

## BUILDING PROTECTION DESIGN IN FIRE HAZARD PREVENTION (CASE STUDY: FAJAR UNIVERSITY BUILDING (UNIFA) MAKASSAR)

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### ABSTRACT

The growth and arrangement of existing buildings are sometimes not balanced with the readiness of building and urban infrastructure. The main danger of fire for humans is poisoning due to inhalation of smoke, about 75% of human deaths in burning buildings are caused by smoke, about 25% of deaths are caused by heat generated by fire. To carry out the functions and uses, the building consists of several systems, the system consists of sub-systems that form integrally in a single unit. Fire prevention is one of the building systems, which aims to save lives. Fire prevention is one aspect of building safety. To find out and assess the level of reliability of a building against fire hazards, a problem formulation is formulated, namely How to design a fire prevention analysis that can be applied to buildings. The conclusion that can be drawn regarding the design of a fire prevention inspection system and its application is, the design of a building reliability inspection system in fire prevention is one of the tools in assessing and inspecting buildings for fire prevention measures in buildings. Inspection of building reliability in fire prevention is carried out at the smallest level or on building components, can provide a more detailed assessment/inspection of the fire prevention system, Assessment of Rescue Means Components, Assessment of Active Protection Components, Passive Protection Assessment Means.

**Keywords:** building; fire prevention; fire protection design; safety.

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### INTRODUCTION

The main danger of fire for humans is poisoning due to inhalation of smoke, about 75% of human deaths in burning buildings are caused by smoke, about 25% of deaths are caused by heat generated by fire. To carry out the functions and uses, the building consists of several systems, the system consists of sub-systems that form integrally in a single unit. Fire prevention is one of the building systems, which aims to save lives. Quoted from (Ramli, Soehatman. 2010) reliability against fire hazards is the building's ability to resist to minimize the possibility of fire. For this reason, a guideline is needed that can be used to examine fire prevention in buildings, in order to face the demands of increasingly complex urban and residential developments as well as control and supervision of fire hazards. Fire prevention is one aspect of building safety.

According to Law No. 28 of 2002 concerning buildings, the safety factor is a requirement that must be met by buildings, where fire is one aspect. Therefore, the UNIFA building must be adapted to the principle of benefit, the principle of safety, the principle of balance, and the principle of harmony for the benefit of the surrounding environment as explained in Law No. 28 of 2002 Chapter II article 2 (two) that "The principle of safety is used as the building meets the building requirements, namely technical reliability requirements to ensure the safety of building owners and users, as well as the community and the surrounding environment, in addition to administrative requirements. In accordance with the Minister of Public Works Decree No. 441/KPTS/1998 concerning Technical Requirements for Buildings, every building must have technical requirements which aim to implement building functions that are safe, healthy, comfortable, efficient, balanced, harmonious, and in harmony with their environment. The absolute requirement in building construction must have building technical requirements which include building layout requirements and building

reliability requirements. One of the reliability requirements is that the building must have the ability to protect against fire hazards through passive and active protection systems.

Fire protection must be owned by every building, the more large, luxurious, and important the building is, the more complex and automatic the reliability of the building against fire protection will be. fire protection infrastructure and facilities as well as the readiness and readiness of managers and building tenants in anticipating and overcoming fires. The location of the Unifa Building which is near residential areas has the potential to spread fire from settlements around the Unifa Building area. In addition, the condition of building protection that is already 6 years old has the potential to decrease the quality of protection until the absence of such protection is caused by damage or loss. Therefore, we feel the need for research and re-testing the reliability of the Unifa Building. Thus, the reliability of the UNIFA building must meet the requirements for safety, health, comfort, and convenience of the building in accordance with the requirements of the functions that have been determined. In its development, it has become a requirement in the construction of UNIFA buildings that the technical reliability of the building must be considered, regarding the Technical Requirements of Buildings Article 3 states that there are 13 (thirteen) technical requirements that must be owned by buildings, namely: Designation and Building Intensity, Architecture and Environment , Building Structures, Security against fire hazards, Entry and Exit Means, Transportation in Buildings, Emergency Lighting, Exit Direction Signs, and Hazard Warning Systems, Lightning Protection Electrical Installations and Communications in Buildings, Gas Installations, Sanitation in Buildings, Ventilation and Air Conditioning, Lighting and Noise and Vibration. The technical requirements of this building must be owned by UNIFA buildings in order to fulfill the principle of benefit, the principle of safety, the principle of balance, and the principle of harmony.

