Building Reliability Management Against Fire Hazards (Case Study of The Dasan Cermen Mataram Store Complex)

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Abstract. Dasan Cermen Store Complex Mataram was a mass made up of a community that made some money to improve people's living, so it isn't uncommon for people to visit every day. This building houses two floors of employees or staff, valuables and archives to be protected in case of a fire. So it requires the application of component fire systems to the building. The purpose of this study is to know the availability of components of the fire safety system and the reliability of the fire safety systems of Dasan Cermen Store Complex Mataram. The method of this study involved a quantitative descriptive description of the building's safety system's reliability to fire hazards. The dosing was done using Analytical Hierarchy Process (AHP) methods and reliability value assessments of building safety systems. The results of the building's safety system safety value analysis are 50.9915% or K (less). Assessment using the analytical method of the Analytical Hierarchy Process (AHP) shows variable consistency of the building's safety system (KSKB); there is a value of CR 0.0252, because of CR < 0.100, thus the preference for housekeeping is consistent. Recommendations are recommended for periodic checkups, periodic maintenance treatments, periodic maintenance or repairs, element repairs, and inadequate components to sustain reliability and safety against fire hazards on the Dasan Cermen Store Complex in Mataram.

Introduction

A building is a structure that is erected and/or placed in an environment, either partially or entirely on, above, or in land and/or waters, permanently, which functions as a place for humans to carry out their activities [1]. Public buildings are buildings used for all kinds of work activities, including public meetings, offices, hotels, shopping centers/malls, recreation/entertainment places, hospitals/treatment, and museums [2].

The development of increasingly complex building structures and increasingly diverse building uses and increasingly high safety demands make building owners or developers have to start thinking about fire safety management. Several fire incidents in high-rise buildings, both commercial and office buildings, should be important lessons in preparing fire safety management [3]. Fire is a disaster or tragedy that can happen anywhere and anytime. Explosions or fires caused by explosions can cause property damage, injury, or even death [4]. Fire is a case that causes great losses, both material losses, injuries, and deaths, and a bad image if a fire occurs in a company or organization[5]. Fire can have critical consequences for human society due to the damage it causes to buildings and infrastructure. Also, a large number of people lose their lives or become seriously injured as a result of fires [6].

High-rise buildings have a high risk of fire because high-rise buildings are inhabited by many people, and evacuation must be carried out if a fire occurs. The amount of losses caused by fire, according to various data, is only the direct costs that are visible after the fire occurs, but the costs incurred as a result of the fire incident are incalculable, especially if the fire incident occurs in the workplace. These indirect losses can be in the form of loss of important company documents, bad company image, insurance costs, and payment of employee wages even though they cannot work, and costs for repairs after the fire so that the visible costs can increase by 2 to 3 times [5].

Building safety reliability is one part of checking the reliability of a building. A building is said to be reliable if the condition of the building or building utilities shows excellent performance or functions optimally according to the applicable building safety provisions and requirements. Based on the findings of the United States National Fire Protection Association (US NFPA), fires in high-rise buildings are more deadly and detrimental than in other locations where fire disasters occur. Handling fires at building locations is more difficult and high-risk, potentially resulting in losses due to fires in buildings and the complexity of the evacuation process for building occupants, making building managers need to anticipate the dangers of fires that can't be predicted [7].

When there's a disaster, everyone does not know when it can happen. Therefore, in anticipation of a fire in the case of the Dasan Cermen Store Complex Mataram, it is necessary, in an effort to maintain the reliability of the buildings and prevent fire hazards, to provide a deeper study of the quality of the Dasan Cermen Store Complex Mataram to identify the extent of the building's dependable maintenance system against the fire hazard.

To find out how well the fire protection system in the Dasan Cermen Store Complex Mataram works, a study is needed; for that, the writer has made this building an object of study. The background image above is that some of the problems that can be raised in the study include: first, "how does the availability of components of a fire safety system include completeness, means of rescue, active protection and passive protection in the Dasan Cermen Store Complex Mataram?". Second, "how reliable is the fire safety system of the buildings in the Dasan Cermen Store Complex in Mataram?".

