

Towards improving evacuation operation on passenger ships through investigations of past passenger ships accidents

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Abstract: The paper reviewed the investigation reports and media reports of passenger ships accidents through the past two decades. In addition to personal interviews with people involved in order to study the root causes of the accident, the reaction of crew and passengers, and the efficiency of the evacuation process.

Eight cases are thoroughly studied and compared because of their significance, some of the chosen accidents are similar in nature but different in out concerning the efficiency of following the procedures and the condition of survival crafts on board. The author intentionally selected modern accidents to evaluate and review the safety culture capability to cope up with current regulations and training criteria. The author through these comparison aims to highlight the common mistakes led to these disasters and he concludes the comparison by illustrating the lessons learnt from each case and in the end of the study the author introduces his recommendations to improve the safety of lives at sea and to avoid the recurrence of those mistakes in the near future. A number of accidents are deeply studied and compared. Comparing between successful evacuations and failed ones is done, the aim of the comparison is to identify and study the errors that took place from the moment of the incident to the evacuation phase.

Keywords: investigation - passenger ships – accidents – Evacuation – SAR – LSA.

1. INTRODUCTION

Despite the improvements and progress in marine transportation technology and regulations, still accidents occur which leads to losses in lives and properties specially when happens on passenger ships which led the International Maritime Organization (IMO) to take special measures and guidelines to facilitate the evacuation process.

2. CASE STUDIES

The researcher provides a comparison between the following Eight passenger ships accidents throughout the last two decades.

2-1. Caribbean Fantasy:

Ro/Ro Pax, Panama Flag, Classification Society (RINA)

2-1-1. The accident:

On 17th of August 2016 About 0725, while approaching the pilot station at the entrance to the port of San Juan, Puerto Rico, a fire broke out in the main engine room of the (Ro/Ro) passenger vessel Caribbean Fantasy when fuel spraying from a leaking flange came in contact with a hot surface on the port main propulsion engine.

When the crew of Caribbean Fantasy failed to control the fire, the master decided to abandon the ship (maritime Cyprus, 2018).



Fig. (1)
CARIBBEAN FANTASY on scene SAR operations

Source: (maritime Cyprus, 2018)



Fig. (2)
Close look to the deficient MES

Source: (maritime Cyprus, 2018)

2-1-2. Lifesaving appliances:

Life boat no. (1) faced difficulties releasing the hooks and suffered from engine failure. Life boat no. (2) faced difficulties releasing the hooks. Life boat no.3 failed to release the hooks and was hoisted fully loaded against the winch design which made it hang six feet above water line. The MESs were installed on either side of the ship but the port side MES was not deployed because of the flames and smoke coming from the port side. The starboard MES was also not deployed as designed. The slide was kinked, with an extreme angle at the top of the slide and a flat angle at the bottom, due to that kink, several passengers suffered injuries. A Coast Guard vessel solved this problem by fixing a line to the floating platform of the MES to pull the slide out straighter and prevent further injuries.

2-1-3. The evacuation:

Life boats of the vessel were loaded and lowered in 45 minutes from the moment of the abandon call. The boats were partially filled with passengers and designated crewmembers from the ship. The evacuation process suffered number of difficulties due to the lack of training of the crew.

At 0825, life boat no. (1) was in the water but the crew on life boat no. (1) could not release the release hooks for some time but eventually they were able to release the hooks manually one by one. After the hooks were released, the engine started but did not have any thrust so it was towed by coast guard boat.

At 0837, the master gave orders to lower lifeboat no. (2), once lifeboat no. (2) was in the water, the crew were unable to open the hooks using the release handle, so the crew had to manually remove each lifting eye from the closed hook by hand. People started gathering at the embarkation of life boat no. (3), embarkation of the boat was delayed because there was no commander for the boat. Master ordered the 2nd mate who was on bridge watch to proceed as a commander.

At 0847, the master ordered lifeboat no. (3) to be lowered when ready, the boat was lowered shortly after but the crew suffered from the same issue as they failed to open the release hooks, the boat was hitting the ships side and was taking water. The crew tried to open the hooks manually but at 0854, the commander informed the master he could not manually release the hooks, all attempts to release the hooks manually failed and the commander reported that the boat was getting damaged.

The captain decided to hoist the life boat but due to the winch design, the winch motor could not hoist the fully loaded boat and the boat was hanging (6) feet above the water. Few coast guard boats attempted to evacuate life boat no. (3) but they failed because the height was restricting the operation, eventually a higher coast guard boat successfully evacuated them. Remaining passengers on board the Caribbean Fantasy were required to evacuate using the ship's marine evacuation systems (MESs).

