Sudan University of Science and Technology
College of Graduate Studies
Building services specialization

Evaluation of Firefighting Systems in Hospitals in Khartoum city

تقويم أنظمة مكافحة الحرائق في المستشفيات في مدينة الخرطوم

A supplementary research to obtain a master's degree in architecture (Specialty building services)

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قال تعالى :-

{ يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ}

[المجادلة: 11]،

صدق الله العظيم

Dedication

This is dedicated to my dear parents ....., my teachers and my friend.....

Always and forever …to the bright heart whites.....

To symbol of love and healing balm …...

My beloved mother....God bless you

To the one who did not spare anything in order to push me on the road of success.....

To who taught me to rise the ladder of life wisely and patiently...

My dear father...God bless you

To the pure and kind hearts and innocent souls to the winds of my life ... my brother and sisters …...

... To those who enjoy fraternity and excellence to meet and give to the springs of pure sincerity to those with whom I was happy with them in the paths of life and sweet sad Sirte

My friends, my sisters and my colleagues...be save

Acknowledgment

First and foremost, Praise and thanks be to God for his kindness and success.
Who blessed me to complete the letter to the fullest.....

First, praise be to God, who blessed me to complete the letter to the fullest

Thank you my Lord that facilitated me to complete this search on the face, which I hope to satisfy me.....

I extend my sincere thanks and appreciation to Dr. Essam Abakr Isaac for the knowledge and guidance he has given me for continuous and beneficial and tender excellence, and for his continued effort until the completion of this letter ... Whatever I wrote from the words of the words of thanks remain incapable of fulfilling his right ... God rewarded him with the best penalty and made it in the balance of his good deeds.

I extend my thanks to my distinguished professors at the Faculty of Engineering, Sudan University of Science and Technology.

My thanks go to the distinguished professors who have conducted research questionnaires and sincere help without delay or hesitation.

Dr. Essam Abakr Isaac

T.Walid Mansour

T.Mokhles Othman Saleh

My thanks and appreciation go to all members of my generous family.

And everyone who contributed to the completion of this research.....

Abstract

This study dealt with the evaluation firefighting systems in health buildings (hospitals) in Khartoum city to know the efficiency of the systems and the response to fires and the awareness of workers in this area, It also sought to find out the causes of fires and the classification, the systems used to control the fire and impact on architectural design and design precautions for fire in buildings in order to maintain the safety of the building and users and reach proposals to solve existing problems.

The study used a descriptive analytical approach and several methods of data collection references and previous studies, visits and interviews with some officials, in addition to the questionnaire, which was designed to target a random sample of the population of the study and included 50 questionnaires distributed to 20 hospitals. The questionnaire also included a set of questions to obtain data that clarifies the current situation of hospital fire systems and the problems facing patients and workers in the building.
The conclusions were reached, the most important of which were the reasons for the fires in hospitals. Electrical solicitation and negligence in electrical connections, changing the uses of buildings also lack of maintenance or misuse of equipment. There are insufficient emergency exits and unplanned evacuation plans.

The study concluded to provide some recommendations for future studies, To contribute to solving the problems related to fire alarm and extinguishing system in hospitals, Where the study recommends the management of hospitals to work on the application of fire control systems and early warning through the application of safety and prevention procedures and civil defense laws and spread adequate awareness among workers.

The research seeking to protect facilities from the risk of fire by developing architectural designs to be able to protect themselves from danger by creating appropriate escape paths to evacuate the disabled and sick on a Stretchers to ensure the safety of medical equipment and devices when transporting The patients . commitment to provide safety requirements such as the automatic sprinkler system in view because of its importance and effectiveness in preserving the safety of the building and its occupants..

Inspection, monitoring and follow-up of electrical and mechanical equipment, gas connections and misuse of buildings during operation and maintenance Installation of mechanical ventilation systems due to their role in the disposal of fumes and harmful gases in cases of fire.

المستخلص

تناولت هذه الدراسة تقويم أنظمة مكافحة الحرائق في المباني الصحية (المستشفيات) في مدينة الخرطوم لمعرفة مدى كفاءة النظم والاستجابة للحرائق وتوعية العاملين في هذا المجال ، كما سعت إلى معرفة أسباب الحرائق وتصنيفها ، والأنظمة المستخدمة للسيطرة على الحريق وتأثيرها على التصميم المعماري وتصميم احتياطات الحريق في المباني من أجل الحفاظ على سلامة المبنى والمستخدمين والتوصل إلى مقترحات لحل المشاكلات القائمة.

استخدمت الدراسة المنهج الوصفي التحليلي وعدة طرق لجمع البيانات التي تمثلت في المراجع والدراسات السابقة والزيارات والمقابلات مع بعض المسؤولين بالاضافة الي الاستبيان الذي اعد ليستهدف عينة عشوائية من مجتمع الدراسة و شملت 50 استبانة تم توزيعها علي 20 مستشفي كما تضمن الاستبيان مجموعة من الاسئلة للحصول علي البيانات التي توضح الوضع الحالي لانظمة الحرائق في المستشفيات والمشاكل التي تواجه المرضي والعاملين بالمبني .

تم التوصل للعديد من النتائج اهمها تمثل في اسباب وقوع الحرائق في المستشفيات كانت بسبب الاتي : التماس كهربائي واهمال في التوصيلات الكهربائية , تغير استخدامات المباني ايضا عدم صيانة الاجهزة او سوء استخدامها .التدخين بالقربب من مستودعات الغازات الطبية ,لاتوجد مخارج كافية للطوارئ وكذلك خطط الاخلاء غير مدروسة.

خلصت الدراسة لتقديم بعض التوصيات للدراسات المستقبلية للمساهمة في حل المشكلات المتعلقة بنظام انذار واطفاء الحريق في المستشفيات , حيث توصي الدراسة إداراة المستشفيات العمل على تطبيق انظمة مكافحة الحريق والانذار المبكر من خلال تطبيق اجراءات السلامة والوقاية وقوانين الدفاع المدني ونشر الوعي الكافي بين العاملين .

يسعي الباحث لحماية المنشات من خطر الحريق وذلك عن طريق تطوير التصميمات المعمارية لتصبح قادرة علي حماية نفسها من الخطر عن طريق انشاء ممرات هروب مناسبة لإخلاء المقعدين والمرضى على أسرة التاكد من سلامة المعدات والاجهزة الطبية عند نقل المرضي والمصابين ,الالتزام بتوفير متطلبات السلامة مثل نظام المرشات الآلية نظرا لأهميته وفعاليته في الحفاظ على سلامة المبنى ومـن فيه.

فحص ومراقبة ومتابعة المعدات الكهربائية والميكانيكية ووصلات الغاز وسوء استخدام المباني أثناء التشغيل والصيانة تركيب أنظمة التهوية الميكانيكية بسبب دورها في التخلص من الأبخرة والغازات الضارة في حالات الحريق.

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Background:

In the name of God, the Most Gracious and the Most Merciful, the prayers and peace be upon the Prophet's Muhammad peace be upon him.

Man has known fire for a long time and used it in its primitive form in his daily life without knowing that it will one day be a cause of its destruction. Fires are one of the oldest problems and the biggest risks faced by humans.

Fires are one of the oldest problems and the biggest risks faced by man. Therefore, we must take preventive measures from fires to prevent their occurrence and eliminate their causes, and to achieve the possibility of controlling them in the event of fire and extinguish as soon as possible with minimal losses

Hospitals and health care centers have spread, where the patient receives all types of treatment and full care as it must be a high degree of design in terms of the accuracy of the design of all services within it of the utmost importance enjoyed by these buildings,

Hospitals are sensitive areas that must be handled with great care in cases of fire as they are vital places always congested and trying to control human lives is not easy, so follow the safety instructions and apply them carefully and develop a plan to put out fires quickly.

This research deals with the causes of health facilities fires and to know the impact of safety measures in the reduction of fire accidents and ways to prevent them to protect lives and property, which is the main objective that the study seeks to achieve.

1-1 Problem statement :

This study deals with an important aspect of the security in the society, which is the firefighting systems in hospitals. Many hospitals suffer from low fire alarm systems and fire extinguishers in health facilities, it also suffers from insufficient awareness for community members in the fight against fire.

The seriousness of fire accidents in hospitals and the resulting loss of life and property

Weak security and safety means that must be provided in hospitals, which makes firefighting and control difficult, Knowledge of the necessary safety procedures.

1-2 Significance of research :

Add an important knowledge aspect about preventive safety and firefighting.

Hospitals are sensitive areas that must be handled with great care in cases of fire, as they are vital places always congested and trying to control human life is not easy, so follow safety instructions and apply them carefully and develop a plan to put out fires quickly.

1. Add an important knowledge aspect about the procedures for the application of fire systems in hospitals
2. Finding results through which suggestions and recommendations can be submitted to the competent authorities such as civil defense, ministries and others.
3. Enriching libraries with scientific research and adding a new scientific library.

1-3 Research Questions:

1. What causes fire?
2. What are firefighting systems?
3. What is the availability of preventive safety in terms of procedures followed ?
4. The awareness of the workers about preventive safety measures and evacuation methods?
5. What are the building materials and finishes help to reduce the spread of fire?
6. What are the obstacles that affect fire control?
7. What extent are safety measures implemented to reduce fire accidents in hospitals in Khartoum?
8. What are the preventive plan and procedures for fire accidents in hospitals?

1-4 Research objectives :

1-5-1 the main objective of the study :

Securing and equipping hospitals against disasters with fire alarm systems, control and evacuation method.

In case of fire by providing a safe environment for all patients and building staff.

Fire fighting in hospitals and saving lives when a fire in buildings.

1-5-2 Specific objectives:

- Identify the main causes of fires and their spread in buildings.
- Safety and security requirements in hospitals.
- Preventive measures that should be followed in case of fire.
- Reporting and identifying the various types of risks, hazardous and non-sound situations.

- Ensuring employees' awareness and knowledge of the importance of follow-up safety procedures that aimed preventing any injuries during work.
- Identify the systems used and the means used to combat the fire and its location.
- Periodic maintenance of fire-fighting and alarm systems by the competent authorities.
- Provide suggestions and recommendations to help solve hospital problems in fire fighting

1-5-3 Means of achieving the objectives:

- Identify equipment used in firefighting (fire extinguishers, alarm bells and fire hoses) and where they are located.
- Know how to contain smoke and fire and how to report various types of hazards and hazardous work and cases and determine the quality of each of them.
- Building occupants must be trained in the operation and use of fire-fighting systems
- Emergency exits allow the evacuation of patients and users.
- There should be regular maintenance by a competent authority

1-5 Research Method :

The study followed the descriptive analytical approach of a set of statistical data to infer some indicators that serve the objectives of the study, and illustrate the current status of firefighting systems in hospitals and their future needs.

The researcher followed the scientific method based on scientific sources and references and previous studies and conducted a survey and personal interviews to collect information related to the study area to find out the means and procedures prescribed by the laws in the safety of health buildings.

1-6 Sources of information collection:

- The researcher relied on field visits during the study to collect the necessary information in the study area
- Interviews and meetings with officials and specialists relevant to the subject of the study.
- Research and published studies, magazines, newspapers and internet networks
- Training courses, conferences and research papers on the subject of study.
- Books and references dealing with the subject or part of it and reports and statistics from the competent authorities.

- Questionnaire: It is the researcher's tool in obtaining the required information and facts regarding firefighting systems in hospitals in Khartoum locality.

1-7 Research limits :

1.8.1 Spatial Research Limits:

Firefighting systems in hospitals in Khartoum city.

The study was based on a random sample of hospitals (governmental and private) in the city of Khartoum because of the possibility of measuring its results on the other types of hospitals taking into account the conditions and means necessary for each type.

1.8.2 Objective Research Limits:

Firefighting in hospitals in Khartoum city.

1-8-3 Time Search Limits:

The study began in April 2018 and continued until 2019.

1-8 Research Constraints:

- Lack of books, references and information related to the subject of the study, which dealt with design and architectural aspects and related to the subject of safety in hospitals.
- There are no detailed previous studies on the subject.
- Some security considerations are an obstacle to providing information about the study.

1-9 Structured Research:

The research consists of five sections started with the introduction and identify the problem and objectives and research methodology to reach the results and recommendations.

Section I: consists of the introduction and the basics of research, background and problem statement, the Significance of research, the research objectives, methodology of the study followed, sources of information collection, and limits of the study and structure of research.

Section II: consists of the theoretical framework and previous studies where it is divided into the following chapters (Chapter one: Introduction to fire safety,

Chapter two Fire Fighting and Fire Alarm Systems, chapter three previous studies).

Section III: Consists of the following chapters (chapter one Introduction to Health Buildings and chapter two the method of conducting the research, the community of study, the procedures used to obtain the results and the research samples

Section IV: the analysis and interpretation of samples and answer questions of research.

Section V: the conclusion of the study, results and recommendations and a list of appendices and terminology and a list of references, sources and curriculum vitae of the researcher

1-10 Study Definitions

Fire:

This is the chemical that occurs as a result of combining the flammable material with oxygen under the influence of a certain temperature.

Fire Extinguishing Systems:

The systems that are designed to extinguish the fire in any of the facilities in an automatic manner so that the building and its occupants and properties are protected.

Fire Fighting:

Is to carry out firefighting after the occurrence using appropriate mechanisms and equipment by firefighters trained to deal with various accidents that may occur.

Or are the positive dealing with the fire to extinguish.

Fire Protection:

Is the procedures or precautions to be taken before the incident to reduce its occurrence by removing its causes and limiting its impact.

(The source of the Quran, 1995, p. 25)

Hospital: Every place is prepared to receive and detect patients and injured

And their treatment and hypnosis.

2 - Exits: are the doors that lead to the usual discharge from the hospital.

Emergency exits are the doors intended for unusual exit in case of emergencies.

Emergency

CHAPTER II

Section one

Theoretical framework

- Introduction
- Definitions
- The process of combustion (ignition theory)
- Combustion products
- Heat Transfer
- Fire Stages:
- Causes of fires:
- Firefighting methods (fire theory)
- Classification of Fires
- Fire hazards
- Fire prevention
- Fire Behavior of Building Fires

Section two

Fire Fighting & Fire Alarm Systems

- Preface
- Fire safety
- Fire detection and alarm systems
- Importance of firefighting systems
- Firefighting system equipment
- Fires in Khartoum
- Civil Defense Authorities
- Objectives of the Civil Defense
- Civil Defense Works
- General rules for extinguishing fires
- Fire statistics in Khartoum

Section three

Health building
Previous studies

Theoretical framework

2-1 Introduction :

Fire is one of the greatest discoveries of mankind but it can also be a major risk in accidents. On average, 8 out of every 1,000,000 people are killed each year in Europe and more are taken to hospital by fire. Man has used fire since ancient times in many fields in agriculture to cleanse the ground, cook, generate heat and light, signals and propulsion purposes, Smelting, burning and burning of waste, as well as a weapon or a means of defense or destruction.

Fires are one of the most important risks to the human body directly through fire damage and heat and indirectly suffocation due to smoke inhalation or collapse of the building as a result of exposure to heat that dissolves its foundations. Buildings specifically. Plastics are used in a wide and growing range of construction applications, from durable pipes and window frames to modern insulation solutions.

The most important thing in building safety the possibility of safe escape when a fire occurs.

2-3 Definitions:

2-2-1 what is the fire?

Fire is a rapid mixture of oxygen with fuel in the presence of heat, usually characterized by flame, a body of incandescent gas that contains the reaction and supports it and emits light and heat.

For example: The process of combustion of flammable substances that produce heat, light and smoke (often)

Source: NAFFCO Fire Awareness Team

2-2-2 Fire safety:

Fire safety is the set of practices intended to reduce the destruction caused by fire. Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, to limit the development and effects of a fire after it starts.

Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to occupants of the building.

Source https://en.wikipedia.org/wiki/Fire_safety

2-2-3 Fire Protection:

Is the measures or means to be taken before the incident to reduce its occurrence?

Systems designed to extinguish the fire in the facility in an automatic manner and the purpose of equipping buildings with alarm systems, control and prevention in order to protect the building occupants from the dangers of fire.

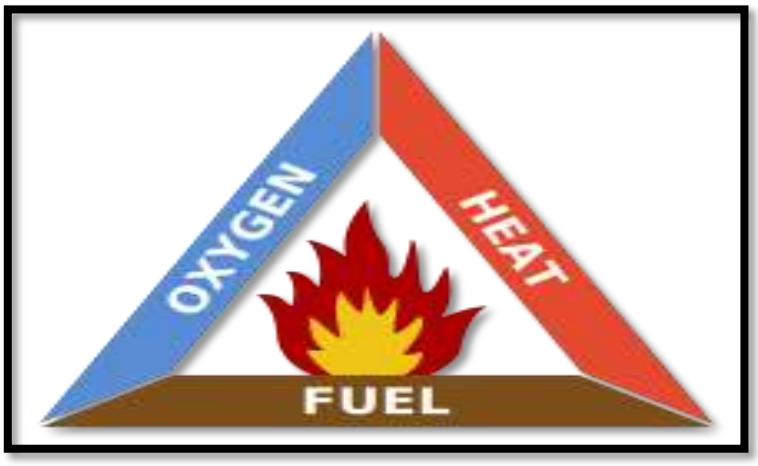
(Source: | Younis and Hweiti, 1417, p. 8)

2-2-4 Fire Fighting

Scientific definition: Is to fight fires after the fact using appropriate mechanisms and devices dealing with various accidents that are likely to occur

2-2-5 Fire:

It is a chemical reaction between the burning material and atmospheric oxygen at the ignition temperature of the material (1)



(Source: Younis and Hweiti, 1417, p. 8)

The Figure (2-1) illustrates the basic elements of fire composition

The source: https://en.wikipedia.org/wiki/Fire_triangle

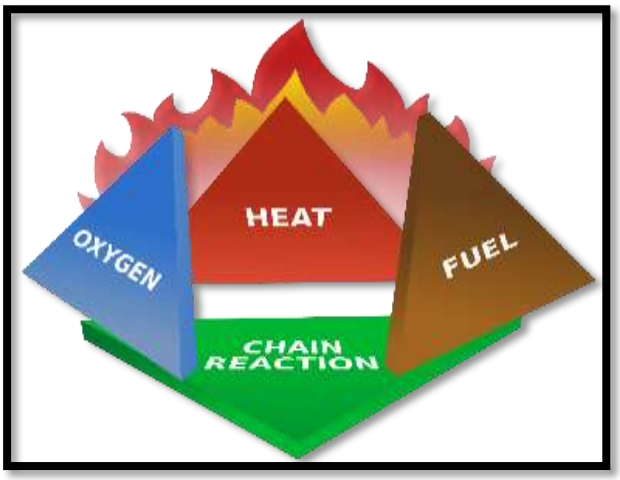
2-2-6 Combustion:

- Flammable combustion caused by the evaporation of flammable material, mixing with atmospheric oxygen, and ignition where a fire is formed.
- Glowing Surface Combustion caused by the surface temperature of the flammable material without evaporation, where the result of chemical reaction with oxygen glows.

2-4 The process of combustion (ignition theory): -

Ignition is defined as the chemical phenomenon that occurs as a result of the combustion of oxygen flammable material under the influence of a certain temperature. The temperature at which this phenomenon occurs depends on each substance and is called the ignition point of the material.

- The principle of ignition is based on the occurrence of chemical reactions sequential between the elements of fire and sufficient proportions (fuel, heat, oxygen) and the component of what is known as the fire triangle
  (Source: Yunus and Hweiti, 1417 e, p. 9)
- The recent studies have proved that there is a fourth element that must be in addition to the three elements preceding the fire is a series of chemical reaction and thus the fire box is formed instead of the fire triangle)



(Source Hazza, 1425 p.)

The Figure (2-2) illustrates the basic elements of fire formation.

The source: https://en.wikipedia.org/wiki/Fire_triangle

2-3-1 Flammable substance (fuel) :

A substance is all that occupies a space of space, has a certain mass and may consist of one or several elements, a chemical compound or several chemical compounds.

The material is one of the main elements of fire and has several cases:

- **Solid State**: All materials that maintain their shape and size in temperature and natural pressure such as wood, charcoal, paper, cotton ... etc.
- **The liquid state** is the material of fixed size and variable form, where it takes the shape of the container in which it is placed in the normal temperature and pressure (water, oils of all kinds, solutions, kerosene)

- **Gaseous state**: They are all substances that have no shape and no fixed volume at normal temperature and pressure (such as propane, butane, and hydrogen)

2-3-2 Heat:

Is a form of energy and is considered one of the most important elements of ignition and without them to complete the oxidation and therefore does not ignite.