Method

This chapter will discuss the methodology of this research and the presentation of the research design used to achieve the objectives of this paper. The objectives of the research are to determine the availability of fire safety system components, including site completeness, rescue facilities, active protection systems, and passive protection systems, and to determine the level of reliability of the building safety system of the Dasan Cermen Mataram Shopping Complex. This research methodology will discuss the research location, data collection methods, research stages, data analysis, and research flow.

This research study was conducted in the Dasan Cermen Shopping Complex building located in Tgh. Lopan street, Dasan Cermen, Sandubaya District, Mataram City, West Nusa Tenggara. The Dasan Cermen Mataram Shopping Complex building consists of 36 shophouses with 2 floors, consisting of 1 ground floor and 1 upper floor. Based on the building layout, the location of the Dasan Cermen Mataram Shopping Complex is in the provincial route, so it is easy to reach because the location of the shophouses is in the main route.

The data collection technique in this study was conducted using a survey. The survey used questionnaires and interviews with personnel directly involved in project implementation activities. The data to be examined and analyzed consisted of primary and secondary data [8]. Primary and secondary data related to the research objectives were collected in this study.

Primary data is obtained through field studies. Field studies are a method of collecting data through interviews and obtaining data from respondents' questionnaire responses [8]. This study uses direct data from observations and documentation at the Dasan Cermen Shopping Complex. During the analysis, the variables to be measured must be present. The following fire safety system components were included in this assessment:

Table 1. Fire Safety System Components.

No	Fire Safety Components	Subcomponent Description	
1	Tread Completeness	1	Water Sources
		2	Neighborhood Road

No	Fire Safety Components		Subcomponent Description
		3	Distance between Buildings
		4	Yard Hydrant
2	**Means of Salvation**	1	Exit
		2	Exit Road Construction
3	**Active Protection System**	1	Detection and Alarm
		2	Siamese Connection
		3	Light Fire Extinguishers
		4	Building Hydrants
		5	Sprinkler
		6	Overflow Fire Extinguishers
		7	Smoke Control
		8	Smoke Detection
		9	Smoke Exhaust
		10	Emergency Lights
		11	Emergency Power
		12	Operational Control Room
4	**Passive Protection System**	1	Fire Resistance of Building Structure
		2	Space Compartmentation
		3	Opening Protection

Source: Processed Results

First, an interview (question and answer session/face-to-face meeting) will be conducted regarding location equipment, rescue facilities, and fire protection systems at the Dasan Cermen Mataram Shopping Complex with 3 (three) respondents to validate the risk variables that have been compiled by researchers and to determine the risk level of the risk variables at the implementation stage of the building construction project to improve the safety quality performance of the building.

Table 2. Profile of Respondents in Phase I Research.

No	Name	Position
1	Mr. Ida Bagus Oka Suryatna	Director of PT Bola Mas
2	Mr. Azwar Kholidi	Head of PT PMN Consultant
3	Mr. Drs. H. Yoga Safari, MM	President Director of PT BPR Abdi Warga Mulia

Source: Processed Results

The second stage involved a preliminary survey and interviews with 4 (four) respondents to determine the related factors that influence the components of the fire safety system and to determine the level of reliability of the building fire safety system in the Dasan Cermen Mataram Shopping Complex building.

Table 3. Profile of Phase II Research Respondents.

No	Name	Position
1	Mr. Lalu Sastriawan, S.H	Fire Inspector of the Mataram City Fire and Rescue Service
2	Mr. Arifiawan Marjun, S.STP	Head of the Rescue Section of the Mataram City Fire and Rescue Service
3	Mr. Nasrullah, S.H	Platoon Commander of the Mataram City Fire and Rescue Service

No	Name	Position
4	Mr. Multazam, S.Sos	Head of Fire Prevention and Control of the Mataram City Fire and Rescue Service

Source: Processed Results

Secondary data comes from data collected by the implementing agency and other sources of information needed to verify the building safety system permit (KSKB) for fire hazards. In this study, the secondary data consisted of a site plan for the Dasan Cermen Shopping Complex. The plan includes overall building details. This data was used to calculate the reliability level of the fire protection system, as well as books, articles, journals, and research related to evaluating the reliability level of the fire prevention system.

