Journal of Social Research
P-ISSN: 2827-9832
E-ISSN: 2828-335x
http://ijsr.internationaljournallabs.com/index.php/ijsr

ANALYSIS OF FIRE EMERGENCY RESPONSE READINESS AT HOSPITAL BUILDING: FIRE EMERGENCY RESPONSE READINESS ASSESSMENT TOOLS METHOD

Dwi Septiana, Fatma Lestari
[1,2]Departmen Keselamatam dan Kesehatan Kerja Fakultas Kesehatan Masyarakat Universitas Indonesia
E-mail: fatma@ui.ac.id

ABSTRACT

Fire safety in healthcare facilities is a crucial aspect of risk management, especially in hospitals that have a high level of complexity in patient evacuation and medical asset protection. Therefore, an evaluation of fire emergency response readiness is needed to ensure the effectiveness of the mitigation system implemented. This study used the Fire Emergency Response Readiness Assessment Tools (FERRAT) form to assess the readiness of fire safety management in hospitals. Data was collected through direct observation methods, in-depth interviews with fire safety teams, and analysis of policy documents and emergency response procedures. The study showed that the overall fire safety readiness of the elements that had reached an average of <90% with an overall value of 91.28%. This achievement indicates that risks in hospital operational activities have been managed safely, so that mitigation of patient safety in fire emergency conditions can be carried out optimally. Although several aspects still require significant improvement. The main weaknesses were identified in the frequency of staff training, the maintenance of fire protection systems, and the effectiveness of coordination between units in dealing with emergency situations. this study may support hospitals in independently evaluating in conducting independent evaluations and immediately implementing improvements related to risk-based system design, adequacy according to potential fire risks, and ensuring that emergency response equipment is always in a ready and optimal condition for operation.

Keywords: *patient safety; Fire safety; emergency response readiness; risk management; hospitals*

INTRODUCTION

Fire safety management is a critical aspect in building operations, especially in healthcare facilities such as hospitals. Hospitals have a high risk of fire due to the complexity of building systems, the use of high-voltage medical equipment, as well as the presence of flammable materials in various units such as radiology rooms, kitchens, laundry, and generators. In addition, the limited mobility of patients, especially in intensive care units, increases the complexity of the evacuation process when a fire occurs. Therefore, the implementation of an effective fire protection system is very important. (Rahardjo and Prihanton, 2020) (Kurd) *et al.*, 2021)

Fire safety in healthcare facilities is a crucial aspect of risk management, especially in hospitals that have high complexity in patient evacuation and medical asset protection. Data shows that fire incidents in hospitals can cause significant casualties and material losses. Globally, based on a report by the National Fire Protection Association (NFPA), in 2017 there were 1,319,500 fire incidents in the United States, with total losses reaching 23 billion US dollars and 3,400 fatalities. In Indonesia, data from the National Disaster Management Agency (BNPB) shows that fires occupy the highest number of non-natural disasters. In 2017, there were 1,212 fire incidents with 97 fatalities. In health care facilities, several fire incidents in

hospitals in Indonesia in the past five years were at Mintohardjo Hospital, Jakarta, which required the deployment of seven units of fire engines and a fire that hit the warehouse of the former medicine storage of dr. Dradjat Prawiranegara Hospital, Serang, which required seven fire engines and two water cannon cars to extinguish the fire (Nada, Koesyanto and Artikel, 2020) (Zulkifli and Mangindara, 2020).

Numerous incidents of fire in hospitals have been reported in Indonesia and other countries, demonstrating the urgency of strengthening fire protection systems. For example, a fire at a hospital in Calcutta, India, which killed more than 89 patients due to a failure in the evacuation system. In Indonesia, a fire that occurred at Pamekasan Hospital in 2010 scorched all patient data, while a fire at NTB Hospital caused losses of up to Rp50 billion and two patients died (Irwanto *et al.*, 2023). Similar incidents also occurred in other hospitals, resulting in structural damage and the cessation of hospital operations for a certain period of time. This incident shows that the fire in the hospital not only has an impact on the financial aspect, but also threatens the safety of patients and the continuity of health services.

The main factors affecting the level of fire risk in hospitals include fire load, ventilation, and access to life safety. High fire loads are caused by the abundance of electrical equipment and flammable materials, while suboptimal ventilation systems can accelerate the spread of smoke and fire within buildings. In addition, limited evacuation access and lack of dedicated routes for firefighters are challenges in fire control. To address this risk, the implementation of a comprehensive fire emergency response system is essential (Kurd) *et al.*, 2021).

To minimize the occurrence of fires in the workplace, especially in hospitals, good and planned prevention and control efforts are needed. Fire management does not only provide extinguishers or conduct routine extinguishing exercises once a year, but also provides a planned program in a system known as a fire management system. The fire management system is carried out in three stages, namely prevention before a fire (pre-fire), countermeasures during a fire, and rehabilitation after a fire (post-fire). There are three factors for handling fires, namely supervision, prevention, and evacuation systems. This study discusses the tools of these three factors. The results of the study show that the fire safety system is one of the efforts to minimize losses to buildings. With the right equipment, the factors that cause the fire can be detected early with a monitoring system, and can be handled quickly and precisely, so that losses can be minimized (Mahbub and Darmawan, 2019).

A fire emergency response system aims to ensure that hospitals have adequate fire protection infrastructure and effective risk mitigation strategies. This includes meeting fire safety standards, increasing the preparedness of medical personnel in the face of emergencies, and implementing routine inspection and maintenance procedures for fire fighting equipment. However, in practice, many hospitals still experience obstacles in the implementation of this system, both in terms of fire protection design, the availability of facilities and infrastructure, and the readiness of human resources in handling emergency situations.

PT X is a company engaged in the *Healthcare Operation Industry* in providing health services to create national health resilience. PT X runs *Healthcare Operations* throughout Indonesia consisting of hospital operating units, clinics, medical evacuation and onsite clinic management at *oil and gas companies*. Even though it already has a fire safety system, PT X has experienced several obstacles in fire management. This fire that has occurred has caused

losses of approximately 5M and the company's image. The results of the investigation that have been carried out show several results, including improving fire system management and management of changes in the design and operation of facilities, adequacy of facilities and infrastructure in accordance with fire risk, readiness of fire extinguishing equipment and firefighters in the field. In addition, the feasibility of fire emergency response preparedness both from regulations and company management also needs to be improved.

Although numerous studies have examined fire safety in hospitals, most focus on technical aspects of fire detection and suppression or general risk assessments. This study is novel in its comprehensive evaluation of fire protection systems within the context of operational healthcare facilities managed by a large healthcare company (PT X) across Indonesia. Unlike prior research, which often centers on isolated incidents or individual hospitals, this study integrates system effectiveness, human resource readiness, infrastructure adequacy, and regulatory compliance within a multi-site corporate healthcare operation. It addresses a critical gap by linking fire safety system performance directly with organizational management practices and emergency preparedness at a national scale, offering holistic insights that are scarce in existing literature.

This study aims to (1) evaluate the effectiveness of fire protection systems implemented in hospitals managed by PT X, (2) identify the operational challenges and obstacles faced in fire safety management, and (3) develop evidence-based recommendations to enhance fire risk mitigation strategies and emergency preparedness in healthcare facilities. Through this, the study seeks to support safer hospital environments that minimize risks to patients, staff, and infrastructure.

The findings of this research are expected to benefit hospital administrators and facility managers by providing actionable insights into optimizing fire safety systems and emergency response protocols. For policymakers, the study offers empirical evidence to refine fire safety regulations and enforcement in healthcare settings, emphasizing comprehensive preparedness beyond equipment availability. Strengthening regulatory frameworks and promoting standardized fire management practices will contribute to improved patient safety and operational continuity in hospitals nationwide. Ultimately, this research supports the development of resilient healthcare infrastructure capable of effectively responding to fire emergencies and safeguarding public health.

METHOD

This study is a descriptive research with a cross-sectional study design that aims to describe the implementation of fire emergency response preparedness. The population in this study is the entire operating unit of PT XX Hospital in Indonesia and took samples of one of the hospital buildings in the Makassar area. This study uses the FERRAT (Fire and Emergency Response Readiness Assessment Tools) form for Buildings. The FERRAT Building form consists of 33 sub-elements classified into 3 (three) elements with 66 indicators of assessment item questions.

The first element is the *Basic design & philosophy* of the hospital building which includes 5 sub-elements with 5 indicators of assessment items related to the basic principles and design of fire emergency response preparedness, based on hazard identification and fire risk assessment. The second element in the aspect *of Fire & gas detection and emergency response*

resources adequacy which includes 19 sub-elements with 28 indicators of assessment items related to fire and gas detection systems is already available, adequate, and in accordance with the expected design. The third element on *the Existing fire & emergency response resources readiness* aspect which includes 9 sub-elements with 17 indicators of assessment items that focus on the actual readiness of available resources in the field, including fire fighting equipment, emergency response teams, and operational procedures that have been implemented.

Data was collected through in-depth interviews with management, *site verification* of fire safety facilities and procedures, and analysis and assessment of related documents. Yulianti et al. (2021) emphasize the importance of combining these methods to get a comprehensive picture of a fire safety management system. Measurement with the FERRAT Form uses 4 (four) types of questions to explore the implementation of the FERRAT criteria, namely Conformance Test (CT) and Proportional Test (PT). CT is an assessment carried out by directly comparing the implementation of the FERRAT criteria. PT is an evaluation that assesses the extent to which the implementation has covered part or all of the FERRAT criteria that must be applied.

The data obtained were analyzed descriptively, quantitatively and qualitatively, by identifying 4 (four) types of questions to explore the implementation of FERRAT criteria through interviews, *site verification* and document analysis. The provisions of the assessment range are in accordance with 4 (four) types of questions, namely CT, FT, PJ and PT. CT is in the range of 0% or 100% of the maximum value, FT is in the range of 0% to 100%, PJ is in the range of 0%, 25%, 50%, 75% and 100% of the specified assessment portion and PT is in the value range between 0% to 100% according to the specified weight. They used this approach to analyze their findings related to fire protection systems.

RESULTS AND DISCUSSION

Overview of the results of the fire emergency response readiness analysis questionnaire in hospital buildings using the fire emergency response readiness assessment tools method.

Table 1. Results of Fire Emergency Response Readiness Assessment Tools Assessment Based on Document Assessment and Site Verification.

Element	Description	Document Assessment Value (%)	Site Verification Value (%)
Element 1	Basic Design & Philosophy	96	97
Element 2	Fire & Gas Detection and Emergency Response Resources Adequacy	89	87
Element 3	Existing Fire & Emergency Response Resources Readiness	87	92

Table 1. Shows that there is a consistency between Document Assessment and Site Verification, with some differences in values. Basic Design & Philosophy shows good consistency between documentation and field implementation. The difference between these two assessments indicates that readiness in the field is generally in accordance with existing

documents, but there are some aspects, particularly in the adequacy of fire detection and emergency response resources, that still require adjustments to be more optimal

Table 2. Site *Verification Fire Emergency Response Readiness Assessment Tools* (FERRAT) assessment questionnaire results

Element	Main Components	Site Verification Assessment Results		
		>90%	70% to <90%	<70%
Element 1	Basic Design & Philosophy of Hospital Building	80%	20%	0%
Element 2	Fire & Gas Detection and Emergency Response Resources Adequacy	63%	32%	5%
Element 3	Existing Fire & Emergency Response Resources Readiness	62%	38%	0%

Table 3. *Fire Emergency Response Readiness Assessment Tools Forms and Indicators*

Element	Indicators	How to Score
Basic Design & Philosophy of Hospital Building	Availability of Aspects of Basic Design & Philosophy of Hospital Building	CT
	Basic design of the security system during emergency conditions	PT
	Identification of potential fire hazards (Potential Fire Risk Survey)	PT
	Pre - Fire Planning based on Fire Basic Design & Philosophy	PT
	Evaluation of the availability of Fire readiness	PT
Fire & Gas Detection and Emergency Response Resources Adequacy	Emergency Management Command Organization & Facilities	PT
	Competence of the Emergency Management Team	PT
	STK Emergency Response	PT
	Fixed Fire & Gas Detection System	PT
	Fire Water Supply	PT
	Collaboration with support resources around the site	PT
	Fire Pumps (Fixed and Portable)	PT
	Fire Main Pressure Requirement	PT
	Fire Main, Hydrant & Hose Cabinet	PT
	Fixed Fire Water Spray / Sprinkler	PT
	Hose Reel	CT
	Monitor	PT
	Fixed, Semi Fixed, portable Foam System	PT
	Fire Extinguisher	PT
	Fire Alarm / Detection System	PT
	Fire Hose	PT
	CCTV Installation	PT

Element	Indicators	How to Score
	Security control facilities and facilities	CT
	Availability of Manpower Security	PT
Existing Fire & Emergency Response Resources Readiness	Source Of Water	PT
	Fire Pump	PT
	Fire Water line, Hydrant and Hose Cabinet	PT
	Sprinkler System	PT
	Water Spray Fixed System	PT
	Hose reel	PT
	Alarm and Detection System	PT
	Portable & special Fire Extinguisher	PT
	Security control facilities and facilities	PT

Source: Author Research

Table 2 Demonstrating good fire emergency response preparedness, all elements have been optimally met and ready for use in an emergency and only minor repairs are required. All elements have been optimally fulfilled and are ready for use in an emergency. Overall, the elements that have reached an average of greater than < 90% with an overall value of 91.28%. In the first element, the results of the FERRAT questionnaire show that 80% of the preparedness design at PT X Hospital has been at a fully acceptable level and meets optimal preparedness standards. However, 20% of these aspects are quite adequate and are still at a level that requires further improvement. The results of the second element showed that 63% of all aspects of facility availability were in acceptable or excellent condition, 32% were at a level of adequate and acceptable but still required some improvement, and only 5% of those aspects were unacceptable and required significant improvement. The results of the third element show that PT X Hospital has excellent readiness of equipment and resources in the field. In this element, 62% of the aspect points are at a level that meets the optimal preparedness standards and 38% are at a fairly good level and only require some further improvement.

Discussion

Preparedness for fire disasters in hospitals is essential to ensure the safety of patients, staff, and visitors, as well as maintain the continuity of health services (citra amanda). Fire disaster preparedness requires planning and policy, effectiveness in procedures, infrastructure, equipment, training and simulation, knowledge and behavior to achieve successful implementation. A study conducted by Marylin P on hospital preparedness in disaster response, stated that good planning and policies play an important role in preparedness for fire disasters. Hospitals should have comprehensive emergency response plans and policies that support their implementation. Adequate infrastructure and equipment play an important role in preparing for fire disasters. This is in line with the research conducted by Musyafak on fire management systems in hospitals, stating that the availability and maintenance of fire extinguishing equipment, alarm systems, and evacuation routes play an important role in fire management management (Youngo *et al.*, 2018) (Parulian Simanjuntak *et al.*, 2021) (May Hadip Musyafak *et al.*, 2020).

A study conducted by Gary Glauberman on fire preparedness, states that fire training and education are among the important things that can help workers to understand fire situations. Fire prevention and preparedness show that there is a potential threat to the safety of life, property, and the environment. Quick action at the time of an incident is crucial, so a good understanding of fire prevention and control measures is required. In addition to initial actions, a person's personal knowledge related to fire disasters contained in the surrounding environment is an important element in preparedness in dealing with fire disasters. Regular training and fire simulations for hospital staff improve preparedness and effective response in the event of a fire (Glauberman and Qureshi, 2020) (Hastutik, 2010) (Ardiyanto, Candra and Masribut, 2021) (Tambunan *et al.*, 2024).

Analysis of fire emergency response readiness in the PT X Hospital building showed that overall, the preparedness level reached 91.28%, with all elements (*Basic Design & Philosophy, Fire & Gas Detection and Emergency Response Resources Adequacy, and Existing Fire & Emergency Response Resources Readiness*) optimally fulfilled based on document assessment and *site verification assessment*. This shows that the implementation in the field is in line with the readiness of documents and provides a comprehensive picture of the readiness of health facilities in handling fire emergencies and there are only a few aspects that still need further improvement. According to the Regulation of the Minister of Public Works of the Republic of Indonesia No. 20 of 2009 concerning Technical Requirements for Buildings in the 4th appendix, the management of fire prevention and pre-incident activities is often referred to as "preliminary planning" and/or "pre-fire planning". Although the two are interconnected, they have differences. In fire prevention, it is assumed that incidents have the potential to occur so preventive measures are required. Meanwhile, pre-incident management assumes that an incident has already occurred, so that through the implementation of tactics, strategies, and resource coordination, the impact on human and property safety can be reduced. (Ministry of Public Works of the Republic of Indonesia, 2009)

Analysis of Basic *Design & Philosophy* aspects of Hospital Building

The five indicators in the first element regarding fire preparedness include questions regarding the availability of *the Basic design & philosophy* of the hospital building related to fire aspects, ensuring that the preparedness system has been designed with safety standards, regulations, and the specific needs of the Hospital into consideration. This includes the availability of detailed engineering design of hospital buildings, the design of safety systems related to emergency conditions, the implementation of identification of potential fire hazards, fire pre-incident planning and evaluation of the availability of fire readiness. According to the *Basic design & philosophy indicator of* the hospital building, the evaluation was carried out using *the Conformance Test* (CT) test with a direct comparison of the suitability of documents to the implementation through *site verification*, and the results showed a score of 120 points and 100% compliance with the assessment criteria. This score shows that *Basic design & philosophy* related to fire aspects is available on site and meets the applicable criteria.

The results of the indicator regarding the availability of the basic design of the security system against emergency conditions carried out using the Proportional Test (PT) showed an assessment result of 120 and met 100% of the assessment criteria. This value indicates that the basic design of the fire protection system is available at the site based on the results of the

identification of safety hazards. In the indicator of the identification aspect of potential fire hazards (Potential *Fire Risk Survey*) using a Proportional Test (PT) with 150 pounds of assessment results and 100% compliance with the assessment criteria. This value gives an idea that the potential fire hazard is carried out against flammable materials, potential *ignition sources* and *fire risk equipment*. This shows that the identification of potential fire hazards at the facility has been carried out comprehensively and in accordance with standards and reflects full readiness and compliance with fire safety protocols. Indicators regarding the evaluation of the availability of fire preparedness were carried out using the Proportional Test (PT) with an assessment result of 120 and meeting 100% of the assessment criteria. This value shows that the evaluation of the availability of fire preparedness has been carried out periodically in accordance with applicable standards.

In the last indicator, *Pre - Fire Planning* is based on the Fire *Basic design & philosophy* of the hospital building using the Proportional Test (PT) with 120 points and 80% compliance with the suitability of the assessment criteria. This value shows that pre-fire incident planning is available, but it is not optimal for *the worst case scenario* (*single fire/specific location*) as well as the needs and competencies of fire personnel. According to the Regulation of the Minister of Public Works of the Republic of Indonesia No. 20 of 2009 concerning Technical Requirements for Buildings in the 4th appendix, the completeness of fire pre-planning documents is very important in efforts to prevent and control fires in hospitals. The technical guidelines for building fire protection management emphasize that fire emergency response procedures include the formation of a planning team, the preparation of a building risk analysis of fire hazards, and the creation and maintenance of fire pre-planning documents. Hospitals that have disaster preparedness plan guidelines are better prepared to deal with emergency situations. (Ministry of Public Works of the Republic of Indonesia, 2009) (Zafira Tanjung *et al.* , 2024)

A study conducted by Musyafak (2020) on fire management systems in hospitals states that a fire management system is an integrated effort to manage fire risk starting from planning, implementation, monitoring, and follow-up. In line with the research conducted by Pratiwi et al. (2023) on the implementation of the fire emergency response system at the X Sragen General Hospital, it was stated that the implementation of the fire policy was carried out well, but the means of saving lives were not optimal, and the coaching and training were carried out in accordance with regulations. A study conducted by Arrazy et al. (2018) on the implementation of fire safety management systems in hospitals states that the fire safety management system in hospitals has been implemented, but there is still some improvement needed in policy socialization to patients, routine training, addition of protective equipment, recording and documentation of every activity or event and management evaluation (May Hadip Musyafak *et al.*, 2020) (Pratiwi, Ekawati and Jayanti, 2023) (Arrazy, Sunarsih and Rahmiwati, 2014).

Analysis of Fire & Gas Detection and Emergency Response Resources Adequacy

The design of facilities and infrastructure related to fires is described in the Regulation of the Minister of Health Number 40 of 2022 concerning Technical Requirements for Hospital Health Buildings, Infrastructure, and Equipment. The regulation establishes technical standards

to ensure the safety of occupants and buildings from fire hazards which include active fire protection systems, passive fire protection systems, life-saving means and ensuring medical equipment has protection against fire risks. In addition, the Regulation of the Minister of Health Number 24 of 2016 concerning Technical Requirements for Hospital Buildings and Infrastructure, in articles 4 and 17 stipulates the technical requirements for hospital buildings and infrastructure that consider fire safety aspects against fire hazards, including the provision of evacuation facilities, fire alarm systems, and active and passive fire protection. In the Regulation of the Minister of Public Works Number 26/PRT/M/2008 concerning Technical Requirements for Fire Protection Systems in Buildings and Environments, in articles 4, 11 and 16 stipulate the technical requirements of fire protection systems that must be met by buildings that each building must be equipped with an active and passive fire protection system that is in accordance with the function and classification of the building and must have an exit facility that meets the technical requirements for evacuation during a fire emergency. (Ministry of Health of the Republic of Indonesia, 2022) (Ministry of Health of the Republic of Indonesia, 2016) (Ministry of Public Works of the Republic of Indonesia, 2008)

Not only in Indonesia, a study conducted by Mishra et al (2022) also shows that the implementation of fire-related facilities and infrastructure designs in hospital buildings is carried out in other countries. Their research revealed that fire safety readiness has not yet become a priority in hospitals in Kathmandu, Nepal. Although buildings are designed in accordance with national building codes, the implementation of fire safety measures is often inadequate, indicating that even if standards and regulations exist, their implementation still needs to be improved to ensure the safety of hospital residents. Similarly, a study by Salim et al. (2021) examined issues related to fire safety management and offered potential solutions to improve safety in public health facilities in Malaysia. The study emphasizes the importance of a proper institutional framework, an improved emergency response team, and a better occupational health and safety system to improve fire safety management in hospitals. It is important for hospital management to proactively identify and address weaknesses in their fire safety systems to ensure the safety of patients and staff. To prevent fire hazards must have a system. The system in question aims to protect property and life in the building in the form of Fire Management (MPK), MPK consists of active and passive protection systems, fire management teams, and operational procedures (Bashyal, Mishra and Aithal, 2022) (Agus Salim *et al.*, 2023) (Agustin *et al.*, 2016).

The second element, there are 19 sub-elements consisting of 28 assessment indicators, namely the organization & facilities of the disaster management command, the competence of the Disaster Management Team, the Emergency Response Team, the fixed gas and fire detection system, the availability of fire water supply, cooperation with relief resources around the location, the number and capacity of fire pumps and their availability, the pressure needs of the fire department's main pipe, fire extinguishing main pipes, hydrant & hose cabinets, fire water sprinklers, protection systems, hose reels, availability of monitors, fixed, semi-fixed, and portable foam systems, fire extinguishers, detector and alarm systems, fire hoses, CCTV installation, security control facilities and facilities, and the availability of security personnel. In this second element, there are sub-elements that have not run optimally and some further improvements are needed. Some of these sub-elements are in the 2nd, 3rd, 6th, 17th, 18th and 19th sub-elements.

The 2nd sub-element contains the competence of the emergency management team. The results showed that this indicator was measured using PT and obtained 11.25 points and met 25% of the assessment criteria. This value shows that of the number of personnel, only 25% have the competence of the fire emergency management team based on Kepmenaker No. 186 of 1999 concerning Fire Management Units in the Workplace is still not optimal and needs to be improved. In the Regulation in article 5, which states that the fire management unit consists of fire role officers, fire management squads, fire control unit coordinators and K3 experts who are fire management specialists as technical managers. These results are in line with the findings of several previous studies by Putra (2018) on the preparedness of the Disaster Committee Team of PKU Muhammadiyah Bantul Hospital in dealing with disasters, stating that although the disaster team has been formed and carried out training, there is still a need for improvement in internal coordination and implementation of emergency response procedures. In addition, research by Salim et al. (2021) on fire safety management in public health facilities in Malaysia, stated that the lack of training and competency development of staff is an obstacle in effective fire safety management. They emphasized the importance of ongoing training to improve preparedness and response to emergencies (Putra, 2018) (Agus Salim *et al.*, 2023).

The 3rd sub-element contains the emergency response STK measured using the assessment method of PT. This sub-element is further divided into two indicators, namely scenario preparation and the availability of a community safety management system. The first indicator shows a score of 45 and meets 100% of the assessment criteria. This value indicates that there has been an emergency response STK/Procedure in accordance with *the Multiple* scenarios that have been determined. Meanwhile, this second indicator has an assessment result of 30 and meets 50% of the assessment criteria. This value shows that there is already a safety management system for the community, but the training or simulation system has not been implemented together with the community around the location. This is in line with the findings of several studies that emphasize the importance of active community involvement in disaster preparedness programs. Research conducted by Trifianingsih (2022) emphasizes that communities and communities need to strengthen and improve their ability to respond to disasters at the community level. One of the indicators of preparedness is the early warning system that exists in the community, especially in areas that are vulnerable to fire disasters. This warning system includes warning signs and information distribution in the event of a disaster, so that the community can take appropriate actions to reduce casualties (Trifianingsih) *et al.*, 2022).

The sixth sub-element contains Establishing Cooperation with Assistance Resources around the location. The results of the study show that this indicator was measured using PT with an assessment result of 31.5 and met 70% of the assessment criteria. This value shows that efforts to establish cooperation with assistance resources around the location have been made, but there is still room for improvement to achieve more optimal collaboration with related agencies closer to the hospital location. This is in line with research conducted by Maula and Vestabilivy (2022) examining the implementation of the fire emergency response system at the Jakarta Sukapura Islamic Hospital. The study found that although the emergency response system has been implemented, there are still some aspects that need to be improved,

such as regular training for staff and coordination with relevant agencies in fire management. (Maula and Vestabilivy, 2020)

The 17th sub-element contains the availability of CCTV installations to reach all areas that are prone to fire and have the potential for fires. The results of the study showed that this indicator was measured using PT with an assessment result of 33.75 and met 75% of the assessment criteria. This value shows that CCTV installation is available, but it has not reached all areas prone to fire and the potential for fires. This is in line with research findings that emphasize the importance of optimal CCTV coverage in fire protection systems in healthcare facilities. A study conducted by Fadilah (2021) on the fire protection system in the Emergency Installation (IGD) building of Leuwiliang Bogor Hospital stated that although CCTV has been installed at various points, the control center is outside the hospital close to the emergency room building. The study emphasizes that strategic placement and coverage of CCTV is essential to effectively monitor fire-prone areas. (Fadilah *et al.*, 2019)

Sub-element 18 contains facilities and means of security control on the availability of personal on board counting and metal detector equipment. The results showed that this indicator was measured using CT with a measurement result of 38.5 and met 85% of the assessment criteria. This value shows that the security control facilities and facilities that have been available are inadequate. The use of Walk-Through Metal Detectors (WTMDs) and/or Hand-Held Metal Detectors (HHMDs) is at the forefront of security and plays a crucial role in preventing the entry of weapons, explosives, and other dangerous objects into protected areas, such as hospitals, such as airports, schools, and government buildings. Personal on board counting or the role of security officers in evacuation management in the event of a fire in the hospital through alliances with security services to ensure control and strengthen a sense of security during the evacuation process (Novita *et al.*, 2020) (May Hadip Musyafak *et al.*, 2020)

