

**FORMULATION OF FIRE SAFETY EVACUATION
MANAGEMENT STRATEGY FOR THE
GOVERNMENT HOSPITAL BUILDINGS**

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**FORMULATION OF FIRE SAFETY EVACUATION
MANAGEMENT STRATEGY FOR THE
GOVERNMENT HOSPITAL BUILDINGS**

by

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**Thesis Submitted in fulfilment of the requirements
For Master Degree of
Master of Sciences**

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DECLARATION

“I declare that this research entitled ‘The formulation of the main novelty for fire safety management in dealing with fire safety issues in the government hospital buildings’ is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree”.

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**FORMULASI STRATEGI PENGURUSAN PEMINDAHAN KESELAMATAN
KEBAKARAN UNTUK BANGUNAN HOSPITAL KERAJAAN**

ABSTRAK

Kebakaran boleh berlaku pada bila-bila masa tanpa sebarang tanda terutamanya di bangunan lama kerana bahan dan keadaan bangunan tersebut sudah lama. Apabila kebakaran berlaku dalam struktur, ia boleh memberi kesan kepada operasi bangunan serta menyebabkan kecederaan. Apabila kebakaran berlaku dalam struktur, pemindahan keselamatan kebakaran adalah penting untuk menyelamatkan nyawa penghuni bangunan. Terutamanya di bangunan hospital di mana majoriti banduan adalah orang yang tidak dapat berpindah sendiri dan memerlukan bantuan. Majoriti hospital kerajaan Malaysia telah didirikan lebih 50 tahun lalu, justeru ia dianggap sebagai struktur lama. Bangunan yang dibina sebelum menerima pakai Undang-undang Kecil Bangunan Seragam 1984 mungkin tidak memenuhi keperluan yang digariskan dalam peraturan itu. Oleh kerana semua struktur di Malaysia mesti mematuhi UBBL 1984, kebanyakan bangunan yang didirikan sebelum tarikh tersebut mesti diaudit. Tujuan penyelidikan ini bukan sahaja untuk menyiasat pengurusan pemindahan keselamatan kebakaran, tetapi juga untuk menilai pematuhan bangunan terhadap kod pemindahan. Pengurusan pemindahan keselamatan kebakaran telah disiasat untuk mendapatkan pemahaman mengenainya, dan komponen utama juga telah dikenal pasti. Kod pematuhan pemindahan keselamatan kebakaran juga telah dikenal pasti untuk mengesahkan bahawa bangunan itu mempunyai pengurusan pemindahan keselamatan kebakaran yang betul.

FORMULATION OF FIRE SAFETY EVACUATION MANAGEMENT STRATEGY FOR THE GOVERNMENT HOSPITAL BUILDINGS

ABSTRACT

Fire may occur at any time without any signs especially in old building as the materials and the condition of the building are old. When a fire breaks out in a structure, it can have an impact on the building's operations as well as cause injury. When a fire breaks out in a structure, fire safety evacuation is critical in order to save the lives of the building's occupants. Especially in hospital buildings where the majority of the inmates are persons who are unable to evacuate on their own and require assistance. The majority of Malaysia's government hospitals were erected more than 50 years ago, hence they are considered old structures. Buildings constructed prior to the adoption of the Uniform Building By-Laws of 1984 may not meet the requirements outlined in that regulation. Because all structures in Malaysia must conform to UBBL 1984, most buildings erected before that date must be audited. The purpose of this research is not only to investigate fire safety evacuation management, but also to redefine the fulfilment of the design criteria of needed Means of Escape (MOE) by-Laws and other associated fire safety rules and regulations and to assess the building's compliance with the evacuation code. The study also seeks to develop parameters for fire safety management at the Government hospital buildings. The fire safety evacuation compliance code has also been identified to verify that the building has proper fire safety evacuation management. To achieve these objectives, the researcher uses a structured interview session with specialists, followed by a quantitative technique that includes inspecting the fire safety management aspects in the government hospital facility using a checklist and observation method. This research has been essential in raising the issue on the need for efficient and effective fire safety measures in public spaces especially hospitals to promote the safety of the general public.

CHAPTER 1: INTRODUCTION

1.1 Introduction

Hospitals are complex organisations with much-sophisticated equipment, treating patients suffering from various complex diseases and involving the services of many health professionals. Patient safety has been increasingly emphasised, especially over the last two decades. These are issues that have been raised by the Ministry of Health nationally and internationally by organisations such as the World Health Organization. This is the focus and emphasis built on the Quality Assurance Program (QAP) in Malaysia. QAP was launched nationwide by the Ministry of Health in 1985. As part of this program, an organisational structure for quality management at the institutional and district levels was developed, with guidelines for distributed activities that require reporting to the State and national levels.

Safety for patients and staff in hospitals is quality's primary and fundamental issue. Safety standards described by applicable laws in this country should apply to private and government hospitals. Hospitals are at a very high-risk level for fire because most of the equipment is electrical equipment, and there is a lot of explosive and flammable equipment in the hospital. Fire can occur for any reason, and hospitals must follow the Uniform Building Code (UBBL) 1984 and the Fire Services Act 1988 to protect hospital inhabitants during a fire. The UBBL and Fire Services Act 1988 applies to government and private hospitals. Private hospitals must also adhere to the Private Healthcare Facilities and Services Act (PHCFSA) standards. On the other hand, private hospitals are obliged under the Private Healthcare Facilities and Services Act (PHCFSA) to adhere to the requirements set out by the Malaysian Fire and Rescue Department, known as the Fire Safety Certificate. PHCFSA is only applicable to private hospitals and not enforced for government-owned hospitals.

The Malaysian Society for Quality in Health (MSQH) Accreditation Standards have been reviewed and revised. One of the things set out in the MSQH is fire safety. The hospital needs to be implemented to get accreditation from this body. In July 2017, the 5th Edition Standards were accepted for deployment. The current requirements of the

Private Health Care Facilities & Services Act 1998 and its accompanying Regulations 2006 and other related current regulatory needs have been factored into these standards. The needs of WHO Patient Safety Initiatives, Malaysian Patient Safety Goals, and assessment of service outcomes are all addressed in these revised Standards. Thousands of healthcare professionals rely on ISO management systems to deliver high-quality care with complete confidence. In contrast, ISO symbols serve as a worldwide language for warning individuals about potential dangers and assisting them in staying safe.

