Conference Paper

Evaluation of Reliability Values of the Building Safety System against Fire Hazards in the X Government Office Building in Jakarta

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Abstract

Fire incidents in Jakarta during the year 2015 reached 1582 cases, with 22 people dead and material losses of around IDR 377 billion Indonesian Rupiah (IDR). To minimize the risk of fire hazards in office buildings, buildings must be equipped with a reliable fire response system. This study evaluated the reliability of the building safety system against fire hazards in the X government office building in Jakarta. This is a descriptive study that evaluates fire safety systems based on DKI Jakarta Province Local Regulations, Ministry of Public Works Regulations and National Fire Protection Association (NFPA) requirements. There are four system reliability parameters in building fire safety. The first one is the completeness of site resources where the building is located/build, that is, water sources, road environment, road between buildings, and hydrant yard. The second one is means of rescue completeness, that is, exit doors, exit construction, and helicopter pad. The third one is completeness of active protection system, that is, alarm detection, light fire extinguisher, sprinkler, etc. The last one is completeness of passive protection system, that is, fire-resistance building structure, compartmentalization of space, and protection of openings. The study undertook a literature review, field observation and in-depth interviews. The X government office building considered in this study consists of 15 floors and 2 basement floors with a square area of 34,948 m^2. The results of the study indicated the reliability value of the building safety system against fire hazards in the X government office building rate was sufficient, which is to say that it was 67.75 percent in compliance with standards. Parameters considered were completeness of site (82.5%), means of rescue (72.7%), passive protection (58.0%), and active protection (57.4%). The low value of the active protection parameter was caused by the functional failure of smoke detectors, fire alarms, sprinklers, and building hydrants. For the passive protection parameter, there were several improvements in shaft protection and dividing room compartments that need to be made to comply with the standard.

Keywords: fire protection, reliability, passive protection system, active protection system

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1. Introduction

Jakarta, the capital of Indonesia, currently has 362 skyscrapers, making it the city with the seventh most skyscrapers in the world [1]. The increase of high-rise buildings in Jakarta has led to increased risk of fire hazards. Building reliability in dealing with fire hazards is a key requirement in minimizing the impact of fire disasters. Unexpected fires require rapid response and action to minimize the loss of materials and lives; therefore, the fire protection system in high-rise buildings must be functional and ready whenever needed.

DKI Jakarta Government Agency of Fire Prevention and Safety data shows that during 2015, fire incidents in Jakarta reached 1,582 cases, with 22 people dead and material losses of around IDR 377 billion. The following data also shows that in 2016, Jakarta fire incidents reached 1,139 cases, with 20 people killed and material losses of around IDR 212 billion. Fire incidents are mostly caused by electricity short circuiting, which happened in 870 cases in 2015 and 836 cases in 2016 [2]. Investigation results of fire incidents in high-rise buildings have often found that the building fire protection systems were not functioning properly at the time of the fire. This caused the fire detectors and alarms to fail to give early warning, preventing early extinguishing of the fire. The Ministry of Public Works, through their Housing and Settlements Research and Development Centre, released Building Fire Safety Examination technical guidance in 2005 (Pd-T-11-2005-C) [3]. The technical guide examines building reliability rates against fire hazards by conducting a series of inspections, assessments and calculations.

The fire hazard systems in office buildings face several problems that can cause fire incidents to be repetitive and have fatal impacts, such as policy compliance issues (not all office buildings in Jakarta have Building Fire Safety Management as required by government policy), low fund for fire protection management, institutional commitment, completeness of the protection equipment and its operational mechanism [4]. Therefore, this study aims to evaluate the fire protection system and building reliability of the X government office building in Jakarta against fire hazards.

2. Methods

This is a descriptive study conducted on the X government office building in Jakarta. References used as the standard are the DKI Jakarta Province Local Regulation [5–9], Ministry of Public Works Regulation [10], and NFPA requirements [11–17]. A calculation

is executed using the Building Fire Safety Examination technical guidance that was released by the Ministry of Public Works (Pd-T-11-2005-C) [3]. There are four parameters in fire protection building safety system reliability: the completeness of site, means of rescue, active protection system and passive protection system. The X government office building was built in 2008 and first used in 2010. It consists of 15 floors and 2 basement floors and has an area of 34,948 m^2. This building serves as an office building and document storage location for the government.

