A CASE STUDY OF MAINTENANCE OF FIRE PREVENTION

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

_____

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ABSTRAK

Salah satu objektif utama dalam rekabentuk bangunan ini adalah untuk menyediakan satu struktur yang boleh memenuhi cita rasa pemilik dan selaras dengan tujuan bangunan dibangunkan. Bangunan ini direka dengan baik dan akan dapat menggunakan ruangan secara cekap dan mempunyai persekitaran yang menarik dan estetik. Dalam merekabentuk bangunan, ciri-ciri Keselamatan, dan kemudian membuat penyelenggaraan peralatan dan kebakaran pencegahan Sistem Pencegah Kebakaran perlu dipertimbangkan dengan sewajarnya. Kebanyakkan Bangunan dibina dengan reka bentuk yang canggih dan mempunyai alat-alat dan sistem mencegah kebakaran yang baik dan teknologi moden, tinggi moden. Malangnya, alat-alat dan sistem adalah terbiar dan rendah Nota tentang penyelenggaraan, menyebabkan berlakunya kebakaran peralatan dan sistem tidak berfungsi menyebabkan kebakaran dengan mudah. Memandangkan hakikat bahawa bangunan ini dibina untuk kegunaan tertentu atau aktiviti, Keselamatan disebabkan api hendaklah diberi pertimbangan yang wajar apabila Merekabentuk bangunan. Penyelenggaraan mestilah terdiri dari awal lagi apabila bangunan pada asalnya direka. Langkah-langkah sewajarnya perlu diambil kira supaya penghuni bangunan di tingkat teratas mempunyai risiko sama atau kurang daripada penghuni bangunan yang disusun di atas tanah. Ini boleh dilakukan dengan melaksanakan langkah-langkah keselamatan seperti penyenggaraan peranti aktif dan pasif dan petak sistem penindasan kebakaran serta membina dan merekabentuk jalan keluar keselamatan yang baik dan sesuai untuk penghuni bangunan.

ABSTRACT

One of the main objectives in the design of the building is to provide a structure that can meet the tastes of the owner and in accordance with the purpose of the building was developed. The building is designed well and will be able to use the space efficiently and has the aesthetic and attractive environment. In designing the building, security features, and then makes the maintenance of fire fighting equipment and fire prevention system should be considered accordingly. Most of the buildings built with a sophisticated design and has the tools and a good fire prevention system and modern technology, modern high. Unfortunately, the tools and the system is idle and low note about maintenance, resulting in the occurrence of fire equipment and systems were not functioning causing a fire easily. Considering the fact that the building was built for a specific use or activity, the safety of life due to fire should be given due consideration when designing the building. Maintenance must comprise from the outset when the building was originally designed. Appropriate measures need to be taken into account so that the occupants of the building on the top floor have the same or less risk than residents of buildings that are ranked above the ground. This can be done by performing security measures such as the maintenance of active and passive devices and fire suppression system partition as well as building and designing roads out good safety and appropriate to the occupants of the building.

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LIST OF ABBREVIATIONS

BOMBA	Malaysia Fire and Rescue Department
CCC	Certificate of Completion and Compliance
COF	Certificate of Fitness
NFPA	National Fire Protection Association

CHAPTER 1

INTRODUCTION

1.1 Introduction

One of the main objectives in the design of the building is to provide a structure that can meet the tastes of the owner and in accordance with the purpose of the building was developed. The building is designed well and will be able to use the space efficiently and has the aesthetic and attractive environment.

In designing the building, security features, and then makes the maintenance of fire fighting equipment and fire prevention system should be considered accordingly. Most of the buildings built with a sophisticated design and has the tools and a good fire prevention system and modern technology, modern high. Unfortunately, the tools and the system is idle and low note about maintenance, resulting in the occurrence of fire equipment and systems were not functioning causing a fire easily.

Report of The National Commission on Fire Prevention and Control, 1973 titled America Burning stated that the main weakness in the practice of building design and construction is due to too much emphasis on issues related to cost. Utilities and appearance of the building that does not focus on fire prevention measures. This statement is addressed to architects, builders and building owners.

Considering the fact that the building was built for a specific use or activity, the safety of life due to fire should be given due consideration when designing the building. Maintenance must comprise from the outset when the building was originally designed.

Appropriate measures need to be taken into account so that the occupants of the building on the top floor have the same or less risk than residents of buildings that are

ranked above the ground. This can be done by performing security measures such as the maintenance of active and passive devices and fire suppression system partition as well as building and designing roads out good safety and appropriate to the occupants of the building.

1.2 Background of Study

Fire Alarm System, Portable Fire Extinguisher and Hose Reel System are essential equipments that must be installed in every building for safety purpose and requirements. The installation should follow the guidelines and procedures highlighted by the state government which control by Malaysian Fire and Rescue Department. Many cases on fire occurred annually caused by human factors because there is minimum knowledge on how to prevent the fire with the equipments provided in the building. Another factor that contributes to these cases is the lack of proper maintenance or servicing schedule for the fire fighting equipments. When the fire fighting equipments have been installed, Malaysian Fire and Rescue Department needs to do the testing and approve the systems before they can be used by customers.

In Malaysia, every building must have the Fire Fighting System in order to prevent building from fire. After approval has given by Malaysian Fire and Rescue Department, the fire fighting system needs to be maintained in order to make sure the system is in good condition in term of its functions. The building maintenance committee should have the maintenance schedule for the system and needs to follow the schedule correctly. The maintenance schedule should include of maintenance procedures, services and documentation record. This paper will discuss about the maintenance, procedure and documentation recorded in fire fighting system that implement in Malaysia.

Based on the annual report by Malaysia Fire and Rescue Department (BOMBA), the total numbers of buildings caught up in fire were 5609 for the year 2015. The figure is very worrying where Selangor has recorded the highest number of accidents with a total of 1048 cases. Meanwhile The Federal Territory of Putrajaya recorded the lowest number of accidents with only eight cases.

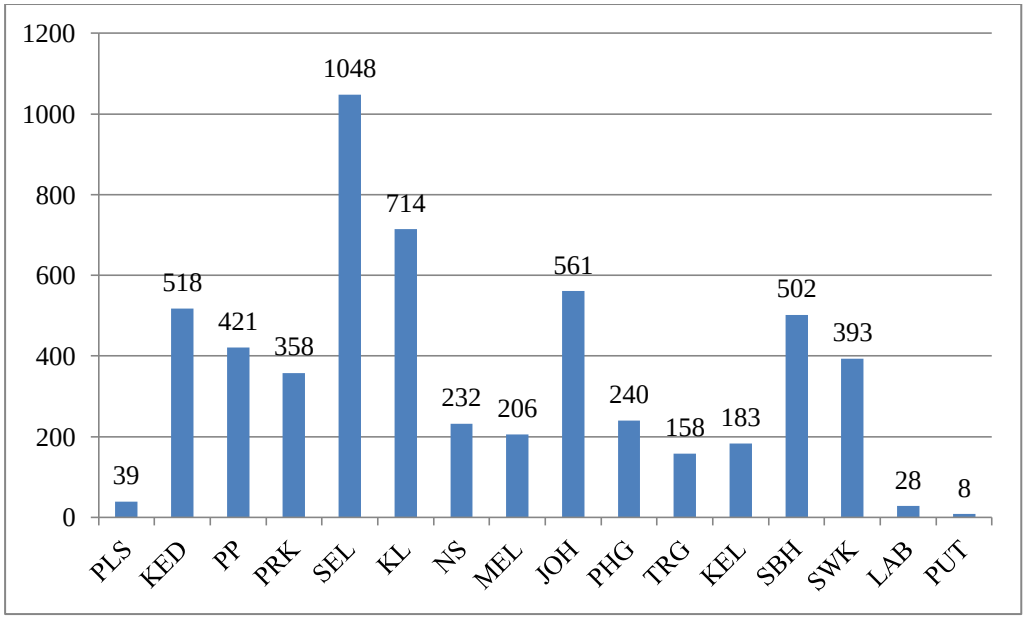

Figure 1.1: Total Fire on Building by State

The focus was only given on the earlier stage of construction until the building is complete. This is due to the fact that, the developer gives emphasize on building a firm structure, solid foundation, high aesthetic value and appealing design rather than focusing on the maintenance works that need to be done once the buildings are completed. This takes into account the maintenance of fire prevention system. Many projects are spending lots of money on fire protection systems that did not function during an emergency, whether it was detectors that didn't function, back-up batteries that failed or pumps that didn't work. (Ibrahim, 2016)

Based on the statistic by BOMBA, it is made clear that the maintenance of fire prevention system is not being taken seriously by the developer.

