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Review article
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WORK RELATED DEATHS AT SEA

Seafaring has long been recognised as one of the more dangerous occupations as it presents workplace hazards in a combination rarely encountered in other occupations. Available recent studies on occupational health and safety of seafarers have concentrated on nationally manned fleets mostly operated out of North-European countries.
Recent studies on the supply and demand of seafarers have pointed to the fact that international shipping relies pre-dominantly on ships manned with seafarers from mostly Asian nations.
This study examines the records of the Singapore Marine Department of fatalities on board Singapore ships.
In the ten year period covered (1986-1995), a total of 373 deaths were identified which fulfilled the inclusion criteria. The victims came from 26 different countries, with Singapore resident seafarers forming only the fourth largest group. The biggest number of deaths was attributed to maritime disasters, followed by deaths due to illness, of which the biggest share was formed by heart related illnesses. The third biggest cause of death were occupational accidents and personnel working on deck constituted the biggest group of victims. Most occupational accidents were caused by lack of procedures or negligent working practices.

KEYWORDS: occupational accidents, seafarers, merchant ships, fatalities, Maritime disasters, total losses

1. INTRODUCTION

The occupation of merchant seafarers is a dangerous one exposing them to hazards in a rarely encountered combination. Among these specific risks are exposure to extreme weather conditions, dangerous enclosed spaces, noisy mechanical equipment or toxic cargoes. When travelling all over the world, seafarers may be exposed to unusual or rare diseases caused by infectious agents unknown in their countries of residence. All of these hazards might be even more increased through the lack of direct access to medical assistance while at sea or in remote ports.

A recent study into the supply and demand of seafarers world-wide estimated that approximately 1,030,000 seafarers are employed on merchant cargo ships world-wide. The study also highlighted that the majority of modern day seafarers originate from non-industrialised countries, mainly East and Southeast Asia.

Available recent studies investigating the risks for, and mortality and morbidity of, seafarers concentrate on industrialised countries thus examining pre-dominantly nationally manned fleets with often particular characteristics of trade or employment or types of ships involved. Little is known about the causes and circumstances of deaths at sea on merchant ships from other countries, manned by multinational crews.

The study presented in this paper investigates patterns of fatalities in an internationally manned fleet with a view to establish differences to other fleets.

2. MATERIALS AND METHODS

The Republic of Singapore has a long tradition in operating a shipping register, which over time evolved from being perceived as an open register to a quality register with a well established maritime administration. As a Commonwealth member, Singapore has reporting system for deaths on board ships, which is similar to that of other Commonwealth nations and is largely modelled on the British system prior to the introduction of the *Merchant Shipping Act* (1979).

Singapore shipmasters are obliged to report any birth or death occurring on board a Singapore ship to the Marine Department, failure to do so would result in a maximum fine of Sin$ 2,000 (Singapore *Merchant Shipping Act, Sect. 91, Ch. 179*).

The reports and statements submitted by the shipmaster are reviewed by a Marine Superintendent, who decides upon the necessity to hold a marine inquiry or carry out an investigation.

The study covers deaths of seafarers signed on Singapore flag seagoing ships. A seafarer was defined as a person gainfully employed on board a merchant ship, having been signed on the ships' articles. This definition excludes passengers or accompanying family members but includes company superintendents. Not included were deaths on non-merchant ships, such as dredgers, harbour craft and fishing craft.

The categorisation of cases was based on the evidence as found in the case files and comprised mainly extracts from ships' logbooks; ship masters' statements; statements from various crew members; communication with the shipowners or managing agents, often in the form of telex or telefax communication; death certificates or autopsy reports, if necessary accompanied by a translation; police statements and other case records; lawyers' statements; and occasionally correspondence with relatives.

No documents or files of marine inquiries or investigations were made available, since these are considered confidential under the Singapore Merchant Shipping Act. To ensure completeness, the records were compared with a print-out of shipping accidents as recorded by the Institute of London Underwriters, which covered the years 1990-94; the annual casualty statistics as published by Lloyd's Register of Shipping , the on-line database of Lloyd's List, for the years 1991-95 and a book covering maritime disasters which is largely based on information compiled by Lloyd's Maritime Information Services Ltd.

