

EVALUATION OF THE PERFORMANCE OF FIRE CONTROL TOOLS AND SIMULATION OF EXISTING EVACUATION ROUTES AT THE EMPIRE XXI CINEMA BUILDING IN YOGYAKARTA: POST-FIRE CASE STUDY YEAR 2024

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ABSTRACT: *The fire that occurred at the previous Empire XXI Cinema Building in Yogyakarta raised concerns about the safety and suitability of the existing evacuation system and fire prevention tools. This research aims to measure the effectiveness of existing evacuation routes and evaluate the suitability of fire prevention tools in fire scenarios. The research methods used include field surveys, computer simulations, and data analysis. Evaluation was done by giving scores through fire hazard tools. A pathfinder simulation was also done to analyze the effectiveness of the evacuation route. The results of the research will provide a better understanding of building safety conditions. The results of the research will be in the form of feasibility test values carried out using spreadsheets. It will also be proven whether the fire prevention system has become better than before the fire. Therefore, a pathfinder simulation was also carried out to find the right evacuation route. It also provides recommendations for repairing or upgrading existing evacuation systems and fire hazard prevention tools. In this way, we predict that this research will help improve the safety of visitors and employees of the new Empire XXI Yogyakarta Cinema Building and contribute to increasing awareness of the importance of building performance assessment in mitigating fire risk.*

Keywords: *cinema, fire, effectiveness, evacuation, safety, tools*

INTRODUCTION (new)

Fire safety in buildings is important, especially in public buildings, such as cinemas. Cinemas often accommodate large numbers of people. If a fire occurs, it can threaten the lives of many people in a short time. Fire control equipment must be available and function properly for the safety of the lives of the people inside. Clear evacuation routes can evacuate people safely and quickly from a burning building. Fire can cause economic losses, especially related to damage to facilities. If the physical damage is severe, it will cost a lot of money to repair. Apart from that, it can also result in the cessation of cinema operations so that no income is generated. Overall, fire safety not only protects lives and property, but also ensures sustainable business operations, complies with legal regulations, and maintains a good image. Therefore, good implementation of fire prevention arrangements must be carried out.

Evidence of negligence and inadequacy in fire prevention can be seen from the fire tragedy at the Empire XXI cinema in Yogyakarta in the past. Based on an article from IDN Times Jogja (2021), when the fire occurred, the building was a Hero supermarket that had a Regent cinema in it. The building consisted of two floors, where the first floor was used as a supermarket, while the second floor was used as a cinema. In the past, this place was so popular that many local people came there to have fun. The location was on *Jalan Urip Sumoharjo no. 104, Klitren, Gondokusuman, Yogyakarta City* where it is very strategic so the place was often busy with lots of customers.

In 1999, a fire occurred on the second floor of the building which functioned as a cinema. The fire resulted in property damage and the cessation of cinema operations. However, the police reported that there were no casualties in the first incident. Not long afterward, the cinema experienced a fire and caused fifteen deaths. Police reported that there were four victims whose bodies were not found. The cause of the fire is currently unknown because

the technology and methods for investigating fires may not be as good or sophisticated as they are now, making it difficult to accurately identify the cause. The fire which spread quickly and burned most of the area also contributed to the dead end of the investigation.

After a fire occurred, the cinema was rebuilt in the same location. Then in 2002, the cinema returned to operation after going through a renovation process. According to a street vendor selling in front of the cinema, it underwent an update and was renamed the Empire XXI cinema in 2009. The Cinema XXI network took over and brought changes to more modern facilities and technology to date. Afterward, there was an urgent need to reassess the performance of fire control equipment and the design of evacuation routes in cinema buildings. Therefore, it is necessary to carry out further analysis regarding possible factors that cause fires and examine the feasibility of fire prevention systems in the past.

After analyzing past incidents, it is necessary to assess the suitability of fire prevention equipment and evacuation routes after the building is revitalized. The analysis begins by collecting data on fire prevention equipment through direct observation. The use of computer simulation with a pathfinder was also carried out to determine the effectiveness of existing evacuation routes. So, conclusions about whether today's fire prevention systems are better than before can be reached.

