PAPER NAME

Mapping Analysis of Active-S2-juli 2021.pdf

AUTHOR

Rindang Diannita

WORD COUNT

4189 Words

CHARACTER COUNT

22943 Characters

PAGE COUNT

7 Pages

FILE SIZE

709.9KB

SUBMISSION DATE

Mar 19, 2023 2:21 PM GMT+7

REPORT DATE

Mar 19, 2023 2:22 PM GMT+7

5% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 5% Publications database
- Crossref database
- Crossref Posted Content database

Excluded from Similarity Report

- Internet database
- Submitted Works database
- Bibliographic material
- Quoted material
- Cited material

Mapping Analysis of Active Fire Protection System on Dormitory Building in X University

Analisis Model Pemetaan Sistem Proteksi Kebakaran Aktif Di Gedung Asrama Universitas X

Eka Rosanti, Selamet Ujang Irawan, Rindang Diannita, Muhammad Rifki Taufik
Occupational Safety and Health Department, Faculty of Health Science, Universitas Darussalam Gontor
Siman Street, Demangan, Simana, Ponorogo 63471 East Java, Indonesia

ABSTRACT

Introduction: Fire cases increase in residential buildings because short circuits, at dormitories are mostly affected by human factors. X university dormitory building is a place for 24 hours of students' activities with a lot of electricity consumption, bad behavior; overpowering extensions, and many flammable objects such as paper and furniture. Research objectives are to investigate the appropriateness and mapping needs of fire protection systems with regulations. **Methods:** The research is a semi quantitative analysis. Primary data is conducted with observations by using a checklist form that refers to the regulations and results of managers' interviews. The obtained data are categorized into good with suitability >79-100%, moderate ≥60%-79% and poor<60%. **Result:** The appropriateness of the active fire protection system is under 60% or in the poor category. The appropriateness of the fire extinguisher is 47.77%, the hydrant is 58.75%, the alarm is 18.75% and the heat detector is 35.90%. There is no sprinkler installation in the dormitory building and no commitment from the top management regarding occupational safety and health. Fire extinguisher's need is 10 tubes per floor, the number of hydrants have been fulfilled, alarm requires an additional 1 unit on each floor and a heat detector requires a total of 114 units. **Conclusion:** The active fire protection system is still under 60% (poor category) and no maintenances. Based on the aforementioned mapping results, it needs to add the number of piece equipment according to the regulations and maintenance efforts.

Keywords: active fire protection system, dormitory, mapping

ABSTRAK

Pendahuluan: *Meningkatnya kasus kebakaran dikarenakan hubungan arus pendek pada gedung hunian seperti asrama sebagian besar disebabkan oleh faktor manusia. Gedung asrama universitas X merupakan tempat aktifitas mahasiswa selama 24 jam dengan konsumsi listrik yang banyak, perilaku yang tidak baik seperti ekstension yang melebihi daya serta banyak bahan yang mudah terbakar seperti kertas dan furniture. Tujuan penelitian ini untuk menganalisis kesesuaian sistem proteksi kebakaran dengan peraturan serta melakukan pemetaan kebutuhan.* ***Metode:*** *Penelitian ini merupakan penelitian semi kuantitatif analisis. Data primer berasal dari hasil observasi sistem proteksi kebakaran aktif dengan menggunakan form checklist yang mengacu pada peraturan dan hasil wawancara dengan pengelola. Data yang diperoleh dikategorikan menjadi baik dengan kesesuaian >79-100%, cukup = ≥60% - 79% dan kurang = <60%.* ***Hasil:*** *Kesesuaian sistem proteksi kebakaran aktif berada di bawah 60% atau dalam kategori kurang. Kesesuaian kebutuhan fire extinguisher sebesar 47,77%, Hydrant sebesar 58,75%, Alarm sebesar 18,75% dan heat detector sebesar 35,90%. Belum ada pemasangan sprinker di gedung asrama dan belum adanya komitmen dari pimpinan terkait K3. Kebutuhan fire extinguisher adalah 10 tabung setiap lantai, jumlah hydrant sudah memenuhi, alarm membutuhkan penambahan 1 unit di setiap lntai dan heat detector membutuhkan total 114 unit.* ***Simpulan:*** *Sistem proteksi kebakaran aktif masih berada di bawah 60% atau dalam kategori kurang dan tidak adanya pemeliharaan. Berdasarkan hasil pemetaan masih perlu adanya penambahan jumlah dari masing-masing peralatan sesuai peraturan perundangan serta upaya pemeliharaan..*

