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Reliability Level Evaluation of Passive Fire Protection System in Hospital Buildings (Case Study: Grandmed Lubuk Pakam Hospital)

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Abstract. This research focuses only on passive fire protection systems in-hospital buildings because the Hospital is public buildings that many people use as facilities for health needs. Hospital residents are not only healthy people, but most sick people are not able to save themselves because of that the building safety system must be reliable especially fire protection systems. This study uses descriptive analysis method by checking directly in the field against the variables that have determined and then analyzed, based on the weight of the AHP method after that each variable and sub-variable will be assessed with a Likert scale according to its suitability with regulations and standards, then weights will be multiplied by the value of conformity to get the reliability value. The results are the level of reliability of the building fire passive protection system 2,250 it includes which in the category enough. This is to increase the value of the level of reliability, it must fulfill the design guidelines in the form of standards.

Keyword: evaluation, fire protection, hospital, the reliability level

1. Introduction

Fires can occur in various places such as forests, residential environments, and also buildings, namely markets, schools, libraries, terminals, shopping centers, offices, and hospitals. In buildings, there are management and fire protection systems that can rely on to prevent and overcome fire hazards. It can group fire protection systems into two parts, namely active and passive protection systems [1]. Fire active protection system is a fire protection system which comprises a complete manual or automatic fire detection system while a passive fire protection system is a fire protection system that formed or built through regulating the use of building structures and components, compartmentalization or building separators based on fire resistance, and protection against openings [2].

Hospital buildings are public facilities that used daily in a large population. The hospital is a building that must get attention in the matter of fire prevention and control, which some of its inhabitants are sick people who cannot afford to do self-rescue. The act of Republic of

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Indonesia No. 44 of 2009, concerning "Hospital," states that the need for technical requirements relating to "fire prevention and control." The fire protection system in the hospital must be reliable, especially the passive protection system. Therefore this study aims to identify and find out how reliable the application of the passive fire protection system in the hospital. We only focus this research on passive protection systems and life-saving facilities based on Planning Procedures for Passive Protection Systems for Fire Hazard Prevention in Building Buildings Based on standards and regulations relating to passive fire protection systems.

2. Literature Review

According to the Ministry of Public Works No.10 of 2000, the function of this passive protection system is to create stability in the construction structure of buildings during fires and provide protection against the spread of fires. The passive fire protection system is the ability of structural and element stability, fireproof construction, compartmentalization, and separation, and protection at existing openings to withstand and limit the speed of fire and smoke fire propagation [3]. The passive fire protection system is a fire protection system that formed or built through regulation of the use of materials and components of building structures, compartmentalization or separation of buildings based on the level of fire resistance and protection against an aperture [2].

The minimum criteria for designing a passive protection system must meet the standards set out in the Planning Procedures for Passive Protection Systems for Fire Hazard Prevention in House Buildings and Building [4]. The passive fire protection system includes 1. Buildings fireproof are Construction, Building Materials 2. Life-Saving Equipment is Signboard, Emergency Door, Emergency Stairs, Emergency Lights, Evacuation Route, Ram, Assembly Points.

3. Method

This research method is a descriptive method by conducting field observation and evaluation and collecting secondary data on the literature review of references, standards, and regulations related to the passive fire protection system of hospital buildings and by using the checklist to get primary data. The results got will analyze for its suitability to standards and regulations. Then the data processed to find out the hierarchy and weighting of each variable and sub-variable using the AHP method with the help of the Expert-choice application. Next is assessing each variable based on the completeness of the passive fire protection system components in the building. It modifies this assessment scale from the Likert scale theory, where the criteria for assessment determined by the number of categories used in this study. We divide the existing passive protection system rating scoring categories into four[5], (Table1).

Table 1. Rating Scale Components of Passive Fire Protection Systems

No.	Value of sub-variable availability in case studies	Explanation
1.	1	There is no component of a passive fire protection system that meets the standards
2.	2	There are several components of a passive fire protection system that do not meet the standards
3.	3	There are several components of a passive fire protection system that meet the standard
4.	4	All components of a passive fire protection system are standard

Reliability values obtained by multiplying the weights with the values set for each sub-variable. Then each value got from each sub-variable will add to get the final value of the reliability of the passive fire protection system. The reliability value of a passive fire protection system determined based on a Likert scale we determine whose value based on how many categories, in determining this category there are five assessments namely terrible, bad enough, good enough and excellent. Where the value set 0 - 4 and of each interval is rounding the middle value of the number of categories (Table 2).

Table 2. Reliability of Passive Fire Protection System

No.	The reliability value of a passive fire protection system	Explanation
1.	$0,5 \leq x \leq 1$	Terrible
2.	$1 \leq x \leq 1,5$	Bad
3.	$1,5 \leq x \leq 2$	Enough
4.	$2,5 \leq x \leq 3$	Good enough
5.	$3 \leq x \leq 3,5$	Good
6.	$3,5 \leq x \leq 4$	Excellent

4. Results and Discussion

This hospital building is a class B based on the classification of the Ministry of Health RI No. 986/Menkes/Per/11/1992.Based on the fire resistance construction in the class of this hospital building included in type A fire construction, which is a fire-resistant construction can withstand structural loads. It reinforces the construction used concrete construction with a column thickness of 40 cm which is fire resistant for 3 hours and able to withstand structural loads. This building uses a material that is non-flammable fire-resistant.

Variable Proportion and Sub-Variable Hospital Passive Fire Protection System. The proportion of each component is in the hierarchy arrangement (Table 3).

