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Evaluation of Hospital Disaster Resilience

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Abstract

The purpose of this study is to develop fire management strategies at Hospital X in Batam City, Riau Islands. The research design to be used in this study is a qualitative method. Data indicates that Hospital X has an emergency response team; however, the number of certified employees is still below the standards set by the regulations. Although Hospital X conducts evacuation simulations and fire training annually, there are several shortcomings in the evacuation routes, including inappropriate handrail height and unpainted emergency exit doors. The evaluation also found that, despite the availability of fire-fighting facilities such as fire extinguishers and detectors, regular inspections are not conducted uniformly. The distance between fire extinguishers exceeds the stipulated 15 meters, which could increase the risk of fire. Based on these findings, it is recommended that the Occupational Health and Safety Team take corrective actions to ensure compliance with existing regulations, including enhancing employee certification and updating evacuation facilities. By implementing these recommendations, it is expected that Hospital X can improve disaster resilience, ensure the safety of patients and staff, and be prepared for future emergencies.

Introduction

Disasters can be defined as a series of events that pose risks and disrupt the lives of communities. Disasters may be caused by natural factors, non-natural factors, or human activities. Disasters can lead to loss of human lives, environmental damage, property loss, and psychological impacts on society (Chaudhary & Piracha, 2021). Indonesia is the most disaster-prone country, mainly due to its location between four major tectonic plates: Indo-Australian, Eurasian, Pacific, and the Philippine Sea plates. Several volcanic mountain ranges are located in Sumatra, Java, Bali, Nusa Tenggara, northern Sulawesi, Maluku, and Papua, making Indonesia highly susceptible to disasters.

Fires are one type of non-natural disaster as described in Law No. 24 of 2007. Fires can occur anytime and anywhere, including in the workplace. Fires pose threats to human safety, property, and the environment, often resulting from flames, smoke, and gases. The rapid development and progress in construction are directly correlated with increased fire risk (Firman et al., 2023; Darmawi, 2022).

Hospitals have experienced several fire incidents, one of which occurred in the ICU of Misr Al Amal Hospital in Cairo, Egypt, resulting in the deaths of seven COVID-19 patients (Hudson & Zimmermann, 2021). This fire was caused by damage to the electrical panel room. On July 12, 2021, the Imam Al-Hussein Teaching Hospital in Dhi-Qar, Iraq, caught fire. The fire in the COVID-19 patient care unit was triggered by an explosion of an oxygen gas cylinder, leading to 89 deaths and 100 injuries. According to data from the National Disaster Management

Agency, there were 1,678 building fire cases at the end of 2019. In this context, building owners must conduct fire risk level analyses to minimize the causes of fires (Wantouw et al., 2023; Kurniawan & Sutiyo, 2024; Kuntoro, 2017). In 2018, 722 incidents were reported by the Fire and Rescue Department of Jakarta. Electrical short circuits caused 469 cases, making it the most common cause, followed by 82 cases of gas stove explosions, 20 cases of cigarette butts, and 151 cases of unknown causes.

Recent reports indicate that several hospital buildings frequently experience fires (Hambyah, 2016; Ramadina & Ibad, 2024; Saputra, 2019). On May 31, 2013, Pondok Indah Hospital (RSPI) in South Jakarta caught fire from the main PLN cable network located in front of the building, with no casualties reported. Another incident occurred at Mayapada Hospital in Lebak Bulus, South Jakarta, on October 28, 2019, caused by an electrical short circuit, allegedly originating from the server room (Pangestu et al., 2023). The pharmacy of Pioso Regional General Hospital in Jombang Regency, East Java, also caught fire. On December 9, 2019, a fire damaged medicines, patient records, and a hearse. One common cause of hospital fires is air conditioning short circuits. The latest fire incident at Pasar Rebo General Hospital occurred on March 9, 2022, where an electrical short circuit in the battery storage room on the first floor caused the fire.