Kata kunci: *gedung asrama, pemetaan, sistem proteksi kebakaran aktif*

Corresponding Author:
Eka Rosanti
Email: ekarosanti@unida.gontor.ac.id
Telephone: +6285642171748

INTRODUCTION

Government Regulation of the Republic of Indonesia (2005) concerning Buliding Structure, emphasizes that every building, except for single houses and simple row houses, must be equipped

 doi:10.20473/ijosh.v10i2.2021.240-246
Received January 09, 2021, received in revised form March 28, 2021, Accepted May 28, 2021, Published: August 2021

with an active protection system that protects the property against fire hazards based on the provision of equipment that able to work either automatically or manually, used by residents or firefighters in carrying out suppression operations. Minister of Public Works (2008) concerning Technical Requirements for Fire Protection System in Buildings and Environment, emphasizes that fire hazard is a danger caused by a potential threat and degree of exposure to fire from fire's start to the spread of the fire which causes smoke and gas.

Some fire cases have occurred in residential homes and educational facilities, mostly affected by electrical short circuits. As in the fire case at the Grand Palace Fire Extinguisher, Kemayoran, Central Jakarta, Belleze Apartment, Pondok Hijau, South Jakarta, and Campus in the Islamic University of Malang. According Sufianto, Nugroho and Aditama (2018) fire cases, especially in campus buildings, were not only common occurred in Indonesia, but also frequently in several universities in America. From 2000 to 2015 there were 118 fatalities with a total of 85 fire incidents. A total of 58% of fire incidents that claimed lives came from student meeting center places and dormitory buildings with damaged heat detectors, while 85% of incidents were found in buildings with an incomplete sprinkler.

According to a data report from National Fire Protection America (NFPA) that the number of fire cases in America in 2012 reached 1,375,000, affected 2,855 deaths, 16,500 injuries, and caused approximately $12,400,000 in property losses (Kowara and Martiana, 2017).

According to Wahadamaputera *et al.* (2015), fires causes were analyzed by three factors. The first factor was humans as users who are lack discipline. The second factor was technical, either physical or mechanical, such as an increase in hot temperature and the presence of an open fire or electrical engineering like a short circuit. The third factor was natural disasters such as earthquakes, lightning, floods, and volcanic eruptions. According to Putri (2016) fire alarms error contributed to 11% of increased fire severity and caused $ 110,000 in losses, sprinklers could reduce 83% of civilian deaths per 1000 house fires, from 7.3 deaths per 1,000 fires to 1.3 deaths per 1,000 Fire. Sprinkler also reduced as much as 69% of property damage per 1000 home fires, from a $20,000 loss to $6,000 per 1,000 fires. Smoke heat detectors also contributed to saving approximately 890 lives each year from 2000 to 2004.

The Dormitory at X University has a four-story building that serves as a student residence with various facilities such as a house. Dormitory buildings have the largest number of rooms with the density of their inhabitants. The individual student needs for electricity grid consumption are very high. As a building with a high-level fire category, it had to have an active and passive fire protection system design (Wahadamaputera *et al.*, 2015). Based on the monitoring, there are active fire protection facilities such as un-optimally functioning fire extinguishers, hydrants, heat detectors, and alarms.

The need for electric power can be a potential factor for fire, this is exacerbated by inappropriate usage. Based on observations' results, students use electricity unsafe; overpowering extensions, as well as tools that can facilitate the spread fire path such as mattresses, cupboards, shelves, books, and so on. All of these activities can trigger a fire.

Based on the aforementioned description, it is necessary to have an analysis of the active fire protection system to determine the appropriateness level with relevant standards by considering the dormitory building is a building used for twenty-four hours for student activities. This research is conducted to analyze the mapping model of implementation of an active fire protection system by assessing its appropriateness with relevant regulations. The fire protection system consists of a fire extinguisher, hydrant, alarm, and heat detector.