Our government is still working on the most up-to-date set of laws and standards to guarantee that fire safety in government hospital facilities is on par with industrialised countries. It is unclear why fire safety in government hospital facilities is not up to par and why relevant laws are not strictly followed. This study aims to provide comprehensive fire safety and management requirements model for existing and future Malaysian government hospital structures. The state of fire safety management in government hospital facilities is critical because it can prevent fire incidents, property damage, and fatalities. The research will be conducted based on quantitative and qualitative methods such as literature review and case study, distribution of questionnaires among the hospital staff and users, and interviews with professional specialists. The holistic model for the hospital fire safety management is developed and improved through data collection in the analytical technique process and getting the current data. Then, the final output model will be calibrated into the Government hospital buildings randomly selected. The expected output will be the assessment of the parameters for fire safety management used for fire safety issues in Government hospital buildings. Three key objectives must be met in this study. In the beginning, a site visit to the hospitals will be conducted to examine the fire safety management and arrangements at each facility. Every hospital will be inspected thoroughly and focused on the parts that operate 24 hours. This ensures we get correct information about the fire safety appliances and fire safety management in the hospital itself.

1.2 Problem Statement

There are many examples where accidents occur in hospitals mainly caused by improper fire safety management. All the fire safety appliances and management need to

be inspected well and ensure all are ready to use. Proper fire safety management needs to be prepared to avoid all these accidents. Hospitals themselves have much flammable equipment that can start a fire in just a second. All the equipment must be taken care of and managed well to decrease an accident. Other than the equipment itself, the immovable patient must be focused. This type of patient cannot evacuate by themselves without the help of others. To help the patient with machines is more challenging because most of the machines are not portable. In another country, many hospital fire cases occurred this year. At a South Korean hospital, at least 37 people were killed in the fire breakout. Nearly 130 were injured in that fire incident. The original cause is unknown; however, the building manager was eventually arrested for safety violations, including faulty sprinkler systems (Choe & Sang-Hun, 2018). There, one more case occurred in Saint Petersburg, Russia. In that fire accident, five patients died. That hospital was specialised in coronavirus patients. After a fire broke out on the sixth floor of the Saint George Hospital, another 150 patients were evacuated. The fire breakouts are because of the short circuit (BBC News, 2020).

A fire broke out inside the National Institute of Forensic Medicine's disposable products store at Hospital Kuala Lumpur on Saturday, March 17, 2018. (HKL). The fire started around noon and was brought under control by 2.00 pm with no injuries or casualties reported. About 40 fire and rescue department personnel from six stations around Kuala Lumpur arrived at the scene when it was reported. A short circuit at its shop triggered the catastrophe at the forensic department. The fire swiftly spread and destroyed a chunk of the forensic department. MIMS Today (MIMS Today, 2018). On June 28, 2020, a fire broke out in the female ward of Hospital Sultanah Aminah (HSA). (Malaysian mail, 2020). In addition, on October 3, 2021, a fire broke out in a public clinic in Kuching, destroying the pharmaceutical storehouse to the tune of 40%. Both occurrences were lucky in that no one was hurt. This accident is a good lesson for all other agencies and buildings to avoid this type of accident to happen again. Table 1.1 shows the fire accidents in government hospitals in Malaysia that had accidents before this.

Among the many fire incidents, the fire at the Intensive Care Unit (ICU) on the second floor of the Sultanah Aminah Hospital in Johor Bahru on October 25, 2016, horrified the public and raised concerns about fire safety in Government hospital

facilities. This catastrophe resulted in the deaths of six patients, the injuries of eleven more, and the evacuation of hundreds of others. Following the recent incidents, former Health Minister Datuk Seri Dr S Subramaniam stated that most government hospitals need to be audited (Kili et al., 2016). This is because most of the fire accidents involving government hospitals are mainly the old hospitals built before the existing regulation, as stated by State Health and Environment Committee chairman Datuk Ayub Rahmat. The hospital was erected in the 1930s, and there was no need for certification because the Fire Services Act of 1988 only applies to buildings constructed after that year (Said, 2016). It is critical to learn from this situation since it can bring valuable lessons and experiences that can help to avoid a similar blunder in the future. Our government is still working on the most up-to-date set of laws and standards to guarantee that the quality of fire safety in government hospital facilities matches that of industrialised countries. This afternoon, June 28, 2020, a fire broke out at Sultanah Aminah Hospital (HSA) in Johor Bahru, Johor, and the second blaze at the government hospital following a tragic fire in 2016 at the same hospital but in a different location. The fire started in the women's ward. The incident occurred at 3 pm, according to Health Minister Datuk Seri Dr Adham Baba, and was first brought under control by the hospital's emergency response team. The fire, however, flared up again, and the Fire and Rescue Department (JBPM) was dispatched. They came in five minutes and put out the fire in ten minutes. The emergency response team and personnel were able to rescue 24 patients from the unit. Ten patients were sent to the Permai Hospital for isolation, while the remainder were relocated to different wards inside the hospital (New Straits Time, 2020). Safety for patients and staff in hospitals is a fundamental issue in quality. The standards for safety as prescribed by the relevant laws (building and fire safety codes) should apply to Government hospitals.