2-1-4. SAR:

The SAR operation was successful and no lives were lost but there were only a small number of injuries.

2-1-5. Working language:

Three languages were used on the bridge of the Caribbean Fantasy: English, Spanish, and French. The cadet explained that they only didn't speak English when the discussion was personal. However, according to the vessel's VDR audio, all three languages were being spoken on the bridge during the accident. Because the master did not speak Spanish, he did not realize that the abandon-ship announcement was being made at that time. This is a violation of sections 6.6 and 6.7 of the international safety management code.

2-1-6. The outcome:

1. The decision to abandon the vessel was a good decision taken in sufficient time.
2. The abandonment process on board the Caribbean Fantasy was disorganized and inefficient.
3. The crew onboard the Caribbean fantasy proved that there is a poor safety culture on board and lack of training was very obvious.

2- 2. Norman Atlantic:

Ro/Ro Pax - Italian Flag - Classification Society (RINA)

2-2-1. The accident:

On 28 December 2014, a very serious fire suddenly broke out on board the RO/Ro Pax Norman Atlantic. The incident took place during navigation, on the route line between Igoumenitsa and Ancona. The fire was detected by the alarm system at 04:15, in the ship open garage - deck (4). The deck officer on the bridge, applying the correct procedure, immediately sent the seaman to the area concerned. the seaman said that in the signalled position there was only a refrigerated truck, whose combustion generator for the cooling system was working and there was no incipient fire. After about 15 minutes a fire pre-alarm was heard again and a Fire Alarm followed.

The Distress signal was launched at 04:38 when the ship was in the Greek SAR area.

The Captain, who already was on the navigation bridge ordered to transmit the fire alarm and to issue the "crew call". And activate the Drencher system. Based on the evidence gathered on board, in the Drencher room the valves of deck 3, instead of those of deck 4 (which was affected by the fire) were open (MIT, 2018).

After few minutes, the chief mate informed the Captain that the situation could not be dealt and recommended the immediate intervention of the tugboats to extinguish fire. The first black-out took place at 04:46.

2-2-2. Lifesaving appliances:

The rescue boat on the starboard side was destroyed by the flames coming out from deck (4), also the mini-chute on the starboard side could not be used, as it was destroyed by flames. The boat on the portside was lowered to the embarkation deck by the crew following the captain's order. Afterwards, without any orders from the Captain, 88 persons got on board the lifeboat that was lowered to the sea. Also the life rafts placed on the portside of the ship were launched in water, without the Captain's authorization and the control of the crew members appointed. It is probable that some passengers used the MES, placed on the portside of the ship, and boarded on the life raft. However, after a while the life raft separated from the vessel.



Fig. (3): Illustrates the damaged starboard side chute which was never used in evacuation. Source: (MIT, 2018)

2-2-3. The evacuation:

Soon after the fire broke out, the fire fighters reported that the fire could not be controlled, captain made distress calls asking for assistance and ordered for evacuation.

The passengers used survival crafts and lowered life boat without master orders. Also the life rafts placed on the portside of the ship were launched in water, without the Captain's authorization and the control of the crew members appointed.

2-2-4.SAR:

In the initial phases, precisely at 04:50 of the 28th, the SAR was led by the JRCC PIRAEUS, at 09:00 the MRCC ROMA took control of the rescue operations. Several merchant ships, which were navigating in the nearby of the area concerned, were invited to change course and reach the area.

The rescue means rescued 88 persons, the remaining persons were rescued by helicopters.

Some passengers died of hypothermia, after they fell or jumped in water. 452 persons were rescued, 11 persons died, 12 are missing and 31 were injured. In addition, based on the claims the families to the competent authorities, 6 other persons could be missing (MIT, 2018).

2-2-5. Working Language:

The working language on board was English, although, during the interviews, it was noticed that few of the low-rank crewmembers could not have a good knowledge of the English language, this could have led to some difficulties in the performance of their duties, during the emergency.

2-2-6. The outcome

1. The master followed the emergency procedures and ordered to evacuate in proper time.
2. Evacuation process was not organized; both passengers and crew did mistakes.
3. Deficiencies in the survival crafts were mainly due to fire.
4. SAR operations were carried out properly resulting minimum losses of life.

2-3-Lisco Gloria:

Ro/Ro Pax - Lithuanian Flag - Classification society (ABS)

2-3-1. The accident:

At 2335 hrs. on October 8th, 2010, while the vessel was en route from Germany to Lithuania, the fire in the upper deck garage was detected by a crew member and a fire alarm was sounded.