METHODS

This research applies a combination of quantitative and qualitative research methods (Mixed Methods). Primary data is conducted with observations of active fire protection systems by using a checklist form and the results of managers' interviews. The checklist form refers to Minister of Manpower and Transmigration (1980) concerning Requirements for Installation and Maintenance of Light Fire Extinguishers, Badan Standar Nasional Indonesia (2000b), Ministerof Manpower (1983) concerning Automatic Fire Alarm Installing, and Badan Standar Nasional Indonesia (2000a) concerning Procedures for Planning, Installing and Testing Fire Detection and Alarm Systems for Prevention of Fire Hazards in Buildings. The categories of observation results are as follows (Kurniawan, Sugiyarto and Laksito, 2014) :

1. Good = >79% - 100%
2. Moderate = ≥60% - 79%

3. Poor = <60%

Based on the results of observations and assessments, the author will map the level of suitability to design the application of an active fire protection system on the Dormitory Building at X University.

RESULT

The X University dormitory is consists of four floors was built without integrated passive fire protection during construction. There are several active fire protection installed with poor performance and there is no maintenance. The dormitory is a type C fireproof construction.

The source of fire hazards in the dormitory are heaters and electrical malfunction. The fires that occur can be exacerbated by combustible household materials, materials producing toxic smoke on combustion and, combustible building components like timber. The dormitory building is a poor re-compartmentation design with a balcony so that it can facilitate the spread of fire by providing a constant supply of oxygen to fire. Through the optimal performance of active fire protection, it can be able to detect and control fire at an early stage.

Interviews with top management were also conducted to complete the information based on the facts obtained with the following results (Table 1).

Table 1. The Results Of Interviews With Top Management

Aspects of The Interview	Information
The Fire Management Commitment	Not available
Fire Emergency Response Team	Not available
Standard Operational Procedure of Routine Maintenance	Not available
Active Fire Protection System Inventory Document	There is an active fire protection system inventory document during the initial installation
Knowledge and Skill about Using the Existing Active Fire Protection	Management has never conducted training, so they do not have the knowledge and skills
Top Management Perception	Top management understands the importance of an active fire protection system, but currently still prioritizing completing the inventory in the building

The following is a plan of the X University dormitory building before the analysis was conducted (Figure 1). Based on figure 1, there are three fire extinguishers are laid on the right, left, and center on the first floor, 2 hydrants and 2 alarms.

Based on figure 2, there are three fire extinguishers are laid on the right, left, and center on floors 2, 3, and 4 so there are nine fire extinguishers, 2 hydrants and 2 alarms. Besides, there are 94 heat detectors total for the floor 1 to 4 on dormitory building.

The following is the recapitulation of observations results compared with the relevant regulations (Figure 3). Based on figure 3, the appropriateness of the active fire protection system is under 60% or in the poor category. The appropriateness of the fire extinguisher is 47.77%, the hydrant is 58.75%, the alarm is 18.75% and the heat detector is 35.90%. Details of fire extinguisher inappropriateness with Regulation of the Minister of Manpower and Transmigration No. Per 04/MEN/1980 the mapping of fire extinguisher is

