THE ANALYSIS OF FIRE ENGINEERING AND ADMINISTRATIVE CONTROL AT BUILDING X UNIVERSITY Y YEAR 2018

ANALISIS PENGENDALIAN TEKNIK DAN ADMINISTRATIF TERHADAP KEBAKARAN DI GEDUNG X UNIVERSITAS Y TAHUN 2018

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ABSTRACT

Jakarta Provincial Fire and Rescue Agency mentioned that the capital approximately has 900 high building, however only 20 % of them possessed adequate safety precaution. Data from the Jakarta Provincial Fire and Rescue Agency show that in 2018, 1,106 fire cases caused economic loss worth around Rp 151,498,186,111. Building X University Y is used every day with more than 500 occupants for education purpose. The aim of this study was to analyze fire engineering and administrative controls in the building according to the standards (National Fire Protection Association standards and the Regulation of Minister of Public Works No. 26/PRT/M/2008). This study used analytical descriptive design with direct observation as study method. The study was conducted in July 2018. The study found that the building has not met the adequate standards yet, such as active and passive protection systems, and the means of the evacuation system. There were no active protection systems. The only implemented passive protection system was a compartmentation system which divided the building into cells designed to resist the fire spread when it happens. There were no other passive protection systems found in the structure. All doors and windows were made of woods and glasses. There were no means of evacuation in the building. There were no administrative controls in the building. Appropriate controls are required in the building, involving fire engineering and administrative controls because the building lack of fire protective and precaution systems.

Keywords: evacuation system, fire control, protection system

ABSTRAK

Dinas Penanggulangan Kebakaran dan Penyelamatan Provinsi DKI Jakarta menyebutkan bahwa terdapat kira-kira 900 gedung tinggi di Jakarta dan hanya 20 % di antaranya memiliki sistem pencegahan kebakaran yang sesuai. Terdapat 1.106 kasus kebakaran yang terjadi di Jakarta sepanjang tahun 2018 dan menyebabkan kerugian sebesar Rp. 151.498.186.111. Gedung X di Universitas Y digunakan oleh lebih dari 500 orang untuk kepentingan pendidikan setiap hari. Tujuan pelaksanaan penelitian ini adalah untuk menganalisis pengendalian teknik dan administratif terhadap kebakaran di dalam gedung tersebut sesuai dengan standar-standar yang berlaku (Standar National Fire Protection Association dan Peraturan Menteri Pekerjaan Umum No. 26/PRT/M/2008). Desain penelitian ini adalah deskriptif analitik dengan metode observasi langsung. Penelitian dilakukan pada bulan Juli 2018. Penelitian ini menemukan bahwa gedung tersebut belum memenuhi standar yang berlaku, meliputi sistem perlindungan aktif, pasif, dan sistem evakuasi. Tidak terdapat sistem proteksi aktif sama sekali di Gedung X. Sistem proteksi pasif yang ada di Gedung X hanya meliputi sistem kompartemenisasi, yang membagi gedung dalam sekat-sekat yang diharapkan dapat memperlambat penyebaran api jika terjadi kebakaran. Tidak terdapat sistem proteksi pasif yang lain. Semua pintu dan jendela dibuat dari kayu dan kaca. Tidak terdapat sarana evakuasi di Gedung X. Tidak terdapat pengendalian administratif di Gedung X. Diperlukan tindakan pengendalian terhadap kebakaran yang sesuai di Gedung X yang meliputi pengendalian teknik dan administratif karena Gedung X kurang memiliki sistem perlindungan dan pencegahan kebakaran yang sesuai.

Kata kunci: *pengendalian kebakaran, sistem evakuasi, sistem perlindungan*

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INTRODUCTION

There are hazards and risks in every place, including workplace. Health Safety Authority (2017) mentioned that hazard is the potensial source of harm that can

Fire is generally a turbulent ensemble of flames (or flamelets) which can be explained as a chemical reaction producing a temperature of the order of at least 1500 K and generally about 2500 K at most in the air (Quintiere, 2006). Fire can start if proper conditions meet, which are an adequate level of oxygen, a sufficient amount of fuel, an ignition source, and an ample chemical reaction (Henderson, 2005). These conditions are well known as fire tetrahedron.

