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Medical Technology and Public Health Journal

Journal Home Page: https://journal2.unusa.ac.id/index.php/MTPHJ

Research Article

Modelling Fire Protection System Implementation in the Esa Hotel

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DOI: *10.33086/mtphj.v10i2.6560*

Article History:
Received, January 5th, 2025
Revised, January 21th, 2026
Accepted, February 18th, 2026
Available Online: September 9nd, 2026

Please cite this article as:
Diannita, Rindang, et. al., "Modelling Fire Protection System Implementation in the Esa Hotel" Register: Medical Technology and Public Health Journal, Vol. 10, No. 2, pp. 148-160, 2026

ABSTRACT

One of the potential hazards that often occur in houses and buildings is fire. One of the problems in hotels is that there are non-permanent residents who carry out various activities in the hotel for up to twenty-four hours, one of which is the Esa Hotel which has many facilities and rooms that have a risk of fire. The type of research used is a qualitative method, with the approach used in this study being descriptive quantitative. The results of the study showed that the active protection system had an average percentage value of 18%. The passive fire protection system had an average percentage value of 16%. The conclusion of the implementation of active and passive fire protection systems at the Esa Hotel is included in the "not enough" category with an overall percentage value of 24%. The level of implementation of the active protection system based on 18% is included in the "not enough" category. which consists of fire detectors, fire alarms, sprinklers, fire extinguishers and hydrants. The level of implementation of the passive protection system with a percentage of 16% is included in the "not enough" category which consists of fire-resistant door construction, fire-resistant and fire-resistant windows, interior coating materials, fire-resistant partitions, smoke barriers, and atriums.

Keywords*: Fire Protection System, Fire Implementation Model, Hotel*

INTRODUCTION

One of the potential dangers that often occurs in houses and buildings is fire. The potential danger of fire requires special attention and has become quite a serious threat, especially in multi-storey buildings. The potential for fires can occur anywhere and at any time because there are many factors that trigger fires (Harianja, et al. 2020). Fire is a danger that has a very broad impact, especially social and economic impacts, so it is necessary to be prepared to deal with fires.. Fire data in Indonesia collected by the National Disaster Management Agency from 2011 to 2015 included 979 fire incidents and 31 of them were fires in factory buildings, offices, school buildings and hotels. Meanwhile in the city of Ponorogo, according to data from the 2020. Communications, Informatics and Statistics Service, there were 43 fire incidents that occurred in industry, 0.3%, forests 0%, land 0.9%, housing and hotels 2%.

According to the National Fire Protection Association (NFPA), fires in tall buildings such as hotels tend to spread from outside the room and the floor where the fire occurred. This is because multi-storey buildings tend to have many occupants and are far from the main exit. Multi-storey buildings have diverse occupant characteristics, the spread of danger is relatively fast, limited access, limited outside assistance and lots of flammable materials so fires spread easily. The most common causes of fires are human and technical factors. Humans often neglect security and safety procedures at work. Light Fire Extinguishert from that, the technical aspects of building multi-storey buildings must be in accordance with the design and still implement work safety.

Multi-storey buildings are grouped into several types, one of which is hotels as temporary residences. A hotel has a variety of residents ranging from young people to adults, with varying physical conditions, health, education, work and different knowledge about fire. The problem that arises in a hotel is that there are non-permanent residents who carry out activities in the hotel. 50% of the causes of fires in hotels are caused by cooking activities, 9% are caused by heating of equipment, and 8% are caused by clothes dryers. Hotel fires have occurred in Indonesia due to electrical short circuits, such as the Mid Plaza Hotel in Jakarta, the Novita Hotel in Jambi, the Tasia Ratu Hotel in Pekanbaru, and the Central Jakarta Media Hotel in Jakarta.