The master started the drencher system but the system failed to deliver water to the fire area which led to the quick spread of fire. Fire fighters failed to reach the source of fire due to dense smoke then master decided to evacuate the ship.

2-3-2. Lifesaving appliances:

The organisation of lifeboat stations were smooth and when crew members faced difficulties loosening the lashing ropes they managed to quickly cut them off. All survival crafts were in good condition and were used in the evacuation.



Fig. (4): Due to successful evacuation by life boats, many life rafts were left unused, life boat lowering cables shown to be parallel lowered indicating smooth lifeboat lowering. Source: (Investigation Report 445/10, 2010)

2-3-3. The evacuation:

From the moment of detecting the smoke, it took the master only 35 minutes to decide evacuating the ship. The passengers proceeded to the muster station once the alarm was sounded, the evacuation of all 235 people was done in 81 minutes, evacuation was done by lifeboats and life rafts

2-3-4.SAR

The master initiated the first contact with Bremen Rescue Radio at 0007 Local time through VHF channel 16, the master reported the vessel name and reported that he has fire on board in English language but due to language barriers from the other side, the Bremen rescue radio took few minutes to classify the message. The Bremen Rescue Radio sent the mayday relay message six minutes after receiving the accident report, vessels in vicinity immediately responded to the distress call and changed their courses accordingly.

All people in life boats and life rafts were successfully taken on board the rescued vessels. The rescue operation was a very successful and challenging one, saving people from a burning ship in very bad weather at night was not easy but because of the good SAR and good communication all 235 persons were saved.

2-3-5. The outcome

1. The crew member did a proper safety round and reported the fire before the alarm started
2. The master and the crew had a good situation awareness and the situation was evaluated properly and he ordered for evacuation in sufficient time.
3. SAR operation was very well performed from RCC and vessels in vicinity.
4. All factors led to a successful evacuation and rescue operation, no lives were lost (Investigation report 445/10, 2010).

2-4-Sorrento:

Ro/Ro Pax - Italian Flag - Classification Society (RINA)

2-4-1. The accident:

On 28th of April 2015, at 11:45 UTC, about 20 miles off West of Palma de Mallorca island (Spain), occurred a very serious fire on board the Ro/Ro Pax Sorrento, the ship had left the port of Palma de Mallorca at 09:55 UTC, with 156 people on board and 123 trucks., a fire developed at the garage deck number (4), despite the intervention of the firefighting teams and the activation of the Drencher fixed firefighting system, the fire could not be controlled due to high wind speed which hit the vessel increasing the speed of fire spread. (MIT, 2015).

2-4-2. Lifesaving appliances:

Life boats were used for the evacuation, starboard side life boat was successfully lowered and worked properly. Port side life boat was successfully lowered but the engine was turned off only 500 meters after sailing in the water due to engine failure.

2-4-3. The evacuation:

After launching a distress signal at 12:12 UTC, the Captain ordered to abandon ship because the fire spread and went out of control. At about 12.35 UTC, despite the adverse weather conditions, the starboard lifeboat was lowered with 113 people heading to M/V Puglia. Shortly thereafter, the port side lifeboat was lowered into the water with 33 people including the Captain.

2-4-4.SAR:

During the rescue operations all the 156 people, that were on board the ship, were safely rescued; thanks to the coordination of the activities operated by MRSC PALMA together with the ships intervened for assistance (MIT, 2015).

2-4-5. The outcome:

1. Master ordered abandon in sufficient time.
2. Successful evacuation resulted in zero casualties.
3. Successful SAR operation from RCC and other vessel in vicinity.
4. Engine failure of the port side life boat indicates possibility of poor maintenance on board (MIT, 2015).

2-5- Costa Concordia:

Ro/Ro Pax- Italian Flag - Classification Society (RINA)

2-5-1. The accident:

At 2145 Hrs (local time) On 13 January 2012, the Italian ferry Costa Concordia collided with the "Scole Rocks" at the Giglio Island. The vessel was sailing in the Mediterranean Sea with 4229 people on board from which 3206 are passengers and 1023 are crewmembers.

The ship was sailing too close to the coastline, in a dark shore area, under the Master's command who had planned to pass at an unsafe distance during night time at high speed (15.5 knots).

Suddenly, the ship hit the rock and heeled. The vessel immediately lost propulsion and blacked-out. At about 24:00 the heeling of the vessel seriously increased reaching 40°. During the rescue operations it has reached 80°.

2-5-2. Lifesaving appliances:

Out of 26 lifeboats, 23 were launched while the other three portside could not be launched due to the significant list of the vessel. Six Life rafts were launched.