Table 1. 1 List of Fire Accidents in Government Hospitals in Malaysia

Hospital Name	Death	Date
A fire at Neurology Institute, Kuala Lumpur Hospital	-	July 8, 1993
The staircase on the third floor of University Hospital Kuala Lumpur caught fire.	-	July 16, 1995
Power supply tripping in an elevator caused the fire on the first floor of Neurology Institute, Kuala Lumpur Hospital.	-	May 2, 2007
A fire in store room at the South ICU ward, Sultanah Aminah Hospital (HSA), Johor Bahru.	-	July 30, 2008
A small fire at the electrical wiring at the South ICU ward, Sultanah Aminah Hospital (HSA), Johor Bahru	-	January 2010
The fire occurred in Mental Patient's Isolation room at Kuala Lumpur Hospital's emergency department.	One death (patient)	July 30, 2011
A small fire at Centralise Air Handling Unit (CAHU) room at the Komplek Pakar dan Rawatan Harian, Kuala Lumpur Hospital.	-	February 6, 2014
A block of a new building at Sarawak General Hospital caught fire.	One death (construction worker)	Feb 15, 2014
A fire in an empty ward at Tuanku Jaafar Hospital, Seremban the ward while the ward was empty at Tuanku Jaafar Hospital, Seremban	-	May 16, 2015
There was a small fire at the switch oxygen pipeline and socket outlet in the ward at Level 7, Tengku Ampuan Rahimah Hospital, Klang.	-	May 27, 2015
A small fire at the air conditioning system near-bed No. 26 in the South ICU ward, Sultanah Aminah Hospital (HSA), Johor Bahru	-	May 5, 2016
A fire in the storeroom at Sri Kota Hospital, Klang	-	August 15, 2016
A small fire at the switch socket outlet near bed No. 31 in the South ICU ward, Sultanah Aminah Hospital (HSA), Johor Bahru	-	October 14, 2016
A fire broke out at the storage room of South ICU ward, Sultanah Aminah Hospital (HSA), Johor Bahru.	Six death (patients)	October 25, 2016
Faulty wiring (in a cubicle or dividing wall between the beds) causes a small fire in ward 5B, Raja Permaisuri Bainun Hospital, Ipoh.	-	November 9, 2016
A small fire at the NICU ward, Shah Alam Hospital	-	February 15, 2017
A fire broke out at the Linen room of 3 & 4 wards, Segamat Hospital.	-	March 25, 2017
The short circuit causes a small fire in ward 23, Sibul Hospital.	-	November 17, 2017
At the disposable items storage room in the Institute Perubatan Forensik Negara (IPFN), Kuala Lumpur Hospital, a fire broke out.	-	March 17, 2018
A fire broke out at Female ward, Sultanah Aminah Hospital (HSA), Johor Bahru.	-	June 28, 2020
A fire occurred in a public clinic in Kuching	-	October 3, 2021

(Source: Researcher Survey, 2021)

The building and fire safety codes which applied in the Malaysia hospital buildings are Street, Drainage and Building (SDB) Act 1974 (Act 133), Uniform Building By-Laws 1984 (UBBL 1984), Fire Services Act 1988 (Designated Premises), Fire Services (Fire Certificate) Regulations 2001, Occupational Safety and Health (OSHA) Act 1994 (Act 514) & Regulations and Orders, Electrical Supply Act 1990 (Act 447), Malaysia Standard, British Standard, National Fire Protection Association 101 (NFPA 101) and others. The fire safety compliance procedure was based on these building and fire safety rules. However, it was discovered that several actions were not effectively enforced in hospital buildings, particularly those erected before the creation of building and fire safety rules, such as the government hospital building. (Suliman & Ong, 2015).

On October 5, 2021, the Dewan Rakyat was informed that a 2016 fire audit, conducted by the then-health minister, discovered that 47 public hospitals and institutions were over 50 years old, with another 32 being between 30 and 49 years old; and that hospital assets older than ten years surpassed 50%. These data pointed to a significant danger of fire. 32 of the 76 public hospitals and clinics that require a fire certificate have received one, while the remaining 44 are obtaining one. What is the current state of fire protection in public hospitals? Is there any evidence of progress since 2016? When will all facilities be modified to increase fire safety in five or ten years?

The research will be conducted based on quantitative and qualitative methods such as literature review and case study, distribution of questionnaires among the hospital staff and users and interviews with professional specialists. The holistic model for the hospital fire safety management is developed and improved through data collection in the analytical technique process and getting the current data. Then, the final output model will be calibrated into the Government hospital buildings randomly selected. The expected output will be the assessment model used for fire safety issues in Government hospital buildings. This study will ensure that one of the essential things impacting a hospital's reputation is safe. The government owns and operates government hospitals. If a fire accident occurs due to negligence in fire safety management, this will

have a negative impact on the competency of the Government hospitals versus Private hospitals.

The fire safety management system refers to a set of fire safety hazard risk scenarios of the most significant relevance and fire safety codes scenarios are to be defined on the hazard map. In addition to assessing modes, impact on operations or demand and prioritising modes, the study will explore how adaptations issues might be considered in Government hospital buildings. This assessment methodology can assist human resource management in conducting a periodic health check on their fire safety management and making the appropriate decisions. One of the most important advantages is that fire safety management may help to improve the overall fire safety of a structure. The study is going to deal with the following questions.

1.3 Hypothesis

- H1** The majority of the selected Government hospital buildings experience fire safety issues and face challenges in implementing fire safety management systems.
- H2** The Government hospital buildings obey and observed all Malaysia local building codes and fire codes such as; (1) Street, (2) Drainage and Building (SDB) Act 1974 (Act 133), (3) Uniform Building By-Laws 1984 (UBBL 1984), (4) Fire Services Act 1988 (Designated Premises), (5) Fire Services (Fire Certificate) Regulations 2001, (6) Occupational Safety and Health (OSHA) Act 1994 (Act 514) & Regulations and Orders, (7) Electrical Supply Act 1990 (Act 447), (8) Malaysia Standard, British Standard, (9) National Fire Protection Association 101 (NFPA 101), (10) and others primarily related law to the Means of Escape (MOE) design elements and specifications.
- H3** The fire safety management in the selected Government hospital buildings was considered above the acceptable level based on the fire safety ranking system developed for the Government hospital buildings.

1.4 Research Questions

The following research questions were chosen and prepared with the intent of offering a solution to the research problem and addressing the objectives:

RQ1: Why do the Government hospital buildings in Malaysia experience fire safety issues and face challenges in implementing fire safety management systems?

