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# RELIABILITY STUDY OF HOSPITAL BUILDING IN MATARAM CITY AGAINST FIRE HAZARD

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**ABSTRACT**

*Construction work usually only takes into account structural strength technically regardless of non-technical elements such as fire safety inspection systems. Therefore, the provision of fire protection equipment to maintain the service life of the building becomes dormant. Fire incidents always cause losses in the form of properties and casualties and their impact on the reduced service life of the building. Hospital buildings have a high fire risk. Fire on hospital buildings has a huge impact because they are a vital object as health service. The purpose of this study is to know the application of fire prevention system and reliability level of a hospital building in Mataram City.*

*The hospital buildings under study were the General Hospital of West Nusa Tenggara Province (RSUP) and Graha Ultima Medika Hospital (RSGUM). To find out the application of fire prevention system at the buildings, the descriptive method was used. Then the results obtained were analyzed using a Likert scale. Meanwhile, to know the reliability of the buildings, the method used was descriptive-quantitative based on the Regulation Pd-T-11-2005-C on Building Fire Safety Inspection.*

*The results show that the regulation implementation values of safety equipment and passive protection system in RSUP are 4.18 and 2.71 respectively. Meanwhile, in RSGUM, the regulation implementation values of 3.63 and 3.0 for safety equipment and the passive protection system respectively are obtained. Therefore, it can be concluded that the implementation of safety regulations and passive protection system at RSUP is better than that of RSGUM. Moreover, utility component assessment in RSUP and in RSGUM produced values of Reliability of Building Safety System of 73.27% and 67.82% respectively. This indicates that RSUP building is more reliable than the building of RSGUM.*

**Key words:** Building, fire protection system, reliability, safety system.

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## 1. INTRODUCTION

The hospital is one of the buildings that have a high risk of fire disaster. Hospital fires in addition to being triggered by short-circuiting electrical currents can also be triggered by the use of electrical equipment, the use of pressurized gas cylinders, as well as the use of flammable, corrosive, and harmful chemicals. A large number of potential sources of fire hazards makes hospitals a relatively high risk of fire, according to the National Fire Protection Association (NFPA). The main cause of casualties in any fire is not caused by fire alone but by inhaling toxic fumes and fumes. In many cases of fire incidents, casualties also occur in rooms and floors that are different from the location of fire, especially on floors and rooms located above the scene of the fire.

In 2011, a fire incident took place at the NTB Provincial Public Hospital killing one patient and singing 17 poly rooms. In March 2016 there was also a fire at Mintoharjo Naval Hospital that killed four people, which, according to the results of the investigation, the fire incident was caused by short-circuiting electricity in the tube room at the High-Pressure Air Space Building. The same incident also occurred towards the end of 2016 ie the fire that occurred at the Hospital Cement Gersik caused by an electric wheelchair. Fire incident is a lesson for us to always anticipate the potential for fire hazards in buildings, especially in hospital buildings.

In the city of Mataram, there are several hospitals consisting of various types of national to international standards such as Risa Hospital, Harapan Keluarga Hospital, Graha Ultima Medika Hospital, Mataram City General Hospital and General Hospital of West Nusa Tenggara Province. The above hospitals are almost all located in the middle of residential areas, even Graha Ultima Medika Hospital, its location is directly adjacent to the gas station in Majapahit Street so this certainly endangers the existence of the hospital. Law No.28 of 2002 [1] defines that the building is a physical form of the result of a construction that is united with its place of position, partly or wholly located above and/or in the soil and / or water, which functions as a place for human to perform activities, or residence, religious activity, business activity, social activities, culture, as well as special activities and utilization shall be in accordance with predetermined functions, including periodic maintenance, maintenance and inspection activities.

Ramli [2] defines fire as a natural condition due to the uncontrolled meeting of fuel, oxygen, and heat. The three elements above are the cause of the fire, if one of the three elements is not met then there is no fire. According to Triyono [3], fire incidents occur due to various things such as human, natural events, ignition itself and due to intentional factors. While based on data compiled by the National Fire Protection Association (NFPA) in 2005 as shown in Table 1, it is mentioned that the causes of the fire incident and the incidence of occurrences, especially the fire that occurred in hospital buildings are as follows:

**Table 1** Causes of fire in hospitals (NFPA, 2005)[4]

| Special category | Event number (%) |
|---|---|
| Related to cigarettes | 32.0 |
| Sabotage | 13.8 |
| Faulty equipment | 10.0 |
| Electrical distribution system | 8.0 |
| Lighters, light, and combustion in the open area | 6.1 |
| Dryer | 3.6 |
| AC (refrigeration) | 2.6 |
| Room heater | 2.0 |
| Electrical equipment (X-rays, computers, phones) | 1.7 |

| | |
|---|---|
| Generator | 1.3 |
| incinerator | 1.1 |
| TV, radio, machine fax | 0.8 |
| Biological equipment | 0.5 |
| Elevator | 0.1 |
| Other tools | 2.5 |
| Other equipment | 2.1 |
| Another unknown cause | 10.3 |

According to Pd T-11-2005-C on Fire Building Safety Inspection [5], utility components include: (1) completeness of the footprint, its component is water source, road environment, and hydrant yard; (2) rescue plan, its component is the way out and its construction; (3) active protection system, its components are fire detection and alarm, seams connection, light fire extinguisher, building hydrant, sprinkler, extinguishing system, smoke controller, smoke detection, smoke exhaust, fire elevator, emergency light, emergency power, and control room operation; (4) passive protection system, its components are the completeness of the site/ footprint, the components of the rescue tool, fire resistance and stability, compartmentalization of space, and the protection of openings.

According to Saptaria and Erry et al. [6], the value of the reliability condition of the building safety system is the value of the building or building utility showing the best condition, functioning optimally or whether it is appropriate or not with the specified requirements. The steps of building safety inspection are as follows: (1) provide assessment of all sub parameters of building safety system reliability based on field observations; (2) calculate the condition value of all sub parameters available; (3) calculate the value of the reliability condition of the building safety system by summing the condition values of all sub parameters into the building safety system; (4) calculate the reliability of the building safety system against fire hazard by adding 4 components of fire protection system in the building structure i.e. building site, rescue device, passive protection system and active protection system.

## 2. RESEARCH METHOD

Stages of analysis conducted in research Assessment Application of Rescue Equipment and Passive Protection System is to determine the variable for data retrieval. Data collection is done by doing direct observation in the field. The results of these observations are then analyzed using the Likert scale which is used as the value of the scale of conformity measurement between two or more components reviewed.

**Table 2** Likert scale, Sugiyono [7].

| No. | Explanation | Likert scale |
|---|---|---|
| 1. | In line with the rules | 5 |
| 2. | In accordance with the rules | 4 |
| 3. | Sufficient according to the rules | 3 |
| 4. | Lack of rules | 2 |
| 5. | Very unfulfilled | 1 |

To get the final result of each component, the average formula can be used:

$$X = \frac{x_1 + x_2 + ... + x_n}{n} \quad (1)$$

Where $X$ is the average value of each component, $x_1$, $x_2$,.., $x_n$ are the sum of the values, $n$ the number of data.

Based on the regulations issued by Balitbang PU Pd-T-11-2005-C concerning fire inspection of building fire [5], reliability is the level of perfection of the condition of the protective equipment that ensures the safety, functionality and comfort of a building and its environment during the life of the building in terms of the danger of fire, while the safety of the building is a condition that ensures safety and disaster prevention in a building and its contents (human, equipment, goods) caused by failure or malfunction of building utilities. Referring to technical guidance issued by Balitbang PU Pd - T - 11 - 2005 – C [5], the assessment is based on criteria or restrictions on the condition of building components. The value of the condition of the fire protection component of the building is divided into three levels, namely: GOOD = "B", MIGHT or ENOUGH = "C", and LESS = "K", Equivalence value B is 100, C is 80 and K are 60 as described in Table 3 below:

**Table 3** Level of fire audit assessment

| Value | Conformity | Reliability |
|---|---|---|
| > 80 - 100 | As per the requirement | Good (B) |
| 60 - 80 | Installed but there is a small installation that does not meet the requirements | Enough (C) |
| < 60 | It is not accordance with | Less (K) |

Based on Regulation Pd - T - 11 - 2005 - C, the weighting on each component must be done by Analytical Hierarchical Process (AHP) method, where the result of weighting parameter of building safety system components as according to the above rule is shown in Table 4:

**Table 4** Results of parameter weighing components of building safety systems

| No. | Parameter KSKB | Weigh KSKB (%) |
|---|---|---|
| 1 | Tread Completeness | 25 |
| 2 | Rescue Facility | 25 |
| 3 | Active Protection System | 24 |
| 4 | Passive Protection System | 26 |

Source: Regulation Pd - T - 11 - 2005 - C [5]

In this study, the method used is: (1) descriptive method, to know the application of rescue and passive protection system to fire hazard through direct observation at research location based on Regulation of Minister of Public Works No.26 / PRT / M / 2008 [8] for further analysis based on Likert scale; (2) descriptive-quantitative method, to determine the reliability of the building safety system against fire hazard through direct observation based on Regulation Pd - T - 11 - 2005 - C on fire building fire inspection, which includes: (a) site completeness component; (b) component of the means of rescue; (c) passive protection system components; (d) active protection system components that affect the passive protection system.