Crew assigned to manage the lifeboats and life rafts have been extracted from the Concordia Muster List have either expired certificates or without the said qualification. The crewmembers in the muster list were not properly familiarized.

2-5-3. The evacuation:

The abandon ship was ordered; but it was not followed by an effective general emergency alarm. The first lifeboats were lowered at 22:55 and at 23:10 they moved to the shore with the first group of passengers on board.

Crewmembers along with the master abandoned the bridge at about 23 :20 and left one officer behind on the bridge to complete the abandon ship process. At 0034 the Master communicated with the SAR Authorities explaining that he was on board a lifeboat with other officers.

2-5-4.SAR:

The Master did not warn the SAR Authority of his own initiative (the warning was received by a person calling from shore) and, despite the SAR Authority started to contact the ship few minutes after 22: 00, he informed these Authorities about a breach only at 22: 26 Hrs.

All the rescued passengers and crewmembers reached Giglio Island. First rescue operations were completed at 06 17, saving 4194 persons. The number of victims were 32 (26 passengers, 4 crewmembers and 2 people went missed).

2-5-5. The outcome:

1. The master was careless to decide approaching the shore to unsafe distance at night for no reasonable reason.
2. Non-qualified personnel were designated to critical evacuation duties.
3. The general emergency alarm was not sounded.
4. The company violated the STCW requirements by hiring non-certified crew.
5. The company received previous warnings from the master related to the poor training and familiarization of the crew 3 months before the accident but violations found proves that no or poor corrective action was taken.
6. The master and officers abandoned the ship before the completion of the evacuation.
7. The master did not initiate the distress call; it was reported by persons ashore.
8. The investigations revealed that newly joined 700 passengers joined the vessel only couple of hours before departure which resulted to an amendment to the SOLAS regulations related to on board drill requirements. Chapter III / Regulation 19-2.3 states "Whenever new passengers embark, a passenger safety briefing shall be given immediately before sailing, or immediately after sailing" instead of "within 24 hours". (MIT, 2012).

2-6. M/V AL SALAM BOCCACCIO 98

Ro/Ro Pax - Panama Flag - Classification Society RINA

2- 6-1. Accident:

At 1909 UTC on the 2nd of February 2006, a fire broke out in the garage of the vessel. Crew members started fighting the fire with all possible means but due to the blockage of the scuppers, water used in fighting the fire started accumulating and was not drained and caused an excessive list of the vessel to starboard.

At 2333 UTC, the ingress of sea water due to the excessive list of the vessel eventually caused the sinking of Al Salam Boccaccio 98.

There were 1,321 passengers and 97 crew members, a total of 1,418 persons on board.

As a result of this disaster, 1031 lives were lost; only 387 persons could be rescued.

2-6-2. Evacuation

The master did not accept the recommendations of his officers to contact vessels in the vicinity, the company, or the authorities. Moreover, he ignored the recommendations to abandon ship. No orders of evacuation were given to the crew members or the passengers at any time.

2-6-3. LSA

The vessel was equipped with the required safety equipment for the number of passengers on board. The vessel had 10 life boats (5 on each side) which could accommodate 890 persons and 88 life rafts that could accommodate 2200 persons. Survival equipment were never used because no abandon ship order was given by the master.

2-6-4.SAR

The SAR operations were significantly delayed in arriving at the site of the sinking.

The failure of the master to notify the ongoing situation and to request help or assistance delayed the initiation of the SAR operations.

The SAR efforts started approximately 10 hours later. It is important to remember that the vessel sank at approximately 0133 hours, Egyptian local time, even though, the first vessel arrived at the area of the accident at about 1500 hours, Egyptian local time, after more than 13 hours of the time of the sinking.

It is also important to remember that the vessel sank in February which is winter season in Egypt, many people who could have survived, died due to hypothermia.

According to the 2nd officer statement, he succeeded to activate the EPIRB. At 0037 hours UTC on February 03, 2006, Algerian MCC received an alert message, with position in Egypt area at and they delivered it to Official Egyptian SAR Point of contact.

Another important issue in the search and rescue operation is the action of the master of the M/V Saint Catherine who received a call from the second officer of the M/V Al Salam Boccaccio 98 informing that the vessel had sank, and that he was on board a life raft, specifying also the location of the sinking. He verified that he was near to the location of sinking but he decided not to proceed to the place of the sinking to avoid endangering the passengers he was carrying because of bad weather (Investigation Report, 2006)

2-6-5. Working language:

The entire crew of the M/V Al Salam Boccaccio 98 was of Egyptian nationality, and their working language was Arabic. All communications and orders during the final voyage between the master, officers and ratings were conducted in their native language.

