



The Influence of the Conformity Level of Fire Alarm Installations, Fire Detectors, and Portable Fire Extinguishers on the Fire Protection System

Anton Abdullah^{1*}, Cris Kuntadi²

¹Politeknik Penerbangan Palembang, email: anton@poltekbangplg.ac.id

²Universitas Bhayangkara Jakarta Raya, email: cris.kuntadi@dsn.ubharajaya.ac.id

*Corresponding author: Anton Abdullah¹

Abstract: This article aims to review the literature on the effect of the suitability level of fire alarm installations, fire detectors, and portable fire extinguishers on fire protection systems in buildings. Previous research is needed to support or oppose the new hypothesis. From the research conducted, it was found that the suitability level of fire protection equipment installation is very important to increase the effectiveness of the fire protection system. Appropriate fire alarms and fire detectors, as well as suitable portable fire extinguishers, are required to detect fires as quickly as possible and provide a rapid and appropriate response to address the fire. In addition, proper maintenance of fire protection equipment is also required to ensure optimal system performance. The results of this article show that: 1) The suitability level of the fire alarm installation affects the fire protection system; 2) The suitability level of the fire detector installation affects the fire protection system; and 3) The suitability level of portable fire extinguisher installation affects the fire protection system. Increasing the suitability of the installation of fire protection equipment in buildings, can increase the effectiveness of the fire protection system and minimize the risk of fire.

Keywords: Fire Protection System, Fire Alarm, Fire Detector, and Portable Fire Extinguisher

INTRODUCTION

Occupational Health and Safety is a system implemented in an organization or company to protect the health, safety, and comfort of workers from risks that may arise from work activities. Occupational Health and Safety also aim to ensure that the company or agency concerned meets the applicable legal requirements and established occupational safety and health standards. Implementation of Occupational Health and Safety within a company can be done by identifying risks of work accidents, establishing risk prevention and control measures, as well as monitoring and evaluating their implementation. Implementing good Occupational Health and Safety is hoped that it can reduce the risk of work accidents and increase company productivity and ensure worker welfare (Ismara, 2019).

The rapid development of the economy and the needs of the community have encouraged the government to build buildings that are used for activity centers such as office buildings, learning, education, shopping centers, and housing. Buildings are exposed to various risks of emergency hazards such as earthquakes, floods, and fire hazards. Fire starts with fire. Fire is defined as a chemical reaction known as a rapid oxidation process which produces heat, flame, gas and smoke (Nugraha & Abdullah, 2021). The fourth additional element, namely the tetrahedron causes the fire to continue to grow (Ramli, 2010).

All fire events can be divided in many ways depending on the cause of the fire, but in general, there are two types of fires, natural and man-made. Forest fires, for example, are caused by natural causes or by humans. All residential and non-residential structural fires are predominantly human-caused. Likewise, all industrial and chemical fires are caused by man-made explosions or fires, or machine breakdowns. In order to protect yourself, workers, or structural building occupants, it is important to understand the basic characteristics of fire. The fire spread quickly; No time to collect property or make phone calls. In just two minutes, the fire could be life-threatening. In five minutes, a residence can be engulfed in flames. Heat and smoke can be more dangerous than fire. Breathing super-hot air can burn your lungs (Shakil & Dhaka, 2005).

According to data from the United States Fire Service in 2018, 1,318,500 fire cases were handled, resulting in 3,655 fire deaths, 15,200 burns, and an estimated \$25.6 billion in losses, including \$12.4 billion from California's wildfires. On average, a fire death occurred every 2 hours and 24 minutes, and a burn victim every 35 minutes in 2018 (Bintoro, Ilham, 2021). Additionally, data compiled by the DKI Jakarta Province Fire and Rescue Service show that there were 8,081 fire incidents in DKI Jakarta from 2016 to 2020, with 62% of these incidents, or 4,893 incidents, caused by electricity (Jakarta Command Center Dinas Gulkarmat Provinsi DKI Jakarta, 2021).

Understanding the nature and scope of the problem of fire disasters is necessary to provide a basis for reducing losses caused by fires. Losses offer valuable lessons as they provide the information needed to prevent or mitigate the effects of similar losses in the future. A comprehensive understanding of fire behavior is a crucial foundation for effectively preventing, planning, and controlling fire losses. To effectively plan for the impact of a loss, it is important to know not only how it occurred, but also the reasons behind it. In order to control losses, it is essential to have a thorough understanding of fire's strengths and weaknesses (Schroll, 2002).