Heat Definition: Heat is a form of energy that can be transferred from one object to another or even created at the expense of loss of other energy forms

Sources of heat: (Al-Wahda, 1996)

- Natural sources: The heat produced by the sun, volcanic lava, lightning, lightening,
- Chemical sources: Chemical reactions are one of the most important thermal sources in this era
- Mechanical sources: Mechanical heat is produced by the friction of moving objects such as metal cutting, friction of machines and the fall of tools and metal parts
- Electrical sources: The heat generated by electrical charges, whether due to electric current or static electricity (static)
- Nuclear sources: They occur as a result of nuclear fission, or the nuclear fusion of radioactive element atoms, whether in nuclear reactors or nuclear weapons

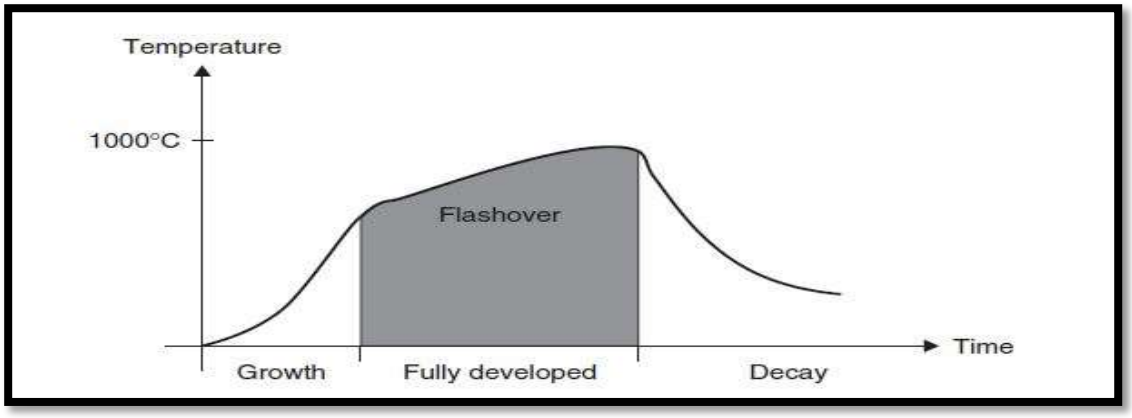


Figure (2-3) shows the temperature change graph over time in a closed fire

The source: (Fire Safety Manual - N sesha prakash)

2-3-3 Oxygen:

It is a component of air and is necessary to complete the ignition of any material except oxidizing substances and the main factor of the ignition

Also, the presence of oxygen is necessary for human life is also necessary to complete the ignition by at least 16% of the proportion in the air,

Where the air contains (9.20%) oxygen,

Oxygen properties:

- A gas that has no color, no taste, no smell.
- B - Helps the ignition process
- C- Very necessary for the process of breathing organisms.

2-3-4 Chemical reaction chain:

The chemical reaction chain means the presence of elements (fuel, heat, oxygen) at specific and fixed rates for the necessary reaction and its persistence to complete the ignition hence, ignition is not observed in the following cases:

1. If the fumes of flammable material are present but do not form with the oxygen in the air the appropriate mixture for flammability
2. Lack of temperature to start ignition
3. The presence of what causes the flame to slow down despite the availability of elements necessary for flammability] such as moisture

2-5 Combustion products:

Combustion products vary depending on the quality and composition of the flammable material cause damage and risks to organisms and property.

The most important of these products are:

1. Combustion gases: Including carbon dioxide gas, which is suffocating gas, carbon monoxide gas and toxic gas produced from incomplete combustion.
2. Flame: The radiant energy from the combustion that can be seen with the naked eye in the form of a glow associated with the combustion process
3. Heat: Airborne thermal energy from the place of fire is the product of combustion, which is often responsible for the spread of fire inside buildings. (Ahmad, 2002).
4. Smoke: It is a substance containing very fine solid particles, condensed vapor, fire gases and some drops of tar and exposure to it may lead to serious damage, especially eye injuries and respiratory infections. (Younis and al-Huwaiti, 1411, pp. 85, 86).
5. Toxic gases: is the sum of the gases and particles released by combustion according to the type of material or fuel and when the fire occurs produce carbon dioxide and carbon monoxide as well as cyanandric acid (HCN) and chloride acid (HCL) and fluoridic acid (HF) and sulfur dioxide (SO2)
Source (Orfali, 1408e, p. 122).

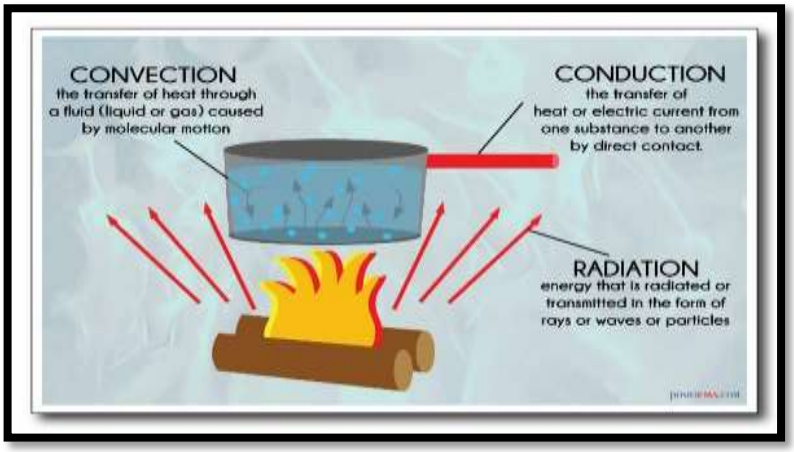
Figure (2-4) shows the Combustion products

http://www.safety4arab.com

2-6 Heat Transfer :

Objects exchange heat with their surroundings that heat travels from the hot body to the body that is less than the temperature and this happens by one of the following means:

1. **Contact - Connection**: - Heat transfer by connection is done by direct contact or through a conductor,
   As happens in the case of a hot pot contactor as the heat passes from the receptacle to the hand
   The metals vary in their degree of conductivity, some of them good conductor of heat and others not heat conductive,
2. **Pregnancy currents**: - Heat is transmitted in liquids and gases because of the change in density according to the temperature change. It is transmitted by convection currents. It moves from bottom to top. The convection heat transmission can be observed in the hot water pipes network in buildings, chimney stoves, and Bottom floors to upper.
3. **Radiation**: - Thermal radiation absorbed by some objects and reflected by others. Black or dark objects absorb more heat than bright objects or bright glossy surface



The figure (2-5) shows the heat transfer

NAFFCO Fire Awareness Team

2-7 Fire Stages:

The International Fire Service Training Federation (IFSTA), there are 4 stages of fire:

These stages are preliminary, growth, fully developed, and decompose. Below is a brief overview of each stage.

- **Primary** - This first stage begins when heat, oxygen and fuel source accumulate and have a chemical reaction leading to a fire.
  This is also known as "ignition"
- **Growth** - The growth stage is where fire and oxygen structures are loaded as fire fuel. There are many factors that affect the growth phase including where the fire started, what combustible materials are nearby, the height of the roof and the possibility of "thermal layers".
- **Fully developed** - when the growth stage reaches its maximum and all combustible materials are ignited, the fire is considered fully developed.
- **Decay** - usually the longest stage of a fire, the decay stage is characterized by a significant reduction in oxygen or fuel, which puts an end to the fire. The two common hazards during this stage are the first - the presence of non-flammable non-flammable materials, which can ignite a new fire if not completely extinguished. Second, there is a risk of a rear defect when oxygen is reintroduced into a confined and volatile place.

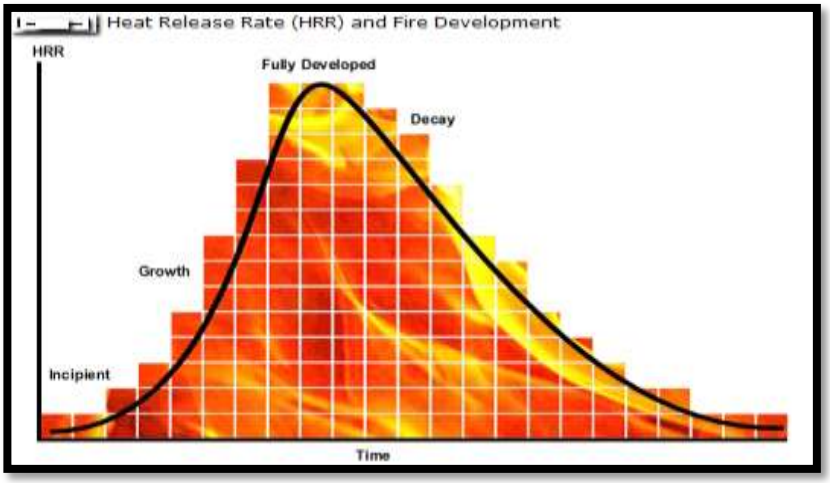
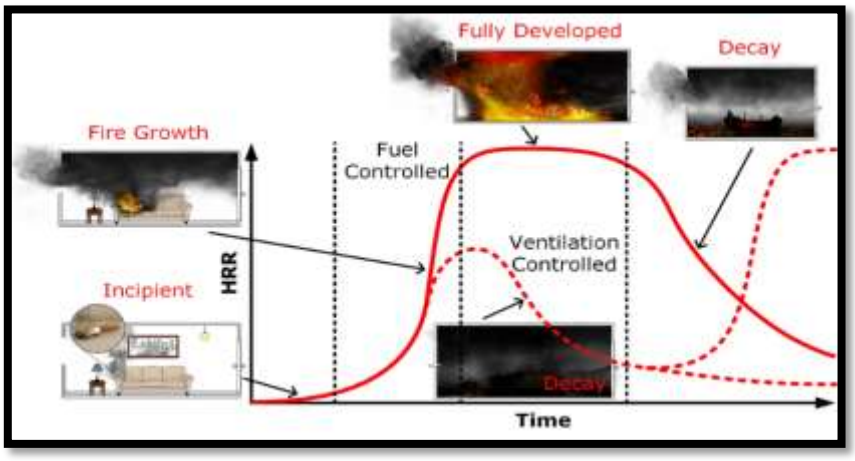


Figure (2-6) Fire development and fire behavior indicators

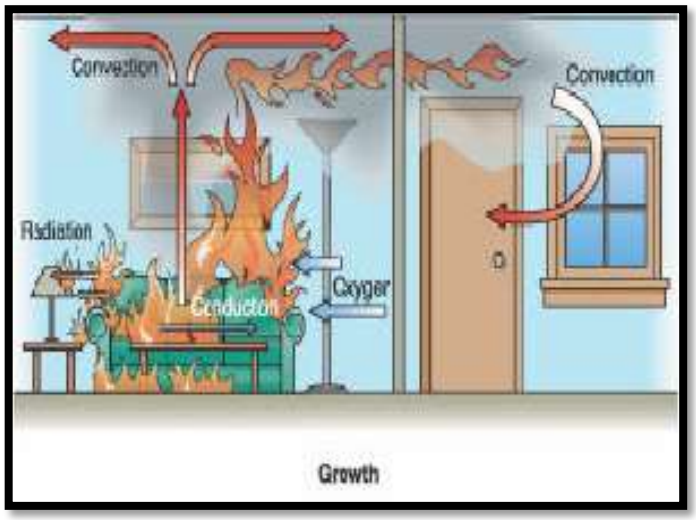
Source: Battalion Chief Ed Hartin, www.firehouse.com

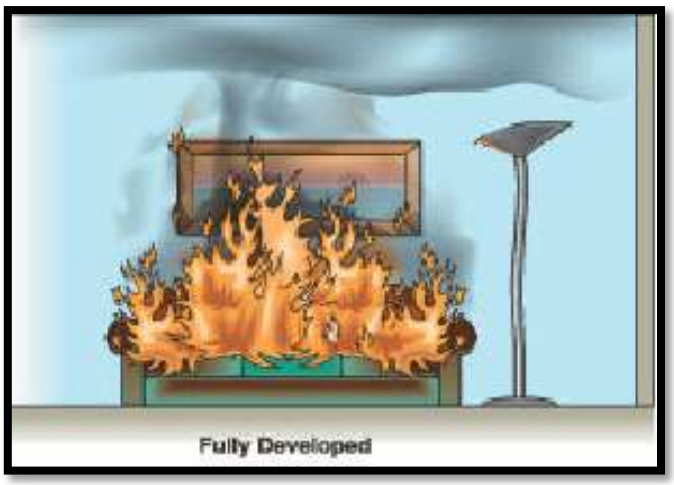


The Figure (2-7) Stages of Fire Development | FD203 Enclosure Fires | Guides Guides.co

Source: Basic Curriculum of Fire Science - Module 3 OSU Catalog Extension University of Oregon

Stages of Fire:





The figure (2-8) shows the stage of fire ignition

The figure (2-9) shows the stage of fire growth

The figure (2-10) shows stage of fire fully developed

the figure (2-11) shows the fire decay

The source: https://www.google.com/search

2-8 Causes of fires:

There are a number of causes of fire depending on the type of study:

First Category Design mistake:

1. Design faults such as electrical contact or inadequacy of electric wire sizes with loads or non-stability of wires and an incomplete electrical grid
2. Non-standard gas connections with severe ventilation in the kitchen
3. Bad and dangerous storage of flammable or explosive materials
4. Saturation of the place with steam and gases in the presence of poor ventilation

5. High temperatures due to friction in the mechanical parts or the occurrence of sparks
6. Electrical faults or presence of inflammable materials near electrical appliances used for heating purposes
7. Hot works such as cutting, welding, flying sparks, molten metal and failure to take necessary safety measures when carrying out such works
8. Damage of equipment and electrical equipment and failure to follow the technical assets in the connections.

Second Category Human causes:

1. The behavior of the users of the building, such as neglect and indifference, accounts for 90% of the house fires
2. Acts of vandalism which are part of deliberate fires with intent to damage
3. Set fire to dangerous places or throw cigarettes.
4. Excessive load of electrical connections and sockets

Third Category: Self-ignition:

1. Self-ignition of some substances when exposed to moisture grow some bacteria that cause the chemical reaction to raise the temperature to a higher degree of flammability of organic matter, which leads to fire
2. Fire near dangerous places
3. The presence of liquid waste and flammable oils
4. Classification IV: Natural causes:
5. Lightning, volcanoes and heat of the sun
6. Wars, natural disasters and floods

(Source: Osman al-Tayeb Hassan - 2007 - 1428 e) The basics of fire science)

2-9 Firefighting methods (fire theory): -

The theory of the fire depends on the fracture of the ignition triangle by removing one or all of its ribs. Therefore, fire operations are subject to three methods

1. Fire-cooling (heat-prevention heat)
2. Fire stifling (preventing oxygen oxygen)
3. starving the fire (preventing fuel)

1- Fire cooling: -

It is intended to reduce the temperature of the flammable material, using the water which is thrown into the fire.

This method mainly depends on the ability of water absorption of the heat of the material in the fire, where the temperature rises to the boiling point and turn it into

vapor above the surface of the fire, and the use of mute operations by reducing the proportion of oxygen air.

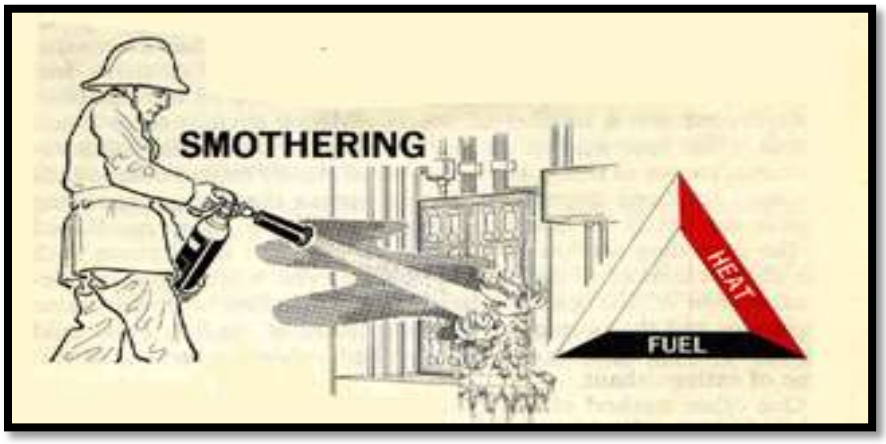
The Figure (2– 12) shows Fire-cooling (heat-prevention heat)

The source: (www.arabicsafety.com)

2- Fire Smothering:

The fire is choked with a barrier that prevents air oxygen from reaching it by:

- Close ventilation outlets and openings in the fire area to reduce the proportion of oxygen in the air to the proportion that does not allow the continuation of ignition.
- Covering material with chemical foam.
- Replace oxygen with water vapor, carbon dioxide, dry chemical powders or halogen vapors.
- The fire can be extinguished by separating the flame from the burning material by blowing up the fire place using explosive materials such as dynamite. This method is usually used to extinguish oil well fires



The Figure (2– 13) shows fire Smothering

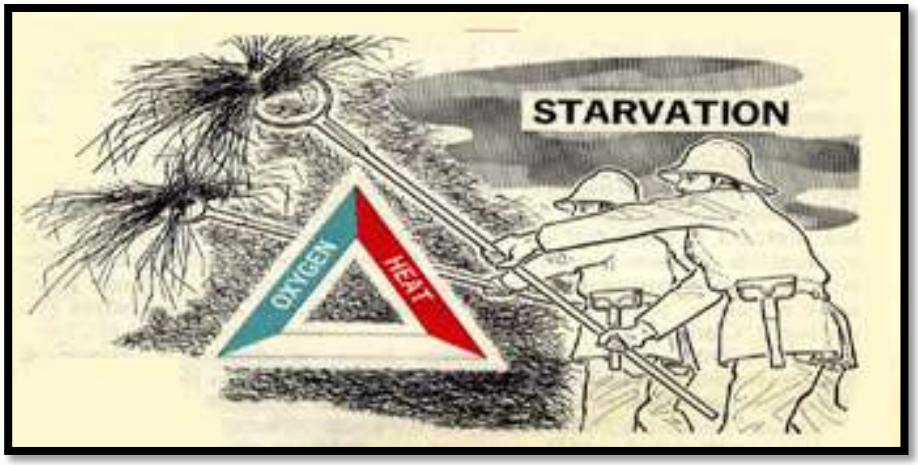
The source :(www.arabicsafety.com)

3- Starving the fire:

Is to prevent the extension of fire to new quantities or parts of flammable materials by reducing the amount of flammable materials by the following means

- Displacement and removal of flammable materials away from flammable neighborhoods for heat and flame hazards
- Close flammable gas gaskets.
- Splitting the combustible materials into small pieces into a manageable small set of fires, such as cracking burning wood for dispersion into small parts, or mixing water molecules with a flammable liquid surface.

(http://www.moe.gov.bh/divisions/safety/index.htm)

- 

The Figure (2– 14) shows fire Starvation or Limitation of fuel
(http://www.moe.gov.bh/divisions/safety/index.htm)

The source (www.arabicsafety.com)

2-10 Classification of Fires :

2-9-1 European Classification:

Fire is divided in terms of type and properties of flammable material, which entails the choice of theory and the appropriate fire extinguisher into five main sections or groups:

Table (2-1) shows the classification of fires according to the European classification:

Source Osman Tayeb Hassan - (2007 - 1428) the basics of fire science Khartoum

The group	**classes**	**Type of material**	**Example**	**Fire style**
Ordinary combustible A	**Class A**	Carbon materials	Wood - Fabrics - Plastic - Rubber - Paper (burns in the form of emeralds)	By suffocation using sand or foam, carbon dioxide or dry chemical fertilizers
Flammable and combustible gases liquid B	**Class B**	Flammable liquids - Petroleum substances or hydrocarbons	Petroleum materials and their derivatives and liquids that are not easily combustible - Water - soluble liquids - Alcohol	The use of foam to prevent oxygen and prevent fumes and cooling, and can be controlled by isolating the substance burned from oxygen or the storage of flammable fumes and prevent the spread of flame
Flammable gases C	**Class C**	Flammable gases	Natural gas is burned in the air in the same way as flammable liquids in the air	Use of dry chemical powder to reduce the mixture ratio and cool the neighboring water with the possibility of using water spray intensively
Flammable and combustible gases metal D	**Class D**	Flammable metals	Sodium - Magnesium - Titanium - Potassium	Dry powders are prohibited from using water or using co2 or using sand, granite, or metal pulverization. They contain thermoplastic plastics to form an insulating shell to prevent air penetration of the flammable metal.
Electrical E	**Class E**	Electrical equipment up to 1000 volts burning type I	Transformers - Cables - high pressure and which are not separated by current	It is extinguished by the theory of suffocation

2-9-2 United States classification:

This classification was based on the existence of five groups of fire classified as follows:

Table (2-2) shows the classification of fires according to US code NFPA:

the group	class	Type of material	Example	Fire style
Group I	**Class A fire**	Carbon materials	Wood - Fabrics - Plastic - Rubber - Paper	Use water to reduce the material's gravity to below the ignition temperature
Group II	**Class B fire**	Fluids and flammable gases	Liquid petroleum products	Work to prevent or reduce oxygen and prevent vapors
Group III	**Class C fire**	ELECTRICAL EQUIPMENT	Transformers - Cables - Wire	Use of a non-conductive medium
Group IV	**Class D fire**	Flammable metal	Sodium - Magnesium - Uranium	Metal powder
Group V	**Class K**	Cookware and what it contain	Fireplaces - Furnaces – Vegetables. Oils	Chemical powder wet - dissolved chemical substances

Source: Osman al-Tayeb Hassan (2007 - 1428), the basics of the science of electricity Khartoum.

2-9-3 Third Category:

According to the European standard BS EN 3, fire extinguishers in the United Kingdom as all throughout Europe are red RAL 3000.

They then feature a band or circle of a second color covering between 5–10% of the surface area of the extinguisher indicates the contents.

Before 1997, under the old British Standard, the entire body of the fire extinguisher was color coded according to the type of extinguishing agent.

The UK recognizes six fire classes under the EN 3 regulations:

- Class A fires involve organic solids such as paper and wood.
- Class B fires involve flammable or combustible liquids, including petrol, grease, and oil.
- Class C fires involve flammable gases.
- Class D fires involve combustible metals.
- Class E fires involve electrical equipment/appliances* (discontinued – see note below)
- Class F fires involve cooking fat and oil.

