

ASSESSMENT OF FIRE HAZARD SYSTEM AND EVACUATION ROUTE QUALITY: COSAN CAFE AND DRAGON HOTPOT BUILDING

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ABSTRACT: Commercial places in Yogyakarta are currently experiencing an increase in popularity, especially restaurants and cafes. One example is Cosan Cafe and Dragon Hotpot with a location and feel that attracts many visitors to come. The purpose of this research is to provide a performance development of fire disaster mitigation and handling systems in Cosan Cafe and Dragon Hotpot building, (1) where the existing facilities will be evaluated to find out the quality of the fire hazard system and evacuation routes according to the standard. (2) To understand the problem, the research will be accompanied by a literature review as a reference for discussion. The research will use two stages of methods, first, direct observation and measurement of the study object by applying the Fire Hazard Assessment tool for standard analysis. Evacuation data will be analyzed using Pathfinder simulation tools to assess the quality of existing evacuation routes. (3) Based on the research results, there is a fire hazard system that is still inadequate in quantity and quality. On the other hand, the quality of evacuation routes still has a long duration when judged by the standard time, which is 150s. (4) Overall, the results and discussions include some improvements in the selection of more efficient evacuation routes and the completeness of fire hazard systems to improve building performance.

Keywords: Evacuation, Performance, System

INTRODUCTION

Restaurants are part of the commercial sector and are usually occupied by a large number of visitors at the same time. Hence, the safety and strength of the building are very important for the maximization of its function. The development of the shape and function of the building still undergoes till this time. This action encourages many restaurants to compete to create material designs and spatial arrangements by being concerned with comfort and captivating visitors. A restaurant defined as a commercial space arranged to serve food and drinks to visitors by providing a good experience (Atmodjo, 2009).

Causes Of Fire Accidents In Restaurants

To be remembered from the natural problems during cooking that can be created from the restaurant experience is fire. Restaurants not only have occupancy for their visitors but also the workers and cooking tools. Cooking utensils are the source of fire and heat, which can cause a fire. Fire hazards in restaurants are also in line with the city of Yogyakarta, which is experiencing an increasing trend in the number of commercial buildings for restaurants and cafes. The data results of 56 fire cases in Yogyakarta were triggered by equipment and electrical problems. In detail, 27 cases were caused by electrical issues, 11 cases were caused by LPG gas leaks, and 9 of them were caused by human error. The types of buildings burned were 20 industrial/commercial buildings, 18 residential buildings and six other objects (Fire and Rescue Departments, 2023).

Location

Fire hazards are generally easy to occur in commercial buildings with large electricity usage activities and cooking, especially in Yogyakarta. This is also related to a cafe and restaurant that will function in 2022, Cosan Cafe and Dragon Hot Pot, located in the Seturan area, Sleman, Yogyakarta. Located in the same building, the division of the Dragon Hotpot and Cosan Cafe restaurant area is as follows: Cosan Cafe is located on the 1st floor and rooftop of the building, Dragon Hotpot is situated on the 2nd floor or the center of the building. Both

are connected with access to a staircase and elevator (lift) located at the center of the building.

There is a further need for a review of the current state of the fire appliance system and evacuation routes in the specific case of a restaurant and café building in Yogyakarta's building. This review asks the following questions whether the quality of the fire hazard system and evacuation routes are in accordance to the standard and can accommodate users. The objective of this research paper is to provide a performance development of fire disaster mitigation and handling systems at Cosan Seturan and Dragon Hotpot building, where the existing facilities will be evaluated to identify and eliminate fire hazards. With the scope of architecture in maintaining building performance through fire hazard systems and providing evacuation routes.

This research paper followed by hypothesis of a shortfall between the fire hazard equipment requirements, the perceived effectiveness of the fire hazard system and the quality of the evacuation routes decreased, resulting in increased concerns among occupants regarding their safety and ability to evacuate in the event of an emergency.