Table 3. Components Proportions of Building Passive Fire Protection Systems

Components of Passive Fire Protection System Building	Proportion
Life-saving equipment (0,750)	
Evacuation Route	0,308
Emergency Stairs	0,159
Emergency Lights	0,152
Ram	0,122
Signboard	0,103
Assembly Points	0,082
Emergency Doors	0,074

Buildings (0,250)	
Fireproof Construction	0,515
Building Materials	0,485

Variable and Sub-variable Assessment of Hospital Building Passive Fire Protection Systems. The following table evaluates the variables and sub-variables of the passive fire protection system of hospital buildings (Table 4).

Table 4. Component Assessment based on conformity with criteria

Criteria	Results	Score	Explanation
Life-saving Equipment		2	There are several components of a passive fire protection system that do not meet the standards.
Evacuation Route			
Corridors must be equipped with signs indicating the direction of the emergency door or exit direction.	Inappropriate		There are several components of a passive fire protection system that do not meet the standards.
Corridors must be free from items that can interfere with the smooth evacuation.	Appropriate	2	
The distance of each point in the corridor to the emergency door or the direction of exit cannot be more than 25m.	Appropriate		
Emergency Doors			
Each state-building that has more than three stories must have an emergency/rescue ladder min. 2 pieces with max. 30m (when using sprinkler max. 45 m).	Appropriate		There are several components of a passive fire protection system that do not meet the standards.
Made of material that is resistant to smoke.	Inappropriate	2	
Emergency/Rescue ladder should not be in a vertical circle, exit on the ground floor directly outside.	Inappropriate		
Emergency/rescue ladders must be able to withstand in min.2 hours	Inappropriate		
Emergency Lights			
There is no emergency lighting component.	Inappropriate	1	There is no component of a passive fire protection system that meets the standards.
Ramp			
The slope of the ramp in a building must not exceed 70º.	Appropriate		There are several components of a passive fire protection system that do not meet the standards.
The minimum width of the ram is 2.40 m with the security edge.	Inappropriate		
Bordes on the beginning or tip of ram must be free from flat so that it allows at least to rotate the wheelchair and patient bed, with a minimum size of 160 cm.	Inappropriate	2	
Signboard			
The writing must have the word 'exit' or another word which means the same.	Appropriate		There are several components of a passive fire protection system that do not meet the standards.
Placed in a location that is easy to read from all directions	Appropriate	2	
Must be equipped with artificial lighting with a reading distance of 30m.	Inappropriate		
Assembly Points			
There is no assembly place component	Inappropriate	1	There is no component of a passive fire protection system that meets the standards.
Emergency Door			
Open to the staircase except on the ground floor opening outwards	Inappropriate		There is no component of a passive fire protection system that meets the standards.
Must be equipped with fireproof glass with max.1m^2 and placed in the upper half of the door leaf.	Inappropriate	1	
Emergency doors must be fire resistant min. 2 hours.	Inappropriate		
Emergency doors must be equipped with an automatic cover.	Inappropriate		
Emergency doors must be equipped with warning signs.	Inappropriate		
Buildings		3	There are several components of a passive fire protection system that is standard.
Fireproof Construction			
Made of fire-resistant material.	Appropriate		There are several components of a passive fire protection system that is standard
It has a structural element that can withstand structural loads	Appropriate	3	
There is compartmentalization to prevent the spread of fire to and from the surrounding space.	Appropriate		
Building Materials			
Made of fire-resistant material.		3	There are several components of a passive fire protection system that is standard

Reliability Value of Hospital Building Passive Fire Protection Systems

After the value of each variable and sub-variable is obtained by its proportion multiplied by the value of each of its completeness based on the criteria that have been determined on the rating scale. Multiplying the proportion with the value of each sub-variable (Table 5).

Table 5. Number of proportion multiplication with sub-variable values

Passive fire protection system components of buildings	Score	Proportion	Total
Life-saving equipment (0,750)			
Evacuation Route	2	0,308	0,616
Emergency Stairs	2	0,159	0,318
Emergency lights	1	0,152	0,152
Ramp	2	0,122	0,244
Signboard	2	0,103	0,206
Assembly Points	1	0,082	0,082
Emergency doors	1	0,074	0,074
Total			1,692
Buildings (0,250)			
Fireproof Construction	3	0,515	1,545
Building Material	3	0,485	1,455
Total			3,000

From the results of the tabulation above obtained the value of the reliability level of each sub-variable of the passive fire protection system is (1) Life saving equipment with a reliability value of 1.692; (2) Buildings with a reliability value of 3,000; (3) Calculation of the evaluation of the reliability of the Passive Fire Protection System (Table 6).

Table 6. Reliability of Building Fire Passive Protection Systems in Hospitals

Passive Building Fire Protection Components	Score	Proportion	Total
Lifesaving Equipment	2	0,750	1,500
Buildings	3	0,250	0,750
Total			2,250

Based on the above calculation, it is obtained the reliability value of a passive fire protection system of 2,250, which is categorized as sufficient that is in the range of $1.5 \leq x \leq 2.5$ (Table 2).

5. Conclusion

The results of the evaluation of the reliability level of hospital building passive fire protection systems are 2,250 of the total value of 4, which is categorized as sufficient that is at an interval of $1.5 \leq x \leq 2.5$ (Table 2). The hierarchy of passive protection systems in hospital buildings is a means of saving lives in the first place and buildings in the second place while the sub-variables are evacuation routes as the first order in life-saving facilities and fireproof construction is the first order in buildings. The reliability of life-saving facilities for passive fire protection systems

is 1.692 at 1.5 1,5 x ≤ 2.5 intervals, which are categorized as sufficient, and building variables have a reliability level of 3,000 which is at 3 ≤ x ≤ 3.5 intervals, which are categorized as good (Table 2).

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