Class E has been discontinued, but covered fires involving electrical appliances

The table (2-3) shows the color classification

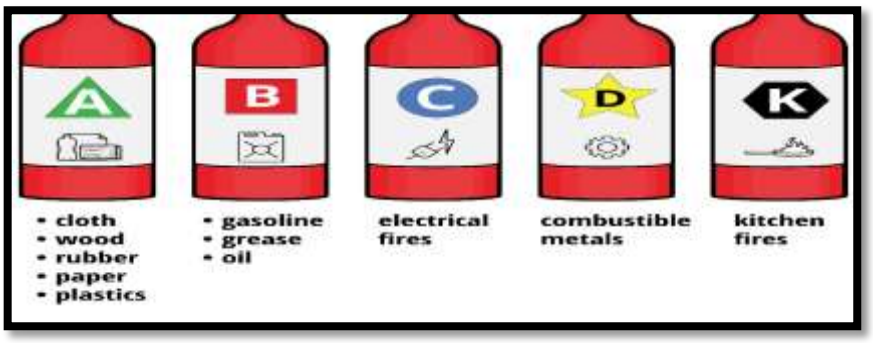
Type	Old code		BS EN 3 colour code	Fire classes (brackets denote sometimes applicable)					
				A	B	C	D	E	F
Water	Signal red		Signal red	A					
Foam	Cream		Red with a cream panel above the operating instructions	A	B				
Dry powder	French blue		Red with a blue panel above the operating instructions	(A)	B	C		E	
Carbon dioxide, CO_2	Black		Red with a black panel above the operating instructions		B			E	
Wet chemical	N/A		Red with a canary yellow panel above the operating instructions	A	(B)				F
Class D powder	French blue		Red with a blue panel above the operating instructions				D		
Halon 1211/BCF	Emerald green		No longer in general use	A	B			E	

https://www.dun-bri-group.com/help/article/fire-extinguisher-classification-codes-bs-en-3/

The figure (2-15) shows the types of extinguisher color code

The source: **https://www.dun-bri-group.com/help/article/fire-extinguisher-classification-codes-bs-en-3/**

BRITISH STANDARDCLASSES OF FIREEN3FIRE EXTINGUISHERSHEALTH & SAFETYHEALTH &



The picture (2-16) shows Fire Extinguisher Colors': we explain each fire extinguisher...

The source: https://www.google.com/search

4. Fourth category

Classification of fires based on the nature of flammable materials and fire theory and firefighter:

The table (2-4) shows Classification of fires based on the nature of flammable materials and fire theory and firefighter:

Type of fire	**Type of Flammable Materials**	**Firefighting theory and firefighter**
Solid waste fires	Fire resulting from the use of solid material that is organic in nature - carbon compounds such as paper, plastic, wood and textiles	The extinguishing of these fires depends on cooling theory
Fires of liquid materials	Fire resulting from the use of flammable or flammable liquid materials such as oil and grease oils	Using water or water containing a large percentage of water
Fires of gaseous substances	Fire resulting from the use of flammable gaseous substances such as methane, ethylene, oxygen and butane	Throttle theory: Using sand, foam, carbon dioxide, or dry chemical waste.
Fire-resistant materials	Fire resulting from the use of flammable metals	The theory of starvation: the use of foam liquid and dry chemical powders in the case of liquidity when leaking on the ground and used water sprayers to cool gas packs
Electricity fires	Following the theory of strangulation: • Disconnect the power supply before the fire operation • Use fire extinguishers that suit the quality of flammable materials • In the case of failure to break the electric shock, fire extinguishers that do not have electrical conductivity are used, as well as non-harmful effects on the equipment such as halogen fumes, dry chemical powders and carbon dioxide	

Source: Determinants of the application of fire safety and security factors in buildings and their impact on architectural design (Dr. / Nader Jawad Al-Nimra)

To determine the size of the fire, the following points are considered:

1. A huge fire requires the use of twenty or more launchers.
2. A large fire used from nine to nineteen launchers.
3. Medium Fire recalls the use of three to eight shells.

4. A small fire requires the use of a launcher or two or three or more ambulances.
5. A simple fire requires the use of one or two fire lines or the use of hand extinguishers

2-11 Fire hazards: -

1. **PERSONAL RISK (hazard to individuals)**, which poses life-threatening risks to individuals
2. **Destructive hazard**: The destructive danger is the destruction of buildings and installations as a result of fire. The severity of this destruction varies according to the contents of the building itself.
   The degree of fire impact varies due to many factors, including the type of materials in them, the degree of their incineration, the method of distribution inside the building, and their economic value. All this means that the quantity and nature of the components of the building are the ones that control the seriousness of the fire, its continuation and the destructive effect it produces.
3. **Exposure hazard**: **(hazard to neighbors**), which are the dangers that threaten the locations close to the fire and therefore called external danger

(http://www.moe.gov.bh/divisions/safety/index.htm)

2-12 Classification of US Code NEPA (National Environmental Policy Act) Risk to:

1. The degree of seriousness of the building is determined according to the materials with high and medium heat load and the British specifications are based on the classification of thermal load to
1. Low, whose buildings need to resist fire for at least one hour and constitute residential buildings and hospitals
2. Medium: The buildings need a minimum of two hours to resist the fire, such as commercial and industrial buildings
3. High: whose buildings need at least four hours in fire resistance such as warehouses and store

(Research the safety measures in the protected areas against burning - a supplementary research to obtain a master's degree, Muhammad Sulaiman Siddiq Ali, 2015 - p. 26)

Classification of establishments according to the materials included in the buildings:

- Fire-resistant facilities - Class to Ole, the time of evacuation is three minutes.
- Fire-fighting facilities with a non-resistance auction. Second class evacuation time is two and a half minutes
- Non-fireproof facilities - third class, evacuation time is two minutes.

Source: General Directorate of Civil Defense - Prevention and Safety Department

2-13 Fire prevention:

- In all types of buildings, the following steps should be taken:
- Determination of electrical loads and calculation of cable size with a safety factor of not less than 50%.
- Design circuit protection system with electric circuit breakers and lightning arresters.
- Use one option key to enter electricity, either general electricity or a generator.
- Periodic review of public gas links.
- Concentration of kitchen ventilation on hot air currents and upper suction fans.
- Providing signs and instructions for awareness raising, training (stifling fires, separation of electricity,).

2-14 Fire Behavior of Building Fires:

1. Ignition of the Neon: When the heat of any material rises, the material will absorb part of this heat inside and keep the other part accumulated near the exposed surface when the solid material heat reaches the ignition the gases will flare up immediately
2. The spread of flame: means the spread of the flame horizontally and vertically where the presence of hot air currents and oxygen pushes the flame to the vertical spread more than horizontal usually smoke spread away from the flame and sometimes smoke increases after extinguishing the flame the heat of the material can be transmitted by carrying, conduction or radiation
3. Flood of the fire: After the spread of flame exceeds the general temperature of the vacuum the degree of ignition of all internal materials Vtstl all the materials in the vacuum at one time and increase the fire and must be trapped and extinguish the fire
4. Fire explosion: The flood of fire inside the building consumes large amounts of oxygen in a short time and may take the fire in decline, the structural imbalances expected such as falling windows or collapse will enter the oxygen again but in a closer to the explosion

Section two

Fire Fighting & Fire Alarm Systems

2-15 Preface:

Spirits are the first consideration when a fire occurs in buildings and facilities, so it is necessary to inform and alert the people inside the site by providing alarms or by manual or automatic equipment and calling fire brigades and civil defense for effective control and rescue if necessary.

2-16 Fire safety

1. **Fire Detection and Alarms**
2. **Firefighting system**

2-17 Fire detection and alarm systems:

- **Fire alarm**

An integrated electronic device consisting of several devices sensitive to different fire outputs and controllers and network auxiliary extensions and others.

- **Fire alarm system**:

It is an integrated electronic device consisting of several devices sensitive to different fire0tputs and control devices and auxiliary network and others.

The figure (2-17) shows Fire Alarm System

Fire Alarm in Hospitals | Security Alarm

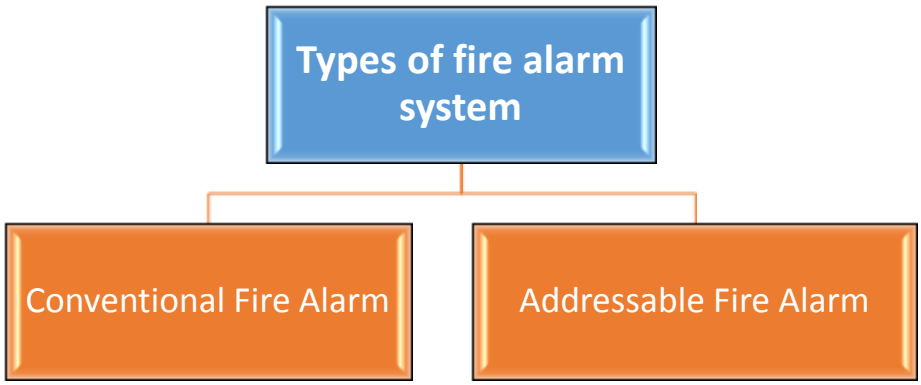
The main purpose of these systems is:

To quickly respond to the fire, and then turn this early response into an audio-visual signal to alert individuals in the building or place or the relief or fire station that there is a fire in its early stages.

- A fire alarm system has a number of devices working together to detect and warn people through visual and audio appliances when smoke, fire, carbon monoxide or other emergencies are present.
- These alarms may be activated automatically from smoke detectors, and heat detectors or may also be activated via manual fire alarm activation devices such as manual call points or pull stations.
- Alarms can be either motorized bells or wall mountable sounders or horns. . Fire alarm warning devices can also be set to different volume levels…

2-18 Types of fire alarm system:

1) Conventional Fire Alarm
2) Addressable Fire Alarm



The shape (2-1) shows the types of fire alarm system
The source researcher

Type 1: Conventional Fire Alarm (Non-Addressable) or manual alarm system

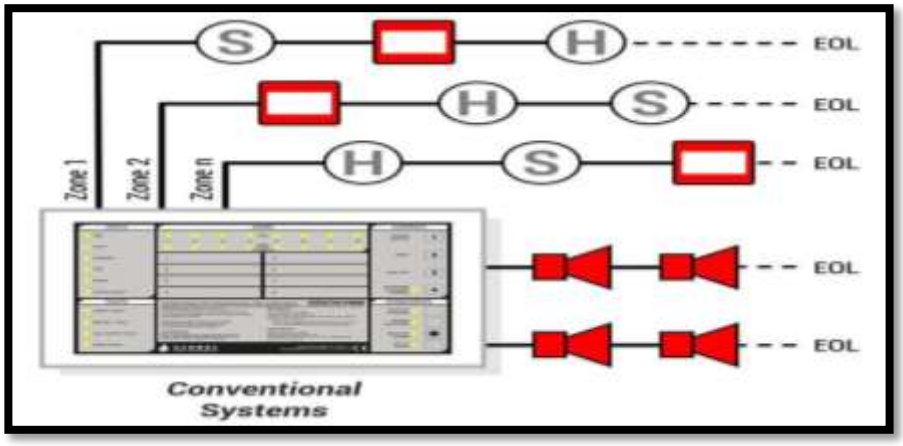
Conventional fire alarm systems all the components are wired to the same cable that connects them to a fire alarm control panel.

Systems are in which each group of devices or automatic fire detectors are connected to one electrical circuit to monitor the alarm area in the building

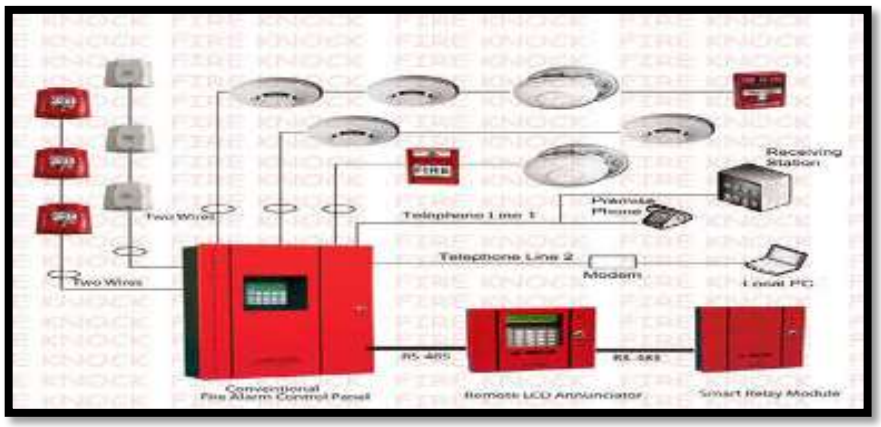
So that any detector or device in the group gives a signal to the alarm panel and control the presence of fire in the alarm area as a whole without specifying the number or address of the detector or device.

It is a device operated manually by switches (call points) distributed in certain places and works by electric current and has two types:

1. Call points are operated manually by breaking the glass cover.
2. Call points operated manually by managing a private key.



The figure (2-18) shows Conventional Fire Alarm (Non-Addressable)



The source: https://en.wikipedia.org/wiki/Fire_class

The figure (2-19) shows Conventional Fire Alarm (Non-Addressable)

https://www.securityalarm.com/blog/why-hospital-fire-alarms-are-so-important/

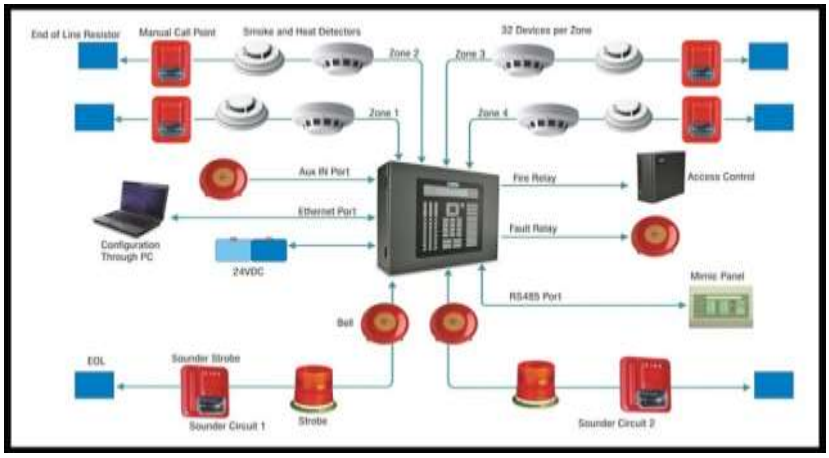
Type 2: Addressable Fire Alarm

Addressable fire alarm systems are the most modern type of system.

Addressable system depends on a group of detectors connected to each other in the region take the numbers and names of places where the detector is such that when a fire appears on the control panel shows the number of the detector and the name of the area and the hour of the fire, and therefore these systems rely on (Control Panel - Fire Detectors - Manual alarm units - Alarm bells - Alarm units)

- When one of the system's components initiates, it indicates the component's address on the fire alarm panel.

- Large facilities utilize these systems because they can quickly pinpoint where the trouble signal originated.
- This saves a lot of time because it eliminates the need to search for the component that produced the signal.



The figure (2-20) shows Addressable Fire Alarm

The source: https://en.wikipedia.org/wiki/Fire_class

Fire Alarm System Components

A. Fire Alarm Control Units (control board – alarm panel)
B. Detectors of combustion products include (Ionized Gases Detectors - Carbon Monoxide detector- Smoke Detectors - Heat Detectors - Light Detectors - Rate of Rise Detectors.)
C. Primary Power Supply
D. Initiating Devices
E. Notification Appliances (Alarm Bells)
F. Manual Call Points Manual Call Points

1. Fire Alarm Control Units

It receives signals from
Alarm-initiating devices processes the signals, and produces output signals that activate audible and visual appliances.

The figure (2-21) shows Fire alarm Control Panel

Source: https://en.wikipedia.org/wiki/Fire_class

2. **Primary Power Supply:** The primary electrical power supply usually comes from the building's main power connection to the local utility provider. In rare instances where electrical service is unavailable or unreliable

The figure (2-22) shows Primary Power Supply

Source: https://en.wikipedia.org/wiki/Power_supply

3. Initiating Devices

A fire detection system consists of manual and automatic alarm-initiating devices that are activated by the presence of fire, smoke, flame, or heat

Detectors of combustion products include (Ionized Gases Detectors - Smoke Detectors - Heat Detectors - Light Detectors - Rate of Rise Detectors.)

- Manual pull stations

The figure (2-23) shows Manual pull stations

The source: https://www.vikinggroupinc.com/manual-pull-station

The figure (2-24) shows fire detectors

The figure (2-25) shows fire smoke detectors
Source: https://en.wikipedia.org/wiki/Smoke_detector

The figure (2-26) shows fire smoke and heat detectors
Source: https://en.wikipedia.org/wiki/Smoke_detector

The table (2-5) shows Coverage of smoke and temperature detectors with European standard EN54

Surface area (square meters)	Type of detector	Height (m)	Ceiling slope ≤20°		Ceiling slope >20°	
			S max (square meters)	Rmax (m)	S max (square meters)	Rmax(m)
SA ≤80	Smoke detector	≤12	80	6,6	80	8,2
SA >80	Smoke detector	≤6	60	5,7	90	8,7
		6< h ≤ 12	80	6,6	110	9,6
SA ≤30	Temperature detector Class A1	≤7,5	30	4,4	30	5,7
	Temperature detector Class A2,B,C,D,F,G	≤ 6	30	4,4	30	5,7
SA >30	Temperature detector Class A1	≤7,5	20	3,5	40	6,5
	Temperature detector Class A2,B,C,D,E,F,G	≤6	20	3,5	40	6,5

- EN54-7: Smoke detector
- EN54-5: Temperature detector

- SA: Surface area
- Smax (square meters): Maximum surface coverage
- Rmax (m): Maximum radio

The source: https://en.wikipedia.org/wiki/Smoke_detector

4. Notification Appliances

A fire alarm notification appliance is an active fire protection component of a fire alarm system. A notification appliance may use audible, visible, or other stimuli to alert the occupants of a fire or other emergency condition requiring action.

The primary function of the notification appliance is to alert persons at risk.

Alerting methods include:

1. **Sound (audible signals)**

- ~ 3 kHz / ~3100 Hz tone (high frequency). Used in many current notification devices.[1]
- 520 Hz (low frequency). Used in newer notification devices.[1]
- 45 dB to 120 dB A weighted for human hearing (higher decibels, in the 100 to 120 dB range, were common with older electromechanical horns

2. **Light (visible signals)**

- 15 cd to 1000 cd candela output
- 1 to 2 flashes per second

This is done by means of a pulsing incandescent light, flashing strobe light, electromechanical horn, siren, electronic horn, chime, bell, speaker, or a combination of these devices. Strobes are either made of a xenon tube (most common) or recently LEDs**.**

Alarm bells and sarnies

Alarm sirens are installed outside the building at a height of about 3 meters. The sarines operate at a constant voltage of 24 volts and draws a current of about 80 mA**.**

The figure (2-27) shows fire bell
The source: https://en.wikipedia.org/wiki/Smoke_detector

2-19 Importance of firefighting systems:

A fire alarm system is intended to enable a fire to be detected at a sufficiently early stage so that people who are at risk can be made safe either by escaping from the fire, or by the fire being extinguished

The effectiveness of the fire detection and alarm System depends on the stage of the fire at which it is operated. In order for all the occupants to escape without too much difficulty, an early alarm should operate before the escape routes becomes smoke logged to such an extent as will cause occupants to have difficulty finding their way out of the building

2-20 General Fire Fighting Equipment

Firefighting systems and equipment vary depending on the age, size, use and type of building construction. A building may contain some or all of the following features:

1. Fire extinguishers
2. Fire hose reels
3. Fire hydrant systems
4. Automatic sprinkler systems.

http://www.mfs.sa.gov.au/site/community_safety/commercial/building_fire_safety/fire_fighting_systems_and_equipment_in_buildings.jsp

1. Fire hose reels

Fire hose reel systems consist of pumps, pipes, water supply and hose reels located strategically in a building, ensuring proper coverage of water to combat a fire.

The figure (2-28) shows Hose **Reel Accessories**
The source: https://en.wikipedia.org/wiki/Smoke_detector

2. Fire hydrant systems

A fire hydrant is a connection point by which firefighters can tap into a water supply.

The figure (2-29) shows a fire hydrant
Source: https://en.wikipedia.org/wiki/Smoke_detector

3. Automatic sprinkler systems.

A fire sprinkler system is an active fire protection method, consisting of a water supply system, providing adequate pressure and flowrate to a water distribution piping system, onto which fire sprinklers are connected

https://en.wikipedia.org/wiki/Fire_sprinkler_system

Types

1. Wet pipe systems
2. Dry pipe systems
3. Wet pipe antifreeze
4. Deluge systems
5. Pre-action systems
6. Foam water sprinkler systems
7. Water spray
8. Water mist systems

The figure (2-30) shows Automatic sprinkler

Source: https://en.wikipedia.org/wiki/Smoke_detector

2-21 Firefighting system equipment:

1. Manual fire extinguishing equipment
2. Automatic fire-fighting systems and equipment
3. Automatic fixed firefighting systems and equipment

2.1 Manual fire extinguishing equipment:

Mobile fire extinguishers are the primary firefighting equipment used for firefighting in the early stages. The fire extinguisher shall comply with the standard specifications and approved by the competent authorities.

NAFFCO provides fire extinguishers to meet all types of emergencies. . We offer the following types of fire extinguishers: CO_2, dry powder, water, foam, cleaning agent and wet chemicals.

- Manual water pumps.
- Sand and water containers.
- Special fire resistant blankets.

The table (2-6) shows types of fire extinguishers

Type	Code	Picture	The Use
Compressed Water Filtration:	**Water**		It can be used to extinguish fires of wood, paper, textile and plastics. This type of fire cannot be used to extinguish the fires of electrical equipment or equipment connected to live electricity or oil, grease or metal fires. The water extinguisher reduces the temperature of flammable substances.
It is a cylinder filled with water under the pressure of inert gas	**Co2**		Used to extinguish fires of oil, grease, dyes, electrical fires and flammable liquids. Carbon dioxide (CO 2) acts as a flame stopper and cooled temperature, starts at a temperature of 76 ° C (minus 76 ° F), a low impact outdoor heater, dissipates by wind, and produces a strong sound when used.
Carbon dioxide extinguisher	**foam**		The extinguisher is used to extinguish fires of oil, oil, grease and dyes ... Be careful. The extinguisher cannot be used with electrical fires connected to live electricity. Works to isolate the surface of the material from oxygen and cooling as it contains water
It is a steel cylinder containing carbon dioxide that has been compressed to the degree of liquefaction,	**Powder**		It is used to extinguish the fires of alcohol, petroleum, dyes, and inflammable materials and metals (magnesium - sodium - potassium).
Foam extinguisher (B)	**Halon**		It is not recommended to use this type because the resulting vapors are poisonous and affect their users, especially in indoor areas. Because it is on a base of chlorine, fluorine and bromine and all are poisonous gases and affect the ozone layer. Although it is well extinguished for all types of fires.
A fire bucket	**Sand container or water**		a bucket filled with water or sand which is used to prevent or extinguish fires.
Fire blanket	Blanket		The fire blanket is used in the kitchens. The blanket is pulled out of the box and completely opened, and the fire is covered to prevent oxygen. usually made of fiberglass and sometimes kevlar, and are folded into a quick-release contraption for ease of storage.