LITERATURE STUDIES

Materials And Equipment In Ignition

Fire safety in commercial buildings, particularly restaurants, is a critical concern due to various factors including equipment standards, material combustibility and structural vulnerabilities. The primary cause of fire in restaurants often stems from faulty cooking equipment and the use of flammable materials in interior furnishing (Utami, et.al 2020). These factors not only exacerbate the intensity of fire but also contribute to their rapid spread within the building. Additionally, structural weakness with insufficient fire extinguisher and inadequate fire disaster training for employees preparedness further compromise building safety during fire emergencies (Wahab, 2015).

Besides the material and user preparedness, The spatial layout of a restaurant or café significantly influences evacuation efficiency during emergencies. Factors such as user density, the arrangement of interior spaces, and designated paths of travel can create obstacles that hinder smooth evacuations. Studies have demonstrated that congestion and delays, particularly at stairwell exits, often arise as individuals opt for the closest and fastest routes rather than the most efficient ones. To enhance safety, it is crucial to design clear and accessible escape routes, reduce obstructions, and ensure adequate wayfinding signage throughout the building (CFPA-E, 2023).

Detection, Prevention And Evacuation

A fire will create smoke with a quantity determined by the amount and type of material burning (Clark, 1988). This smoke is then the source of detection and notification through a fire hazard system or device. Fire hazard warnings are intended to be responded to by all users of the precariousness of the situation and directed to the fire extinguisher system or fire brigade assistance (Bryan, 1982). This sump creation process and protection system will relate to the evacuation and fire hazard systems.

Beside that, all fire hazard systems in medium-large buildings can be analyzed by SNI 03-3989-2000. This standard can guide the minimum requirements for fire fighting installations, especially sprinkler systems. Hence this standard can be followed for this research suggestion. Beside that, a fire hazard system is also detected using the Aspirating Smoke Detector (ASD) that has the principle of detection through the collection of a certain amount of smoke with a certain threshold limit. The ASD system can provide advantages in settings such as detection sensitivity and covering large area networks (Lee, Y.M., 2022).

Evacuation In Fire Hazard System

The safety of commercial buildings is significantly bolstered by the presence of robust and well-designed evacuation route systems. Critical factors that ensure effective evacuation encompass evacuation time, procedural clarity, occupancy levels, travel distances, rescue routes, and the clarity and visibility of emergency signage. In response to catastrophic fire events, innovative engineering approaches, such as Fire Modelling, have been developed to test and enhance the feasibility of building evacuation routes. These efforts utilize advanced computer simulations like Pathfinder, which leverage technology from the gaming and computer graphics industries to create realistic and precise evacuation scenarios.

Pathfinder consists of key determinants of evacuation time, including individual decision-making processes regarding route selection, the accuracy of communication, and established procedural guidelines (Qin, J. et.al,2020). Assessment on evacuation procedure underscore the significant placement of stairways, design of exits and the occupants character in evacuation process (Kodur, 2024). At the same time, the evacuation process also illustrates the variability of natural reactions from the occupants towards the disaster (Jumaidi, 2018).

For instance, low-rise commercial or office buildings typically achieve faster evacuation times due to the occupants' higher disaster preparedness and awareness, in stark contrast to high-rise buildings. Additionally, public buildings tend to have more established protocols and better disaster preparedness tools. Therefore, post-evacuation behavior analysis can reveal that evacuation efficiency varies significantly depending on building type and occupant awareness (Ronchi, 2013).

A critical design for clearness, well-placed and easily readable emergency signage in facilitating effectiveness of wayfinding process can enhance the building performance towards disaster (Sari, 2022). Conversely, some examples of emergency stairs performance evaluation in a 6-story building, Telkom Surabaya Hospital. Obtained several evacuation scenarios and encompassed bad and good impacts on the performance by time as the jury (Haqqur, 2020). While the standard evacuation time for the building as a reference for the quality of the evacuation scenario is around 150s (Ramli, 2010).