Research Stages. Preliminary Survey; To obtain initial data for this research, field observations were conducted. Observations were conducted by gathering information through direct observation of the building conditions, rescue facilities, and fire protection systems at the Dasan Cermen Shopping Complex in Mataram. The observations were conducted under the guidance of Mr. Hari Wahyono, ST, the developer of CV. Rinjani Teknik, West Lombok. The researchers conducted several observations related to the components of the fire safety system. These observations included site completeness, security facilities, and active and passive protection systems. These observations were conducted directly using a questionnaire or checklist containing several criteria for the fire safety system components.

Determination of Fire Safety Component Weights Using the Analytical Hierarchy Process (AHP) Method; *First*, identification of problems; The purpose of the activity, the use of standards for selecting priorities, and alternatives must be part of the priority-setting problem. *Second*, arranging a hierarchy of the problems faced; To show system elements or decision options, a hierarchical or decision structure is created. The first step is to determine the activity's objectives. Once the objectives are established, the objective criteria are established. *Third*, Priority assessment of criteria elements and alternatives; Once the problem is decomposed, there are two stages of evaluation, also known as comparison elements, compare the criteria with their alternatives, and second and determine the importance of each criterion. *Four*, building a pairwise matrix; for each criterion and alternative, pairwise comparisons must be performed to compare each element with other elements at each level of the hierarchy. This results in a qualitative assessment of the element's importance, which is then aggregated into a number. *Five*, determine the priority weight value; to determine how important a criterion is, Importance determines the priority weight value. This value is calculated as the element of the eigenvector connected to the maximum eigenvector of the matrix. *Six*, weighting consistency test; to reduce the inconsistency of the comparison matrix, the maximum eigenvector is used to measure the consistency of the matrix. *Seven*, alternative performance matrix; the alternative performance matrix shows how well the alternative criteria are met. This cooling rate is determined by multiplying the criteria weights by the alternative performance scores. The results of the calculation of the component and subcomponent parameter weights use the Analytical Hierarchy Process (AHP) method.

Building Safety System Reliability Assessment (KSKB); *First*, assessment of the condition of each building component; Table 4 shows the criteria for assessing the condition of each building component or part for fire protection. These criteria are as follows: good = “B”; moderate = “C”; and poor = “K.” a B score is 100, a C score is 80, and a K score is 60.

Table 4. Reliability Level of Fire Protection System.

Value	Suitability	Reliability
>80-100	In accordance with requirements	Good (B)
60-80	It has been installed but there are small parts of the installation that do not meet the requirements.	Moderate (C)
<60	Not appropriate at all	Poor (K)

Source: Pd-T-11-2005-C

In the final step, the inspection results must be entered into the building safety protection and building reliability component assessment list and processed to calculate the condition value. *Second*, Recommendation; recommendations are based on the calculated results of the Building Safety System Precision Value (NKSKB) inspection. To restore a condition from Poor (K) or Fair (C) to Good (B), the recommended steps include periodic inspections, regular maintenance and upkeep, routine maintenance and repair, component salvage and repair, and replacement of missing parts.

Assessment of Building Safety System Implementation; at this research stage, the steps taken in the research process include all implementation from start to finish, with the aim that the research can be carried out in a structured and focused manner. To address the existing fire protection system, an analysis of the fire protection system implementation was conducted. This was done using a Likert scale, with values deemed to be highly consistent with building safety inspection guidelines [9]. This assessment was carried out by means of direct observation of the field site at the research location.

Data analysis; for the measurement of the implementation of fire safety facilities according to the Regulation of the Minister of Public Works No. 26/PRT/M/2008 and the level of confidentiality of the building safety system against fire hazards according to Regulation Pd-T-11-2005-C concerning Building Safety Inspection, the data obtained from direct observation and checklists. After the data was collected, statistical data analysis was carried out using the Microsoft Excel program.

Results

This section presents the results of the post-data collection phase, known as data analysis. The data analysis includes an evaluation of the Building Safety System (KSKB) of the Dasan Cermen Shopping Complex in Mataram City, including the means of escape, site equipment, passive protection systems and active protection systems. To determine the reliability of the fire safety system in the Dasan Cermen Shopping Complex in Mataram City, the planned results from the primary data will be outlined here.