The first step in this study is analyzing building characteristics, collecting data of fire incidents occurring in office buildings and studying literature relevant to the topic.

The second step is conducting, recording and examining in-depth interviews about existing fire protection systems inside and outside of the building, as shown in Table 1.

The third step is assessing and calculating results of these examinations. To assess the fire protection system, the researcher used the appraisement rate shown in Table 2. Calculation was done using the Building Fire Safety Examination technical guidance in Pd-T-11-2005-C.

3. Results

Based on this study's assessment results and data calculation, the reliability values of the building safety system are 82.5 percent for completeness of site, 72.7 percent for means of rescue, 57.4 percent for active protection system and 58.0 percent for passive protection system (Table 3).

The total calculated reliability result of the building safety system of the X government office building in Jakarta against fire hazards is 67.3 percent (Table 3).

4. Discussion

The building safety system reliability sub-value for completeness of site falls under the 'Good' category at 82.5 percent, meaning that the average value of all sub-categories available in the building have fulfilled the requirements of DKI Jakarta Province Local Regulation, Ministry of Public Works Regulation and NFPA. However, on the environment road sub-category, the value is merely sufficient because the environment roads on the back and west of the building are fewer than 4 meters in width, whereas according to the standard they should be 6 meters width at minimum.

Table 1: Fire protection systems checked and recognized.

Completeness of site	Water sources
	Environment Road
	Road between buildings
	Hydrant yard
Means of Rescue	Way out
	Outlet construction
	Helicopter pad
Passive protection system	Fire resistance building structure
	Compartmentalization of space
	Protection of openings
Active protection system	Detection and alarm
	Siamese connection
	Light fire extinguisher
	Building hydrant
	Sprinkler
	Extinguishing system
	Smoke controller
	Smoke detection
	Smoke exhaust
	Fire elevator
	Emergency light and directions
	Emergency power supply
	Operating control room

The building safety system reliability sub-value for means of rescue falls under the 'Sufficient' category at 72.7 percent, meaning that the average value of all sub-categories available in the building fulfilled the requirement, but small portions did not. Requirement incompliance was caused by 'Emergency Exit' signs that were down/inactive and the outdoor air conditioning units that blocked the evacuation routes on the emergency stairs on the 7^{th}, 9^{th} and 15^{th} floors.

The building safety system reliability sub-value for active protection system falls under the 'Less' category at 57,4 percent, meaning that the average value of all sub-categories available in the building did not fulfil the requirements. This was caused by the main pump being inactive and not ready and the backup pump needing to be switched on manually. The pressure switch jockey was also broken, which made

Table 2: Rating level.

Score	Condition
100	Serves very well beyond the required minimum requirements
90	Serves very well in accordance with minimum requirements required
80	Functioning well as required minimum requirements
70	Works well for the minimum requirements required but there are a few shortcomings
60	Functioning quite well with few shortcomings of minimum requirements in the must
50	It works pretty well but there are quite a few shortcomings of the minimum requirements in need
40	Function is not good because there is little damage
30	Not Working because there is quite a lot of damage
20	Does not have an assessment standard

the building hydrant and sprinkler fail to function. The alarm control panel was also broken, which led to the failure of the smoke detection system, alarms and pressurized fan, which cannot work automatically in the event of a fire. As per standard, the alarm control panel must be automatically alerting the building if there was a smoke detected.

Other requirement incompliance was found related to the fire extinguishers' location. Fire extinguisher must be placed 10 – 120 cm above the floor. But in this building, some extinguishers were placed 120 cm above the floor, and there were also fire extinguishers that were placed fewer than 10 cm from the floor. The building hydrant was not functioning due to pump failure, and each building hydrant doesn't have a complete components, such as hose, nozzle, clutch, faucet and hose rack. The manual for how to use the hydrant was not available in the building. Hydrant check-up was not regularly conducted, which means the hydrant hose may not be feasible, as it may leak and be unable to hold pressure from the Fire Department pump in the event of a fire.

The fire alarm and smoke detectors were not ready to be used. Periodic check-up and testing of the fire alarm and smoke detectors were not conducted, and there was no installation diagram that maps the detector and alarm locations in the alarm control panel room. The alarm control panel was also broken, which added to the building alarm and detection system functionality failure.

A sprinkler system was already installed on all floors. Sprinkler systems are expected to be able to put out fires, or at least to localize the fire within 30 minutes of the

Table 3: Score Reliability of Building Safety Systems (RBSS).