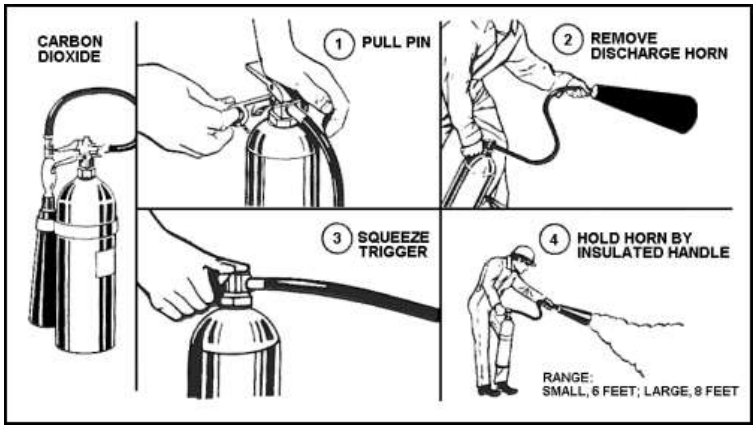
The source: the researcher

How to Use Fire Extinguishers:

The following are important considerations before you attempt to fight a fire:

- Make sure that everyone else is leaving the area, someone has sounded the alarm, and someone has called the fire department.
- Ensure that you have an unobstructed escape route at your back.
- Verify that the fire is small, confined, and not spreading.
- Make sure that you know what is burning and that you have the appropriate type of extinguisher to fight the fire.
- You are knowledgeable regarding the use of the extinguisher.
- Make sure that you keep your back to a clear exit and stand 2 to 3 meters (6 to 8 feet) away from the fire.
- Your safety is paramount; if the fire is out of control, leave the area immediately.
  Fire wardens (or health and safety officers) and hospital staff should be trained on how to use fire suppression devices.
  Regular training sessions should be undertaken as part of the medical facility's scheduled safety and evacuation Simulations.

The four steps in using a fire extinguisher can be remembered through a simple acronym: PASS



The figure (2-31) shows the methods of using a fire extinguisher

https://en.wikipedia.org/wiki/Fire_extinguisher

2-2 Fixed firefighting equipment:

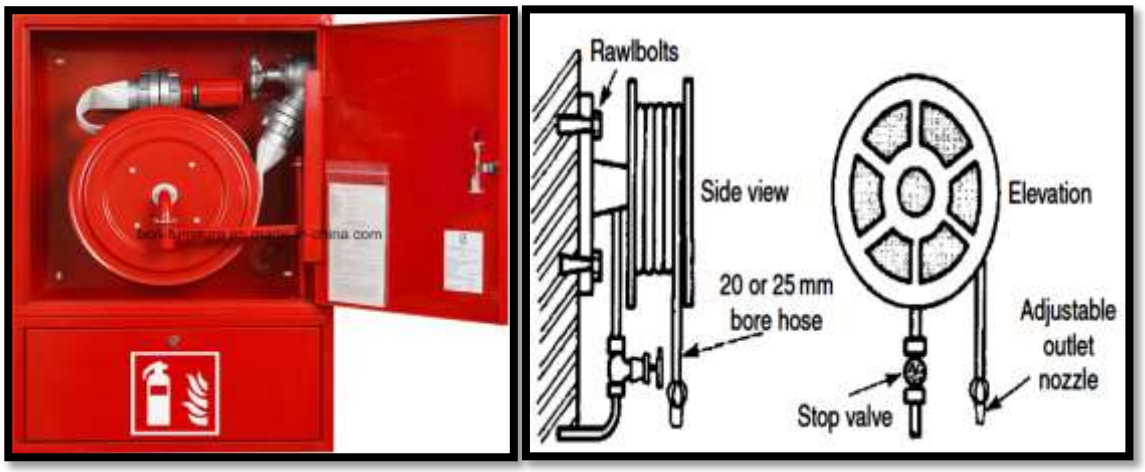
It is a network of fixed installations, including what is used to combat the fire in its early stages by ordinary people in the building, and some of which should be used by knowers such as special control teams or civil defense. In terms of its work, it is divided into the following:

Rubber hose with pulleys: hose reel

The rubber hose with pulley is a simple method of fire fighting for first aid only by the users of the building themselves, without the need for previous training. It is a rubber hose with a diameter of 25 mm (1 inch) wrapped on a pulley stored inside or inside a metal box attached to the water network directly. Ready to use once the hose is pulled out.

The rubber hose with pulley consists of:

1. Network
2. Pulley
3. Khartoum and its connections
4. Water source.



The figure (2-32) shows Rubber hoses with pulleys
The source: https://en.wikipedia.org/wiki/Dry_riser

- **Vertical dry pipe:**

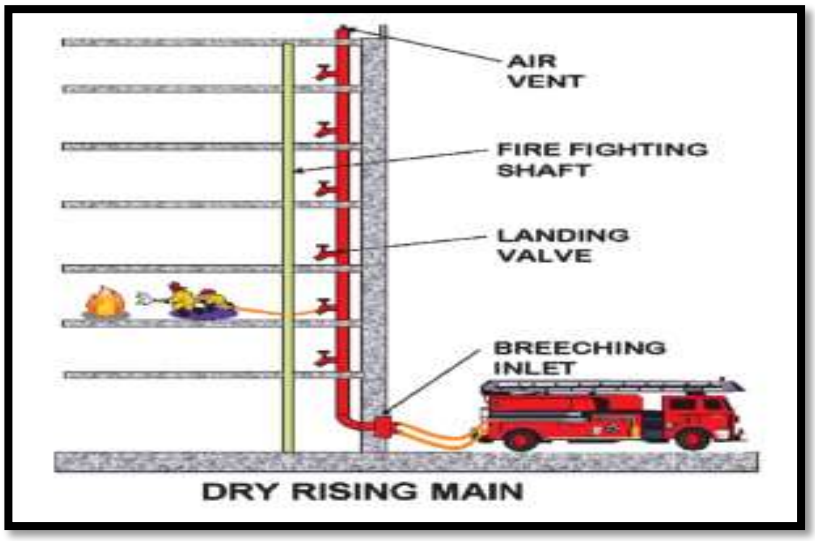
It is a fixed water-free installation network, including a push point for pumping water from outside the building, and fire extinguishing nozzles (sockets) distributed in the necessary places of the building and is used to assist civil defense officers in pushing water and use it to the upper floors.

The dry vertical pipe network in buildings consists of:

5. The vertical tube that feeds the nozzles.
6. Payment point at the bottom of the network to be pumped by the Civil Defense (INLET).
7. Fire nozzles (exits) in the floors (OUTLET).

Dry vertical pipes are required in the following buildings and conditions:

1. Buildings consisting of five floors or more, including the ground or with a height of (18 meters) and above.
2. Buildings more than two floors if the floor area exceeds 1000 m2.
3. Buildings where there is a risk to life or content at the discretion of the Civil Defense.



The figure (2-33) shows the dry vertical pipe network in buildings
The source: https://en.wikipedia.org/wiki/Dry_riser

- **Wet vertical pipe:**

It is a network of fixed installations with a continuous water source that feeds the fire extinguishing nozzles (outlets) distributed in the necessary places of the building and used by civil defense personnel or by trained people to fight the fire in the building.

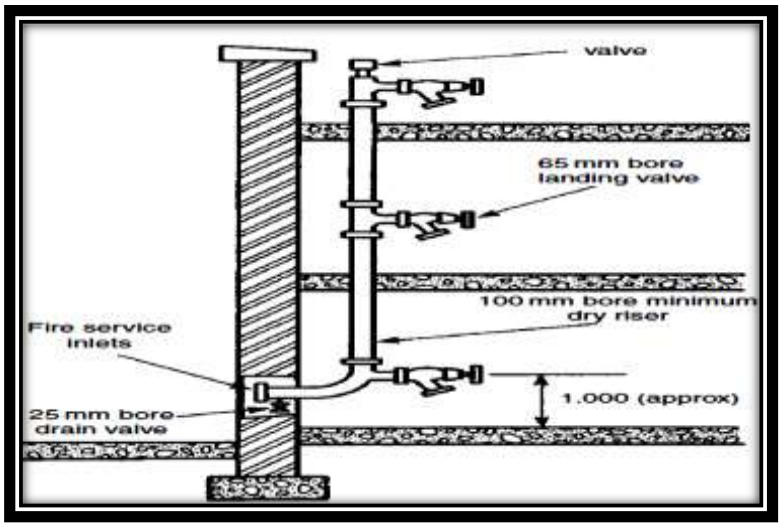
The wet vertical pipe network consists of the following sections:

1. The vertical tube that feeds the nozzles.

2. Water sources.

3. Pumps.

4. Hoses and fittings.



5. Point or nozzle payment

The figure (2-34) shows the wet vertical pipe network in buildings

The source: https://en.wikipedia.org/wiki/Dry_riser

Vertical fire extinguishers above ground:

1. A fixed vertical tube that connects from the bottom to the feeder net and ends upwards with one or more nozzles (sockets) with a cover for each nozzle tied to a chain or chain.

2. The diameter of the vertical pipe depends on the number of nozzles and their uses and the amount of water coming out of it, which is not less than 4 inches and no outlet no less than 2.5 inches.

3. Each valve nozzle shall be placed next to the inspection hole according to the specifications and conditions of the civil defense.

Fire extinguishers underground:

It is a tube that includes the valve and ends with a "socket" nozzle with a whole (socket) with a cover attached to a track, according to the Civil Defense specifications. Fire water intakes shall be kept in an inspection pit according to the specifications and conditions of the Civil Defense

Fire Hydrants Outside:

It is an underground extension network with a continuous water source that feeds the water intakes and is used to provide fire extinguishing water for the possibility of fighting fires from outside by civil defense.

External fire extinguishers shall be required in the following cases:

1. On all public streets in cities.
2. Outside buildings equipped with a vertical wet pipe network to be complementary.
3. On the streets and squares of large facilities of special risk such as airports, ports, large factories and complexes of buildings and others

2-3 Automatic fire-fighting systems and equipment

It is a network of fixed extensions with openings distributed in the places to be protected and fed from a continuous source of the appropriate extinguishing material, operating automatically by the sensing of heat from the fire or by the sensing of smoke or both means.

Automatic fire water sprinkler system:

Overhead pipeline network distributed above the places to be protected, fed water from a suitable source in terms of quantity and pressure, to push the water through the heads of sprinklers closed (wet sprinklers), open automatically by the impact of heat. Automatically opened by an auxiliary alarm

Types of Automatic Fire Water Sprinkler Systems:

1. Wet network

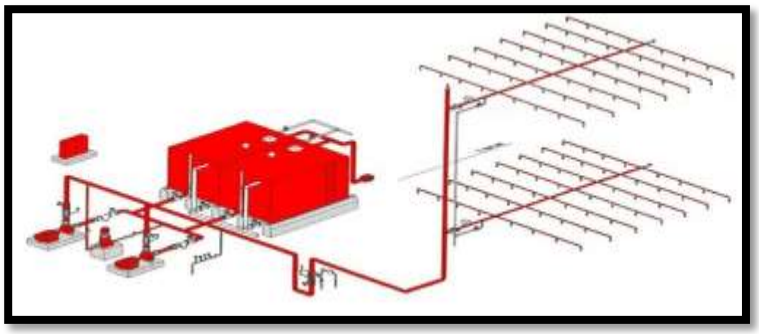
2. Dry grid.

3. The wet network with pre-operation

4. Total immersion network.

5. Composite network.

1. **Wet water fire extinguishers:**



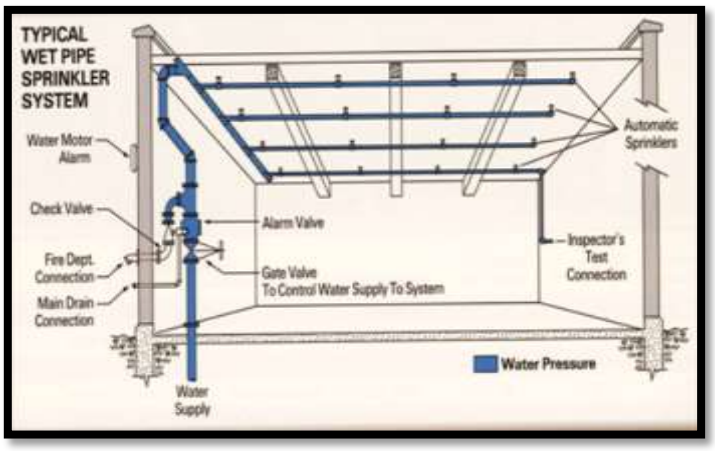
It is a pressurized water network that rushes through closed sprinkler heads that open when affected by heat.

The figure (2-35) shows the Wet pipe system

Source: https://en.wikipedia.org/wiki/Dry_riser

2. Dry-water fire extinguishers:

It is similar in the extensions to the wet network, but it is compressed by air, and



water is suspended at the main valve by air pressure.

The figure (2-36) shows the dry pipe system

Source: https://en.wikipedia.org/wiki/Dry_riser

3. Wet pre-operated network

It is a similar network in the extensions of the wet network, and the water is turned off at the valve, plus an auxiliary alarm network, either pneumatic or electric, automatically works when affected by the fire to open the valve to rush water in the network and then rush through the heads of thermal sprinklers, which in turn open after Affected by heat

4. Total immersion network.

It is a similar network in the wet-wiring network, but all sprinkler heads are open, flooding the entire site when the system is running

5. Composite network.

It is a common system of pre-operated wet grid and dry grid.

6. . Foam push mesh

It is a fixed piping network used to propel the mixture of water and foam and deliver it to inaccessible places, which are commonly used to store or use liquid fuels. The water and foam mixture flows in the form of bubbles that act as an insulating curtain for the flared surface from the outside air, and the water cooling

Wet vertical pipes are required in the following buildings and conditions:

- Buildings whose height is more than 28 meters are calculated from the ground floor to the floor of the last floor.
- Buildings with a fire hazard to life and property as estimated by the Civil Defense.
- The use of the network shall be limited to firefighting only.
- The main valve switches of the network shall be kept in locked private places and a copy of the switch shall be kept in a closed box with a glass panel installed on the building door to prevent tampering with the public or irresponsible persons.

2-22 OSHA division of warning signs:

The warning and indicative signs in OSHA specifications are divided into three types:

1. Danger Signs
2. Caution Signs.
3. Safety Instruction Signs

2-23 Evacuate users:

It is intended to remove all users outside the building or at least to the area of the staircase room as an isolated fire sector, preferably within 2 minutes and a maximum of 3 minutes. The evacuation process requires the design of emergency exits and then the design of evacuation corridors connecting to the exits.

The figure (2-37) shows emergency exit door

Source: https://en.wikipedia.org/wiki/Emergency_evacuation

2-24 Emergency Exit Design:

Exterior fire doors are designed with the following designations: locations, number and dimensions, composition, signage and lighting. This is as follows:

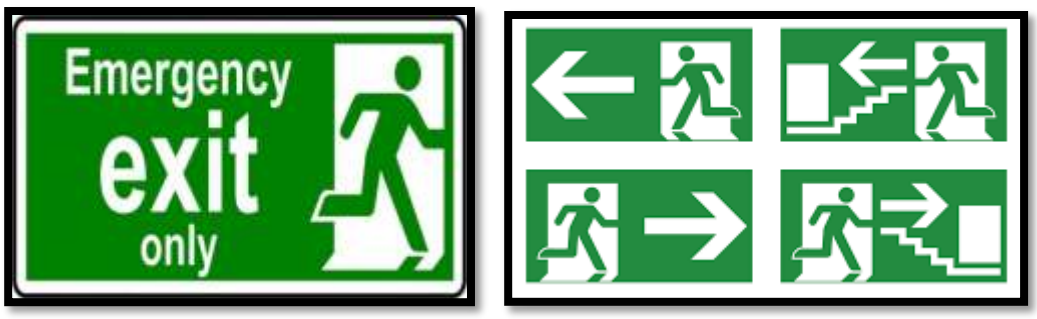
Emergency Exit Locations:

Emergency exit sites are the first thing building users will think of when they hear the sarines

Therefore, these sites must be known and clear and have already been seen repeatedly by users, even if they do not exit them under normal circumstances.

The locations of emergency exits should be separated from each other so that they can accommodate all users, whatever the building is distributed and to evacuate them away if the fire is concentrated near one of the exits.

Exit locations should not force users to run and travel long distances



The figure (2-38) shows emergency exit

Source: https://en.wikipedia.org/wiki/Emergency_evacuation

2-25 Number and dimensions of emergency exits:

In principle, any building should at least be designed with two separate exits

But the first point of determining the number of emergency exits is the distribution of their locations. In any previously identified location, an emergency exit should be constructed even if one user is saved.

The second wave, which determines the number of emergency exits, is the number

Estimate of occupant numbers

Occupancy	*Occupant Load* *Square feet per person*	*Square meters per person*
Residential	200	18.6
Educational		
classrooms	20	1.9
shops	50	4.7
Institutional		
sleeping areas	120	11.2
treatment areas	240	22.3
Assembly	15	1.4
without fixed seats	6	0.6
standing areas	3	0.3
Business	100	9.3
Mercantile		
first floor	30	2.8
other floors	60	5.6
storage and shipping	100	9.3
Industrial	100	9.3
Storage	300	27.9
Hazardous	100	9.3

of all users in the building

The figure (2-39) shows emergence exits

The source: en.wikipedia.org/wiki/

Table (2-7) shows the number of exits required for specific numbers of people

Number of people	**Number of exit**	**Minimum width**
200 person	2	90 cm
300 person	2	122 cm
500 person	2	152 cm
700 person	3	152 cm
1000 person	4	152 cm

Source: Civil Defense Act 2005

2-26 The Evacuation plan as mentioned (Salem, 1429H) as follows:

- Warning Plan: Warning is to inform residents by various means of warning about the presence or removal of any source of natural or military threats to their lives or property or to save the instructions of the security and safety departments to take the necessary measures to protect lives.
- A counseling plan is a program designed to guide and inspire people to behave in times of emergency and when accidents and disasters occur.
- Evacuation plan: Evacuation of citizens from the stricken or endangered area for evacuation, transportation and identification of shelter areas
- Shelter plan: The plans implemented by the security and safety services in cooperation with the civil protection services to provide safe housing for citizens away from risks.
- Ambulance plan: The plans implemented by the security and safety services in cooperation with the civil defense or civil protection in cases of collective ambulance

2-27 Evacuation instructions rules when hearing alarms (for everyone)

- Close electricity, gas and water sources
- Leave the room and the building quietly, and do not try to return in any way
- Do not use elevators, and use stairs in this case
- Go to emergency exits and then to the pre-determined assembly points
- Wait at the assembly point and cooperate with supervisors
- Report the presence of any individual in the building and make sure everyone is present
- Report any information, to the officials of the assembly points contribute to the rescue of others
- Avoid running and scrambling so as not to cause injury to others
- If the person is in a position not to leave the building, they must go to the office with a window and close the door

Table (2-8) illustrate the transition distance for different area types:

Type of zone	**Direction of transition**	
	One direction	Two directions or more
Open area	15 m	40m
Divided area	10m	30m
Area divided through a corridor	10m	30m
Internal fire sectors less than 50 m2	undefined	undefined
Underground fire sectors more than 150 mA less than 50 people	Not allowed	30m

Source: Civil Defense Act 2005

Emergency Exit Sign and Lighting:

All emergency exits must have a clear sign with the word "Outlet" in local and English.

Each emergency exit and sign area should be illuminated from the general source and from a standby generator running 10 seconds after the power is disconnected or lit by self-charging batteries.

2-28 Fires in Khartoum

Historical background of the Civil Defense in Khartoum:

Fire services entered Sudan in 1907 with the beginning of railway services, the first nucleus of an organized fire brigade was established in April 1952 as a small unit with a strength of 110 ranks and soldiers from Khartoum State Police.

In December 1991, the first law of the Civil Defense was issued

As an organ concerned with national disasters, headed by the Minister of the Interior and his two related ministers

In January 1992, the regular forces were merged under the banner of the police forces and the Civil Defense Department became one of the specialized police departments.

2-29 Civil Defense Authorities:

- Civil Defense Department of the Railway Authority: It is located in the city of Atbara and is under its management most of the fire stations in various Sudanese cities.
- Civil Defense Department of the Sea Ports Authority: It is based in Port Sudan and its scope of responsibility covers sea ports on the Red Sea.
- Head of Civil Defense (Khartoum)
- Department of Civil Defense project Al Jiziza (Marjan - Alhasahisa - Albaidi - 24 Qurashi - Shawwal)
- Department of Civil Defense Central State (Presidency and Civilian)
- Northern State Civil Defense (Damer)

2-30 Objectives of the Civil Defense:

1. Protecting private and public lives and property from disaster risks.
2. Minimize losses when disasters occur.

3. Provide necessary and effective support to the neighboring environment.
4. Accelerate post-disaster rehabilitation to ensure early continuation of daily life and production.
5. Strengthening the morale of citizens with a force capable of dealing with the disaster and mitigating its effects.