Ramli (2010) stated that fire is a disaster that often occurs in the society, especially in residential areas, workplaces, and cities. Statistical data from the International Association of Fire and Rescue Services in 2005 mentioned that 8 million fire cases caused 70,000-80,000 death casualties and 500,000-800,000 people injured (Brushlinsky, et al., 2017). Brushlinsky and colleagues (2017) suggested no more than 44 countries suffered the most fire cases in the world. These countries reported a total of 3,354,523 fire incidents in 2012 which indicated a slight decrease compared to the number of the similar cases occurred in 2009. During this period, all 44 countries reported 3,421,645 fire cases which symbolized the highest occurrence of a fire disaster to date (Brushlinsky, et al., 2017).

Data from the Jakarta Provincial Fire and Rescue Agency show that in 2018, 1,106 fire cases caused economic loss worth around Rp. 151,498,186,111 (Jakarta Provincial Fire and Rescue Agency, 2018). The most fire cases happened in the Administrative City of West Jakarta (165 cases), followed by East Jakarta with 154 cases, South Jakarta (152 cases), North Jakarta (123 cases), and Central Jakarta (104 cases) (Jakarta Regional Disaster Management Agency, 2017). An electrical short circuit was responsible in causing about 65% of fire cases (Jakarta Provincial Fire and Rescue Agency, 2017). Jakarta Provincial Fire and Rescue Agency (2018) mentioned that the capital approximately has 900 high building, however only 20 % of them possessed adequate safety precaution. The regulations obligate the building to have the fire protection system, including the active and passive protection system and means of evacuation. Jakarta Provincial Fire and Rescue Agency (2018) mentioned that they already punish 17 buildings which did not comply with the standards. Jakarta Regional Disaster Management Agency (2017) mentioned that in 2017, there were 26 fire cases in the building and the common cause of the cases was electrical short circuit.

A fire case occurred on January 8th July 2018 at Ministry of Transportation Republic of Indonesia building, causing 3 fatalities (ISAFETY Magazine World Safety Organization, 2018). A similar case happened at Faculty of Art and Design, Trisakti University on 18 July 2005 because of the electrical short circuit (Jakarta Provincial Fire and Rescue Agency, 2017). On 6th February 2006, a fire case happened at Institute of Economic Sciences Perbanas because of the electrical short circuit (Jakarta Provincial Fire and Rescue Agency, 2017).

Parti (2011) who conducted a study at a hospital in Jakarta mentioned that the hospital lack of fire protection system, including active and means of evacuation. Some of the fire protection system do not comply with the regulation and standards. Similar with that, Putri (2011) who conducted a study at PT. Reckitt Benckiser Indonesia Semarang Factory Department of Pre Production found that of the 32 points were discussed, 20 points (62.5%) were fulfilled and in accordance with the standards, 9 points (28.1%) were fulfilled, but not accordance with the standards. While the 3 points (9.4%) were not fulfilled. The research suggested the company to improve the fire protection system according to the standards.

Stephanie (2017) who analyzed the biggest electronical shopping centre in Medan found that the building well enough of the fire passive protection system. However, she found that some of them have not comply yet with the standards. Ummah (2016) found out that the fire protection systems at PT. PLN (Persero) Central Java area are unadequate according to the relevant regulation.

Arraxy (2013) who conducted a study at a hospital found that the hospital already implemented fire management safety, however, the implementation must be improved regarding the information dissemination, regular training, add the fire equipment including portable extinguishers, record and documentation. Kowara (2017) found that PT. PJB UP Brantas Malang lack of active and passive fire protection system, and means of evacuation. Siregar (2016) who conducted a study at University of Lampung found out that the central library and rectorate building have unadequate fire

Figure 1. Building X College Y

protection system. The study also found that the university experience a fire case on 2008 (Siregar, 2016).