The 19th sub-element contains the availability of manpower security. The results showed that this indicator was measured using PT with an assessment result of 22.5 and met 75% of the assessment criteria. This value shows that the available security manpower has not been able to meet the needs for security in the hospital building area. Security officers have a strategic role in the operation of active protection systems, such as smoke detectors and fire alarms, which are crucial in the prevention and control of fires in healthcare facilities. The presence of trained security officers not only serves as a situation controller in the event of a fire, but also as a key element in the effectiveness of the hospital evacuation system. (Astrianti and Elwindra, 2019)

Analysis of Existing Fire & Emergency Response Resources Readiness

The success of a fire management system in a hospital depends on the effectiveness of the maintenance, maintenance, and inspection of fire protection system equipment, as well as the readiness of available resources in the field. The frequency of periodic maintenance greatly affects the operational readiness of fire protection equipment in the event of an emergency. The results of this study indicate that hospitals with good maintenance systems have a higher level of preparedness in dealing with fires. The company is responsible for maintaining, improving, and reviewing policies, programs, procedures, and capabilities by setting performance targets, especially those related to disaster preparedness. To ensure the effectiveness of the program, companies need to evaluate the implementation of changes caused by preventive and corrective

measures. According to NFPA, evaluations must be carried out regularly and whenever conditions change, so that the program remains relevant and in accordance with the current situation (Iwan Jatmika *et al.*, 2024)

The third element contains 17 indicators with 9 sub-elements. The sub-elements are as follows: water source, fire pump, fire hydrant, hydrant and cabinet hose, sprinkler system, water spray system, hose reel, alarm and detector system, fire extinguisher and APAB as well as facilities and resources for security control. Of the 9 sub-elements, there are three sub-elements that do not meet the criteria in sub-elements 1, 3, and 7. Sub-element 1 is related to the water source related to the condition of the water pond/tank. Based on Table 3, this indicator is measured using PT with an evaluation score of 56.25 and meets 75% of the evaluation criteria. The score shows that the water source is available and meets the needs for dealing with fire emergencies with maintained conditions, regular inspections are carried out and no leaks occur. However, further improvements are needed due to the lack of water level signs in the groundtank and no capacity signs in the ground tank to ensure that the water volume is in accordance with the set needs.

The presence and condition of water sources, such as ponds or water tanks, play a crucial role in a hospital's fire protection system. Research conducted by Martini et all (2021) regarding the analysis of clean water needs for daily operations and sprinkler fire extinguishing systems at Bhayangkara Hospital Palembang shows that adequate water storage capacity is essential to ensure the availability of water in the event of a fire. This study emphasizes the need to add a roof tank and a ground water tank as a water storage place to meet the operational needs of the Hospital. Hospitals with good fire management systems, including adequate water resource management, have higher preparedness in dealing with fires. The study emphasizes the importance of patient evacuation procedures and an active protection system supported by a reliable water source (R.A. Sri Martini, Erny Agusri and M. Nur Ridho Hasan, 2021) (May Hadip Musyafak *et al.*, 2020).

Sub-element 3 concerns the periodic inspection and maintenance of the Fire Water line, Hydrant and Hose Cabinet in the hose cabinet. It consists of two assessment indicators. The first indicator is the implementation of maintenance, maintenance and periodic testing of fire water lines, intersection valves, hydrants, hose cabinets in accordance with NFPA 25. According to Table 3, this indicator was measured using PT with a score of 67.5 and met 75% of the evaluation criteria. The score shows that the implementation of maintenance, maintenance, and periodic testing of fire water lines, intersection valves, hydrants, and hose cabinets has been carried out on indoor hydrants, but carried out on outdoor hydrants to meet the standards set by NFPA 25. The second indicator is the condition of all equipment, which is in good condition and ready for operation through inspection and testing in the previous year. According to Table 4, this indicator is also measured using PT with a score of 75 and meets 100% of the evaluation criteria. The score indicates that the condition of the equipment is suitable for operation.

Periodic inspections and maintenance of fire protection system components, such as fire water lines, hydrants, and hose cabinets, play a crucial role in ensuring hospital readiness in dealing with fire emergencies. This activity ensures that all equipment functions optimally

when needed, so that it can minimize the risk of material loss and fatalities. According to the Technical Guidelines for Hospital Infrastructure issued by the Directorate of Medical Support Services and Health Facilities of the Ministry of Health of the Republic of Indonesia, an active fire protection system must be held for hospital buildings, considering that most of its residents are patients in conditions that require evacuation assistance. These guidelines emphasize the importance of the installation of qualified fire protection systems, including the selection of fire pumps, the placement of fire alarm detectors, sprinkler heads, and their piping systems, to prevent losses due to fire. In addition, the hydrant inspection standards applicable in Indonesia, as stipulated in the Regulation of the Minister of Public Works No:26/PRT/M/2008 and referring to NFPA 25, stipulate that inspections and maintenance of fire hydrant installations must be scheduled periodically. The goal is to ensure that the performance of the fire management system is in good condition and ready to be used at any time, especially during fire emergencies (Ministry of Health of the Republic of Indonesia, 2012) (Ministry of Public Works of the Republic of Indonesia, 2008).