The fire protection system is a unified system in an effort to prevent fires which includes the completeness of equipment, and facilities, installed or constructed in a building or buildings that function as a protection system (active or passive) and other management methods to protect buildings and their environment against fire hazards (Menteri Pekerjaan Umum, 2008). The effectiveness of a building's fire protection system is influenced by a variety of factors, with the suitability of the installation and distribution of alarm systems, fire detectors, and portable fire extinguishers being the primary focus of this research. Based on the explanation above, this article is a literature review study in the field of occupational safety management to discuss the effect of the level of compatibility of fire alarm installation, fire detector, and Light Fire Extinguishing Equipment on the Fire Protection System in the Building.

The problem statement to be discussed for building the next research hypothesis based on the background above is:

1. Does the level of compatibility of fire alarm installation affect the Fire Protection System?
2. Does the level of compatibility of fire detector installation affect the Fire Protection System?

3. Does the level of compatibility of Portable Fire Extinguishing Equipment affect the Fire Protection System?

THEORETICAL REVIEW

Fire Protection System in Buildings

Fire protection system in building is a system consisting of equipment, accessories and facilities, both installed and built in the building, used in order to protect the building and its environment against fire hazards (Menteri Pekerjaan Umum, 2008). Furthermore, it states that active fire protection system is a fire protection system consisting of fire detection system, water-based fire extinguishing system (sprinkler) and chemical-based fire extinguishing system (fire extinguisher and special extinguisher).

Fire alarm

Fire alarm is the original component of the system that sends a signal/indication after a fire is detected (SNI 033985, 2000). The fire alarm system is used to notify workers or occupants where the fire started. Automatic fire alarm installation is a system or alarm circuit that uses heat detectors, smoke detectors, flame detectors, manual call points, and other equipment installed in the fire alarm system (Zhang & Wang, 2009). The level of compatibility of fire alarm installations in buildings has been studied by researchers including (Kowara, 2017; Nurwulandari, 2017; Ramadhani et al., 2018; Ratnayanti et al., 2019;).

Fire Detector

A fire detector is a device designed to detect the presence of fire. (SNI 03-3985, 2000). The fire detection system is a very important innovation in the efforts of prevention and control of fire. With this system, we can identify the factors that trigger the occurrence of fire before it happens, so that we can take the appropriate preventive actions. In addition, this system can also assess the environmental impact of fires that may occur, which can help in decision-making in terms of environmental recovery. It is extremely important for all parties to pay attention to this fire detection system and take the necessary actions to prevent and handle fires (Mahdipour & Dadkhah, 2014).

The planning of the number of fire detectors in a building must take into account the multiplying factor as a safety factor. The multiplying factor is affected by the height of the building's roof, the higher the roof, the smaller the multiplying factor because the effectiveness of the detector will be smaller. However, if the height of the roof is not too large, the effectiveness of the detector will be greater and the multiplying factor will also be greater.

Many studies have been conducted to evaluate the level of appropriateness of fire detector installations in buildings, among them are (Bintoro, Ilham, 2021; Kowara, 2017; Maharani et al., 2020; Ramadhani et al., 2018).

Portable Fire Extinguisher

The Regulation of the Minister of Manpower and Transmigration No: Per.04/Men/1980 defines APAR as an easy-to-operate tool for extinguishing fires at the onset of a fire. Its usage is listed on each APAR cylinder/label, which are: Pull the Pin (remove the pin), Aim (point towards the fire), Squeeze the handle (press the valve), and Sweep (move back and forth) (National Fire Protection Association, 2013; Ramli, 2010).

The technical requirements or conditions for the placement and installation of fire extinguishers include the following: 1) availability of light fire extinguishing equipment; 2) classification of fire extinguishers according to the type of fire; 3) easy accessibility and readiness of the fire extinguisher; 4) clear visibility and unobstructed placement of the fire

extinguisher; 5) sturdy installation on manufactured hangers or brackets, in addition to fire extinguishers with wheels; 6) fire extinguishers with a gross weight not exceeding 18 kg must be installed so that the top of the fire extinguisher is not more than 1.5 meters above the floor and fire extinguishers with a weight greater than 18 kg must be installed no more than 1 meter above the floor; 7) Operating instructions must be placed on the front of the fire extinguisher and be clearly visible; 8) fire extinguishers should not be exposed to temperatures outside the range specified on the label; 9) fire extinguishers must have a label that provides information on the manufacturer's name or the name of its agent, mailing address and telephone number; 10) fire extinguishers must always be maintained in full and ready-to-operate condition (Menteri Pekerjaan Umum, 2008).