Based on the magnitude of the problems, adequate controls are required at every building. The hierarchy of hazard controls consists of elimination, substitution, engineering control, administrative control, and personal protective equipment (PPE) use (National Institute for Occupational Safety and Health, 2018). Fire engineering and administrative controls involve active and passive protection system use, life-saving facilities, Standard Operating Procedure (SOP) formulation and implementation, and fire organization forming.

The study was conducted at Building X University Y, located in Depok City, West Java, Indonesia in July 2018 (see Figure 1). This study seeks to implement the fire engineering and administrative controls at the structure based on regulations applied in Indonesia.

METHODS

The study was conducted at Building X University Y, located in Depok City, West Java, Indonesia in July 2018 (see Figure 1). This study seeks to implement the fire engineering and administrative controls at the structure based on regulations applied in Indonesia.

This study was a descriptive analytic study conducted in July 2018. Data were collected using an observational approach consisting of direct observation and measurements on parts of the building. Data were analysed by comparing them to the applicable standards, such as NFPA 10, NFPA 13, NFPA 14, NFPA 72, NFPA 99, NFPA 101B, and the Regulation of Minister of Public Works No. 26/PRT/M/2008 on Technical Requirements for Fire Protection System at Buildings (Ministry of Public Works of Indonesia, 2008; National Fire Protection Association, 2002, 2010a, 2010b, 2012, 2013a, & 2013b). We analyzed active fire protection systems, passive fire protection systems, and means of evacuation.

RESULT

Around 500 people inhabited Building X University Y, including students, lecturers, and administrative workers. The building was used every day for learning purposes. The structure consists of five floors. The first, third, and fourth floors are used for lectures. Offices for lecturers and the heads of study programmes are located on the second floor. The auditorium is situated on the top floor. Based on our observation, half of the first floor located underground (Figure 2).

According to the Fire Tetrahedron, a fire can happen because of the meeting of four conditions, involving the existence of fuel, ignition source, oxygen, and chemical reaction. There are many flammable materials in the building X, for example, wood as furniture material and paper used by the students, the lecturers, and the administrative workers. The flammable materials can serve as the fuel. The existence of cafetaria which used gas stove can become the ignition source. Furthermore, there are many smokers in the campus area which can increase the percentage of fire case if they throw the cigarette butts carelessly. The oxygen as the next condition is available in the open air. The chemical reaction will occur if these conditions met. Building

Figure 2. Half of the Building Located Underground

X has the fire risk which can raise the damage if this risk is not controlled well.

Hazard Identification

We found that electrical installations of cabling and associated devices, such as control panels (see Figure 3), served as the main hazard sources in the structure. Regarding control panels, they were likely to be opened by unauthorized individuals due to their exposed locations. Furthermore, classrooms and offices utilized numerous electronic instruments, including personal computers, printers, water dispensers, and slide projectors.

Fire Engineering Control

Active Protection System

We found that there were no active protection systems in the building, such as portable fire extinguishers, hydrant, fire alarms, fire detectors, and sprinklers. These systems are essential to the building to detect and control fire. We observed every floor in the building and the surrounding of the building.

Passive Protection System

Building X University Y only implemented compartment systems which involved the separation of the buildings into cells. There were no fire-resistant windows, firewalls, partition, fire doors, and smoke barrier partitions in the building. All doors were made of woods while the windows consisted of woods and glasses. In addition, the walls were made of painted bricks.

Means of Evacuation

There were no means of evacuations in the building. In case of fire, the exit door at the end of the corridor would be the only way to evacuate people.

Figure 3. Electrical Control Panel

Fire Administrative Control

There were no fire administrative control in the building, which can be known as the absence of fire organization, there were none Standard Operating Procedure (SOP) for electrical equipment and emergency situations, and there were no installation of safety information in the building.