The study began in July 2017 by taking research sites at public and private hospitals. The object of research is the General Hospital of West Nusa Tenggara Province (RSUP) and Graha Ultima Medika (GUM) Hospital as in Figure 1.

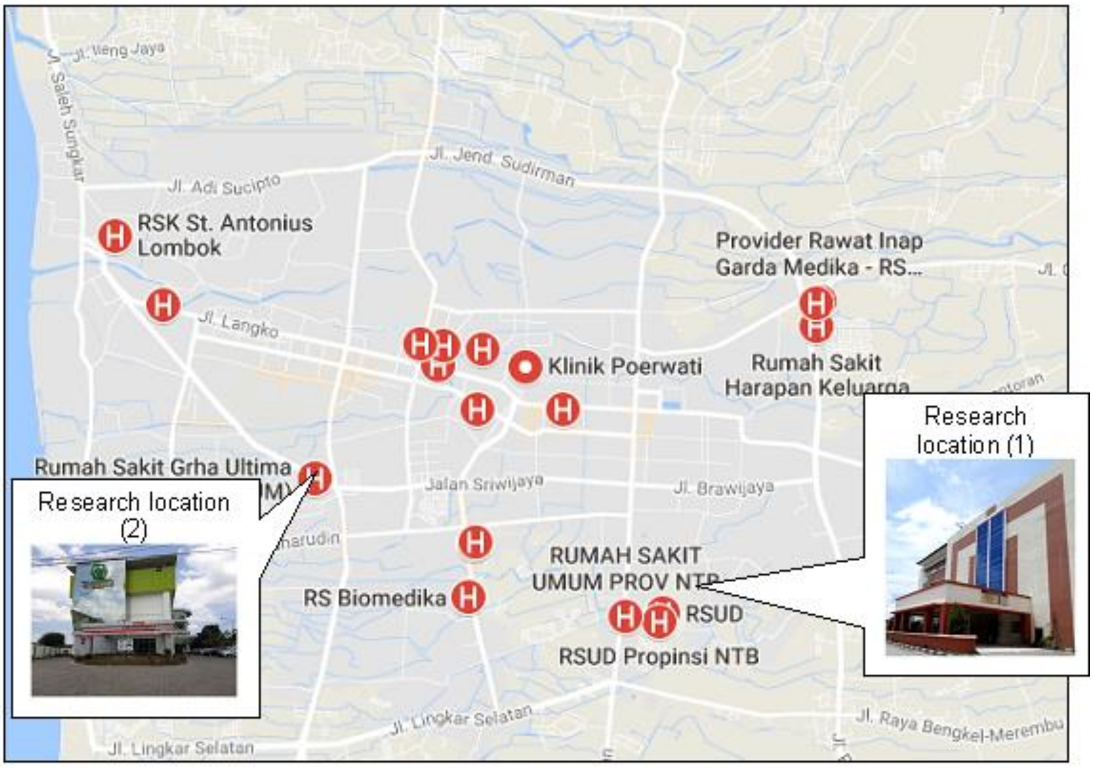


**Figure 1** Location of RSUP and GUM hospitals.

Data collection techniques in this study are to use 2 methods, namely by collecting primary and secondary data directly related to the research objectives to be achieved. Primary data collection is in the form of primary data obtained directly based on the results of observation and documentation directly at the study site. The data is in the form of condition of building rescue system component to fire hazard covering component of site completeness, rescue device, passive protection system and active protection system. To add the source of information about building safety system of the 4 hospitals above against fire prevention, the secondary data is divided into 2, namely: (1) secondary data in the form of literature and legislation obtained from several regulations, such as Regulation of the Minister of Public Works No.26 / PRT / M / 2008 [8] and Pd-T-11-2005-C [5] concerning Fire Inspection of building fire; (2) secondary data for the examination of reliability in fire prevention on the object of study obtained from the building manager as the responsible executor, covering the drawing of the hospital building plan, the accomplished picture (As Built Drawing) and other sources of information needed in the examination of the reliability of building system buildings against fire hazards.[9]

Data obtained from direct observation and check list in the field are used to find out the application of rescue facilities against fire hazard as written in [8], and the reliability value of building safety systems against fire hazard under regulation [5]. The results of the next observation are analyzed by Likert scale, ie the scale used for the measurement of conformity between two or more components reviewed. After the assessment of the condition of the building is done, then it can provide recommendations for conducting repair or rehabilitation system in order to obtain good building reliability.

