
MARITIME ACCIDENTS: TECHNOLOGY LINKS TO CASUALTY INVESTIGATION AND RISK MANAGEMENT

♦ A B S T R A C T ♦

The shipping industry is rapidly evolving to new technologies and even autonomous vessels. Therefore, new safety challenges have emerged, and the human factor plays new roles in risk assessment and mitigation. Moreover, accident investigation has been a tool for learning lessons and correcting processes, but historically, those corrections have resulted from significant accidents. This academic essay critically analyzes the relationships between Maritime Accidents, Technology, and Casualty Investigation based on risk management with a proactive approach toward the future.

Keywords: Autonomous, Accident, Investigation, Risk Management

ACCIDENTES MARÍTIMOS: VÍNCULOS TECNOLÓGICOS CON LA INVESTIGACIÓN DE SINIESTROS Y LA GESTIÓN DE RIESGOS

♦ R E S U M E N ♦

El transporte marítimo está evolucionando rápidamente hacia nuevas tecnologías e incluso buques autónomos. Consecuentemente, han surgido nuevos desafíos en materia de seguridad, y el factor humano desempeña nuevas funciones en la evaluación y mitigación de riesgos. Es más, la investigación de accidentes ha sido una herramienta de "lecciones aprendidas" y corrección de procesos, pero históricamente esas rectificaciones han sido producto de graves accidentes. Se analiza la relación entre accidentes marítimos, tecnología y la investigación de siniestros, basándose en la gestión de riesgos, con un enfoque proactivo hacia el futuro.

Palabras clave: Autónomo, accidente, investigación, gestión de riesgos



MANUEL FUENZALIDA LÓPEZ

Capitán de corbeta LT

MSc in Maritime Affairs, Maritime Safety and Environmental
Administration (World Maritime University Sweden)

(mfuenzalida116@gmail.com)

Viña del Mar, Chile.

The shipping industry moves about 80% of international trade worldwide ("UNCTAD", 2023). However, the industry is not without risk, and casualties are unfortunately a reality. Since the TITANIC accident in 1914 and the subsequent adoption of the SOLAS Convention, international and national regulations have been primarily reactionary, written in response to significant accidents with high casualties. It is essential to understand the causes and precursors of past accidents to identify areas for improvement and reduce the likelihood of a similar incident occurring in the future (Fadda et al., 2021).

Proper investigation is crucial for interpreting accident information effectively and avoiding repeating past mistakes. As the industry evolves with new technologies and innovations, new safety challenges and threats must be proactively identified, analysed, and addressed. Moving towards a proactive approach to maritime regulations is an exciting challenge for international policymakers, who constantly aim to improve risk assessment and management in the industry.

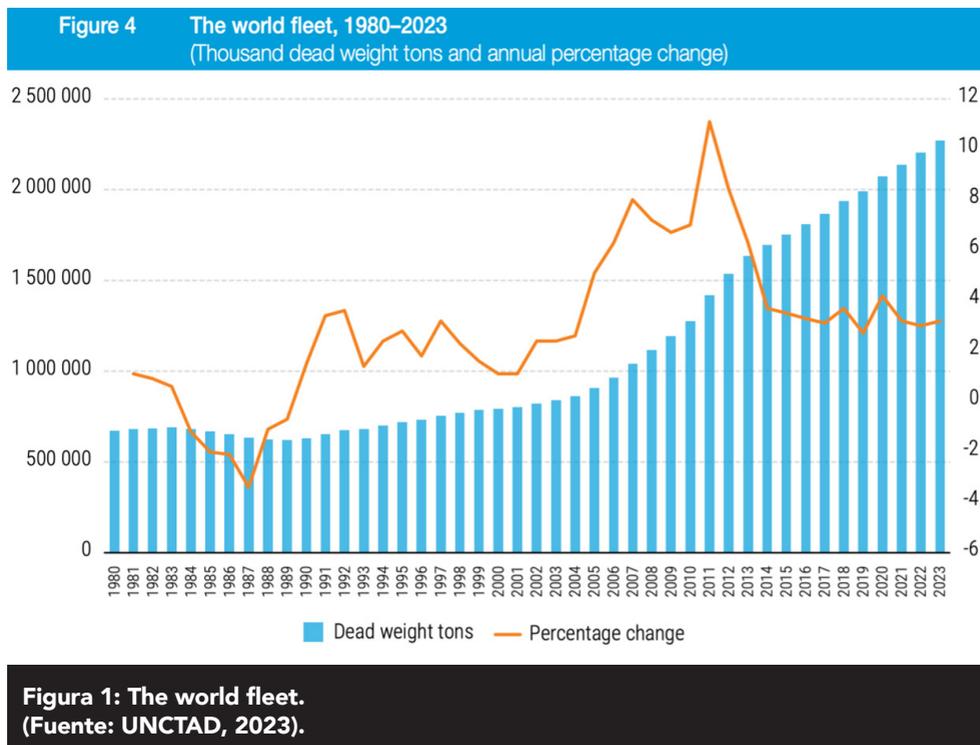
This essay will explore the importance of investigating maritime casualties, the link between accident investigation and risk management, and the impact of digitalization and autonomous shipping on safety investigations following a maritime accident. This analysis will better understand the relationships between these approaches and the need to maintain safety standards for all maritime operations, including the new challenges that will arise with technological advancements and the constantly growing world fleet.