2-31 Civil Defense Works:

These are the means taken to minimize the effects of the disaster and can be limited to the following

1. Preventive measures.
2. Control procedures.
3. Prevention and Safety Department

2-32 Firefighting low :

Implemented by fire prevention officers within the municipalities and the Fire Fighting Department, a set of rules providing for minimum security requirements for fire prevention, explosion hazards, storage and use of hazardous materials

2-33 General rules for extinguishing fires:

1. In open spaces, the fire must fight with the direction of the wind and not reverse it.
2. Indoor fire must be combated so that the smuggler is behind those who are struggling and the fire in front of him.
3. Keep away from the fire by about 3 - 5 meters and start fighting
4. Do not fight the fire from the middle but from front to back.
5. Move the extinguisher left and right during control.
6. Fire always struggled from the bottom up.
7. Do not leave the fire place before making sure it is completely extinguished.

2-34 Civil Defense Sites:

The figure (2-40) shows the location of civil defense site

Source: Ministry of Defense Prevention and Safety Branch

2-35 Fire statistics in Khartoum:

The reasons for the fire in 2018 in months

The table (2-9) shows the reasons for the fire in 2018 in months

Statement Sector	Revealing fire	Gas	Electricity	unknown heat source	Manipulation of children	riot	Heater making machine	high pressure	Spark welding	intentionally	For cleaning purpose	Total
January	142	0	1	1	1	0	0	21	1	57	13	47
February	167	14	0	1	1	1	3	8	4	64	14	57
March	198	3	1	2	1	5	0	13	2	87	19	65
April	270	16	3	5	8	8	1	23	10	98	21	77
May	224	9	4	7	7	3	1	25	4	82	18	64
June	158	22	1	1	1	11	6	3	7	57	16	33
July	128	11	1	0	6	3	0	3	0	46	16	40
August	115	4	1	2	2	0	0	0	1	68	19	17
September	129	12	1	1	5	0	0	0	2	57	17	34
October	172	12	1	0	2	0	0	5	1	70	12	69
Nov	119	7	1	0	1	0	1	13	2	49	6	39
Dec	154	4	5	2	2	0	11	1	5	61	14	49
Total	1976	114	20	22	37	31	23	115	39	796	185	591

Source: Ministry of Defense Prevention and Safety Branch

2-36 Facilitating the work of the Civil Defense Forces:

- The height of the gates in the wide buildings shall not be less than 4.5 meters.
- Provide paved internal corridors that reach close to all parts of large buildings such as universities and hospitals with a width of not less than 4 meters and a maneuvering area with a diameter of not less than 18 meters.
- The corridors above shall not be more than the following values:

- 46 meters if the buildings are two floors and at a low risk.
- 28 meters if the buildings are four floors and floor area of about 139 meters.
- 17 meters when using dry pipes.
- 5 meters if the building is more than four floors or the buildings have a high risk.
- Installing light barriers or grooves in the windows of the upper floors and balconies.
- Put more than one entrance on the fence of buildings more than 5000 m2.
- install the fire information map at the entrance of the building

Section three

Health buildings :

2-37 Introduction :

An independent healthcare facility providing 24-hour boarding services for patients undergoing treatment for illnesses, injuries, abnormalities, abnormal mental conditions, births, newborns and dispensaries

The hospital provides basic services for emergencies and central care for patients.

The hospital has a high level of health care management in various medical and surgical fields. The hospital also includes support services such as clinical laboratory, radiology and pharmacy. The hospital must have a medically equipped ambulance.

Hospital is a place that treat and care for patients with acute or chronic diseases and can be distinguished according to the number of specialties and the size of the different branches and therapeutic equipment, and also its sensitive areas that must be handled with great care in cases of fires. Carefully and develop a plan to put out the fires very quickly

- One of the most complicated types of facilities that a firefighter will ever respond to is a health care facility. This article will give firefighters an overview of health care facilities and some of the unique challenges they pose.
- Incapable of self-preservation" means that the individual would not be able to get out of the building by himself in case of fire.
- In addition to the problems posed by inpatient areas who cannot evacuate on their own, there are surgical procedures that cannot be stopped because of a fire

2-38 Definition of Health Buildings:

The hospital is defined as a place of diagnosis and treatment of patients or wounded and sheltered during their treatment.

Hospitals:

A medical organization is an essential part of a social organization whose function is to provide complete health care to the population for treatment, prevention, education, research and study (WHO)

The hospital is the therapeutic institution responsible for providing health care to patients through medical staff and medical equipment, which is a vital part of public health services.

Hospitals contain all medical specialties and must be equipped with the following facilities: operating rooms, recovery rooms, rooms for patients, outpatient clinics for non-resident patients, laboratories and radiology departments, emergency department and all service departments

The figure (2-41) shows hospital rooms

Source: https://www.google.com/search?q=Hospital

2-39 Classification of hospitals:

3-4-1 Hospital Service Scope:

- The general hospital at the city level serves from 4-8 km around the hospital.
- The city-wide hospital serves from 20 to 30 km around the hospital.
- Specialized hospital and the scope of service is unlimited.

3-4-2 According to the type:

1. **Public hospitals** (non-specialized): This is the hospital where all clinical and medical services are available to treat and diagnose various general conditions.
2. **Private or specialized hospitals**: This is the hospital where specialized clinical services are available Mental Health Hospital, Al-Ayoun Hospital, and Hospital children.
3. **Teaching or university hospitals :**It contains the elements necessary for scientific research in addition to the necessary elements of the hospital

4. **Hospital injured patients (emergency):** It is in large cities and have a selection of surgeons road accidents

3-4-3 Classification of hospitals according to supervision and ownership:

1. **Governmental Hospital**

   It is administered and owned by the state, such as hospitals of the Ministry of Health.

2. **Private Hospital: It is divided into two sections**:

   First: the private hospital owned by a party to do well and is not behind it to achieve

   Profit such as hospitals owned by some industrial companies or a charity or Social organizations.

   Second: A private hospital owned by a facility, individual or group of individuals for profit

   As a commercial enterprise (Harastani,, 1410 p. 9)

3-4 -4 Classification of hospitals in terms of clinical capacity:

In terms of clinical capacity, hospitals were divided as follows:

- Up to 50 beds are the smallest hospital.
- 50 - 150 beds is a small hospital.
- From 150 to 600 beds is considered a medium hospital.
- from 600 to 1000 beds is a large hospital)

"Shishtawi, 1405 AH, p. 54 (57

3-4-5 Types of hospitals in terms of specialties:

1- **General hospitals**: contain all specialties and treat all diseases.

2 - **Specialized hospitals**: It specializes in the treatment of certain types of diseases such as neurological and cardiac hospitals and cancer treatment hospitals major at least 120 beds, including medicine and general surgery

3**. Central hospitals with 200 beds**, including general medicine, general surgery and additional specialties such as eyes, nose, throat and obstetrics

General Surgery, Gynecology, Obstetrics, Pediatrics, Radiology and other specialties such as Anesthesia, ENT and Eyes

4 - **Central hospitals more than 650 beds** the same specialties of the former in addition to urology and neurology and anatomy and medical analysis

3 - **Major hospitals more than 1000 beds** include centers for study and scientific research in addition to mental illness or surgery and orthodontics and dermatology and venerology.

2-40 Planning and Design Standards for Hospitals:

Planning standards for hospitals: Site planning conditions:

1. 16. It is preferable to have multiple roads connecting the hospital to avoid congestion, especially for ambulances
2. The site should be close to basic public services such as electricity, telephone and sewage lines
3. The shape of the earth is rectangular by a ratio of 2: 1 or 3: 2 with the largest side facing east-west or northeast-southwest.
4. The hospital is 40 m from the hospital road and 80 m from the public roads of the hospital.
5. If you find contour lines in the land of the project, it is better to be in line with the project and that allows the presence of more than one entrance and more than a level
6. Prefer to choose high places and cellular for the establishment of hospitals
7. The hospital should be allocated a health facility according to the approved plan.
8. Approval of the Ministry of Health on the site.
9. The selected site should be clean away from areas of fog, pollution and unpleasant odors and away from noise.
10. The site should be connected to the main road networks and public transport stations operating within the scope of the hospital.
11. Orientation of the hospital building: Both the sun and wind controls the orientation of the hospital, directing the building of the hospital towards the prevailing winds and good impact, while the building is parallel to the unwanted winds.
12. There is a relationship between the land area and the number of beds in the hospital, where is usually allocated between) 120-125)m 2 per bed, as well as 10 m 2 per bed of gardens.
13. Taking into account the possibility of future expansion.
14. The area of utility spaces shall be determined and added to about 40% for corridors, elevators, drainage wells, ventilation and wall thickness.

15. The size of the general hospital of any city is determined on the basis of a rate of 5 beds per 1000 inhabitants, an average and appropriate rate to provide a good treatment service.

16. Hospital area: The area of the hospital is estimated on an average basis of 42 m2 per bed in the outpatient clinic. This area does not include accidents and related services.

2-41 Hospital departments:

The hospital is divided into several different departments in terms of function and is linked by functional relationships, so that it can be in one building or several buildings.

1. Emergency department
2. Operations Department
3. Department of Internal Medicine
4. Department of Obstetrics and Gynecology
5. Department of Psychiatry
6. Children Section
7. Department of Surgery
8. Department of Cardiovascular Diseases
9. Department of laboratory and blood bank
10. Department of Radiology
11. Diagnostic services
12. Sterilization Section
13. Department of Neurosurgery.
14. Department of Orthopedics.
15. Department of Ophthalmology.
16. Department of ENT.
17. Neurology Department.
18. Department of Dermatology.
19. Department of Psychiatry.
20. Department of Anesthesia.

21. Department of Dentistry.

22. Nursery

23. Pharmacy

24. Personnel Affairs

25. Financial Section

26. General and Medical Maintenance Department

27. Medical Records Section

28. Infection Control Section

29. Department of Informatics

30. Department of Nutrition

31. Department of Nursing

32. Medical Administration

33. Department of intensive care

- **Emergency Department:**

Is a medical treatment facility specializing in emergency medicine, the acute care of patients who present without prior appointment; either by their own means or by that of an ambulance.

The emergency department is usually found in a hospital or other primary care center.

The figure (2-42) shows Emergency Department – Oak Valley Hospital Distric

Source https://www.google.com/search

The most important spaces of the emergency department:

1- Emergency treatment rooms:

Each room (4 * 5) m and equipped for the first treatment, with cold and hot water, laundry, oxygen, table and lighting sufficient for simple surgery.

Examination and treatment rooms:

These rooms are often between this department and the outpatient department with doors on each, so they can be used in case of disasters and the need for more rooms either in the emergency department or outpatient clinics.

3 - Rooms of doctors and nurses and places of sleep.

4 - Places of comfort of doctors and nurses and their services.

5 - Supply rooms for sterile materials and drug stores.

6 - Cleaning rooms.

7 - Lobbies and places waiting for the people.

8 - Places for vehicles, mobile beds and stretchers.

9- External parking space.

- **Diagnostic and Internal Treatment Services**:

Outpatient clinics:

The outpatient clinics are one of the main departments of the hospital, but it is preferable to isolate the outpatient movement from the inpatient movement.

The entrance to the outpatient clinic must be close to the main entrance of the hospital, and thus arrange reception services, social services, accounting and others.

The outpatient clinic is preferably on the ground floor, and if it is on more than one floor there should be good vertical communication between the floors.

Advantages of separating outpatient clinic:

1. Easy access for the patient, with the possibility of organizing the services provided to patients separately.

2 - The possibility of future expansion as it has an independent building.

3- Provide better freedom of movement for outpatients in clear axes.

Disadvantages of separating the outpatient clinic from the hospital:

1 - Difficult communication or movement of doctors between the clinic and patients in the hospital.

2 - Causes administrative difficulty in general.

3. The need to double some of the services that may be shared with other parts of the hospital.

4. Some outpatient services have to do with the central hospital because they are used by inpatients, including radiology rooms, physiotherapy rooms, laboratories, pharmacies and doctors' rooms.

- **Department of Operations and Surgery:**

He is very interested in the design of the hospital's operations department because it is an element that the rest of the departments in the hospital are working to make the work inside. The operations department requires a high degree of organization and movement control to maintain the sterilization system, so it must be designed and equipped to meet the special procedures to maintain the highest degree of sterilization within an operating theater.

Design Considerations for Operations Department:

1 - The appropriate guidance for him to be away from the service activity and not be a passage to other elements Valmstfah and the movement within the limited.

2. Entry shall be close to the entrance of the injured.

3- It should be easy to contact the sterilization center and radiology department.

4 - Guidance for the original destinations in the case of the use of natural lighting, where the theater of operations to the north.

5 -be adjacent to the elevator wing and nursing unit.

6. All surfaces and materials used in the section shall be easy to clean.

7. The floor shall be sealed and the floor shall be electrically insulated and fixed.

8. It must be conveniently located for the hospital

Public services:

These services include elements that are far from the eyes of patients and are not predominantly therapeutic, and does not depend on the assembly or distribution of

these units on relations with each other, but on the relations of each with the basic service in the hospital, nursing services and therapeutic services.

These services are described below:

1- Pharmacy:

The area of the pharmacy is determined based on the number of workers, which depends on the workload which in turn depends on the number of beds in the hospital and daily visits to outpatient clinics.

The pharmacy is often located on the ground floor.

2- Kitchen:

Its contents differ from the normal kitchens due to the different feeding policy for each patient and its size depends on the size of the hospital where allocated in the kitchen 1 m2 per bed in the hospital and the area of warehouses in the kitchen 80% of its area.

3- Laundry Section:

This section includes a place to receive, delivery, squeezing, drying, ironing and repairing thousands of laundry. The area of this section is based on 3 m2 per hospital bed.

4. Central sterilization:

The sterilization department shall be provided with sterile instruments or clothing. It shall serve all parts of the hospital without exception. The central sterilization area can be divided into:

- Washing area and initial decontamination.
- Processing and cleaning area.
- Cooling area.
- Sterile warehouse area.
- Raw material store area.
- Inspection area and the area of this section is calculated within the area allocated to the laundry department.

5- General Stores:

These stores include:

- Stores of supplies of non-sterile supplies, materials and tools.
- Hardware stores.
- Stores for incoming materials that need to be checked and audited.

The more centralized warehouses, the better inventory and distribution of goods and less costs and the area of warehouses is not less than 5% of the area of buildings where 2.5 to 3 m 2 is allocated to the hospital bed.

6- Mortuary and refrigerator:

Located in the hospital basement, preferably in a separate building within the hospital. They must have a separate entrance

7. Staff Services:

It includes essential services needed by staff such as rest lounges, changing and preserving areas, dining and parking.

8- Mechanical Units:

It includes electricity generators, water boilers and central air conditioning, in addition to repair workshops and equipment and maintenance of the building, and estimated space for mechanical units on the basis of 3 m 2 per hospital bed.

- Electricity:

Emergency generators are required in all sections when power is off automatically when power is off.

9- Medical Gas Sections:

There are many uses of medical gases in hospitals

Respirators and what is used for medical anesthesia and what is used for cooling shows danger in

This field has different forms as there are toxic gases and flammable gases and those

Gases used according to (Aqayleh and Jabarin, 1424H, pp. 145-142)

Ethyl chloride is a flammable and poisonous gas

It is used for cooling and as a local anesthetic.

B - Nitrous oxide (Nitrous oxide) it is an explosive gas if mixed with petroleum derivatives and used as a medical anesthetic and in the operation of spectroscopy devices.

Ethylene oxide is a flammable gas that can explode

In case of leakage and used in sterilization of medical supplies.

2-42 Risk sources in hospitals:

The hospital has special features that make it dangerous in several dimensions

One such notification is the nature of the users of the building

First: The nature of building users:

The safety regulations of different residential buildings are treated relatively especially because they are characterized by the presence of people around the clock and sleeping in multiple hours during sleep.

Here I am talking about the category of inpatients who often have several advantages, including:

1 - Ignorance of the building and ways of survival and emergency exits where this may cause some

With the confusion that always accompanies accidents to wrong behavior

2. Their health in general may cause smoke, albeit non-lethal

Severe harm to patients of certain categories such as patients with chest and asthma.

Unconscious or critical patients

3 - Patients with mental illness and mental and neurological diseases

Second: Hospital facilities and their expected risks

Table (2-10) showing firefighting equipment in hospitals:

Required cases	**Type**
All floors	Manual fire extinguishing equipment
	A - Hand extinguishers
	Fixed installations
	A network of rubber hoses
Above 3 floors with a height of less than 30 m or 2 floors	B_ dry nozzles network
With an area of more than 1000 m2	C_ external nozzles network
	3. Fixed automatic systems
Basement and all hospital floors and places specified	Automatic network of water sprinklers for fire fighting
According to automatic fire fighting systems.	Automatic network of sprinklers of other materials
On all floors	Fire alarm equipment
	A- Manual alarm network

Source: Hospital Safety and Fire Protection Regulations

Saudi Arabian Standards Organization

Previous studies

2-42 Introduction:

There are many studies that have concerned the fire phenomenon and its impact on the installations and the fires caused by the material and human losses.

Because of the importance of the subject in practice and to reduce the devastating effects of fire and the threat posed by the real need to develop practical in the architectural design and provide a proposed methodology for the architectural design determinants that can be applied to buildings

Therefore, this study is an important study, and we will show the most important studies related to the research: -

1) **First study:** Sudan University of Science and Technology

College of Graduate Studies - College of Architecture and Planning.

Name of research: Fire Extinguishing and Safety Requirements in Health Buildings (Case Study of Police Hospital and Medical Corps)

Prepared by: Nizar Mohammed Alfaki

Supervision: Dr Essam Abaker Ishaq January 2013

This study dealt with the requirements of fire and safety in health buildings against fire and the extent of commitment to the application of these requirements, as well as to the causes of fire and its importance and classification and methods of control and equipment used for fire alarm.

The descriptive analytical method was used by studying the National Rabat Hospital (Police Hospital) and the Medical Weapons Hospital and reached the results by statistical analysis of the data in SPSS. The study concluded with conclusions and recommendations for the purpose of evaluation and performance improvement.

- From these studies we conclude that the fire and control is one of the most important topics that should be addressed, especially in health buildings, which is one of the most important buildings where a high percentage of people are based and must adhere to the application of safety and security measures to preserve lives and property

2) **Second Study**: Naif Arab University for Security Sciences - Faculty of Graduate Studies - Department of Police Sciences

Name: Descriptive study of the reality of safety measures and procedures in the governmental hospitals in Riyadh

(Descriptive study of the reality of safety measures and procedures in government hospitals in Riyadh)

Prepared by: Abdul Hakim Hamad Al-Wahaib (4250115)

Supervision: Brigadier Dr. Mohamed Fathi Eid

Research Objectives: To know the availability of safety means aimed at reducing fire accidents in government hospitals in Riyadh city and to know the extent of applying preventive measures aimed at reducing fire accidents in government hospitals in Riyadh city.

The main objective is to know the availability and application of safety measures and preventive measures that aim to reduce fire accidents in government hospitals in Riyadh

3) **The third study:** The role of modern architecture in securing health facilities from fire hazards.

Prepared by: Marwa Mohamed Abbas Saleh

Lecturer at Modern Academy of Engineering and Technology

The aim of this research is to develop architectural design parameters to prevent fire in the facility and in case of fire control to minimize losses.

The research dealt with three main axes: the theoretical study, where the study explained the concept of fire and the causes of occurrence and different extinguishing systems and the second axis applied study of the said model and design advantages and disadvantages related to fire hazards and then reached the findings and recommendations should be taken into account when designing health buildings

4) **Fourth Study:** Gulf Cooperation Council - General Secretariat (Protection Requirements for Fire Protection in Buildings, Second Edition, 2003)

Subject: Safety Requirements and Preventive Supervision of Different Establishments

Findings reached:

- Know and identify the sources of hazard in buildings and use it to facilitate the process of fire fighting and the arrival of civil defense vehicles

- Determination of building materials and their role in fire prevention and knowledge of construction requirements
- Know the requirements that help in reducing fire accidents

2-43 Summary of previous studies:

The benefits of the previous studies the following:

- From these studies we conclude that fire and its control are the most important safety and security topics in buildings and should occupy an important part of the attention and awareness of architects, especially with regard to the safety and security of life;
- The study agrees with the previous studies in the difficulty of evacuating patients and residents because of the health status of them so it must be resistant to fire in various ways
- The study clarified the concept of fire and the causes of fire extinguishing systems and advanced technological uses in architectural design, which significantly reduce the outbreak of fires and help the possibility of extinguishing at the beginning or confined to the scope of the fire and non-spread of fire to other places of the facility and protection
- The need to adhere to the laws of safety and security in the design stages leading to the successful application of these factors.
- Studies have concluded that most buildings lack safety, firefighting, routine maintenance, lack of means of communication, and civil defense
- One of the most important obstacles to fire fighting in buildings is not to use early warning devices and because of the sensitivity of health buildings we have to offer how to find a solution to this problem.

CHAPTER III

Research Method

- Introduction
- About the study area
- Reasons for choosing the study area
- Study method
- Study population
- Data collection
- Questionnaire design
- The sincerity of the questionnaire

Research Method

3.1 Introduction:

This chapter explains the methodology of the study and the area chosen for the study in terms of location, and climate. It will also identify the steps taken by the researcher in the design of the research tool (questionnaire) and the method of sampling and collection of information and methods of statistical processing used in the analysis of statistical data.