RESEARCH METHODS

This study will employ quantitative methods, particularly in data analysis, using assessment tables and state simulations conducted through specialized software. Additionally, a literature review will support the study in achieving its objectives and enhancing the discussion. The initial phase will involve assessing the fire hazard system and emergency evacuation routes within the building. This assessment will be conducted using fire hazard assessment tables and measurement tools. Data for the assessment tables will be collected through direct observations and quantitative evaluations of building elements based on predefined parameters. Observations will be carried out in each three-story building.

The analysis will be further supported by simulation programs. Specifically, natural scenario simulations will be conducted using Pathfinder software to evaluate the effectiveness of evacuation routes. These simulations will include various scenarios, such as user density, activity intensity, user location, emergency route placement, and different emergency situations. The Pathfinder simulations will aim to achieve specific parameters related to evacuation time, user density, and movement patterns, following the standards set by the Society of Fire Protection Engineering (SFPE).

RESULTS AND DISCUSSION

Building Material

The exterior of the Cosan Cafe and Dragon Hotpot building is covered in a combination of concrete and red bricks. With a minimalist box-shaped design, it is clear that the building

has a large opening design with a ratio of 6:10 of the wall area. Massive use of glass, brick and concrete materials will have a major impact on the strength of the building against fire hazards.

All three materials are part of non-combustible materials that support the building structure to withstand fire hazards. The application of material location is also very important in the Cosan Cafe and Dragon Hotpot buildings. The reason is that all boundaries between the inside and outside of the building use tempered glass. Lightweight tempered glass is implemented as doors and windows so that evacuation needs are very easy to do. Concrete materials are applied as the main columns to support the strength of the building structure so that it is not vulnerable to collapse and fire.



Image 1 Front building facade

Source : Writer, 2024

This building is famous for its beautiful interior design with traditional Chinese nuances in the Dragon Hotpot section and futuristic in the Cosan Cafe section. The majority of materials that are often implemented are wood as an interior form of tables and chairs. This combustible material triggers the fastest spread of fire in fire hazards. The dense interior arrangement also supports a very dangerous fire outbreaks distribution medium (CFPA-E, 2023). On the other hand, the interior wall design at Dragon Hotpot restaurant implements wood ornaments as the main aesthetic value. The implementation of wood on brick walls is a contradiction to the strength of the building in the face of fire.



Image 2 Interior visualization (a) Dragon Hotpot & (b) Cosan Cafe

Source : Writer, 2024

Fire Safety Tools

This low-rise building has a fire hazard system that is considered insufficient to meet existing standards. The assessment identifies the active protection system in the building is considered quite low in the provision of facilities. Such as smoke detectors, smoke control devices and smoke exhausts have a small quantity per building floor. The placement of fire hazard equipment is too far to be reached on the side of certain rooms. Besides, that fire hazard equipment also has different categories or types and some of the tools were already expired.



Image 3 Fire safety tools APAR (a) and the implementation
 Source : Writer, 2024

The placement of fire hazard equipment aligns with the direction of hazard warning and evacuation. For example, the extinguisher is placed close to the emergency stairs and the exhaust system on each room’s ceiling. When the danger manual warning and evacuation process starts, users can reach the tools quickly and concisely while evacuating themselves. This action is in accordance with research conducted by Bryan (1982) where the fire management system will support the evacuation process.

Table 1 Fire Hazard Assessment

Parameters	Total
Site Completeness	21.45
Evacuation Families	22.3
Active Protection System	17.712
Passive Protection System	22.464
Total	83.926

Source : Writer, 2024

The fire hazard system performance check assesses several aspects including site completeness, evacuation systems, active protection systems and passive protection systems. Through observation, the data table shows the assessment value of the fire hazard system that indicates weak provision of facilities is based on the aspect of the active fire protection system which has the lowest value. According to research of Lee, Y.M. (2022) incomplete, effective and sophisticated fire hazard systems will adversely affect the building's performance in responding to fire hazards.