Suwanda et al. (2009) conducted a study on evaluating the application of a fire safety system in the DR.M.Djamil Hospital building in Padang. In this study they calculated and produced the NKSKB with a value of 82.17%, which indicates that the hospital building has a level of reliability that is still in good condition. Pratama and Trikomara (2017) wrote that the results of the NKSKB calculation with a value of 57.24% where the level of building reliability is in a poor condition (K) due to the absence of components and not in accordance with regulatory criteria (Pratama & Trikomara, 2017). Another study that gave the results of the NKSKB calculation with a value of 93.93% for USU Hospital and 93.27% for Bunda Thamrin Hospital. However, for the USU hospital building that does not have fire protection management, it is in the poor category (K) because of the emergency response process variables, fire protection organizations and human resources have a 0% compliance rate with the Minister of Public Works Regulation No. 26/PRT/M/2009, while Bunda Thamrin Hospital is in the good category (B) because it has a conformity rate of 87.6% with the Minister of Public Works Regulation No. 26/PRT/M/2009 (Harahap, 2018). For government buildings, there is a study conducted by Trikomara, Sebayang and Mahmudah (2012) entitled Evaluation of the Reliability of Fire Protection Systems in Buildings (Case Study of Indragiri Hilir Regent's Office Building). This study provides the results of the NKSKB calculation with a value of 79.07% where the level of reliability of this building is in sufficient condition (C). To restore the condition to good enough, the building management can identify and complete the building's fire protection system deficiencies. Means of rescue and passive protection system by taking a case study of the Solo Paragon apartment building. This study provides the results of the NKSKB calculation with a value of 92.35%, these results indicate that the reliability value of the building is in good condition and in accordance with applicable regulations (Kurniawati, 2012). Research on fire protection system in UNY hotel building which consists of five floors in Yogyakarta. This study provides the results of the NKSKB calculation with a value of 91.6% where the level of reliability of the UNY hotel building is in good condition (B) (Zulfar & Gunawan, 2018). This study aims to design a fire prevention inspection system in the UNIFA Building and analyze the reliability level of each fire variable contained in the UNIFA Building.

### **Definition of Fire and its Losses**

Fire cannot be separated from the theory of the emergence of fire, where fire is an uncontrolled fire, meaning that it is beyond human ability and desire. Fire is a compound between a fuel with oxygen at a certain temperature which in the process arises flame, sound and light. Thus, fire is a natural condition due to uncontrolled contact of fuel, oxygen and heat. Fires cause losses to people, assets, and productivity, among others (Rian Trikomara I, Mardani Sebayang, 2012):

1. Loss of Life Fire can cause casualties, either directly or as a result of a fire.
2. Material Losses The impact of fire also causes huge material losses. Direct losses in the form of the value of assets or buildings that are burned. Behind these losses, indirect losses are much higher, for example production disruptions, fire recovery costs, social costs and others.
3. Decreased Productivity In the event of a fire the production process will be disrupted, it can even stop completely. The value of the loss will be very large which is estimated to reach 5-50 times the direct loss.
4. Business Disruption The decline in productivity and damage to assets due to fire resulted in extensive business disruption of a market or mall being burned down, resulting in total cessation of trading activities, disrupted flow of goods and cessation of all business activities.
5. Social Losses The impact of the fire resulted in a group of fire victims losing all their belongings, destroying their lives, and causing their families to suffer. Social activities also experience obstacles that result in a decline in the welfare of the community.