The need to investigate Maritime Casualties

The IMO recognizes the importance of marine safety investigations into marine casualties and marine incidents to prevent reoccurrence, promote maritime safety, and prevent pollution (IMO, 2019). Thus, marine casualty investigations are an official maritime administration policy, but why?

Maritime Accidents: Technology Links to Casualty Investigation...

M. Fuenzalida



Analyzing the origins of some of the leading maritime regulations, it is a historical fact that International Maritime Regulation has come from significant maritime accidents/casualties. For example, after the Titanic accident, the SOLAS Convention was created; after the Torrey Canyon Disaster, the MARPOL convention was created; or after the Attacks of 09/11, ISPS came into force (as part of the SOLAS Convention). It took time to conduct the proper investigations and agree on a legal basis before publishing the new regulations. However, some of the incidents "motivated" the international community to increase maritime safety and minimize the risks by developing rules and regulations that we keep using up to these days.

Building from the idea that the risk is impossible to erase, and the lesson-learned process is what was conducted to better regulation in the past, it is clear that a deep and responsible investigation is needed to find the weaknesses of the process. By understanding the "logic" (or lack of logic sometimes) of the steps that ended up in a maritime accident, the policymakers/stakeholders could analyze the data and build the procedures to mitigate the same type of incidents from happening again.

Another important line of thought that reinforces the relevance of maritime casualty investigations is the human factor and its complexities. As social beings, the last few decades also impacted seafarers' performance on board, especially when it comes to fatigue associated with a lack of communication with the outside world. Moreover, the social network effect and the dependence on always being online affected younger generations in ways unknown a few years ago. So, stress and its consequences can now be present onboard due to new reasons that are complex to identify for more old and experienced seafarers. In this manner, developing a constant improvement safety culture makes more sense than ever. Some causes that can lead to maritime accidents in 2024 were not even possible a few years ago. At the same time, nobody knows what shipping will bring for seafarers and what their working conditions will be in the future. The complexities of humans make that factor the most dominant regarding accidents at sea, and it must be continuously addressed by all the levels of the "chain of command" to reduce the risks and increase the safety of maritime operations worldwide.



Figura 2: What events led to shipping conventions. (Fuente: Marine Insight, 2021).

Maritime Accidents: Technology Links to Casualty Investigation...

M. Fuenzalida

The evidence highlights that sea accidents will continue even with the latest technologies and equipment. The strength of such an approach comes from the fact that a whole new horizon of issues might happen with new equipment, always based on the human factor and the interpretation of more sources of information. This scenario also proves how important it is to investigate casualties at sea whenever they happen due to the never-ending valuable information that can be helpful from previous experiences. New technology comes with no experience, so typically, its implementation comes with many "mistake corrections" on the field. The process associated with dominating the use of new devices is not automatic, and the risk is even higher initially. So, making suitable corrections from those mistakes to mitigate the associated risk can primarily be achieved by the learning process after a maritime investigation.

From the above paragraphs, it is clear that it is necessary to investigate Maritime Casualties. The information obtained from those investigations is the key to preventing them from happening again, and the process of reducing risks is constantly improved. Sharing the investigation findings helps build capacities and increase safety levels in shipping as an international business.

The Link between accident investigation and risk management

"IMO encourages full cooperation between States in the conduct of investigations, the recognition of mutual interest, and the exchange of information regarding investigations" (IMO, 2019). This statement helps us understand the relevance of accident investigations and how they are linked with the permanent risk management processes. As shown in the previous section, accident investigations are vital to understanding the causes and adopting measures to reduce the recurrence of maritime accidents.