Table 2 Site completeness component values

No.	Site Completeness	Scoring	Total
1	Water source	B	6.75
2	Neighborhood road	B	6.25
3	Distance between building	K	3.45
4	Yard Hydrant	C	5
	Total		21.45

Source : Writer,2024

This building has 1 water source from PAM which is accommodated in a Roof WaterTank with a capacity of 320 liters with the designation of commercial buildings. Based on the standard fire hazard assessment system, the assessment results can be categorized as ‘Good’ with condition value 6.75. This building location also has a large road access with a distance of 9 meters which includes vehicle and pedestrian roads. Based on the standard

fire hazard assessment system, the assessment results can be categorized as ‘Good’ with condition value 6.25.

The Cosan Cafe and Dragon Hotpot buildings have deficiencies in the design of the distance between the buildings. Between the buildings on the south and north sides only have a distance of 1.5 meters, the distance has not met the assessment standards at a minimum distance of 3m. The assessment results can be concluded with the ‘Less’ category with condition value 3.45. The aspect of the hydrant yard is its availability without a poor working function due to its placement which is too far from the building. The aspect assessment can be categorized as ‘Sufficient’ with condition value 5.00.

Table 3 Evacuation families component values

No.	Site Completeness	Scoring	Total
1	Exit access	B	9.5
2	Exit construction	B	8.75
3	Helicopter pad	K	4.05
Total			22.30

Source : Writer,2024

The Cosan Cafe and Dragon Hotpot designed the exit access by several considerations such as tempered glass door with 2m length and 2.5m meter height. The door mechanism uses a 2 direction swing with 5m distance from emergency stairs. This exit access design meets the standards in the fire hazard system assessment. The assessment of this aspect can be categorized as ‘Good’ with a condition score of 9.5. The performance of the exit access is also driven by its construction performance, which uses non-combustible materials such as tempered glass that can withstand the heat of the fire and has good material strength. The access construction has no obstructions and is of a size that will not interfere with evacuation. The assessment of this aspect can be categorized as ‘Good’ with a condition score of 8.75. This building has the category and function of a restaurant-café that does not support and require a helicopter pad. Therefore, the assessment on this aspect can be categorized as ‘Less’ with a condition score of 4.05.

Table 4 Active protection system component values

No.	Site Completeness	Scoring	Total
1	Detection and alarm	K	1.152
2	Siamese connection	C	1.536
3	Light fire extinguisher	C	1.536
4	Building hydrant	K	1.536
5	Sprinkler	K	1.344
6	Overflow extinguisher	K	1.344
7	Smoke control	C	1.536
8	Smoke detection	C	1.536
9	Smoke exhaust	C	1.344
10	Fire elevator	C	1.344
11	Emergency light and direction	K	1.152
12	Emergency electricity	B	1.92
13	Operation control room	C	1.344
Total			18.48

Source : Writer,2024

The unavailability of fire detection and alarm equipment in this building is an important problem for the fire hazard system. This is because detection and warnings arise manually from the appeals of users and workers of Cosan Cafe and Dragon Hotpot. The assessment of this aspect can be categorized as ‘Less’ with a condition value of 1.152. Siamese connection building is available in the parking area (outdoor) but this facility cannot reach the inside of

the building. The assessment of this aspect can be categorized as 'Sufficient' with a condition score of 1.536.

The type of fire extinguisher used in this place is in accordance with SNI 03-3988 standards, but unfortunately there are several fire extinguishers that have expired. The quantity of these tools is also inadequate to the needs of the size of the space, this is the weakness of the fire hazard system in this building. The assessment can be categorized as 'Sufficient' with a condition score of 1,536. Other fire hazard system equipment such as building hydrants and sprinklers are also not available in buildings so they do not meet the quantity criteria. The assessment of this aspect can be categorized as 'Less' with a condition score of 1.152.



