

Analysis of Failure in The Fire System Alarm on The Ship KL.02 Sultan Hasanuddin

Rachmat Tjahjanto, Fadjrin Wira Perdana
Politeknik Ilmu Pelayaran Makassar
E-mail: rachmatnursyam@gmail.com, fadjrinwira@gmail.com

KEYWORD

*fire alarm system;
false alarm; fire; ship*

ABSTRACT

International Maritime Organization (IMO) has set regulations governing the installation of fire alarm systems on ships. The basic principle of the control system is to control the system output by comparing the actual output with the desired output. This study aims to determine the causes of false alarms on the fire alarm system on ships and to describe recommendations and solutions for failures in the fire alarm system on ships. This type of research uses a mix of methods by utilizing primary and secondary data. The data is processed by quantitative analysis and qualitative research. The results of this study indicate that the cause of the False Alarm on the Fire Alarm System is caused by the MFCA, Smoke Detector, and Cable Installation. The case that occurred in KL. 02 Sultan Hasanuddin there is no correlation between false alarms on the Fire Alarm System. The Smoke Detector correlation data with the False Alarm Fire Alarm System shows that there is a correlation with the Pearson Correlation of $0.857 > 0.4973$. This study concluded that improving the reliability of fire alarm systems can be achieved through better maintenance of smoke detectors and proper technical training for ship operators.

INTRODUCTION

The International Maritime Organization (IMO) has set regulations governing the installation of fire alarm systems on ships (Joseph & Dalaklis, 2021). These regulations are regulated in the International Convention for the Safety of Life at Sea (International Convention for the Safety of Life at Sea/SOLAS) and the Safety Code for Ships Carrying Liquid Dangerous Goods (International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk/IBC Code) (Mutmainnah et al., 2020). In the last five years (2019 - 2023) there have been 15 cases of ship accidents caused by fires (He et al., 2022). Based on NTSC data, there were 4 cases of shipping accidents and 3 of them were fire cases (Reason, 2016). This shows the need for special attention to the fire extinguishing system on board (Eyres & Bruce, 2012). The things that need to be considered in the fire extinguishing system on board are the condition of the device fire alarm, alarm working fires, and installation of a good fire alarm (Garcia-Martin et al., 2019).

Procurement of a fire alarm system in construction including ships is urgently needed (Council et al., 2007). The safety of each component, especially Human Resources, is the most important part of construction. In general, Control and indicating equipment (CIE) is very important for construction safety which affects the safety of occupants and stored property (Yang et al., 2024). Given such an important role, it is highly emphasized that the operating system is in an active condition whose job is to detect fire hazards early and to send information to its various components (Eliopoulou et al., 2023).

Improving efforts to deal with fire disasters, in general, requires changes and strategies. Along with several alternative strategies for future improvements including forming a fire emergency response team equipped with education and training in an integrated and comprehensive manner (Gupta et al., 2022). Preparing Standard Operating Procedures (SOP) taking into account standardization and the need for implementing disaster management based on laws and regulations, carrying out routine and continuous building fire simulations, as well as strengthening other active protection systems including making hydrants, fire alarms, and smoke detectors (Guevara & Dalaklis, 2021). Installation of fire alarm system in KL.02 Sultan Hasanuddin which is owned by PIP Makassar has 12 Zones. Based on the results of the researchers' observations, several zones sometimes give False Alarm MFCA (Chen, 2011).

The purpose of this study is to analyze the effectiveness of the fire alarm system installed on the KL.02 Sultan Hasanuddin ship owned by PIP Makassar, especially in handling false alarm cases in several zones. This study aims to identify the causes of false alarms, evaluate the condition of the existing system, and provide recommendations for improvements to improve the reliability of the fire alarm system on the ship. Thus, it is expected that this study can contribute to improving safety on ships and minimizing the risk of fire through more accurate early detection.

The benefits of this research include improving ship safety by identifying and fixing weaknesses in the fire alarm system, thus increasing system reliability and reducing the potential for accidents due to fire on board. This research also contributes to reducing the risk of false alarms by identifying zones that often experience false alarms, providing practical solutions to minimize operational disruptions due to false alarms that often cause confusion in emergency situations. In addition, this research is expected to provide valuable recommendations for system improvement, especially in improving operational procedures and better fire mitigation strategies. Another contribution made is in the development of Standard Operating Procedures (SOP) for fire control on ships, so that the evacuation process and response to fires can be carried out more effectively and efficiently. Finally, this research is useful for developing human resource (HR) capacity by providing a better understanding of the fire alarm system, which can then be used in training and education for ship crews regarding better and more integrated handling of fire protection systems.