No	Reliability of Building Safety Systems (RBSS)	Score	Quality	Score Sub RBSS (%)
Sub RBSS Completeness of Site				
1	Water sources	90	27	24.3
2	Road environment	70	25	17.5
3	Road between buildings	90	23	20.7
4	Hydrant yard	80	25	20.0
Total Score Sub RBSS Completeness of Site				**82.5**
Sub RBSS Means of Rescue				
1	Way out	70	38	26.6
2	Outlet construction	70	35	24.5
3	Helicopter pad	80	27	21.6
Total Score Sub RBSS Means of Rescue				**72.7**
Sub RBSS Active Protection System				
1	Detection and alarm	30	8	2.4
2	Siamese connection	90	8	7.2
3	Light fire extinguisher	70	8	5.6
4	Building hydrant	30	8	2.4
5	Sprinkler	30	8	2.4
6	Extinguishing system	60	7	4.2
7	Smoke controller	60	8	4.8
8	Smoke detection	30	8	2.4
9	Smoke exhaust	60	7	4.2
10	Fire elevator	80	7	5.6
11	Emergency light and directions	70	8	5.6
12	Emergency power supply	80	8	6.4
13	Operating control room	60	7	4.2
Total Score Sub RBSS Active Protection System				**57.4**
Sub RBSS Passive Protection System				
1	Fire resistance building structure	90	36	32.4
2	Compartmentalization of space	40	32	12.8
3	Protection of openings	40	32	12.8
Total Score Sub RBSS Passive Protection System				**58.0**
RBSS against the risk of fire				
1	Completeness of Site	82.5	25	20.6
2	Means of Rescue	72.7	25	18.2
3	Active Protection System	57.4	24	13.8
4	Passive Protection System	58.0	26	15.1
Total Score RBSS against the risk of fire				**67.7**

sprinkler activation. However, in the X building, the sprinkler system was not functional because the main pump and pressure switch jockey were broken.

For extinguishing systems, the building's capacity was not yet in accordance with the potential fire load in the protected room, which can lead to failure of overcoming the fire. The smoke control/exhaust fan could not rotate automatically and sequentially to dispose smoke because the smoke detector did not work. The smoke detector that should activate the building occupant warning system did not work because the alarm control panel was broken.

Emergency directions on each exit sign were present but were turned off, so they did not have enough lighting to provide clear instructions. The operating control room had all required equipment, but unfortunately, it was broken, so it could not monitor fire hazards. Currently Closed Circuit Television (CCTV) is the only tool available in the operating control room that can provide assistance in monitoring fire hazards.

The reliability sub-value of the building safety system for passive protection systems is categorized as 'Less' at 58.0 percent, meaning that the mean values of all subcategories did not meet the requirements. This requirement incompliance was caused by the lack of room compartmentalization and the absence of fire stoppers at the opening shaft (mechanical and electrical shaft), which prevent the fire from spreading from one floor to another in the event of a fire.

Building management must be aware that if the building fire safety assessment result is not complying with standards, the building will be exposed to a great risk of fire hazards, because if there is a fire, then the building and fire protection systems cannot guarantee the safety of lives and property inside the building. This can lead to large disasters with extensive consequences. These standards violations also mean the building management can be threatened with criminal sanctions in accordance with the regulations enforced in DKI Jakarta.

5. Conclusions

By using the technical guidance for building fire inspection in Pd-T-11-2005-C, released by the Ministry of Public Works to assess and perform calculations, and by referring to the DKI Jakarta Regulation, the regulation of the Ministry of Public Works and the requirements of NFPA, this study found that the reliability level of the fire protection system in the X government office building is in the 'Sufficient' category at 67.7 percent. This means that on average, all the categories that exist are currently installed, but there are some categories that are not compliant.

The X office building management needs to make improvements to sub-categories of environmental roads, exits, exit construction, space compartment, openings protection, detection and alarm systems, fire extinguishers, building hydrants, sprinklers, extinguishing systems, smoke controllers, smoke detection, smoke exhaust, emergency light and direction and the operating control room in order to ensure the reliability of the building against fire hazards.

This is a preliminary study for further research on building fire safety management, with the goal of getting a broader picture of fire preparedness and prevention.

Conflict of Interest

The authors declare that they have no significant competing financial, professional, or personal interest that might have influenced the performance or presentation of the work described in this article.

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