RESEARCH QUESTIONS

1. How did fire happen in the past in Empire Cinema? Is the current condition of the fire hazard tools performing well enough to prevent fires from escalating?
2. What are the existing evacuation routes in the Empire XXI cinema building and how effective are they in the event of a fire emergency?

LITERATURE REVIEWS

According to Roderick Ham (2014), the cause of fires in cinemas or theaters can come from the use of conductor materials such as wood or canvas. A small amount of fire that is exposed can result in a large fire. Therefore, the solution is to provide smoke detectors and sprinklers in the room. (page 38) Automatic sprinklers will reduce the scale of the fire as much as possible. The use of flammable materials produces large volumes of smoke in walls and ceilings, light fittings should be avoided, and soundproofing materials, resonant paneling, and other acoustic treatments must have a satisfactory degree of flame resistance. (page 39).

According to Jim Burtles (2016), the ideal evacuation route must be accessible from the exit access to the gathering area point. Evacuation routes must not cause congestion. Evacuation route signage must also be clear so as not to confuse occupants. According to him, there are also cases where evacuation doors are locked in a cinema to prevent public use, such as people entering the cinema without paying or for homeless people to stay. However, when a fire occurs, it causes the death of many people. This made him think that the evacuation doors should be left unlocked.

According to James P. Tubbs and Brian J. Meacham, it is critical to maintain structural integrity when a fire occurs and prevent the spread of fire and smoke. This includes the use of anti-fire materials that can withstand fire exposure for a certain duration. Installation of fire-resistant walls, floors, and ceilings to compartmentalize buildings and limit the spread of fire as fire barriers.

According to him, it is important to have an integral fire protection system to ensure the safety of occupants. They classify systems into detection systems, suppression systems, containment systems, and evacuation aids. Detection systems in the form of smoke detectors and fire alarms which warn occupants if there is a fire. Suppression systems in the form of sprinklers and fire extinguishers help control fire extinguishing. Containment

systems in the form of fire-resistant walls, doors, and barriers can also prevent the spread of fire. Meanwhile, evacuation aids can be in the form of emergency lights and exit signage that can guide occupants to exit the building safely.

According to Hui Zhang (2022), Pathfinder is software for carrying out simulations related to disaster evacuation, including evacuation in a fire. The application can visualize the movements of several groups or individuals. In it, people can adjust the speed at which people move depending on their age classification, shoulder width, or body height. By making a 3D model of an existing building, people can check whether the evacuation route is correct or smooth if there is a certain number of people inside. If the simulation results are less effective, it can be revised the previous evacuation route and simulate it again until it gets effective results.

RESEARCH METHODS

Table 1.

Variabel	Parameter	How to Collect Data	How to Analyze Research Data
Causes of Fires in the Past	1. Fire Source 2. Physical condition 3. Previous Building Design 4. Existing Evacuation Procedures/Limitations	Documentation, Interview with Trusted Parties	Using mapping & connecting related theoretical studies
Fire Prevention Tools	1. Site Completeness 2. Evacuation Facilities 3. Active ProtectionSystem 4. Passive ProtectionSystem	Observation, Documentation	Using assessments based on fire hazard tools spreadsheets
Evacuation Routes	1. Capacity & Distribution Occupants 2. Spatial Arrangement & Infrastructure	Observation, Documentation, Measurement	Effectiveness simulation with the Pathfinder application

Source: Author

Research data was taken by conducting direct field observations. Data in the form of photographs and notes relating to the availability of fire prevention equipment (active and passive systems), including evacuation routes and exit doors in the current building. Researchers also conducted searches regarding the causes of fires in the past by interviewing residents and people who had experience with going to the Empire Cinema in the past.

To assess buildings with fire hazard tools, the researchers will do the scoring by scoring spreadsheets. The additional research methods that are used by the researchers are field observation and surveys. This involves direct observation and collection of field data about the physical condition of the building, including fire extinguishing systems, fire detection equipment, and evacuation routes. Researchers identify the installation locations of fire hazard tools, such as smoke detectors, sprinklers, fire warning systems, and fire extinguishers, and evaluate their quality and adequacy. It also allows researchers to understand directly the environmental and infrastructure factors that can influence the risk of fire in buildings.