RQ 2: What are the challenges related to the enforcement of the Means of Escape (MOE) design elements and specifications such as the local building codes and fire codes that increase fire safety risks in the government hospitals buildings?

RQ 3: Why the need to measure the effectiveness of the fire safety management at the Government hospital buildings?

1.5 Research Objectives

The primary goal of this study was to look at the development of significant innovation, a fire safety audit parameter, and its management standards in dealing with fire safety concerns in government hospital facilities.

RO 1: To investigate the reasons why Government hospital buildings in Malaysia experience fire safety issues and face challenges in implementing fire safety management systems.

RO 2: To determine the challenges related to the enforcement of the Means of Escape (MOE) design elements and specifications such as the local building codes and fire codes that increase fire safety risks in the government hospitals buildings

RO 3: To establish parameters for measuring the effectiveness of the fire safety management at the Government hospital buildings

1.6 Scope of the Study

This research will focus on a fire safety assessment of government hospitals. The study's scope is limited to the following:

- Only government hospitals are involved in this research because the fire codes for government and private hospitals are different.

- This study focuses only on the ward block of the selected hospitals because the ward blocks are usually the ones occupied by the most number of patients who are especially vulnerable and are at a greater risk in case of a fire breakout.
- The number of government hospitals that could be selected as a case had narrowed down to six (6) hospitals at the Pulau Pinang and North of Perak, as shown in Table 1.2.
- Only the aspect of fire safety management in hospital buildings is being assessed.

Table 1. 2 List of hospitals with the year of hospital operation and number of beds

Hospital Name	The year of hospital operation	No. of bed
Hospital Pulau Pinang	81	1090
Hospital Seberang Jaya, Seberang Perai Tengah	20	314
Hospital Bukit Mertajam, Seberang Perai Tengah	50	242
Hospital Kepala Batas, Seberang Perai Utara	15	108
Hospital Sungai Bakap, Seberang Perai Selatan	50	105
Hospital Parit Buntar, Perak	91	150

(Source: Researcher Survey, 2021)

1.7 Conceptual Framework

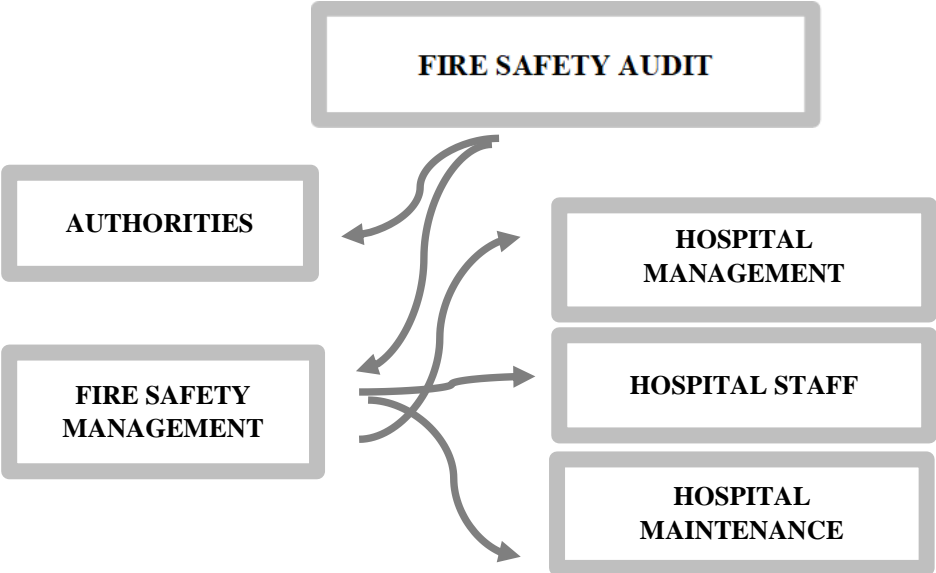


Figure 1. 1 Conceptual framework

(Source: Researcher Survey, 2021)

The fire safety audit is influenced by two main factors: fire safety management and authorities. Basically, in this research, the experts from the authorities will be selected and will be interviewed. There are three headings and questions prepared for the semi-structured interview with the experts. Moreover, fire safety management relates to three main components: hospital management, hospital staff, and hospital maintenance. The researcher chose a semi-structured way to interview both hospital management and maintenance. For hospital staff, a questionnaire will be given for them to answer. Interview question prepared for the hospital management team consists of seven headings, and all questions are related to fire safety. Questions prepared for the hospital maintenance team consists of 3 headings that will be useful for the researcher

to gain information about the maintenance. The relations here are the statement given by authorities will be a basic guideline for the researcher to know how the situation is supposed to be at the hospital.

1.8 Significance of the Study

By incorporating the research findings into the management of Government Hospital Buildings, this study can benefit the Ministry of Health (MoH) and other associated departments. This study will aid in finding gaps in fire safety compliance in a government hospital structure. This evaluation technique aids human resource management in doing a health check on their fire safety compliance regularly and making the appropriate choices. A building that conforms to existing standards and regulations cannot provide enough protection and reassurance without a strong fire safety compliance management system. One of the most critical aspects determining a hospital's reputation is patient safety. If the public is exposed to inadequate fire safety management or a fire tragedy caused by poor fire safety compliance, the hospitals and government's reputations will suffer.

The contributions of this research may be summarised in two ways: from an academic standpoint and the standpoint of the construction industry. Academic contributions might include the following: Toward an understanding of the conceptual and theoretical frameworks for fire safety audit approach.

- To provide conceptual, theoretical and applied strategies for a fire safety audit to be considered at the design stage.

The following are the study's contributions to the industry:

- i. To encourage the government to draw a policy and adopt more fire safety policy at the design stage.
- ii. Provide awareness on fire safety management to the key players in their construction project.
- iii. As a practical guide for the key players to adopt a fire safety plan at the design stage.