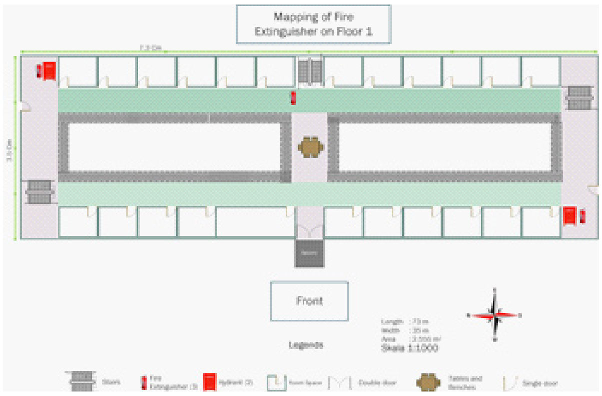

Figure 1. The Dormitory Building on Floor 1 Before Analysis was Conducted

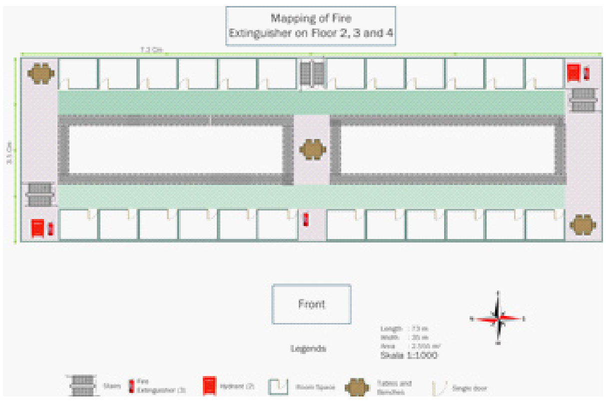

Figure 2. The Dormitory Building on Floor 2, 3, and 4 before Analysis was Conducted

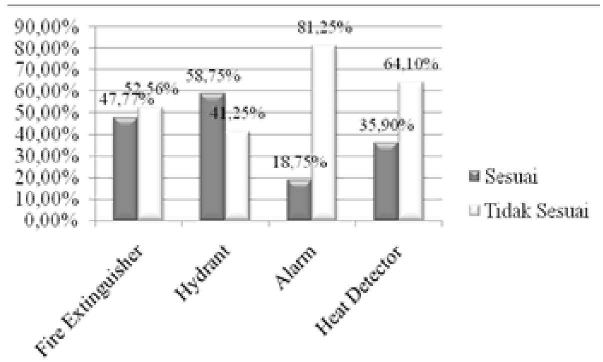

Figure . Appropriateness Level of Active Fire Protection Systems

blocked by plywood walls, fire extinguisher color has faded to pink, the marking height exceeds the regulatory standards (125 cm) which reach 153-154 cm from the floor base, mapping of fire extinguisher with another exceeds the regulatory provisions (<15m) which reach ±30 m, there is rust on the tube, no inspection and no fire extinguisher filling data consisting of date, month, and year, there is the un-sealed tube, an abnormal tube with a pressure gauge condition.

The appropriateness level of the fire extinguishers is 47.44% so that 52.56% does not address the regulations. The major non-conformities (<60%) are in the marking, the height is 125 cm from the floor base, plan distance, inspection, fire extinguisher filling data, safety seal state, and tube pressure appropriateness.

The hydrant appropriateness level is 58.75% so that 41.25% does not address the regulations. Major non-conformities (<60%) are in the function of the hydrant box, hydrant inspection, readiness, and instructions completeness. The details of the hydrant inappropriateness with SNI 03-1745-2000 are in the hydrant box no equipment for the occupants of the dormitory building that blocks the hose connection, which has never been periodically checked, and no usage instructions.

Based on the figure 3, the alarm appropriateness level is 18.75% so that 81.25% does not address the regulations. The relevant criteria with the regulations for the visible alarm are only 87.50%. Details of alarm inappropriateness with Regulation of the Minister of Manpower and Transmigration No. Per.02/Men/1983 is an un-optimal function of alarm, push-button malfunction, no complete installation mapping, and no complete bells.

Based on the table 3, the heat detector level is 35.90% so that 64.10% does not address the regulations. The relevant criteria with the regulations are only on placement (100%), installation (87.23%), heat detector affordability (100%). The details of the incompatibility of the heat detector with SNI 03-3985-2000 are un-integrated control unit that affects its inactivity, no complete information about fire heat detectors such as floor plans and technical requirements, no heat detector protection such as wire mesh, no inspection, no testing and maintenance.

DISCUSSION

The dormitory building was not installed with a sprinkler, according to Wahadamaputera *et al*. (2015), the evacuation process reliability was supported by an active security system, like a sprinkler. According to NFPA 13 in Djunaidi, Tuah and Rafifa (2018) an active fire protection system had to be installed on each floor to reduce losses when a fire occurs. Based on Chow, *et al*. (2001) and Ong, *et al*. (2014) in Djunaidi, Tuah and Rafifa (2018) the fire protection system had to be able to detect and extinguish fires, a warning system, and ensure a safe evacuation route for residents. Analysis of requirements number for active fire protection system equipment based on regulations is as follows.