# 3. RESULTS AND DISCUSSION

Based on the observation in the field, the value of implementing the Rescue Facility rules can be obtained and shown in Tables 5 and 6:

**Table 5** Results of analysis of rescue equipment rules in Likert scale

| No. | Reviews | Likert scale | |
|---|---|---|---|
| | | RSUP | GUM |
| 1 | Exit | 5 | 5 |
| 2 | The reliability of exit | 4 | 5 |
| 3 | Doors | 5 | 2 |
| 4 | Protected spaces and stair protection | 2 | 1 |
| 5 | The exit canal | 5 | 5 |
| 6 | Number of exits | 5 | 3 |
| 7 | The arrangement of exits | 4 | 4 |
| 8 | Exit release | 3 | 5 |
| 9 | Illumination of means of exit | 5 | 5 |
| 10 | Emergency lighting | 3 | 1 |
| 11 | Marking of way out | 5 | 4 |
| | Average number of rescue | 4.18 | 3.63 |

**Table 6** Results of regulatory analysis of passive protection system in Likert scale

| No. | Reviews | Likert scale | |
|---|---|---|---|
| | | RSUP | GUM |
| 1 | Couples of fireproof construction | 4 | 5 |
| 2 | Fireproof doors and windows | 2 | 5 |
| 3 | Interior coating material | 5 | 5 |
| 4 | Barrier of fire | 1 | 1 |
| 5 | Partition the smoke barrier | 1 | 1 |
| 6 | Smoke barrier | 1 | 1 |
| 7 | Atrium | 5 | 3 |
| | The average number of passive protection systems | 2.71 | 3.0 |

Implementation of the rescue regulations as shown in Table 5 resulted in the average number of regulations applied for 4.18 for NTB Provincial general (RSUP) hospital and 3.63 for the reliability of Graha Ultima Medika (GUM) hospital in Likert scale, while the application of passive protection system regulation as in Table 6 resulted in an average amount - average of 2.71 and 3.00 in Likert scale. This shows the means of rescue at NTB RSUP hospital in accordance with the regulations, while in GUM hospital is quite in accordance with existing regulations, meanwhile, based on passive protection system, NTB RSUP hospital and GUM hospital is quite in accordance with regulations. Thus, it can be concluded that related to fire protection system with rescue component, RSUP hospital is better than GUM hospital. While based on the above results, indicating that the passive protection system in hospital GUM is better than hospital RSUP.

Based on the result of calculating reliability[11] value for each utility component, it can be concluded as shown in table 7:

**Table 7** Results of utility component assessment

| No. | Utility component | Value | | Maximum value |
|---|---|---|---|---|
| | | RSUP | GUM | |
| 1 | Safety facility | 23.65 | 23.53 | 25 |
| 2 | Passive protection system | 16.54 | 15.72 | 26 |
| 3 | Tread completeness | 18.78 | 15.93 | 25 |
| 4 | Active protection system | 14.29 | 12.64 | 24 |
| | | 73.27 | 67.82 | 100 |

The result of calculation of utility component valuation resulted in 73.27% of system building safety[10] value (NKSKB) for RSUP and 67.82% for GUM, it shows that the reliability value of hospitals building of RSUP and GUM is in good enough category with its reliability value is still below 80%.

## 4. CONCLUSIONS

From the results of analysis and observation in the field, it can be concluded that the application of rescue regulation in RSUP generates the average value of 4.18 in the Likert scale, while the application of passive protection system produces an average value of 2.71. This indicates that the rescue facilities at RSUP are in accordance with the regulations, while the application of passive protection system is sufficiently in accordance with the regulations. Implementation of the rescue facility regulations in GUM hospitals, in Likert scale, results in an average number of applicable regulations of 3.63, while the application of passive protection system produces an average value of 3.0. It indicates that the application of rescue facilities and passive protection systems at GUM hospitals is sufficient in accordance with existing regulations. Based on the above assessment results, it can be concluded that the application of the rules of rescue facilities and passive protection system at RSUP better than at GUM.

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