Fires are the most frequent disasters in Batam City. Hospitals play an important role in fire management, including public outreach and education, and coordination with fire departments and other relevant agencies to ensure effective emergency response (Landesman, 2005; Muhamad Salleh et al., 2020; McEntire, 2023; Wolf-Fordham, 2020). The locations of health centers (Puskesmas) scattered across Batam Island and its surroundings necessitate good communication, cooperation, coordination, and collaboration in managing fires at these centers (Marzuki & Tharim, 2024).

Fire Safety Management is a system for managing and controlling elements such as personnel, equipment, costs, materials, methods, and information to ensure and enhance overall building safety against fire hazards (Minoli et al., 2017). With numerous equipment that may trigger fires, such as LPG gas, medical gases, and incinerators, control measures are needed before incidents occur, such as providing fire extinguishers and hydrants.

Methods

This research is a qualitative study aimed at describing the actual conditions based on current factual data through observations and interviews with employees to provide an overview of the implementation of Fire Safety Management at Hospital X in Batam City in 2024. The study was conducted at Hospital X, located in Batam City, from March to June 2024. The research subjects involved employees directly related to the implementation of Fire Safety Management. The research instruments used in this study were interview sheets and observation sheets, which served as data collection tools to measure the observed social and natural phenomena, as explained by Sugiyono (2013).

The data used in this study consisted of primary and secondary data. Primary data were collected directly from the first source through observation, while secondary data were obtained from journals, theses, e-books, regulations, and relevant official company documents (Suharsimi, 2006). Data processing was carried out in several stages, including editing to review the completeness of data, coding to assign codes to the variables studied, entry to input data into files using statistical computer programs, and cleaning to ensure that the data entered into the computer were error-free (Suharsimi & Pace, 2008; Barchard & Pace, 2008).

The data analysis in this study aims to provide an overview of fire prevention and control efforts at Hospital X and evaluate communication, cooperation, coordination, and inter-organizational collaboration in fire management (Gilja, 2013; Bongiovanni et al., 2017). The qualitative approach allows researchers to explore the implementation process of Fire Safety Management

through observational and interview data, thus mapping the real conditions in the field. This analysis is expected to provide insights into the effectiveness of the fire safety management system and the roles of various elements within it, including the hospital's internal policies and compliance with applicable regulations (Vinodkumar & Bhasi, 2010). Consequently, the results of this study can serve as a reference for improving fire management systems in healthcare institutions, particularly at Hospital X and its surroundings, to enhance the safety of patients, staff, and hospital facilities.

Result and Discussion

Periodic Inspection

Table 1. Summary of Interview Results and Documentation Related to Fire Extinguisher Maintenance and Readiness at Hospital X

No	Question	Answer	Document Review
A	How many fire extinguishers (APAR) are there in RS X?	Informant 1: "The latest data registered with the fire department shows 79, all types of APAR."	Found on the inspection certificate by the fire department that RS X has 79 APAR units.
B	Are there instructions for using APAR near the APAR units?	Informant 1: "Yes, instructions are present; we use acrylic signage placed near the APAR."	-
C	How is the maintenance (inspection method) of the APAR conducted (Dry Powder APAR and CO2 APAR)?	Informant 1: "We have internal and external inspections; internal inspections are done monthly, and external inspections are scheduled by the fire department annually. During powder APAR inspections, we check the expiration date, nozzle, pin, pressure, and perform a rolling action on the cylinder to prevent freezing. For CO2 APAR, we also weigh the cylinder to detect any leakage."	An inspection certificate by the fire department is available annually.
D	When is the APAR maintenance and testing performed periodically?	Informant 1: "Once a month."	APAR tagging is updated monthly. Inspection in the pathology laboratory is not done monthly.
E	How many sprinklers and detectors are in RS X?	Informant 1: "There are 850 heat detectors and sprinklers each, and around 250 smoke detectors."	Found on the fire department certificate that there are 850 sprinklers and heat detectors, and 250 smoke detectors.
F	When is the maintenance conducted, and what is the method?	Informant 1: "Inspections are conducted every three months, but specific checks are done monthly—for instance, floors 1-3 are checked in the first month, floors 4-6 in the second month, and floors 7-Utility in the third month. Smoke detectors are	Maintenance frequency and methods are stipulated as follows: Smoke Detector: Maintenance using "Smoke Test"; Heat Detector: Checked using lamps placed near heat sensors; Sprinkler: Inspections are