Top Management Commitment

Based on interviews' results with the manager and person in charge, as long as the dormitory building was established or since its procurement and installation. It has never been checked for an active fire protection system. It is so risky for exacerbating losses in fire cases. It is also proven by the absence of maintenance documents and its commitment to OSH policy from the top management. Its occupational safety and health policy set by the top management was the primary requirement in implementing the occupational safety and health program for the workplace (Najihah, Wahyuni and Nasution, 2019).

According to Hanford in Sufianto, Nugroho and Aditama (2018) apart from technological factors in buildings, management, and behavior factors were closely related to the sustainability of fire protection systems' implementation. Guan, Fang and Wang (2018) also stated that one of fire risk factor identification is fire protection management that consists of regulation, supervision, response capacity of emergency, and education training. So, management is the key to manage the fire prevention program to reduce a loss (Muchtar, Ibrahim and Raodhah, 2016).

Fire Extinguisher

Based on observations, the dormitory building has 12 fire extinguisher units laid on three sides on each building floor; the right, left, and center. So that there is 3 fire extinguisher on each floor with a distance of 30 m. This is not based on the Regulation of the Minister of Manpower and Transmigration of The Republic of Indonesia No. Per.04/Men/1980 concerning the Requirements for the Installation and Maintenance of Light Fire Extinguishers which states that the fire extinguisher distance is 15 m. If it is correctly calculated on a building size of 73 x 35 m with an area of 2.555 m2, 10 fire extinguisher is needed on each floor. The result of the study conducted by Lufyana (2020) in the plastic sack industry stated that the workers have difficulty

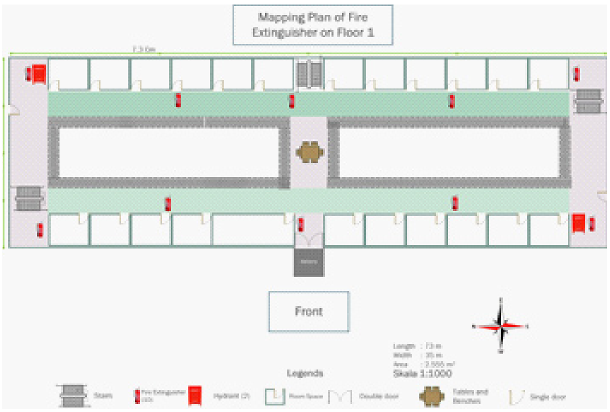

Figure 4. Mapping Recommendation for Dormitory Building on Floor 1 Containing Fire Extinguisher Number and Hydrant Requirements after Analysis was Conducted

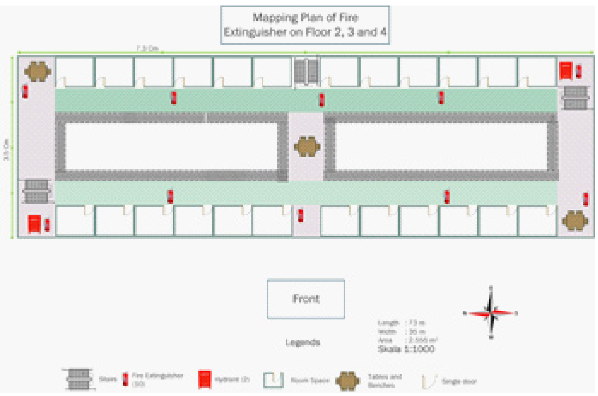

Figure 5. Mapping Recommendation for Dormitory Building on Floor 2, 3, and 4 Containing Fire Extinguisher Number and Hydrant Requirements after Analysis was Conducted

extinguishing the fire if the distance of the fire extinguisher is more than 15 meters.

According to Garcia-Martin, González-Briones and Corchado (2019) mapping of fire extinguishers had to be visible, accessible, and the minimum number of fire extinguishers must be available depending on the building area. The inspection of fire extinguisher function effectiveness periodically by specialized operators is needed. Besides that, it can also be economically saving due to the optimally working of fire extinguishers.