The level of compatibility of Portable Fire Extinguisher installation and distribution has been extensively studied by previous researchers, including (Hesna et al., 2009), (Hidayat et al., 2017), dan (Novrikasari et al., 2021).

Table 1. Previous Relevant Research

No	Author (year)	Previous research findings	Equivalence with this article	Differences from this article
1	(Bintoro, Ilham, 2021)	The level of compatibility of Fire Alarm Installation, Fire Detector, Portable Fire Extinguisher, Sprinkler, Hydrant, and Life Safety equipment is suitable and has a positive and significant impact on the fire protection system	The level of compatibility of Fire Alarm Installation, Fire Detector, Portable Fire Extinguisher Equipment is appropriate and affects the Fire Protection System	Sprinklers, hydrants, and life-saving facilities have an impact on the fire protection system."
2	(Medina Azzura et al., 2021)	Perceived Threat Factor and Evacuation Decision-Making in relation to the Fire Protection System	-	Factors of Threat Perception and Decision Making for Fire Disaster Evacuation affect the fire prevention and protection system
3	(Maharani et al., 2020)	Level of the suitability of fire alarm installations, fire detectors, fire extinguishers, sprinklers, hydrants, life-saving facilities and organizational management according to and have a positive effect on the fire protection system	The level of compatibility of Fire Alarm Installation, Fire Detector, Portable Fire Extinguisher Equipment is appropriate and affects the Fire Protection System	Sprinklers, hydrants, life-saving equipment, and organizational management affect the fire protection system
4	(Ratnayanti et al., 2019)	The level of suitability of the installation of fire alarms, fire detectors, fire extinguishers, sprinklers, and hydrants is appropriate and has a positive and significant effect on the fire protection system	The level of compatibility of Fire Alarm Installation, Fire Detector, Portable Fire Extinguisher Equipment is appropriate and affects the Fire Protection System	Sprinklers and hydrants affect the fire protection system
5	(Ramadhani et al., 2018)	Level of suitability of fire alarm installations, fire detectors, fire	The level of compatibility of Fire Alarm Installation, Fire	Sprinklers, hydrants, life-saving equipment, and organizational and

		extinguishers, sprinklers, hydrants, life-saving facilities, organizational management, and human resources are appropriate and have a positive effect on the fire protection system	Detector, Portable Fire Extinguisher Equipment is appropriate and affects the Fire Protection System	human resource management affect the fire protection system
6	(Reddy et al., 2014)	Safety awareness, and safety training affects the fire protection system	-	Safety awareness, and safety training affects the fire protection system

METHODS

This scientific article is written using a combination of qualitative method and library research. This involves studying theories and connections or effects between different variables by reading books and journals in the library as well as online sources such as Mendeley, Google Scholar, and other online platforms.

The library research should be conducted in line with the methodological assumptions of qualitative research, which means it should be used in an inductive manner and not to direct the researcher's questions. A key reason for using qualitative research is because it allows for exploration of the topic (Ali & Limakrisna, 2013).

RESULTS AND DISCUSSIONS

The discussion of the literature review article in the field of Occupational Safety Management is based on relevant previous studies and theories, including the following:

1. The Influence of Fire Alarm Installation Compliance Level on Fire Protection System

The compliance level of Fire Alarm Installation has an effect on the Fire Protection System, with six indicators of Fire Alarm Installation Compliance Level requirements (a. Number of fire alarms installed in the building, b. Fire alarms must include manual and automatic alarms, c. Maximum distance between alarms is 30 m, d. Has a unique sound and rhythm, e. MCP is located a maximum of 1.4 m above the surface, f. MCP is installed on every floor) impacting the dimension or indicator of Fire Hazard Prevention (Ratnayanti et al., 2019).

To improve the implementation of the Fire Protection System by considering Fire Alarms, management should carry out regular maintenance, inspection, and testing of the installation and performance of fire alarms that have a positive impact on the fire protection system as an effort to prevent and protect against fire hazards as soon as possible (Bintoro, Ilham, 2021).

Fire Alarms have an effect on the Fire Protection System, if the compliance level meets the applicable standards and regulations that have been examined by authorized officials and the performance of the installed Fire Alarms receives a good response from building occupants or users, so that the effort to prevent and protect against fire hazards can be achieved as expected together (Maharani et al., 2020).