The research that has been conducted obtained results in the form of an active fire protection system at the Fire Department Post in Depok of 18% with a percentage of life-saving facilities of 15.78%. The results of the study show that the level of active fire protection is still lacking and does not comply with applicable regulations. Previous research also found that efforts to prevent and handle forest fires consist of two steps, namely prevention of forest and land fires and their handling. Inhibiting factors include human resources, budget, facilities and infrastructure. Previous research also obtained the results of calculating the value of utility components at the Yogyakarta State University hotel with a Building Safety System Condition Value with a percentage of 91.60%. This shows that the building is in good condition and is included in accordance with applicable provisions. One effort that can be made to reduce the risk of work accidents, occupational diseases, and reduce disasters in the workplace is by being aware of the importance of occupational safety and health (Diannita, 2022).

Survey at the Esa Hotel is the only hotel with narrow road access so that it has the potential for fire, where on the right and left sides of the hotel entrance there are walls so that the hotel entrance resembles an alley (Figure.1). This makes access for firefighters very difficult because the road facilities are not wide enough, in addition to the inadequate fire protection system and not being implemented properly, the location of the building is difficult to reach and the trees around the hotel, which have a high potential for fire, Here is the location of the Esa Hotel from the front and seen using maps:

Figure.1 Location of the Esa Hotel

Risks that can occur at the Esa Hotel include sources of fire when customers or restaurants cook from the stove and guests staying in rooms specifically for smoking. This is a potential danger and can cause a fire. The active fire protection system provided is in the form of a light fire

extinguisher, however some of the equipment does not meet standards and is out of date, there are no hydrants, and the gathering point has been used as a parking area.

MATERIAL AND METHODS

Research Design in this study employed a qualitative research design with a descriptive quantitative approach. The qualitative approach was used to explore in depth the implementation of fire protection systems at the Esa Hotel, while the quantitative descriptive approach was applied to measure the level of compliance of each fire protection component using percentage scores.

Study Location and Object in the research was conducted at Esa Hotel, a multi-storey hotel building located in Ponorogo, Indonesia. The object of the study was the implementation of fire protection systems, which include:

1. Active fire protection systems
2. Passive fire protection systems
3. Life-saving facilities

Data Collection Techniques is data were collected using the following methods at the Esa Hotel, Ponorogo:

1. Observation

Direct field observations were conducted to assess the availability, condition, placement, and functionality of fire protection components. Observations were guided by a structured checklist developed based on:

a. Regulation of the Minister of Public Works No. 26 of 2008
b. Relevant Indonesian National Standards (SNI) related to fire protection systems

2. Interviews

Semi-structured interviews were conducted to obtain supporting qualitative information related to fire protection implementation, maintenance practices, and constraints. Informants were selected using purposive sampling, consisting:

a. Hotel manager
b. Hotel technician
c. Hotel security personnel

These informants were chosen because they are directly responsible for building safety and fire protection systems.

3. Document Review

Supporting documents such as building layout information and fire safety-related records were reviewed to complement observation and interview data.

Research Instruments

The main research instrument was an observation assessment checklist containing indicators for each fire protection system component. Each indicator was assessed based on compliance with applicable regulations and standards, and classified as:

1. Implemented
2. Not implemented
3. Data Analysis

Data analysis was conducted in several stages:

1. Scoring of Each Indicator: Each fire protection indicator was assessed and assigned a score based on its compliance with applicable standards.
2. Percentage Calculation: The level of implementation for each system component was -

$$i = \frac{\text{Total score obtained}}{\text{Maximum possible score}} \times 100\%$$

Information:
i = average percentage value of each fire protection system (active, passive, or life-saving facilities)

3. Overall Fire Protection System Calculation
4. Lack of active protection system components, most of which do not function properly and have capacities far below the provisions. The percentage of each known component can be calculated by calculating the average compliance for active, passive protection systems and life- saving means. The overall implementation level of the fire protection system was calculated using:

$$Y = \frac{X1 + X2 + X3}{N}$$

Information:
Y = average value of fire protection system implementation
X_1 = average percentage of active fire protection system
X_2 = average percentage of passive fire protection system
X_3 = average percentage of life-saving facilities
N = number of system categories assessed

5. Categorization of Implementation Level

The results were classified according to the criteria issued by the Ministry of Public Works (2005). After obtaining the average value for each component of the active, passive protection system and life-saving means, it can be categorized according to Table 1.