		tested using smoke tests; heat detectors are tested with lamps placed near the heat sensor; sprinklers are rarely tested as they require breaking, so inspections are mostly visual checks conducted every six months."	rare, mostly visual checks conducted every six months.
G	Do you know what APAR and Hydrant are?	Informant 2: "Yes, I know, APAR is a light fire extinguisher, and hydrant is used for extinguishing larger fires." Informant 3: "Yes." Informant 4: "A hydrant, as far as I know, is like a water outlet for firefighting, and APAR is a fire extinguisher that sprays." Informant 5: "Yes, APAR is usually found in rooms to extinguish fires, while hydrants also extinguish fires but use long hoses that need multiple people to handle."	-
H	Do you know the types of APAR available at RS X?	Informant 2: "There are two types here: powder and CO2." Informant 3: "Outside, there's CO2 and powder." Informant 4: "Yes, powder and CO2." Informant 5: "If I'm not mistaken, there's powder and CO2."	There are 2 types of APAR: powder and CO2.
I	Can you use the APAR and Hydrant in your room/nearby?	Informant 2: "Yes, both APAR and hydrant." Informant 3: "Yes, I can use both APAR and hydrant." Informant 4: "I can use APAR but not hydrant." Informant 5: "I was taught the theory during orientation but haven't practiced yet as I've only been here for a month and haven't participated in a fire drill."	The hospital provides training on the use of APAR and hydrants.
J	Who performs the periodic maintenance of APAR?	Informant 2: "In this hospital, the K3RS team." Informant 3: "K3RS." Informant 4: "The K3RS team." Informant 5: "K3RS."	-
K	Are you involved in the maintenance	Informant 2: "Yes." Informant 3: "Yes."	-

	of APAR and hydrants around you?	Informant 4: “Yes, if there’s visible damage or depletion in APAR or hydrants, we report it to K3RS. K3RS is very important here.” Informant 5: “Yes, we occasionally check the condition of APAR, hydrants, and safety boxes in our rooms and report any issues to the K3RS team.”	

Hospital X Batam has 79 fire extinguishers, 850 sprinklers, and heat detectors, and 250 smoke detectors. Periodic inspections of fire extinguishers and detectors at Hospital X are conducted in accordance with regulations every six months. The hospital also has a stipulation for checking fire extinguishers once a month. Some areas, such as the Pathology Laboratory, were missed in the monthly inspection. The installation of fire extinguishers at Hospital X still does not comply with legal regulations.

According to the Minister of Manpower and Transmigration Regulation No: Per.04/Men/1980 on the Conditions for Installation and Maintenance of Portable Fire Extinguishers: Article 4, Paragraph (5) states: "The placement referred to in paragraph (1) between one fire extinguisher and another or between groups must not exceed 15 meters, unless otherwise determined by a supervising officer or occupational safety expert." Article 8 states, "Portable fire extinguishers must be installed in such a way that the highest point is at a height of 1.2 meters from the floor, except for CO2 and dry chemical types which can be placed lower with the condition that the distance between the base of the portable fire extinguisher must not be less than 15 cm from the floor." Article 11, Paragraph (1) states, "Each portable fire extinguisher must be inspected twice a year, namely: inspections within a six-month period; inspections within a twelve-month period."

