

Human Factors Analysis and Classification System (HFACS) on Accidents Due to Tilting Ship

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Abstract

The transportation industry is the main point of the distribution of goods and passengers. Data shows the number of shipwrecks is very high. The accident was caused by many factors, one of which was the tilting of the ship. The research starts from categorizing the causes of ship accidents through existing secondary data, FGD with expert judgments to find the root of the problem and also looking for what mitigations can be done so that similar incidents do not repeat. And the analysis is made in the Human Factors Analysis and Classification System (HFACS) method. The results of this study indicate that there are human factors in recurring events at all stages of HFACS such as unsafe acts, the preconditions for unsafe acts, unsafe supervision and organisational influences. For the stages of unsafe acts are Skill based Errors, decision errors, Perceptual Errors, and Exceptional. For the stage of the preconditions for unsafe acts are technological environment, physical environment, and adverse mental state; and for the stage of unsafe supervision is the lack of supervision; for organizational influences there are resource management and organizational climate.

Keywords: *Transportation, Human Factors Analysis, Classification System*

INTRODUCTION

Transportation is a system including facilities and infrastructure, good transportation services are those that can provide certainty, tranquility for users, protect business activities and the socio-economic community. The transportation industry is the main point of the distribution of goods and passengers. Therefore, it needs to be supported by adequate facilities and infrastructure so that the wheels of the economy can run well [1].

The latest research on ship accidents caused by humans, this is focused on analyzing the relationship between humans and aspects of humans, ships, the environment, and software. The study found a chain of causes consisting of human factors in ship accidents, explained the process of accident formation, and confirmed the human factor [2]. "Accident-causing chain" means "accidents occur when many factors are linked together like a chain". Accident prevention focuses on preventing the formation

of causal chains and taking appropriate precautions for the human factor at a certain stage so that the chain can be cut and the accident rate is effectively reduce [3]. However, until now there has not been a single report that empirically explains these factors and their contributing causes.

Ship accidents ultimately have an impact on damage to the ship, passengers and cargo. The indirect impact of the accident involves the victim's family. To avoid or reduce these impacts, it is very important to know the cause of the accident to provide appropriate corrective action [4]. The causes of ship accidents are very diverse, such as accidents/human negligence (human error), natural conditions when the ship sails, technical conditions of the ship, climate and safety culture of crew and passengers.

The method that will be used in this research is the HFACS method. Method (HFACS) is an accident analysis tool that is used to analyze the Human Factors. Wiegmann and Shappell (2003) developed this method to analyze the military and civil aviation accidents based on the Swiss Cheese Model.

Although this method was originally developed to analyze accidents in military and civil aviation, the advantage of this method is that it is general in nature, so it can be applied in any industry (Human Factors guideline). The HFACS method covers individual and organizational aspects, the HFACS method is also easy to learn and the output is easy to interpret, making it easier for researchers to analyze accidents that occur.

Cases of ship accidents that occur based on secondary data obtained, indicate the need for improvements in the marine transportation system. From the NTSC data from 2018 to 2020, there were 590 accidents. The data is then categorized into several causes of accidents that often occur. It shows the causes of ship accidents that occurred in the range of 2018 to 2020, most of which are ship incidents with the cause of the ship tilting/ sinking which increases every year. While the most rare is the cause of accidents due to pollution which occurs only 1 time per year in 2019 and 2020. From the accident data, the number of accidents investigated is only 4%, while those that are not investigated are 89%, and this is occur throughout Indonesia [5].

METODE

The study started from categorizing the causes of ship accidents through existing secondary data, then FGD interviews were conducted with several expert judgments to find the root cause of why the incident occurred. The FGD is also looking for any mitigation that can be done so that similar incidents do not recur. The analysis is made in the Human Factors Analysis and Classification System (HFACS) chart. This study only focuses on the cause of the accident in the form of a tilted ship so that there was a ship accident [6].

The root cause of the accident is divided into three aspects, namely the design aspect, the engine condition aspect, and the last is the human aspect (human error) carried out by the crew, supervisors and ship management. In addition to categorization, expert judgments also provide input on the severity, impact, risk and status of each category. From the results of the accident analysis then classified with HFACS and

grouped in the form of a graph, so that it can be seen that the dominant error or violation occurred in the case of a tilted ship that caused a ship accident.