Hydrant

The hydrant's number is following Badan Standar Nasional Indonesia (2000b). Procedures for planning and installing vertical pipe systems and hoses for fire prevention in houses and buildings are served by two units per floor that can supply water and laid near on the right and left side of the stairs dormitory building.

The existing hydrant must periodically be checked because based on Hyun *et al*. (2014), one of the factors affecting the hydrant efficiency was sediment density as a manifestation of routine maintenance absence. Hydrant testing is carried out to evaluate the reliability of the system, the adequacy of the water supply source in distribution storage, and the overall condition of the system (Yadav and Patel, 2014).

Alarm

Based on observations, alarms are laid on two sides of each building floor; the right and left sides and integrated with the hydrant box. However, in the center, students gathering activity venue, an alarm has not been installed. So it still requires 1 alarm unit to be laid in the middle on each floor.

The un-optimal function of alarm because it is not completed with supporting equipment must be addressed immediately. An alarm is very useful for identifying fire from the initial, because it gets a fire signal from a fire detector (Guan, Fang and Wang, 2018). Based on the previous study, the alarm has important role in most cases (Shokouhi *et al*., 2019). Therefore, it is necessary to have an inspection by a competent technician to ensure that the alarm optimally works.

Heat Detector

Heat detector was an important element in automatic fire detection because it could provide

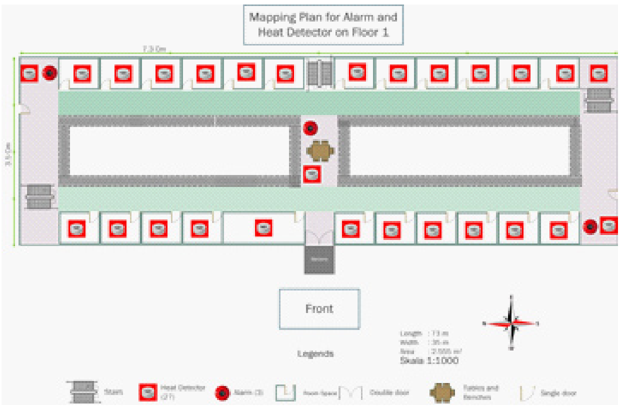

Figure 6. Mapping Recommendation for Dormitory Building on Floor 1 Containing Alarm and Heat Detector Number and Hydrant Requirements after Analysis was Conducted

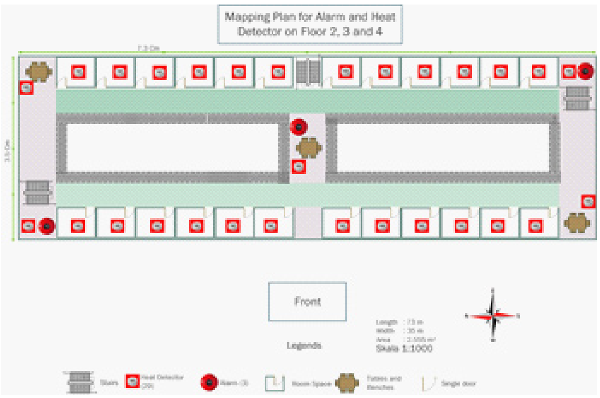

Figure 7. Mapping Recommendation for Dormitory Building on Floor 2, 3, and 4 Containing Alarm and Heat Detector Number and Hydrant Requirements after Analysis was Conducted

early warning of a fire, thereby reducing material and life losses (Ryu and Kim, 2015). Therefore, it needs to be periodic inspections.

Based on observations' results, the dormitory building has only 94 heat detectors installed in each room. However, the hallway and student gathering venues have not been installed. So that after conducting the analysis, it is obtained the need for 20 heat detector alarm units for the areas which are not installed yet. A study conducted by Jevtić (2015) states that the most important thing in optimizing a function is the number and position of the heat detector against the object. Nam (2005) also stated that the installation of the heat detector must be based on the purpose and objective.