Image 4 Electrical room & water source pump
Source : Writer, 2024

The overflow extinguisher system in this building is also absent in its availability, this is due to the selection of the use of CO2 extinguisher which is easier and more efficient. This assessment can be categorized as 'Less' with a condition score of 1.008. Smoke handling systems such as detectors and controllers have sufficient availability and design. The distance between installations on the ceiling is 10m without cover or interference from other objects. However, the presence of the installation is only in the cooking room, especially the quality of the detector is also in accordance with SNI 003-3689. This assessment can be categorized as 'Sufficient' with a condition score of 1.536.

The building has a smoke exhaust duct that leads to the west of the building, but its exhaust capacity is still insufficient with its size of 15 inches. In addition, the lift transport system in this building does not fully meet fire hazard standards. The lift has instructions and hazard warnings in addition to the infrastructure is equipped with metal shaft parts that are resistant to fire. The assessment of these two aspects of the building can be categorized as 'Sufficient' with a condition score of 1,344.



Image 5 Electrical fuses at the storey 3 and exhaust at storey 2
Source : Writer, 2024

The Cosan Cafe and Dragon Hotpot buildings do not have emergency lighting and signage. So that the visibility path of the exit route can only be helped by natural lighting and several emergency lights. This assessment can be categorized as 'Less' with a condition score of 1,152. Emergency lights are the main source of light during power outages, the driving factor is the availability of emergency electricity in the form of generator sets in the operating room. This assessment can be categorized as 'Good' with a condition score of 1.92. The last aspect of assessment in the form of electrical and other system operation control rooms is also available on the west side of the building. However, this room only supervises and controls the security and electrical facilities of the building. The assessment can be categorized as 'Sufficient' with a condition score of 1.344.

Table 5 Passive protection system component values

No.	Site Completeness	Scoring	Total
1	Fire resistance building	C	7.488
2	Space compartmentalization	C	6.656
3	Aperture protection	B	8.32
Total			22.464

Source : Writer,2024

The resistance of the building structure to fire is assessed by the use of concrete steel construction supported by brick wall materials. However, this non-combustible material has a contradiction with the use of combustible materials in the interior so that the building resistance criteria are categorized as 'Fair' with a condition score of 7.488. In addition to the structure, supporting infrastructure such as road compartment space in the fire hazard system assessment is available and in accordance with the standard 9 meter wide road section. But unfortunately with a building area of 660m² the availability of sprinklers is not sufficient. Therefore, the assessment can be categorized as 'sufficient' with a condition score of 6.656. The last aspect of opening protection has been developed with consideration of material selection on glass doors. The assessment can be categorized as 'Good' with a condition score of 8.32.

Less judgment on aspects such as: Distance between buildings, Alarm-detection devices, Building hydrant, Sprinkler, Lighting and emergency route marking should have further consideration to improve the performance of the fire hazard system in the Cosan Cafe and Dragon Hotpot buildings. The great influence of lack of aspects can cause several problems such as:

1. Buildings that have no distance between other buildings can make it easier for flames to spread and increase the fire hazard,
2. The unavailability of detection and alarm devices encourages user unawareness when a fire disaster occurs,
3. The unavailability of building water sources and sprinkler systems results in the absence of fire fighting efforts,
4. Lack of lighting and emergency lane markers will hinder the evacuation process as a support for the fire hazard system.

Building Evacuation System and Mechanism

The evacuation quality assessment of the Cosan Cafe and Dragon Hotpot building has several evaluation aspects. The main influence of evacuation quality comes from the number, habits and preparedness of the users in dealing with fire hazards. The number of building users is formed by the number of visitors and workers at the same time. The average user density of the building is 180 people spread over 50-70 people per floor.



Image 6 Density and distribution of building
Source : Writer, 2024 on all these floors

Based on the habits of visitors and workers, common or majority activities were found. Such as talking, eating, drinking and relaxing in a food commercial building. These activities build a high level of self-awareness of the surrounding environment. In the event of a fire hazard this high level of awareness can assist and encourage a more time-efficient evacuation process. Through faster reception of appeals and more responsive evacuation movements. On the other hand, workers also receive some fire hazard training such as how to prevent gas damage, prevent damage to electrical fuses, how to extinguish fire and evacuate visitors (Wahab, 2015). This is in line with research conducted by Ronchi, E. (2013), where a building that has commercial functions and activities will have a high level of user awareness that makes evacuation efficiency work more optimally.