RESULTS AND DISCUSSION

Human Factors could be measured by using the tool which is called by Human Factors Analysis and Classification System (HFACS) based on Swiss Cheese Model representing a hole in cheese.

The hole consists of 4 (four) levels where each layer/level has error holes or errors in random positions, the number and size of the holes indicate the number of possible accidents. HFACS is a tool used to analyze an accident case in a systematic and organized manner. HFACS looks at all aspects, so it can be seen where the real human factor lies. HFACS can also see failure relationships at each level of HFACS.

One of the factors that contributed to the failure of HFACS was human error. What is meant by the contribution of human error is the negligence of the ship owner, ship operator, classification party, and all parties related to the care, maintenance and operation of the ship used. This research is focused on ship accidents due to ship tilting.

The tilts of the ship can be divided into 2 (two), namely List and Heel. List means the ship's slope due to unbalanced loading arrangements between the right and left sides of the vertical plane. The position of the ship's center of gravity or the position of the ship's center of gravity when the list is outside the vertical plane, while the ship's center of gravity is in the vertical plane. (Rachman et al., n.d.) Heel or ship tilt caused by the influence of external forces. Example: waves, wind, waves, storms, and currents.[4]

Figure 1 is a picture of the results of the analysis based on the HFACS method after interviews with expert judgments. From the results of the analysis that has been carried out, it is obtained an analysis chart of ship accidents due to tilting ships.

From Figure 1, it can be seen that the distribution of error types on organizational influences can be seen from 2 aspects that contribute. In resource management, especially from the human side, the crew is less competent. From the organizational climate, it is mainly dominated by culture, where intervention from other parties is able to make the crew and captain take inappropriate decisions such as allowing to carry excess loads. While organizational influence does not contribute to the influence that causes accidents, due to the ship tilting.[2]

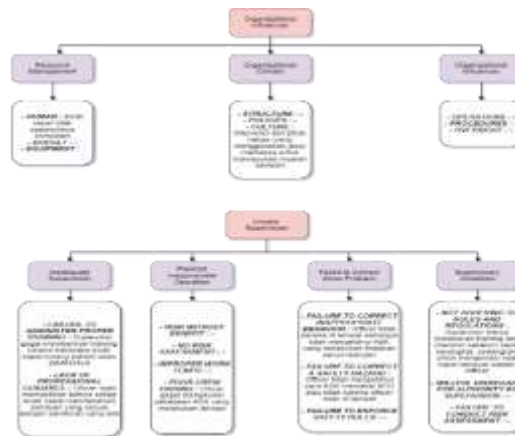


Figure 1. Organizational influence and Unsafe Supervision Chart

Table 1. Causes of ship accidents per year

Causes of ship accidents	2018	2019	2020	Total
Tilt/sink	143	184	306	633
Burned/ exploded	69	64	59	192
Died/ person fall into the sea	41	48	65	154
Damage to machinery/ equipment/ structure	20	33	42	95
A ground	28	37	54	119
Collision	49	42	63	154
Polution	0	1	1	2
Total	350	409	590	1349

Organizational Failure, relates to mistakes made by the organization as the initial defense of the defense system, is not directly related to the occurrence of the incident directly but is a trigger that brings another failure to the incident. The most important step in explaining organizational failure is to distinguish between active failure and latent failure. Active failure is a failure characterized by the effects of the failure being felt very quickly. Latent failure is a failure where the effects are felt for a long time and are only felt when combined with other factors that can break through all existing defense systems[3]