METHOD

This type of research is research mixed method, especially the sequential explanatory strategy. In the first stage, the researcher collects and analyzes qualitative data then collects and analyzes quantitative data in the second stage which is based on the results of the first stage. The source of data comes from primary data by measuring directly on the field related to the components included in the integrated gas detection system up to the Addressable fire alarm control panel / MCFA (Master Control Fire Alarm) (Guevara & Dalaklis, 2021). Secondary data contained in the smoke detector alarm system manual data can also be obtained through the interview method. Data collection was carried out through direct observation of the subjects

studied. Information data collection was carried out through survey methods (observation) and interviews with expert informants and technical informants (Wang et al., 2021).

RESULTS AND DISCUSSION

The correlation test aims to find out how big the relationship between each variable (X) is with the variable (Y) or whether or not the relationship between these two variables is strong.

Table 1. Correlations

		X1	X2	X3	Y
	Pearson Correlation	1	-.151	.972**	-.065
X1	Sig. (2-tailed)		.639	.000	.842
	N	12	12	12	12
X2	Pearson Correlation	-.151	1	-.104	.857**
	Sig. (2-tailed)	.639		.748	.000
	N	12	12	12	12
X3	Pearson Correlation	.972**	-.104	1	-.033
	Sig. (2-tailed)	.000	.748		.920
	N	12	12	12	12
Y	Pearson Correlation	-.065	.857**	-.033	1
	Sig. (2-tailed)	.842	.000	.920	
	N	12	12	12	12

Based on the significance value of the 2-tailed sig from Table 1, it is Bkentwoewenn that X1 and Y are $0.842 > 0.05$ and the Pearson Correlation is $-0.065 < 0.4973$, which means that there is no significant correlation between the MFCA variable (X1) and False Alarm Fire Alarm System(Y). The 2-tailed sig significance value between X2 and Y is $0.000 < 0.05$ and the Pearson Correlation is $0.857 > 0.4973$, which means that there is a significant correlation between the Smoke Detector variable (X2) and the False Alarm Fire Alarm System (Y). The significance value of the 2-tailed sig between X3 and Y is $0.920 > 0.05$ and the Pearson Correlation is $-0.033 < 0.4973$, which means that there is no significant correlation between Cable Installation (X3) and False Alarm variables Fire Alarm System(Y), then Ho is accepted. There is no correlation between Cable Installation (X3) and False Alarm variables Fire Alarm System(Y) (McEntire, 2021).

Table 2. Simple Regression of the Smoke Detector Variable Against the Alarm Variable Fake Fire Alarm System

Model	Unstandardized Coefficients		Standardized Coefficients	t
	B	Std.Error	Betas	Sign.
1 (Constant)X2	-.221	.146	.857	.160
	.137	.026	-1,517	.000
			5,251	

In Table 2, constant (a) is -0.221, while the value of work motivation (b) is 0.137, so the regression equation can be written:

$$Y = a + bX$$

$$= -0.221 + 0.137X$$

The constant of -0.221 states that if there is no Smoke Detector value then the False Alarm value Fire Alarm System of -0.221. The X2 regression coefficient of 0.137 states that for every addition of 1 smoke detector value, it will be a False Alarm value Fire Alarm System of 0.137.

MFCA condition of False Alarm Fire Alarm System

False Alarm Appears on Fire Alarm System may result from conditions on the installed MFCA. The expert informant stated that: "One of the common causes of false alarms in such systems is technical faults in the fire detection sensor and the indicators on the MFCA are not reached or are not in normal conditions. In addition, human errors such as system operational errors or lack of operator training can also be the cause of false alarms."

MFCA conditions on the KL Trainer. Sultan Hasanuddin obeyed Field informants are in normal condition. Every MFCA indicator is in normal condition. "The MFCA remains in normal conditions so there is no correlation between the false alarm and the KL ship's MFCA. Sultan Hassanudin. We have tested each indicator (Nikcevic Grdinic, 2015).

Smoke Detector Conditions for False Alarms Fire Alarm

The Smoke Detector system is the most important part of the Fire Alarm System installation. Smoke Detector becomes a sensor for a fire. The expert informant explained that: "In the installation of a Fire Alarm System, the Smoke Detector functions as a recipient of information about a fire. Of course, with such a function, it indicates that a smoke detector is needed (McLoughlin, 1985)."