Condition of the Dasan Cermen Mataram Shopping Complex Building. The Dasan Cermen Mataram Shopping Complex is a shophouse building that was built in 2012. This building is located in Tgh Lopan Street, Dasan Cermen, Sandubaya District, Mataram City, West Nusa Tenggara. In the shophouse building, there are 36 rooms that have been built, but only 6 of them are used. Meanwhile, many other shophouse buildings are still empty and unoccupied. The available shophouse buildings include PT. Bola Mas Utama, PT. BPR Abdi Warga Mulia, and PT. PMN Consultant. As business entities that collect funds from the community to improve the quality of life of the people, these buildings attract many visitors every day.

Evaluation of the Fire Safety System in the Dasan Cermen Shopping Complex Building, Mataram City. The results of the site completeness component observations consist of four subcomponents. The water source has one criterion that meets the requirements, the neighborhood road has three criteria that meet the requirements, the distance between buildings is in accordance with the requirements, and the yard hydrant has three criteria that meet the requirements. From the four components above, it can be concluded that the three components that meet the requirements are the site completeness, namely the neighborhood road, the water source, and the distance between buildings. The only component that does not meet the requirements is the yard hydrant.

The facility provision component consists of two subcomponents. The first component, exits, has 10 criteria, with observations showing that 6 meet the requirements and 4 are less than satisfactory. The second component, exit construction, has 8 criteria, with observations showing that 3 meet the requirements, 2 are adequate, and 3 are less than satisfactory.

The results of observations on the components of the active protection system, which consists of twelve subcomponents. The first subcomponent, detection and alarm, has five criteria that do not meet the requirements, and the second subcomponent, Siamese connection, has two criteria that do not meet the requirements. Then the third component, namely the light fire extinguisher, has 3 criteria that do not comply with the statement, and the fourth component, namely the building hydrant, consists of 2 criteria that do not comply with the statement. Next, the building hydrant has 2 criteria that do not comply with the statement. The fifth component is the sprinkler, which has 6 criteria that do not comply with the statement. The next component is the overflow extinguishing system, which has 2 criteria that are not available. The seventh component, namely the smoke controller, has 5 criteria that are also not available. The eighth component is smoke detection, which has 4 criteria that do not comply with the requirements. The ninth component, namely smoke exhaust, has 8 criteria that do not comply with the statement. The tenth component, namely emergency lighting and directions, has 5 criteria that do not comply with the statement and conditions in the field. The eleventh component, namely emergency electricity, has 3 criteria that are quite in accordance with the statement. And the last component, namely the operation control room, does not comply with the statement. So, from the 12 components above, it can be concluded that 11 components of the active protection system do not comply with the statement and 1 component of the active protection system has requirements that are quite appropriate.

The passive protection system component consists of three subcomponents. The first subcomponent is the fire resistance of the building structure, with one criterion not meeting the requirements. The second subcomponent is space compartmentalization, with two criteria not meeting the requirements and one criterion meeting the requirements. The third subcomponent is opening protection, with four criteria meeting the requirements. Therefore, from the three components above, it can be concluded that one criterion meets the requirements for each element of the passive protection system, while the remaining criteria do not meet the requirements.

The observation results of the 4 components of the fire safety system in the Dasan Cermen Mataram Shopping Complex building have different values, including a Good value (B) with a rating of >80-100, which is in accordance with the requirements, which means that all components can function well and the building can be used optimally. Next, a sufficient value (C) with a rating of 60-80 is in accordance with the requirements, which means that some installations have not been installed so that they can cause disruption to the building. Then a poor value (K) with a rating of <60 does not comply with the requirements, which means that some or even all components are not available in the building, so it can result in disruption to the operation and functionality of the Dasan Cermen Mataram Shopping Complex building.

Building Safety System Reliability Assessment (KSKB) in the Dasan Cermen Mataram Shopping Complex Building. To begin the analysis of the building safety system (KSKB) reliability assessment in the Dasan Cermen Mataram shopping complex building, the results of the assessment of the condition of the fire safety system components have been shown in **Table 5** to **6** below.

Table 5. Results of Building Safety System Reliability Assessment (KSKB).