DISCUSSION

Electrical control panels as hazard sources must have adequate precautions, including safe key use. Therefore, only authorized personnel are allowed to access it. The electrical wiring must be monitored regularly to ensure that they are in proper condition and would not cause any fire. The electronic devices must be maintained properly.

Fire Engineering Control

Active Protection System

An active fire protection system consists of instruments that can extinguish fire actively. This system requires activation through a combination of sensors or mechanical means to operate efficiently in the event of a fire. From the observation, we found that no active fire protection system was installed. This is not allowed according to Regulation of Minister of Public Works No. 26/PRT/M/2008 (Ministry of Public Works of Indonesia, 2008). Regarding the Building X which has five floors, there should be a standpipe system that protects all building's sections.

Building X had not been equipped with portable fire extinguishers and an automatic sprinkler system. This condition was not allowed because buildings for education must have portable fire extinguishers to control the early fire so that the fire would not become unbridled. The sprinkler system must be provided in case of a fire incident as well because the building has more than two stories. An early fire detection system which includes smoke, flame, and heat detectors is required in the building.

Passive Protection System

A passive protection system consists of the building construction, including firewalls, fire barrier walls, fireproof windows, fire and smoke partitions, and a compartmentation system. This

present study refers to the Regulation of Minister of Public Works No. 26/PRT/M/2008 which is derived from the National Fire Protection Association Codes (Ministry of Public Works of Indonesia, 2008).

Building X uses a compartmentation system which has a purpose to contain the fire in one place. The compartmentation system divides the building into cells which can delay the fire spread. However, the firewalls, fire doors, stairs, and protected corridors have not been implemented yet.

Fire barriers are including walls, windows, doors, and floors (Li et al, 2016). NFPA 221 (2005) mentioned that firewall is a wall that separates structure of the building to prevent the fire spread and having the fire resistance rating and structural stability. NFPA 221 (2005) argued that fire barrier wall is a wall that only have fire resistance rating. The existence of firewall and fire barriers wall can contribute for the evacuation process because they can hold the fire spread so they people will evacuate safely.

NFPA 221 (2005), as a standard for high challenge fire walls, firewalls, and fire barrier walls, explains that firewalls must be designed to be stable after the collapse of a structure resulting from an exposure on either side of the walls. Table 1 shows that the length of end wall protection will be distinct and based on the height of the exposed area. Each floor of Building X has a height of around 3 meters. It needs 1830 mm for the length of end wall protection. Figure 4 shows the recommended measurement and position for the firewalls and end walls. Firewalls must be built at Building X because exposure can happen on either side of the walls. However, it is not necessary to build angled walls because of the shape of Building X. Firestop Contractors International Association (2008) recommends the utilization of concrete, concrete block, plaster, gypsum block, and drywall as fireproof materials.

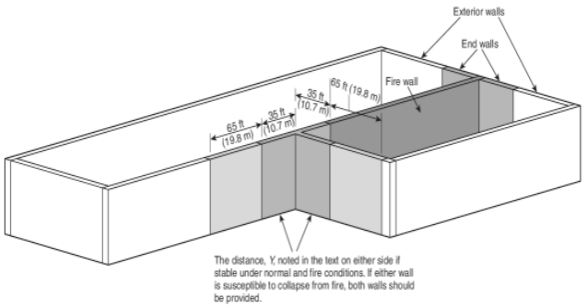

Figure 4. Angled Wall Exposure Protection (NFPA, 2005)

Table 1. Length of End Wall Protection based on the Height Exposing Area (NFPA, 2005)

The Height of Exposing Area		Length of End Wall Protection	
Ft	**m**	**ft**	**mm**
≤40	≤12.2	6	1830
41—70	12.5—21	10	3050
≥71	≥21.6	14	4265

NFPA 80 (2006) requires the fire doors hardware to include hinge brackets, hinges, latches, latch keepers, operating handle mechanisms. In addition, the document suggests hardware for inactive doors or pairs of doors shall include bolts and keepers. Fire doors may be made of a combination of wood, metal, and materials, for example gypsum (Richards, 1998).