The experimental research method is also used. An assessment regarding the effectiveness of the evacuation routes at the Empire XXI cinema was carried out using a Pathfinder simulation. Researchers collected data on evacuation routes at several points in the building. Then form a floor plan with precise measurements of average occupants in real

conditions. Then simulate it with a pathfinder to find the results if a fire occurs at a certain point, whether the occupants managed to exit the building smoothly and safely.

FINDINGS

Past Conditions in 1999



Figure 1

Source: Kaskus Community

The Empire Cinema is located on the second floor and is combined with the Hero supermarket which is on the first floor. According to Klitren residents, the layout of the previous building was more or less the same as the current cinema building. The difference lies in the completeness of fire hazard tools. The cinema has 8 Cineplex studios. There is a lobby for exchanging tickets and also a food court. Based on information from Maryanto, the fire occurred in the morning around 8 or 9 o'clock, and was caused by an electrical short circuit in studio 1. The fire burned down the cinema but fortunately, there were no fatalities at that time because the fire occurred in the morning.

According to Yoga Prasetya, the cinema building is a modern building where at that time the electrical installation was much neater than other old buildings in Jogja. At that time, the fire brigade immediately helped put out the fire. The Regent Cinema is located in the same location as the Empire Cinema, to the west. The cinema consists of 4 cineplex studios on the second floor. Meanwhile, the first floor functions as a stationery shop and casino gaming area. According to Donny Verdian (personal blog), the Empire cinema is much neater and nicer than the Regent. There is a café downstairs which makes it easy to bring snacks before going upstairs to the cinema.

According to Agung Handoko Prasetyo, when the fire occurred for the second time, the cinema was running at full capacity. The fire occurred at the last film screening at 22.00. The majority of victims were women, according to sources, many were trapped in the women's toilet and could not evacuate themselves because the fire had spread and there were no proper fire prevention tools. Therefore, there was a man who tried to save through a window roster.

Current Conditions in 2024



Figure 2
Source: Author



Figure 3
Source: Author

The current Empire XXI cinema is facing north. The building has only one floor but has a high height. The building area is around 3000 m² while the site area is around 5000 m². The main entrance is from the car parking area on the north side of the building. The cinema has 6 movie studios (1,2,3,4,5, premiere). The lobby area consists of a ticket box, an F&B area with a kitchen, a seating place, a cafe with a kitchen, and a premiere ticket box. The cinema has two toilets (men and women's). There are two hallways. The first is for the studio 4 entrance. The second is for studio 1,2,3, the premiere entrance. Along the hallways, there are always many seating places. Both hallways have their own emergency exit.

Fire Hazard Tools Conditions

I. Site Completeness

Water Source	Neighborhood Road	Distance between Buildings	Yard Hydrant
			

Figure 4
Source: Author

II. Evacuation Facilities

Exit Access	Exit Construction
	

Figure 5
Source: Researcher

III. Active Protection Components

- Hallway 1 = 5 sprinklers, 1 smoke detector, 1 emergency exit door, 1 emergency light.
- Hallway 2 = 6 sprinklers, 1 emergency exit door, 1 fire alarm, emergency lights, smoke

detector

- Lobby = sprinklers, emergency lights, smoke detector, fire alarm
- Toilets = sprinklers, emergency light
- Outdoor = fire hydrant

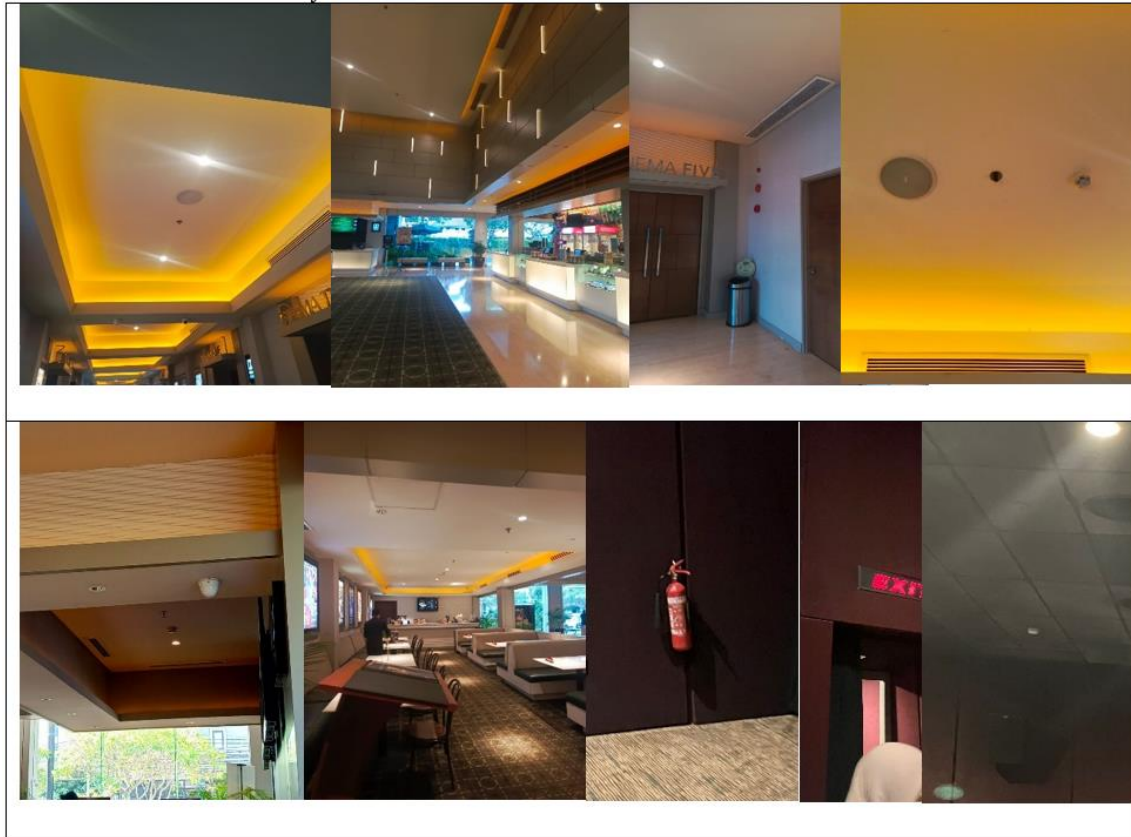


Figure 6

Source: Author

IV. Passive Protection Systems

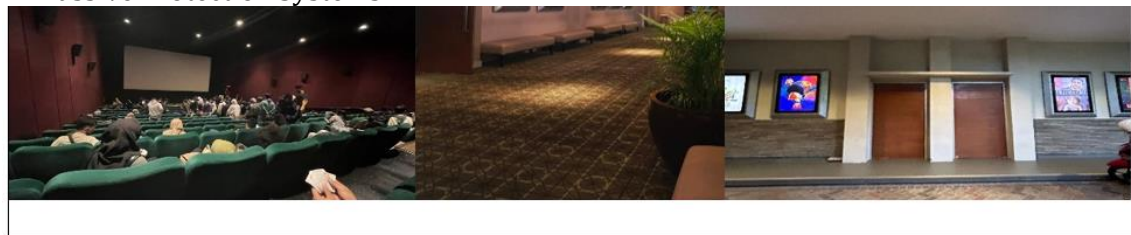


Figure 7

Source: Author

Fire Hazard Tools Assessment

Table 2

I.	Site Completeness	Scoring G/E/L	Point Score	Weight	Component Score	Total Score
1.	<u>Water Source</u>	Enough	80	27	5.4	22.5
2.	<u>Neighborhood Road</u> The north main road has a width of 13 m and the East the road has a width of 7 m.	Good	100	25	6.25	

	It is also paved and has a minimum driveway width of 4 m.					
3.	<u>Distance</u> Between nBuildings It has a height of around 8-14 but the distance between buildings on the the south side is less than 6 m.	Enough	80	23	4.6	
4.	<u>Yard Hydrant</u> The hydrant is located on the south side of the building (in the motorcycle area). It has a pipe to the front.	Good	100	25	6.25	
II.	Evacuation Facilities	Scoring	Point	Weight	Component	Total

		G/E/L	Score		Score	Score
1.	<u>Exit Access</u> The cinema has two exit access to the motorcycle parking areas.	Enough	80	38	7.6	18.65
2.	<u>Exit Construction</u>	Enough	80	35	7	
3.	<u>Helicopter Pad</u> Unavailable	Less	60	27	4.05	
III.	Active Protection Components	Scoring G/E/L	Point Score	Weight	Component Score	Total Score
1.	Detection and Alarm	Enough	80	8	1.536	18.912
2.	Siamese Connection	Less	60	8	1.152	
3.	Light Fire Extinguisher	Enough	80	8	1.536	
4.	Building Hydrant	Good	100	8	1.92	
5.	Sprinkler	Good	100	8	1.92	
6.	Overflow Extinguishing System	Enough	80	7	1.344	
7.	Smoke Control	Good	100	8	1.92	
8.	Smoke Detection	Good	100	8	1.92	
9.	Smoke Exhaust	Enough	80	7	1.344	

10.	Fire Elevator	Less	60	7	1.008	
11.	Emergency Light and Directions	Enough	80	8	1.536	
12.	Emergency Electricity	Enough	80	8	1.536	
13.	Operations Control Room	Enough	80	7	1.344	
IV.	Passive Protection Systems	Scoring G/E/L	Point Score	Weight	Component Score	Total Score
1.	Fire Resistance of Building Structure	Enough	80	36	7.488	20.8
2.	Space Compartmentalization	Good	80	32	6.656	
3.	Aperture Protection	Enough	80	32	6.656	

Result of Assessment

No.	Fire Hazard Parameters	Weight (%)	Score
1.	Site Completeness	25	22.5
2.	Evacuation Facilities	25	18.65
3.	Active Protection System	24	18.912
4.	Passive Protection System	26	20.8
		100	80.86

Source: Author

The results of the overall assessment show that current cinema buildings have good fire prevention safety qualities. The final score of **80.86** is included in the Good qualification. However, the fire building has deficiencies in evacuation facilities where the lowest score is **18.65/25**. This is because the exit access and exit construction are not good enough, and there is no helicopter pad. Therefore, researchers conducted deeper research using pathfinder simulations in the next section to find out how quickly people can evacuate safely and have definite results.

Pathfinder Simulation Assessment

In the 1999 fire, the source of the fire came from an electrical short circuit in studio 1. Therefore, a fire evacuation simulation was carried out in studio 1 based on the existing evacuation routes to determine the effectiveness of their duration.

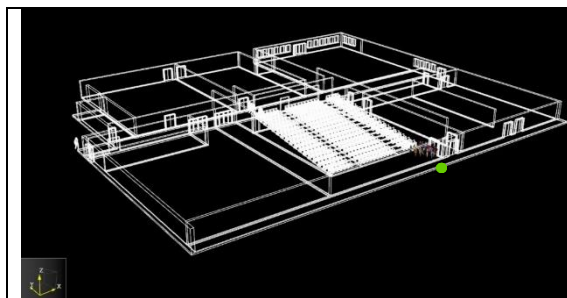


Figure 8
Source: Author

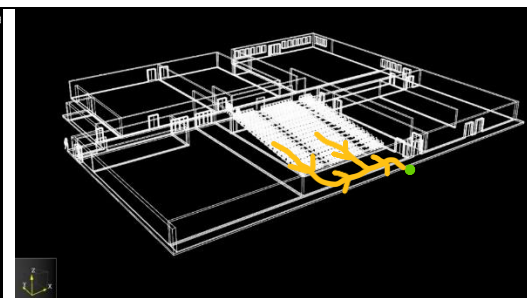


Figure 9
Source: Author

The number of occupants in the first simulation is thirty people which is included in the category when there are few visitors. Initially, the occupants entered the cinema one by one and there was a small queue near the exit of the cinema. The duration needed for everyone to evacuate is 59.5 seconds, meaning each individual only needs 1.98 seconds to get out via the emergency exit.