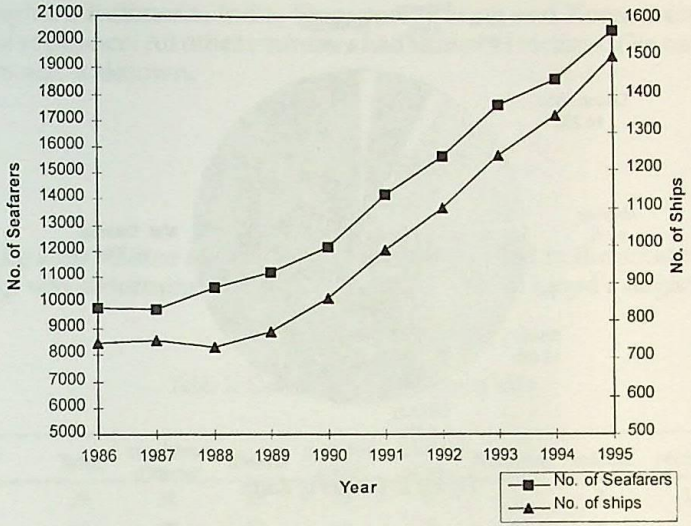

Figure 1: The Singapore Fleet and the Number of Singapore Seafarers (1986–1995)
surce: annual reports Marine Depertment, personal communication

For the purpose of this study, deaths were categorised in 8 broad groups: maritime disasters; occupational accidents; deaths due to illnesses; individual persons missing at sea for no apparent other reason; homicides; suicides; off-duty and finally unclear causes.

3. RESULTS

The Signapore Fleet and Safarer employment:

Over the study period, the Singapore fleet expanded continually from 738 ships with 6,859,814 grt in 1986 to 1,501 ships with 13,498,279 grt in 1995. In line with this growth of fleet, the number of seafarers employed on Singapore ships rose from 9,785 in 1986 to 20,534 in 1995.

Figure 1 shows the development of the Singapore fleet in terms of numbers of ships registered and the employment of seafarers.

4. CAUSES OF DEATH

The Singapore Mercantile Marine Office (MMO) gave access to files concerning a total of 313 deaths on board ship. From the other sources mentioned above, another 4 accidents to the ship could be identified, which resulted in a further 60 deaths.

263 of the deceased were males, the gender of the remaining victims could not be established.

Figure 2 gives the distribution of causes of deaths. The majority of deaths is to be attributed, to maritime disasters, mostly vessels sinking or disappearing without trace.

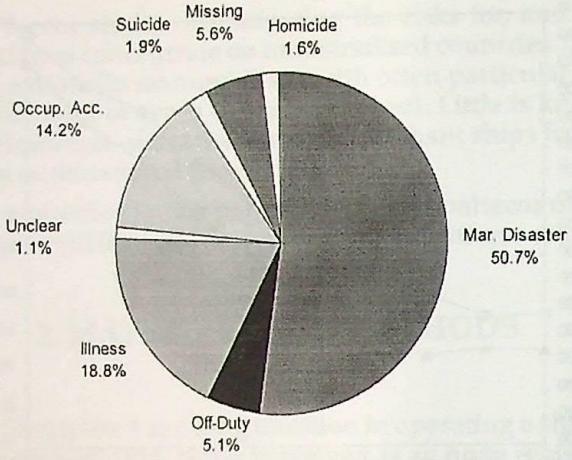

Figure 2: Causes of death

source: author

5. LOCATION OF THE SHIP AT THE TIME OF DEATH

The location of the ship at the time of death is shown in table 1. Given the fact that 42.5% of all deaths were attributed to maritime disasters, it would not surprise that the majority of deaths occurred while the ship was at sea.

Table 1: Location of the ship at time of death

Cause of Death	Total	at sea	in port	on roadstead	River
Occupational Accident	53	23	22	6	2
Illness	70	33	29	8	2
Maritime Disaster	193	169	12	12	
Individual Person missing at Sea	21	17	0	4	
Homicide	6	0	6	0	
Suicide	7	4	2	1	
Off-duty Accident	19	2	12	4	1
Unclear Cause	4	1	2	1	
Total	373	249	85	36	3

Note: Roadstead: an area near a port river estuary, where the ship lines at anchor or where the ship may drift waiting for a pilot or clearance to enter the port. The ship is thus neither in port nor at sea.

6. COUNTRIES OF ORIGIN OF THE VICTIMS

Singapore manning regulations are strict and detailed, but they stipulate no restrictions as regards the nationality or country of origin of the seafarer. The freedom of Singapore shipowners in sourcing their crews is reflected in the distribution of nationality of the deceased who came from 26 different countries.