2-6-6. Outcome:

1. The vessel suffered a fire began in the car-deck; however, the origin of the fire could not be properly located at an early stage.
2. The fire alarm detected at the panel was reset before the response teams were in place.
3. As a result of the fire-fighting operations, a critical increase in the level of water on the car deck happened which was impossible to be discharged in a timely manner by the crew.
4. The large volume of water delivered may have also contributed to the accumulation of debris, trash, and residue around the car-deck, and perhaps blocking the scuppers, and thus impeding the water from being freely discharged overboard which led to an unsafe stability condition.
5. Emergency response procedures were not properly followed by the crew as established in the Safety Management Manual of the vessel.
6. The master was in panic and could not take the right decisions.
7. The master did not accept the recommendations of his officers to contact vessels in the vicinity, the company, or the authorities. Moreover, he ignored the recommendations to abandon ship.
8. The abandon ship operation was neither ordered nor carried out at any stage resulting which led to avoidable loss of 1031 lives.
9. The delay of SAR contributed in the catastrophic loss of 1031 lives, SAR started very late and it was not organized even though they have received and acknowledged the receipt of the distress (Investigation Report, 2006).

2-7.M/V Pella:

Ro/Ro Pax - Jordanian Flag - Classification Society Helinick

2-7-1. Accident:

At 0815 on the 3rd of November 2011, The RO-RO ship Pella which was sailing between port of Aqaba and port of Nowebaa at a fixed route suffered from a fire which started in the ships' storage room, the fire spread and could not be controlled which eventually led to the evacuation of all passengers and crewmembers, attempts to fight the fire was done but none of the attempts succeeded, the ship finally sank on the 8th of November after a total loss due to fire.

The master decided to follow the firefighting procedures with the firefighting team, the master decided to start drencher system but unfortunately the fire was too strong to overcome and the possibility of the team getting injured was very high. At 08:45 the ship sent distress signals with the VHF headed to Nowebaa port, Aqaba port, Arab Bridge maritime company, and all ports and airports surrounding the area and they prepared for evacuation.

2-7-2. Evacuation:

The evacuation procedures started at approximately 09:09 local time. Crewmembers started by evacuating women, children, elderly people and handicaps directly to the 4 lifeboats all wearing lifejackets. The lifeboats and life rafts were then launched. Rafts on the starboard side were then transferred to port side. Some small rescue vessels with length of 25 to 30 meters managed to rescue people directly from the ships' ladder without the need of the life rafts.

The master, the Bosun, a seaman, and two cadets remained on the ship trying to fight the fire until the tug boat reported to them that the fire is spreading to the forward of the ship so they went down to the tug boat. Everyone was transferred to Aqaba port and the evacuation process was done at 10:45 lasting for 96 minutes according to port Aqaba's administration.



Fig. (5): Evacuation of the M/V Pella using embarkation ladders.

Source: (Jordan maritime authority administration 2008).



Fig. (6): Photo of unused life rafts due to the spread of the fire on starboard side. (Jordan maritime authority administration, 2008).

2-7-3.LSA

The vessel was equipped by 4 life boats (55 persons each) and 60 life rafts (25 persons each). The 4 life boats were used in the evacuation, two of them were motorised and the other two were propelled by oars.

The fast rescue boat was damaged because it was overloaded by panicked passengers who rushed to embark without any instructions, due to the overload, the davits were damaged.

2-7-4. SAR

The SAR operations started quickly because the ship was not far from port, the SAR coordination centres of Aqaba and Nowebaa took appropriate actions in ample time, also the presence of small ships and fishing boats in the vicinity helped saving a lot of people.

2-7-5. Working language:

All crew was from Arab nationalities who communicated in their native language, Arabic, so no issues were encountered regarding the communication among the crew.

2-7-6. Outcome

1. The master had a proper evaluation as he went by himself to inspect the fire area.
2. The master followed the emergency procedures properly and the firefighting was carried out as plan.
3. The master who had the proper situation awareness decided the abandon in ample time without hesitation.
4. Most of the survival crafts were used and functioned in good condition.
5. SAR operations were successfully carried out and well organized. (Jordan maritime authority administration 2008).

2-8. M/V Sewol

2-8-1. Accident:

On 16th of April 2014 Sewol capsized and sank during a sharp turn in the south-western corner of South Korea. The ship was carrying 476 people, mostly teenage high school students, 124 cars, 56 trucks and 1,157 tonnes of cargo. Nearly twice its legal limit. The helmsman was inexperienced, he made the deadly sharp turn. The master ordered the passengers to remain in their cabins as the ship sank. The Master failed to provide the proper evacuation instructions in case of emergency situations. (Howitt, A., 2017).