NFPA 80 (2006) states that fire windows need to protect the windows opening in corridors, smoke barriers, or room partitions inside buildings, or in exterior walls for exterior exposure. Those partitions are required to have a fire-resistance rating that is not greater than an hour for interior partitions and four hours for exterior walls.

Means of Evacuations

Every building has to be complemented means of evacuation to allow all occupants to vacate the building safely before fire, smoke, or heat threatens their lives. Those means of evacuation must be designed in such a way that all occupants of the buildings could save themselves in a short amount of time.

According to the Regulation of Minister of Public Works No. 26/PRT/M/2008, every building with 30 or more occupants must have special

Figure 5. The Corridor of the Second Floor

corridors separated from other parts of the building (Ministry of Public Works of Indonesia, 2008). These corridors must have walls which are able to resist fire for at least one hour. Based on NFPA 101B (2002), a floor area exceeding 185 m^2 or with travel distance to the primary means of escape exceeding 23 m should be provided with two primary means of escape. Building X did not have any special corridor that was used as a means of escape when a fire happened. Only one corridor was used for daily activities in the building (see Figure 5). It also had a lot of furniture and objects such as waiting chairs. This condition downgraded the corridor's role as a means of egress.

Every door leading to the corridor in the building could fully swing into the room. However, a few doors could not be fully opened because they were hindered by misplaced furniture or objects. The building only had two exit doors located on the first and second floor respectively. In contrast, there was no exit door on the third, fourth, and fifth floor. All exit doors swung inwards. This is not allowed because according to the Regulation of Minister of Public Works No. 26/PRT/M/2008, an exit door is allowed to swing inwards only if less than 50 people occupy the building and no highly hazardous materials are stored inside the building (Ministry of Public Works of Indonesia, 2008). Emergency lighting must be available in case of a blackout and it should be able to last for ten hours at a minimum. An electrical generator must be provided in the building as an alternative energy source.

The campus can collaborate with the electrical provider, for example the National Electrical

Table 2. The Comparisons between the Building Condition and the NFPA Standards

Variable of NFPA Standards	Description	Building Condition	Remarks
I. Active Fire Protection System			
Fire Detector (NFPA 72)	Fire detectors are available on each floor of the building operating properly	There were no fire detectors	Inapplicable
Fire Alarm (NFPA 72)	The manual call sign is on another side of the exit lane with 1.4 m height from the floor	There were no fire alarms	Inapplicable
Fire Extinguisher (NFPA 10)	The fire extinguisher certificates are available	There were no fire extinguishers	Inapplicable
	The signs or symbols of fire extinguisher are available on the placement	There were no fire extinguishers	Inapplicable
Sprinkler (NFPA 13)	The distance between sprinklers is 1.8—4.6 m	There were no sprinklers	Inapplicable
Hydrant (NFPA 14)	Hydrants that can function properly are available both inside and outside the building	There were no hydrants	Inapplicable
	The hydrant boxes are installed above the floor surface between 0.9 m and 1.5 m	There were no hydrants	Inapplicable
	The user guide is available in the visible place	There were no hydrants	Inapplicable
II. Passive Fire Protection System			
Compartmentalisation (NFPA 101)	The compartment using fireproof doors	The building was already divided into cells, but there were no fireproof doors	Inapplicable
III. Means of Evacuation			
Means of Egress (NFPA 101)	The furnishings, decorations or other objects must not be put on the exit lane.	There were obstacles on the exit lane, for example, waiting for chairs and trash bins	Inapplicable