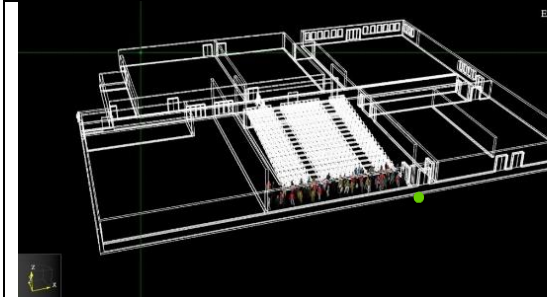


Figure 10
Source: Author

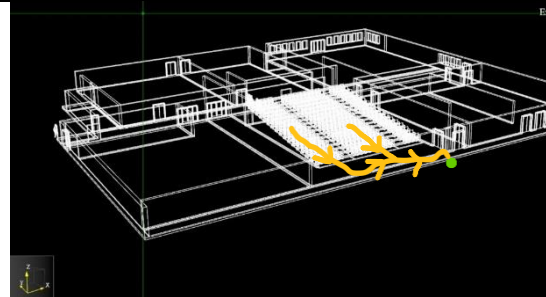


Figure 11
Source: Author

The number of occupants in the first simulation is seventy people which is included in the category when there are many visitors. Initially, the occupants entered the cinema one by one and there was a small queue near the exit of the cinema. The duration needed for everyone to evacuate is 149.5 seconds, meaning each individual only needs 2.13 seconds to get out via the emergency exit.

From the Pathfinder simulation that has been carried out on Studio 1 in Empire XXI, shows that the existing evacuation routes are quite good. It was recorded that 70 occupants could leave via the emergency exit for 149.5 seconds. This is because the cinema exit is close to the emergency exit so they can go outside directly. Apart from that, the width of the evacuation route is 4 meters wide, which helps occupants safely escape.

CONCLUSION

Based on the evaluation with fire hazard tools and simulation with Pathfinder, the following conclusions are drawn:

1. The results of the overall fire hazard assessment show that current cinema buildings have good fire prevention safety qualities. The final score of **80.86** is included in the Good qualification. However, the fire building has deficiencies in evacuation facilities where the lowest score is **18.65/25**. This is because the exit access and exit construction are not good enough.
2. The results of the fire simulation with the fire source from studio 1 went smoothly. If the studio is at full capacity, for example, 70 occupants, they can save themselves in 149.5 seconds. This is influenced by the location of the exit and emergency exit which are close together. However, the southern area is used as a motorbike parking lot which is not in accordance with the provisions for empty and open areas.

RECOMMENDATION

From the existing conclusions, the recommendation is to improve the quality of exit access in the southern part by widening open space. Motorbike parking which can be a nuisance because it contributes to filling up the area must be moved to an empty area such as the west area of the cinema. The use of flammable materials such as floor carpets, wooden doors, walls covered with dampers must be balanced with fire hazard tools, especially sprinklers. Additional sprinklers can be placed in cinema rooms that have a lot of fire-permeable materials.

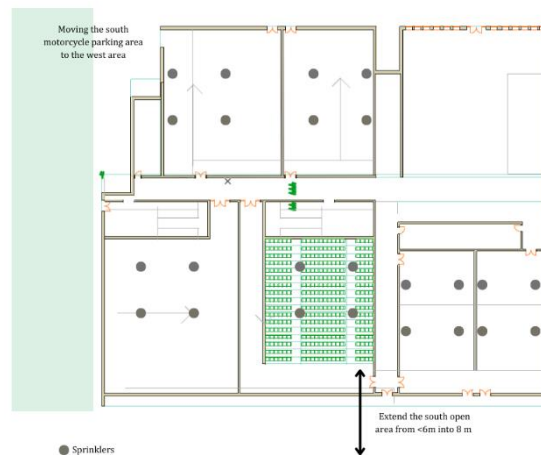


Figure 12
Source: Author

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