CONCLUSION

Based on observations and analysis results, concluded that the top management of X University was not yet committed to the implementation of safety for building occupants, so there was no applied policy related to the fire management system. This can be identified from the appropriateness of all active fire protection system equipment which is still under 60% or in the poor category and no maintenance qualification. Based on the mapping results, it is still necessary to increase the number of pieces of equipment according to the rule laws: 10 fire extinguishers on each floor, add 1 alarm unit in the middle on each floor, add 20 heat detector alarm units and maintenance for the hydrant. Commitment from top management is the key to improving the performance of the active fire protection system.

ACKNOWLEDGEMENTS

We acknowledged the top management of X University and the dormitory building person in charge who kindly provide information to the development of this article.

REFERENCES

Badan Standar Nasional Indonesia (2000a) *SNI-03-3985-2000 Tata Cara Perencanaan, Pemasangan dan Pengujian Sistem Deteksi dan Alarm Kebakaran untuk Pencegahan Bahaya Kebakaran pada Bangunan Gedung*. Jakarta: Badan Standar Nasional Indonesia.

Badan Standar Nasional Indonesia (2000b) *SNI 03-1745-2000 Tentang Tata Cara Perencanaan dan Pemasangan Pipa Tegak dan Slang untuk Pencegahan Bahaya Kebakaran pada Bangunan Rumah dan Gedung*. Jakarta: Badan Standar Nasional Indonesia.

Djunaidi, Z., Tuah, N. A. A. and Rafifa, G. (2018) 'Analysis of the Active and Passive Fire Protection Systems in the Government Building, Depok City, Indonesia', *KnE Life Sciences*, 4(5), pp. 384–398.

Garcia-Martin, R., González-Briones, A. and Corchado, J. M. (2019) 'Smartfire: Intelligent Platform for Monitoring Fire Extinguishers and Their Building Environment', *Sensors*, 19(10), pp. 1–19.

Government Regulation of the Republic of Indonesia (2005) Nomor 36 Tahun 2005 Tentang Pelaksanaan Undang-Undang No.28 Tahun 2002 Tentang

Bangunan Gedung. Jakarta: President of the Republic of Indonesia.

Guan, Y. X., Fang, Z. and Wang, T. R. (2018) 'Fire Risk Assessment and Daily Maintenance Management of Cultural Relic Buildings Based on ZigBee Technology', *Procedia Engineering*, 211, pp. 192–198.

Hyun, I. H. *et al*. (2014) 'Improvement of Fire Hydrant Design to Enhance Water Main Flushing', *Procedia Engineering*, 70(2014), pp. 857–863.

Jevtić, R. B. (2015) 'Heat Detectors: Division, Positioning in Object and Simulation', *Tehnika*, 70(2), pp. 303–311.

Kowara, R. A. and Martiana, T. (2017) 'Analisis Sistem Proteksi Kebakaran Sebagai Upaya Pencegahan dan Penanggulangan Kebakaran (Studi di PT. PJB UP Brantas Malang)', *Jurnal Manajemen Kesehatan Yayasan RS Dr. Soetomo*, 3(1), pp. 70–85.

Kurniawan, A., Sugiyarto and Laksito, B. (2014) 'Evaluasi Penerapan Sistem Proteksi Kebakaran Pada Bangunan Rumah Sakit (Studi Kasus RS. Ortopedi Prof. Dr. R. Soeharso Surakarta)', *Matriks Teknik Sipil*, 2(4), pp. 824–832.

Lufyana, R. D. (2020) 'The Evaluation of the Application of Fire Extinguisher Installation in the Plastic Sack Industry', *The Indonesian Journal of Occupational Safety and Health*, 9(2), pp. 163-172.

Minister of Manpower and Transmigration (1980) Peraturan 04/men/1980 tentang Syarat-Syarat Pemasangan dan Pemeliharaan Alat Pemadam Api Ringan. Jakarta: Minister of Manpower and Transmigration.

Minister of Public Works (2008) Peraturan Menteri Pekerjaan Umum No. 26/PRT/M/2008 Tentang Persyaratan Teknis Sistem Proteksi Kebakaran pada Bangunan Gedung dan Lingkungan. Jakarta: Minister of Public Works.