1.3 Problem Statement

Safety and accommodating nature are the crucial aspect for a building. A building needs to fulfil the standards and regulations that are set by the Fire and Rescue Department to ensure the building is qualified for the Certificate of Completion and Compliance (CCC). The CCC was made by the Fire and Rescue Department to ensure the premises or buildings are in a safe condition and conducive to be accommodated.

Even though the BOMBA has set the regulations very clearly, fire cases that were recorded are still at a worrying rate. This is due to the fact that the building owners often take maintenance of fire prevention system for granted. They compromised the importance of the said maintenance works.

Therefore, the objectives of this study are to identify the maintenance of fire prevention system in buildings and which method is the most effective in maintaining the fire prevention system for particular buildings.

1.4 Research Objectives

Research objectives are as follow:

1) To examine the schedule of maintenance of fire prevention system in buildings.
2) To identify the activities of maintenance fire prevention system work.
3) To analyze the most effective fire prevention system maintenance.

1.5 Scope of Study

This study focuses on the maintenance of equipment and fire prevention system against three categories of building which are high-rise building, residence premise and preemies. The study involved a few of individuals and agencies such as Fire and Rescue Department Malaysia, owner of building and also fire prevention system maintenance contractor. This study will conduct at buildings in Kuantan, Pahang.

1.6 Significance of Study

This study is meant to provide sufficient knowledge in regards to the maintenance of fire prevention system for a building. Maintenance of fire prevention system is the most important aspect to ensure the fire prevention devices are in good shape and well-functioned in cases of emergencies. Based on the data and result which will later be collected and analyzed, the safety level of a building can be assessed by taking into account the safety measures and maintenance works of the buildings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Fire extinguishers are effective in extinguishing fires when they are small in size, but they are not suitable in fighting large or spreading fires. Such fires should be extinguished by the building's fire extinguishing systems or firefighters. Fire protection systems, including fire extinguishing system, are very important to detect, control, extinguish and alert building occupants to fire or smoke. Fire protection systems include sprinkler systems, standpipe systems and fire alarm systems. They are required in many buildings. You may find at least one kind of fire protection system in restaurants, retail stores, day cares, place of assembly, etc.

Functional fire protection systems are useful to prevent injuries and deaths from fires. FDNY requires qualified Certificate of Fitness (COF) holders to provide regular inspection, testing and maintenance for the required fire protection systems. These COF holders ensure that the systems are in good working condition.

It is important for you to know the following information if your building is protected by a fire protection system.

Fire Prevention and Protection is the section sets forth the requirements for fire prevention and protection.In addition to the fire prevention and protection requirements of this section, other sections of these standards address requirements relating to specific hazards and operations, welding and cutting, etc. Where these standards do not provide more specific instructions, they adopt, by reference, the current edition of the

National Fire Codes, published by the National Fire Protection Association (NFPA). (Reclamation Safety and Health Standards, 2009)

The design of buildings for fire safety relies upon an understanding of the sources of fire, materials and systems likely to be involved in fire, and the likely spread of fire. The recommendations and guidance given in this Malaysian Standard are based on the assumption that under normal circumstances (i.e. except in the case of arson) a fire is unlikely to start in two different places in a building The recommendations given in this Malaysian Standard are general, and all fire safety protection measures, procedures, etc., need to take into account the particular circumstances of the individual building or complex concerned. The same recommendations generally apply to both existing and new buildings, but existing buildings, especially historic buildings, often pose problems which are unlikely to arise in new buildings. In assessing the fire safety management needs of an existing building which is being modified, it is essential to have a full understanding of the existing structure and any fire safety provisions incorporated, and to take into account all of the following:

1) Any change in use of the premises which could affect the purpose group (e.g. increased fire load and process risks, introducing the public, changes to sleeping risk);
2) How the necessary fire safety levels can be practicably achieved in the existing premises and whether they are appropriate;
3) Historic and environmental aspects of the premises and to what extent they need to be disturbed;
4) legislation and guidance introduced since the premises were originally constructed, or last altered, or since their fire safety was last assessed;
5) the interrelationship between life safety and measures to protect property/contents; and
6) business continuity.

Historic buildings present particular challenges, as many are listed, and permitted alterations are limited without the agreement of the appropriate authorities. The advice of consultative bodies, such as *Jabatan Warisan Negara*, should be sought in the early stages of design. The appropriate authorities sometimes agree to limited modifications to improve life safety where, in turn, there will be added long-term

protection and preservation of the original building fabric. Specific issues relating to historic buildings can be divided into four areas:

a) The preservation of the ambience and important features of the building such as timber linings to accommodation stairs and slender cast iron structure, both of which can sometimes conflict with the desired fire safety construction but can be accommodated with suitable compensating features;

b) the existing construction of the building, including hidden features such as the extent of cavities through which fire could spread and the quality of walls, partitions and floors the fire resistance of which might be unknown or questionable. Life safety can often be addressed by the use of suitable compensating features, but these do not always cover property protection and business interests;

c) the fire performance of the building structure. Although modern construction standards seldom apply to historic buildings, action to improve the level of fire and life safety might be necessary based on change of use or due to the need to reduce the fire risk and potential for loss of the structure and/or interior in any other context; and

d) the sensitivity of historic structures and interiors (finishes and contents) to fire and smoke damage.

In both new construction and upgrading existing buildings, the various aspects of fire precautions are interrelated and weaknesses in some areas can be compensated for by strengths in others. A higher standard under one of the areas might be of benefit in respect of one or more of the other areas. This standard provides a level of flexibility that allows the fire protection measures and the risks to be assessed to enable reasonable practical solutions to be designed.

Fire precautions in all premises - however old - need to be seen as a whole, a package aimed at achieving an acceptable standard of fire safety. In modifying existing structures, if the new work can be shown not to have a negative impact on the remainder, it is expected that no work will be needed on the remainder, although it might be possible to offer improvement as good practice.

The principles and recommendations in this Malaysian Standard apply straightforwardly where premises have a single main use and are contained in a single, separate building. However, complications might arise where a building comprises two or more different main uses. In such cases it is important to consider the effect of one risk on another. A fire in a shop or unattended office could have serious consequences on, for example, a residential or hotel use in the same building. Similarly, a high fire risk in one part of a building could seriously affect other areas in another part of that building. (MALAYSIA, 2014)

2.2 Maintenance of Fire Prevention System

Fire continues to be a major threat to your business and your personal safety.Each year several thousand people are injured or killed by fires and billions of dollars are lost to property damage. In the case of businesses, many of them fail after experiencing a fire.

To minimize and possibly eliminate the effects of a fire, many buildings have engineered fire protection systems to detect, control, and possibly suppress a fire if one should occur. These systems have a proven record of effectiveness, and are generally very reliable. These systems, however, must be maintained and periodically tested to assure they will function properly. This maintenance and testing is the responsibility of the business or building owner and is generally done through a contractor who specializes in fire protection systems.

There are generally a number of fire protections systems in a building. There are fire extinguishers, which are a first-aid fire-fighting device. There are fire alarms, which are designed to warn occupants in case of a fire and summon the fire department. Fire alarms may be manual, automatic or a combination of the two. There are also fire sprinklers, which are designed to control or suppress a fire. Some buildings have standpipes, which are used by the fire department in case of a fire. Finally, some businesses and buildings with special hazards such as restaurants or companies with expensive electronic equipment may have special agent fire protection systems designed specifically to protect those hazards.