Moreover, accident investigations and risk management are deeply linked, even daily onboard. Life at sea is rough, and decision-making is a constant process that includes safety in the equations. Captains of officers on duty are constantly making decisions based on the information they get from different sources and the lessons learned from their professional past experiences. For instance, when facing specific complicated conditions at sea, the lessons learned from previous accidents could come to a watchkeeping officer on the bridge before taking a call to the captain or manoeuvring just as a bridge team on duty. That "calling or not calling" the captain in moments of doubt is a common factor in many accidents at sea, and maritime investigations provide the evidence to identify that human factor and the lessons to learn from it.

Sometimes, maritime accidents rely entirely upon a lousy risk assessment (or lack of it) from the responsible one at the bridge. For example, the World-famous Costa Concordia accident in January 2012 "demonstrated that accidents can occur even with ships that are considered masterpieces of modern technology and despite more than 100 years of regulatory and technological progress in maritime safety" (Schröder-Hinrichs et al. I, 2012). Consequently, an investigation was conducted to understand the reasons and define the responsibilities of this maritime accident that cost 32 lives. Therefore, the result demonstrated that the responsibility was almost entirely on the captain of the cruise vessel. He did not do a proper risk assessment when navigating close to danger zones off the coast, with the outcome that sadly is well known by the international maritime community.

Moving back in time until the beginning of the SOLAS Convention, the maritime accident of the Titanic had surprisingly (or is not a surprise) many things in common with Costa Concordia that ended up causing both incidents. On behalf of this section of the analysis, only the captains and their risk management will be assessed to compare." Both masters were aware of the potential dangers but felt that the risks

were so small that they could easily be controlled" (Schröder-Hinrichs et al. I, 2012). Subsequently, proper risk management was not addressed in these two examples of maritime accidents, even though a hundred years went by between both incidents. In this comparison, it is clear that besides technological advances, the human factor remains under similar conditions. Both cases led to major maritime accidents that could be easily avoided. Also, in the 1912 and 2012 cases, the causes and responsibilities of the accidents were confirmed due to accident investigations that showed the common conclusion between them, 100 years apart.

As shown in this section of the essay, there is a strong link between accident investigations and risk management, especially regarding the consequences of doing it correctly or not. Even one hundred years apart, human factors motivate most accidents at sea, and the only way to identify those errors and work appropriately to mitigate the risk is by doing accident investigations. By conducting those investigations, the stakeholders can correct their tracks to minimize the risk and assess the upcoming challenges of new technologies.

The impact of digitalization and autonomous shipping in safety investigations following a maritime accident

"It is assumed that there will be periods when uncrewed ships will operate together with crewless either autonomous or remote-controlled ships. Mixed traffic scenarios seem especially challenging regarding the safety and efficiency of the vessel traffic flow" (Baldauf et al., 2018). One aspect that illustrates the impact of digitalization, especially autonomous shipping, in safety investigations is that it has been addressed way before, and the technology is yet to be available. Firstly, it is a severe concern for the maritime community that is being addressed proactively, different from the approach used over the 20th and 21st centuries (as analysed in the first section). On the other hand, there are no accidents