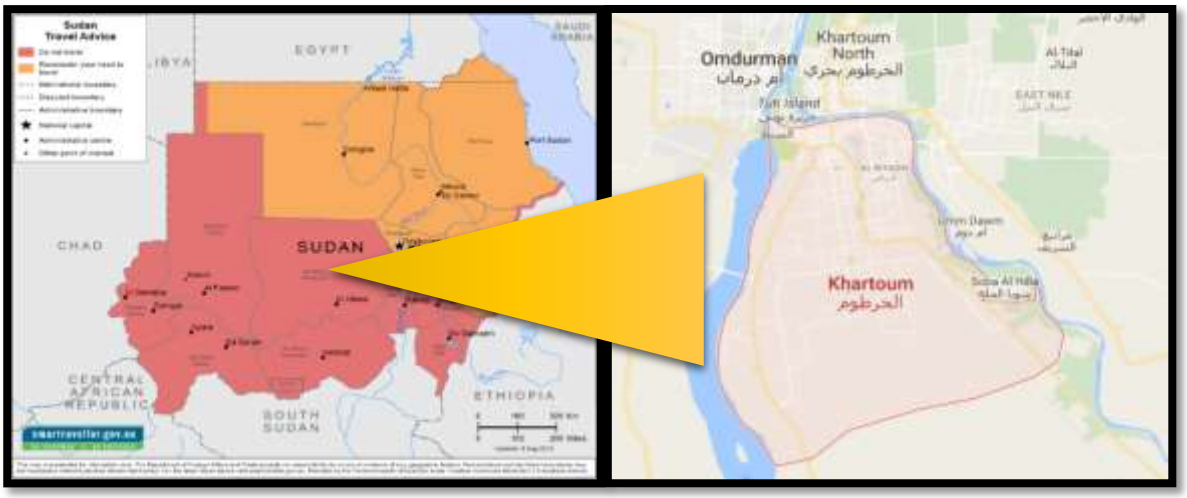
3.2 About the study area:

1- Site :

Khartoum is the capital of Sudan and the capital of the state of Khartoum, located at the confluence of the White Nile with Blue Nile (Muqrin), forming together the Nile.

Khartoum is located in the middle of the inhabited area in Sudan, northeast of the center of the country between latitude 16 degrees north and latitude 15 degrees south latitude and longitude 21 degrees west and 24 degrees east The eastern and northern sides and the eastern bank of the White Nile from the west and the plain of the island towards the south, an area that extends the city architecturally.

Khartoum mediates the states of Kassala, Gedaref, Nile, Gezira, White Nile and



North Kordofan.

The figure (3-1) shows the map of Sudsn

Source: https://www.lonelyplanet.com/maps/africa/sudan/

2- Climate

Khartoum is one of the hottest major cities in the world, where most of the year the region is characterized by an arid climate with temperatures exceeding 48 degrees Celsius in mid-summer, except for July and August, where tropical rain falls, and in winter from December to February the weather is pleasant to a certain extent, temperatures drop in the morning to noon and after sunset and the temperature during this period ranges between 32 ° C and 28 ° C and falls at large rates at night to below 15 ° C when passing Cold air wave.

(Source: https://en.wikipedia.org/wiki/Khartoum)

3- Population:

The state is home to about 8 million people representing all ethnic, political, social and cultural spectrum in Sudan and is divided into seven administrative localities. One third of the population has been displaced from Sudan's other states and the state is now densely populated with almost a quarter of the country's population.

3.3 Reasons for choosing the study area:

The Khartoum area was selected for study because it is considered the most densely populated and health services and other social services in Khartoum.

There are several health and medical institutions, including hospitals, medical clinics, private doctors' clinics and specialists in addition to the offices of health insurance institutions.

Fire statistics in Khartoum

3.4 Study Methods :

The researcher used the descriptive method in several stages began to review the information available in books, references and scientific research as well as publications and websites related to firefighting and prevention in various buildings

The researcher also made field visits that contributed to overcoming the shortcomings of the research data which were represented in the study population (Khartoum hospitals), civil defense, safety and prevention branch, Sorouh and safety companies.

3.5 Study Population:

The population of this study consists of hospitals within the city of Khartoum

Due to the limited population of the study and its concentration in a specific area, the researcher followed the comprehensive inventory method by applying his research tool to all hospitals.

3.6 Data Collection

The process of gathering information depends on two aspects.

1) The process of gathering information depends on two aspects. the first aspect is the collection and recording of information. It is related to the theoretical, field and training aspects, depending on the interview and observation.
2) The second aspect (collection of information from documentary sources) references and scientific research, scientific publications and visit, which included (the Ministry of State Health and the Department of Civil Defense and engineering consulting companies and contractors in the field of safety to collect information on laws, standards and foundations

3.7 Questionnaire Design:

The questionnaire is designed from a set of questions with a specific type of answers, in the field of fire fighting in hospitals and the availability of firefighting systems and the awareness of employees of safety procedures and shortcomings to reach solutions and recommendations.

The researcher follows these steps in designing the questionnaire:

1) Determine the general subject and the type of information that the researcher wishes to obtain.
2) Divide the general topic into sub-topics, so that the researcher can cover each branch, where it decides the type of questionnaire (open, closed, multiple).
3) Turning the problem (the subject of the study) into a number of sub-questions it contains so that it is clear understanding. The order is as follows:
4) Personal data to fill the questionnaire with no need to mention the name, in order to encourage the respondent to answer more credibly and realistic.
5) Design aspects of firefighting systems
6) Technical aspects.

3.8 The sincerity of the questionnaire

The sincerity of the study tool means making sure that it will measure what it has prepared to measure

(Al-Assaf, 1995, p. 429). (Obeidat et al., 2001, p. 179)

The researcher has verified the validity of the study tool through:

The questionnaire was presented to a number of arbitrators, namely supervisor and some specialists in the field of safety and fire and the owners of practical experience in the field of safety

In the light of the opinions of the arbitrators, the researcher omitted some of the phrases, reformulated some of them and added other phrases.

CHAPTER IV

Section One

- Data analysis and hypothesis testing
- Presentation and interpretation of search results
- Discussion

Section One

Data analysis and hypothesis testing

4-1 Questionnaire analysis:

Using statistical analysis program SPSS (Statistical package for social sciences)

It is an integrated computer package for data entry and analysis and is commonly used in all research Scientific data that includes many digital data and is not limited to social research only , Although it was originally established for this purpose, but due to the inclusion of most statistical tests (The ability to handle data and compatibility with most of the advice software has made it a tool Effective to analyze various types of scientific research to analyze the data and get us the conclusions drawn. And in

This research uses SPSS version 20 to analyze this data

4-2 Presentation and interpretation of search results :

Data analysis and hypothesis testing

In this chapter the researcher presents the practical procedures for field study, data analysis and hypothesis testing as follows:

1. First: Field study procedures
2. Second: Analysis of personal data
3. Third: Analysis of data statements of the questionnaire
4. Fourth: Testing the hypotheses of the study.

4-2-1 First: Field Study Procedures:

The field study procedures are as follows:

1- Study Tool (Preliminary Data):

To achieve the objectives of the study, the researcher designed a questionnaire that included:

A- Personal data: This is information related to the envoys and contains (6) questions (age, sex, educational level, workplace experience, occupation, type of institution).

B- Questions related to hypotheses: They are five hypotheses and contain (47) words with an average of 8 phrases for each of the first hypothesis and the second

hypothesis, 11 words for the third hypothesis and 10 phrases for each of the fourth and fifth hypotheses.

The study sample was randomly selected from the study population 20hospitals,

Where the researcher distributed a number of questionnaire (50) and the questionnaires were filled with all the required information, (100%)

2. Stability and sincerity of the study tool:

A. Stability and sincerity of the study tool:

To ensure the apparent stability of the questionnaire and the trustiness of its terms in terms of formulation, and clarity, the researcher presented the questionnaire to a number of arbitrators and academic academics and their number (3) from various functional sites and scientific degrees, Arbitrators:

Dr• Issam Abaker Isaac

T• Mukhlas Othman

T• Waleed Mansour

The questionnaire was also presented to a specialist in statistical analysis.

B. Statistical reliability:

The Cronbach's Alpha coefficient was used to measure the stability of the resolution for each hypothesis and the overall rate of hypotheses.

Table (4-1) illustrates Cronbach's Alpha coefficients for measuring the consistency of resolution statements

Hypothesis	Number of phrases	Cronbach's Alpha coefficient of stability
The first hypothesis	8	83%
The second hypothesis	8	78%
The third hypothesis	11	90%
The fourth hypothesis	10	%91
The fifth hypothesis	10	86%
All phrases	47	%86

Source: Preparation of the researcher based on field study data for 2019 using spss program

The researcher notes from Table (1) that the accuracy of the questionnaire 86% this means that the questionnaire has a very strong coefficient of stability

3- Statistical methods used:

Statistical analysis of the study sample answers was done using the following statistical methods:

1. Alpha-Cronbach coefficient to test the reliability and reliability of the questionnaire questions used in data collection
2. Frequencies and percentages to describe the study members and determine the proportions of his answers with the statements of the questionnaire
3. Arithmetic mean and pattern to arrange the answers of study members to the questionnaire statements according to the degree of approval
4. Standard deviation to indicate the efficiency of the arithmetic mean in the data center representation
5. Test the kai box to determine the statistical evidence for the resolution statements

4-2-2 Second: Preliminary data analysis

Table (4-2) shows the distribution of sample by age

Age	frequency	percentage
20-30 years	19	38%
31-40 years old	22	44%
41-50 years	4	8%
50 years and over	5	10%
Total	50	100%

Source: Preparation of the researcher based on field study data for 2019 using spss program

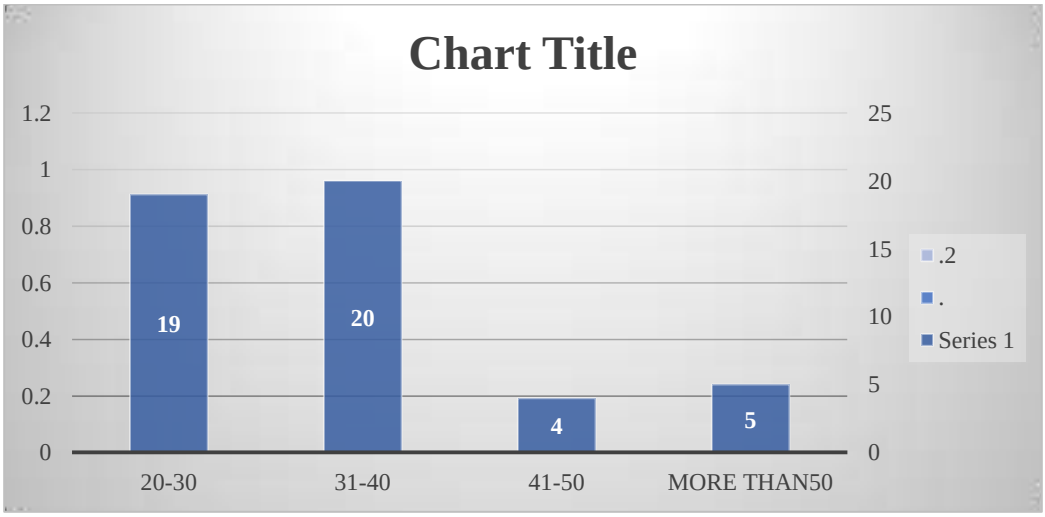


Figure (4-1) shows the distribution of the sample by age

Source: Preparation of the researcher based on field study data for 2019 using spss program **distribution of** respondents according to their age, where we find the number of (19) individuals and by 38% between the ages of 20 to 30 years and the number (22) individuals and by 44% between the ages of 31 to 40 years and the number (4) Individuals with a rate of 8% ranging in age from 41 years to 50 years and a number of (5) individuals and by 10% aged 50 years and over

Table (4-3) shows the distribution of the sample by sex or gender

Type	Duplicates	percentage
Mention	29	58%
female	21	42%
Total	50	100%

Source: Preparation of the researcher based on field study data for 2019 using spss program

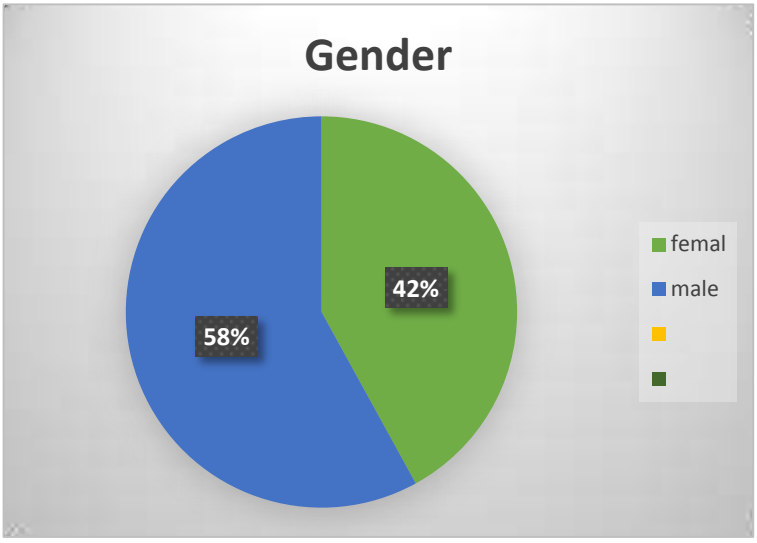


Figure (4-2) shows the distribution of the sample by sex or gender

Source: Preparation of the researcher based on field study data for 2019 using spss program

Distribution of sample members by sex or gender

Where we find that the number of (29) members of the sample and the rate of 58% are male and the number (21) of the sample and 42% are female

Table (4-4) shows the distribution of the sample according to their educational levels

Educational level	frequency	percentage
secondary	3	6%
BA (Bachelor)	31	62%
M.A. (Master)	11	22%
Postgraduate and above	5	10%
Total	50	100%

Source: Preparation of the researcher based on field study data for 2019 using spss program

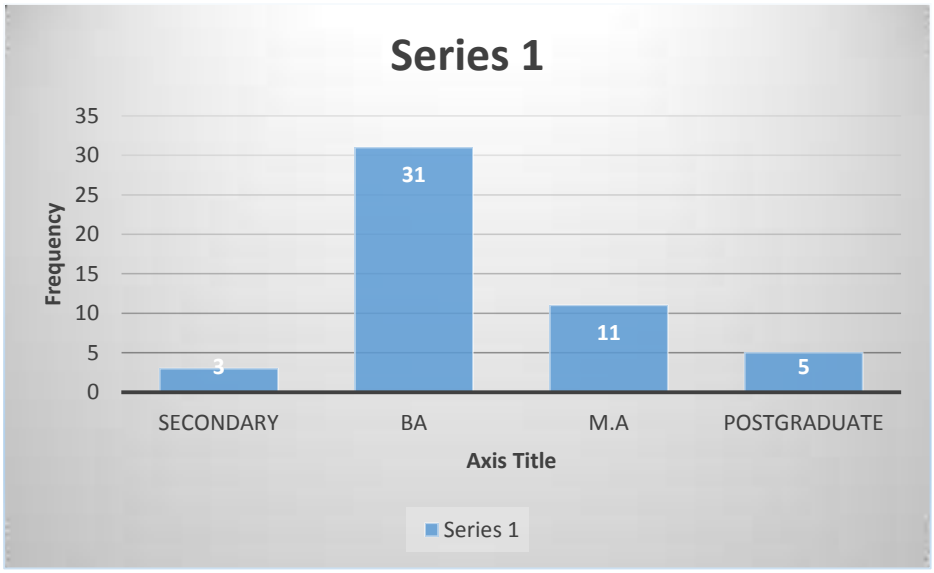


Figure (4-3) shows the distribution of the sample according to their educational levels

Source: Preparation of the researcher based on field study data for 2019 using spss program

The distribution of sample according to their educational levels:

Where we find that the number of (3) individuals by 6% of secondary school holders and the number of (31) individuals and 62% of the bachelor holders and the number of (11) and 22% of the masters and the number of (5) individuals and 10% of the graduate holders above Masters

Table (4-5) shows the distribution of respondents according to their workplace experience

Experience in work	frequency	percentage
4 years and over	31	62%
3 years	9	18%
Two years	9	18%
Set new	1	2%
Total	50	100%

Source: Preparation of the researcher based on field study data for 2019 using spss program

Figure (4-4) shows the distribution of the sample according to experience in their workplace

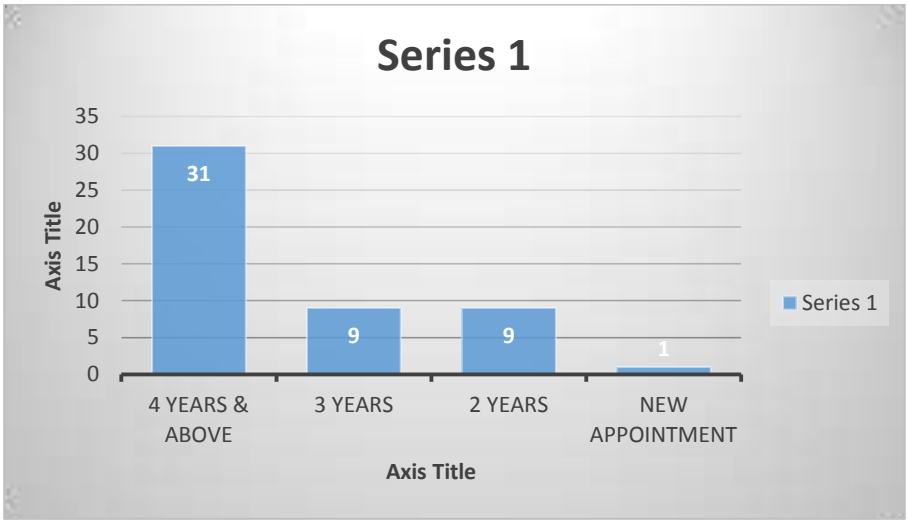


Figure (4-4) shows the distribution of the sample according to experience in their workplace

The distribution of sample members according to years of work experience
There are (31) individuals with 62% of their time in service from 4 years and more and (9) individuals and 18% of their duration in work 3 years and (9) individuals and 18% of their duration in work two years and one member of the sample and by 2% of New appointments at work.

. **Table (4-6) shows the percentage of occupation**

Occupation	frequency	percentage
medical staff	30	60%
Non-medical staff	20	40%
Total	**50**	100%

Source: Preparation of the researcher based on field study data for 2019 using spss program

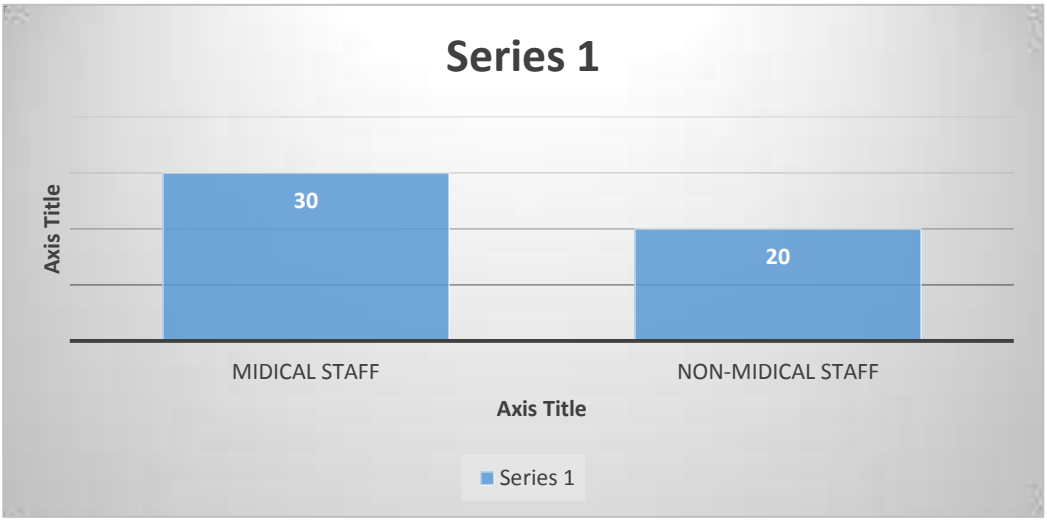


Figure (4-5) shows the percentage of occupation

Source: Preparation of the researcher based on field study data for 2019 using spss program

The distribution of the sample according to the profession at work

Where we find that 30 members of the sample (60%) work inside the hospitals and they are medical queuing and 20 members of the sample and 20% are non-medical queuing inside hospitals such as administrators, engineers, employees ... and other non-medical jobs.

Table (4-7) shows the distribution of the sample of individuals belonging to institutions

Enterprise	frequency	The ratio %
Government institutions	16	32%
Non-governmental organizations	34	68%
Total	50	100%

Source: Preparation of the researcher based on field study data for 2019 using spss program

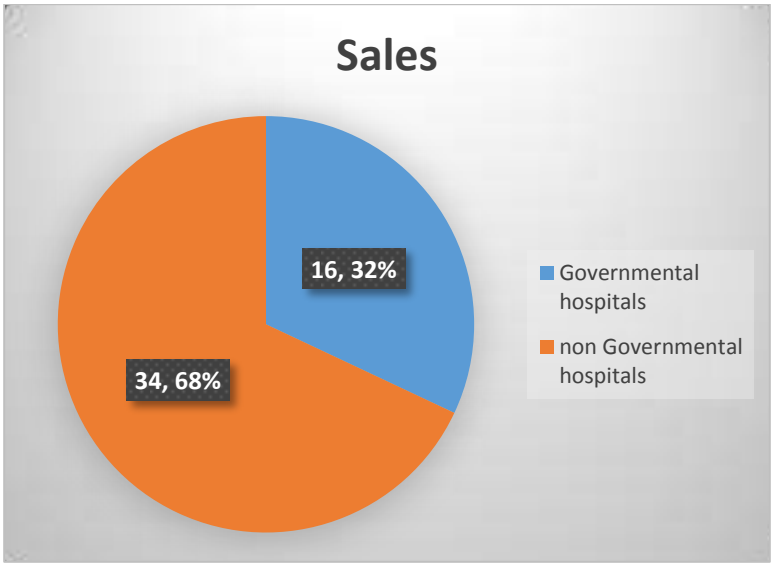


Figure (4-6) shows the distribution of the sample according to the dependency of the institutions

Source: Preparation of the researcher based on field study data for 2019 using spss program

The distribution of the sample according to the dependency of the institutions

Where we find that 16 members of the sample in the study, 32% belong to government hospitals and 34 members of the sample and 62% belong to non-governmental hospital.