Based on research by Baskoro and Maulana titled "Evaluation of Active Fire Protection Systems in Pratama Yogyakarta Hospital," it was found that all fire extinguishers in Pratama Hospital are inspected once a year, as evidenced by the inspection cards attached to the extinguishers indicating the valid dates and inspection dates. According to research by Astrianti and Elwindra titled "Description of Fire Emergency Response System Implementation at RS X Bekasi Barat," it is known that RS X Bekasi Barat conducts fire extinguisher inspections every six months, and the extinguishers at RS X are installed properly with a distance of less than 15 meters between them.

The researchers concluded that the periodic inspections of fire extinguishers and detectors at Hospital X have been conducted in accordance with regulations, which is every six months. The hospital also has a stipulation for checking fire extinguishers once a month. Although inspections are conducted at least every six months, a consistent monthly inspection can provide more attention to the fire extinguishers that need to be checked. The distance between fire extinguishers exceeds 15 meters, reaching 35 meters. Hospital X Batam may need to reduce the distance or add more extinguishers to minimize the fire risk.

Emergency Response Team

Table 2. Evaluation of the Understanding and Readiness of the Fire Emergency Response Team at Hospital X

No	Question	Answer	Document Review
A	Is there any work instruction/SOP for	Informant 1: “Yes, there are work instructions detailing tasks	The hospital has a standard operating procedure (SOP)

	emergency fire handling at RS X?	during emergencies." Informant 2: "Yes." Informant 3: "Yes." Informant 4: "Yes." Informant 5: "As far as I know, there is."	for handling fire emergencies.
B	Is the work instruction known to all employees at RS X?	Informant 1: "Yes, all employees are informed when they start working." Informant 2: "Yes." Informant 3: "Yes." Informant 4: "Yes, we were informed about the core and emergency response duties before starting work." Informant 5: "Yes, during orientation, we were informed about our duties in emergencies, and it can be reviewed on the dashboard if needed."	Instructions are given by hospital management to all new employees.
C	Is there an emergency response team at RS X?	Informant 2: "Yes." Informant 3: "Yes, Security is part of the emergency response team." Informant 4: "Each floor has an emergency response team, including medical and security teams with coordinators." Informant 5: "Yes, including nurses and security teams."	The organizational structure includes a fire emergency response command center directing room fire response teams (red, yellow, blue, white teams), communication team, maintenance team, medical team (medical services, nursing), and security team.
D	Who are the members of the emergency response team during a fire?	Informant 1: "There are medical teams identified by red, white, blue, and yellow helmets, the Maintenance team ensures power is cut off and hydrant pumps are running, the Communication team informs code red and contacts the nearest Fire Department, and the Security team assists with fire extinguishing and evacuation."	
E	Who determines the members of the emergency response team?	Informant 2: "The K3RS Team." Informant 3: "Probably K3RS, not sure." Informant 4: "K3RS." Informant 5: "K3RS, yes."	The K3RS team approves the selection of emergency response team members.
F	Do all emergency response team members have the skills to handle emergencies?	Informant 1: "Yes, all employees, not just the team, are taught theory on how to use APAR and conduct evacuation drills annually. New employees receive initial theoretical training, followed by annual practical simulations."	Annual training and simulations on the use of APAR and evacuation procedures are conducted, covering both theoretical knowledge and practical drills.
G	Is there certification for the	Informant 1: "Yes, there is certification data. There are 29	There are Level D and C fire response certifications

	hospital's emergency response team?	employees certified in fire response, 7 of whom no longer work here, leaving 22 certified employees."	from the Ministry of Manpower of the Republic of Indonesia for 29 employees at RS X.
H	Do you know your duties as a team member during a fire emergency?	Informant 2: "From Kesling, the task is to assist with evacuation." Informant 3: "Yes, if a fire occurs, we go to the site to help extinguish the fire using APAR/Hydrant. Those on standby outside assist with evacuation routes." Informant 4: "We go to utility areas to ensure hydrant pumps are running, and power is cut off. Maintenance assists with evacuating those trapped."	
I	Is the emergency response team task information updated with each shift change?	Informant 5: "Yes, every shift change, the room coordinator assigns roles for red, yellow, white, and blue helmets, which are recorded on the duty board."	Observation Results: It was found that emergency response team boards were not updated in several locations, including the Nurse Station in the Poli, Pharmacy on the 1st floor, and the Nutrition Room.