The Phillippines, Indonesia, India, Singapore, Burma and Korea were the main countries of residence. All other countries had under 10 victims. The nationality of 60 seafarers was unknown.

7.TYPE OF SHIP

Based on the ship's name and gross tonnage as recorded in the accident files, the type of ship was determined by referring to the annual Lloyd's Register of Ships books .

Table 2: Causes of death by type of ship

Type of Ship	Total	maritime disaster	illness	occupat. accid.	missing at sea	homicide	suicide	offduty	unclear
Oil Tanker	75	34	15	14	6	1	2	1	2
Bulk Carrier	64	30	13	9	2	4	6		
Ore-Bulk-Oil	3	1			1	1			
General Cargo	128	98	12	10	4	1	2	1	
Container Ship	35	10	10	8	3	1	3		
Chem. Tanker	1	1							
LPG Tanker	6	2	1	2	1				
Tug	42	19	10	4	3	1	1	4	
Supply Vessel	10	3	4	2	1				
Vehicle Carrier	8	4	3	1					
unknown	1	1							
Total	373	133	70	53	21	6	7	19	4

When assessing the risk of death in relation to type of ship, table 2 seemingly suggests that general cargo ships followed by tankers and bulk carriers pose the highest risk, as they report the highest numbers of death. A look at the annual fleet statistics, as published by the Singapore, Marine Department, tells us, however, that the Singapore fleet is dominated by tugs, oil tankers and general cargo ships. Statistics on the number of seafarers employed on different types of ships would then allow a more informed assessment of risk of death. Unfortunately, the Singapore Marine Department does not compile such statistics and it is therefore suggested that the number of ship-years at risk could be used as a denominator to compare the risk of fatality.

In figure 3 the relative risk of death due to maritime disasters is shown.

The risk of death due to a maritime disaster is much higher on general cargo ships and bulk carriers than the average, with container ships and oil tankers being close to the average rate of fatalities. For both general cargo ships and bulk carriers, the higher risk of death is mainly due to foundered or sunken ships.

The mean age of seafarers dying in a maritime disaster was 38.04 years (standard deviation: 8.03; median age: 37.0 years), the age was known for 110 of the 193 victims.

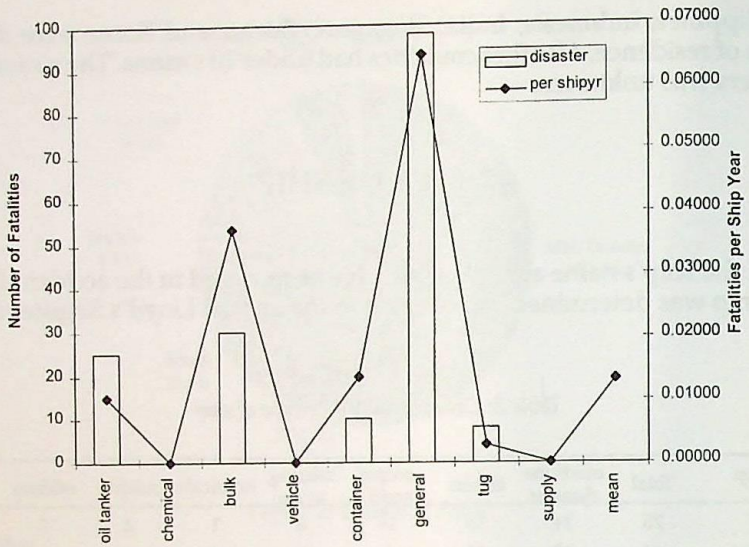

Figure 3. Risk of death due to maritime disasters

source: author

8. DEATHS FOLLOWING AN OCCUPATIONAL ACCIDENT

The second largest group of non-natural deaths is due to 'occupational accidents', with 53 reported deaths.

A more detailed review shows that there are several areas of particular danger, and the accidents were grouped according to the area of work on board the ship, where the accident happened. Six subgroups were formed:

- falls over board when working on deck or on the ship's side
- accidents in cargo holds
- accidents in the engine room
- accidents in tanks or enclosed spaces
- accidents while working on deck including mooring/ anchoring operations
- various causes

The deck department is the most dangerous workplace on board. Indeed only 13.2% of the victims were working in the engine department and no occupational accident resulting in a death occurred among the group of catering workers. Most victims are manual workers on deck (petty officers and ratings) and the highest numbers of death are attributable to falls over board or accidents during opening and closing of hatches, often involving a fall into the hold. When working on deck, in some cases basic rules of seamanship seem not to have been observed. Crew members were washed over board when trying to secure loose items on the foc'sle or were crushed by waves against bulkheads.