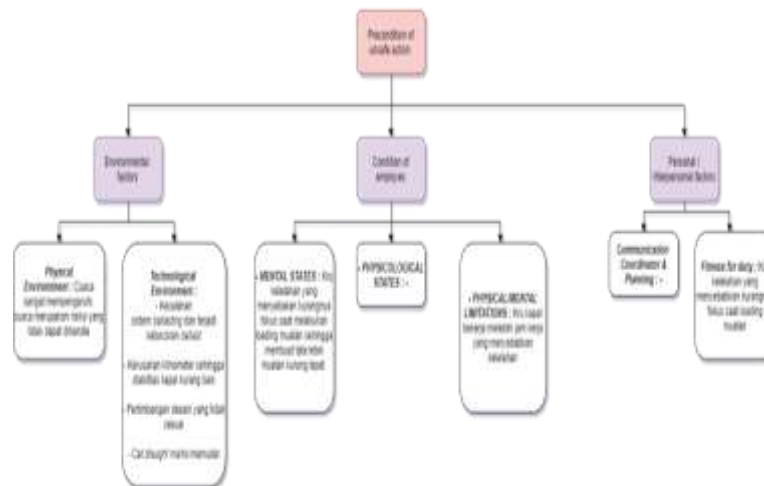


Figure 2. Precondition of Unsafe Action Chart

In the chart of unsafe supervision, Figure 2 illustrates that there are 3 main factors that make the biggest contribution to accidents, namely inadequate supervision, failed to correct know problems, and supervisory violations. The role of supervisors is very important as they have a duty to ensure the work is carried out safely and efficiently. So supervision is essential in any successful organization. If the supervisor commits a violation, this will put the workers in a dangerous condition, where the risk of an accident is very large. Frequent failures are related to breaking the rules, and understanding the team's duties. [6]

Furthermore, the chart discussed is about the precondition of unsafe action, as shown in Figure 2. This Furthermore, the chart discussed is about the precondition of unsafe action, as shown in Figure 2. This precondition is a condition that triggers the occurrence of the Unsafe Act. In ship accidents due to tilted ships there are 3 contributing factors, namely environmental factors, conditions of employees and interpersonal factors. In environmental factors, the most contributing factor is technological environment.

After the analysis of the precondition of unsafe action, then the analysis is carried out on the unsafe action chart, as shown in Figure 3 From the unsafe action chart, there are 2 contributing factors, namely errors and violations. On the error most contributing errors in the layout of the payload. The decision errors stage is a lack of knowledge about systems and procedures, so that the crew misplaces the cargo so that it affects the slope of the ship. The next error is a perceptual error, namely the crew miscalculated the layout of the cargo, causing the tilt and the ship to sink. After describing the chart, then the HFACS relationship chart is made as shown in Figure 4.

After the relationship between charts is made, mitigation can then be made per chart, so that this incident does not happen again. The strategy to minimize the incidence of

ship accidents involves the role of all parties, namely regulators, operators and facilitators. From the regulator side, namely the government, it has the role and authority to carry out supervision and inspection in the form of ongoing audits in the application of both national and international regulations on board ships. Here are the possible mitigations per chart. The details can be seen in Table 2. Table 2 shows that each aspect can be mitigated and mitigation between stages is interconnected.