Image 7 Interior layout at all three floors
Source : Writer, 2024

In addition to the density of users, the number and interior arrangement of tables and chairs are also very influential for the quality of evacuation movement. The large number of tables and chairs designated on the 1st and 3rd floors is a challenge and obstacle for users to transport from one place to another. This situation will encourage a longer time in evacuation and reduce the quality of evacuation in wayfinding. In accordance with research conducted by Sari, P. (2022) the improper arrangement of goods will affect the ease of finding evacuation routes. This problem is the assessment in this research.



Image 8 Building vertical transportation system
Source : Writer, 2024

The Cosan cafe and Dragon Hotpot building has a vertical transport system in the form of stairs and elevators. These two transportations have adjacent placement positions and are located on the south side of the building. Under the circumstances, when a fire disaster occurs the direction of evacuation will be centered on the 1,5 meter width stairs. However, this will create interference between users. This interference will affect the quality of evacuation based on inadequate evacuation route design.



Image 9 Evacuation route at all three floors
Source : Writer, 2024

Based on the evacuation route drawn on the 3 floors of the Cosan Cafe and Dragon Hotpot building, there are 2 main exits located on the north and east sides of the building. The north exit has a longer distance to the hazard-free field area. While the east door is closer to the open area in the form of a motorway. Both of these create the potential for a closer selection of evacuation routes. Unfortunately, this also has the potential to create collisions that occur due to the accumulation of users at one time and place. This potential problem requires further analysis using Pathfinder software.

Pathfinder software applies Agent Based Simulation which is a computational framework to create accident scenarios for simulation. This simulation will involve autonomous agents that can sense their activities and surroundings to create activity decisions. The agents in this analysis are describing visitors and workers at the Cosan Cafe and Dragon Hotpot buildings. Another purpose of Agent Based Simulation is to illustrate real conditions, describe the evacuation process in large numbers, and provide a way for the evacuation process to be carried out properly. The agent population assumption in this analysis will follow the potential number of people. On the other hand, the speed of the agents is also considered quite even with an average speed of 1.1m/s.

Pathfinder Simulation

To obtain optimal simulation results in this research on the quality of evacuation routes in the Cosan Cafe and Dragon Hotpot buildings, 2 evacuation simulation scenarios were made when a fire disaster occurred, including the Uncontrolled Wayfinding scenario. Simulation with this scenario assumes that all users can access emergency stairs and elevators (lifts). On the other hand, the users have not received instructions for evacuation routes and are looking for ways independently.

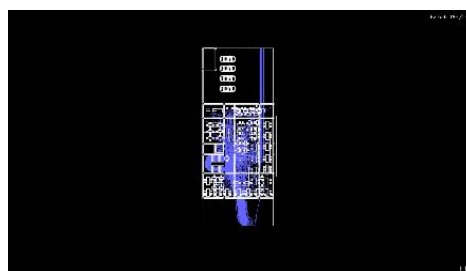


Image 10 Plan of flow simulation shows congestion
Source : Writer, 2024

The simulation with this first scenario shows the density of the flow of visitors. In the figure, it is clear that the congestion and interference of users' directions are centered on the stairs. Besides that, there are two directions of evacuation exit paths that lead west and east. The west route has a greater distance compared to the east route, hence the higher density of use of the east evacuation route.



Image 11 Section of flow simulation shows density
Source : Writer, 2024

In addition, another factor that affects the buildup of emergency staircase use is the condition of elevator (lift) access which is considered to take a lot of time and also makes users have to wait a while. The speed of travel and waiting for elevators (lifts) in this building is 3 minutes, with a capacity of 10 people in it. This is what makes users prefer to use emergency access rather than elevators. Overall, the simulation with scenario 1 took 161 seconds to evacuate. With the possibility of additional delay due to the barrier factor of 180 seconds. Therefore, the total evacuation time is 341 seconds.