Each of these systems is unique and requires special training to inspect test, and maintain them. Usually, one individual will not have the necessary expertise and credentials to test all systems. Inspecting fire alarms, for example, requires knowledge of electricity and electronics. Fire sprinkler systems, on the other hand, require knowledge of plumbing. Most fire protection companies have the necessary personnel to inspect and test all types of fire-safety systems, but in most cases these are separate services performed by different technicians at different times. It is very rare that one technician will be able to test all of your systems together. Once the technician has completed the inspection, he will provide the business or building owner with documentation of his findings. Business or building owners are required to maintain this documentation and present it to the fire department on request. Generally, if the technician uncovers any problems with the system, it must be repaired. The business or building owner may authorize the technician or his company to make the repairs, or he may use another technician or company to do the work.

The City of Park Ridge requires that fire protection systems be maintained and tested in accordance with National Fire Protection Association standards. These standards are accepted nationwide and are considered minimum requirements. Frequency of testing depends on the type of system. Below is a breakdown of the maintenance that is required to be performed for each system.

2.2.1 Fire Alarm System Maintenance

The building's fire alarm system may do one or more of the following:

a) Notify occupants in case of a fire.
b) Notify the fire department in case of a fire.
c) Monitor the premises and detect heat or smoke.
d) Monitor the sprinkler system and detect water flow.
e) Supervise valves on the sprinkler system and detect tampering.
f) Monitor air pressure for dry-sprinkler systems.
g) Monitor the fire pump.
h) Close fire doors in case of a fire.
i) Shutdown HVAC systems in case of a fire.
j) Operate smoke control systems.
k) Control elevators in case of a fire.

l) Monitor special fire suppression systems.

While more frequent tests are recommended, the City of Park Ridge requires an annual test of the fire alarm system. A fire alarm inspection tests each component of the alarm system to ensure it is working properly. Devices not working properly must be repaired or replaced. The main fire alarm panel will be checked to make sure it is operating properly. The battery back-up system will be load tested, and the batteries replaced as needed. Finally, the technician will test the communications link to the fire department or private monitoring company.

Depending on the size of your building, the test may take anywhere from a few hours to a few days. Special lift equipment may be required to test devices in atriums or areas with high ceilings. Tests may be scheduled for the early morning or later in the evening to minimize disruptions to your business.

The technician should provide you with documentation, which shows:

a) Date of the test.
b) That each device was tested and passed.
c) That the batteries were load tested or replaced.
d) Any work that was done to bring the system into compliance with applicable standards.
e) Any work which must be done to bring the system into compliance with applicable codes.
f) A notation stating whether or not the system is in full service.
g) An explanation of any discrepancies.

The fire alarm system is connected to other fire protection systems such as sprinkler, hood and duct suppression systems, and standpipe systems. This leads to some confusion because a business or building owner will look over the documentation he receives from the fire alarm technician and see references to the sprinkler system and/or the hood and duct system. The fire alarm technician will inspect and test only the alarm components on these other systems. Other technicians will be necessary to fully check these other systems.

2.2.2 Sprinkler System Maintenance

The sprinkler system is designed to suppress or control a fire. Sprinkler systems operate by means of sprinkler heads located throughout the building. The heads are usually in the ceiling or high on the walls, but may be in other locations in certain applications. In the event of a fire, heat from the fire melts a fusible element in the sprinkler head causing the head to open and discharge water. Only heads that are heated hot enough, usually 135 degrees or more, will open and discharge water. In most cases, only one or two heads will operate. The case where every head in the building goes off is a Hollywood myth.

The sprinkler system is generally fairly simple, but nevertheless requires maintenance and testing. While more frequent inspection and testing are recommended, the City of Park Ridge requires only an annual test. Valves for the sprinkler system must be operated and lubricated. Gauges must be checked for damage and accuracy. Heads must be checked to make sure they are not damaged—very often heads are painted which compromises their effectiveness. Hangers are checked to make sure they are properly supporting the piping. The fire department connection will be checked to make sure that it is operating properly and is properly capped. Technicians will also conduct a main drain test and an inspector's test.

The main drain test measures pressure in the system. These pressures must be recorded on the inspection/test documentation. If there is a variation in the pressures from one year, to the next, it is possible that there is a blockage in the water system, which must be evaluated. The inspector test simulates the activation of one sprinkler head and is used to test the flow alarm on the sprinkler system. The technician will time how long it takes for the alarm to activate once water starts flowing. Generally, this is about one minute. This time should also be recorded on the inspection/test documentation.

Generally, valves on the sprinkler system have a monitoring device to ensure that they are not inadvertently closed. The technician will verify that these monitoring devices are working properly. The technician who performs the alarm test also performs these tests of the monitoring devices along with the inspector’s test. Unfortunately, there is some overlap in the testing processes.

The sprinkler technician will also make an overall assessment of your system and your building. Sprinkler systems are designed very carefully to protect certain types of hazards. If the operations in a building have changed, it is possible that the sprinkler system may have to be upgraded to protect any new hazards. Generally, the sprinkler system will only have to be modified if the level of hazard has increased. In most cases, the city will not require you to downgrade a sprinkler system if the level of hazard has decreased. The technician will also verify that no major remodeling has occurred that will interfere with the sprinkler systems. Sprinklers are required to be within certain distances to walls and obstructions. Sprinklers are also required to be in every room or combustible space within a building. If walls were added or removed, it is likely that some sprinkler heads will need to be relocated. The technician will also evaluate whether or not the building is adequately heated to protect the sprinklers from freezing.

Sprinkler heads have a service life. Heads must be tested periodically to ensure their effectiveness. Fortunately, with most sprinkler heads, the heads can go fifty years before testing is required, though some heads must be tested more frequently. Testing involves only a sample portion of the heads, not all heads in the facility will require testing. Also, recently, their manufacturers have recalled sprinkler heads. The technician will advise you if a recall programs affect your heads.

The standards require that technicians check the heads from floor level. They are not required to look above drop-in ceilings or in concealed spaces.There are also specialized sprinkler systems, which require special inspections and testing.

Sprinklers in cold areas may have anti-freeze systems. The solutions must be checked before winter to assure they are providing adequate protection. While most sprinkler systems are filled with water all of the time, some sprinkler systems are considered dry. These systems are used in cold areas or in highly sensitive areas where water damage is a major concern. These dry sprinkler systems have special valves and pressurization systems, which require special testing.

Testing the sprinkler system will require flowing a large amount of water. Generally, tests are not scheduled during freezing weather. Most systems are designed

to discharge the water outdoors. However, some systems discharge the water indoors. Sewers must be able to handle the water flow. Direct connection of the sprinkler system to the sewer is not permitted.

When the technician has completed his test and inspection of the sprinkler system, he should provide the business or building owner with documentation showing the following:

General

a) Date of test.
b) The type of sprinkler system.
c) Changes to the building since the last inspection.
d) Changes to the sprinkler system since the last inspection.
e) Whether or not there is adequate heat.
f) Whether or not all valves are properly supervised.
g) Whether or not all valves are properly identified.
h) Whether or not there is a supply of spare sprinkler heads.
i) Whether or not there were any changes to the water supply.
j) Whether or not the fire department connection is working properly.
k) Whether or not the gauges were working properly.
l) Whether or not the hydraulic nameplate is present.
m) Verification that heads and hangers were checked.
n) Verification that valves were operated and lubricated.
o) Whether or not any valves or heads were tested.
p) Results of the main drain test (residual and static pressure).
q) Results of the inspector's test (time).
r) Explanation of any discrepancies.

Anti-Freeze Systems

a) Date of test.
b) Results of solution check.

Dry-Systems

a) Date of test.

b) Whether or not priming water was present.

c) Results of low-pressure alarm test (pressure).

d) Results of dry-valve trip test (time).

e) Verification that air compressor was checked.

f) Verification that dry valve was opened and inspected.

g) Explanation of any discrepancies.

h) Verification that quick-opening devices were inspected and tested.

2.2.3 Specialized Sprinkler Maintenance

Specialized sprinkler systems may require special testing in addition to items mentioned above. Please contact the Fire Department for information on these systems.

2.2.4 Backflow Prevention Maintenance

Fire sprinklers are connected to the municipal water supply. The Illinois Plumbing Code requires that fire sprinklers have back-flow protection devices to prevent water from the sprinkler system from mixing with potable water. Backflow devices are also required on lawn sprinklers or other systems that use water for industrial purposes. The plumbing code requires that these devices be inspected and tested every year by a licensed plumber certified to check backflow protection devices. Most sprinkler contractors do not perform this type of work, but many of them have associations with plumbing companies that do. You may use the contactor your sprinkler company suggests to check your backflow device or you may hire another contractor to do the work. If you have a lawn sprinkling system or another system that requires a backflow device, you may want to hire the same contractor to check all of them.