The compliance level of Fire Alarm Installation affects the Fire Protection System, which is in line with the research conducted by: (Reddy et al., 2014), (Ramadhani et al., 2018), dan (Medina Azzura et al., 2021).

2. The effect of the level of compliance of fire detector installation on the fire protection system

The suitability level of the installation of fire detectors has an effect on the fire protection system, with eight requirements indicators including: 1) availability of fire

detectors; 2) on flat roofs, detectors must be installed at a distance of more than 10 cm from the wall; 3) the distance between detectors is a maximum of 9.1 m or as recommended by the manufacturer; 4) clean, unpainted sensors; 5) detectors should not be installed within a distance of less than 1.5 m from air conditioning units; 6) each system group should not have more than 20 smoke detectors; 7) each system group should not have more than 20 flame detectors; 8) each system group should not have more than 40 heat detectors (Ratnayanti et al., 2019).

Building managers must focus on maintaining, inspecting, and testing the suitability of fire detector installation and performance in order to improve the fire protection system, as a preventive measure and protection against fire hazards as soon as possible (Bintoro, Ilham, 2021).

The fire detector has an impact on the fire protection system, when the level of compliance has met the applicable standards and regulations that have been inspected by authorized officials and the performance of the installed fire detector has received positive responses from the building's inhabitants or users, so that prevention and protection efforts against fire hazards can be achieved as soon as possible according to what is expected together (Maharani et al., 2020).

The level of compliance of the fire detector installation affects the fire protection system, this is in line with the research conducted by: (Reddy et al., 2014), (Ramadhani et al., 2018), dan (Medina Azzura et al., 2021).

3. The Influence of the Level of Compatibility of Light Fire Extinguisher Installation on Fire Protection System

The level of compatibility of the installation and distribution of portable fire extinguishers has an impact on the fire protection system, with five indicator requirements: 1) availability of lightweight fire extinguishers; 2) maximum distance between fire extinguishers of 15 m; 3) there are operating instructions on the front of the fire extinguisher; 4) fire extinguisher inspections at least twice a year; 5) fire extinguishers are placed in very clear and easily accessible locations during fires (Ratnayanti et al., 2019).

What needs to be done by building management to improve the fire protection system, focusing on lightweight fire extinguishers, is to regularly maintain, inspect, and test the compatibility and performance of the lightweight fire extinguishers, which have a positive effect on the fire protection system as an effort to prevent and protect fire hazards as soon as possible (Bintoro, Ilham, 2021).

Portable fire extinguishers have an impact on the fire protection system if the level of compatibility meets the standards and regulations that have been examined by authorized officials and the performance of the installed lightweight fire extinguishers receives positive response from the building's occupants or users, thus the effort to prevent and protect against fire hazards as soon as possible can be achieved as expected (Maharani et al., 2020).

The level of compatibility of the installation and distribution of lightweight fire extinguishers has an impact on the fire protection system, in line with research carried out by: (Reddy et al., 2014), (Ramadhani et al., 2018), dan (Medina Azzura et al., 2021).

Conceptual Framework

The idea presented in this article, which is based on identifying the issue, reviewing relevant literature, and analyzing the effects of certain factors, can be illustrated in the following image.

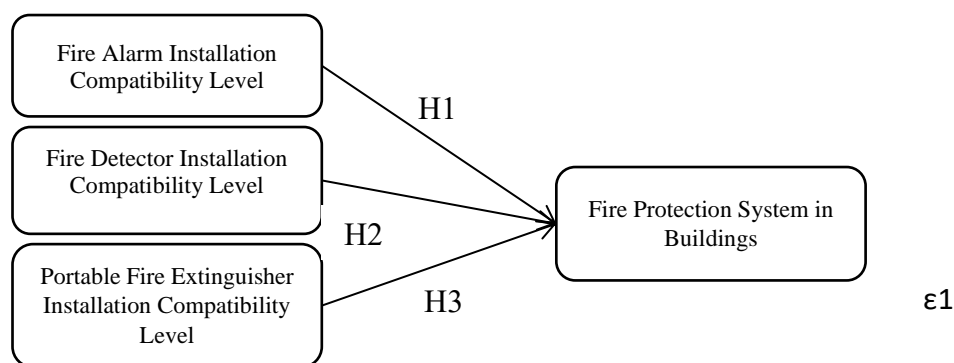


Figure 1. Conceptual Framework

Based on the conceptual framework image above, the level of compatibility of Fire Alarm, Fire Detector, and Light Fire Extinguisher installation affects the Fire Protection System in buildings. In addition to these three exogenous variables that affect Fire Hazard Prevention, there are many other variables that affect it, including:

- a) Sprinkler affects the fire protection system, (Bintoro, Ilham, 2021), (Maharani et al., 2020), (Ratnayanti et al., 2019).
- b) Hydrant, a life-saving facility, affects the fire protection system, (Bintoro, Ilham, 2021), (Maharani et al., 2020), (Ratnayanti et al., 2019).
- c) Life-saving facilities affect the fire protection system, (Bintoro, Ilham, 2021), (Maharani et al., 2020), (Ratnayanti et al., 2019).
- d) Threat perception affects the fire prevention and protection system, (Medina Azzura et al., 2021).
- e) Decision-making for Fire Disaster Evacuation affects the fire prevention and protection system, (Medina Azzura et al., 2021).
- f) Organizational management affects the fire protection system, (Maharani et al., 2020), (Ratnayanti et al., 2019).
- g) Human resources affect the fire protection system, (Ratnayanti et al., 2019).
- h) Safety awareness affects the fire prevention and protection system, (Reddy et al., 2014)
- i) Safety training affects the fire prevention and protection system, (Reddy et al., 2014)

CONCLUSION AND RECOMMENDATION

Conclusion

Based on theory, relevant articles, and discussion, the following hypotheses can be formulated for further research:

- 1. The level of compatibility of Fire Alarm installation affects the Fire Protection System in buildings.
- 2. The level of compatibility of Fire Detector installation affects Fire Hazard Prevention.
- 3. The level of compatibility of Light Fire Extinguisher installation affects Fire Hazard Prevention.

Recommendation

The article concludes that there are multiple factors that impact the effectiveness of Fire Protection Systems in buildings, not just the compatibility of Fire Alarm, Fire Detector, and Light Fire Extinguisher installation. Additional research is needed to identify other factors, such as the use of sprinklers, hydrants, emergency facilities, threat perception, evacuation planning, organizational management and personnel, safety awareness and training.