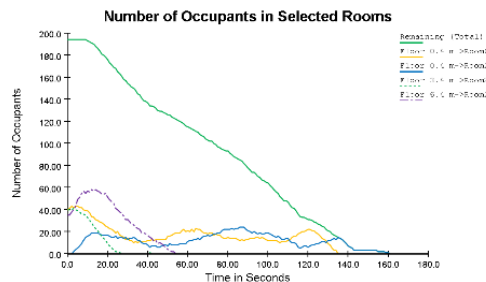


Image 12 Space user density result
Source : Writer, 2024

Based on the results of the analysis with Pathfinder, it can be seen that the highest density appears on the 3rd floor section with 60 people at 17 seconds and decreases drastically at 55 seconds. This is driven by users simultaneously finding the path to the third floor. At the 2nd floor, there were 2 intervals of overcrowding caused by queuing for the evacuation route to the 1st floor by users of the 2nd floor and users of the 3rd floor who had already descended. This was also repeated on the 1st floor which received a surge of congestion from the 2nd and 3rd floors. Until 125 seconds there was a surge of congestion at the open space exit.

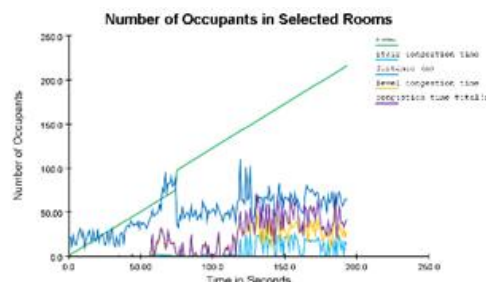


Image 13 Bottleneck test result for user in space
Source : Writer, 2024

Based on the graph above, the highest and most frequent congestion is found in the evacuation lane distance. In other words, the evacuation route creates a large queue so that congestion causes congestion in the evacuation route. The highest congestion occurs at 123 seconds, where users accumulate on the first floor in queuing for the building exit, which is in line with Figure 11. In addition, the second large spike occurs at 60 seconds where users choose 2 evacuation accesses, one of which is the elevator. At 160 seconds, the congestion was at an average level which illustrates that the evacuation routes were filled with users evenly without any major obstacles.

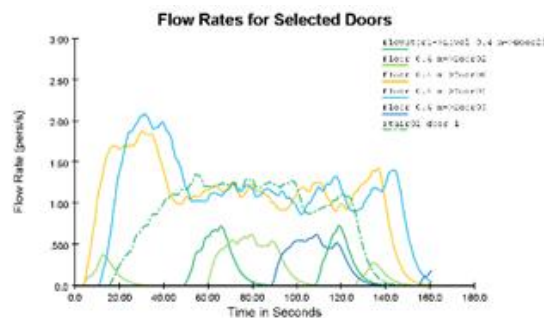


Image 14 Evacuation route selection test result

Source : Writer, 2024

Based on the figure, users are more inclined to use the eastbound evacuation route (yellow & light blue) compared to the north-west evacuation route (light green & dark blue). The selection of vertical transport access shows that users prefer to use stairs as an evacuation route rather than elevators. It can be concluded that closer evacuation routes and fast transport access are the main choices of users in this simulation. However, at the same time, this scenario has several drawbacks such as congestion due to queues, delays in transport waiting times, inefficient evacuation and inefficient use of both evacuation routes.

The evacuation time requirement of 340 seconds is an important comparison with evacuation time analyses in other buildings. For example, the 6-storey Telkom Surabaya Hospital case study by Haqqr et al. (2020) has an evacuation time of 445 seconds for the uncontrolled wayfinding evacuation scenario. Therefore, the evacuation time for the Cosan Café and Dragon Hotpot buildings should be faster, reaching 222 seconds as a half comparison to the case study results. Another time comparison is found in the Practical Guide to Fire Management compiled by Ramli (2010) that the maximum evacuation time for buildings with non-combustible structures is 180 seconds. Therefore, this is a potential development of a more efficient and maximally functional evacuation route design.