No	Components	Sub KSKB	Assessment Results	Assessment Standards	Final Weight (%)	Condition Value
1	**Tread Completeness**	Water Sources	B	100	25.00%	25
		Neighborhood Road	B	100	25.00%	25
		Distance between Buildings	B	100	25.00%	25

No	Components	Sub KSKB	Assessment Results	Assessment Standards	Final Weight (%)	Condition Value
		Yard Hydrant	K	0	25.00%	0
			Number of Condition Values			**18.75**
2	**Means of Salvation**	Exit	C	60	50.00%	30
		Exit Road Construction	K	52.5	50.00%	26.25
			Number of Condition Values			**28.125**
3	**Active Protection System**	Detection and Alarm	K	0	8.33%	0
		Siamese Connection	K	0	8.33%	0
		Light Fire Extinguishers	K	0	8.33%	0
		Building Hydrants	K	0	8.33%	0
		Sprinkler	K	0	8.33%	0
		Overflow Fire Extinguishers	K	0	8.33%	0
		Smoke Control	K	0	8.33%	0
		Smoke Detection	K	0	8.33%	0
		Smoke Exhaust	K	0	8.33%	0
		Emergency Lights	K	0	8.33%	0
		Emergency Power	C	60	8.33%	4.998
		Operational Control Room	K	0	8.33%	0
			Number of Condition Values			**0.4165**
4	**Passive Protection System**	Fire Resistance of Building Structure	K	0	33.33%	0
		Space Compartmentation	K	33.33	33.33%	11.11
		Opening Protection	K	0	33.33%	0
			Number of Condition Values			**3.70**

Source: Processed Results

The study was conducted twice as many times as the first research to weigh the variable fire safety systems and the second to find the reliability of fire safety systems in the building of the Dasan Cermen Store Complex Mataram. From field observations and calculations using Microsoft Excel, it is found that the reliability of the Dasan Cermen Store Complex Mataram can be seen in the following **Table 6**.

Table 6. The Reliability of Building Safety System.

No	Building Safety System Components	State Value	Weight (%)
1	Completeness	18.75	25
2	Means of Salvation	28.125	25
3	Active Protection System	3.70	24
4	Passive Protection System	0.4165	26
	Total	50.99	100

Source : Research Result

The results of the reliability assessments of the building safety systems in the chat above show a value 50.99% with 100% weight. Therefore, the reliable value of the building safety systems in the building of the Dasan Cermen Store Complex Mataram remained below the requirements.

The results of this study are relevant to several previous studies, including, first, an article by Hariyanto in 2022 entitled "Analysis of Building Safety Reliability Against Fire Hazards," which contains the results of a case study of the Vyatra VIII Building, PEM Akamigas Cepu, which produced a building safety value against fire hazards, resulting in a building safety value (NKSKB) of 87.12% with a Good category. This indicates that the building is classified as reliable for building safety against fire hazards. The comparison with the author's research lies in the difference in the Building Safety Reliability Value (NKSKB) which shows a value of 50.99%, but the similarities can be seen from the method applied in this study, which both use the Analytical Hierarchy Process (AHP) method which is effective in helping solve the problem of the level of speed of fire extinguisher access to buildings, by providing questionnaires to respondents who work in building construction.

Paired Matrix

Table 7. Paired Matrix.

Criteria	Completeness	Means of Salvation	Active Protectio System	Passive Protection System
Completeness	25	0.5	3.01	0.75
Means of Salvation	0.5	50	9.38	1.5
Active Protection System	3.01	9.38	8.33	0.25
Passive Protection Systen	0.75	1.5	0.25	33.33
Total	29.26	61.38	20.97	35.83

Source : Research Result

Through this pair of matrices, some of the element's values are first 29.26 on completeness. The second element's value is 61.38 on the element of the means of salvation. The value of the third element is 20.97 for the elements of active protection system, and the value of the fourth element is 35.83 for the elements of the passive protection system.

Pairwise Element Comparison Matrix

Table 8. Pairwise Element Comparison Matrix.