In short, if you have a sprinkler system, there are three inspections that must be done: the sprinkler system must be inspected by a sprinkler contractor, the backflow device must be checked by a properly certified technician, and the fire alarm must be checked by a fire alarm technician.

2.2.5 Standpipes Maintenance

Standpipes are usually tied into the sprinkler system, but there can be stand alone standpipe systems. Standpipes are required to be flow tested every five years. If

you have a dry standpipe, it must be pressure tested every five years. If you have hoses on your standpipe system, they must be tested after five years and every three years thereafter. Generally, either your sprinkler contractor or your fire pump contractor will perform this test.

The documentation should show the following:

a) Date of test.

b) Results of hydrostatic test (dry pipe system only).

c) Results of flow test.

d) Results of hose testing.

e) Explanations for any discrepancies.

2.2.6 Fire Pumps Maintenance

Fire pumps are used when the municipal water system cannot meet the water flow requirements for a sprinkler system or a standpipe system. Fire pumps may be either electric or diesel driven and are very complicated devices. Fire pumps require weekly and monthly maintenance, which may be performed by specially trained building personnel. A contractor usually does flow testing, which must be performed annually. Usually, a member of the Fire Department should witness the test. The test involves flowing water to measure the pump's capacity as well as starting and stopping the pump several times. If the flow tests show a loss of performance, the technician may dismantle the pump to check its internal components. The technician will also check all components to make sure they are in proper working order.

The maintenance requirements depend on whether the pump has an electric or diesel driver. Diesel drivers, like any diesel engine, require fluid and filter maintenance and checks of the starting system. Electric drivers require exercise of control switches and periodic cleaning of the circuit breakers. All pumps should be inspected to make sure that all valves are operating properly and in the proper position. Gauges must also be checked for damage. Diesel driven pumps should be run for thirty minutes every week. Electric driven pumps should be run for ten minutes every week.

The Fire Department requires that the results of the annual test be documented. The following items must be noted on the documentation:

a) Date of test.
b) Type of pump, make, and model number.
c) Type of flow test (via hose or flow meter).
d) Capacity of the pump.
e) Pump cut-in/cut-out pressures.
f) Type of driver.
g) Type of controller, make, model number.
h) Results of flow tests (chum, capacity, 150 % of capacity). RPM's during each test phase.
i) Amperage/voltage at each test phase (electric driver).
j) Pressure readings from each hose (if hose test conducted). Municipal pressures and net pressures.
k) Whether or not all devices were working properly.
l) Whether or not all valves are in proper position.
m) Explanation of any discrepancies.

All previous pump test records should be maintained on the premises for comparative purposes.

2.2.7 Special Agent Extinguishing Systems Maintenance

Some hazards such as restaurant cooking areas require special fire protection systems often called suppression systems. The City of Park Ridge requires that these systems be inspected and tested on a semi-annual basis. There are several types of special agent extinguishing systems each with unique testing and inspection requirements. But in general, the following features must be checked:

a) Tanks must be visually inspected.
b) Tanks must be hydrostatically tested at least every twelve years.
c) Tank pressures must be recorded.
d) Piping must be visually inspected.
e) Nozzles must be inspected and changed or cleaned as necessary.
f) Nozzle position must be checked.
g) Fusible links must be inspected and changed if necessary.
h) A full discharge test is not required, but the system must be tripped to test mechanical and electrical components and shutoffs.

i) Manual activation devices must be tested.

j) Verify that activation of the system tripped the fire alarm.

Many special agent extinguishing systems are located in the hoods for restaurant ventilation systems. The City of Park Ridge requires that these hoods be cleaned and inspected. Maintenance and cleaning of the hood and ducts is a separate procedure from checking the extinguishing system and more than likely is done by a different contractor. Many companies that service restaurant extinguishing systems can provide recommendations on contractors who perform hood and duct cleaning.

Since the special agent suppression system is tied into the fire alarm, your alarm contractor will check the alarm contacts in the system. This is another example of redundancy in the testing fire protection systems.

The contractor should check the hazard to make sure that there have been no changes. Special agent systems are designed to protect specific hazards. Nozzles, for example, must be a specific size and in a specific location. Changing the hazard, for example, adding a new cooking appliance in a restaurant, may require modifying the special agent extinguishing system.

Most contractors who service special agent suppression systems will leave a tag on the system. The tag does not provide adequate documentation and does not fulfill the requirements of the city's fire code. After completing his inspection and test, the contractor should give the business or building owner documentation
that notes the following:

a) Date of test.

b) Hydrostatic test date of tanks.

c) Date fusible links (if applicable) were changed.

d) General condition of the system.

e) Any changes to the hazard protected.

f) Whether or not all devices work properly.

g) Whether or not the fire alarm was tripped during the test.

h) Any repairs required to place the system back in service.

i) Any discrepancies.

j) System and alarm are in full service.

2.2.8 Fire Extinguishers Maintenance

The State of Illinois requires that all fire extinguishes be inspected every year by a licensed contractor. Contractors will check the pressures, inspect the extinguisher for damage, and make sure the extinguisher is properly mounted. Every six years, extinguishers must be discharged, taken apart and internally inspected. A hydrostatic test may also be performed at this time. Contractors will tag the extinguisher with a color-coded tag with their company name and license number. This tag provides adequate documentation. In the event a tag is accidentally tom off, the business or building owner should keep the tag as proof that the extinguisher was checked.

Extinguishers are generally checked on-site, but some fire extinguisher companies have a drop-off service that saves you from paying a travel charge. The National Fire Protection Association requires all fire protection system testing to be done by qualified individuals. It is not always necessary to hire an outside contractor to maintain, inspect, and test your systems. The City of Park Ridge will accept testing done by properly trained building personnel. The city requires evidence of competence that may be one or more of the following:

a) State license.

b) Manufacturer's training.

c) Nationally recognized certification.

d) Other documentation as the city deems appropriate.

All testing documents must be in proper form. Suggested reporting forms can be found in the National Fire Protection Association standards. While some fire protection contractors service more than one type of fire protection system, it is not necessary to use the same company to test all of your systems. You are welcome to select any qualified contractor or individual to do the work. For a list of fire protection contractors and services, you may consult the yellow pages or the Internet-look under or search for "fire protection". Unfortunately, the City of Park Ridge cannot make recommendations. The City can provide you with information as to whether or not the contractor is licensed to do business in the City.

Properly installed and maintained fire protection systems have a proven record of saving lives and protecting property from fire. Insurance companies recognize the effectiveness of these systems and will often discount premiums where these systems exist. Like any other building system, fire protection systems require periodic maintenance. Hopefully, this guide has answered some of your questions concerning the maintenance of your fire protection system. If you have any additional questions, please contact the Park Ridge Fire Prevention Bureau at 847-318-5312. (Department)

The following list outlines the checks, inspections and tests required by the Ontario Fire Code (388/97). The information provided in this schedule is a guideline to the scope of work. The Ontario Fire Code should be consulted for exact details on the Codes listed in this section.

It is important to recognize that the requirements for equipment, testing and preventative maintenance may vary depending on the building classification and/or occupancy type. The Ontario Fire Code sets out specific requirements for checking, inspecting and testing of fire safety equipment in existing buildings. Whenever a defect or deficiency is discovered in any fire safety device, the property owner or his agent must take immediate corrective action.

The Facility Manager from PROFAC Facilities Management Services will carry out the provisions of the code on behalf of the owner, the Ontario Realty Corporation. Written records will be kept of all test and corrective measures for a period of two years after they are made, and the record shall be made available upon request to the Chief Fire Marshall.

For the purpose of carrying out these maintenance procedures, the following definitions should be considered applicable. These definitions can be found in the Ontario Fire Code.

CHECK

Visual observation to ensure that the device or system is in place and is not obviously damaged or obstructed.

INSPECT

Physical examination to determine that the device or system will apparently perform in accordance with its intended function.