Solution

With the results of the discussion above which is in accordance with the current condition of the Cosan Cafe and Dragon Hotpot buildings, this research provides input on improving the quality of the evacuation route. This is intended as a consideration for the managers and owners of the Cosan Café and Dragon Hotpot buildings. The need for a complete evacuation system and active-passive protection from fire hazards. Some equipment must be designed accordingly:

1. Provide a fire detection and alarm system with a total of 3-5 per floors. Purpose of this item is to direct a stern warning of the dangers for all people inside the building.
2. Provide a water source for emergency use and an active protection system in the form of sprinklers on each floor with a distance between each other not exceeding 4.6m following SNI 03-3989-2000 standards. With this system, fire hazards can be immediately erased and inhibit the spread of fire.
3. Provide evacuation signage that is clear enough and provide emergency evacuation lights on the emergency stairs. Signage and evacuation light play a vital role to create

controlled wayfinding evacuation. Therefore, this suggestion was implemented as well in Picture 15.

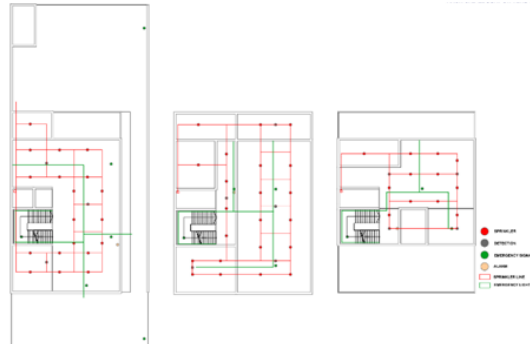


Image 15 New suggestions for designing fire hazard system
Source : Writer, 2024

While the simulation result shows underqualified quality of evacuation route and time. This research also gave input on improving effectiveness of evacuation as a further consideration of fire hazard safety systems. By using a controlled wayfinding scenario, evacuation time could be reduced till 128 seconds. Beside that, the evacuation exit especially at the western part of the building will function optimally and congestion is minimized slightly around the stairs.



Image 16 New suggestion for evacuation routes through Pathfinder simulation
Source : Writer, 2024

The simulation generates controlled wayfinding evacuation by dividing exit doors for the user's location. Those users that stay at the first floor can use the east exit door as part to maximize time efficiency. Continued users that stay at the second floor will be directed to use the west exit door to minimize hassle in the first floor queue. Last, third floor users will be directed to use both exit doors to accelerate the evacuation time. By this scenario, the evacuation route seems to be more efficient and quick. Hence evacuation routes can be better to provide safety towards the user activity.

CONCLUSION

The building of Cosan Cafe & Dragon Hotpot has key features with non-combustible materials such as concrete, bricks and tempered glass that enhance structural integrity against fire hazards. However, the extensive use of combustible materials in the interior poses a risk by facilitating the rapid spread of fire. The evaluation revealed deficiencies in the active protection system. Some critical fire safety equipment was found to be inadequate in both quantity and distribution across floors. These inadequacies may compromise the building's ability to detect and respond effectively to fire incidents.

The evacuation route assessment highlighted several issues that affect user safety and time efficiency during an emergency. Factors such as user density, interior layout and path of travel create obstacles. With Pathfinder Software, simulations showed significant congestion and delays especially at stairwell exits with users showing a preference for

closer and faster evacuation routes. A comparison of results and standards can be concluded with the quality of performance of the fire management system and evacuation routes still below the minimum value.

This research identified significant gaps in the fire hazard system and evacuation routes at Cosan Cafe and Dragon Hotpot buildings. Addressing these deficiencies through recommended improvement is crucial for enhancing the safety and readiness of these establishments in responding to fire emergencies. Future studies can focus on implementing these recommendations and evaluating their effectiveness in improving overall fire safety standards in similar functions of restaurant-cafe settings.

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