Criteria	Completeness	Means of Salvation	Active Protection System	Passive Protection System
Completeness	0.854	0.008	0.143	0.020
Means of Salvation	0.017	0.814	0.447	0.041
Active Protection System	0.013	0.152	0.397	0.006
Passive Protection System	0.025	0.024	0.011	0.930
Total	1.000	1.000	1.000	1.000

Source : Research Result

Determine the significance of the component selection based on certain criteria using this pairwise element comparison matrix. The assertion that element A is more significant than element B, or that element B is less significant than element C, etc., can typically be made with ease by others. They struggle, though, to express how much more significant element A is than element B or how less significant element C is. They consequently had to make a database that turns priority statements into numerical values. Thus, it is clear from the above table that, of the four criteria, the passive protection system is the most crucial one, with a total value of 1.000 (and an importance level of 7). This can be demonstrated by a significant preference for one activity over another. With a total value of 1.000 (and an importance level of 3), the next criterion is the site's completeness, indicating that it is somewhat more significant than the others. With an importance level of 1, the following criterion, the active protection system and the methods of rescue, have the same total value of 1.000, indicating that both components have the same impact.

Priority Weight Value

Table 9. Eigenvector Matrix.

Criteria	Completeness	Means of Salvation	Active Protection System	Passive Protection System	Number of Rows	Eigenvector Value
Completeness	0.854	0.008	0.143	0.020	1.025	0.256
Means of Salvation	0.017	0.814	0.447	0.041	1.319	0.330
Active Protection System	0.103	0.152	0.397	0.006	0.658	0.164
Passive Protection System	0.025	0.024	0.011	0.930	0.99	0.247

Source : Research Result

There are four criteria on the chart; the first criterion is a Completeness having an eigenvector value of 0.256. The second criterion is a means of salvation having an eigenvector value of 0.330. The third criterion is an active protection system with an eigenvector value of 0.164. The fourth criterion is a passive protection system with an eigenvector value of 0.247.

Consistency Tests

Maximum Lambda Value (λ max)

λ max = Average data consistency obtained

= 4.068

Consistance Index (CI)

$$CI = \frac{\lambda\, maks - n}{n-1}$$

$$= \frac{\lambda\, maks - 4}{3}$$

$$= \frac{4.068-4}{4-1}$$

$$= \frac{0.068}{3}$$

= 0.0227

Consistance Ratio (CR)

$$CR = \frac{CI}{RI}$$

$$= \frac{0.0227}{0.90}$$

$$= 0.0252$$

The results show a variable consistance in the safety of buildings in the Dasan Cermen Store Complex in Mataram; there is a value 0.0252, because CR < 0.100 means a boating preference is **consistent**.

Recommendation

The reliability value of the building safety system of Dasan Cermen Store Complex Mataram is 50.99%, with a 100% value on a K (minus) weight due to several components of the existing fire protection system. There is completeness, a means of rescue, active protection, and passive protection that are damaged or not functioning properly or cannot function at all, and their capacity is far below the values set in the specifications so that the comfort value and function of the space and building cannot be used optimally. In order for a building to function completely, good fire protection is needed, and thus the following things are recommended: periodic inspection, periodic maintenance, periodic repairs, element correction, and complete replacement of damaged components.

Conclusion and Suggestion

Conclusion Based on the terms of purpose and research on the building's reliability, the management of fire in the Dasan Cermen Store Complex, Mataram, could be drawn as follows: First, at the Dasan Cermen Store Complex in Mataram, fire protection systems such as completeness, means of salvation, active protection systems, and passive protection systems are now largely available. Second, the results of the inspection of the fire safety of the building complex, which was done using traditional observation of the building's danger of fire. Third, the cost-effective value of the fire safety system is 50.99%, which is less reliable. Four, the results show a variable consistency in the safety of buildings in the Dasan Cermen Store Complex, Mataram; there is a value of 0.0252, because CR < 0.100 means a boating preference is consistent.

Suggestion Based on the research that has been explained, some suggestions have been offered as follows: *First*, for those in charge of the firefighting system of Dasan Cermen Store Complex Mataram, it is expected that they manage the components of the uninstalled fire safety system and manage the fire safety system well to maintain the reliability of the building blocks of Dasan Cermen Store Complex Mataram. *Second*, care for a fire protection system that is already available in the Dasan Cermen Store Complex in Mataram is essential to avoid any obstructions when used.

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