4-2-3 Third: Analysis of data statements questionnaire and test hypotheses

1. The first hypothesis

Table (4-8) shows the rates and frequency of the first hypothesis, which states (what are the causes of fire accidents in hospitals in Khartoum)

Phrases		I totally agree	I agree	neutral	disagree	Strongly Disagree
Fires occur due to electrical contact and neglect in electrical connections	Duplicates	26	19	4	1	0
	The ratio	52%	38%	8%	2%	0
The occurrence of the fire as a result of the failure of employees to comply with the instructions of fire prevention	Duplicates	7	27	10	6	0
	The ratio	14%	54%	20%	12%	0
Fire occurs due to the presence of flammable materials or poor storage of materials	Duplicates	15	18	12	5	0
	The ratio	30%	36%	24%	10%	0
Not maintenance or misuse of devices	Duplicates	10	20	14	5	1
	The ratio	20%	40%	28%	10%	2%
Fire caused by smoking in stores or near gas depots	Duplicates	14	14	13	8	1
	The ratio	28%	28%	26%	16%	2%
Lack of lightning rod	Duplicates	8	15	18	7	2
	The ratio	16%	30%	36%	14%	4%
High temperatures near gases and hazardous substances	Duplicates	10	24	13	3	0
	The ratio	20%	48%	26%	6%	0
Lack of monitoring workers' behaviors	Duplicates	13	16	14	6	1
	The ratio	26%	36%	28%	12%	2%
Percentage of the average answers of the respondents		25.75%	38.75%	24.5%	9%	1.25%

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table (8) shows the percentages and frequencies of the hypothesis that

"What are the causes of fire accidents in hospitals in Khartoum city?"

Consisting of eight phrases and through the respondents 'answers to the hypothesis phrases and the percentage of the respondents' average answers for each hypothesis of the selected sample we find that:

- 75.75% of respondents strongly agree with the hypothesis
- 38.75% of respondents agreed with the hypothesis
- 24.5% of respondents were neutral on the statements

- 9% of respondents disagree with the hypothesis.
- 1.25% of respondents strongly disagree with the hypothesis
  Through the interpretation of the ratios we find that those who answered the approval in both parts (25.75% + 38.75%) = 65%

This means that there is a positive opinion about the statements of the hypothesis

Table (4-9) Descriptive statistics of the hypothesis which states (what are the causes of fire accidents in hospitals in Khartoum city)

Phrases	Arithmetic mean	mode	standard deviation
Fires occur due to electrical contact and neglect in electrical connections	1.60	1	728
The occurrence of the fire as a result of the failure of employees to comply with the instructions of fire prevention	2.30	2	.863
Fire occurs due to the presence of flammable materials or poor storage of materials	2.14	2	.969
Not maintenance or misuse of devices	2.34	2	.982
Fire caused by smoking in stores or near gas depots	2.36	1	1.120
Lack of lightning rod	2.60	3	1.050
High temperatures near gases and hazardous substances	2.18	2	.825
Lack of monitoring workers' behaviors	2.30	2	1.058

Source: Preparation of the researcher based on field study data for 2019 using spss program

What are the causes of fire accidents in hospitals in Khartoum City?

Note the whole arithmetic circles around the number (2) which is the phrase (I agree) as well as the most common value model It is the number (2) It is the phrase (I agree) and the standard deviations do not exceed the difference between them 0.2

This means that there is agreement with the hypothesis statements that are really the reasons that lead to the occurrence of fire accidents in hospitals in Khartoum city.

Table (4-10) Test box Kai for the hypothesis which states (What are the causes of fire accidents in hospitals in Khartoum)

Phrases	Calculated kai value	Degrees of freedom	Significance level ((sig
Fires occur due to electrical contact and neglect in electrical connections	34.320	3	.000
The occurrence of the fire as a result of the failure of employees to comply with the instructions of fire prevention	23.120	32	.000
Fire occurs due to the presence of flammable materials or poor storage of materials	7.440	3	.059
Not maintenance or misuse of devices	22.200	4	.000
Fire caused by smoking in stores or near gas depots	12.600	4	.000
Lack of lightning rod	16.600	24	.002
High temperatures near gases and hazardous substances	18.320	3	.000
Lack of monitoring workers' behaviors	15.800	4	.003

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table (10) to test and contribute to any hypothesis on the hypothesis that "What are the causes of fire accidents in hospitals in Khartoum city"

the researcher used the statistical method square chi square and by comparing the values of the significance level and the level of significance 0.05 we find that the values of the significance level The majority of sig values are less than 0.05 (sig <0.05).

By interpreting the proportions table, descriptive statistics table and square table, most of the statements in this hypothesis can be said to be this proves the hypothesis text.

2. The second hypothesis

Table (4-11) Ratios and Repetitions of the Second Hypothesis, which states

(The Availability of Preventive Safety Procedures in Hospitals in Khartoum City in terms of Location, Structural System and Finishing Materials)

Phrases		I totally agree	I agree	neutral	disagree	Strongly Disagree
Multiple use of the building in terms of function (such as converting it from a residential building to a hospital)	Duplicates	25	9	12	4	0
	The ratio	50%	18%	28%	8%	0
Fire resistance of building materials used in construction (walls, ceilings, floors, partitions and false ceilings)	Duplicates	6	18	16	8	2
	The ratio	12%	36%	32%	16%	4%
Easy access of civil defense vehicles to the building site	Duplicates	10	17	12	9	2
	The ratio	20%	34%	24%	18%	4%
Provide natural ventilation with openings (upper openings and windows)	Duplicates	6	24	11	7	2
	The ratio	12%	48%	22%	14%	4%
After hospital all sources of fire hazards such as fuel and chemical stores	Duplicates	9	14	20	7	0
	The ratio	18%	28%	40%	14%	0
Divide each sector into several fire breaks to prevent the spread of fire	Duplicates	7	22	18	3	0
	The ratio	14%	44%	36%	6%	0
Easy implementation of evacuations from one section to another	Duplicates	8	25	12	5	0
	The ratio	16%	50%	24%	10%	0
Availability of water sources	Duplicates	10	22	15	3	0
	The ratio	26%	44%	30%	6%	0
Percentage of the average answers of the respondents		25.75%	37.75 %	29%	11.75%	1.50%

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table (4-11) shows the percentages and frequency of the hypothesis that "the availability of preventive safety procedures in hospitals in Khartoum city in terms of location, construction system and finishing materials"

We find that:

- 20% of respondents strongly agree with the hypotheses
- 37.75% of respondents agreed with the hypothesis
- 29% were neutral about the hypothesis

- 11.75% of respondents disagree with the statements of the hypothesis
- 1.50% of respondents strongly disagree with the hypotheses

Through the interpretation of the ratios we find that those who answered the approval (20% + 37.75%) = 58%

This means that there is a positive opinion on the terms of the hypothesis versus a small percentage in the neutral and disagreement.

Table (4-12) Descriptive statistics for the second hypothesis, which provides

(The availability of preventive safety procedures in hospitals in Khartoum city in terms of location and construction system and finishing materials)

Phrases	**Arithmetic mean**	**mode**	**standard deviation**
Multiple use of the building in terms of function (such as converting it from a residential building to a hospital)	1.90	1	1.035
Fire resistance of building materials used in construction (walls, ceilings, floors, partitions and false ceilings)	2.64	2	1.025
Easy access of civil defense vehicles to the building site	2.52	2	1.129
Provide natural ventilation with openings (upper openings and windows)	2.50	2	1.015
After hospital all sources of fire hazards such as fuel and chemical stores	2.50	3	.953
Divide each sector into several fire breaks to prevent the spread of fire	2.34	2	.798
Easy implementation of evacuations from one section to another	2.28	2	.858
Availability of water sources	2.22	2	.840

Source: Preparation of the researcher based on field study data for 2019 using spss program

The descriptive statistics of the individuals of the sample of the hypothesis statements

"The availability of preventive safety procedures in hospitals in Khartoum city in terms of location, construction system and finishing materials"

Note the whole arithmetic circles around the number (2) which is the phrase (I agree) as well as the most common value is the number (2) which is the phrase (I agree) and standard deviations does not exceed the difference between 0.1

This means that there is an agreement on the hypothesis statements and most of the respondents responded by agreeing to the statements that came up with the hypothesis.

Table (4-13) Test box Kai hypothesis which states (the availability of preventive safety procedures in hospitals in Khartoum city in terms of location, construction system and finishing materials)

Phrases	Calculated kai value	Degrees of freedom	Significance level ((sig
Multiple use of the building in terms of function	19.280	3	.000
Fire resistance of building materials used in construction (walls, ceilings, floors, partitions and false ceilings)	18.400	4	.001
Easy access of civil defense vehicles to the building site	11.800	4	.019
Provide natural ventilation with openings (upper openings and windows)	28.600	4	.000
After hospital all sources of fire hazards such as fuel and chemical stores	8.080	3	.044
Divide each sector into several fire breaks to prevent the spread of fire	19.280	3	0.000
Easy implementation of evacuations from one section to another	18.640	3	.000
Availability of water sources	15.440	4	.001

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table (13) to test any phrase on the hypothesis which states the availability of preventive safety procedures in hospitals in Khartoum city in terms of location, construction system and finishing materials.

The researcher used the statistical method chi square

By comparison we find that the values of the level of significance most of the values of the levels of significance sig less than 0.05 (sig <0.05) and this means a statistical significance of the hypothesis statements

Through our interpretation of the proportions table, descriptive statistics table, and square table, most of the statements in this hypothesis prove the text of the hypothesis.

The third hypothesis

Table (4-14) Ratios and frequency of the third hypothesis, which states (what is the effectiveness of fire safety systems in hospitals)

Phrases		I totally agree	I agree	neutral	disagree	Strongly Disagree
Fire sirens and contact the fire department	Duplicates	21	21	4	3	1
	The ratio	42%	42%	8%	6%	2%
Provides a regular extinguishing system with hoses	Duplicates	13	31	1	4	1
	The ratio	26%	62%	2%	8%	2%
Provide fire extinguishers in sufficient number and well distributed	Duplicates	16	25	6	3	0
	The ratio	32%	50%	12%	6%	0
Provide automatic fire extinguishing system (water sprinklers) to fight the fire	Duplicates	14	24	5	5	2
	The ratio	28%	48%	10%	10%	4%
Provides integrated alarm network (fire detectors, smoke detectors, heat detectors, alarm bells) well distributed and clear linked to the control panel	Duplicates	15	24	5	4	2
	The ratio	30%	48%	10%	8%	4%
The presence of a special plate of the evacuation scheme distributed on the sections of the hospital	Duplicates	16	21	7	6	0
	The ratio	32%	42%	14%	12%	0
The presence of anti-sign boards indicating emergency exits	Duplicates	18	23	4	5	0
	The ratio	36%	46%	8%	10%	0
Provides backup lighting at exits, corridors and escape routes	Duplicates	18	23	6	3	0
	The ratio	36%	46%	12%	6%	0
Availability of backup generator	Duplicates	18	30	1	1	0
	The ratio	36%	60%	2%	2%	0
Lack of periodic inspection and maintenance and follow-up to the work of alarms and extinguishing	Duplicates	9	21	15	4	1
	The ratio	18%	42%	30%	8%	2%
The escape exits provide the right number, width and clear passages to escape	Duplicates	14	28	5	3	0
	The ratio	28%	56%	10%	6%	0
Percentage of the average answers of the respondents		31.27 %	49.27 %	10.78 %	7.45%	1.23%

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table shows the ratios and frequency of the hypothesis "What is the effectiveness of safety systems for firefighting in hospitals"

- 31.27% of respondents strongly agree with the statements of the hypothesis
- 49.27% of respondents agreed with the statements of the hypothesis
- 10.78% were neutral on the terms of the hypothesis
- 7.45% of respondents disagree with the hypothesis
- 1.23% of respondents strongly disagree with the hypothesis

By interpreting the ratios we find that those who answered with approval (31.27% + 49.27%) = 80%

This means that there is a positive opinion about the terms of the hypothesis against a small percentage in the neutral and non-approval.

This means that there is a positive opinion about the statements of the hypothesis versus a simple and limited percentage of the option of neutral and disagreement

Table (4-15) Descriptive statistics for the third hypothesis, which states (what is the effectiveness of fire safety systems in hospitals)

Phrases	**Arithmetic mean**	**mode**	**standard deviation**
Fire sirens and contact the fire department	1.84	1	.955
Provides a regular extinguishing system with hoses	1.98	2	.892
Provide fire extinguishers in sufficient number and well distributed	1.92	2	.829
Provide automatic fire extinguishing system (water sprinklers) to fight the fire	2.14	2	1.069
Provides integrated alarm network (fire detectors, smoke detectors, heat detectors, alarm bells) well distributed and clear linked to the control panel	2.08	2	1.047
The presence of a special plate of the evacuation scheme distributed on the sections of the hospital	2.06	2	.978
The presence of anti-sign boards indicating emergency exits	1.92	2	.922
Provides backup lighting at exits, corridors and escape routes	1.88	2	.859
Availability of backup generator	1.70	2	.614
Lack of periodic inspection and maintenance and follow-up to the work of alarms and extinguishing	2.34	2	.939
The escape exits provide the right number, width and clear passages to escape	1.94	2	.793

Source: Preparation of the researcher based on field study data for 2019 using spss program

The descriptive statistics of the sample members of the hypothesis phrases "What is the effectiveness of fire safety systems in hospitals"

Note the whole arithmetic circles around the number (2) which is the phrase (Agree) as well as the most common value (2) which is the phrase (Agree) and standard deviations does not exceed the difference between 0.1 This means there is agreement on the hypothesis statements and most of the respondents responded with approval On phrases

Table (4-16) Test box Kai hypothesis which states (What is the effectiveness of fire safety systems in hospitals)

Phrases	Calculated kai value	Degrees of freedom	Significance level ((sig
Fire sirens and contact the fire department	40.800	4	0.000
Provides a regular extinguishing system with hoses	64.800	4	0.000
Provide fire extinguishers in sufficient number and well distributed	24.080	3	0.000
Provide automatic fire extinguishing system (water sprinklers) to fight the fire	32.600	4	0.000
Provides integrated alarm network (fire detectors, smoke detectors, heat detectors, alarm bells) well distributed and clear linked to the control panel	34.600	4	0.000
The presence of a special plate of the evacuation scheme distributed on the sections of the hospital	12.560	3	0.006
The presence of anti-sign boards indicating emergency exits	21.520	3	0.000
Provides backup lighting at exits, corridors and escape routes	21.840	3	0.000
Availability of backup generator	48.080	3	0.000
Lack of periodic inspection and maintenance and follow-up to the work of alarms and extinguishing	26.400	4	0.000
The escape exits provide the right number, width and clear passages to escape	31.120	3	0.000

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table (17) to test the hypothesis, which states "What is the effectiveness of fire safety systems in hospitals"

The researcher used the statistical method square chi square and by comparing the values of the significance level and the level of significance 0.05

We find that the significance level values are the majority of the values of the significance levels (sig <0.05) and this means that there is a statistical significance for the hypothesis statements

Through our interpretation of the proportions table, the descriptive statistics table and the square table so that most of the statements in this hypothesis mean the stability of the hypothesis

3. Fourth hypothesis

Table (4-17) Ratios and frequency of the fourth hypothesis, which states

(What is the interest of the hospital and the staff to apply preventive safety procedures?)

Phrases		I totally agree	I agree	neutral	disagree	Strongly Disagree
Workers' knowledge of preventive safety procedures and how to control well and monitor electrical and technical installations in the hospital	Duplicates	13	16	11	6	4
	The ratio	26%	32%	22%	12%	8%
Act calmly and wisely in time of fire	Duplicates	10	15	19	4	2
	The ratio	20%	30%	38%	8%	4%
Speed in informing civil defense emergency	Duplicates	16	15	14	5	0
	The ratio	32%	30%	38%	10%	0
Check the workplace before departure and arrangement	Duplicates	9	19	17	5	0
	The ratio	18%	38%	34%	10%	0
Evacuation of the sick and handicapped	Duplicates	17	23	6	4	0
	The ratio	34%	46%	12%	8%	0
Know how to use the fire extinguisher and availability in wards, operating rooms and all departments of the hospital	Duplicates	18	19	9	3	1
	The ratio	36%	38%	18%	6%	2%
Emergency exits open out	Duplicates	14	18	8	10	0
	The ratio	28%	36%	16%	20%	0
Know how to operate machinery and machinery and how to stop	Duplicates	12	18	14	6	0
	The ratio	24%	36%	28%	12%	0
Lack of periodic review and follow-up by the owner of the institution	Duplicates	10	13	17	9	1
	The ratio	20%	24%	34%	18%	2%
Workers' knowledge of preventive safety procedures and how to control well and monitor electrical and technical installations in the hospital	Duplicates	10	22	14	4	0
	The ratio	20%	44%	28%	8%	0

Percentage of the average answers of the respondents	**25.58 %**	**35.4 %**	**26.8 %**	**11.2%**	**1.02 %**

Source: Preparation of the researcher based on field study data for 2019 using spss program

The percentages and iterations of the hypothesis

"The interest of the hospital and the staff in applying preventive safety measures"

- 25.58% of respondents strongly agree with the hypothesis
- 35.4% of respondents agreed with the statements of the hypothesis
- 26.8% were neutral about the hypothesis
- 11.2% of respondents disagree with the statements of the hypothesis
- 1.02% of respondents strongly disagree with the hypothesis

By interpreting the ratios, we find that those who answered both sides agreed (25.58% + 35.8%) = 60%.

This means that there is a positive opinion about the terms of the hypothesis versus a small percentage of choice and disagreement.

Table (4-18) Descriptive statistics for the fourth hypothesis, which provides (what is the extent of interest of the hospital and staff in the application of preventive safety procedures)

Phrases	**Arithmetic mean**	**mode**	**standard deviation**
Workers' knowledge of preventive safety procedures and how to control and monitor electrical and technical installations in the hospital	2.44	2	1.232
Act calmly and wisely in time of fire	2.46	3	1.034
Speed in informing civil defense emergency	2.16	1	.997
Check the workplace before departure and arrangement	2.36	2	.898
Evacuation of the sick and handicapped	1.94	2	.890
Know how to use the fire extinguisher and availability in wards, operating rooms and all departments of the hospital	2.00	2	.890
Emergency exits open out	2.28	2	1.089
Know how to operate machinery and machinery and how to stop	2.28	2	.970
Lack of periodic review and follow-up by the owner of the	2.56	3	1.072

institution			
Workers' knowledge of preventive safety procedures and how to control and conduct training courses in safety	2.24	2	.870

Source: Preparation of the researcher based on field study data for 2019 using spss program

The descriptive statistics of the individuals of the sample of the hypothesis statements

"The interest of the hospital and the staff in applying preventive safety measures"

Note the whole arithmetic circles around the number (2) which is the phrase (Agree) as well as the most common value (2) which is the phrase (Agree) and standard deviations does not exceed the difference between them 0.1 This means that there is agreement on both terms hypothesis.

Table No. (4-19) Test box Kai hypothesis, which provides

(What is the interest of the hospital and staff in the application of preventive safety measures?)

Phrases	Calculated kai value	Degrees of freedom	Significance level ((sig
Workers' knowledge of preventive safety procedures and how to control well and monitor electrical and technical installations in the hospital	9.800	3	0.044
Act calmly and wisely in time of fire	20.600	4	0.000
Speed in informing civil defense emergency	6.160	3	0.104
Check the workplace before departure and arrangement	10.480	3	0.015
Evacuation of the sick and handicapped	19.600	3	0.000
Know how to use the fire extinguisher and availability in wards, operating rooms and all departments of the hospital	27.600	4	0.000
Emergency exits open out	4.720	3	0.193
Know how to operate machinery and machinery and how to stop	6.000	3	0.112
Lack of periodic review and follow-up by the owner of the institution	14.000	4	0.007
Workers' knowledge of preventive safety procedures and how to control and conduct training courses in safety	13.680	3	0.003

Source: Preparation of the researcher based on field study data for 2019 using spss program

"The interest of the hospital and the staff in applying preventive safety measures"

The researcher used the statistical method chi square ,by comparing the values of the significance level and the significance level 0.05, we find that the values of the significance level are the majority of the values of the significance levels sig <0.05).

By interpreting the proportions table, descriptive statistics table, and square table, most terms mean that the hypothesis is constant

4. The fifth hypothesis

Table (4-20): Ratios and Repetitions of the fifth Hypothesis, which states (what are the obstacles that limit the effectiveness of fire fighting in hospitals)

Phrases		**I totally agree**	**I agree**	**neutral**	**disagree**	**Strongly Disagree**
Lack of firefighting water source	Duplicates	15	24	6	5	0
	The ratio	30%	48%	12%	10%	0
Lack of civil defense centers and distance from the hospital	Duplicates	16	22	9	3	0
	The ratio	32%	44%	18%	6%	0
Lack of communication and fire alarm	Duplicates	11	24	10	4	1
	The ratio	22%	48%	20%	8%	2%
The fire spread rapidly among the hospital sectors due to the weakness of the used building materials	Duplicates	12	19	12	6	1
	The ratio	24%	34%	24%	12%	2%
Failure to implement the Civil Defense Instructions concerning the fever and safety of establishments, in addition to the workers' lack of awareness of the seriousness of fire accidents	Duplicates	12	27	7	2	2
	The ratio	24%	54%	14%	4%	4%

Lack of companies working in the field of providing safety systems in Khartoum	Duplicates	15	17	11	7	0
	The ratio	30%	34%	22%	14%	0
The location is close to the storage areas of petroleum and chemical materials, workshops and streams	Duplicates	10	10	16	11	3
	The ratio	20%	20%	32%	22%	6%
Medical devices and devices are not valid and conform to the approved standard specifications	Duplicates	14	10	14	10	2
	The ratio	28%	20%	28%	20%	4%
If the hospital is part of another building, it must be separated	Duplicates	15	16	17	2	0
	The ratio	30%	32%	34%	4%	0
Provide the Civil Defense with the necessary plans to implement the evacuation as soon as possible	Duplicates	22	15	12	1	0
	The ratio	44%	30%	24%	2%	0
Percentage of the average answers of the respondents		28.4%	36.4 %	22.8 %	10.2 %	2.2%

Source: Preparation of the researcher based on field study data for 2019 using spss program

The percentages and frequencies of the hypothesis

"What are the obstacles that limit the effectiveness of fire fighting in hospitals?