The condition of the Smoke Detector at KL.02 Sultan Hasanuddin often experiences error. Several assessment indicators have negative values, especially on smoke sensors and smoke detector humidity. The technical informant explained the condition of the cable installation in the KL. 02 Sultan Hasanuddin That: "Tests are often carried out on smoke detectors, some points of the smoke detector do not work properly. For example, when we add smoke and try to increase the humidity in the room, this condition does not give a signal to the MFCA or vice versa (Organization, 2019).

Cable Installation Conditions for False Alarms Fire Alarm System

Cable Installation or cable installation is the component that is responsible for connecting each component that is connected in a fire alarm system. The existence of an installation cable is needed to connect data to the control center. According to the expert informant, explained that: "The installation cable is the lifeblood of the fire alarm system (Weyman, 2015). They are responsible for connecting the various components in a fire system, such as detectors, fire stations, sound alarm devices, and other components. These cables carry signal and power from the control center or fire panel to detection and warning devices dispersed throughout the protected area."

KL. 02 Sultan Hasanuddin which is the object of research. Has a decent cable. Ensure that all cable installations are connected properly so that the information that reaches the control center is good. This was explained by the technical informant KL.02 Sultan Hasanuddin. "All Cable Installations are still working well, after checking each indicator on this cable installation."

Causes of False Alarms on the Fire Alarm System

Overall, the use of the Main Fire Control Alarm (MFCA) in a fire alarm system can have a positive effect on reducing alarms false. With its ability to recognize patterns, overcome data uncertainty, and improve detection precision, MFCA can increase the reliability of fire warning systems. However, careful planning, implementation and maintenance is required to ensure optimal performance of these systems in protecting the safety and security of buildings and their occupants (Paś et al., 2022).

In the False Alarm Case on KL.02 Sultan Hasanuddin the condition of the MFCA is normal. Researchers found no damage to the MFCA installation used in KL.02 Sultan Hasanuddin. Some of the MFCA indicators that became the researcher's analysis data were input voltage, output

voltage, capacity, zone indicator, Alarm Output, Communication Protocol, Control Functions, Operating Temperature Range, Humidity Range, and Compliance Standards (Kubiak et al., 2024).

The use of smoke detectors is one of the most commonly used technologies in fire alarm systems for the early detection of fires. Smoke detectors work by detecting smoke particles generated during combustion and converting them into an alarm signal. While smoke detectors have proven to be highly effective at detecting fires, there is still a risk of false alarms, which are situations where the smoke detector declares that there is a fire hazard when there is no fire.

Based on the results of the researcher's analysis conducted by KL.02 Sultan Hasanuddin in the smoke detector section with indicators namely Sensitivity to Smoke, Response Time, Operating Temperature, Operating Humidity, Working Voltage, Working Current, Alarm Current, Installation Height, and Mounting Distance to the Nearest Wall. Researchers found that many indicators did not function normally.

Electrical/Cable Installation Wire Diagrams Accurate and precise control of the onboard fire system has a significant influence on the likelihood of a false alarm. With attention to installation accuracy, separation of cable paths, clear labeling, and adherence to standards, fire systems will function more reliably and responsively. Electrical/Cable Installation Wire Diagrams. It also facilitates monitoring, testing, and troubleshooting, helping to reduce the risk of false alarms and increasing the efficiency and effectiveness of fire systems in protecting ships and crew from fire hazards. Electrical/Cable Installation Wire Diagrams has observation indicators namely: Cable Quality and Continuity, Proper Installation and Connection, Labeling and Clear Identification, Integration with Other Devices, Compliance with Standards and Regulations, and Routine Testing and Monitoring. In the observations made at KL.02 Sultan Hasanuddin conditions Electrical/Cable Installation Wire Diagrams are in good shape (Gupta et al., 2022).

In quantitative research, data analysis activities are divided into two namely activities that describe the data obtained from the object of research and perform statistical tests (inference). The activity of describing quantitative data is describing existing data to obtain a real form of the research object.

CONCLUSION

False alarms in the fire alarm system are caused by issues with the MFCA, smoke detectors, and cable installation. An analysis of false alarm data from the fire alarm system at KL.02 Sultan Hasanuddin indicates that there is no significant correlation between MFCA and false alarms, with a Pearson correlation of -0.065 ($p > 0.4973$). However, there is a significant correlation between smoke detectors and false alarms, with a Pearson correlation of 0.857 ($p < 0.4973$). Additionally, there is no significant correlation between cable installation and false alarms, with a Pearson correlation of -0.033 ($p > 0.4973$). Therefore, the primary cause of false alarms at KL.02 Sultan Hasanuddin is malfunctioning smoke detectors. To address failures in the fire alarm system on board, it is crucial to follow Standard Operating Procedures (SOPs) during repairs. This involves analyzing research findings on the fire alarm system, identifying repair priorities for smoke detectors, consulting with experts on smoke detectors, planning repairs, verifying requirements and budgets, implementing repairs, conducting performance tests, and performing evaluations and documentation. Effective solutions to mitigate fire alarm system failures on board include planning preventive maintenance, providing training and qualification for personnel, monitoring and supervision, managing inventory and spare parts, implementing the latest technology, and conducting evaluations and data analysis.