Sub-element 7 concerns the implementation of maintenance, maintenance, inspection and testing of alarm and detection systems. It consists of two indicators. The first indicator is related to the implementation of the maintenance, maintenance, inspection and periodic testing program of the Alarm and Detection system. Based on Table 3, this indicator is measured using PT with a score of 67.5 and meets 75% of the assessment criteria. The score shows that the implementation of the maintenance, maintenance and periodic testing program of the Alarm and Detection system has not been carried out in accordance with the required criteria. The second indicator is the condition of all alarm equipment and detection system equipment located in good condition and ready to operate through the results of inspection and testing in the previous year. Based on Table 3, this indicator is also measured using PT with a score of 75 and meets 100% of the assessment criteria. The score shows that the equipment is in good condition and ready for operation.

Regular maintenance, maintenance, and testing of alarm and fire detection systems have a vital role in dealing with fire emergencies in hospital buildings. This activity ensures that the active fire protection system is functioning properly, so that it can provide early warning and quick response in the event of a fire. The implementation of fire protection management has not been effective, characterized by the absence of special access for fire engines, smoke control systems, emergency exits, emergency stairs, and ram. In addition, the inspection and maintenance program of the facility is not carried out periodically, even though the active fire protection system and building structure have complied with applicable regulations. The existence of an active fire protection system and life-saving means are crucial elements in determining the level of reliability of hospital buildings against fire risk, so their existence is a must. Regular maintenance of fire protection systems has an essential role in ensuring its functionality so that it can operate optimally in the event of an emergency. The implementation of systematic and standard-compliant maintenance procedures for fire alarm systems, including routine inspections and maintenance, is of high significance in ensuring optimal system performance and supporting the effectiveness of fire risk mitigation (Pratiwi, Ekawati and Jayanti, 2023) (Irwanto *et al.*, 2023).

The implementation of an effective fire protection system in hospitals requires careful planning, periodic maintenance, and continuous evaluation. Research shows that even though

fire policies have been well implemented, aspects such as life-saving means and risk assessments still require special attention. In addition, the maintenance of a suboptimal fire protection system can affect fire safety in hospitals. Therefore, a holistic and standards-based approach to fire protection management is essential to improve occupant safety as well as the protection of hospital assets from potential fire hazards.

CONCLUSION

The effectiveness of fire protection systems in hospitals is greatly influenced by regular maintenance, maintenance, and inspection of all components of the passive protection system, life safety system and active protection system including water sources, fire pumps, fire water lines, hydrants, hose cabinets, sprinklers, and alarm and detection systems. The results of this study show that although most fire protection systems have met the set standards, there are still critical aspects that need to be improved and further improved, such as the clarity of water source capacity indicators, the regularity of fire protection equipment inspections, and compliance with Indonesian national standards and NFPA 25. In addition, the readiness of human resources in the operation of fire protection systems is also a determining factor in the success of fire risk mitigation in hospitals. The implications of this study show that the management of fire protection systems must prioritize a risk-based approach, taking into account the characteristics of the building, the level of hazard risk, and the availability of supporting facilities and infrastructure. In the long run, the integration of technology in the monitoring of fire protection systems, such as the use of sensors for early detection of fires, can improve the overall reliability of the system. Thus, the results of this study not only provide insights for hospital management in improving fire preparedness, but also become a foundation for the development of more adaptive and sustainable fire protection policies.

REFERENCES

Agus Salim, N.A. et al. (2023) 'Fire Safety Management In Public Health-Care Buildings: Issues And Possible Solutions', Journal Of Facilities Management, 21(1), pp. 69–83. Available at: Https://Doi.Org/10.1108/Jfm-01-2021-0008.

Agustin, R. et al. (2016) 'Analysis of the Implementation of the Fire Emergency Management Unit at Mall X, Jakarta', Journal of Public Health (e-Journal), 4, pp. 2356–3346. Available at: Http://Ejournal-S1.Undip.Ac.Id/Index.Php/Jkm.

Ardiyanto, T., Candra, L. and Masribut, M. (2021) 'Review of Worker Readiness in Fire Emergency Management at the Nutrition Installation Building of the Tatangan Mental Hospital in Riau Province in 2020', Public Health Media, 1(2), pp. 257–262. Available at: Https://Doi.Org/10.25311/Kesmas.Vol1.Iss2.56.

Arrazy, S., Sunarsih, E. And Rahmiwati, A. (2014) 'Implementation Of Fire Safety Management System At Dr. Sobirin Hospital District Of Musi Rawas 2013', Journal of Public Health Sciences, 5.

Astrianti, Y. and Elwindra (2019) 'Overview of the Implementation of the Fire Emergency Response System at Awal Bros West Bekasi Hospital', Persada Husada Indonesia Journal, 6(23).

Bashyal, C., Mishra, A.K. and Aithal, P.S. (2022) 'Fire Safety Compliance Among Hospital Buildings: A Case Study From Nepal-Asia', International Journal Of Research - Granthaalayah, 10(10), pp. 33–57. Available at: Https://Doi.Org/10.29121/Granthaalayah.V10.I10.2022.4827.

Fadilah, F. et al. (2019) A Study of the Fire Protection System of the Emergency Installation Building (Igd) of the Leuwiliang Regional General Hospital, Bogor Regency in 2018, Promoter of the Public Health Student Journal.

Glauberman, G. And Qureshi, K. (2020) 'Exploratory Qualitative Study Of Fire Preparedness Among High-Rise Building Residents', Hawai'i Journal Of Health & Social Welfare [Preprint].

Hastutik, F.Y. (2010) Special Report on Fire Hazard Prevention and Mitigation Efforts at Pt. Semen Gresik (Persero) Tbk. Tuban Factory, East Java.

Irwanto, B.S.P. et al. (2023) 'Evaluation Of Fire Prevention And Control System In Dr. R. Koesma Regional General Hospital Of Tuban Regency In 2021', Indonesian Journal Of Occupational Safety And Health, 12(1), pp. 143–155. Available at: Https://Doi.Org/10.20473/Ijosh.V12i1.2023.143-155.