Hospital X Batam employs 650 staff, with 29 certified in fire response, while 7 employees have resigned. Hospital X Batam has a stipulation in the health department for an emergency response team task board that is updated according to employee shifts.

According to the Decree of the Minister of Manpower of the Republic of Indonesia No.Kep.186/Men/1999 regarding Fire Response Units at the Workplace, Article 3 states, "The establishment of a fire response unit as referred to in Article 2, paragraph (1) must consider the number of workers and/or the classification of fire hazard potential." "The fire response unit consists of: Fire role officers; Fire response teams; Coordinators of the fire response unit; Occupational health and safety experts specializing in fire response as technical supervisors." Article 6 states, "Fire role officers must be at least 2 (two) for every 25 (twenty-five) workers. The coordinator of the fire response unit is appointed as follows: For workplaces with light and moderate fire hazard risk levels, at least 1 (one) for every 100 (one hundred) workers."

In the health department of Hospital X Batam, it is stipulated that the emergency response team task board is adjusted according to employee shifts. In recent months, the Nutrition, Pharmacy on the first floor, and Nurse Station rooms have not updated their information. The K3RS team must ensure that rooms without an updated fire emergency response team task board are revised so that employee coordinators are not confused in the event of a fire. Hospital X is categorized as having a low fire hazard according to the Decree of the Minister of Manpower of the Republic of Indonesia No. Kep.186/Men/1999 concerning Fire Response Units. Hospital X has 650 employees and only 22 employees certified in categories "D" and "C" based on Low Fire Hazard Risk Classification. There are no certified "B" and "A" category employees, and the number of certified "D" category employees still falls short of requirements. For employees in categories "A, B, and D," Hospital X can conduct fire response training in accordance with applicable regulations.

Training and Evacuation

Table 3. Summary of Fire Emergency Preparedness and Response Measures at RS X

No	Question	Answer	Document Review
A	How often is fire emergency response training conducted annually?	Informant 2: "We conduct training once a year." Informant 3: "Overall, it's annually, but security has monthly training sessions held by the team leader to ensure they don't forget how to use APAR, Hydrant, and patient mobilization." Informant 4: "Once a year." Informant 5: "Once a year."	New employees receive theoretical training, and simulations are conducted annually, with certification provided by the hospital management.
B	What is practiced during fire emergency response training?	Informant 2: "APAR usage, hydrant usage, and evacuation." Informant 3: "APAR, Hydrant, and fire blanket usage." Informant 4: "APAR and Hydrant." Informant 5: "As far as I know, it's APAR and Hydrant."	Training includes the use of APAR, Hydrant, and fire blankets during fire simulations.
C	Are there emergency exits in RS X? Are they easily accessible to the public?	Informant 1: "Yes, each floor has an emergency exit. Once inside, you cannot re-enter as the door locks automatically to prevent re-entry during emergencies." Informant 2: "There are emergency exits on each floor, both left and right." Informant 3: "Yes, I frequently check around." Informant 4: "Each floor has an easily accessible emergency exit." Informant 5: "Every room has an emergency exit."	
D	Do the installation of emergency doors and stairs comply with regulations?	Informant 1: "Yes, although our emergency stairs do not meet the regulatory requirements based on my last count."	Observation Results: Emergency doors and stairs do not meet the standards set by the Minister of Health Regulation No. 48 of 2016 on Occupational Health and Safety Standards for Office Buildings.
E	Are there signs directing visitors and staff to emergency exits?	Informant 2: "Yes." Informant 3: "There are directions during a fire emergency." Informant 4: "There is an EXIT sign before each emergency door, clearly visible and accessible to the public." Informant 5: "Yes, EXIT signs provide direction."	
F	Are emergency lights available	Informant 1: "We call them emergency lights; they are present at each nurse station, in every room,	