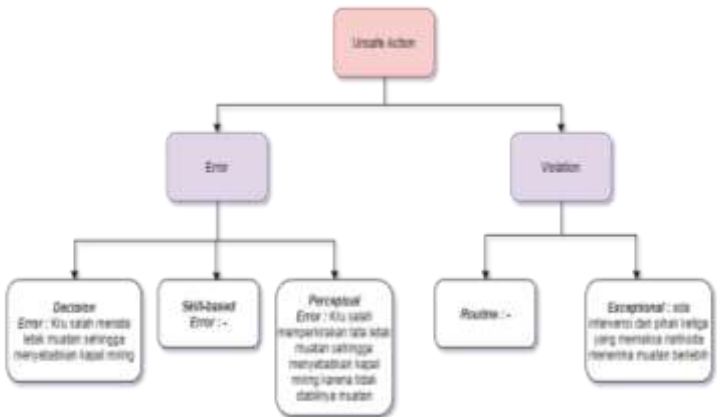


Figure 3. Unsafe action Chart

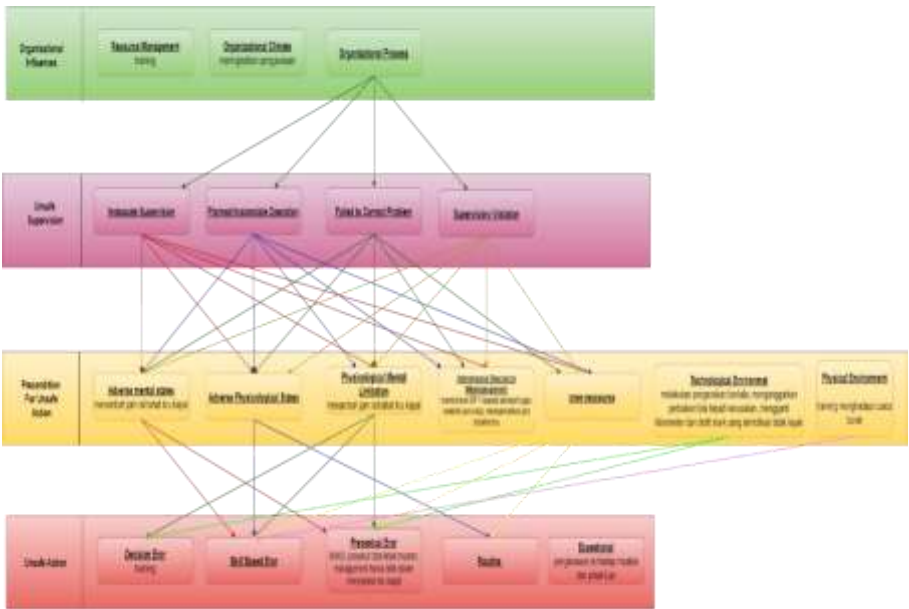


Figure 4. Relationship between HFACS Stage Charts in Accidents Due to Ship tilting

Table 2. Mitigation for Ship Accidents Due to Ship tilting

No	HFACS	Mitigation
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1.	Unsafe Action	Errors	Skill based Errors	Provide training to the crew on how to layout the cargo so as not to cause the ship to tilt.
			Decisions Errors	Provide soft skill training to make decisions to the crew on how to layout the cargo so as not to cause the ship to tilt.
			Perceptual Errors	Improving SMK3 especially for cargo layout procedures, as well as from the management itself must be more careful in selecting ship crews.
		Violations	Routine	-
			Exceptional	Increase supervision of cargo and external parties so that there is no intervention.
2.	Preconditions for unsafe acts	Environmental Factors	Physical Environment	Provide training on how to deal with bad weather while sailing.
			Technological Environment	Perform periodic checks, budget for repairs in the event of damage, replace clinometers and draft marks that are indicated to be inappropriate.
		Personnel factors	Communication coordinator & planning	-
			Fitness for duty	Provide light sanctions in the form of SP 1 to crews who exceed working hours and pay more attention to crew rest hours.
		Condition of operators	adverse mental state	Increase crew rest hours so that crew focus is maintained and does not cause errors in loading cargo.
			Adverse physiological states	-
			physical/mental limitations	Provide light sanctions in the form of SP 1 to crews who exceed working hours and pay more attention to crew rest hours.
	Unsafe Supervision	Inadequate supervisions		To reduce container loading errors, it is necessary to re-check the cargo and ensure that the cargo is ready to be

				loaded with the cargo data sent to the ship.
		Planned In-appropriate operations		-
		Failure to corrects problem		Supervisors must understand how to fix existing problems according to regulations.
		Supervisory violations		The supervisor must supervise until the load has been loaded, laid out and the ship sails.
	Organizational influence	resource management	Human	Provide training to ship crews and be more thorough in recruiting crew members so that all ship crews master their jobdesk.
		organizational climate	Culture	Increase supervision of cargo and external parties to avoid intervention.
		organizational process		-

CONCLUSION

Based on the analysis using the HFACS method, this study concluded that there are human factors in recurring events in all stages of HFACS, namely for the unsafe acts stage, namely Exceptional Errors, Perceptual Errors, Skill based Errors, and decision error. The preconditions for unsafe acts are the technological environment, physical environment, and adverse mental state; for the stage of unsafe supervision is the lack of supervision; for organizational influences on resource management and organizational climate. Suggestions that can be given in this study include, addressed to the government as a regulator and shipping operator, namely shipping companies and ship crews. The role of the government as a regulatis related to the inspection and supervision of shipping safety through applicable shipping regulations. The government as a regulatory function can carry out stricter supervision before issuing certificates or recommendations to companies and ships. Before carrying out the loading process, make sure the making of the bay plan is exactly the same as the condition of the ship, so that while carrying out the voyage it is safe to arrive at the destination. When carrying out the loading process for containers that are not in accordance with standard sizes, it is better to follow the bay plan that has been made and loaded the container cargo is placed last to make it easier to regulate the stability of the ship.

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