Iwan Jatmika et al. (2024) 'Analysis Of Fire Emergency Response Readiness At Oil And Gas Company', Media Publication Promotion Kesehatan Indonesia (Mppki), 7(6), pp. 1678–1685. Available at: Https://Doi.Org/10.56338/Mppki.V7i6.5234.

John, J.S. et al. (2018) 'Fire Safety Preparedness In Building Construction Sites In Dar-es-Salaam, Tanzania', International Journal Of Engineering Trends And Technology, 66(3), pp. 154–169. Available at: Https://Doi.Org/10.14445/22315381/Ijett-V66p224.

Ministry of Health of the Republic of Indonesia (2012) Technical Guidelines for Hospital Infrastructure, Active Fire Protection System. Ministry of Health of the Republic of Indonesia.

Ministry of Health of the Republic of Indonesia (2016) Technical Requirements for Hospital Buildings and Infrastructure. Jakarta. Available at: Www.Peraturan.Go.Id.

Ministry of Health of the Republic of Indonesia (2022) Technical Requirements for Hospital Health Buildings, Infrastructure, and Equipment. Available at: Www.Peraturan.Go.Id.

Ministry of Public Works of the Republic of Indonesia (2009) Technical Guidelines for Fire Protection Management in Urban Areas. Jakarta: Ministry of Public Works of the Republic of Indonesia.

Ministry of Public Works of the Republic of Indonesia and General, P. (2008) Technical Requirements of Fire Protection Systems in Buildings and Environment.

Kurd, H. et al. (2021) 'Research Paper: Determining Factors Affecting Fire Risk In A Hospital In Qazvin, Iran', Health In Emergencies And Disasters Quarterly, 6(2), pp. 115–122. Available at: Https://Doi.Org/10.32598/Hdq.6.2.370.

Mahbub, P.K. and Darmawan, C. (2019) 'Fire Safety System Building', in IOP Conference Series: Materials Science And Engineering. Institute Of Physics Publishing. Available at: Https://Doi.Org/10.1088/1757-899x/662/4/042001.

Maula, H. and Vestabilivy, E. (2020) 'Overview of the Implementation of the Fire Emergency Response System at the Jakarta Sukapura Islamic Hospital', Persada Husada Indonesia Journal, 7(24).

Mei Hadip Musyafak, A. et al. (2020) 'Fire Management Systems in Hospitals', Higeia Journal of Public Health Research and Development [Preprint]. Available at: Https://Doi.Org/10.15294/Higeia.V4ispecial%201/39387.

Nada, A.P., Koesyanto, H. and Artikel, I. (2020) 'Fire System Management in the Market', Higeia Journal of Public Health Research and Development, 5(1). Available at: Https://Doi.Org/10.15294/Higeia/V5i1/35734.

Novita, D. et al. (2020) 'A Study of Security Systems at Security Check Point (SCP) 2 of Minangkabau Padang International Airport', Scientific Journal of Aviation Langit Biru, 13, pp. 1–282.

Parulian Simanjuntak, M. et al. (2021) 'Hospital Preparedness in Disaster Management (Case Study at Elpi Al Aziz Rantauprapat Hospital in 2020)', Prepotif Journal of Public Health, 5(2).

Pratiwi, R.A., Ekawati, E. and Jayanti, S. (2023) 'Implementation of Fire Emergency Response System at X Sragen Hospital', Indonesian Public Health Media, 22(2), pp. 105–113. Available at: Https://Doi.Org/10.14710/Mkmi.22.2.105-113.

Putra, H.A. (2018) A Qualitative Study of the Preparedness of the Disaster Committee Team of Pku Muhammadiyah Bantul Hospital in Dealing with Disasters, Health Sciences and Pharmacy Journal Issn. Online. Available at: Http://Journal.Stikessuryaglobal.Ac.Id.

Rahardjo, H.A. And Prihanton, M. (2020) 'The Most Critical Issues And Challenges Of Fire Safety For Building Sustainability In Jakarta', Journal Of Building Engineering, 29. Available at: Https://Doi.Org/10.1016/J.Jobe.2019.101133.

R.A. Sri Martini, Erny Agusri and M. Nur Ridho Hasan (2021) 'Analysis of Clean Water Needs for Daily Operations and Sprinkler Fire Extinguishing System of the New Main Building of Bhayangkara Hospital Palembang', Paduraksa: Journal of Civil Engineering, Warmadewa University, 10(2), pp. 338–349. Available at: Https://Doi.Org/10.22225/Pd.10.2.3335.338-349.

Tambunan, M.H. et al. (2024) 'An Overview of the Knowledge and Preparedness Attitude of the Emergency Response Team in Dealing with Fires at the Regional General Hospital (RSUD) X Central Jakarta in 2024', Gudang Jurnal Multidisciplinary Ilmu Ilmu, pp. 253–257. Available at: Https://Doi.Org/10.59435/Gjmi.V2i8.878.

Trifianingsih, D. et al. (2022) 'Community Preparedness To Prevent Fire Disaster In The City Of Banjarmasin', Journal of Nursing Asylum Insan (Jksi), 7(1).

Zafira Tanjung, S. et al. (2024) 'Analysis of Preparedness in Hospitals in Dealing with Disasters', Gudang Jurnal Multidisciplinar Sciences, 2, pp. 256–259. Available at: Https://Doi.Org/10.59435/Gjmi.V2i5.468.

Zulkifli And Mangindara (2020) 'Analysis Of Hospital Preparedness In Efforts To Deal With Fire Disasters At Haji Hospital, South Sulawesi Province', Journal of Health Research Pelamonia Indonesia, 03, pp. 2654–9921.