### **Fire Protection System**

According to the Minister of Public Works No: 26/PRT/M/2008, the fire protection system in buildings is a system consisting of equipment, fittings and facilities both installed and in buildings that are used for the purpose of passive protection systems, active protection systems, and other methods of protection. -Management methods in order to protect buildings and their environment against fire hazards. Fire protection systems are used to detect and extinguish fires as early as possible by using equipment that is driven manually and automatically. The Regulation of the Minister of Public Works has regulated in it the fire protection system in buildings including (Salena, Safriani and Novrizal, 2019).

### **Water Access and Supply**

In order to protect against the spread of fire and facilitate extinguishing operations, within the building environment there must be an environmental road with a pavement so that it can be passed by fire fighting vehicles, a fire engine access point is provided and the minimum distance between buildings is determined. Access roads for fire fighting vehicles must be provided and maintained in accordance with the technical requirements stipulated in the regulations which include vehicle roads, fire fighting roads, roads to parking lots or a combination of these roads. The building environment must be planned in such a way that water sources are available in the form of yard hydrants, fire wells or water reservoirs and so on that make it easier for firefighters to use them so that every house and building can be reached by the water jet of the fire fighting unit from the road in their environment (Salena, Safriani and Novrizal, 2019).

### **Rescue Means**

Facilities that are prepared to be used by residents and firefighters in an effort to save human lives and property in the event of a fire in a building and the environment. enough to save oneself safely without being hampered by things caused by an emergency (Salena, Safriani and Novrizal, 2019).

### **Passive Protection System**

A fire protection system that is formed or built through the regulation of the use of building structural materials and components, compartmentalization or separation of buildings based on the level of fire resistance, as well as protection against openings. Passive protection system is a means, system or design that is part of the system so that it does not need to be actively driven. The components of the Passive Protection System according to (Regulation of the Minister of Public Works No. 26/PRT/M/2008) include: Fire-resistant construction pairs, fire-resistant doors and windows,

interior lining materials, fire barriers, smoke barrier partitions, smoke barriers, atrium (Salena, Safriani and Novrizal, 2019).

### **Active Protection System**

An active fire protection system is a complete fire protection system consisting of a manual or automatic fire detection system, water-based fire extinguishing systems such as sprinklers, standpipes and fire hoses, as well as chemical-based fire extinguishing systems, such as fire extinguishers and special extinguishers (Salena, Safriani and Novrizal, 2019).

### **Building Utilities**

Electrical power supply from primary and emergency sources must comply with applicable technical provisions and be used, among others, to operate the following equipment: emergency lighting, emergency communication facilities, fire lifts, fire detection and alarm systems, standpipe systems and fire hoses, automatic fire sprinkler system, smoke control system, automatic fireproof door, fire control room. The electrical power supplied to operate the emergency electric power system is obtained from at least the following two sources of electricity: PLN, or emergency power sources in the form of: Batteries, Generators and others. Emergency power sources must be planned to work automatically if the main power source does not work and must be able to work at any time. Buildings or rooms whose main power source is from PLN must also be equipped with a generator as an emergency power source and their placement must meet foreign workers applicable. All distribution cables that serve emergency power sources must meet a cable with a Fire Resistance Level (TKA) for 1 hour (Salena, Safriani and Novrizal, 2019).

In planning a building that must be considered is the reliability of the planned building. Building planning must take into account many considerations. The most important consideration is that the safety of the occupants of the house must be paramount. This consideration is needed so that the comfort of the occupants is guaranteed. Residential buildings and public buildings have more complex requirements. The main requirement is to meet quality standards and the quality of building materials so that their strength is guaranteed. It is important that the house built meets the technical specifications regarding the main requirements of residential buildings. The superiority of the material used will affect the quality of the structure above it. A strong and sturdy structure will ensure the safety and comfort of its occupants (Sinabarita D, et.al, 2021; Prastowo I, 2020; Marwahyudi M, 2020; Lutfi M, subtoni S, 2017; Lutfi M, Rusandi E, 2019; Lutf M, Mulyadi EB, 2021; Sibarani PHP, et.al, 2021; Syaiful S, et.al, 2018; Bagio TH, et.al 2021).

### **RESEARCH METHODS**

In this study, the authors use quantitative descriptive research methods, considering that this descriptive method is a type of research that seeks to describe and interpret objects as they are. The descriptive analysis method here conducts several studies which include analysis of the internal circulation design, the division of function zones, the shape and size of the evacuation route, the materials used, fire safety devices, and the placement of these tools in the building. the width and length of the corridor and the hydrant service area, as well as reviewing the number of uses and the layout of the fire safety equipment for the space circulation system in the UNIFA Building.

Parameters for checking the reliability of buildings in fire protection in this study use the literature Pd-T-11-2005-C on Building Fire Safety Inspections initiated by the Center for Research and Development for Settlements, Research and Development Agency for Public Works, Ministry of Public Works. The data that has been collected is then compiled and identified in accordance with the plan to use the data for the assessment of an aspect then the analysis process is carried out, the data analysis is carried out in two stages which include: 1). Analysis of building reliability analysis designs in fire prevention. 2). Analysis of fire prevention inspection on the object of study. Performed on the five aspects of fire prevention, using the planned design, namely: site completeness, means of rescue, passive protection system, active protection system, fire prevention management / fire management system.

## RESULTS AND DISCUSSION

### Site Completion Component Assessment

**Table 1.** Assessment of site completeness components

No.	KSKB / SUB KSKB	Rating result	Rating Standard	Weight	Condition Value	Total Value
1	2	3	4	5	6	7
<b>I. Site Equipment</b>				<b>25</b>		
1	Water Source	B	100	27	6,7	
2	Environment Street	B	100	25	6,2	
3	Distance Between Building	C	70	23	4,0	
4	Hydrant Page	B	100	25	6,2	23,1

Source: Research results, 2021

Water sources are obtained from the PDAM water network, and drilled wells, which are accommodated in the Ground Tank within the Unifa Campus area with a capacity of 234 m<sup>3</sup>, located in the rear/side area of the Nitro Building. Environmental roads in the research location are available with a width of 8m, road conditions in Cor, the width of the driveway is 10 m. The distance between buildings in the field where the distance to the Nitro building according to the requirements is height > 40m - > 8 m) = 9m, the distance to the Rectorate / Postgraduate Building is 6m. Hydrants are available in the yard in an easy-to-reach place and function perfectly and completely

### Assessment of Rescue Means Components

**Table 2.** Assessment of the components of rescue facilities

No.	KSKB / SUB KSKB	Rating result	Rating Standard	Weight	Condition Value	Total Value
1	2	3	4	5	6	7
<b>I. Rescue Means</b>				<b>25</b>		
1	Way out	B	100	38	9,5	
2	Exit Construction	B	100	35	8,7	
3	Base Helicopter	B	100	27	6,7	24,9

Source: Research results, 2021

At the research location for exits on Floors 1 & 2 there are 3 exit stairs with a height/effective of 3.5 m. Floors 3 to 10 there are 2 exit stairs with an effective height of 2 m. Each exit is protected from fire hazards. The distance is less than 20 meters from the exit. The size of the ladder is 300 CM. Exit door is not blocked. Exit door directly leads to an open space. The condition of the exit road construction is made of concrete, free of obstructions, 300 cm wide. The canal is protected against fire, Non-combustible material, surrounded by stone fitting walls. Sufficient time for evacuation of occupants with access to large buildings for firefighter action. 3. Helicopter runway only on buildings with a minimum height of 60 meters. The height of the Unifa Building is 42.6m.

**Active Protection Component Assessment****Table 3.** Rating of active protection components

No.	KSKB / SUB KSKB	Rating result	Rating Standard	Weight	Condition Value	Total Value
1	2	3	4	5	6	7
<b>I. Active Protection</b>				<b>24</b>		
1	Detect and Alarm	B	90	8	1,7	
2	Siamese Connection	B	100	8	1,9	
3	Light fire extinguisher	B	90	8	1,7	
4	Building hydrants	B	100	8	1,9	
5	Sprinkler	B	100	8	1,9	
6	Overflow Extinguishing System	K	59	7	0,9	
7	Smoke Control	B	90	8	1,7	
8	Smoke Detection	B	100	8	1,9	
9	Smoke exhaust	B	100	7	1,6	
10	Fire Elevator	C	70	7	1,1	
11	Emergency light	C	70	8	1,3	
12	Emergency electricity	B	100	8	1,9	
13	Control room Operation	C	70	7	1,1	
<b>TOTAL VALUE OF SUB KSKB</b>						<b>22,5 %</b>

Source: Research results, 2021

**Results of the Sub KSKB Field Assessment:**

1. Detection and Alarm Field assessment The design and installation of a fire detection and alarm system is in accordance with SNI 03-3986. A detection and alarm system has been installed. One of the alarm systems installed at Unifa uses a check valve alarm as the main equipment. Installed heat detectors on each floor. An alarm trigger manual tool is installed in every Fire Hydrant Box (Hose Rool)
2. Siamese Connection, field assessment is available and placed at the front of the building and easily accessible by city fire engines. The light fire extinguisher found was of the type of APAR according to SNI 03-3988. The amount corresponds to the area of the building. In 1 floor there are 6 fire extinguishers (4 in the main building and 2 in the front building). The distance between fire extinguishers is about 25 m. Using APAR Type ABC (POWER/FOAM).
3. Hydrant Building, the condition in the field is that there is a 35 mm diameter hose connection in good condition equipped with a manual alarm in the form of a sprinkler, with an overflow extinguishing system where the building is not equipped with an overflow extinguishing system, it should be for the Lab room. Computers and Rg Servers are prepared for an Overflow Extinguishing System, in order to reduce damage to computers or other electrical equipment
4. Smoke control in multi-story compartments, the air treatment system operates by using all fresh air through the empty space of the building not being one with the exhaust chimney. Smoke detection where the condition of the smoke detection system meets SNI 03-3689, activates the building occupant warning system. The smoke detector is clean and unobstructed by other objects around it
5. Smoke exhaust, the condition encountered is that the exhaust fan exists and rotates sequentially after the smoke detector is activated which is placed in a zone according to the smoke reservoir served by the fan. Located in a smoke reservoir 3 meters high from the floor. Each smoke

- reservoir has been served by one fan
6. The fire elevator is located in a fire-resistant shaft, the power source is planned from 2 sources using fire-resistant cables, has access to each residential floor and is also prepared for the FireMan's Lift Switch Panel to replace resources in the event of a fire.
  7. Emergency light and directions at the building location. There are several emergency lighting systems installed on every staircase, but we still think it's lacking. Design Emergency lighting system operates automatically, already providing sufficient lighting. There are several exit signs visible and installed adjacent to the door that provides a direct exit, the door from a staircase, but we still consider it lacking.
  8. Emergency electricity in the building The power is supplied from 2 sources, namely the PLN electricity source, or an emergency power source in the form of a generator
  9. The Operations Control Room in the building is available with relatively simple equipment such as CCTV, but it is sufficient to provide assistance in monitoring the danger of a fire that will occur.

### Passive Protection Component Assessment

Table 4. Passive protection component assessment

No.	KSKB / SUB KSKB	Rating result	Rating Standard	Weight	Condition Value	Total Value
1	2	3	4	5	6	7
<b>I. Passive Protection</b>				<b>26</b>		
1	Building Structure Fire Resistance	B	90	36	8,4	
2	Room Compartment	B	80	32	6,65	
3	Aperture Protection	B	90	32	8,3	
<b>TOTAL VALUE OF SUB KSKB</b>						<b>23.3%</b>

Source: Research results, 2021

For passive protection components where the fire resistance of the building structure is in conditions because the Unifa Building is above 4 floors, then if it is associated with the type of construction, the Unifa Building is categorized as Type A: Construction whose structural elements are fire resistant and able to withstand structurally against the load of the building.

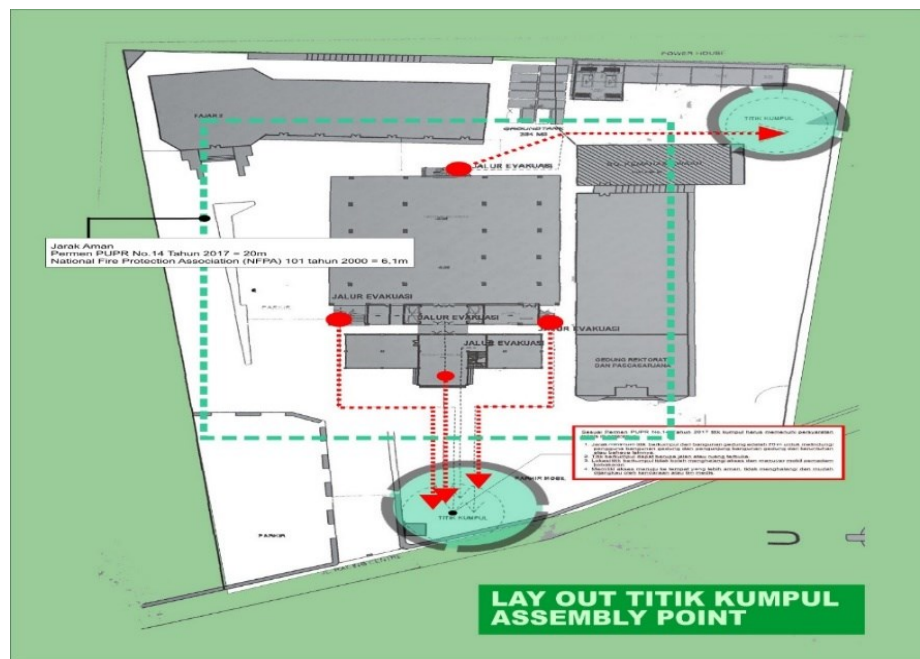
Compartmentization of space In the construction of the Unifa Building, there are separate components forming compartments to prevent the spread of fire to and from adjoining rooms and walls that are able to prevent the spread of heat to the walls of adjacent buildings. The existence of several parts of the ceiling that have been damaged and not repaired are at risk for the spread of fire and smoke. The presence of Void on floors 3 – 10 which has the potential to accelerate the spread of fire to the upper floors. Aperture Protection where vertical openings from the walls are closed from bottom to top on each floor given a fireproof cover. The windows in the Unifa building are made of 8mm Panasap / Tempered glass. Fire doors, fire windows, smoke retaining doors and fire shutters conform to fire door standards. The thickness of the door is made of fireproof material with a thickness of 35mm door leaf. Egress/entrance on fireproof wall, self-closing/automatic

**Parameter Weighting Results of UNIFA Building Safety System Components**

**Table 5.** Weighting of the parameters of the building safety system of the UNIFA Building

No.	Parameters KSKB	Bobot KSKB(%)
1	Site Equipment	23,1
2	Rescue Means	24,9
3	Active Protection System	22,5
4	Passive Protection System	23.3
<b>TOTAL</b>		<b>93,85 %</b>

Source: Research results, 2021



**Figure 1.** Design of meeting point location in Fajar University Building

Although the Unifa Building Fire Protection Reliability Value is considered Good (Good) but there are some components / damaged / lacking or even non-existent so we recommend the following: (1) Periodic Component Inspection, (2) Periodic maintenance/maintenance, (3) Periodic maintenance and repairs (4) Completing/Adding missing components (5) Repairing damaged and non-existent components (6) Designing a protection system that is not/inadequate in number and its placement that needs to be re-planned due to changes in function and area of space. Designing a protection system that has not/less in number and its placement that needs to be re-planned due to changes in the function and size of the room: (a) Design for Placement of Evacuation Directional Signs (b) Placement of Exit / Non-Exit Signs (c) Design Directions for gathering points ( d) Addition of Hydrant Point (e) Addition of Point / Overflow Extinguisher (f) Addition of Fire Fighting Control Room (Figures 1 and 2).



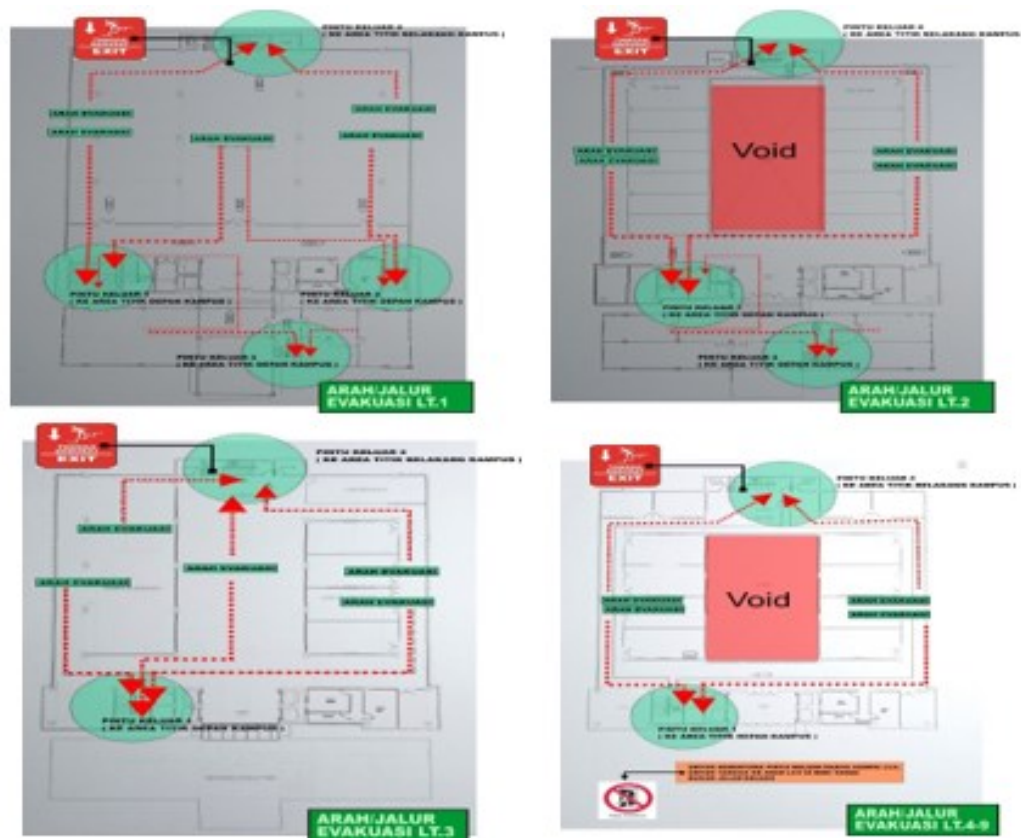


Figure 2. Evacuation route design in Fajar University Building

## CONCLUSION

Based on the results of the study, it can be concluded that the completeness of the site on the Unifa building as a whole exists and is in accordance with the requirements of SNI and applicable regulations, although one of the requirements for the distance between buildings is not met, because the distance between the Unifa Building and the Old Building (Rectorate Building) does not meet the distance standard, but the Distance to the Nitro Building still meets the standard, and overall the Completeness of the Tread on the Unifa Building is considered Good. The rescue facilities in the unifa building as a whole, starting from the Stairway Exit Access, meet the requirements in terms of both dimensions and number of facilities. Active Protection System, several active protection components have been fulfilled, but there are also some protection components that are lacking such as: Emergency light, and Operation Control Room, some are not even available such as: Overflow Extinguishing System, Fire Elevator. Passive Protection System, Passive Protection Components in the Unifa Building meet the requirements, but we found that there are components that do not meet the requirements, such as the exit door that should not be locked when the building is in use, we found it in a locked condition. The presence of Void in the center of the building that has the potential to accelerate the spread of fire, and the presence of a damaged ceiling.

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