	throughout the hospital?	and along emergency stairs. They function independently of the power supply with backup batteries." Informant 2: "Yes." Informant 3: "Yes." Informant 4: "Yes." Informant 5: "Yes."	
G	How are patients who cannot protect themselves evacuated?	Informant 1: "We divide individuals into four groups during an emergency: Group 1 includes ambulatory patients, directed to emergency stairs with team assistance. Group 2 consists of conscious but non-ambulatory patients needing stretchers, carried by at least four people. Group 3 covers critical care patients needing additional support, such as oxygen. Group 4 includes DNR/deceased individuals, evacuated last."	Documentation exists detailing evacuation procedures divided into four groups.

Hospital X Batam provides fire training theory to all new employees. Additionally, Hospital X conducts fire extinguishing simulation drills every year, usually held in December. Hospital X also performs patient evacuation simulations in various rooms at different times. The stairs and emergency exits in the evacuation routes of Hospital X Batam do not meet applicable standard requirements.

In the installation of emergency stairs and exits at Hospital X Batam, based on measurement and observation results, it still does not meet the applicable standard requirements, such as handrails with a height of 95 cm, emergency exit doors only 85 cm wide, lack of warning signs stating: "EMERGENCY EXIT - CLOSE AGAIN," and fire-resistant glass (maximum 1 m^2) placed in the upper half of the emergency door. The emergency exit doors are not painted red.

Conclusion

Hospital X Batam has an emergency response team; however, the number of employees certified as part of the emergency response team does not meet the regulatory requirements. The emergency response team has a ticket board procedure aimed at updating the team's duties according to employee shift changes.

Hospital X Batam conducts patient evacuation simulations and fire extinguisher training annually. New employees are also trained in fire extinguisher theory. However, the evacuation routes on the stairs and emergency exits are not installed according to applicable standards. The height of the handrail is not compliant (95 cm), the width of the emergency exit door does not meet the standard (85 cm), there are no warning signs on the emergency exit door, the placement of fire-resistant glass is not compliant, and the emergency exit door has not been painted red. This situation indicates that the hospital's evacuation facilities do not meet safety requirements and need to be repaired according to applicable standards. Hospital X Batam has a sufficient number of fire extinguishers, sprinklers, and smoke detectors. However, the periodic inspections of fire extinguishers and detectors, which are required to be conducted monthly, have not been fully carried out uniformly. The installation of fire extinguishers does not comply with regulations, particularly regarding the distance between extinguishers exceeding 15 meters.

Based on the results obtained, there are several recommendations to be considered for future improvements:

The Occupational Health and Safety Team (K3RS) should take immediate corrective actions to ensure the safety and readiness of the emergency response team in accordance with the regulations set forth in the Minister of Manpower Decree No. Kep.186/Men/1999. These steps include increasing the number of employees receiving fire safety certification, monitoring updates on the emergency response team duty board in health facilities, and providing specialized training for employees in categories "A, B, and D." By implementing these changes, Hospital X Batam can ensure compliance with fire safety standards and improve responses to emergency situations.

The K3RS team can discuss with management the need to repaint all emergency exit doors red, replace doors and handrails in accordance with the Regulation of the Minister of Health of the Republic of Indonesia No. 48 of 2016, and conduct fire safety management theory refreshers every few months to prevent lapses in memory during a fire event. As considerations and input for the Hospital, it is recommended to improve the installation of fire extinguishers in accordance with regulatory requirements, enhance periodic inspections, and pay attention to rooms that may have been overlooked during monthly checks. To reduce fire risks, it may also be necessary to add fire extinguishers or decrease the distance between them.

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