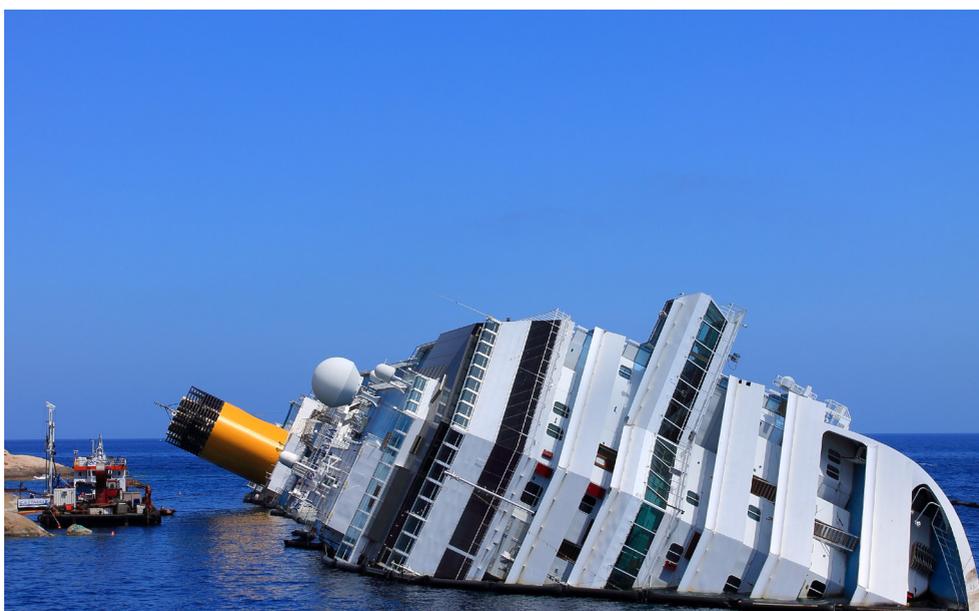


Figura 3: Maritime Accidents
(Fuente: Wikimedia Commons).

to investigate because technology is still away from reality but is getting closer every day.

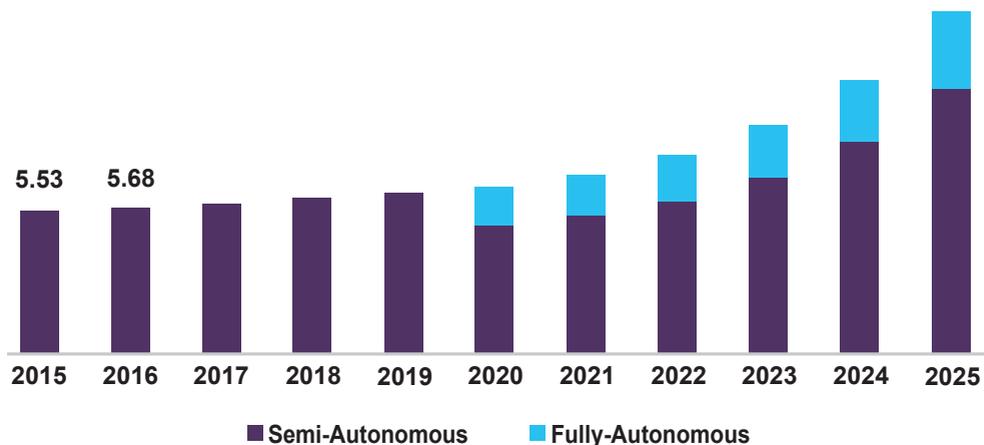
Furthermore, the impact of digitalization can be analysed based on the results of investigations, while the impact of autonomous shipping is still based on only assumptions about a future reality.

On the one hand, digitalization has increased in only a few decades, which has never been seen before in the industry. With more, newer, and better marine equipment, the human factor of the decision-making process should get smaller in the equation. The reality, on the other hand, stated as shown when comparing the accidents of Titanic in 1912 and Costa Concordia, "accidents seem to happen for the same underlying human and organizational reasons even though they are separated by a century of improvements to technology and safety regulations" (Baldauf, 2018). Safety Investigations following maritime accidents can show technical issues in some specific equipment. However, nowadays, there is always more than one piece of equipment

to contrast the information alongside the "traditional" navigational skills. So, when it comes to investigations, it provides much more detailed info to define the course of actions that define the incident, tracking times, giving data, and presenting valuable information for investigating and defining responsibilities. At the same time, with this broader spectrum of information available, policymakers have more data to define the best courses of action to develop and implement new regulations to mitigate the risks.

On the other hand, Autonomous shipping is an exciting phenomenon that finally makes the international maritime community and IMO work in advance before significant accidents happen. As mentioned, the human factor is essential to determining maritime accident causes. But what now with autonomous shipping? Will that human factor be entirely out of the equation now? Alternatively, will it prevail in different ways? There is no "consensus" on both approaches, but there is consensus on the need to address them in detail. Undeniably, Autonomous shipping already has a massive impact on safety despite not having accidents yet to investigate.

Global autonomous ships market size, by autonomy level, 2015 - 2025 (USD Billion)



Source: www.grandviewresearch.com

Figura 4: Global autonomous ships market size. (Fuente: Grand View Research, 2024).

The most common concern is the transition process to uncrewed vessels and all the risks associated with that period. The interaction between human-crewed and crewless ships in the same area represents a significant challenge, and the training standards and certifications for the people in charge of operating (remotely?) the autonomous ships must also be agreed upon in advance. Defining legal responsibilities might also be a complicated issue to discuss before accidents happen, adding to the need for international and national regulations in this manner.