TEST

Operations of a device or system to ensure that it will perform in accordance with its intended operation or function. (MAINTENANCE PROCEDURES FOR, 2003)

2.3 Advantages of Fire Prevention System

Fire protection systems, including fire extinguishing system, are very important to detect, control, extinguish and alert building occupants to fire or smoke. Fire protection systems include sprinkler systems, standpipe systems and fire alarm systems. They are required in many buildings. You may find at least one kind of fire protection system in restaurants, retail stores, day cares, place of assembly, etc.

Functional fire protection systems are useful to prevent injuries and deaths from fires. FDNY requires qualified Certificate of Fitness (COF) holders to provide regular inspection, testing and maintenance for the required fire protection systems. These COF holders ensure that the systems are in good working condition. It is important for you to know the following information if you're building is protected by a fire protection system. (Fire Protection System)

2.3.1 Sprinkler System

A sprinkler system is a fire extinguishing system that most times uses water as the extinguishing agent. You may find sprinkler systems in residential buildings, retail stores, restaurants or possibly day care centres.

Sprinkler systems will help to control the fire. Because fire sprinkler systems react so quickly, they can dramatically reduce the heat, flames and smoke produced in a fire. According to the National Fire Protection Association, when working sprinklers are present, the chances of dying in a fire can be reduced by 50-75% and the average property loss per fire is cut by 50-66%.

Inspection, testing and maintenance of the sprinkler systems must be regularly done by certified individuals. Basically, an COF holder can perform visual inspection

but cannot do mechanical inspection of the system. The higher the qualifications, the more the COF can do. For example, a Master Plumber with an COF can perform maintenance, testing and repair for the sprinkler systems. See the COF study material for further information.(REGULATED FIRE PROTECTION SYSTEMS)

2.3.2 Standpipe System

A standpipe system is piping installed in a building that assists to transfer water to hose connections located within the building for fire fighting purposes. A standpipe system serves as a fire hydrant inside of a building. These systems are located in high-rise/low rise commercial and residential buildings, shopping malls, parking garages, stadiums, warehouses, etc.

Standpipe systems provide a reliable water source to extinguish or control an interior fire in the building.

Inspection, testing and maintenance of the standpipe systems must be regularly done by certified individuals. Basically, an S-13/S-14 COF holder can perform visual inspection but cannot do mechanical inspections of the system. The higher the qualifications, the more the COF can do. For example, a Master Plumber with an S-13/S-14 COF can perform maintenance, testing and repair for the standpipe systems. See the S-13/S-14 COF study material for further information. (REGULATED FIRE PROTECTION SYSTEMS)

2.3.3 Fire Alarm System

A fire alarm system detects and alerts people when smoke or fire is present. The devices include smoke detectors, heat detectors, strobes, manual fire alarm station, fire alarm control panel, etc. They are commonly found in day care centres, restaurants, high-rise buildings and catering halls. A fire alarm system is designed to detect and alert people to the presence of smoke, fire, and poisonous gas. These devices include smoke, heat, and gas detectors, manual pull stations, and strobes connected to a fire alarm control. These systems are commonly found in daycares centres, restaurants, commercial buildings, and catering halls.

A working fire alarm system provides early warning notification of fire/smoke conditions to the building occupants in addition to the appropriate authorities notified by the monitoring company.

All approved fire alarm systems must be supervised by a COF holder depending upon the nature of the occupancy and/or the type of fire alarm system. However, these COF holders can only perform visual inspections but cannot do mechanical inspection of the systems. Only employees of FDNY approved companies with suitable COF can perform maintenance, testing and repairing of the fire alarm system. All commercial & multi-tenant building fire alarm systems are required to be monitored by an FDNY approved central monitoring company. (REGULATED FIRE PROTECTION SYSTEMS)

2.4 Summary

This chapter has provided the literature review for this particular study. Maintenance of fire prevention system does not only comprise of the devices but also need to take into account the activities and maintenance schedule. It has been proven in previous studies and researches where many sources have provided ample references to the subject matter. In order to provide a holistic and comprehensive study on maintenance of fire prevention system, the definition of fire prevention system must be clearly defined. Previous studies have provided adequate information for the purpose of this research. Other than that, the most compelling devices for fire prevention purposes must be underlined so that the focus of maintenance fire prevention system will not be shifted. The study on maintenance of fire prevention system will not suffice and will be inadequate without highlighting the significance of the activities. Activities and the schedule of maintenance of fire prevention system are directly proportionate to the effectiveness of maintenance of fire prevention system.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This method is one of the important things that should be considered in this report; the word may refer to the proper methodological analysis of the theory and methods in accordance with the field of study or methods and principles specific to a branch of science. The method refers to more than one set of rules instead it refers to the study and research for a particular study.

This chapter portrays the strategy utilized as a part of carrying out the study. Research methodology gives a rule to fulfil the targets and extent of the study. Research methodology gives a rule to perform the goals and the extent of the study. A careful and proper planning had been sorted out on the methodology so that the research can be run easily and in the meantime accomplishes the destinations of the research. Research methodology of this research consists of research method, population and sampling, and development of measure that is basically designed of the questionnaire.

3.2 The Studies Process

The research process is to follow the following steps: -

1) Understand what is being studied and then identify related statement;
2) Make a literature review to understand how the approach done in dealing with a matter;
3) Obtaining and collecting data under controlled conditions and perfect towards achieving the right decision;
4) Analyze data accurately and in line with matters to be identified and reviewed; and

5) Formulate and draw conclusions and suggestions.

These processes are the basic approaches used in implementing this study. It is aimed at avoiding the underlying study of the original objectives. The stages are prioritized and easy to implement from the beginning to the end. In summary, the method of writing of this study can be shown in Figure 3.1.

In order to identify the approach of the study method to be used, the objectives of the study need to be identified first and the objectives of this study are: -

1) To examine the schedule of maintenance of fire prevention system in buildings.
2) To identify the activities of maintenance fire prevention system work.
3) To analyze the most effective fire prevention system maintenance.

3.3 Research Strategy

Successful selection of research methods is important to ensure that the study runs smoothly. All the data and information required to achieve the objectives of the study as outlined are available through the study detailed and orderly. The purpose is to ensure that all data and information obtained can be collected and analyzed clearly and accurately without any doubt.