The single most important cause of occupational accidental deaths are accidents which happen in tanks or other enclosed spaces. All of these accidents in en-

closed spaces took place on oil tankers and the case files point to serious deficiencies in procedures when preparing for entry or monitoring the workers in the tanks or enclosed space. In almost all cases no rescue equipment had been placed near-by, ready for immediate use.

The age of the victim was recorded in the case files in 52 out of the 53 occupational accident cases. Six victims were under 25 years, none under 18 years and another six victims were over 45 years. None of the victims was over 55 years of age.

The mean age of seafarers dying due to occupational accidents was 35.17 years (standard deviation: 8.32; median age: 35.50 years).

Table 3: Rank of victims of occupational accidents

	rank of seafarer														
cause of death	Master	Chief Off.	Deck Off.	Rad. Off.	Chief Eng.	Engineer	P.O. Deck	Deck Ratg.	Eng. Ratg.	Catering	Gen. Purp.	Deck Cad.	Eng. other	Cad.	Total
cargo hatches			2					7				1			10
fall over board		2	1				2	2				2			9
Various				1		1	2	1	1						6
deck/ mooring		5	1				2	3				2		13	
tank/ enclosed space	1	1				1	2	1			1	2		1	10
engine room					1			1	2				1		5
Total	1	8	4	1	1	2	8	16	3	0	1	7	1	1	53

More than one third of the 45 seafarers for whom the time served on board was reported, suffered a fatal accident in the first three months on board and 75% died with up to 6 months service experience on board

The total time served at sea was only known for 27 of the 53 victims of an occupational accident. Nine victims had up to 5 years total sea experience, another 9 had between 5 and 10 years experience, one seafarer had been at sea for 10 to 15 years, 3 seafarers had 15 to 20 years sea time and 5 seafarers had over 20 years experience at sea.

This must be seen in the context of seafaring being an industry with a high fluctuation rate. When looking at all fatalities, the total time served at sea was known for 103 persons out of 373 fatalities. In the category 0 to 5 years sea time the age spread was from 18 to 50 years of age. The category 5 to 10 years seatime had an age spread from 25 to 55 years, 10 to 15 years sea time had an age spread from 30 to over 65 years, 15 to 20 years sea time had an age spread from 35 to 65 years and finally over 20 years reached from 40 to over 65 years of age.

The risk of death due to an occupational accident on different ship types is shown in figure 4.

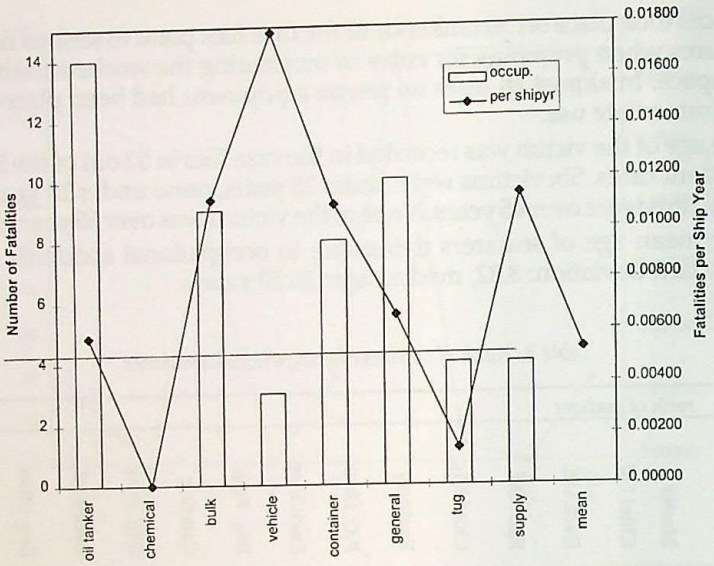

Figure 4: Risck of death due occupational accidents

Ship types with small numbers of ships per year are unduly sensitive to even smaller rates of casualties, thus the high risk on vehicle carriers must be assessed with care. However, bulk carriers and container ships pose an increased risk of an occupational accident to the seafarers, mainly due to falls over board and into the hold in the case of bulk carriers.