Table 1. Implementation Level Category

Value	Category	Information
>80% - 100%	Good	The fire protection system components as a whole function well and their capacity complies with the provisions
60% - 80%	Enough	Most of the components of the fire protection system can be used and function well, but a small number of others function poorly or the fire protection system has a capacity that is less than the applicable regulations and provisions
<60%	Not Enough	Most of the active protection system components do not function properly and have capacities far below the provisions.

Source: (Ministry of Public Works, 2005)

RESULT AND DISCUSSION

RESULT

The implementation and provision of standard operational procedures related to fire at the Esa Hotel began to improve. and with several obstacles there are several components of the fire protection system that have not been implemented. The following are the results of observations and interviews of the Esa Hotel fire protection system:

a) **Active Protection System**

The following are the results of research related to the implementation of an active fire protection system at the Esa Hotel:

Table 2. Points of Implementing the Active Protection System at the Esa Hotel

No	Indicator	Criteria		Information
		Applied	Not Implemented	
1.	Fire Detector		6	The result is 6 points and all of them are not applied
2.	Fire Alarm		7	The result is 7 points and all of them are not applied
3.	Sprinkler		10	The result is 10 points and all of them are not applied
4.	Light Fire Extinguisher	10	1	The result of 11 points, 10 points according to what has been applied according to the standards
5.	Hydrant		8	Result of 8 points and all of them are not implemented

Source: Primary Data, 2025

Based on the research results, there are several factors underlying why the active fire protection system at the Esa Hotel is not implemented:

a. Fire detector

The results of interviews conducted by researchers indicate that the fire protection system of the fire detector indicator is known to have not been installed at the Esa Hotel because the walls and ceilings are made of concrete so that it is not possible to install it.

b. Fire alarm

The results of interviews conducted by researchers indicate that the fire protection system of the fire alarm indicator has not been implemented because it has not been implemented from the beginning of construction and if a fire occurs we give responsibility to the Housekeeping section to go around the hotel area and the security section in the area outside the hotel to notify hotel guests. because every day there is a shift schedule so it is easier.

c. Sprinkler

The results of interviews conducted by researchers indicate that the fire protection system from the sprinkler indicator does not exist and has not been implemented from the beginning of hotel construction.

d. Light Fire Extinguisher

The results of interviews conducted by researchers indicate that the fire protection system from the light fire extinguisher indicator has been implemented, there are 7 light fire extinguishers spread throughout the hotel area (6 light fire extinguishers of the dry chemical powder type, 1 light fire extinguisher of the fire block type). For this type of fire block light fire extinguisher, it is a type of throwing light fire extinguisher to stop the spreading fire. The location of the light fire extinguisher placement is very strategic and easily visible, 1 light fire extinguisher in the kitchen and laundry, 3 light fire extinguisher in the corridor, 2 light fire extinguisher at the security post. Light fire extinguisher is inspected manually and maintenance and inspection of the light fire extinguisher is carried out by the fire department.

e. Hydrant

The results of interviews conducted by researchers showed that the fire protection system

from the hydrant indicator does not exist and has not been implemented, there are only a few taps placed in several places as a water source.

The following are the percentage results of the implementation of active fire protection systems at the Esa Hotel:

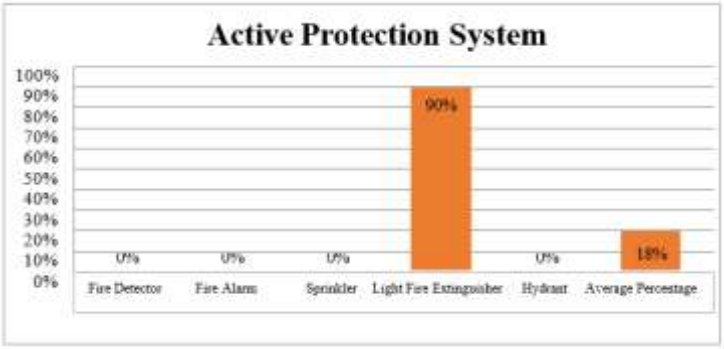

Figure 2. Active Protection System at the Esa Hotel
Source: Primary Data, 2025

Based on the diagram above, there are observation results, the active protection system implemented at the esa hotel is only light fire extinguisher and other indicators have not been implemented. after observing the inspection criteria, the results of the study showed that the fire detector, fire alarm, sprinkler and hydrant indicators obtained a score of 0%, while light fire extinguisher obtained a score of 90% and an average percentage score of 18% was obtained.

b) **Passive Protection System at The Esa Hotel**

The following are the results of research related to the implementation of passive fire protection systems at the Esa Hotel:

Table 3. Points of Implementing the passive fire protection at the Esa Hotel

NoIndicator	Criteria		Information
	Applied	Not Implemented	
1. Fire-resistant construction	2	2	Result of 4 points, 2 points applied and 2 points not applied
2. Fire-resistant doors and windows		3	Result of 3 points and all not applied
3. Interior cladding materials		1	Result of 1 point and all not applied
4. Fire barriers	1	1	Result of 2 points, 1 point applied and 1 point not applied
5. Smoke barrier partitions		2	Result of 2 points and all not applied
6. Atriums		1	Result of 1 point and all not applied

Source: Primary Data, 2025

Based on the research results, there are several factors underlying why the passive fire protection system at the Esa Hotel is not implemented:

a. Fire-resistant construction

The results of interviews conducted by researchers indicate that the fire protection system

from the fire-resistant construction indicator that the building wall construction is made of concrete or cast and the roof is made of gypsum.

b. Fire-resistant doors and windows

The results of interviews conducted by researchers indicate that it is known that there are no fire-resistant doors and windows in the Esa Hotel. and there are only doors made of wood and glass, for windows made of stainless steel and are not fire-resistant.

c. Interior coating materials

The results of interviews conducted by researchers indicate that the fire protection system from the interior coating material indicator is known that the coating used in the Esa Hotel is varnish on furniture made of wood and paint on the walls.

d. Fire barriers

The results of interviews conducted by researchers indicate that the fire protection system from the results of the study that it is known that there are no fire barriers.

e. Immediate barrier partitions

The results of interviews conducted by researchers indicate that the fire protection system from the results of the study that it is known that there are no smoke barrier partitions and there is only ventilation in the air ducts.

f. Atrium

The results of interviews conducted by researchers indicate that the fire protection system from the research results shows that there is no known atrium.

After carrying out an analysis regarding the fire protection system at the Esa Hotel these results are included in the "not enough" category, according to the Ministry of Public Works category in table 1.

The following are the percentage results of the implementation of passive fire protection systems at the Esa Hotel:

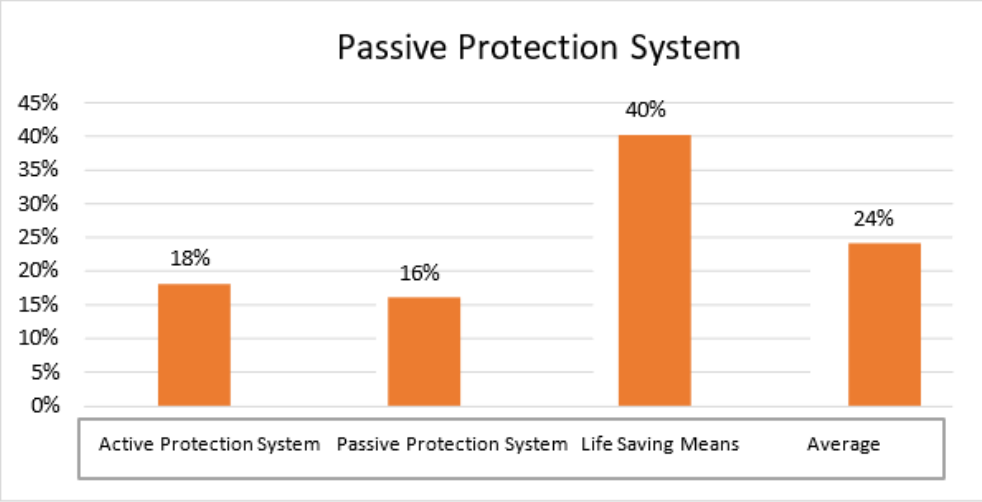

Figure 3. Passive Protection System at the Esa Hotel
Source: Primary Data, 2025

In the diagram above, there are observation results, it is known that the fire protection system at the Esa Hotel. Procurement and installation of equipment that has not been implemented can be carried out according to the terms and conditions of each unit which are implemented according to the standards of the Regulation of the Minister of Public Works Number 26 of 2008 Concerning fire protection systems, namely fire detection systems.

DISCUSSION

Fire Detector

Based on the Regulation of the Minister of Public Works Number 26 of 2008, the fire detection system and communication system installed using alternatives permitted in the technical requirements. The results of the study showed that at the Esa Hotel there was no fire detector applied. Therefore, it is necessary to apply a fire detector as a form of fire disaster prevention. The standard for applying a fire detector according to the Indonesian National Standard 03-3985-2000 is as follows: (1) The detector must be protected from possible mechanical damage, (2) The detector must not be installed by being embedded in the ceiling surface, (3) The detector must be easily accessible so that it is easy to maintain and test, (4) Testing and maintenance must be carried out, (5) Records of the results of the examination are kept for five years for checking purposes (Minister of Manpower, 1983).

The results of the study showed that at the Esa Hotel there was no fire alarm applied. Therefore, it is necessary to apply a fire alarm as a form of fire disaster prevention. This is in accordance with the Regulation of the Minister of Manpower Number 02 of 1983 concerning the installation of automatic fire alarms. The fire alarm requirements are as follows: (a) Each alarm is equipped with an alarm indicator in the form of a red light, (b) Each fire alarm system has a complete installation drawing, (c) Each floor must have its own alarm group, (d) The power source for the fire alarm system must not have an electrical voltage of less than 6 volts, (e) Each alarm system must be equipped with at least 1 siren, (f) Periodic maintenance and testing must be carried out every week, month, and year.The location of the fire detector greatly determines the efficiency of time and energy when a fire occurs. Smoke detectors are usually installed on the ceiling or about 10-30 cm below, while heat and flame detectors should be placed according to their type. This is in accordance with the Regulation of the Minister of Manpower in article 3 which states that (Regulation of the Minister of Manpower, 1983).

Sprinklers

Based on the Regulation of the Minister of Public Works Number 26 of 2008, all high-rise buildings, except those with guest rooms or guest rooms that have access to the outside according to the exterior access road, must be fully protected with a sprinkler system. The results of the study showed that at the Esa Hotel there were no sprinklers applied. Therefore, it is necessary to apply sprinklers as a form of fire disaster prevention. The requirements for installing sprinklers according to Indonesian National Standard 03-3989-2000 are as follows: (1) Each sprinkler system must have at least one pressurized and automatic water source and have sufficient capacity, (b) The water used by the sprinkler does not contain fibers and other dirt, (c) The sprinkler water source must be sufficient to flow water with a capacity of 225 liters/minute and a pressure of 2.2 kg/cm2, (d) The distance between two sprinkler heads is at least 2 meters, (e) The pipes used must meet the requirements, (f) Sprinklers must be corrosion resistant, (g) The maximum number of sprinkler heads on one valve is 500, (h) Spare sprinkler heads and keys are stored in a special box with a room temperature of ≥ 38oC, (i) Spare sprinkler heads are 6, (j) Sprinklers are not coated with paint except for color coating.

