a primary mode of transportation.

Evercat Asia<sup>29</sup> highlighted overcrowding as a causal factor of accidents in the Philippines.

Interferry<sup>39</sup> noted the weakness in the passenger counting and registration process in Bangladesh and Indonesia.

## Human and social issues

CHIRP Maritime (UK)<sup>37</sup> noted that vessel masters in BIP face severe pressure to sail, regardless of weather conditions.

Nesta (UK)<sup>26</sup> identified seafarer fatigue as a significant causal factor in BIP.

SU<sup>38</sup> identified the human element as a significant causal factor in BIP.

## Inadequate search and rescue (SAR) capability

Both Interferry<sup>39</sup> and WFSA<sup>22</sup> mentioned inadequate SAR as a contributory factor in BIP.

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## Regulatory issues

Many experts reject any relationship between regulation and ferry fatalities in BIP. However, there were some suggestions of at least partial elements of a causal relationship, as follows:

ANCORS<sup>1</sup> recognised insufficient enforcement of existing regulations as a problem in BIP, leading for example, to problems in vessel unseaworthiness.

Nesta (UK)<sup>26</sup> identified lack or enforcement of regulation as significant causal factors in BIP.

LR<sup>28</sup> identified inadequate domestic regulations as a significant causal factor globally.

MIMUN<sup>27</sup> identified regulatory enforcement as a significant causal factor in BIP. It was specifically mentioned that domestic vessels are not subject to the same stringent design and operational requirements as SOLAS Convention vessels.

Evercat Asia<sup>29</sup> highlighted lack of regulation/enforcement as a causal factor in the Philippines.

## Weather or knowledge of weather conditions

The WFSA<sup>22</sup> identified a lack of awareness of sudden severe weather as a significant causal factor in BIP.

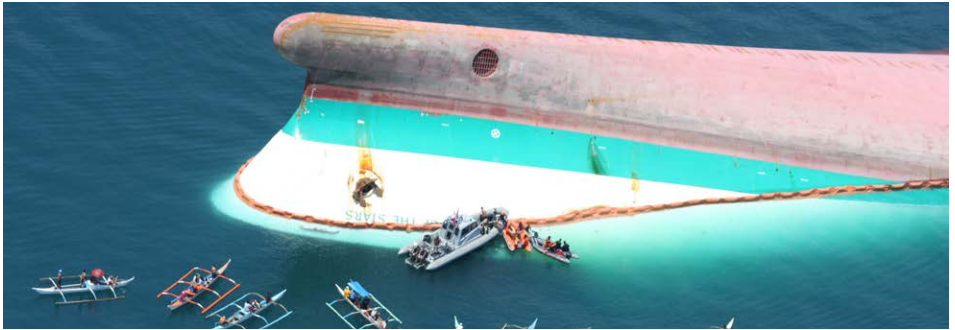
CHIRP Maritime (UK)<sup>37</sup> identified weather issues as the number one cause of fatalities in BIP. The type of impact differed depending on ferry type:

- Small river ferries are affected by local conditions such as tidal surges and flooding from monsoon conditions.
- Larger more 'ship-like' near-coastal ferries are subjected to the forces of unpredictable powerful line-squalls and typhoons or monsoons.

In both cases, a cultural issue also exists – vessel masters face significant pressure to sail, even during floods and other severe weather situations.

MIMUN<sup>27</sup> noted that a significant proportion of ferry accidents happen during violent storms in BIP. There were particular concerns about watertight integrity, vessel operating procedures and shifting cargo in the Philippines and Indonesia.

Interferry<sup>39</sup> noted that sudden hazardous weather accounts for a significant proportion of fatalities in Bangladesh and Indonesia.



Ferry MV *Princess of the Stars* capsized in June 2008 during Typhoon Fengshen in the Philippines; with the loss of an estimated 814 people.

Photo by US Navy photo [Public domain], via Wikimedia Commons

Summary table - Fatality causes as proposed by contributors

	ANCORS	WFSA	MIMUN	CHIRP	Nesta	Interferry	SU	Evercat	LR
Competence/training	x		x	x		x	x	x	x
Poor seamanship	x	x	x						
Unseaworthy/vessel design	x	x		x	x			x	
Safety equipment	x				x	x			
Overcrowding	x	x	x			x		x	
Human/social	x			x	x		x		
Inadequate SAR		x				x			
Regulatory	x		x		x			x	x
Weather		x	x	x		x			

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## Solutions

Prior to the workshop, attendees offered potential solutions to the causal factors identified pre-workshop. The solutions are described in this section, using approximately the same groups as for the causes.