2-8-2. Evacuation:

Orders to evacuate the vessel were never given or carried out. Lack of experience, and poor awareness of the vessel characteristics, loading conditions and environmental limitation that led to under estimate of the outcome of the sudden turn Inadequate training led to inadequate understanding or unaware of job duties in the event of emergency Thought there were enough time to wait for rescue craft to evacuate safely.

The captain, chief officer and chief engineer, abandoned the ship without leaving any evacuation instructions to the passengers.



Fig. (7): A photo of M/V SEWOL before sinking, the photo shows that all life rafts were unused. Source: The New Yorker (2019)

2-8-3. LSA

Lifesaving equipment were inadequate and no evacuation was executed to evaluate the condition of the survival crafts.

From the photo, it appears that there are 28 rafts on the starboard side of a total of 42 rafts visible on the deck and another 14 liferaft containers on the port side just behind the bridge. It revealed that the vessel had 46 life rafts. This would leave only another 4 rafts to be positioned elsewhere on the vessel. It appears that many passengers died from being trapped within the vessel. Simply mustering on deck would have provided an opportunity to abandon ship and be rescued with or without access to a liferaft or lifeboat.

2-8-4.SAR

SAR operations were very poor and slow but the accident awakened the South Korean Government, the Korean Register of Shipping and the South Korean Coast Guard.

2-8-5. Working language

All crew communicated in native language, no communication issues were noticed.

2-8-6. Outcome

1. The master held responsible for killing 304 persons who died because he never ordered to abandon ship, accordingly, he was imprisoned for 36 years for negligence; the chief engineer for 30 years who left the vessel along with the master without leaving any instructions.
2. The company failed to hire competent, qualified crew which was the reason behind the occurrence of the accident.

Comparison table:

Table below illustrates factors of comparison between previously studied ships to evaluate the evacuation process and to illustrate the outcomes. Table (5-2): Illustrates factors of comparison between previously studied ships to evaluate the evacuation process and to illustrate the outcomes

Vessel Name	Type of ship	Accident	Time	Date	Location	Abandon call	Evacuation efficiency	LSA Condition	Evacuation duration	SAR	saved	Lost	Crew
1-Caribbean Fantasy	Ro/Ro	Fire	07:25	17 Aug 2016	Puerto Rico	Good	Bad	Bad	5 Hrs.	Good	511	Nil	Bad
2-Norman Atlantic	Ferry	Fire	Midnight	28 Dec. 2014	Otranto Strait	Good	Uncontrolled	Bad	10 Hrs.	Good 35Hrs nonstop helicopters	452	23	Fair
3-Lisco Gloria	Ferry	Fire	00:02	9 Oct 2010	Kiel - Lithuania	Good	Fair	Good	81 Minutes	V.Good	235	Nil	Good
4-Sorrento	Ferry	Fire	11:45	28 April 2015	Spain	Good	Fair	Good	1 Hrs.	Good	156	Nil	adequate
5-Costa Concordia		Sunk due to strike	21:45	13 Jan 2012	Giglio Island	Very Bad	Bad	Good	6 Hrs.	Good	4197	32	Bad
6-Al Salam Boccaccio 98	Ferry	Fire & Sinking	22:00	2 Feb 2006	Red sea	Not given	None	Poor	N/A	Poor		1031	Fair
7-Pella	Ferry	Fire	07:15	3 Nov 2011	Aqabba-Nwebaa	Good	Good	Good	96 Minutes	Good	1300	1	Good
8-Sewol	Ferry	Capsize	09:00	16 April 2014	South Korea	Not given	None	Not used	N/A	N/A	172	304	Bad

From the table, the author carries out comparison between similar accidents and illustrates the difference between failed evacuation operations versus the successful ones.

Through those comparisons, the author illustrates and explains how different factors relates when comes to life saving, the good training and certification leads to better evacuation operations and better emergency responses.

The table illustrates how in each accident death toll relied mainly on these factors as in cases where the crew were well trained, they successfully carried out the evacuation process with minimum losses as on MV Pella while on the other hand as on MV Caribbean Fantasy where the crew were not well trained they failed to perform the required evacuation which led to more deaths and casualties.

The author addresses through this comparison that all factors are related to life saving and no compromises should be done, training, maintenance and technical specifications of survival crafts are essential factors at the evacuation stage, the crew who receives trainings at marine institutions should be trained on different types of survival crafts including the most modern ones, in the case of MV Norman Atlantic, it was the first time to all crew members to see the MES even though they hold certificates which certifies that they are competent for using those systems and are competent as per STCW.