The location of the fire sprinkler is installed on the upper ceiling to provide an optimal coverage of the spraying process. The maximum distance between sprinklers is 4.6 meters, the distance from wall to wall should not exceed 2.3 meters for a light hazard system, and 2 meters for a medium or heavy hazard system. The installation height should not be more than 12 inches from the ceiling and should not be closer than 1 inch, for the direction of the spray installed with the

direction of the spray downward. While for special placement areas such as warehouses with tiered shelves, special sprinklers (in-rack sprinklers) are required to be able to reach the fire between the shelves, and placement in open spaces, namely sprinklers to the open side should not be more than 1.5 meters (Djafar et al., 2022).

Light Fire Extinguisher

According to the Regulation of the Minister of Public Works Number 26 of 2008, the classification of Light Fire Extinguishers must consist of a classification indicating the class of fire in which the Light Fire Extinguisher is proven effective, preceded by a classification (only class A classification and class B classification) indicating the relative extinguishing effectiveness. Light Fire Extinguishers classified as class C, class D, or other fire hazards are not required to have a number preceding the classification.

Based on the results of research at the Esa Hotel in the laundry section, there are 2 Light Fire Extinguishers on the 2nd floor, 1 Light Fire Extinguisher on the 1st floor and 1 Light Fire Extinguisher in the security section and 1 fire block or commonly called a Throwing Light Fire Extinguisher which functions to prevent fire from spreading. The requirements for Light Fire Extinguishers according to the Minister of Manpower Regulation are as follows Light Fire Extinguishers are placed in a position that is easily visible. Occupational safety and health is one form of effort to reduce the risk of hazards in the workplace and work accidents (Diannita et al., 2022).

The location of the placement of the portable fire extinguisher is placed in a place that is easily accessible, clearly visible, and not obstructed by other objects, mounted on the wall at a distance of 125 cm from the floor or at least 15 cm from the floor. The distance between one fire extinguishers and another should not be more than 15 meters. Portable fire extinguishers should be easily accessible and visible, especially on evacuation routes or near exits, not obstructed by tables, chairs, furniture, boxes, or other objects that could block access. For the height of the installation of portable fire extinguishers, it should be at a height of 125 cm from the floor, but at least 15 cm from the floor. While the distance between one and another should not exceed 15 meters. For markers, clear and standard signs must be given, right above the portable fire extinguisher. Related to room temperature, it should not be placed in a room with a temperature exceeding 49 degrees Celsius or less than -44 degrees Celsius, except for portable fire extinguishers that are specifically designed for extreme temperatures. And for protection, portable fire extinguishers outdoors must be protected with a safety cover (Ministry of Manpower of the Republic of Indonesia, 1980).

Hydrant

According to Regulation of the Minister of Public Works Number 26 of 2008 Concerning Fire Protection Systems, every building must be equipped with a fire extinguishing system which includes, among other things, a hydrant pipe system, hydrant pumps and equipment.

The results of the research show that there are no hydarns installed at Esa Hotel and only water taps are installed in several places. So it is necessary to implement hydrants as a form of preventing fire disasters. The technical requirements for hydrants are regulated in Indonesian National Standard 03-1745-2000 as follows: (1) Place hydrants in a yard that is easily accessible to fire trucks, (2) Distance between hydrant and fire engine ≥ 50 m, (3) Hydrant water is supplied at a minimum of 38 L/second with a pressure of 3.5 bar within 30 minutes, (4) The connection between the hydrant box and the hose must not be obstructed and be located ≥ 0.9 m or ≥ 1.5 m above the floor surface, (5) A floor area of 1000 m2 has a minimum of 1 hydrant point, (6) The minimum length of the

hydrant hose is 30 m, (7) The hydrant box consists of hose nozzles, hose racks, and hose valves, (8) Hydrants in the yard must be inspected every year.

Design of fire handling system, installation of fire hydrants, building location, water requirement, with optimal distance between hydrants for fire handling, use of fire hose, and the existence of safety signs, namely evacuation routes in accordance with regulations, must be taken into account to increase awareness and preparedness for fire in relation to anticipation of fire extinguishing.