1.9 Research Design

The researcher picked a survey research strategy because it best answered the study's questions and objectives. In other words, just a portion of the population is investigated, with the results anticipated to be applied to the whole population (Nworgu, 1998). Similarly, Donald, (1995) defines a survey using questionnaires and sample procedures to gauge public opinion or individual characteristics. For the qualitative part, the research will conduct a structured interview session with the selected expert in the fire safety area in every hospital. The question used will be the same for all the experts. They will be questioned about the fire appliances maintenance, how many times it will be inspected in a year, the cost they need to provide and how to arrange the schedule to make sure all goes well, including the fire appliance and management team. The one being interviewed will be an expert in this area and must be the one who knows well about the fire safety of that particular hospital. For the quantitative part, the researcher chooses the observation method. Observation will be done towards all the Means of Escape (MOE) elements using a complete checklist. It is to check whether it complies with the stated requirement.

1.10 Thesis Organisation

For this study, this report will be divided into five chapters, which as follow: (1) Chapter One: Research Background; (2) Chapter Two: Literature review, (3) Chapter Three: Methodology, (4) Chapter Four: Analysis and Discussion, and (5) Chapter Five: Conclusion and recommendation.

Chapter One: Research Background

Introduction to the research, problem statement, aims, research questions, importance, contribution to body knowledge, and research methods are all covered in this chapter.

Chapter Two: Literature Review

The theoretical basis of fire safety audits in hospital facilities is reviewed in detail in this chapter. The chapter examines fire safety management concerns in research

relevant to literature. The goal is to explain the idea of fire safety management and its link with fire safety facilities in detail, including the causes that lead to fire and the regulations and rules that experts should follow. This chapter briefly discusses the necessity of fire safety management in buildings and its obstacles.

Chapter Three: Methodology

The approach utilised to study the research topics in order to reach the research goal and goals is discussed in this chapter. This elaboration aims to clarify the research technique for this study. The organisation of the research process is discussed, as well as study design, research tools, ethical processes, population sampling, surveys, and data gathering and analysis.

Chapter Four: Data Analysis

This chapter examines the mixed methodology study findings (quantitative and qualitative analysis). The analyses are based on information from the survey questionnaire and focus group discussions, and they cover the following topics: fire safety management in government hospital buildings; design criteria for Means of Escape (MOE) in government hospital buildings as required by -Laws and other related fire safety rules and regulations; and parameters for fire safety audit in government hospital buildings.

Chapter Five: Conclusions and Recommendations for Further Research

This chapter examines and summarises the study's aims and concerns concerning the research findings. The elaboration is organised according to the research goals mentioned in the chapter's content material. This chapter's extra section includes the study conclusion section, the research's primary contribution, the work limitation, and recommendations for future research work.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Any facility or part of a building that is constructed, utilised or altered for the housing, care, or treatment of sick, elderly, infirm, convalescent, or pregnant people is referred to as a hospital (UBBL, 1984). On the other hand, Steven & Martha (2000) explained the hospital building. Only hospitals, nursing homes, and limited-care institutions provide 24-hour patient care, whereas ambulatory health care occupancies and commercial occupancies do not. In addition, four or more patients in health care and ambulatory health care occupancies are made incapable of self-preservation. Hospitals are divided into two types; Government hospitals and Private hospitals. The Government hospitals are also known as Public hospitals because of highly subsidised medical treatments to their citizens. Meanwhile, a private hospital is defined as ‘any other than a government hospital or institution where two or more patients are treated simultaneously’. This includes private nursing homes and private maternity homes. In general, hospital buildings have a unique design to fit the desired purpose.

In this context, hospital buildings are very complicated structures (Kobus, 2008). The proportion of distinct blocks of the floor space was identified by the Netherlands Board (2002) in hospital building recommendations based on the typical function package of a general hospital. Geriatrics, day nursing, special care, paediatric nursing, and general nursing are all part of the nursing primary function category. However, because of the nature of the care delivered, day nursing is classified as part of the significant function of group therapy and diagnostics. Physiotherapy, outpatient treatment, general organ function investigation, an operation unit, imaging diagnostics, nuclear medicine, emergency unit, and outpatient appointment department are among the diagnostics and treatment main function groups, while dialysis, rehabilitation day treatment unit, or radiotherapy unit are among the special main function groups. The function of a hospital building is more sophisticated than that of other buildings. As a result, fire safety in hospitals is more complex and complicated.

For instance, it has been noted that fire hazards in hospitals are very high (Blumhagen, 1987; Orman, 2007; Sulieman & Ong, 2015). There are faulty electrical circuits, weak wiring and insulation, textiles, medical equipment, volatile combustive chemicals, potential fire danger sources and combustible materials in hospital structures. Bedridden patients are the most vulnerable since they cannot leave the building without assistance. Medical equipment is often not portable and large, making the emergency evacuation of patients on mechanical life support such as oxygen delivery systems and dialysis machines difficult (NYCTP, 2006; Taaffe et al., 2005; Wei-Wen et al., 2011).

Therefore, the prevention of fire, particularly concerning the combustibility of building and furnishing materials and the spread of fire and smoke, is a significant concern in the safety design for all facilities. Suppression equipment must be immediately available in the case of a fire, whether accidental or malicious. To minimise fear, health facility employees must have a working understanding of utilising the equipment. If the fire cannot be extinguished, the institution must be evacuated as the last option. Any evacuation aims to get all patients, visitors, and employees out of unsafe and damaged facilities as safe as possible. It is critical to acknowledge that people's attention to detail and processes will be less than ideal in an evacuation situation. To that aim, staff employees will be better able to make intelligent judgments during a chaotic event if they comprehend fundamental concepts.

For example, an investigation into the tragic 2016 fire at Hospital Sultanah Aminah (HSA) Johor, Malaysia's deadliest hospital fire, discovered that the government institution had been operating without a fire certificate for years. Despite previous fires in the Ministry of Health (MOH) hospital since 2008, the entire Hospital Sultanah Aminah (HSA) management and the ministry did not appear to take fire safety seriously, according to an independent investigation by a seven-member committee led by the former Court of Appeal judge Mohd Hishamudin Yunus (CodeBlue, 2020).