We find that:

- 28.4% of respondents strongly agree with the statements of the hypothesis
- 36.4% of respondents agreed with the statements of the hypothesis
- 22.8% were neutral about the hypothesis
- 10.2% of respondents disagree with the hypothesis
- 2.2% of respondents strongly disagree with the hypothesis

This means that there is a positive opinion about the terms of the hypothesis compared to a small percentage in the neutral and non-approval of both parts.

This means that there is a positive opinion about the hypothesis versus a small percentage of the option of neutral and disagreement.

Table (4-21) Descriptive statistics of the fifth hypothesis, which provides (what are the obstacles that limit the effectiveness of fire fighting in hospitals)

Phrases	Arithmetic mean	mode	standard deviation
Lack of firefighting water source	2.02	2	.915
Lack of civil defense centers and distance from the hospital	1.98	2	.869
Lack of communication and fire alarm	2.20	2	.948
The fire spread rapidly among the hospital sectors due to the weakness of the used building materials	2.30	2	1.035
Failure to implement the Civil Defense Instructions concerning the fever and safety of establishments, in addition to the workers' lack of awareness of the seriousness of fire accidents	2.10	2	.953
Lack of companies working in the field of providing safety systems in Khartoum	2.20	2	1.030
The location is close to the storage areas of petroleum and chemical materials, workshops and streams	2.74	3	1.192
Medical devices and devices are not valid and conform to the approved standard specifications	2.52	1	1.216
If the hospital is part of another building, it must be separated	2.12	3	.895
Provide the Civil Defense with the necessary plans to implement the evacuation as soon as possible	1.84	1	.866

Source: Preparation of the researcher based on field study data for 2019 using spss program

The descriptive statistics of the sample members of the hypothesis phrases "What are the obstacles that limit the effectiveness of fire fighting in hospitals"

Note the whole arithmetic circles around the number (2) which is the phrase (Agree) as well as the most common value (2) which is the phrase (Agree) and

standard deviations does not exceed the difference between them 0.1 This means that there is agreement on both terms hypothesis

Table (4-22) Test box Kai hypothesis, which provides (what are the obstacles that limit the effectiveness of fire fighting in hospitals)

Phrases	Calculated kai value	Degrees of freedom	Significance level ((sig
Lack of firefighting water source	18.960	3	0.000
Lack of civil defense centers and distance from the hospital	16.400	3	0.001
Lack of communication and fire alarm	31.400	4	0.000
The fire spread rapidly among the hospital sectors due to the weakness of the used building materials	18.600	4	0.001
Failure to implement the Civil Defense Instructions concerning the fever and safety of establishments, in addition to the workers' lack of awareness of the seriousness of fire accidents	43.00	4	0.000
Lack of companies working in the field of providing safety systems in Khartoum	4.720	3	0.193
The location is close to the storage areas of petroleum and chemical materials, workshops and streams	8.600	4	0.072
Medical devices and devices are not valid and conform to the approved standard specifications	9.600	4	0.048
If the hospital is part of another building, it must be separated	11.920	3	0.008
Provide the Civil Defense with the necessary plans to implement the evacuation as soon as possible	18.320	3	0.000

Source: Preparation of the researcher based on field study data for 2019 using spss program

Table (4-22) to test any phrase on the hypothesis that "What are the obstacles that limit the effectiveness of fire fighting in hospitals"

The researcher used the statistical method square chi square and by comparing the values of the significance level and the level of significance 0.05 we find that the values of the significance level of the majority of the values of the significance of sig levels less than 0.05 (sig <0.05) This means a statistical significance of the hypothesis statements

Through our interpretation of the proportions table, descriptive statistics table, and square table so that most of the statements in this hypothesis are consistent.

"Obstacles are limiting the effectiveness of fire fighting in hospitals," proves the text of the hypothesis.

4-3 Discussion:

Discussion of the research results:

This study was conducted with the aim of studying firefighting systems in hospitals in Khartoum city during the data collection and analysis, the following results were reached:

1- **First: the results of the analysis of the first section of the questionnaire: information and description of the study sample**

We find that 44% of individuals are between the ages of 31-40 years and 38% between 20-30 years.

Also 58% of the individuals are males, that means the vast majority of individuals while females 42%

The distribution of the sample according to their educational levels shows that 62% of the bachelor degree holders and 22% of the master's degree holders.

The distribution of respondents according to years of experience in their place of work was reached to 62%.

Distribution of respondents according to their occupation in the work 60% of medical lineup and 40% of non-medical lineup.

2- **Second: the results of the analysis of the second section of the questionnaire: questions of the study**

Question 1: What are the causes of fire accidents in hospitals in Khartoum?

The reasons are:

- Fire caused by electrical contact and neglect of electrical connections
- Employees' failure to comply with fire protection instructions as a result of the lack of monitoring of the behavior of employees in the building
- The presence of inflammable materials in stores or kitchens or near warehouses
- High temperatures near gas depots as well as lack of maintenance, misuse and storage of devices

The study showed that 65.5% of respondents agreed with the reasons for the fires and 24% were neutral, while the rest rejected them.

Question 2: What is the availability of preventive safety measures in hospitals in terms of location, construction system and finishing materials?

The hypotheses were as follows:

- Multiple use of the building in terms of function any conversion from a residential building to a hospital is one of the most important causes of fires
- Fire resistance of building materials used in walls, walls and ceilings
- Easy access of civil defense vehicles to the fire site in the building
- Divide the building into several sections and breaks to prevent the spread of fire
- Easy implementation of evacuations from one section to another

Through the study, it was found that 58% of respondents agreed with the research hypothesis, 11% were neutral and 31% answered not.

Question 3: How effective are fire safety systems in hospitals?

The hypotheses were as follows:

- Fire sirens with a complete alarm network
- Provide sufficient fire extinguishers and a single dispenser
- Provide automatic extinguishing system
- Provide special plates for the evacuation scheme with back-up lighting in the exits
- The escape exits provide sufficient number and proper width

Through this study, the researcher found that 80.54% agreed with the research hypotheses, 10% were neutral and 8.6% answered disagreement.

Question 4: What is the interest of the hospital and the staff in the application of preventive safety measures?

The hypotheses were as follows:

- Workers' knowledge of safety procedures and good control
- Speed in emergency notification and inspect workplace before departure
- Evacuation of patients and injured and how to deal with extinguishers

Through this study, the researcher reached 60.98

% agreed with the research hypotheses while 26.8% were neutral while 12% answered disagreement

Question 5: What are the obstacles that limit the effectiveness of fire fighting in hospitals?

The hypotheses were as follows

- Lack of defense centers and beyond, as well as non-compliance with defense laws and regulations
- Weak building materials used and the speed of fire ignition
- Lack of companies working in the field of safety
- The location near the petroleum storage areas

Through this study, the researcher found that 64.8% of respondents agreed with the research hypotheses, 22.8% were neutral and 12.4% answered disagreement.

CHAPTER V

Conclusion and recommendations

- Conclusion
- Recommendation
- Reference
- List of appendix

Conclusion and recommendations

5-1 Conclusion

This research deals with the study of fire systems, control and prevention in hospitals in Khartoum where it was identify the different fire systems and their types and methods of use and prevention and disseminate adequate awareness of them to avoid disasters resulting from fires.

This study contained five sections in addition to annexes and references ,the first chapter looked at the introduction of the research and the problem of research and research objectives and the importance of research and methodology followed by the researcher and methods and sources of information gathering and the scope and limits of time and spatial research and research questions. Safety and preventive measures and firefighting by the Civil Defense and what proposals can be developed to take advantage of security means Safety and preventive measures in order to reduce fire accidents in hospitals.

To solve this problem, the study sought to reach its objectives through the application of firefighting systems and early fire alarms and compliance with civil defense laws to reduce these accidents.

In addition to the structure of the research and definitions of the study, the second section contains the theoretical framework and previous studies related to the subject of research and then comment on these studies.

The third section discussed the method of conducting the research and the procedures used to obtain the results. The descriptive and analytical scientific method was used. Where the collection of information appeared in many ways, including references, scientific books, observation and interview, and then the research tool, a questionnaire, which consisted of two sections the first section was the basic information to fill the questionnaire.

Chapter 4 discussed the analysis of samples by the spss program and the presentation and interpretation of research results.

The fifth section contains a summary of the research and recommendations submitted as well as a list of references, sources and abstracts and concluded with the curriculum vitae of the researcher.

The most prominent findings of the study that most of the hospitals do not have alarm systems and special firefighting and escape plans and adequate exits, as well as lack of adequate awareness among individuals of security and safety laws.

Study Recommendations:

5-2 Recommendations

The most important recommendations reached by the researcher from the study:

- Multiple uses of buildings of the most important reasons that lead to the outbreak of fires because of the different design and construction requirements
- Hospital administrations have an obligation to spread adequate awareness about the disasters caused by fires and how to combat them through the specialists of the Civil Defense Department in the work of awareness courses and publications.
- Training of firefighters and monitoring their response to firefighting
- Implement regulations regarding the processing of hypothetical plans to evacuate the building and test it periodically as it became clear from the study neglect this aspect significantly.
- Develop a plan to organize the work and apply all procedures related to safety and how to evacuate the sick and injured
- Hospital administrations should work to establish suitable escape corridors to evacuate the sick and sick on a family
- Emergency plan and escape corridors and ways to evacuate patients and injured and deal with residents
- It is difficult to evacuate patients and residents because of the health status of them, so we must resist the fire in various ways
- The use of escalators and elevators during emergencies is prohibited except by the Civil Defense and is not considered a lifeblood
- Ensure the safety of medical equipment when transporting patients and patients
- Commitment to provide safety requirements such as the automatic sprinkler system due to its importance and effectiveness in maintaining the safety of the building and those in it.
- Maintenance of safety systems by competent authorities
- Provide fire alarms in all floors and sections

- Development of alarm systems and cover all sites such as air conditioning ducts and linking the alarm system to emergency doors, ventilation and other systems to ensure maximum use.
- Installation of mechanical ventilation systems due to their role in the disposal of fumes and harmful gases in cases of fire
- Prevent the presence of warehouses inside the main building of the hospital and the initiative to remove them in order to avoid the risks that may cause in the event of a fire accident
- Do not use broken devices such as worn electrical wires or the use of inappropriate electrical connections
- Hygiene services such as storing materials and equipment well
- When dealing with floors must be put adequate warning signs
- Attention to service facilities such as laundries and kitchens due to the risks that these facilities may cause to the entire building.
- Minimizing the use of decorations and coatings and preventing them from fire
- Attention to operating rooms and intensive care in terms of equipping them with special emergency exits and preferably firefighting without the need to evacuate patients.
- Inspection, monitoring and follow-up of electrical and mechanical equipment, gas connections and misuse of buildings during operation and maintenance;
- Organize internal security so that the human movement is controlled
- Providing infrastructure to deal with medical waste and instructions for this work.
- Divide the building into segments separated by fire-proof barriers and walls
- Separation of sleeping areas and treatment from service areas and that the outpatient clinics should be separate from hypnosis departments.
- The evacuation period shall not exceed three minutes in case of emergency.
- The number of exits shall not be less than two exits on each floor
- The output should be adhered to according to human density
- The doors should be open outside and the doors shall be of insulating material and their resistance shall not be less than one hour.

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List of appendixes

Hospital Safety and Fire Protection Regulations

- The doors should be open to the outside and the doors should be of insulating material
- Resistance less than one hour.
- It is forbidden to cover emergency doors with any kind of decoration or curtains. Also, be careful not to have doors coated from the outside with reflective material such as mirrors or metal
- Polished reflector so as not to cause disturbance or error in determining the direction of the exit.
- Escape routes should lead to safe places with fresh air outside the building, taking into account the need to provide a temporary space for the gathering of evacuees to be confined and to provide them with the necessary assistance.
- the distance traveled from the place of the person to the emergency exit or the stairs are determined
- The safety team in the building will mark the windows and balconies where the Civil Defense teams will need to be stationed in front of them and on the streets that will allow the evacuation of those who are trapped and cannot be exited through another building.
- • Exit of all hypnosis rooms and sections of exits must be accessible to stretchers, wheelchairs and mobile beds
- The width of the main corridors shall not be less than 240 cm.
- The preceding clause should be applied to escape routes and exits so that patients and wheelchairs can be evacuated in emergency situations.
- Emergency corridors and stairs shall be protected from smoke and heat and shall be provided with necessary barriers.
- Non-passageways shall be provided with signs indicating this and their doors shall be opened inside. Patient rooms are prohibited in these corridors.
- The use of escalators and elevators during emergencies is prohibited except by the defense
- Civilian is not considered a life-course.

- The safety team in the building signs the windows and balconies where the civil defense teams need to be stationed against them and on the streets to allow the evacuation of those who are trapped and could not get out through another building.
- Exits of all sleeping rooms must be exits sections for the passage of stretchers, wheelchairs and mobile beds
- The width of the main corridors shall not be less than 240 cm.
- The preceding clause should be applied to escape routes and exits so that patients and wheelchairs can be evacuated in emergency situations.
- Emergency ladders and ladders shall be protected against the provision of exits, escape routes, corridors, corridors and stairways.
- Signboards and illuminated arrows continuously indicate clearly and precisely so that all tarts and visitors to the site can see them from anywhere.
- Do not occupy the corridors with any materials or furniture that impede movement or access to firefighting equipment.
- The use of locks for emergency doors is prohibited except for certain specific cases, namely, the health-care homes for the mentally disturbed, inmates or detainees in hospitals.
- Provided that the security guards are intensified around the clock in such a way as to allow the transfer of those in the building to safe places in case of emergency.
- Intensive care and operating rooms should be specifically protected so that they are designed
- It has its own emergency exits and stairs if not close to the emergency exits in the building
- Smoke and heat are provided with necessary barriers "handrails".
- Non-windowed passages shall be provided with signs indicating this and shall be doors opening inward. Patient rooms are prohibited in these corridors.
- The use of escalators and elevators during emergencies is prohibited except by the civil defense and is not considered as a life course

بسم الله الرحمن الرحيم
جامعة السودان للعلوم والتكنولوجيا
كلية الدراسات العليا – هندسة العمارة والتخطيط
برنامج ماجستير تخصص خدمات مبانى

أخـــى الكريم /.....
السلام عليكم ورحمة االله وبركاته.....

يسرنى أن أقدم هذه الاستبيانة بين يديك وهى أداة لدراسة ميدانية موضوعها (**نظم مكافحة الحرائق فى المستشفيات في مدينة الخرطوم**) ضمن مشروع بحث لاستكمال متطلبات الحصول على درجة الماجستير فى هندسة العمارة والتخطيط جامعه السودان للعلوم والتكنولوجيا تخصص خدمات مبانى .

أرجو أن تحظى هذه الإستبيانة باهتمامكم والتكرم بالإجابة على أسئلتها بكل وضوح وشفافية حتى تتحقق الفائدة العلمية من هذه الدراسة ، مؤكدا أن هذه المعلومات لن تستخدم إلا لأغراض البحث العلمى. وتقبلو فائق الإحترام والتقدير لحسن استجابتكم وتعاونتكم وتخصيصكم جزءا من وقتكم لإستيفاء بيانات الاستيفاء المرفقة ، و السلام عليكم.....

الباحثة
م/ منى الياس الامين الياس

البيانات الأولية:

فضلا أكمل البيانات الأتية وضع علامة (/) أمام الإختيار المناسب لكل عبارة من العبارات التالية:

1- العمر

30-20 ☐ 40-31 ☐

50-41 ☐ 51 سنة فأكثر ☐

2- الجنس

ذكـــر ☐ أنثـى ☐

3- المستوى التعليمى

تانوي ☐ بكلاريو ☐ ماجس ☐ دراسات عليا فااكثر ☐

5- الخبرة فى مكان العمل

4سنوات فااكثر ☐ 3 سنو ☐ سنتين ☐ تعيين جديد ☐

4- المهنة التي تشغلها

.....

6-نوع المؤسسة التي تعمل فيها .....

البيانات الأساسية: محاور الدراسة

1. ماهى أسباب وقوع حوادث الحرائق فى المستشفيات بمدينة الخرطوم؟

الاسباب	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوافق بشدة
وقوع الحرائق بسبب التماس كهربائي واهمال في التوصيلات الكهربائية					
حدوث الحريق نتيجة عدم التزام العاملين بتعليمات الوقاية من الحريق					
وقوع الحريق بسبب وجود مواد سريعة الاشتعال او التخزين السي للمواد					
عدم صيانة الاجهزة او سوء استخدامها					
حدوث حريق بسبب التدخين في المخازن او بالقرب من مستودعات الغازات					
عدم توفر مانعة صواعق					
ارتفاع في درجات الحرارة بالقرب من الغازات والمواد الخطرة					
عدم مراقبة سلوكيات العمال					

2. ما مدى توافر اجراءات السلامة الوقائية فى المستشفيات بمدينة الخرطوم من حيث الموقع والنظام الانشائى ومواد التشطيب؟

الاجراءات	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوفق بشدة
تعدد استخدام المبني من حيث الوظيفة مثل (من مبني سكني تحويلة الي مستشفي)					
مقاومة مواد البناء المستخدمة فى الانشاء(الجدران والأسقف والأرضيات والفواصل والأسقف المستعارة .) للحريق					
سهوله وصول عربات الدفاع المدنى الى موقع المبنى ودخولها .					
توفر التهوية الطبيعة بوجود الفتحات (فتحات عليا ونوافذ)					
بعد المستشفي عن مصادر الأخطار المسببة للحريق كمخازن الوقود والمواد الكيميائية					
تقسيم كل قطاع الى عدة فواصل للحريق لمنع انتشار الحريق					
سهولة تنفيذ عمليات الاخلاء من قسم الى اخر					
توفيرمصادر للمياه					

3. ماهو مدى فعالية أنظمة السلامة لمكافحة الحريق بالمستشفيات ؟

الانظمة	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوفق بشدة
اطلاق صافرات الانذار بوجود حريق والاتصال بدائرة الاطفاء					
توفر نظام اطفاء عادى مزود بخراطيم للمياه					
توفر طفايات حريق بعدد كافى وموزعه جيد					
توفر نظام إطفاء آلى تلقائى (رشاشات مياه) لمكافحة الحريق					
توفر شبكة انذار متكاملة (كواشف حريق ،كواشف دخان،كواشف حرارة ، أجراس انذار)موزعه جيدا وواضحة ترتبط بلوحة تحكم					
وجود لوحة خاصه بمخطط الاخلاء موزعه على اقسام المستشفي					
وجود لوحات ارشادية مضاءة تدل على مخارج الطوارئ					
توفر اضاءة احتياطية فى المخارج والممرات ومسالك الهروب					
توفر مولد كهربائى احتياطى					
عدم وجود فحص دورى وصيانه ومتابعه لعمل أجهزة الانذار و الاطفاء					
توفر مخارج الهروب بالعدد المناسب والعرض المناسب وممرات واضحة للهروب					

4. ماهو مدى اهتمام ادارة المستشفي والعاملين بتطبيق اجراءات السلامة الوقائية ؟

الاهتمام	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوافق بشدة
معرفة العمال بإجراءات السلامة الوقائية وكيفية المكافحة الجيدة ومراقبة التمديدات الكهربائية والفنية في النستشفي					
التصرف بهدوء وحكمة وقت الحريق					
السرعة في ابلاغ الدفاع المدنى بالطوارئ					
تفقد مكان العمل قبل المغادرة وترتيبه					
اخلاء المرضي والمعاقين					
معرفة كيفية استخدام طفاية الحريق وتوفرها في العنابر وغرف العمليات وجميع اقسام المستشفي					
مخارج الطوارئ تفتح للخارج					
معرفة طريقة تشغيل الاليات والماكينات وطريقة ايقافها					
عدم وجود مراجعة ومتابعة دورية من صاحب المؤسسة					
معرفة العمال بإجراءات السلامة الوقائية وكيفية المكافحة واجراء الدورات التدريبية لهم في مجال السلامة					

5. ماهى المعوقات التى تحد من فعالية مكافحة الحريق فى المستشفيات ؟

الاهتمام	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوافق بشدة
عدم توفر مصدر لمياه كافية لمكافحة الحريق					
قلة مراكز الدفاع المدنى وبعدها عن المستشفي					
نقص وسائل الاتصال والانذار بوجود الحريق					
انتشار الحريق بسرعة بين قطاعات المستشفي لضعف مواد البناء المستعملة					
عدم تنفيذ تعليمات الدفاع المدنى الخاصة بحماية المنشآت وسلامتها بالاضافة الي عدم وعى العمال وادراكهم لخطورة حوادث الحريق					
قلة الشركات العاملة فى مجال توفير أنظمة السلامة بمدينة الخرطوم					
قرب الموقع من اماكن تخزين المواد البترولية والكميائية والورش ومجاري السيول					
عدم صلاحية الألات والاجهزة الطبية ومطابقتها للمواصفات القياسية والمعتمدة					
اذا كان المستشفي من ضمن مبني اخر لابد من الفصل بينهم					
تزويد الدفاع المدنى بالمخططات الازمة لتنفيذ الاخلاء باسرع وقت					