Implementation of Fire Protection System in the Esa Hotel

Based on the research results above, the recommendation given is to conduct modeling on densely populated buildings with a concept that is in accordance with the Regulation Minister of Public Works with the provision that there is a fire resistant building pavement layer with a height of 6 meter, a left side width of 10 meter, a middle side of 4 meter and a right side of 10 meter. The following are recommendations for fire protection systems available:

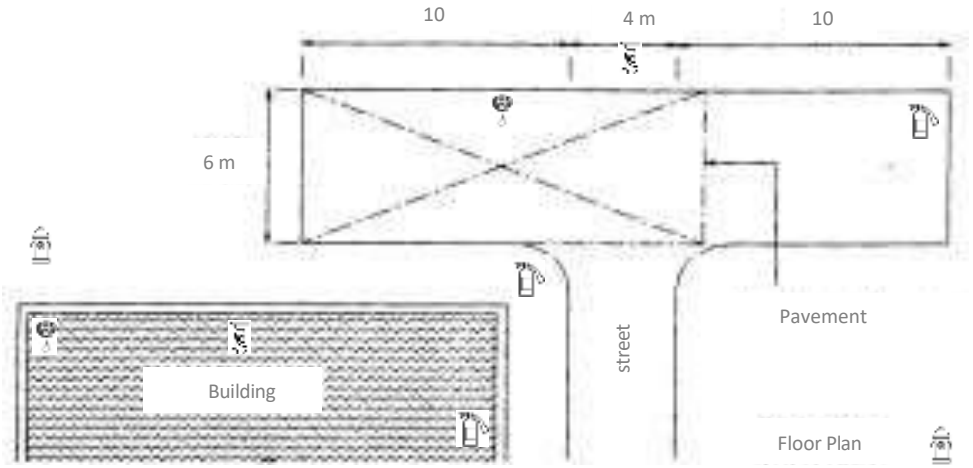

Figure. 4 Recommendation Implementation of Fire Protection System in the Esa Hotel

Based on the management of the Esa Hotel building, the implementation weight of all fire protection system functions, with the best and worst installations that have been observed on the risk of fire prevention and safety of occupants in the hotel. These results were found and became a reinforcement of several previous studies. As one of the service industries, hotel buildings must provide the best service facilities to customers, and fire protection system equipment facilities owned by the hotel.

Fires can be anticipated in various ways, such as extinguishing the fire using a Light Fire Extinguisher, mapping the area, other efforts so that the fire does not get bigger and cause a lot of losses, both in terms of property and losses in the form of physical disability or loss due to death. One of the efforts to reduce the risk of work accidents and work-related diseases is awareness of the importance of worker safety and health (Diannita, 2020). High-rise buildings are triggered by the high cost of hotel construction, high-rise buildings also have the consequence of fire risk. This shows that mitigation needs to be done, to anticipate fires, because the furniture and characteristics of high-rise buildings are flammable. To anticipate this condition, fire safety protection in high-rise buildings must be reliable (Nugroho et al., 2022).

CONCLUSION AND SUGGESTION

The level of implementation of the fire protection system at the Esa Hotel scored 24% and

was included in the "not enough" category. The level of implementation of the active protection system based on 18% is included in the "not enough" category. consisting of fire detectors, fire alarms, sprinklers, fire extinguishers and hydrants, and the level of implementation of the passive protection system with a percentage of 16% is included in the "not enough" category, consisting of fire-resistant door construction, fire-resistant, and fire-resistant windows, interior coating materials, fire partitions, smoke barriers, and atriums.

Suggestions for the Esa Hotel should improve and fulfill the fire protection system and pay more attention to the safety and health aspects of the hotel environment. Suggestions for the government, should ensure that for operational permits for hotel businesses or Tourism Business Registration Certificates that hotels have met the requirements and standards set by the government regarding legality, operations, facilities, and security aspects and conduct monitoring and evaluation every year.

ACKNOWLEDGEMENT

Many thanks to Universitas Darussalam Gontor colleagues who have helped in completing this research and thanks for the Esa Hotel.

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