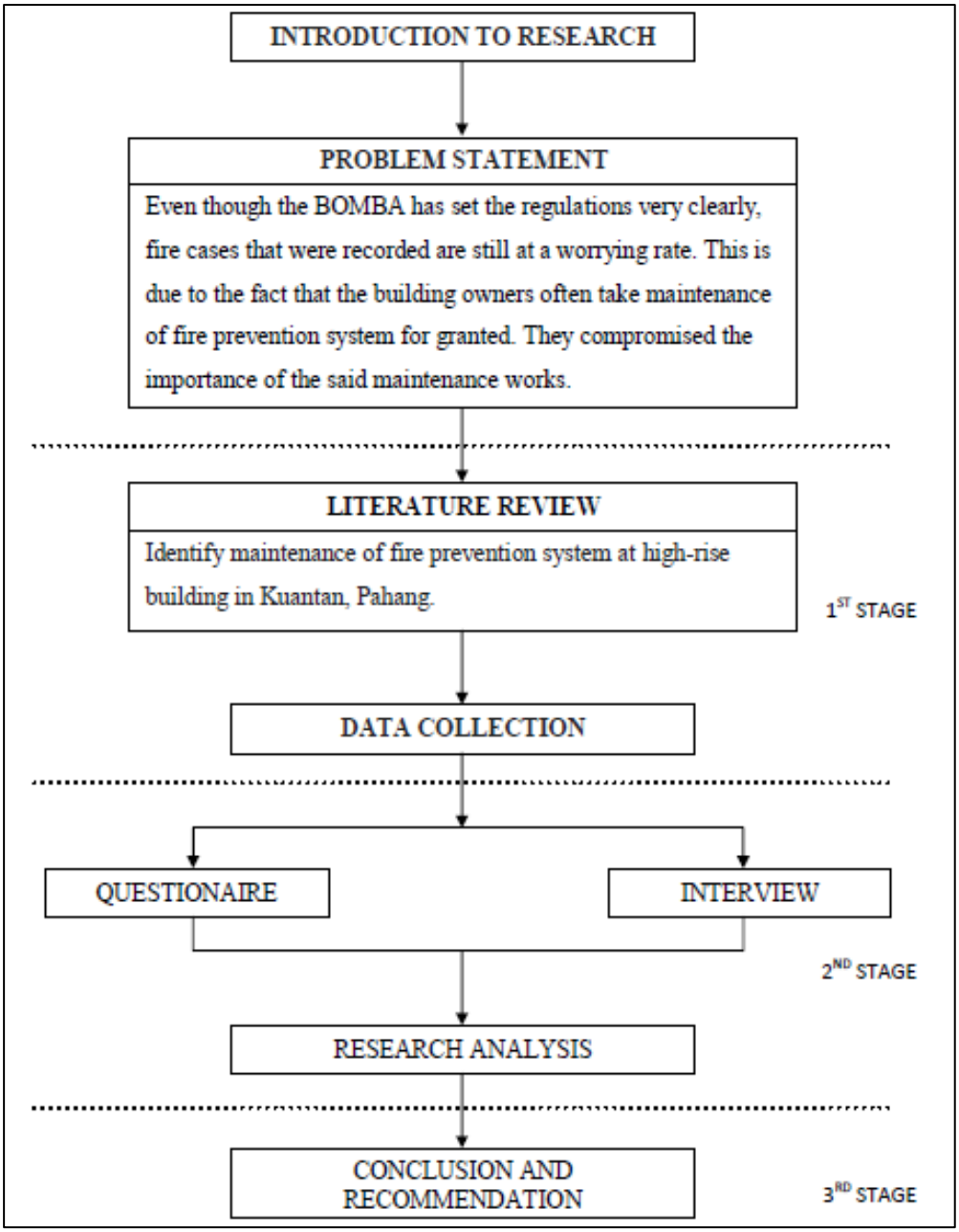

Figure 3.1: Research methodology flow chart

In addition, meeting with workers responsible for management of fire prevention system at high-rise buildings and also involving BOMBA Kuantan, Pahang was held. Data collection was made through questionnaire and interview form. Data collected and received are collected, compiled and analyzed in accordance with the objectives and scope of the study. Some tables and diagrams have been used to give a clearer picture of the data obtained. To control the quality of data collection, this dissertation has been focused on the three stages of the study as stated above.

3.4 Research Design

Objective	Data Collection	Data Analyze
To examine how the maintenance fire prevention system work	Literature Review	Average Index and Likert Scale
To identify the maintenance of fire prevention system in buildings	Literature review and Interview	Average Index and Likert Scale
To analyze the most effective fire prevention system maintenance	Questionnaires	Average Index and Likert Scale

3.5 Average Index

The average index is a set of data are equal to the sum of all the values in the data set divided by the total number of values (Gregory Hamel, 2017). A mean is the same as an average (Gregory Hamel, 2017). This is example for evaluation for the average index.

Tables 3.1: Level of Evaluation Based on the average index

Level of Average Index	Poor	Moderate	Good
Range of Average Index	1.00 – 2.33	2.34 – 3.66	3.67 – 5.00

3.6 Likert-Scale

Likert Scaling is a one dimension scaling method (William M.K. Trochim, 2006). It will be conducted by using likert-scale design in questionnaire to gathering data from sample. These are the basic steps in developing a Likert or "Summative" scale.

Define what it is you are trying to measure

1) Create the set of potential scale items

2) Rating the items (group of judges rate the items)

Tables 3.2: Likert Scale

Strong Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

3.7 Data Collection Technique

The data collection technique is how the researcher gets the feedback or comment from the respondents. There have several methods to complete the data collection from all respondents. Some of the technique send the question by using mail, interview, administrative questionnaire, electronics questionnaire and telephone interview. But, the researcher decides to choose only two types of technique for data collection. That is contributed by hand and also mail questionnaire.

The survey was directed by means a chapter in the development business in Kuantan, Pahang. The questionnaire was personally controlled. This is so that the finished reactions could be gathered back inside a brief time frame. Other than that, personally controlled questionnaire strategy additionally empowered illumination of any questions by the respondent on the spot and offered the chance to propel the respondents to give a blunt answer.

3.8 Conclusion

This study shows the method of sampling techniques or methods known probability sampling methods using simple convenient sampling. It also describes the analysis of the data in this study to collect data. Therefore, the elements of the methodology that is important for researchers to conduct research. It is because, as a result of which it can be analyzed whether this study is important or not.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, was examined about frequency of maintenance of fire prevention system, frequency of maintenance schedule, and ranking of most effective maintenance of fire prevention system. Frequencies are utilized to examine and analyse 3 sets of checklists to recognize respondents in every classification and the quantity of the checklists that were sent to the respondents. Furthermore, to look at the frequencies for the most elevated and least score in answer sheet that was built into information and for the last one to see the respondents answer every scale.

4.2 Data Collection Process

The survey was conducted in September 2017 and convenience samplings were use due to limited time and sources of fund. The below data shown that out of 30 sets of questionnaire for existing high-rise building. The questionnaires divide by six groups by respondents which is 5 respondents each. Number of respondents are obtained as need and meets the requirement of the data to been analysis. The number of respond of the questionnaires is only come from distributed by manual. From the survey, 30 responses were successfully obtained giving a response rate of 100%.

Table 4.1: Table of questionnaire

Item	Number
Number of sample	30
Number of questionnaire distribute by online	30
Number of questionnaire respond	30

Being a convenience sampling, the rate of response (100%) is higher compared to random sampling. Takim et.al (2002) and Dulami et.al (2003) reported that the norm response rate in the construction industry using postal or blast email method of questionnaire is around 20-30%. This research is aimed at showing the indication rather than reliability to ensure quality data obtained.

4.3 Respondent Demographic Analysis

This section was analysed by using Microsoft Excel. There were a total of 30 respondents that involved in maintenance of fire prevention system in buildings. They are from the population of this research there is high-rise building in Kuantan, Pahang. There are two characteristics of demographic are discussed in this study, which included position and working experience. Table 4.3 was shown the title of designation. It showed the first question that has been interpreted as below and following by other question.

Table 4.2: Position

No	Position	Frequency	Percentages (%) (N=30)
1	Engineer	5	16.66
2	Supervisor	7	23.34
3	Technician	17	56.66
4	Worker	1	3.34
		30	100.0

The above Table 4.2 has shown the frequencies and percentage of position of respondents that involve in maintenance of fire prevention system in buildings. Based on the information, four (4) different positions from six (6) six high-rise building in this research survey. Respondent which is technician dominated the number of respondent which bring 17 respondents (56.66%) out of 30 respondents in total. Meanwhile, worker is the least with just 1 respondent (3.34%) that involve in this survey.

Table 4.3: Years of experience working in maintenance of fire prevention system

No	Years of experience	Frequency	Percentages (%) (N=80)
1	Less than 1 years	14	46.67
2	2 - 3 years	14	46.67
3	4 - 5 years	1	3.33
4	More than 5 years	1	3.33
		30	100.0

From the above table 4.3, were the years of experience working at current organization or firm for existing construction project manager. It has shown the range of respondent experience working that involved in this research. The experience working of respondents in this research have been formed in several ranges which were; firsts less than 1 years, seconds 2 to 3 years, third 4 to 5 years, fourth more than 5 years. The data shown that highest respondent that respond to this research survey is less than 1 years (46.67%) and 2 to 3 years (46.67%), and the lowest is 4 to 5 years and more than 5 years with (3.33%).