### Insufficient training or competence

The WFSA<sup>22</sup> suggested enhanced crew training to improve many aspects of the situation in Bangladesh and the Philippines. The use of general electronic media and marine learning systems were proposed, as well as collaboration with a Philippine company that created its own e-learning course with special emphasis on safety culture.

CHIRP Maritime (UK)<sup>37</sup> recommended the following to address competency issues in BIP:

- intense, simplified training packages, specifically for emergency evacuation and use of life saving or fire-fighting appliances
- review of planned ferry routing to improve navigation safety – albeit potentially involving a less direct and more circuitous, but safer, passage
- cascade training, 'train the trainers', while maintaining oversight to ensure that training is effective.

SU<sup>38</sup> suggested the following to address insufficient experiential knowledge in BIP:

- including all types of training: teaching, mentoring, coaching
- addressing language issues
- auditing of the training process
- continuity, team building, crew familiarity.

LR<sup>28</sup> suggested the following to address training inadequacy:

- highlight with foreign university students in marine fields in all locations, the huge number of lives being lost in domestic ferry accidents, and encourage them to influence a reduction in fatalities in their future careers, some in their home countries, some in other locations.
- provide basic training courses in seamanship / STCW-F related to key areas of concern
- provide emergency response training, particularly encouraging captains and crews to ensure their vessels have appropriate emergency response equipment to help other distressed vessels in the vicinity, with merit given to those that save lives.

MIMUN<sup>27</sup> suggested several initiatives to address insufficient training in BIP:

- review current training and education programmes / levels within national agencies and community organisations





- development and training in safety culture
- develop training requirements and competencies for recognised community based vocational and technical institutions
- provide accessible education through online courses
- develop capacity within maritime administrations through the development and / or delivery of training and education in the target sectors
- assess gaps in current education and training offerings (including competency based programming, training for non-traditional learners and access to quality training/ education) and design / deliver programmes to fill the gaps
- build capacity at relevant secondary and post-secondary level institutions through the development and delivery of training and education to key instructors
- build capacity at key training institutions in competency based education and training (CBET) and community based education delivery (CBED)
- deliver focused training in maritime safety and general safety culture training to agency, administrators and institutional staff.

The WFSA<sup>24</sup> reiterated the need to consider where and how courses are delivered, for example so that they do not require personnel to be away from home for months at a time. The World Maritime University (WMU), Marine LMS and New Wave Media are conducting a global survey of operator training.

Evercat Asia<sup>29</sup> suggested the following to address the competency issue in the Philippines:

- improve access to funding for proper education and training of seafarers
- improve safety awareness culture
- provide affordable berths for cadet apprenticeships on board vessels
- enforce standards for proper training
- 'E to E' – education to employment implementation
- encourage / obtain support from shipping companies
- implement 'Blue Ocean' strategies.

Interferry<sup>39</sup> suggested that affordable, basic nautical training would be a very cost-efficient way to reduce fatalities.

- In an Interferry-IMO co-operation in Bangladesh, a two-day DVD training course has been developed and disseminated, but it is not clear what the actual uptake has been among operators.

- Other training courses also exist, for example the US Coast Guard and Washington State Boater's Competency Card. Effort in this area would therefore not need to start from scratch.



### Poor seamanship (including poor lookout activities)

The WFSA<sup>22</sup> proposed the employment of AIS to improve the situations in BIP, and to particularly improve the situation related to insufficient night-time crew vision in Bangladesh.

MIMUN<sup>27</sup> recommended the following to address frequent night-time incidents in the Philippines and Indonesia:

- enhancement of vessel traffic management systems
- accident investigations of night-time incidents to establish root causes and trends
- improvements to night-time navigation.

They also suggested the following to address seamanship or collision issues in Bangladesh:

- minimum competency training for (especially inland waterways) operators
- training at community level, accessible through online delivery
- improvements in navigation bridge viewing arrangements.

ANCORS<sup>1</sup> suggested that problems caused by poor lookout practices in the Philippines and Bangladesh and negligence in the Philippines and Indonesia would be best addressed by the same measures used for unseaworthiness and overcrowding.

Interferry<sup>39</sup> recognised the significant costs of increasing AIS density, and that universal usage is the optimal result, but nevertheless considered it a good candidate to save many lives.



## Unseaworthy or poorly designed or suboptimal vessels and equipment

The WFSA<sup>22</sup> proposed capacity building in naval architecture and marine engineering as a solution to the use of poorly designed ferries in Bangladesh and the Philippines. It sponsors an international competition to design a safe affordable ferry, recently having completed the fifth round of awards.