At this point, at a policy-making level, the only clear fact is that the issues regarding autonomous vessels must be addressed proactively by the stakeholders at all levels. The impact of digitalization and autonomous vessel operations will be huge in accident investigations, considering that the human factor will never be 100% out of the equation. So, the risks associated with human factors will prevail, like when comparing the Titanic and Costa Concordia accidents 100 years apart.

Conclusions

Several conclusions emerge from this analysis, but more importantly, many points are shared across the three subtopics. To summarize, it is essential to consider identifying major factors and implementing targeted measures, which help reduce the severity of total-loss marine accidents and minimize casualties. So, accident investigations are the primary way to go deeper into the steps that caused the accident and the best way to identify the weaknesses and evaluate new procedures to mitigate the associated risks.

Another important line of thought related to the investigation of maritime accidents

is the need to share both the process and especially the results. IMO provides a standard field in which to share expertise between member states. However, it is hard to quantify how much information is not shared with the rest of the world due to "strategic" or national security issues. It can also be assumed that during that transition to uncrewed vessels, safety issues from involved countries might affect the risk management on a global scale, due mainly to national security restrictions to protect technologies before they become massive.

Considering the previously analysed facts, risk can be mitigated but not eliminated. From this, it is crucial to identify the relationship between the primary factors and casualties of total-loss marine accidents to reduce such incidents and the casualty rate to maintain maritime safety. The accident investigation process and the sharing of results of those investigations with the international maritime community develop this link. In addition, Technology has impacted maritime investigations and risk management, but at the end of the day, the responsibilities always come back to the human factor.

The evidence has shown that the human factor is always related to the incidents and is present even in "autonomous" shipping. Hence, the risk is permanent, and accidents will happen. Identifying and addressing the risk adequately in advance may be a big difference in reducing the consequence of an accident (mitigating the risks). Risk Management and accident investigations require constant learning and improvement. Technology can be the key to a more accessible and safer work environment, but it also comes with new challenges and risks that must be identified, addressed, and mitigated.



LISTA DE REFERENCIAS

1. United Nations Conference on Trade and Development. (2023). *Review of Maritime Transport 2023*. <https://unctad.org/publication/review-maritime-transport-2023>
2. International Maritime Organization. (2019). *What events led to shipping conventions?* <https://twitter.com/MarineInsight/status/1446370319753564164>
3. Marine Insight. (2021). *From Titanic to Costa Concordia - a century of lessons not learned*. Springer. <https://link.springer.com/article/10.1007/s13437-012-0032-3>
4. Calgary Herald. (2023). *It was just like the Titanic - 11 years ago, the Costa Concordia*. <https://calgaryherald.com/news/local-news/it-was-just-like-the-titanic-10-years-ago-the-costa-concordia-sank>
5. Grand View Research. (2024). *Autonomous Ships Market Size, Share & Trends Analysis Report by Autonomy Level (Semi-Autonomous, Fully Autonomous), by Solutions (Systems & Software, Structures), By End Use, and Segment Forecasts, 2019-2025*. <https://www.grandviewresearch.com/industry-analysis/autonomous-ships-market>
6. Fadda, P., Fancello, G., Frigau, L., Mandas, M., Medda, A., Mola, F., Pelligra, V., Porta, M., Sierra, P. (2021). *Investigating the Role of the Human Element in Maritime Accidents using Semi-Supervised Hierarchical Methods*. Science Direct. <https://www.sciencedirect.com/science/article/pii/S2352146521000582>
7. Schröder-Hinrichs, J., Hollnagel, E., Baldaud, M. (2012). *From Titanic to Costa Concordia - a century of lessons not learned*. Springer. <https://link.springer.com/article/10.1007/s13437-012-0032-3> Baldauf, M., Kitada, M., Mehdi, D., Dalaklis, D. (2018). *E-Navigation, Digitalization and Unmanned ships: Challenges for Future Maritime Education and Training*. World Maritime University. ResearchGate. https://www.researchgate.net/profile/Dalaktis-Dimitrios/publication/323701325_E-Navigation_Digitalization_and_Unmanned_Ships_Challenges_for_Future_Maritime_Education_and_Training/links/5aa68e930f7e9b463804d132/E-Navigation-Digitalization-and-Unmanned-Ships-Challenges-for-Future-Maritime-Education-and-Training.pdf