9. DROWNING AS A CAUSE OF DEATH

Altogether 197 seafarers (52.8%) drowned and in figure 5 the different causes of drowning are shown.

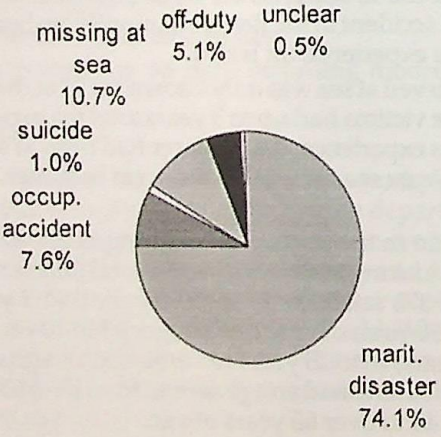

Figure 5: Cause of drowning

Drowning is the main cause of death following a maritime disaster and an occupational accident. Other important causes of drowning are 'missing at sea' and 'off-duty' accidents, often when returning to the ship.

10. DISCUSSION

This study examines reported non-natural deaths of merchant seafarers which occurred on board of Singapore merchant ships. Death is the ultimate consequence of an injury suffered but serious accidents do not always lead to immediate death. The availability of medical help, the position of the ship relative to the shore and of crew properly trained in first aid or advanced medical care may influence the outcome of a serious accident. The results of this study thus do not lend themselves to generalisations on the risks of the occupation as a seafarer. Other data on non-fatal illnesses, accidents and near misses must be taken into account in judging the risks to which modern day seafarers are exposed. For Singapore ships, such records are not available for review.

It is very difficult to judge the quality of reporting or the rate of under-reporting. The main reason for an under-reporting is probably the fact that Singapore laws make the results of marine inquiries confidential, even for research purposes. As mentioned before, other (additional) sources were consulted and four maritime disasters were identified, which led to the death of altogether 60 seafarers.

This study is clearly biased towards sudden deaths following an accident. An analysis of deaths due to natural causes (illnesses) was beyond the scope of this study.

Follow-up studies into serious accidents which may have led to prolonged hospital stays or death after signing-off the ship may have been desirable but cannot be carried out for Singapore flag ships. By law, Singapore ship owners have no restrictions in sourcing their crews. They can choose to employ seafarers from any country in the world, as long as the seafarer complies with the training requirements as stipulated by the then Marine Department and now Maritime and Port Authority (MPA). On the other hand, seafaring has been characterised as an occupation with a high fluctuation rate . In an internationally manned fleet such as Singapore, there is no register of seafarers employed on Singapore ships and seafarers employed by Singapore companies may alternate between Singapore and non-Singapore flag ships.

Additionally, there are other reasons why the study may not cover all work related fatalities among Singapore merchant seafarers. If for example the seafarer has been signed off for the very reason of an injury suffered, or an illness contracted while on board, and he dies shortly after being signed off, there would be no legal obligation for the master to report such a death. Indeed, the ship master may not even be aware since the death may not have been communicated to him.

In general, occupational accidents were not at all investigated by the MMO. As a rule the marine superintendent managing the case file accepted the statements by the ship's master and crew as sufficient. This can hardly be deemed to constitute an in-depth investigation of a fatal occupational accident carried out by Singapore investigators.

Even for several accidents involving the loss of the whole ship or other serious accidents to the ship leading to loss of life, no formal investigation has been carried out. However, two of the maritime disasters which led to the sinking of the ship and

consequent loss of life, were investigated by the German *Seeamt Emden*. The German Marine Accident Investigation law calls for an investigation to be carried out, if the ship in question had been under the command of the holder of a German certificate of competency. The results are then published by the German Maritime Authorities.

The main aim of the Singapore MMO seemed to have been to ensure that the family of the deceased received the personal effects and any outstanding wages and to confirm that indeed death had occurred. This can more be likened to the function of a registrar of births and deaths than to a coroner's inquiry.

The case files thus cannot be used for detailed reviews and analysis of causes of accidents, but the study was able to demonstrate that seafarers working in the deck department are particularly at risk of an occupational accident and most accident victims are of a relatively senior rank (officer or petty officer).