Variable of NFPA Standards	Description	Building Condition	Remarks
	Means of egress is maintained properly, free from any restrictions.	There were obstacles on the exit lane, for example, waiting for chairs and trash bins	Inapplicable
Emergency Doors (NFPA 101)	Each door on each means of egress must be of a kind or a swinging door hinge side and must reach the fully open position.	There were no emergency doors	Inapplicable
	The resistance of the fire doors is at least 2 hours	There were no emergency doors	Inapplicable
Emergency Stairs (NFPA 101)	There must be markings that indicate every level of floors and show the top and bottom ends of each floor if there is an emergency stair that serves the five floors	There were no emergency stairs	Inapplicable
	The markings should be painted or written on the wall or in a separate marking which is secured to the wall.	There were no emergency stairs	Inapplicable
	The stairs are provided with fireproof doors that can close automatically.	There were no emergency stairs	Inapplicable
	The surface of stairs is rough and there are no obstacles.	There were no emergency stairs	Inapplicable
	There are ventilation hoods in the form of emergency stairs.	There are no particular windows in the emergency stairs in case of fire	Inapplicable
Ramp (NFPA 101)	The non-flammable materials are used	The were no ramps	Inapplicable
	The non-slippery materials are used	The were no ramps	Inapplicable
Fire Elevator (NFPA 101)	At least, there is a fire or emergency elevator.	There were no fire elevators	Inapplicable
	The fire elevator can function as a passenger elevator if there is a fire.	There were no fire elevators	Inapplicable
	The fire elevator must be fireproof for at least one hour.	There were no fire elevators	Inapplicable
	The fire elevator should be able to stop at every floor.	There were no fire elevators	Inapplicable
	The fire elevator should be adjacent to the fire exit stairs and easy to reach.	There were no fire elevators	Inapplicable
Emergency Lighting (NFPA 101)	Emergency lighting is mounted on a means of egress.	There were no emergency lighting	Inapplicable
Emergency Communication (NFPA 101)	Emergency number provided	There is no emergency number provided in the building	Inapplicable
Assembly Point (NFPA 101)	Assembly point which is safe, easy to reach, and wide enough is available	There is a wide field near the building, but there is no assembly point sign	Inapplicable

Company or private company which generate the electrical. Furthermore, the renewable energy can become another alternative energy source to produce the electricity. The campus can build the solar system and store the energy so it can be used in case of emergency and the black out happen. Emergency lighting must be tested and managed appropriately.

The markings and symbols for each emergency facility must be provided in the building. The signs must be placed 15—20 cm above the floor surface. The markings must use the special paint. Hence, occupants can see them easily even from distant.

Fire Administrative Control

Administrative controls should be applied to decrease the probability of fire case at Building X. Administrative controls involve the Standard Operating Procedure for electrical devices safety, electrical control panels, and emergency response situation. The safety signs installations providing hazard information and evacuation route signs should be implemented in the building.

The Fire Drills must become the university regular program because The Regulation of Minister of Labour No. KEP.186/MEN/1999 requires the workplace to helds the program. The Fire Drills must involve all of the occupants of the building, including the students, the lecturer, the administrative workers, the cleaning services, and the tenants who sell the food in the cafetaria. The program can be cover how to handle the emergency situations, including fire.

Because the building lack of protection system implementation and has unadequate means of evacuation, the administrative control must be implemented well. The information about the hazard must be disseminate well. The dissemination can be done through the education, seminar, and the installation of the information in the campus area. The information can be installed in the wall and near the hazard, for example, near the electrical control panel.

Another information dissemination that can be done involving use the TV monitor and place them around the campus area. Currently, the TV monitor only be found on the limited area, for example, in the lobby. The proposed place that the TV monitor can be installed is at the cafetaria , because many people will go there regularly, especially the students. The TV monitor can display the hazard and risk information, including the things that must be done to cope with fire disaster. This information must be displayed regularly.

According to the Regulation of Minister of Labour Number 186/1999, one fire coordinator leastwise should oversee every 100 occupants (Ministry of Labour of Indonesia, 1999). Since more than 100 individuals populate Building X on a daily basis, University Y needs to comply with the standard.

CONCLUSION

The results show the lack of compliance with every standard. In order to lower fire risk levels, University Y needs to provide adequate protection systems and evacuation means.

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