4.4 Descriptive Analysis

Descriptive statistics is descriptive coefficients that summarize a set of data which representation of the population or sample from the data. It provides summaries and measures to describe and analysis the basic features of the data in a research or study. McCaffer and Zaimi Majid (1997) stated that the classification of the rating scale is like following:

Table 4.4: Interpretation of the level of rating scale

Rating Scale	N
4.50 to 5.00	Very High
3.50 to 4.50	High
2.50 to 3.50	Fair
1.50 to 2.50	Low
1.00 to 1.50	Very Low

Section B: Job Prospect & Career Development

Table 4.5: Activities of maintenance of fire prevention system for daily

Maintenance of Fire Prevention System	**Buildings**						**Average Index**	**Rank**
Daily	**A**	**B**	**C**	**D**	**E**	**F**		
1. Check the fire alarm system.	5	5	4	4	4	5	4.49	1st
2. Check the voice communication systems and AC power lamp and signal.	5	5	3	4	4	4	4.17	2nd
3. Check the temperature of fire rooms.	5	4	3	4	3	4	3.83	3rd
4. Check the tank heating equipment and water temperature for fire protection water tanks.	5	4	3	4	3	4	3.83	4th

The above Table 4.5 has shown the average index and rank of activities of maintenance of fire prevention system for daily. First ranking for the maintenance of fire prevention system for daily period check the fire alarm system activity with average index is 4.49. The second ranking is checking the voice communication systems and AC power lamp and signal with 4.17 for the average index. For the activity 3 and activity 4, the average index is 3.83, ranking 3 and 4 for both of activity.

Table 4.6: Activities of maintenance of fire prevention system for weekly

Maintenance of Fire Prevention System	**Buildings**						**Average Index**	**Rank**
Weekly	**A**	**B**	**C**	**D**	**E**	**F**		
1. Check the sprinkler system control valves are open and properly supervised	5	5	4	4	3	4	4.17	1st
2. Inspect valves controlling fire protection water supplies.	5	4	3	3	3	4	3.67	3rd
3. Check the water level and pressure for fire protection system pressure tanks.	4	4	3	4	3	4	3.67	4th
4. Check water level in fire pump reservoirs.	4	4	3	4	3	4	3.67	5th
5. Inspect and operate all fire pumps.	4	4	3	3	4	5	3.83	2nd

The above Table 4.6 has shown the average index and rank of activities of maintenance of fire prevention system for weekly. First ranking for the maintenance of fire prevention system for weekly period check the sprinkler system control valves are open and properly supervised activity with average index is 4.17. The second rankings are inspected and operate all fire pumps with 3.83 for the average index. For the activity 2, 3 and 4, the average index is 3.67. Their rankings are 3, 4 and 5.

Table 4.7: Activities of maintenance of fire prevention system for monthly

Maintenance of Fire Prevention System	**Buildings**						**Analyze**	**Rank**
Monthly	**A**	**B**	**C**	**D**	**E**	**F**		
1. Inspect all portable fire extinguishers.	5	5	5	4	5	5	4.83	1st
2. Test all fire hose cabinets.	4	4	4	3	4	4	3.83	2nd
3. Test the sprinkler system alarm.	4	4	4	3	3	3	3.5	3rd
4. Smoke alarms shall be maintained in operating condition.	4	4	4	3	3	3	3.5	4th
5. Test sprinkler system central station connections in every two months.	5	3	3	3	3	3	3.5	5th
6. Test Fire Fighter's elevators for proper operation in every three months.	4	3	3	4	3	3	3.5	6th

The above Table 4.7 has shown the average index and rank of activities of maintenance of fire prevention system for monthly. First ranking for the maintenance of fire prevention system for monthly period is inspecting all portable fire extinguishers activity with average index is 4.83. The second rankings are testing all fire hose cabinets with 3.83 for the average index. For the activity 3, 4, 5 and 6, the average index is 3.5. Their rankings are 3, 4, 5 and 6.

Table 4.8: Activities of maintenance of fire prevention system for yearly

Maintenance of Fire Prevention System	**Buildings**						**Analyze**	**Rank**
Yearly	**A**	**B**	**C**	**D**	**E**	**F**		
1. Carry out maintenance procedures for fire extinguishers.	5	5	5	4	5	5	4.83	1st
2. Conduct a complete test of the building fire alarm system by qualified personnel	5	4	4	4	4	5	4.33	3rd
3. Inspect all standpipe hose valves.	5	4	3	4	4	4	4	5th
4. Inspect all exposed sprinkler system pipe hangers.	5	3	4	3	4	4	3.83	6th
5. Check all sprinkler heads.	5	4	3	4	4	5	4.17	4th
6. Conduct sprinkler system alarm test using the hydraulically most remote test valve.	4	4	3	4	3	5	3.83	8th
7. Inspect fire protection water supply tanks.	4	4	4	3	3	4	3.67	9th
8. Conduct a fire pump flow test.	5	3	4	4	3	4	3.83	7th
9. Inspect and flow test all fire hydrants.	5	3	4	4	3	3	3.67	10th
10. Replace the extinguishing agent in dry chemical fire extinguishers in every six years.	5	4	5	3	5	5	4.5	2nd

The above Table 4.8 has shown the average index and rank of activities of maintenance of fire prevention system for yearly. First ranking for the maintenance of fire prevention system for yearly period is carry out maintenance procedure for fire extinguishers with average index is 4.83. The second rankings are replacing the extinguishing agent in dry chemical fire extinguishers in every six years with 4.5 for the

average index. The third rankings are conducting a complete test of the building fire alarm system by qualified personnel with average index is 4.33. The fourth rankings are check all sprinkler heads with average index is 4.17. The fifth rankings are inspecting all standpipe hose valves with average index is 4.00. The sixth rankings are inspecting all exposed sprinkler system pipe hangers with average index is 3.83. The seventh rankings are conduct a fire pump flow test with average index is 3.83. The eighth rankings are conduct sprinkler system alarm test using the hydraulically most remote test valve with average index is 3.83. For the activity 9 and 10, the average index is 3.67. Their rankings are 9 and 10.

Table 4.9: Maintenance of fire prevention system period

Maintenance Schedule	**Maintenance of Fire Prevention System**	**Average Index**	**Rank**
Daily	1. Check the fire alarm system.	4.49	1st
	2. Check the voice communication systems and AC power lamp and signal.	4.17	
	3. Check the temperature of fire rooms.	3.83	
	4. Check the tank heating equipment and water temperature for fire protection water tanks.	3.83	
	Total Average Index	4.08	
Weekly	1. Check the sprinkler system control valves are open and properly supervised	4.17	3rd
	2. Inspect valves controlling fire protection water supplies.	3.67	
	3. Check the water level and pressure for fire protection system pressure tanks.	3.67	

	4. Check water level in fire pump reservoirs.	3.67	
	5. Inspect and operate all fire pumps.	3.83	
	Total Average Index	3.80	
Maintenance Schedule	**Maintenance of Fire Prevention System**	**Average Index**	**Rank**
Monthly	1. Inspect all portable fire extinguishers.	4.83	4th
	2. Test all fire hose cabinets.	3.83	
	3. Test the sprinkler system alarm.	3.5	
	4. Smoke alarms shall be maintained in operating condition.	3.5	
	5. Test sprinkler system central station connections in every two months.	3.5	
	6. Test Fire Fighter's elevators for proper operation in every three months.	3.5	
	Total Average Index	3.71	
Maintenance Schedule	**Maintenance of Fire Prevention System**	**Average Index**	**Rank**
Yearly	1. Carry out maintenance procedures for fire extinguishers.	4.83	2nd
	2. Conduct a complete test of the building fire alarm system by qualified personnel	4.33	

	3. Inspect all standpipe hose valves.	4	
	4. Inspect all exposed sprinkler system pipe hangers.	3.83	
	5. Check all sprinkler heads.	4.17	
	6. Conduct sprinkler system alarm test using the hydraulically most remote test valve.	3.83	
	7. Inspect fire protection water supply tanks.	3.67	
	8. Conduct a fire pump flow test.	3.83	
	9. Inspect and flow test all fire hydrants.	3.67	
	10. Replace the extinguishing agent in dry chemical fire extinguishers in every six years.	4.5	
	Total Average Index	4.07	

Based on table 4.9, it shows the schedule maintenance of fire prevention system period. The schedule was divided into four periods which are daily, weekly, monthly, and yearly. According to this result, it shows that all buildings have the same periodic maintenance of fire prevention system.