The WFSA suggested 24-hour manning of open Ro-Pax decks by trained crews to deal with the well documented fire problem on those type of ferries in Indonesia.

ANCORS<sup>1</sup> suggested that the unseaworthiness problems in BIP would be best addressed by reducing human errors via a combination of training, education, encouragement, management, and enforcement of existing regulations. ANCORS also saw reformation / re-assignment of IMO responsibilities as a partial solution to the issue.

CHIRP Maritime (UK)<sup>37</sup> made the following recommendations to alleviate the poor vessel design issue in BIP:

- Design-enforced maximum passenger / payload.
- For modifications to small river ferries: expanding the waterplane area with shallow draft, wide beam, multi compartmentalised double bottoms to improve damaged stability criteria; addition of sponsons (stabilising projections) to inhibit passenger movement, specifically to prevent rushing to the side, causing capsiz.
- For modifications to coastal ferries: addition of sponsons; life-saving equipment; and a vessel-by-vessel upgrade.

Nesta (UK)<sup>26</sup> suggested better ship design in BIP.

MIMUN<sup>27</sup> recommended the employment of technology aids to mitigate design issues and improve safety (for example smartphone applications for vessel traffic and stability).

Evercat Asia<sup>29</sup> suggested the following to address poor ferry design and the use of inappropriate boats in the Philippines:

- better regulation and strict enforcement of laws
- implementation of third party audits
- certification requirements
- public awareness programmes
- improved monitoring and certification of boat and ship builders and operators
- government support and incentives
- implementation of a single classification body (IACS approved only).

Continuous training and international exposure of naval architects and marine engineers to innovative designs, methodologies and new materials. For example light crafts (fibreglass reinforced plastic and aluminium) to include buoyancy spaces injected with polyurethane foam to make the vessel 'unsinkable'.

## Safety equipment

Nesta (UK)<sup>26</sup> suggested better training and use of safety equipment in BIP.

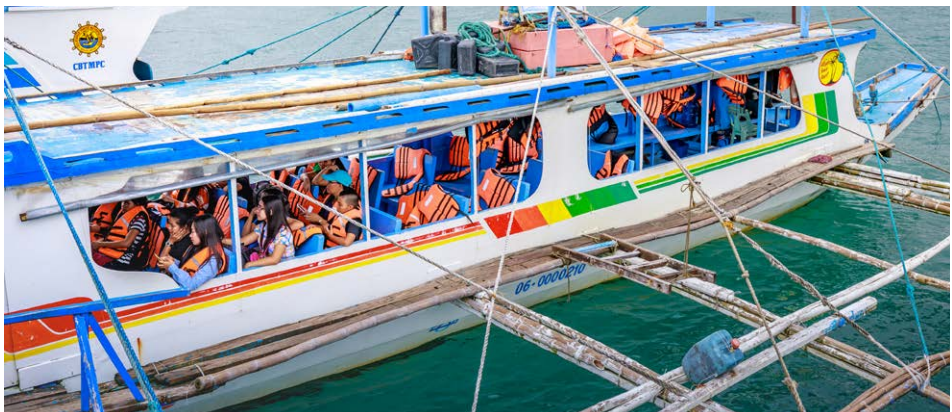
MIMUN<sup>27</sup> recommended lower cost life-saving appliances (for example life jackets and locators) that have historically been cost prohibitive and / or not designed for local conditions.

Interferry<sup>39</sup> mentioned that improvements in safety equipment availability and utilisation could produce significant safety improvements in Bangladesh and Indonesia, particularly:

- distribution of affordable flotation devices
- greater use of emergency position indicating radio beacon (EPIRB).

ANCORS<sup>1</sup> emphasised the need for lighter, simpler, cheaper, maintenance free, float-free lifeboats.

SU<sup>25</sup> mentioned the existence of an effective loan system for EPIRBs. An approach to high technology electronics companies to enact mass production of this type of equipment to reduce cost for small operators could be considered worthwhile. Having a widely distributed branded piece of equipment could assist both technology growth and safety improvements in BIP.





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## Overcrowding

The WFSA<sup>22</sup> proposed crew training as a partial solution to the vessel overcrowding situation in Bangladesh, with a particular emphasis on safety culture.

ANCORS<sup>1</sup> suggested that the overcrowding problem in Bangladesh would be best addressed by the same measures used for unseaworthiness (training, education, encouragement, management, regulatory enforcement, and IMO responsibility reform).

MIMUN<sup>27</sup> recommended the following to address the overcrowding problems in BIP:

- national strategies to mitigate overcrowding
- stricter regulatory enforcement
- education and training, specifically for ro-ro passenger vessels
- establishment and enforcement of maximum loading conditions for existing vessels.

Evercat Asia<sup>29</sup> suggested the following to address overcrowding in the Philippines:

- better enforcement of regulations
- public awareness programmes to increase passenger safety awareness.

Interferry<sup>39</sup> recommended contact with the International Union of Marine Insurance (IUMI), International Association for Lighthouse Authorities (IALA) and / or P&I (protection and indemnity) clubs, with a view to improving the passenger counting process.

## Human and social issues

SU<sup>38</sup> suggested the following to address human elements as a causal issue in fatalities in BIP.

### Ship and company behaviour and influence

- Onboard culture - understand the 'norms' within the country and company. Rooted differences and behaviours between cultures affect working practice, social interaction and team building. This is in addition to an existent historic hierarchy between ranks/ departments at sea. Hands on management and observation of practice are essential to understand how activity and behaviours can be managed for productive and effective results.
- Management of language / communication, onboard management, communication, team building, insecurities.
- Safety culture empowerment.
- Manning levels - crewing / rostering strategies, team building, stable teams and fatigue.

- Company culture - recruitment and selection process, retention, contract types. If the company culture does not have value based management as a strategy (ie supported professional development, continuous appraisal systems, merit based advancement and salary levels) then recruitment success, retention of staff and onboard productivity are likely to be low.

### **Group influence**

Groups of people can be effective in changing behaviours. Their influence, interaction and potential reactions are areas to investigate. Convincing a small group of people of the advantages of improved safety culture and encouraging the aggressive distribution of this message would be a good avenue for altering the course of current practices. This would most likely be more effective than changes being led by developed world influence and / or a national government fighting to enforce regulations.

### **Family and individual passenger influence**

Family is as important in BIP as anywhere else. Creating public awareness using the emotional and psychological routes are likely to be more effective than trying to put pressure on national governments to enforce regulation. IMO stated that rules are in place, they just simply are not being enforced by authorities. Awareness of risks and consequences can be used to change behaviours and thought patterns of both passengers and operators. People opting either not to travel or to choose operators that comply with regulations, as opposed to those who do not, would likely have an influence on other ship owners and businesses. Subsequent changes in social practice could make governments' jobs easier following the behavioural changes.





A short video for display in passenger terminals to show action and consequence for overloading might be particularly effective. The content could be varied and extended depending on the audience. This type of media tool could also be used to demonstrate what life-saving appliances look like, what should be on board and what happens when they are not. The same sentiment could be shared for fire on board and the necessary equipment. A video could also be used to show the expertise and importance of the crew and the need to follow their instruction.

### **Ship owner influence**

Ship owners strongly influence operations and changes to industry practice. Their participation and encouragement would be more effective than state involvement to enforce regulations. Bigger operators, who are already promoting safer travel, could influence smaller owners to change behaviours, practice and positively influence the safety culture.

### **Improved search and rescue capability (SAR)**

Interferry<sup>39</sup> mentioned that enhanced SAR capability could produce significant safety improvements in Bangladesh and Indonesia, particularly liaising with local administrations to support enhanced SAR co-operation.

The WFSA<sup>22</sup> proposed enhanced SAR capability to improve the situations in BIP.

### **Regulatory issues**

Many experts reject the idea that implementation or enforcement of regulations will have any effect in BIP. However, there were some recommendations for improvements via related measures, as follows:

ANCORS<sup>1</sup> suggested that several issues (for example unseaworthiness) in BIP could be partially addressed by enforcement of existing regulations.

Nesta (UK)<sup>26</sup> suggested better regulation / enforcement to address regulatory weaknesses in BIP.

LR<sup>28</sup> suggested the following to address global weaknesses in regulatory enforcement:

- regulation and standards to be addressed on a local basis
- influential support to be provided to assist operators and regulators in regulatory interpretation.

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MIMUN<sup>27</sup> recommended that weaknesses in regulatory enforcement in BIP should be addressed via:

- a review and enhancement of regulation and enforcement regimes
- training for national and local officials and administrators.

Evercat Asia<sup>29</sup> suggested the following to address regulatory issues in the Philippines:

- proper training of law enforcement manpower to effectively enforce regulations
- proper training in regulatory requirements for boat operator personnel.

### Related to weather or knowledge of weather conditions

The WFSA<sup>22</sup> proposed better and affordable weather detection and communication as a practical solution to the situations in BIP, noting the weather monitors employed by Washington State Ferries in the USA. The WFSA supports the 3D printing of inexpensive ferry route weather monitors, which have the added advantage of ease of printing of repair parts.

CHIRP Maritime (UK)<sup>37</sup> suggested the following to address weather-related issues in BIP:

- a simple weather service for small ferry operators (as exists for larger vessels)
- a 'traffic light, safe to sail' system issued by the weather service, specifically aimed at inland ferries.

MIMUN<sup>27</sup> suggested the development of a low cost weather prediction software platform that can be deployed and utilised globally together with a distribution network through text and social media.

MIMUN<sup>27</sup> also suggested the following to deal with the significant number of storm-related accidents in BIP:

- national policies on risk assessment for voyages in inclement weather
- domestic safety management systems to be entrenched as a matter of national policy
- education and training specifically for ro-ro passenger vessels
- technology that promotes specific monitoring for vessels susceptible to water ingress.

Interferry<sup>39</sup> suggested that reliable weather forecasting in developing countries, recognised by the operator and monitored by authorities would be very beneficial. It supported the development of 3D-printed, affordable weather monitors.





## Holistic and general approaches

Memorial University of Newfoundland<sup>40</sup> suggested a holistic approach to the ferry safety issue, commenting as follows:

“It is best to understand how each of the elements interact with each other by modelling them together as a system. The overall system is more representative of how each industry operates than an approach where these elements are considered piece-wise. Researchers from Memorial University’s Faculty of Engineering and Applied Science have been taking a ‘big picture’ approach to maritime operations safety using an approach called FRAM [functional resonance analysis method], which was pioneered by Erik Hollnagel, one of Europe’s leading experts on industrial safety.”

The Herbert Engineering Corporation<sup>41</sup> proposed the following to address several forms of accident (capsizing, fire, collision, sinking) in BIP:

- reduce probability of collision / allision / grounding
- reduce probability of fire
- reduce probability of overloading
- reduce probability of sailing in unsafe weather
- reduce probability of capsize
- increase damage survivability standard, evacuation and life-saving appliances (LSA)
- increase fire containment / insulation and fire-fighting standard
- increase intact stability requirements, limit capacity via design
- increase loadline requirements - freeboard
- vessel maintenance (freeing ports, watertight door seals etc)
- improve crew emergency preparedness.

## Electronic tracking and navigation

The Korea Research Institute of Ships & Ocean Engineering (KRISO)<sup>42</sup> has been developing a Korean e-Navigation system, called SMART-Navigation, which provides an electronic tracking and navigation system for small vessels, and was designed to implement the IMO's 'e-navigation\*' concept.

The SMART-Navigation system provides services to all vessels operating in Korean waters and is comprised of the following components:

- S: Sea traffic co-ordination and optimisation
- M: Marine domain awareness
- A: Active and proactive maritime safety management
- R: Remote assistance
- T: maritime Telematics

The graphic below<sup>42</sup> shows one of the SMART-Navigation services, MESIS, or Maritime Environment and Safety Information Service.



\* e-navigation has been defined as the harmonised collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.



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## Appendix D: List of workshop attendees

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Fauziya Ahmed-Idris  
Lloyd's Register Foundation

Daryl Attwood  
Lloyd's Register Foundation

Andrew Aznar  
Evercat Asia

Gina Aznar  
Evercat Asia

Neil Baird  
ANCORS

Tina Barnes  
Seafarers UK

Cor Blonk  
Pelagic Freezer-trawler Association

Tom Boardley  
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Neil Bose  
Memorial University of Newfoundland

Ruth Boumphrey  
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Emma Broadhurst  
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Tony Bush  
Lloyd's Register Group

Bill Chislett  
Memorial University of Newfoundland

Richard Clegg  
Lloyd's Register Foundation

Courtney Farthing  
Pew Trusts

Laura Ferrarello  
Royal College of Art

Eric Holliday  
FISH Safety Foundation

Sarah Honebon  
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Ghulam Hussain  
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International Maritime Organization

Eileen Kinghan  
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Fabian Lambert  
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Richard McLoughlin  
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Edwin Pang  
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Jeff Parfitt  
CHIRP

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James Pomeroy  
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Jan Przydatek  
Lloyd's Register Foundation

Nurur Rahman  
Hannur Maritime Consultants

Johan Roos  
Interferry

Ian Shields  
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International Maritime Organization



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