REFERENCES

- Ali, H., & Limakrisna, N. (2013). *Metodologi Penelitian (Petunjuk Praktis untuk Pemecahan Masalah Bisnis, Penyusunan Skripsi, Tesis, dan Disertasi)*. Deepublish: Yogyakarta.
- Bintoro, Ilham. (2021). Analisis Implementasi Sistem Proteksi Kebakaran Aktif, Sarana Penyelamatan Jiwa Dan Tanggap Darurat Di Gedung Promoter Polda Metro Jaya Tahun 2021. *Indonesian Scholar Journal of Medical and Health Science*, 1(02), 59–67. <https://doi.org/10.54402/isjmhs.v1i02.50>
- Hesna, Y., Hidayat, B., & Suwanda, S. (2009). Evaluasi Penerapan Sistem Keselamatan Kebakaran pada Bangunan Gedung Rumah Sakit Dr. M. Djamil Padang. *Jurnal Rekayasa Sipil*, 5((2)), 6576.
- Hidayat, D. A., Suroto., & B., K. (2017). Evaluasi Keandalan Sistem Proteksi Kebakaran Ditinjau dari Sarana Penyelamatan dan Sistem Proteksi Pasif Kebakaran di Gedung Lawang Sewu. *Jurnal Kesmas*, 5((5)), 134–145.
- Ismara, K. I. (2019). Pedoman K3 Kebakaran. *Universitas Negeri Yogyakarta*, 29–31. http://mat.fmipa.uny.ac.id/sites/mat.fmipa.uny.ac.id/files/download/Pedoman_K3_Kebakaran.pdf (diakses pada 20 Mei 2020)
- Jakarta Command Center Dinas Gulkarmat Provinsi DKI Jakarta. (2021). *Data Kejadian Kebakaran 2016-2020*.
- Kowara, R. A. (2017). Analisis Sistem Proteksi Kebakaran Sebagai Upaya Pencegahan Dan Penanggulangan Kebakaran. *Jurnal Manajemen Kesehatan Yayasan RS.Dr. Soetomo*, 3(1), 69. <https://doi.org/10.29241/jmk.v3i1.90>
- Maharani, F. T., Yulita, A., & Utari, D. (2020). Analisis Penerapan Sistem Proteksi Aktif, Sarana Penyelamatan Jiwa Dan Pengorganisasian Di Gedung Fakultas Ilmu Komputer Universitas Pembangunan Nasional “Veteran” Jakarta Tahun 2018. *Jurnal Ilmiah Kesehatan Masyarakat: Media Komunikasi Komunitas Kesehatan Masyarakat*, 12(1), 33–42. <https://doi.org/10.52022/jikm.v12i1.57>
- Mahdipour, E., & Dadkhah, C. (2014). Automatic fire detection based on soft computing techniques: review from 2000 to 2010. *Artificial Intelligence*, 42(4), 895–934. <https://doi.org/10.1007/s10462-012-9345-z>
- Marfuah, U., Sunardi, D., Casban, & Dewi, A. P. (2020). Pelatihan Pencegahan dan Penanganan Kebakaran Untuk Warga RT 08 RW 09 Kelurahan Kebon Pala Kecamatan Makasar Jakarta Timur. *Jurnal Pengabdian Masyarakat Teknik*, 7–16. <https://doi.org/10.24853/jpmt.3.1.7-16>
- Medina Azzura, N. A., Novrikasari, N., & Dahlan, M. H. (2021). Hubungan Persepsi Ancaman Bencana Kebakaran Dengan Pengambilan Keputusan Evakuasi Di Kelurahan X Kota Palembang. *PREPOTIF: Jurnal Kesehatan Masyarakat*, 5(2), 554–560. <https://doi.org/10.31004/prepotif.v5i2.1843>
- Menteri Pekerjaan Umum, N. 26/PRT/M/2008. (2008). *Peraturan Menteri Pekerjaan Umum No. 26/PRT/M/2008 Tentang Persyaratan Teknis Sistem Proteksi Kebakaran pada Bangunan Gedung dan Lingkungan*.
- National Fire Protection Association. (2013). *NFPA 10, Standard Portable Fire Extinguishers 2013 Edition*. 83.
- Novrikasari, M, L., D, A., A, C., P, F., & Putri DA. (2021). Penerapan Tanggap Darurat pada Pengunjung Salah Satu Mall di Kota Palembang. *Jurnal Kesmas*, 9((1)), 1–8.
- Nugraha, W., & Abdullah, A. (2021). *Modul Chemistry of Combustion*.
- Nurwulandari, F. S. (2017). Kajian Mitigasi Bencana Kebakaran di Permukiman Padat. *Infomatek*, 18(1), 27. <https://doi.org/10.23969/infomatek.v18i1.506>
- Ramadhani, D., Utari, D., & Maharani, F. (2018). Analisis Implementasi Sistem Proteksi Aktif, Sarana Penyelamatan Jiwa, dan Pengorganisasian Sebagai Bagian dari Upaya Penanggulangan Kebakaran di Gedung Y Pusat X Tahun 2018. *Jurnal Ilmiah*

- Kesehatan Masyarakat, 11(1).*
- Ramli. (2010). *Manajemen Kebakaran*. Jakarta: Dian Rakyat.
- Ratnayanti, K. R., Hajati, N. L., & Rizki Utama, M. I. (2019). Evaluasi Sistem Proteksi Aktif dan Pasif sebagai Upaya Penanggulangan Bahaya Kebakaran pada Gedung X Mall. *Jurnal Rekayasa Hijau, 3(1)*, 1–16. <https://doi.org/10.26760/jrh.v3i1.2816>
- Reddy, B. V., Sandeep, P., Navaneetha, K., & Ujwala, P. (2014). Review on Industrial Hazards and its Prevention. *International Journal of Medicine and Pharmaceutical Research, 2(1)*, 451–461.
- Schroll, R. C. (2002). *Fire Protection Handbook 2nd Edition*.
- Shakil, H. I., & Dhaka, S. (2005). *Fire Hazard , Its Consequences and Possible Preventions*. 1–16.
- SNI 03-3985-2000-Tata cara perencanaan, pemasangan dan pengujian sistem deteksi dan alarm kebakaran untuk pencegahan bahaya kebakaran pada bangunan gedung.pdf. (n.d.).
- Zhang, L., & Wang, G. (2009). Design and Implementation of Automatic Fire Alarm System based on Wireless Sensor Networks Fluid Mechanics View project Turbomachinery and Propulsion Systems. *Proceedings of the 2009 International Symposium on Information Processing (2009)*, September 2015. <https://www.researchgate.net/publication/228365130>