BIBLIOGRAPHY

- Chen, Y. (2011). Reliability analysis of a fire alarm system. *Procedia Engineering*, 24, 731–736.
- Council, N. R., Earth, D. on, Studies, L., Sciences, B. on E., Committee, M. S., Catastrophe, C. on P. for, Data, A. B. for I. G., Tools, & Infrastructure. (2007). *Successful response starts with a map: improving geospatial support for disaster management*. National Academies Press.
- Eliopoulou, E., Alissafaki, A., & Papanikolaou, A. (2023). Statistical analysis of accidents and review of safety level of passenger ships. *Journal of Marine Science and Engineering*, 11(2), 410.
- Eyres, D. J., & Bruce, G. J. (2012). *Ship construction*. Butterworth-Heinemann.
- Garcia-Martin, R., González-Briones, A., & Corchado, J. M. (2019). Smartfire: Intelligent platform for monitoring fire extinguishers and their building environment. *Sensors*, 19(10), 2390.
- Guevara, D., & Dalaklis, D. (2021). Understanding the interrelation between the Safety of Life at Sea Convention and Certain IMO's Code. *TransNav: International Journal on Marine Navigation and Safety of Sea Transportation*, 15.
- Gupta, S., Kanwar, S., & Kashyap, M. (2022). Performance characteristics and assessment of fire alarm system. *Materials Today: Proceedings*, 57, 2036–2040. <https://doi.org/https://doi.org/10.1016/j.matpr.2021.11.184>
- He, X., Feng, Y., Xu, F., Chen, F.-F., & Yu, Y. (2022). Smart fire alarm systems for rapid early fire warning: Advances and challenges. *Chemical Engineering Journal*, 450, 137927. <https://doi.org/https://doi.org/10.1016/j.cej.2022.137927>
- Joseph, A., & Dalaklis, D. (2021). The international convention for the safety of life at sea: highlighting interrelations of measures towards effective risk mitigation. *Journal of International Maritime Safety, Environmental Affairs, and Shipping*, 5(1), 1–11.
- Kubiak, T., Dudziński, Ł., Kasperczyk, R., & Czyżewski, Ł. (2024). Emergency services response to eCall System alerts: Observations from 2016–2022 in the National Fire and Rescue System. *Traffic Injury Prevention*, 25(6), 819–824. <https://doi.org/https://doi.org/10.1080/15389588.2024.2348041>
- McEntire, D. A. (2021). *Disaster response and recovery: strategies and tactics for resilience*. John Wiley & Sons.
- McLoughlin, D. (1985). A framework for integrated emergency management. *Public Administration Review*, 45, 165–172.
- Mutmainnah, W., Bowo, L. P., Nurwahyudy, A., Prasetyo, F. A., & Furusho, M. (2020). Causative factor analysis of passenger ship accident (Fire/Explosion) in Indonesia. *IOP Conference Series: Earth and Environmental Science*, 557(1), 12037.
- Nikcevic Grdinic, J. (2015). Legal regulations in the function of ensuring ship safety. *Pomorstvo*, 29(1), 30–39.
- Organization, W. H. (2019). *WHO benchmarks for International Health Regulations (IHR) capacities*. World Health Organization.
- Paś, J., Klimczak, T., Rosiński, A., & Stawowy, M. (2022). The analysis of the operational process of a complex fire alarm system used in transport facilities. *Building Simulation*, 15(4), 615–629.
- Reason, J. (2016). *Managing the risks of organizational accidents*. Routledge.
- Wang, L., Wang, J., Shi, M., Fu, S., & Zhu, M. (2021). Critical risk factors in ship fire accidents. *Maritime Policy & Management*, 48(6), 895–913.
- Weyman, J. C. (2015). *Manual on Synergized Standard Operating Procedures (SSOPS) for*

coastal multi-hazards early warning system.

Yang, X., Li, Y., & Chen, Q. (2024). Automated image-based fire detection and alarm system using edge computing and cloud-based platform. *Internet of Things*, 28, 101402. <https://doi.org/https://doi.org/10.1016/j.iot.2024.101402>