Building Laws, often known as Fire Safety Rules, are legislative instruments that ensure that, when built in conformity with the regulations, buildings offer socially acceptable levels of health, safety, welfare, and amenity for building occupants and the community in which they are located. (Meacham et al., 2005; Kagan, 1989; May, 2003).

Whether the building is new or old, every local structure should adhere to the authorities' directions, local fire code, and laws. Several essential fire codes apply to Malaysian hospital facilities. Act 133 Street, Drainage and Building Act 1974, Uniform Building By-Laws 1984 (UBBL 1984), Fire Services Act 1988 (Act 341), regulations and orders, Occupational Safety and Health Act 1994 (Act 514) & Regulations and Orders, Act 447 Electrical Supply Act 1990, Malaysia Standard, British Standard, National Fire Protection Association, and others are among the codes used in the hospital buildings (Association, 2005, 2011; "Electricity Supply Act and regulations 1990," 2005; "Fire Services Act 1988 (Act 341)," 2010; "Local Government Ordinance 1961," 2000; "Occupational Safety and Health Act and regulations 1994," 2007; "Sarawak Building Ordinance 1961," 2000; "Street, Drainage and Building Act 1974 (Act 133)," 2008; "Uniform Building By-Laws 1984," 2010.

2.2 Incidents of hospital fires around the world

Many hospital fire cases occur around the world. Not only in our country, Malaysia. Another country also faces some typical problems that we face in our country. With the current situation, the maintenance part is not the main priority anymore. Here are some latest cases which occurred in another country. Notwithstanding enormous damage and monetary loss (expensive medical equipment, medicine), the most significant losses are human life casualties caused by the fire incidents. Table 2.1 below shows various fire incidents occurring at hospitals globally and their respective human casualty toll numbers.

The fire at Sejong Hospital in Miryang, in the south-eastern city of Miryang, comes only weeks after a similar catastrophe in another South Korean city, and it is sure to raise questions about hospital construction and safety standards. A fire at a hospital and care home has killed at least 37 people and wounded scores more. The fire at Sejong Hospital in Miryang, in the south-eastern city of Miryang, comes only weeks after a similar catastrophe in another South Korean city, and it is sure to raise questions about hospital construction and safety standards. A fire at a hospital and care home has killed at least 37 people and wounded scores more. At 7:35 am, a fire broke out on the first floor of the Sejong Hospital. The main hospital had over 100 patients, while the adjacent

nursing home complex had 94. Two nurses said they saw a fire break out in the emergency department, prompting an evacuation of the hospital and nursing home. Large quantities of smoke spilt onto the higher levels as the fire advanced through the first level of the main hospital. (Choe, Sang-Hun, 2018).

Table 2. 1 Casualties Due To Fire at Hospitals

Hospital name	Death	Date
Norman State Hospital, Norman, Oklahoma	38 deaths	13 April 1918
Cleveland Clinic	125 deaths	15 May 1929
St. Anthony’s Hospital, Effingham	74 deaths	5 April 1949
Mercy Hospital, St. Elizabeth’s Ward, Davenport, Iowa	41 deaths	7 January 1950
Guatemala Mental Hospital	225 deaths	14 July 1960
Hartford Hospital, Connecticut, USA	16 deaths	8 December 1961
Shelton Hospital, Shrewsbury	21 deaths	26 February 1968
Coldharbour Hospital, Sherborne, England	30 deaths	5 July 1972
Gorna Gupa mental Hospital, Poland	55 deaths	31 October - 1 November 1980
Saavedra Psychiatric Hospital, Buenos Aires, Argentina	79 deaths	26 April 1985
Liaoyang City Central Hospital, Liaoyang, Jilin, China	39 deaths	12 December 2005
Drug Treatment Hospital No. 17, Moscow	46 deaths	9 December 2006
AMRI Hospital Kolkata, West Bengal, India	95 deaths	9 December 2011
State-Run Hospital, Pakistan’s Eastern City Of Lahore	4 deaths	7 June 2012
Bei-Men Branch Of The Sinying Hospital, Taiwan City	At least 12 deaths	23 October 2012
Moscow Psychiatric Hospital	36 deaths	26 April 2013
Psychiatric Hospital, Luka, Novgorod Region, Russia	37 deaths	13 September 2013
Orthopedic Hospital, Fukuoka, Japan	10 deaths	11 October 2013
Sejong Hospital, Miryang, South Korean	41 deaths Over 70 injured	26 January 2018
Fire erupts at Saint Petersburg Covid-19 hospital after ventilator malfunctions	5 deaths	12 May 2020
Fire Breaks Out At Cygnus Hospital In South Delhi	-	23 May 2020
Five coronavirus patients died in a hospital fire in the Bangladesh capital Dhaka	5 deaths	28 May 2020
8 Patients Killed In Fire At ICU In Ahmedabad Covid Hospital	8 deaths	6 August 2020

(Source: Researcher Survey, 2021)

From Table 2.1, hospitals in under-developing 3rd world countries tend to have higher human casualties than developed countries where proper fire safety management and awareness are well emphasised. Human life losses can be minimised if hospitals are equipped with proper fire safety management systems. A notable example is a fire that

happened on the 9th of December 2011 at AMRI Hospital in Kolkata, West Bengal, India. The hospital's fire safety regulations were examined and highly problematic when the situation was probed further. According to West Bengal Health Ministry, Sudip Bandyopadhyay alleged that the hospital did not meet the fire safety measures required by law. However, the Senior Vice President of the AMRI hospital, Dr S. Upadhyay, refuted this and claimed that the hospital met all the necessary fire safety requirements at the time of the fire (CNN-Ibn, 2011). The final investigation report found out that the water sprinklers, fire alarms, and pumps did not work correctly during the fire. Controversially, before the fire accident, the fire brigade issued a No Objection Certificate (NOC) approval to the hospital, certifying that all the fire safety systems are functioning correctly upon inspection as required by the Building Bylaws to ensure the safety of such buildings and their occupants. Hence, Kolkata Municipal Corporation was held accountable as it was their responsibility and duty to ensure that the certification was done stringently and diligently. AMRI hospital converted its Level basement (initially intended for parking) into a radiography department and a warehouse without alerting the appropriate authorities. The Kolkata Municipal Corporation grants the hospital an operating license (TNN, 2011b). If the hospital's administration is committed to good governance, the hospital should seek approval from the appropriate authorities before making any layout changes to ensure that fire safety standards are met.