In a recent study covering Polish seafarers, the two departments deck and engine had about an equal share of victims . Hansen reports increased standard mortality rates (SMR) for all age groups and departments compared with the Danish male population. But deck ratings and to a lesser extent engine ratings have about two times higher SMRs than deck or engine officers.

The case files also suggested that in several cases there were indications that poor working practices and lack or availability of preventive safety equipment may have led to these fatalities.

In particular the outcome of the cases of falling overboard while working at the ship's side or climbing Jacob's ladders, could perhaps have been mitigated if the seafarers had carried a self-inflating life-vest, used a safety harness or if a security guard had been placed on deck while work was carried out on the ship's side. The merits of these so-called 'single chamber life vests' have been discussed in a recent court decision in England .

Mooring operations have long been recognised as an activity involving a high degree of risk which may sometimes lead to serious and fatal accidents . In this study only one accident was identified which happened while berthing the ship when a mooring rope broke. Six seafarers died while working on deck in bad weather when they were crushed by waves against ships parts and suffered multiple injuries.

But the single most important cause of death was working in enclosed spaces, a particularly dangerous area on board ships, with oxygen depletion leading to suffocation. In this study 10 occupational accidental deaths were to be attributed to this cause. Hansen highlighted that oxygen contents of the enclosed spaces were not checked and safety lines were not rigged which delayed the rescue. Similar facts can be elucidated from the respective Singapore files. All cases of deaths in enclosed spaces happened on oil tankers, a section of the shipping industry which is particularly proud of its good safety record.

The mean age of the victims of occupational accidents (35.2 years) as well as those who perished in maritime disasters (38.0 years) is about the same as reported by Hansen for Danish seafarers (35.5 years) whereas Roberts reports a much higher mean age of 43 years for occupational deaths in the British fleet, which certainly reflects the higher mean age of British seafarers, a fact also mentioned by McConville and Glen(1997).

The mortality rate of confirmed suicides is lower than in other studies, but one must bear in mind that it is possible that any of the cases in the category 'individual persons missing at sea' may have been concealed suicides. It is at least debatable, if a

seafarer distressed enough to take his own life was able to perform his duties and functions on board the ship properly in the time before death. This should give a new perspective to the discussion on human errors being the cause of 80% of all shipping accidents and it is argued that this area is one that should also be addressed in the current, ongoing discussions on manning levels at the International Maritime Organisation. Proposals that 'social matters should not be addressed' (Lloyd's List, 1998) seem to be short sighted.

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Sažetak

POVEZANOST RADA I SMRTNIH SLUČAJEVA NA MORU

Pomorski se život već dugi niz godina smatra jednim od najopasnijih zanimanja budući da se u radnoj sredini javljaju opasnosti inače rijetke u drugim zanimanjima. Najnovija dostupna istraživanja iz područja medicine rada i sigurnosti života pomoraca usredotočena su na brodovlje s nacionalnom posadom koja većinom ne dolazi iz zapadnoeuropskih država.
Najnovija istraživanja o ponudi i potražnji pomoraca ističu činjenicu da se međunarodna trgovačka mornarica pretežno oslanja na brodove s posadom koja u većini slučajeva dolazi iz azijskih zemalja. Ovo se istraživanje bavi proučavanje podataka dobivenih od Odjela koji se bavi proučavanjem nesreća na moru iz Singaporea, a odnose se na nesreće koje su se dogodile na brodovima pod zastavom Singaporea.
U desetogodišnjem razdoblju (od 1986. do 1995. godine) zabilježena su 373 smrtna slučaja. Žrtve su bile porijeklom iz 26 različitih zemalja, a pomorci sa stalnim boravkom u Singaporeu činili su tek četvrtu grupu po broju smrtnih slučajeva. Najveći broj smrtnih slučajeva bio je uzrokovan nesrećama na moru, zatim slijedi smrt kao posljedica bolesti, od čega je najviše zabilježeno raznih srčanih bolesti. Treći velik uzrok smrtnosti obuhvaća nesreće na radu, pri čemu su žrtve u većini slučajeva članovi posade koji obavljaju poslove na palubi broda. Većina nesreća na radu uzrokovana je nepostojanjem načina vođenja poslova odnosno nepažnjom pri obavljanju radnih zadataka.

KLJUČNE RIJEČI: nesreće na radu, pomorci, trgovački brodovi, smrtnost, pomorske nesreće