Ministerof Manpower (1983) No. 02 Tahun 1983 Instalasi Alarm Kebakaran Automatik. Jakarta: Minister of Manpower of Republic of Indonesia.

Muchtar, H. K., Ibrahim, H. and Raodhah, S. (2016) 'Analisis Efisiensi dan Efektivitas Penerapan Fire Safety Management dalam Upaya Pencegahan Kebakaran di PT. Consolidated Electric Power Asia (Cepa) Kabupaten Wajo', *Higiene*, 2(2), pp. 91–98.

Najihah, K., Wahyuni, W. and Nasution, R. M. (2019) 'Penetapan Kebijakan K3, Perencanaan K3 dan Implikasinya terhadap Kejadian Kecelakaan Kerja Di PKS Kebun Rambutan PTPN-III Tebing Tinggi', *Jurnal Kesehatan Global*, 2(1), pp. 1–7.

Nam, S. (2005) 'A Case Study: Determination of Maximum Spacing of Heat Detectors', *Journal of Fire Protection Engineering*, 15(1), pp. 5–18.

Putri, O. A. (2016) *Evaluasi Penerapan Sistem Proteksi Kebakaran Aktif Di PT Reckitt Benckiser Indonesia Semarang Factory Departemen Pra Produksi*. Undergraduate Thesis. Semarang: Faculty of Sport Science, Universitas Negeri Semarang.

Ryu, H. and Kim, D. (2015) 'Study on the Operation Characteristics of Heat Detectors through Fire and Wind Tunnel Experiment', *Journal of The Korean Society of Disaster Information*, 11(2), pp. 203–209.

Shokouhi, M. *et al.* (2019) 'Preventive Measures for Fire-Related Injuries and Their Risk Factors in Residential Buildings: A Systematic Review', *Journal of Injury and Violence Research*, 11(1), pp. 1–14.

Sufianto, H., Nugroho, A. M. and Aditama, M. S. (2018) 'Framework Tanggap Bencana Kebakaran Gedung Kampus', *Jurnal Koridor*, 9(1), pp. 1–8.

Wahadamaputera, S. *et al*. (2015) 'Keandalan Desain Apartemen Terhadap Pengamanan Kebakaran', *Jurnal Reka Karsa*, 3(1), pp. 1–11.

Yadav, A. and Patel, P. (2014) 'Assessment of Water Requirement and Calculation of Fire Flow Rates in Water Based Fire Fighting Installation', *International Journal of Innovations in Engineering and Technology*, 4(1), pp. 5–12.

5% Overall Similarity

Top sources found in the following databases:

- 5% Publications database
- Crossref database
- Crossref Posted Content database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	G N Retriana. "The Standard Operational Procedure (SOP) developmen... Crossref	<1%
2	F Z Rachman, N Yanti, H Hadiyanto, S Suhaedi, Q Hidayati, M E P Widag... Crossref	<1%
3	Venkatesh Kodur, Puneet Kumar, Muhammad Masood Rafi. "Fire hazar... Crossref	<1%
4	E R Novanandini, O C Dewi, Y S Nugroho. "Evaluation of fire safety mai... Crossref	<1%
5	Melia Listia Sari, Tatan Sukwika. "SISTEM PROTEKSI AKTIF DAN SARA... Crossref	<1%
6	Ratih Andhika Akbar Rahma, Fahri Cahyo Satria, Aisy Rahmania, Rinda... Crossref	<1%
7	Biatma Syanjayanta, Reyvaldi C. Joenso. "Evaluation Accessibility Mus... Crossref	<1%
8	D Pontan, A Maxsi. "The important factors of the safety system on fire ... Crossref	<1%
9	Sukawi Sukawi, Satriya Wahyu Firmandhani, Gagoek Hardiman. "Passi... Crossref	<1%

10	F Anwar, T B Aulia, M Afifuddin. "The reliability of fire protection syste... Crossref	<1%
11	I Y Salena, M Safriani, M A R Amin. "Identification of fire protection sys... Crossref	<1%
12	N V Rahman, A S Ginting. "Evaluation of Fire Passive Protection Syste... Crossref	<1%