In May 2020, one more fire case occurred in Saint Petersburg, Russia. In that fire accident, five patients died (Gulf Today, 2020). That hospital was specialised in coronavirus patients. After a fire broke out on the sixth floor of the Saint George Hospital, another 150 patients were evacuated. The fire breakouts are because of a short circuit, said Saint Petersburg governor Alexander Beglov. To avoid the hospital being on fire for the same reason again, they need to prepare a better electricity system and supply to prevent short circuits from occurring—next, fire breakouts at Cygnus Hospital, located in south Delhi. During the fire, there were eight patients in the hospital. A total of eight hospital patients were evacuated successfully. On the third level of the four-story structure, a fire broke out in an Operation Theatre (OT) and a recovery room. The hospital converted into a reserve for COVID-19 patients during the pandemic is located in Hauz Khas, across from IIT-Delhi.

There was a fire in the Bangladeshi metropolis of Dhaka. Five coronavirus victims died as a result of the fire. Five bodies were discovered in the temporary isolation unit of the United Hospital, which was treating COVID-19 patients. Four men and one woman aged 45 to 75 were killed. Based on this scenario, the degree of enforcement should be raised to lessen the likelihood that the structure caught fire. In the city of Dhaka, Bangladesh, there was a fire. That fire resulted in the deaths of five coronavirus victims. Five bodies were discovered in the United Hospital's temporary isolation unit, treating COVID-19 patients. Four males and a woman between 45 and 75 were among the dead. Based on this scenario, the degree of enforcement should be increased to reduce the chance of the structure caught fire.

Another significant occurrence happened in August 2020, when eight (8) coronavirus patients perished in a massive fire that broke out in a private hospital's intensive care ward in Ahmedabad, Gujarat (Reuters, 2020). When a fire broke out at Shrey Hospital in Ahmedabad's Navrangpura neighbourhood around 3 am, the fire service sent eight fire engines and ten ambulances to the scene. Five men and three women receiving treatment for a new coronavirus could not flee. Every year the cases keep increasing. Many factors need to be inspected back.

In some cases, although the building is new, the building still can be on fire. So, a possibility for a building to be on fire is not on the age of the building. The higher the age of the building, the higher the possibility for the building to be on fire, but that does not mean the new building cannot be on fire. Many factors can direct fire, such as defects in the electrical system, oversupply current, and wires bitten by a rat.

Fire safety is vital in hospitals because it reduces operational disruptions, lowers property insurance costs, boosts public confidence, and increases an organisation's profitability. Aside from that, numerous scholars have created fire safety management assessment, models. These assessment methodologies of fire safety management standards have been discovered. These methods can be used to propose an assessment method of fire safety management for government hospital buildings in Malaysia. J. According to Watts (1993), there are numerous techniques to determine the qualities in the system's ranking: fire regulations and fire science engineering. Because it is easier to

develop because there is minimal resistance from government departments (Chow 2000; Chow & Lui, 2001; Lo, 1999), and the fire code is the minimum fire safety standard in buildings, an assessment method in fire safety management based on local fire codes is developed in this research to assess the effectiveness of fire safety management. (Buchanan, 1994). Codes, on the other hand, are changed regularly. Old structures must conform to the most recent codes within a transition time. If necessary, a professional review by professionals can weigh each item according to priority (Zhao et al., 2004; Chow & Lui, 2000). Critical response time must be referenced in safety criteria. For example, it takes time to develop steam at dangerous levels, identify a fire, activate the sprinkler system, suppress a fire, sound the sprinkler system's alarm, and evacuate the building's residents. Time is of importance in defining safety measures and practices in these sectors. Aside from that, most studies believe that the fire code will impact the building's overall fire safety management. (Buchanan, 1994). As a result, a study of the local fire code and some basic fire science is required.

2.3 Government or Public Hospital

Hospitals are often divided into three groups based on their functions. There are three types of acute care hospitals: general acute care, speciality acute care, and community acute care. Neufert et al. (2012) mention university hospitals as a sort of hospital. These hospitals serve different functions. In most cases, public hospitals must adhere to government service requirements. The government offers financial help to ensure that health care is available to as many people as possible, and they may be required to achieve staffing requirements, engage in low-income outreach, and participate in other activities such as public education. Hospitals in Malaysia are divided into four categories by the Ministry of Health (MoH): State Hospital, Hospital with Specialists, Hospital without Specialists, and Special Medical Institutions.

2.3.1 State Hospital

Every state has a primary hospital. Malaysia currently has 14 government-run hospitals. State hospitals are often the largest and most bed-capacity hospitals in each state. They have 49 specialisations and subspecialties to choose from. Hospital Pulau Pinang is an example of a government-run facility.

2.3.2 Hospital with Specialist

A speciality hospital is a type of hospital that offers specialised services. General medicine, general surgery, paediatrics, obstetrics and gynaecology, anaesthesia, pathology, and radiology are professional services accessible in this hospital (Ministry of Health, 2016). However, the Ministry of Health has further categorised this type of hospital into significant and minor specialist hospitals under the Specialty and Subspecialty Framework of the Ministry of Health Hospitals under the Eleventh Malaysia Plan. Hospital Seberang Jaya and Hospital Bukit Mertajam are two hospitals with main and minor specialities.

2.3.3 Hospital without Specialist

This sort of hospital offers services without the need for a specialist. Outpatient, inpatient, accident, and emergency services are among the services available. When a case requires referral to a specialist, the patient will be sent to a hospital in the same state as the specialist, which is the closest hospital. Hospital Kepala Batas, Hospital Sungai Bakap, and Hospital Parit Buntar are examples of non-specialist hospitals.