Figure 4.10: Effective maintenance of fire prevention system

Maintenance Schedule	Maintenance of Fire Prevention System	Building					
		A	B	C	D	E	F
Daily	1. Check the fire alarm system.	5	5	4	4	4	5
	2. Check the voice communication systems and AC power lamp and signal.	5	5	3	4	4	4
	3. Check the temperature of fire rooms.	5	4	3	4	3	4
	4. Check the tank heating equipment and water temperature for fire protection water tanks.	5	4	3	4	3	4
Weekly	1. Check the sprinkler system control valves are open and properly supervised	5	5	4	4	3	4
	2. Inspect valves controlling fire protection water supplies.	5	4	3	3	3	4
	3. Check the water level and pressure for fire protection system pressure tanks.	4	4	3	4	3	4
	4. Check water level in fire pump reservoirs.	4	4	3	4	3	4
	5. Inspect and operate all fire pumps.	4	4	3	3	4	5
Maintenance Schedule	**Maintenance of Fire Prevention System**	**Building**					
		A	**B**	**C**	**D**	**E**	**F**
Monthly	1. Inspect all portable fire extinguishers.	5	5	5	4	5	5

	2. Test all fire hose cabinets.	4	4	4	3	4	4
	3. Test the sprinkler system alarm.	4	4	4	3	3	3
	4. Smoke alarms shall be maintained in operating condition.	4	4	4	3	3	3
	5. Test sprinkler system central station connections in every two months.	5	3	3	3	3	3
	6. Test Fire Fighter's elevators for proper operation in every three months.	4	3	3	4	3	3
Maintenance Schedule	**Maintenance of Fire Prevention System**	**Building**					
		A	**B**	**C**	**D**	**E**	**F**
Yearly	1. Carry out maintenance procedures for fire extinguishers.	5	5	5	4	5	5
	2. Conduct a complete test of the building fire alarm system by qualified personnel	5	4	4	4	4	5
	3. Inspect all standpipe hose valves.	5	4	3	4	4	4
	4. Inspect all exposed sprinkler system pipe hangers.	5	3	4	3	4	4
	5. Check all sprinkler heads.	5	4	3	4	4	5
	6. Conduct sprinkler system alarm test using the hydraulically most remote test valve.	4	4	3	4	3	5

	7. Inspect fire protection water supply tanks.	4	4	4	3	3	4
	8. Conduct a fire pump flow test.	5	3	4	4	3	4
	9. Inspect and flow test all fire hydrants.	5	3	4	4	3	3
	10. Replace the extinguishing agent in dry chemical fire extinguishers in every six years.	5	4	5	3	5	5
	Total Average Index	**4.64**	**4.00**	**3.64**	**3.64**	**3.56**	**4.12**

This table 4.10, the effectiveness of fire prevention system is determined by using the total average index that was computed from the likert scale. Building with the highest total average index is presumably to have the most effective maintenance of fire prevention system. Based on the questionnaire and result, Building A has the most effective maintenance of fire prevention system with a total average index of 4.64. Building C and D on the other hand, have the lowest total average index and the least effective maintenance of fire prevention system with a total average index of 3.64.

4.5 Conclusion

To explore the most effective fire prevention system maintenance is the purpose of this research. All data had been obtained from the questionnaires have been analyzed, presented and discussed in this chapter. The descriptive analyses have been used in order to summarize the demographic information. Based on this chapter, it was proven that both the activities and schedule of maintenance of fire prevention system are equally important in determining the effectiveness of maintenance of fire prevention system.

CHAPTER 5

CONCLUSION

5.1 Introduction

Analysis and result, conclusions, discussion from the findings and recommendations is the aim of this chapter to present. Research influence of most effective fire prevention system maintenance on building and objectives of this research is at the high rise building in Kuantan, Pahang. Conclusion and discussion of the study, proposed and future research will be discussed in this chapter.

5.2 Discussions

There are three objectives for this study. The first one is to examine the schedule of maintenance of fire prevention system. The schedule of maintenance of fire prevention system includes the maintenance period of fire prevention system. It consists of daily, weekly, monthly, and yearly scheduled maintenance of fire prevention system. The buildings' owners need to ensure the maintenance is being taken care of according to the schedule. The second objective is to identify the activities of maintenance of fire prevention system. It consists of 25 activities. Among the activities are checking the fire alarm system, checking the voice communication systems and AC power lamp and signal, checking the water level and pressure for fire protection system pressure tanks. These, among the many, are activities that are required for the maintenance of fire prevention system. These activities need to be conducted in accordance to the schedule. The third objective is to analyze the most effective maintenance of fire prevention system in respect to the studied buildings. The level of effectiveness is measured by using the total average index and likert scale. Building A has the most effective maintenance of fire prevention system while Building C and D have the least affective maintenance of fire prevention system.

5.3 Recommendation

As for the recommendation for future study, the researcher could consider to broaden the scope of this research. As this research is now focusing on the maintenance of fire prevention system, researcher could consider doing research on the standardization of the maintenance of fire prevention system. It can be used to analyze the effect and relationship of standardization and the effectiveness level. For future, the number of respondents and buildings under study can also be increased for better result and analysis.

Recommendation from this research can be applied onto but not limited to the buildings under study. The activities and schedule of maintenance of fire prevention system should be taken seriously by buildings' owners to ensure their buildings are well prepared in case of fire. Casualties and major losses due to fire can also be minimized if they have an effective maintenance of fire prevention system.

5.4 Conclusion

In a nutshell, maintenance of fire prevention system is not something that should be taken for granted by buildings' owners. There are many cases that have been reported due to lack of maintenance of fire prevention system. It is the first thing that should be considered by buildings' owners. Casualties and economic losses are among the accidents that can be avoided if the buildings have an effective maintenance of fire prevention system.

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APPENDIX A

QUESTIONAIRE

"A Case Study of Maintenance of Fire Prevention System"

These questionnaire are be made to identify and examine the maintenance of fire prevention system for high-rise buildings in Kuantan, Pahang and to analyze the most effective fire prevention system maintenance.

Section A: General Information

Position : ……

Working experience : ……...

Section B: Frequency of maintenance for fire prevention system

The following item describe the frequency of maintenance of fire prevention system in your building. Indicate your maintenance frequency with the following activity by circling your frequency using this scale.

1	2	3	4	5
Hardly ever	Rarely	Sometimes	Nearly always	Always

Maintenance Schedule	Activity	Scale					Remarks
Daily	5. Check the fire alarm system.	1	2	3	4	5	
	6. Check the voice communication systems and AC power lamp and signal.	1	2	3	4	5	
	7. Check the temperature of fire rooms.	1	2	3	4	5	
	8. Check the tank heating equipment and water temperature for fire protection water tanks.	1	2	3	4	5	
Weekly	1. Check the sprinkler system control valves are open and properly supervised	1	2	3	4	5	
	2. Inspect valves controlling fire protection water supplies.	1	2	3	4	5	
	3. Check the water level and pressure for fire protection system pressure tanks.	1	2	3	4	5	
	4. Check water level in fire pump reservoirs.	1	2	3	4	5	
	5. Inspect and operate all fire pumps.	1	2	3	4	5	
Monthly	1. Inspect all portable fire extinguishers.	1	2	3	4	5	
	2. Test all fire hose cabinets.	1	2	3	4	5	

	3. Test the sprinkler system alarm.	1	2	3	4	5	
	4. Smoke alarms shall be maintained in operating condition.	1	2	3	4	5	
	5. Test sprinkler system central station connections in every two months.	1	2	3	4	5	
	6. Test Fire Fighter's elevators for proper operation in every three months.	1	2	3	4	5	
Yearly	1. Carry out maintenance procedures for fire extinguishers.	1	2	3	4	5	
	2. Conduct a complete test of the building fire alarm system by qualified personnel	1	2	3	4	5	
	3. Conduct a complete test of the building fire alarm system by qualified personnel.	1	2	3	4	5	
	4. Inspect all standpipe hose valves.	1	2	3	4	5	
	5. Inspect all exposed sprinkler system pipe hangers.	1	2	3	4	5	
	6. Check all sprinkler heads.	1	2	3	4	5	
	7. Conduct sprinkler system alarm test using the hydraulically most remote test valve.	1	2	3	4	5	
	8. Inspect fire protection water supply tanks.	1	2	3	4	5	

	9. Conduct a fire pump flow test.	1	2	3	4	5	
	10. Inspect and flow test all fire hydrants.	1	2	3	4	5	
	11. Replace the extinguishing agent in dry chemical fire extinguishers in every six years.	1	2	3	4	5	