The comparisons also prove that the decision to abandon ship is very sensitive decision, the moment that the master feels the doubt of abandoning the ship is the same moment that he should do so. Every delay between the incident and abandoning the ship is responsible for losing lives, the master must be very wise when evaluating the situation and never hesitate to abandon the ship if the incident seems to be uncontrollable. As always said, the ship is best survival craft but when the abandon is required then every moment counts and holds responsible either for saving or losing lives.

The comparison also was fair enough not to put all blame on crew members as SAR also is essential factor when related to evacuation operations, some cases the ships succeed to carry out the proper evacuation but delay of SAR causes deaths by drown or hypothermia, in some cases SAR assisted to perform successful evacuation because of failure of survival crafts on board the ships, in those cases if the SAR were delayed with failed survival crafts then no one would have survived. Countries with poor SAR capabilities usually suffer from higher death toll from avoidable accidents but needs only better SAR resources.

When comparing between SAR operations it was noticed that some countries used helicopters for the SAR operation while the other did not use helicopters as in the case of Norman Atlantic were the helicopters air lifted non-stop for 35 hours while in other cases no helicopters arrived to the scene at all. The death toll resulted from both is totally different because using helicopter in the SAR helps to cover more areas in less time, it was noticed that death toll in developed countries is much less than developing ones because if the SAR resources and response time.

Through the analysis of the previously studied cases, the author illustrates the factors affected the outcome of the accidents. It is noticed that many factors from the moment of the incident until the completion of rescue can control the outcome of the incident either related to life saving or property losses.

The author illustrates how each factor could have affected the accident separately and It is important to remember that one event led to the other, and sometimes there were parallel events and scenarios taking place at the same time; however, it is important to separate these factors and events while analysing each case.

3. THE FACTORS WHICH THE AUTHOR SELECTED TO STUDY ARE:

3-1. Time of the incident:

Time of the incident can either ease or restrict the master decision, evacuation process and SAR operations. Vision at day makes the evacuation and SAR more easy while at night those operations becomes more complex. From the case studies, Caribbean fantasy, Norman Atlantic, Sorrento and Pella accidents occurred at day, the outcome of the incident was minimum losses compared by accidents occurred at night such as

M/V: Al Salam Boccaccio 98 which outcome was disastrous as 1031 lives out of 1418 persons on board.

The author does not restrict the failure nor the success of live saving operations on the time factor but the study intends to illustrate how each factor can affect the outcome.

3-2. Proximity to the shore:

Indeed, the proximity to the shore affects the SAR operations as the chances of SAR resources to reach the location of the incident in less time are much more than incidents remote from the shore. For example, the passenger ships Caribbean fantasy, Sorrento and passenger ship Pella were very close to the shore, SAR resources were available and near to the incident and responded very quickly, the final outcome was zero casualty except for Pella as one passenger died later due to heart attack on board the vessel which was transferring him after being rescued.

3-3-SAR resources and management:

The resources and the management of the SAR strongly affects the outcome of the accidents. In countries equipped with good resources and properly managed SAR usually responds faster and manage to save more lives. From the cases it was noticed that accidents occurred in countries equipped with good and well managed SAR resources, usually had better outcomes as the SAR operations starts at early stages as proved in the accident of Caribbean Fantasy, Lisco Gloria, Sorrento, Norman Atlantic and Costa Concordia while In The Case of Al Salam Boccaccio 98 And Salem Express, the SAR operations started very late after the incident which led to the death of total 1495 persons.

3-4-Master of the vessel:

It is well known that the master is the overall responsible for the ship. The master's decision must be precise and in ample time.

Abandon ship order is only given by master and confirmed verbally by master, that's why the abandon ship order can either save the lives on board without any losses or leads to the loss of all lives on board.

The evacuation process can be chaotic or well organised depending on the atmosphere that master is responsible of creating among the crew and passengers at the moment of evacuation, if the master orders the abandon at early stages he then can carry out an organised evacuation process without people panicking.

In the case of Lisco Gloria, SORRENTO and Pella, the masters took the decision to abandon the ship in ample time at early stages, they managed to perform an organised evacuation process and the passengers panic was minimum compared to other incidents where the masters delayed the abandon call or never ordered to abandon the ship as in case of Al Salam Boccaccio 98 and Sewol who suffered from many losses of live.

3-5. Communication:

Communication and working language on board is essential to perform and carry out successful operations on board. When evacuating the vessel one simple misunderstanding due to poor communication can lead to a disaster.

M/V Pella carried out successful evacuation and no observations were taken on language barriers or communication issues while on the other hand, M/V Norman Atlantic and M/V Costa Concordia suffered from poor communications due to language barriers as revealed later in the investigation reports.

3-6. Crew training:

It is very important to always remember that in case of emergency, every person on board is responsible for saving lives. The training and drills should never be underestimated or neglected. From the studied cases it was noticed how poor or good crew training affects the outcome of the accident. It was noticed that in case of M/V Pella and M/V Lisco Gloria, the crew were efficient and could handle the situation when evacuating the vessel, the crew did not show any difficulties using the survival crafts while in case of M/V Caribbean Fantasy, all life boats commanders failed to release the hooks because they did not receive the proper training. The ships master and the safety management are responsible to ensure the efficiency and the competency of the crew on board, in the muster list of M/V Costa Concordia, 20 unqualified persons with either expired or without certificates were assigned to command 20 out of 26 life boats which is against STCW requirements.

It was also noticed in the accident of M/V Pella that many people were evacuated by the ladder which indicates that crew could not use the davits to lower more than one life raft and the davit cable was not hoisted to lower the next one. It is clear in the photos that the davit cables are in the water while people disembarked using the embarkation ladder.

3-7. Survival crafts:

It is very important to carry out regular maintenance of survival crafts on board, it is the duty of the crew to make sure that all survival crafts on board are maintained and in good condition. It is also the duty of the management to supply the required spare parts, unfortunately some management companies delay the supply of the parts and does not prioritize the maintenance to save money. It was noticed from the studied cases how the condition of the survival crafts affects the evacuation process, poor condition may lead to casualties and at least injuries. Sometimes after the evacuation process is done successfully, the poor condition of the survival craft becomes the cause of death or injury.

In case of the M/V Caribbean Fantasy and M/V Sorrento, the life boat suffered from engine failure but luckily the SAR was at the scene which assisted to overcome that issue. It was noticed that in some cases even if the evacuation process failed, the deployment of life rafts would save people in the water from dying by hypothermia or drowning as happened in the accident of AL Salam Boccaccio 98, the vessel sunk but the Hydrostatic Release Unit (HRU) of life rafts were not activated and people could not use the life rafts.

In the accident of M/V Caribbean Fantasy, the starboard side MES was not deployed as designed. The slide was kinked in the middle, with an extreme angle at the top of the slide and a flat angle at the bottom which resulted into several injuries while the evacuation.

In the accident of M/V Norman Atlantic, the MES on the starboard side could not be used, as it was destroyed by flames.

It is noticed that in many accidents, the survival crafts were not used because they could not be reachable or damaged due to fire.

4. RECOMMENDATIONS

1- It is recommended that in future ship building designs, the survival crafts and MES should be protected and thermally isolated such in case of fire, people can board and use that equipment without being damaged, this protection shall be capable of protecting the crafts for a duration of time not less than the time required for evacuation as per SOLAS requirements.

2- Thorough maintenance of all wires, sheaves, blocks and hooks should be done to avoid the hooks of the life boats from rusting so that it doesn't fail to unhook. Also keep voice/video record of executed drills on board to be inspected at any time during surveys and inspections and if it was impractical to execute drills on time for reasonable reasons, a documented excuse shall be presented.

3- Increase the number and capacity of the lifesaving appliances on passenger ships and make amendments in the STCW and SOLAS regulations to increase the amount of training and awareness of completely filling the capacity of each lifeboat before launching.

- 4- Lack of training and practical education causes crewmembers to be unfamiliar with the life-saving appliances on board their ships. Consequently, the evacuation procedures can be affected negatively. To overcome the problem, amendments can be done to STCW and SOLAS regulations so that the amount of training is increased and so the trainings should correspond to more realistic settings. The whitelist should be revised and the institutes issuing the mandatory safety courses certificates should be re-inspected.
- 5- Different nationalities of crewmembers should be limited and the most suitable working language must be decided with the predicted language spoken by the passengers taken into consideration, third party inspectors shall review the ability of crew members in communication with the working language onboard.
- 6- Review existing evacuation procedures, technical specifications of survival crafts and regulatory information about times needed to access survival crafts in case of evacuation in the worst weather conditions.
- 7- Arrange "on-job training and familiarization" on the safety equipment on board by competent person from third party and all these trainings should be documented.
- 8- In addition to on board training, it is recommended to create an orientation videos to familiarize the passengers with the safety measures regarding the evacuation methods on the ship before boarding, this can be done in the waiting halls in ports, online when applying for the ticket and in tourist companies which are related to passenger vessels business.

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