2.3.4 Special Medical Institution

A particular medical hospital is a facility that serves a unique purpose. Each hospital serves a distinct purpose in the treatment of patients. Institut Kanser Negara (IKN) offers cancer treatment, Hospital Rehabilitasi Cheras (HRC) provides rehabilitation medical services, and Pusat Kawalan Kusta Negara (PKKN) provides therapy for leprosy patients, to name a few examples of distinct functions to treat patients.

2.4 Private Hospital

A private hospital does not receive government funding and instead relies on direct payments from patients and insurance companies to run its operations. Such facilities can provide a wide range of services to the general population. They are not obligated to reach particular objectives set for public hospitals, which have a mission to provide treatment to low-income patients and meet other conditions because of their lack of reliance on government subsidies. Typically, these organisations are run as for-profit

businesses. Because it is administered as a private business, a private hospital is exempt from these regulations. As a health care provider, it must follow specific health and safety requirements, but it is not required to make services widely available to the general public. Even though a private hospital has no clear public mission, some can participate in public outreach for public relations objectives. This can involve donating services to low-income children or offering community education to lower the prevalence of illnesses that could be prevented. A private hospital could research and teach physicians, nurses, and other medical personnel.

Private hospitals must adhere to the Private Health Care Facilities and Services Act (PHCFSA) criteria, including meeting the minimal standards imposed by other authorities such as the Malaysian Fire and Rescue Department. For example, private hospitals must satisfy the minimal criteria for fire escape safety and obtain clearance from the Fire and Rescue Department. Private hospitals need clearance from the Fire and Rescue Department, but they also need approval from several other agencies, as shown in Figure 2.1 the diagram below. The Private Healthcare Facilities and Services Act (PHCFSA) requires private hospitals to adhere to the criteria set out by Malaysia's Fire and Rescue Department, known as the Fire Safety Certificate. PHCFSA is only applicable to private hospitals and not enforced for government-owned hospitals.

approvals needed for the healthcare facilities and services from different agencies	
Act	Regulate
private healthcare facilities and services Act 1998 (Act 586) MOH	healthcare facilities and services and related matters
the atomic energy licensing Ct 1984 (Act 304) MOH	radioactive material, nuclear material/ prescribed substance
factories and machineries Act 1967	Steam boiler, unfired pressure vessel and machinery equipment
uniform building By-laws 1984 by local authorities	land, certificate of completion and compliance of building or equivalent
fire services Act 1988 (Act 241) by fire department	safety for fire exit
environmental quality Act 1974 (Act 127) b environment department	environment safety and clinical waste management
workers minimum standards of housing and amenities Act 1990 (Act 446) Human resource ministry	Healthcare facilities for workers

medical devices Act 2012 (Act 737) MDA	Medical device
Pathology laboratory Act 2007 (Act 674) MOH	pathology laboratory

Figure 2. 1 Approvals needed for private hospital

(Source: Researcher Survey, 2021)

However, public hospitals must not overlook the owners and managers of private hospitals' duties to meet the Fire and Rescue Department's criteria. Some groups claim that improving fire safety in public hospitals is cost-prohibitive. There is much that can be done without incurring any additional expenses.

2.5 Fire Safety Regulations Audit for government hospital buildings

The previous Minister of Health Datuk Seri, Dr S Subramaniam, said that most government hospitals need to be audited because most fire accidents involving government hospitals are old hospitals. They were built before the existing fire safety regulations as stated by State Health and Chairman of the Environment Committee, Datuk Ayub Rahmat said that the hospital was built in the 1930s. The fire protection regulations in Malaysia are stipulated under the Malaysian uniform building By-laws 1984 with the latest amendments as of 2012. The UBBL regulations on fire fall under part VII on fire requirements and Part VIII fire alarms, fire detection, fire extinguishment and fire fighting access. There is no requirement for such certification as the Fire Services Act 1988, and it only exists and is required for buildings built after 1988 (The Star, 2016). However, the codes have been upgraded from time to time. Now all the buildings are new to obey the stated requirements. A fire safety audit, refers to a thorough, well-organised, and methodical assessment that aids a company in identifying all potential fire threats. It suggests regulatory compliance based on current building codes, rules, standards, and regulations for components, services, and equipment.

A fire safety audit is a systematic and independent assessment of the fire risks present in a facility, including recommendations for appropriate measures to control and mitigate the effects of fires and the relevant documentation about that facility to determine how fire safety is managed. In other words, it is intended to assess the building for

compliance with the Uniform Building By-Laws of 1984 (UBBL), Fire Services Act 2009 (Act 341), NFPA Fire Prevention Code, relevant Malaysian Standards, and fire prevention and life safety legislation passed by various state governments and local bodies. Any non-compliances or particular fire safety risk problems will be identified during a Fire Safety Audit. After completing the audit, suggestions are offered to fix the detected problems, ensuring that the building and its systems comply with applicable laws. According to these laws, every occupier must have an approved fire safety auditor conduct a fire safety audit of the workplace at least once every twelve months.

Building fire audits are a type of risk analysis and assessment in which a systematic inquiry is conducted to identify the extent to which the circumstances necessary for formulating and executing an effective and efficient fire safety policy are present. A building fire safety audit plan aims to offer a systematic method for assessing the fire safety systems servicing a building against the audit criteria and benchmarks established by a building surveyor.

The purpose of fire safety audit are:

- a. To inspect the condition of existing fire fighting equipment.
- b. To learn and identify the existing fire safety audit of the building.
- c. To assess the building fire safety system in compliance with building by-laws and standards.
- d. To understand the purpose and function of the building.
- e. To identify the type of hazard in different buildings, laboratories, or workplaces.
- f. To assess the overall performance of the overall building fire fighting system.

The audit scope was to examine the plan/program and other documents/records of the fire safety inspection plan/program, including such records tests and other auditing procedures as we considered necessary in the circumstances. Significant parts of a fire safety management system should be audited regularly to achieve continuous development in fire safety management. The focus is on an organisation's ability to demonstrate that it has met its legal obligations under fire safety regulations. Evidence of fire safety management may be seen in the following areas: