

## *Chapter I*

### **Introduction**

#### **1-1 Preface:**

It influenced the evolution of architecture in the early nineteenth century AD a large extent the rapid industrial growth in the west of Aruba and eastern North America, has created the Industrial Revolution is an urgent need to design new types of buildings and invent new ways of modern construction techniques such as glass and iron.

The Industrial Revolution required the construction of facilities such as factories, railway stations, warehouses, office buildings, due to the emergence of machine production line led to the development of industry and the emergence of factories and even in the early twentieth century was dirty and dark and poorly equipped factories, many of which poses a risk to workers.

Today, however, most of the factories with good lighting and air-conditioned and their doctors for the treatment of workers and the most important risks faced by human and still pose a threat to life and property safety and the risk of fire, which represents **10%** of the total industrial risks. The firefighting and prevention of the things that interested in all developed and developing communities in order to build a sound society where security and stability.

**There is no doubt that it is impossible to prevent accidents**, but it is possible to reduce the chances of falling and reduce the size of losses, the world today faces a major challenge in the face of disasters and accidents of all kinds. Because of what we are experiencing in the hot summer of high temperatures and heavy design errors, which contributes to the increase in the proportion of the risks of fires and others, it has become these risks pose a major threat to humans and the environment around it and the consequent loss of lives and property.

The proportion of failure to fire losses in capital, plant machinery, raw materials and materials produced and workers, must take into account the provision of means of preventive safety from the fire became factories.

Because of the specificity of industrial buildings category, relevance and where earlier studies in a Sudanese community was not exposed to the subject of fire-fighting factories this study is to shed light on firefighting factories in the city of Khartoum.

Which was invited to think about how prevention and control of these risks and examine ways and means of firefighting scope Industrial which contributes to the state's economy and provide extensive opportunities for working and because of its importance, it must stand up and find out the causes of the fires in the sector and try to find solutions.

### **1-2 Research problem:**

It considers factories within the important facilities that are of interest and oversight officials in all countries of the world, given the importance of ensuring the security and safety of workers and machinery and materials (the economy), which is an essential community pillar as a sector which intertwine with him and other economic sectors, represent incidents of fire in these buildings are a major threat and a major concern workers and officials at all levels, which would be difficult to control or evacuate workers fast, study the problem lies in the following:

1. The weakness of the means of security and safety that must be provided in factories, making the firefighting and control difficult lead to threatening the lives of workers.
2. Workers face the risk of fires as a result of the weakness of the culture and awareness of combating it and ways to prevent them, and the weakness of their knowledge of the means necessary safety at the plant and methods of use and deal with them in case of emergency and fire.
3. Some factory in Khartoum state and means of firefighting and prevention are not applied according to standard specifications.

### **1-3 the study questions:**

The main question for this study is:

**Are the means of firefighting and prevention applied in the factories of Khartoum State according to standard specifications?**

To answer to this question has to be answered on the following sub-questions:

1. What are the reasons for the occurrence of fire accidents in the city of Khartoum factories?
2. What is the availability of fire-fighting measures in the city of Khartoum factories?  
(Location, construction, finishing)

3. How much the effectiveness of safety systems for fire-fighting plants Khartoum?
4. How much interest by factory management in Khartoum application of fire-fighting measures?
5. What is the awareness and knowledge of factory workers in Khartoum application of fire-fighting measures?
6. What are the obstacles that limit the effectiveness of fire-fighting in the factories?
7. What is directly responsible in the fight against fires in factories in Khartoum?

#### **1-4 Goals of the research:**

- 1-identify the main causes of fire accidents and spread.
- 2-identify preventive means to minimize and reduce them.
- 3-achieving safety factor to the building.
- 4-disclosure about the reality of the industry and the dangers that surround them.
- 5-factories provide a safe environment for employees.
- 6-creating ideas and new solutions to the problem.

#### **1-5 Significance of the research:**

- 1-sufficient previous studies in this area do not exist.
- 2-drew the attention of officials to the size of factories fire risk.
- 3-contribute to the knowledge of the shortcomings and work to achieve protection.
- 4-awareness factories and trained workers to know and control means and methods.
- 5-drew attention to the new technologies and systems.
- 6-contribute to the enrichment of the library in this field and to provide information.

#### **1-6 Research Methodology:**

Methodology adopted in this research on the scientific and analytical study and collect information through: -

Follow-based sources and scientific references the scientific method, to determine the means and procedures stipulated by the laws in the safety of the buildings.

- Follow the statistical and analytical method to check the availability of the safety in factories and their workers' culture, and knowledge of these means.

Use of engineering schemes available to the researcher to demonstrate these methods and procedures.

### **Sources of information (methods of gathering information): -**

- \* Field visits, where the researcher was based on field work visits during the study period to collect the necessary information and photography, if possible
- \* Interviews and meetings with officials and specialists is related to the subject of the study.
- \* Conferences, training courses and research papers that were held on the subject of the study.
- \* Research and published studies, journals, newspapers and electronic information network (the Internet).
- \* And reference books that dealt with the subject or part of it.
- \* Reports and Statistics from the competent authorities with jurisdiction.

### **1-7 structure of the study: -**

The study is divided into two parts:

**Part One:** It consists of introduction, three chapters and begun to identifying the problem, objectives and methodology of the study, all the way to the findings and recommendations were as follows: -

#### **Chapter I entitled: Introduction:**

And it contains the basics of search: the problem and the importance and the objectives and methodology of research and questions of the study, and sources of information and the limits of the spatial and temporal search, and study impediments and the study structure.

#### **Chapter II entitled: Literature review and previous studies:**

This chapter has included the definition of the fire and its types and stages, and my theory ignition and fire and industrial buildings and factories, previous studies.

#### **Chapter III entitled: Current situation of factories Khartoum:**

Contains fires in Khartoum (statistics and ratios losses and the buildings prone to fire) and how to combat it in industrial buildings.

#### **Chapter IV, entitled: Method and procedures:**

Factories have been addressed in the local school within the city of Khartoum and the analysis of their results, and be one of the following themes:

First: Study Approach.

Second, the study population.

Third, the study sample.

Fourth: Tools of the study.

Fifth: Believe of the questionnaire.

Sixth: The stability of the questionnaire.

Seventh: study procedures.

Eighth: statistical treatments.

**Chapter VI, entitled: Conclusions and Recommendation:**

**Part two:** It consists of Appendixes, charts, tables and all the important information

### **1-8 the limits of study: (fields of study)**

**Spatial boundaries:** The study, focusing on the study of fire-fighting systems in industrial buildings in the city limits of Khartoum.

**Spatial border:** factories located in the industrial areas in Khartoum Bahre and in Khartoum Omdurman factories in the industrial zone and Industrial Zone in soba.

**Temporal border:** the application of the field study conducted during the latter half of 2015 (first half of 1438 e).

### **1-9Terminology of study:**

**Fire:** is the flame or torch or fire what remained under control, and in the span of control, but if you lose control of them turn into a fire.

**Fire:** Burning random happenstance devoured everything from flammable materials, damage from what Oklahoman Whatever its value and resist things, and displays of human and animal life at risk.

**Firefighting:** is the act of extinguishing, it can be extinguished by water, fuel removal, or chemical flame inhibition.

**The competent authorities:** It means the researcher in the study related to the safety of citizens and their property, and are intended in the study of civil defense.

**Khartoum:** is the capital of Sudan, located at the confluence of the White Nile Blue Nile points in the yoke area to form the Nile River.

## Chapter II

### Literature review

#### 2-1 Introduction:

Fires destroy property and buildings, and threaten human and the environment in their daily life activities directly and indirectly, in all the time and everywhere, and all as a result of the behavior of uncontrolled or ignorance or neglect so it was important to study these problem in this chapter of the fires, Definition, types, components, Fire Properties, Ignition theory, causes and history of fires, Fire risk, Classification of fire, Theory of fire extinguishment and industrial buildings, Factories.

#### 2-2 what is fire?

Fire is a form of combustion, it is a physical chemical process occurs as a result of union Article by oxygen of air under the influence of a certain temperature.[الجمال، 2007].

Fire is a chemical reaction in which a combustible material of union with oxygen in the atmosphere to give out heat and flame. [Prakash, 2013].

#### 2-3 Types of fire: [Prakash, 2013]

2-3-1 Pool fire.

2-3-2 Jet fire.

2-3-3 Flash fire.

2-3-4 Spark fire.

2-3-5 Explosions.



Figure (2-1) shows fire men put out the fire  
<http://www.safety4arab.com,2016>

#### 2-4 Fire Properties:

Fire accidents and other incidents characteristics vary due to fire basic properties:

2- 4-1 **Ignition:** It may be fast (such as gas explosion) or slow in the absence of an appropriate oxygen availability.

2- 4-2 **Spread:** When can catch fire quickly extinguished if we dealt with correctly and fast in the absence and presence of flammable materials in the way of deployment.

2- 4-3 **Evolution:** After quickly spread up to the stage of development and continue to sprawl.

2- 4-4 **Extinction:** is the stage where the fire on flammable material or the expiry of oxygen spends getting smaller than its size. (see app 1).

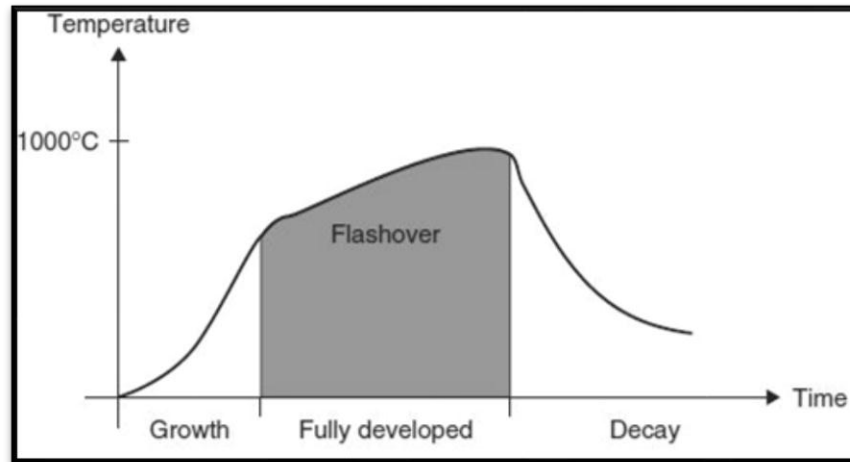


Figure (2-2) shows graph of changing in temperature for time.  
(Manual of fire safety – N sesha prakash)

2-5 **Fire stages:** most of the fires go through four stages since infancy even put out are:

2-5-1 **primary stage:** It is at this stage to generate the amount of combustion particles as a result of chemical decomposition process which is devoid of evidence to indicate the occurrence of fire.

2-5-2 **Stage smoke:** growing at this stage the amount of combustion particles can even be seen with the naked eye and called the name of the smoke.

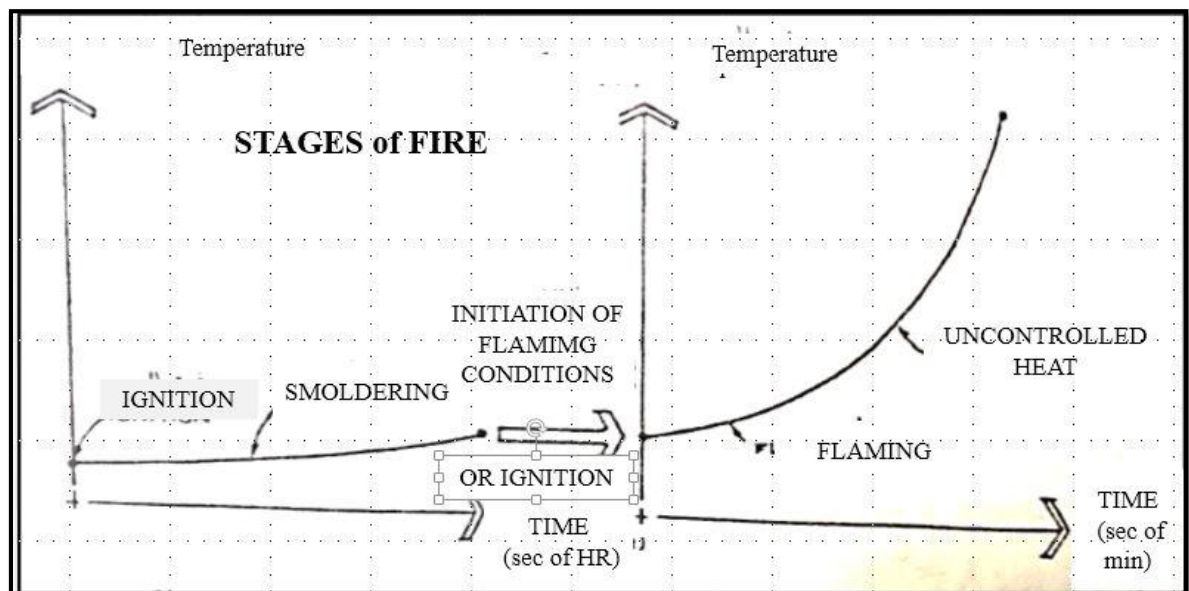


Figure (2-3) shows fire stage.  
Source: (2016، حيدر)

2-5-3 **Flame stage:** as a result of the evolution of the fire up to the ignition point and the appearance of the flame.

2-5-4 **Heat stage:** this phase consists in a large amount of heat and flame, smoke and gases. Characterized by the rapid evolution (Uncontrolled stage).

## 2-6 **Ignition theory:**

Combustion process are those chemical phenomena that occur as a result of the Union Article flaming air by oxygen factor the effect of a certain temperature for each of the substances vary this temperature for each substance called (ignition point), and is therefore clear that in order for a fire happens must have three components of fuel, heat and oxygen it is the so-called fire Triangle.

## 2-7 **the fire Triangle:** [Prakash, 2013]

Fire results from combination of fuel, heat and oxygen which in combination is called Fire Triangle, For example:  $C \text{ (solid)} + O_2 \text{ (gas)} \rightarrow CO_2 \text{ (gas)} + \text{(heat)}$ .

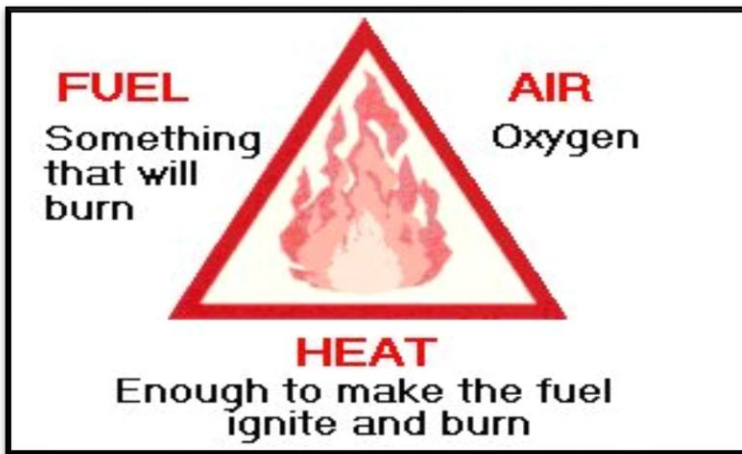
2-7-1. **Fuel:** There are several in the various forms:

- Solid form: such as (wood... etc.).
- Liquid and semi- liquid form as (oils, gasoline... etc.).
- Gas form: such as methane gas, Bhutan gas..., etc.

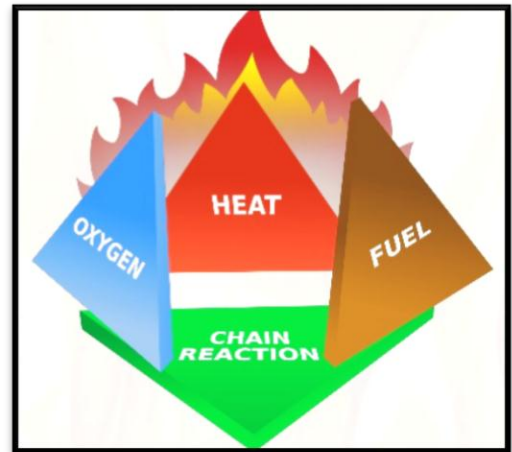
2-7-2. **Heat:** Which reach the temperature to the degree necessary for ignition and the source of sparks, flames, friction, sunlight, chemical reactions ... etc.

2-7-3. **Oxygen:** is available in the air by the air at (19-21%). However, recent studies have shown that there are four overlapping factors for the occurrence of the fire , not three , and these factors are ( fuel - heat - oxygen - Interaction serial) and can be represented in a quadrant called **Tetrahedron** is a regular polyhedron with four faces.





The Figure (2-4) show the Fire Triangle  
<http://www.safety4arab.com>, 2016.



The Figure (2-5) shows fire tetrahedron  
<http://www.safety4arab.com>, 2016.

## 2-8 Causes of fire:

### 2-8-1 Behavior of the building users:

- Faults or misuse of electrical equipment.
- Smoking, matches, cigarettes, etc.
- Spontaneous chemical ignition.
- Arson and deliberate ignition.

### 2-8-2 Self-ignition:

- Burning and faulty generating equipment.
- Uncontrolled rubbish burning.
- Faulty oil, gas and electrical heating, boiler and drying equipment.
- Hot products or waste products.
- Friction generation, bearing, conveyors, drive belts.
- Static electricity

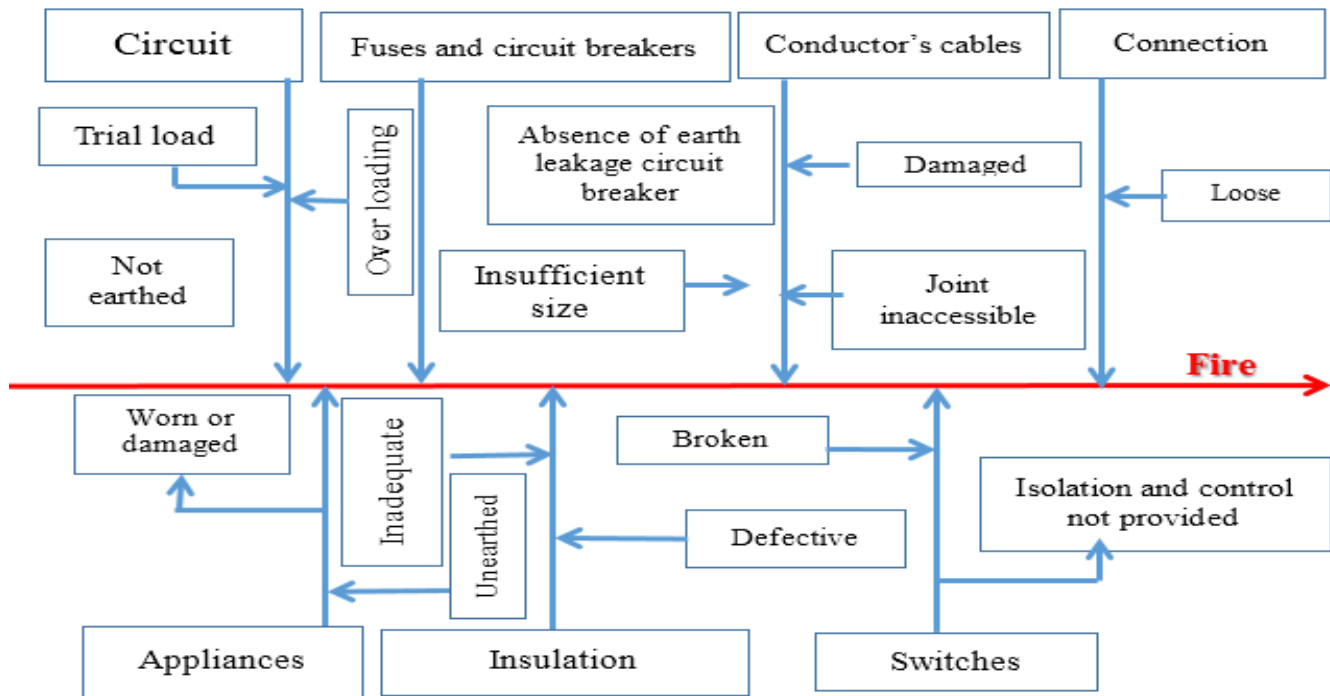
### 2-8-3 Wars and natural disasters:

- Lightning
- Earthquakes



The Figure (2-6) shows fire in factory  
<http://www.safety4arab.com>, 2016.

## 2-8-4 Design mistakes:



The chart (2-1) shows Causes of electrical fires.  
<http://www.safetv4arab.com>. 2016.

## 2-9 Fire history:

fires were Still one of the worst risk threats to human life and everywhere land, sea and air, in homes, factories, forests and others, have started human in thinking from the first moment to combating it and try to eliminate them and risk reduction, and the evolution of the setup in the establishment of early prevention systems , Though the Industrial Revolution had created a revolution of the factories and the use of iron, the massive fire of London in 1666, has been the imposition of laws and equipment for fighting fires revolution after the fire claimed thousands of homes and lives, and there was a need to organize prevention work in the facilities and examined, and took the scientific dimension in the latter half of the eighteenth century, and took this means and laws evolve to suit the evolution of life and the requirements of the Urban age tremendous, where he began the great progress with the development of materials technology in the nineteenth century and the emergence of concrete terms of resistance to fires, and featured the British construction specifications of the end of that century (London building act'1894 which confirmed the presence of the distances between buildings to allow for vehicles amortization Login it,

and go to work in several European and American countries to gain access to structural fire-resistant, and in the twenties of the twentieth century were the modern specifications to test the ability of concrete materials for fire resistance and how to design, which often evolved into the present day to get to the safe protection of life and property

[حسنی -أبوالمجد،1994].

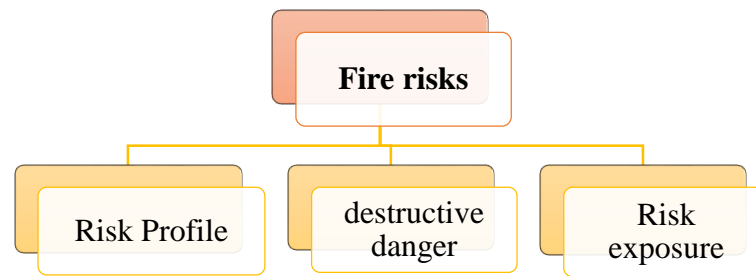
The following table (2-1) shows the most important events in the history of fire prevention and the efforts of researchers and scientific conferences:

**Source:(1994-أبوالمجد، حسنی)**

<b>Year</b>	<b>The event</b>
1666	Great Fire of London.
1790	The first fire tests by architects challengers in London.
1844	Construction Law in cities.
1897	Commission British fire resistance (BFPC).
1901	The first center of the experiences of the fire committee (BFPC).
1902	First Research center in the New York.
1903	The first global conference on the prevention of fire in London.
1917	American Standard Fire Test (c19) Named after that (119).
1932	British specifications fire endurance (Bs476).
1946	According to a report rating the buildings resistance to fire ((PW.BS.NO.20).
1961	Report of the Commission on the ISO standard fire test specification (Tc92).
1975 - 1978	Work of the Joint Committee of the Structural Engineers Association and Concrete Institute British all facilities are designed to resist fire and repaired.
1978	Recommendations of the World Commission for prestressed concrete for structures designed to resist Fire
1981	The recommendations of the European Commission on the work of steel designed to resist fire.
1981	The work of the concrete structures on the ability of fire resistance (ACI commiee, 216)

## 2-10 Fire risk:

Can the risks that may arise from the fire in the three following types summarize: -

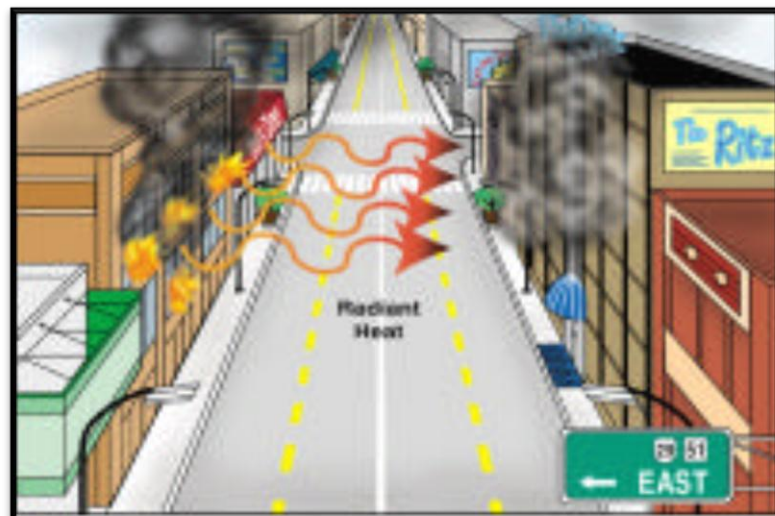


The chart (2-2) shows fire risk.  
(Design research, 2016).

2-10-1 **Risk Profile:** (risk to individuals), the risks that endanger the lives of individual's injury which requires the provision of measures to survive the dangers when the fire occurred.

2-10-2 **destructive danger:** the meaning of danger destructive is what happens from the devastation of the buildings and facilities as a result of a fire and vary the intensity of this destruction, depending on what is in the building itself are subject to the spread of materials, that is, the quantity and nature of the building components that control the extent of the fire dangerous and continuation of the destructive impact that produces about him.

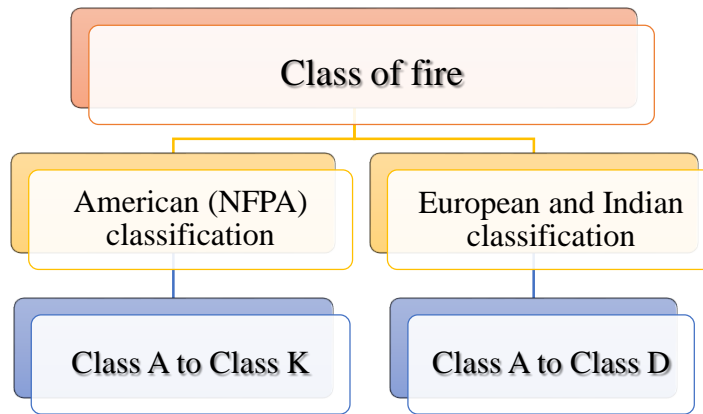
2-10-3 **Risk exposure** (the risk to neighborhoods), which risks to nearby locations to place the fire so-called external danger.



The Figure (2-7) shows risk exposure.  
Source :( NAFFCO Fire Awareness Team, 2016).

## 2-11 Classification of fire:

**Class of fire and suitable fire extinguishers:** The classification is for the purpose of effective firefighting,



The chart (2-3) shows Class of fire  
Source :( Design researcher, 2016)

### 2-11-1 American (NFPA) classification:

**The Table (2-2) show American classification of fire.**

**Source :( Design researcher, 2016).**

Name of c	Type of c	Example	Suitable fire extinguisher
<b>Class A</b>	Ordinary combustibles	Wood , paper Textiles. etc.	Chemical extinguishers of soda-acid type, gas/ expelled water and antifreeze types and water buckets and foam.
<b>Class B</b>	Flammable liquids	Petroleum , alcohol , oil , tar , ....etc.	Chemical extinguishers of carbon dioxide, dry_ power and sand buckets and foam.
<b>Class C</b>	Electrical equipment	Transformers Cables &Wire	Chemical extinguishers of carbon dioxide inert gases and Halona.
<b>Class D</b>	Combustible metal	Sodium Magnesium Uranium.	Special dry- powder and sand buckets.
<b>Class K</b>	Liquid cooking media	Fireplaces Furnaces Oils.	Special chemical agent.

## 2-11-2 European and Indian classification

The Table (2– 3) show European classification of fire.

Sources: (الجمال, 2013)

Name of Class	Type of Class	Example
<b>Class A</b>	Fires of combustible organic materials	Wood , paper ,Textiles, etc.
<b>Class B</b>	Fires of Flammable liquid or liquefiable solids	Petroleum , alcohol , oil , tar , ....etc.
<b>Class C</b>	Fires of Flammable gases or liquefiable gases	Propane , hydrogen , acetylene, etc.
<b>Class D</b>	Fires of combustible metals	Magnesium , aluminium , potassium

## 2-12 determine the seriousness of the fire:

Based on the classification of amounts previously mentioned and material expected its presence in all building buildings, you can determine the seriousness of the fire and a few are either dangerous or medium or high.

The Table (2– 4) show hazard type

Source: (Design researcher, 2016).

Hazard type	Example
<b>Light Hazard</b>	Mosques, schools, hospital wards, museums, houses infirm, office buildings, residential apartments and dining halls.
<b>Ordinary Hazard</b>	shopping malls, public libraries, and merchandise stores, places of service restaurants, bakeries, laundries, milk, soft drinks and canning factories, electronics factories, printing houses, textile factories, public attitudes and auto repair shops.
<b>High Hazard</b>	explosives stores jackhammers, radioactive materials plants, timber mills, plastic factories, workshops, metal casting and dragging, paint factories, solvents, detergents, oils and paints, silos dry, plants and coal stores, chemicals, pharmaceuticals, fertilizers, poisons plants Pest Control.

## 2-13 Theory of fire extinguishment:

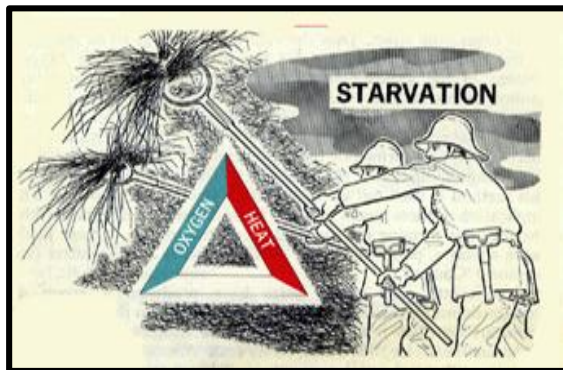
Theory of fire extinguishment is contrary to the theory of ignition, it can be suppressed by controlling or removing one or more sides of the fire tetrahedron.

### 2-13-1 Methods of fire extinction:

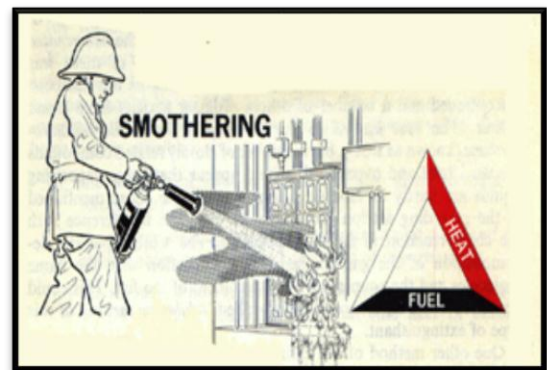
Fire theory relies on breaking the ignition triangle remove one or all of the ribs and the ribs so the fire operations are subject to the three methods are: -

**Starvation or limitation of fuel:** Starve the fire by depriving him of flammable materials that are considered nutritious fodder for the fire. And that the transfer of goods and materials available to place the fire away from the influence of heat and flame you can also pull the flammable liquids from tanks located by the fire.

**Smothering or limitation of oxygen or blanketing:** Fire throttle to mute the flames and prevent the arrival of oxygen to her, and this is done either cover fire Foams or use carbon dioxide gas that replaces oxygen as well as using Halona or powder.



The Figure (2-8) show Starvation method  
Sources :( [www.arabicsafety.com](http://www.arabicsafety.com), 2016)

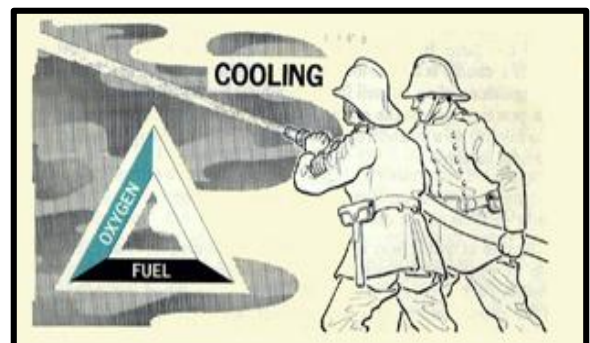


The Figure (2- 9) shows Smothering method  
Sources: ([www.arabicsafety.com](http://www.arabicsafety.com), 2016)

**Cooling or limitation of temperature:** fire cooling to reduce the temperature is most common in the fire this way, using water, this method relies mainly on the ability of the water to absorb the heat of burning materials.

### Stopping the chemical chain reaction:

Some ability to stop the chain reaction of fire extinguishing materials, this material is powdered and Halona.



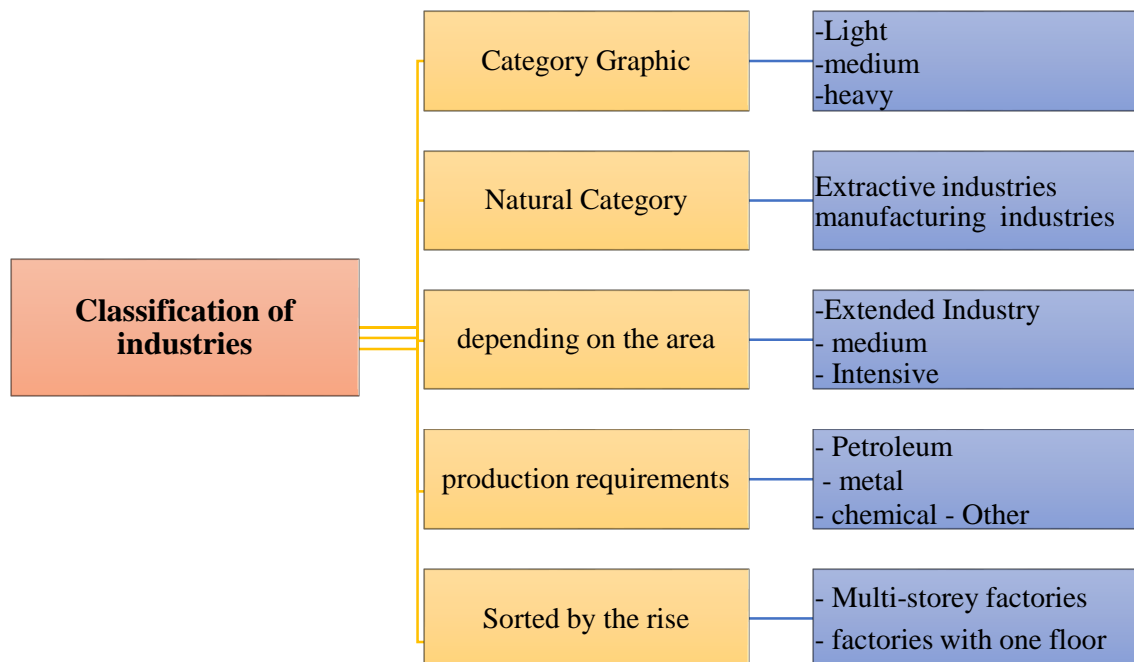
The Figure (2- 10) shows cooling method.  
Sources: ([www.arabicsafet.com](http://www.arabicsafet.com), 2016).

## 2-14 industrial building /Factories

### 2-14-1 Introduction: The industrial sector

There are a lot of sectors on which the economy of a particular country, including the agricultural , commercial and industrial sector , **the industrial sector** is one of the most important sectors in the country ; because of its financial and usefulness of the impact on the state, known as the industry as a shape-shifting raw materials and content of certain ways and tools to make them usable and satisfy the needs and desires , whether simple or complex , to form the industrial sector, a key pillar underpinning the economy in society. And is considered one of the most important sources of national income ; it reduces reliance on traditional sources , and fills the needs of civil society , and achieve greater value of natural resources, and so can the **industry** is defined as the process is based on the conversion of various raw materials from one form to another, so that products become subject to consumption, and is displayed in the market and marketing in order to sell them to consumers, for a sum of money to make a profit and interest, and to achieve the main goal of the industry which is to provide all needs and requirements of human beings.

### 2-14-2 Classification of industries:



The chart (2-4) show Classification of industries

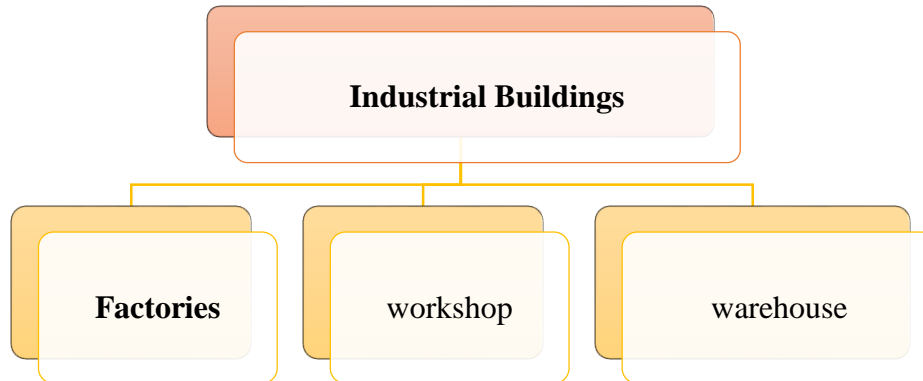
Source: (Design researcher, 2016).



### 2-14-3 Definition of industrial buildings:

Buildings or for industrial purposes or industrial professions parts : and include various facilities such as dairy factories , furniture factories , central laundries , laboratories hazardous chemicals , printing presses , and industrial buildings and crafts of all kinds , including industrial workshops and the like .

### 2-14-4 Types of Industrial Buildings: including



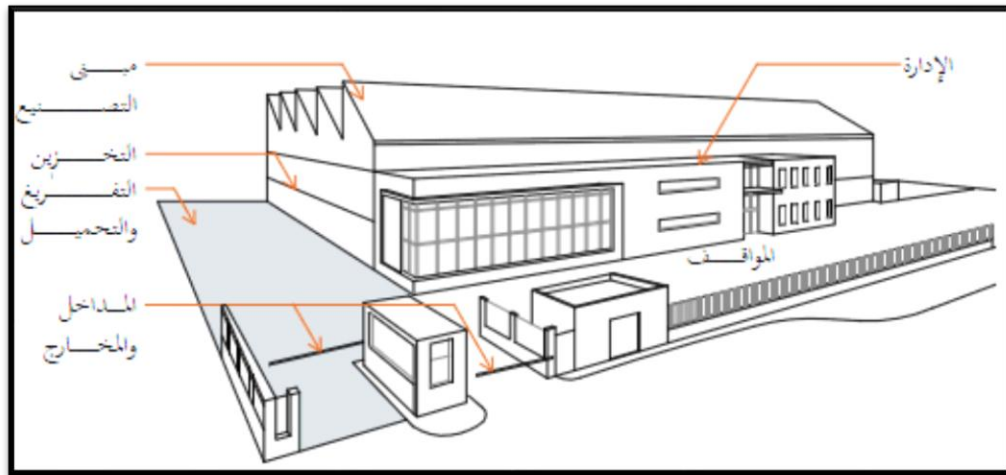
The chart (2-5) show types of industries buildings.  
Source: (Design researcher, 2016).

### 2-14-5 Definition factory:

Production system using the manufacturing capabilities to convert a group of elements called) inputs such as raw materials) into outputs.[د.م.نهاد عبدالمغنى وآخرون، 2009]

Is a building or buildings in which the manufactured products group, ranging from factories in size from small workshops and buildings fill up an entire city, and within the plant are converted raw materials and parts to the ready-to- use products and by adding value to these materials change form and content in accordance with the standards market and using less time and material effort. [خلوصي، 2010]

**A factory** is a complex network of functions, including materials storage, component manufacture, assembly, interposes storage, packaging, dispatch and transport interface all of which must work together. [Jolyon Drury, 1998]



The Figure (2-11) shows Elements of the public site.  
Source: Industrial Property Authority, 2016.

## 2-15 previous studies:

Benefited researcher from previous studies and research related to the study, which dealt with an aspect of this study, but they did not address the conditions of design and architecture of security and safety conditions in industrial buildings to protect them from fire hazards, the following are a part of these studies.

1/ Study **Sami Suleiman Mohammed**, the application of methods to fight the fire in the town of Gadaref, 2014, Sudan University of Science and Technology

The study dealt with ways to combat fires residential buildings (hut) made of local materials in large sizes (extended family) and over the site after the Civil Defense for the housing department and the speed of the fire with the absence of a culture, awareness and behavior among residents of condominiums spread.

### Similarities and differences:

The study are **consistent** with the current study being dealt with in the facility of the important facilities that serve the population group than summoned to maintain their lives.

The study are **consistent** with the current study in the difficulty of evacuating dwelt at trapping fire unless necessary measures are available.

The current study are **consistent** with the use of descriptive approach and survey tool to gather information.

The current study **differed** from the previous study in the spatial domain as the current study in Khartoum and previous study in Gadaref.

**Differed** in their specific area where the previous study examined ways to combat fires in residential units constructed from local materials and study examined the situation factories anti-fire systems

The study **differed** from the current study, the population of the study, which was based on engineers and workers and administrators factories while the previous study done on the dwellers of residential units

**The study concluded that the previous recommendations including:**

- Municipality of Gadaref divided into five sectors to provide civil defense services
- Customize excavations to store rainwater and stored in warehouses to provide fire water share separating the summer.

**2/ study Hassan Omar Hamouda, Evaluation of the safety and security means in high-rise residential buildings in Gaza City, 2012, , the Islamic University – Gaza.**

The study evaluated the current situation of the means of security and safety in high-rise apartment buildings, and see how their efficiency in preserving the lives and property of the population and study the behavior of high-rise apartment buildings residents toward those means, in addition to the role of legislation and building codes in achieving this goal.

**Similarities and differences:**

\*The study are consistent with the current study being dealt with in the facility of the important facilities that serve the people, which summoned the category to maintain their lives.

\*The study are consistent with the current study in the difficulty of evacuating dwelt at trapping fire unless necessary measures are available.

\*The study are consistent with the current study, the use of descriptive approach Social Survey entrance) and use the questionnaire tool to gather information

\*The study differed with the current study, in terms of the spatial area as the current study in the city of Khartoum, but this study are in Gaza City.

\*Also differed in the study population who the occupants of residential buildings and high in all educational and age groups, while the current study, the factories administrators.

**The main findings of the researcher** that 90% of the study sample in high buildings Gaza residential city where safety means are not available with the necessary requirements to achieve security and safety of the dwelling, and the non-conformity of escape ladders in

buildings with the requirements of the necessary safety, the researcher suggested several recommendations, including:

\*Issuance of legal regulations on offense buildings. \*And activating the role of Jean-up high buildings.

**3 / study Majid bin Mohammed Stabilizers**, preventive measures to reduce fire accidents in the city of Riyadh prisons, 2008, the Naïf Arab University for Security Sciences.

The study dealt with the fire danger in the premises of the prison and facing prisoners of dangers due to their inability to escape immediately after the fire discovered because the Department of Corrections applied closing the prisoners and control system in the exit specific gates which increases the loss of lives and property, unless appropriate preventive measures are available.

**Similarities and differences:**

\*The study are **consistent** with the current study being dealt with in the facility of the important facilities that serve the people, which summoned the category to maintain their lives.

\*The study are **consistent** with the current study in the difficulty of evacuating prisoners and the category of workers trapped when the fire unless necessary measures are available.

\*The current study are **consistent** with the application of descriptive approach using social survey tool to gather information.

\*The study **differed** from the previous study in the spatial domain as the current study in Khartoum and previous study in Riyad.

\***Differed** in their specific area where the previous study dealt with preventive measures to reduce fire incidents in prisons and dealt with a case study factories anti-fire systems.

\* The study **differed** from the current study, the population of the study , which was based on engineers and workers and administrators factories while the previous study on the safety officers and fire personnel administration civil defense personnel and officers in prisons.

**The study concluded that the previous recommendations including:**

- Attention to review the presence of flammable materials to help sponge and prevent the circulation.

- provide a means of safety systems and fire-fighting under regulations
- Training on evacuation plans.

**4 / study D/ Nader Jawad Tigress , the determinants of the application of security agents and fire safety in buildings and their impact on architectural design, in classrooms building at the Islamic University in Gaza**

The study dealt with security and safety factors in buildings in order to limit damage or losses in the event of any emergency, because these factors are subject to almost complete control of the designer, which can affect where and raise their efficiency, leading to lift the functional efficiency of the building is generally must occupies an important place in the consciousness of architectural designer, especially since it is the subject of the security and safety of lives and properties, that truth which must be transported from just a general understanding to design the determinants of binding and must be, so that it is bound by these determinants is stable in the consciousness of the architect.

**Similarities and differences:**

\*The study are **consistent** with the current study being dealt with in the facility of the important facilities that serve the people, which summoned the category to maintain their lives.

\*The study are **consistent** with the current study in the difficulty of evacuating the public and the category of workers trapped when the fire unless necessary measures are available.

\***Vary** with the current study in the study stood on an analytical study of the university classrooms, but the current study has applied the descriptive method using social survey tool to gather information.

\*The study **differed** from the previous study in the spatial domain as the current study in Khartoum and previous study in Gaza City.

\***Differed** in their specific area where the previous study examined the determinants of the application of security agents and fire safety in buildings and their impact on the architectural design and study examined the situation factories anti-fire systems.

**The study concluded that the previous recommendations including:**

- The need to compel the architect to observe security and safety factors in the design stages to lead to the success of the application of those factors.

- Determinants recommendations concerning the design to raise the performance of the building itself.
- Determinants recommendations concerning the design to raise the performance of the occupants of the building.
- Determinants recommendations concerning the design to raise the performance of fire-fighters.

## **2-16 Summary of previous studies:**

2-16-1 from these studies we conclude that the fire and control of it is the important topics of the related to safety and security in buildings, and must occupies important part of engineer architect awareness, especially as it concerns the safety and security of lives and properties.

2-16-2 Studies and concluded that the lack of the means of safety systems and firefighting, maintenance periodically, and the lack of means of communication, civil defense, and do not use early warning devices of the most important obstacles for firefighting in buildings and because of the sensitivity of industrial buildings and we should presentation how serious this problem and try to find solutions.

## Chapter III

### Firefighting in factories

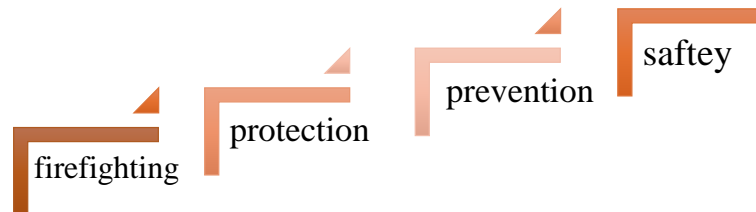
#### 3-1 Introduction:

Firefighting and extinguished is field that jut importance in urban cities, as the part of public safety, industrial safety: is defined as the field that aims to protect the various working groups of the occupational hazards in the work environment .[الطحان،2008]

And even check the factories increase in operating efficiency must achieve a safe and comfortable environment for workers which leads to increase productivity efficiency, But Appeared many of the accidents that have been associated factories and the most of it dangerous is fire Accidents, which is one of the threats to occupational safety and health, It includes industrial safety program and Preparation safety and fire prevention, extinguish of the fire.

Concept of fire safety is a group of equipment and/or behavior that aims to reduce the risk of Injury in the event of fire, it was designed additional measures for fire safety for the protection of private property, and even the safety of the construction. [www.ehow.com, 2016].

Concept of fire prevention it is the instructions and commandments for ways to prevent the fire from suitable design and Avoid the occurrence of fires. (Before the occurrence of fire).



The chart (3-1) show Relation between safety and fire fighting  
Source: (Design researcher, 2016).

#### 3-2 Fire-fighting:

Fire-fighting is to do is to fight fires after the fact by using the appropriate mechanisms and devices by firefighters trained to deal with the various incidents that may occur [2008, الغامدي], and fire-fighting competent **authorities** in each country, based on work safety and the dissemination of culture, including:

\* **Federal US administration to combat the fire** and act in case of emergency (FEMA) and its Website entitled: (FireSafety.gov) publishes information about firefighting and safety in the United States. [www.fire saftey.gov, 2016] .

\* **The National Fire Protection Association in US**, The Society was established in 1896 in the state of Massachusetts, which is developing laws and regulations for factories, buildings and installations...etc. ,these laws to reduce the risk of fires.

\* **British Journal of Safety Engineering and amortization** ((Fire Safety Engineering \_FSE magazine many news and developments and issues raised in the field of safety engineering and fire-fighting, also contain issues related to legislation, regulations and standards in the field of safety.

\***Occupational Safety and Health Administration (OSHA)**: The OSHA identifying business risks and means of protection for those risks, concerning OSHA of all workers, whether in the field of safety, or any area within the organization, from the other hand, the management held a number of courses in the Arab world, which contains: the concept and importance of occupational health and safety, And analyze the risks of the work in accordance with the standards (OSHA), the US, and to investigate the incidents and the discovery of what will come next, and look at the standards and international conventions and recommendations of the Occupational Safety and Health, tasks, duties and responsibilities of the citizen.

### **International associations:**

It's going to developing specifications, laws and regulations to combat the fire, and including:

- (a) British standard (Bs).
- (b) Loss prevention code (LPC).
- (c) Unified Fire Code (UFC).
- (d) European National code (ENC).

### **3-3 General rules for firefighting:** ([www.arabicsafety.com](http://www.arabicsafety.com),july2016)

1. You have to fight fire with the direction of the wind and is not reversible.
2. Stay away from the fire about 3-5 meters and Start Drug Control
3. Do not struggling from the middle of the fire, but from front to back.
4. Move the extinguisher to the right and left during the fight.
- 5 always fought the fire from the bottom up.
6. Do not leave the scene of the fire by making sure switch it off completely.



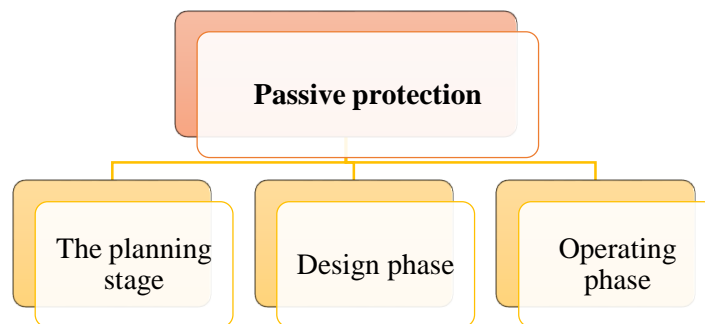
### 3-4 Means of protection:

Protection from fire start from the first moment that the planning and design phase begins in which to set up the factory to provide additional means to extinguish the stage, and from this perspective we can see that there are two kinds of means to protect life and property from fire hazards, namely:



The chart (3-2) show means of protection from fire  
Design researcher, 2016

**3-5 Passive protection:** the building design and construction of its members to withstand fire and addition of its parts inside, including site selection and construction materials fire resistant and the fragmentation of the building and other. (أبو المجد وحسنى، 1990)  
The aim old how to fight fires when they occur and reduce the heavy losses inflicted on people and property, but he is now thinking of ways to protect the building originally from falling into the fire hazards in advance what makes them less susceptible to the building and achieve security of the building are as follows:



The chart (3-3) show Passive protection  
(Design researcher, 2016)

**3-5-1 Means of fire protection in the planning stage:** this phase deals with requirements that the engineer must be taken into account in the general location of the building and its relationship to adjacent buildings and the dimensions of the building and the height and the streets bordering it, and this is determined by the laws and regulations

for building in Khartoum State after taking into account the amortization or near water sources and fire stations. There are factors that affect the planning of a factory:

**3.5.1.1 Building size:** whenever the size of the area exposed to increased fire danger has increased in the building on the property and lives and it has increased the difficulty of control and fire-fighting, so there must be outlets penetrate the large size of the space.

(أبو المجد وحسنی، 1994)

**3.5.1.2 Fire access to a vehicle fire place Ports:** ease and clarity of ports to facilitate the arrival of firefighters quick and safe manner and make it easier to penetrate the building from any direction, and to be entrances is closed and dilated allow the passage of the fire wagon, with the Traffic Insurance (a minimum width of 6.0 m) in order to facilitate the arrival of equipment and mechanisms for civil defense and exit without any obstacles, and does not increase the length or Showcase 50 linear meters, but the existence of the entrance because it prevents the arrival of the fire inside the building. [حیدر، 1994]

It should provide firefighters with water outlet water amortization (emergency water) in the external courtyards and storage areas to facilitate the task of firefighters to connect hoses during the control process.

**3.5.1.3 Exposure Risk of neighborhoods to fire (Risk exposure),** which should prevent the spread of fire to the rest of the neighborhoods factories until it is extinguished, and this is as follows:

1/ using fire-resistant materials in the construction of the building, such as brick and concrete

2/ Separate windows in adjacent buildings so as not to move the flames by conduction

3/ Provide sufficient distance between the buildings of the non-arrival of ignition

temperature radiation of source of flammable materials in the building, or to protect the wall of the building Exposed fire barrier fire resistant and this is used in buildings that are stored materials are affected by heat and possibly a fire in the neighborhood.

**3.5.1.4 Near the fire stations in the city for buildings:** so as to reach the scene as quickly as possible, and the distribution of centers according to the number of residents of the city so that there is only one center for every 35,000 - 50,000 percentage people in crowded cities and less in the least busiest cities for up to 15,000 -35,000 percentage people per fire station in the city. (Dr. H.Sanli & Dr. Tommie , 1998), and the distance between the fire station and another is 5kilometer.

### 3.5.2 Means of fire protection in the design stage:

#### a) Site:

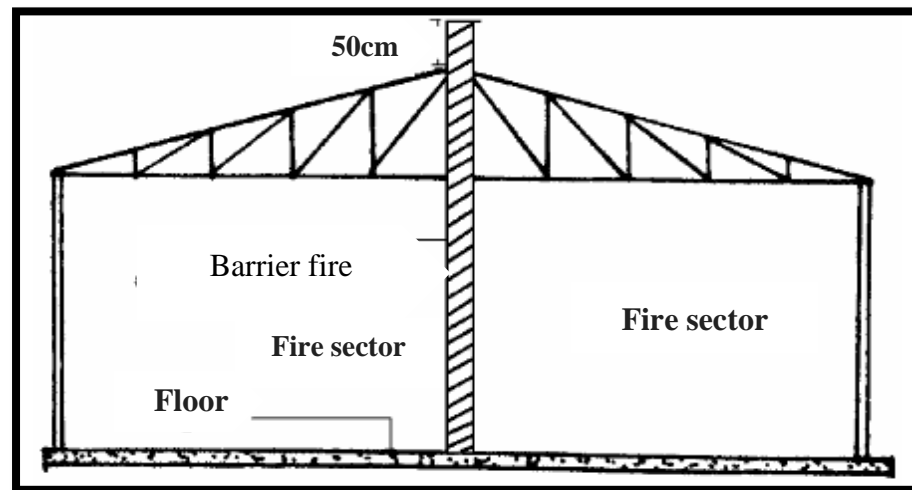
Design Rebounds buildings as Barrier fire, in factories prefer to unload at least 20% of the land area. (See app 3, A) and (See app 4)

#### b) Space:

**The fire barriers:** we must continue the barrier anti-fire Limited breaking vacuum latter ceiling, and if the latter, ceiling (surface) in the form of truss must extend for a distance of (0.50) meters above the confluence with the level of the roof panels cover point.

#### **The fire sectors:**

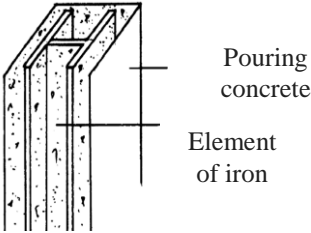
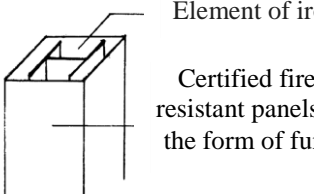
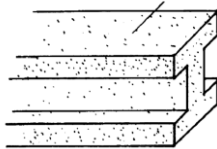
Separate parts of the building to increase the size of the area zones contained about 400 m<sup>2</sup>. (See app 3, B)



The Figure (3- 1) shows barrier fire  
(Design researcher, 2016)

**c) Structure:** Design of structural elements (beams and columns) it must be of materials bear the weight and fire-resistant duration of not less than four hours, materials such as brick or reinforced concrete. (See app 3, D).

Table (3-1) show Ways to protect construction elements of iron.  
Source: (Design researcher, 2016)

Structure type		
<p><b>Dipping:</b></p> <p>Dipping columns by pouring of reinforced concrete, or building a concrete or brick or potter surveyor layer of concrete on the base of networking wire</p>	<p><b>Packaging:</b></p> <p>Packaging Iron element panels, certified fire-resistant box-shaped</p>	<p><b>Coating:</b></p> <p>Coating the iron element layer of certified fire-resistant material in the form of a paste carried out by spraying method or surveyor.</p>
 <p>The Figure (3- 2) shows Dipping way</p>	 <p>The Figure (3- 3) shows Packaging way</p>	 <p>The Figure (3-4) shows Coating way</p>

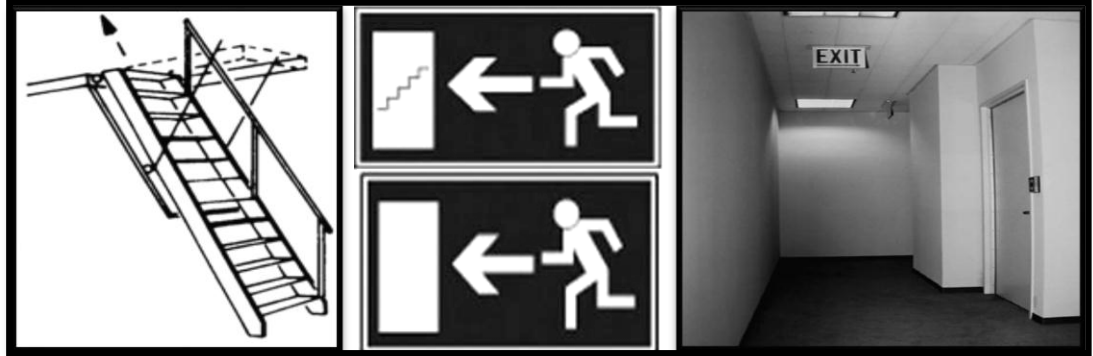
**d) Aesthetic appearance** and good decoration and modern design of means of safety including: fund water hose reel 3/4 "and hand extinguisher and hose burlap.



The Figure (3-5) shows the aesthetic appearance of the fund hose reel and hand extinguishing.  
Source: www.google.com,2016.

**e) Circulation (Provide avenues and outlets to escape):**

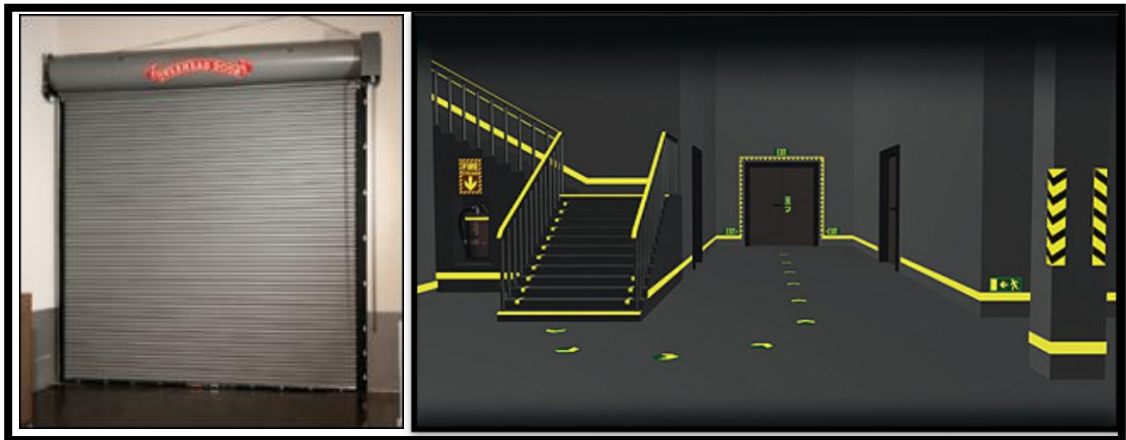
It should not be less than width lanes 1.2 m and a maximum length of the lanes on the 30 m reach directly to escape ladders, and escape ladders reach to outdoor directly, (See app 3, E,F).



The Figure (3-6) shows evacuation corridors  
([www.arabicsafety.com](http://www.arabicsafety.com), 2016)

**f) Finishing:**

Take into account in their design to be of non-flammable materials, and the provision of alternative lighting, and doors are Impermeable to smoke, and resistance fire for at least two hours



The Figure (3-7) show emergency exits  
Source: [www.google.com](http://www.google.com), 2016

The Figure (3-8) shows lighting evacuation  
source: [www.arabicsafety.com](http://www.arabicsafety.com), 2016

**3.5.3 Means of fire protection in the Operating phase:**

It is the most important stage for the continued success of the building in countering the threat of fires, and includes the following: -

3.5.3.1 Follow the periodic maintenance of the building special electrical wiring and connections areas Gas and fuel, as well as maintenance of machines and mechanisms the plant and followed up by technicians.

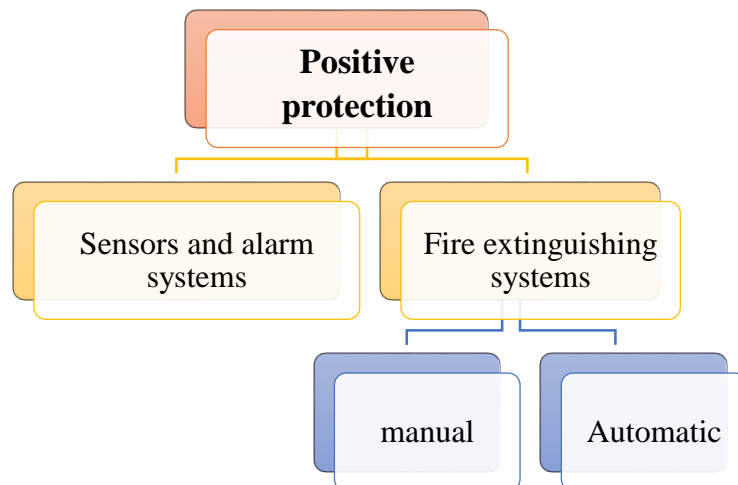
3.5.3.2 Periodic inspection of firefighting equipment and conduct periodic tests to ensure safety and effectiveness.

### 3.6 positive protection:

Include fire extinguishers and various systems sensor systems. An additional means are added to the building in specific places to help in the identification of the first fire and eliminate it, and it can be fixed or moving, and these means consist of two types:

3-6-1 Fire and smoke sensors.

3-6-2 Fire extinguishers (fixed (automatic) and animation (manual). (See app 3,H).



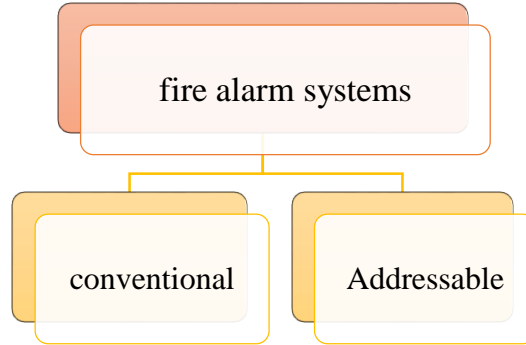
The chart (3-4) show positive protection.  
Design researcher.

#### 3.6.1 Sensors and alarm systems:

Rights may be present at times when the Smell of fire of smoke to evidence by the presence of fire, But more often than fires erupt in times to leave the building occupants fuller closed stores then calls the existence of devices called **smoke sensors** that give the signal for the presence of fire risk and act to combat it , Protection Authority (NFPA) has been known from **the fire sensors** as: a can of visible and invisible sensor outputs fire, and it is clear that the purpose of these devices is the following: (www .NFPA.org.)

An early warning to users **and** give the signal to fire mechanical devices to work on the fire (early control of fire).

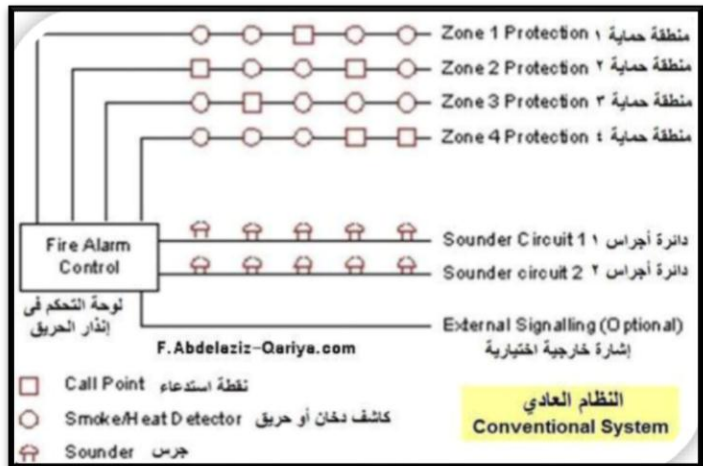
### 3.6.1.1 Types of fire alarm system:



The chart (3-5) show Types of fire alarm systems  
Source :( Design researcher, 2016)

#### Conventional System:

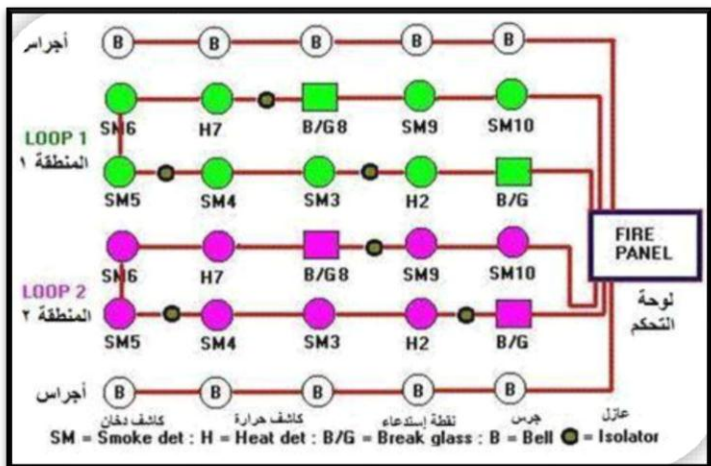
It is a system in which be the detection devices separate from alarm devices and all the separate circles connected to the control panel.



The Figure (3-9) show conventional system  
Source :( www.arabsaftey.com, 2016)

#### Addressable System:

It is a system in which be the detection devices and alarm devices compact in one circuit and connected to the control panel.



The Figure (3-10) show addressable system  
Source :( www.arabsaftey.com, 2016)

### 3.6.1.2 Types of fire detectors:

#### a- Warning System manual:

Is a manually operated by keys (appeal points) distributed in certain places and works by the power supply has two types:



The Figure (3-11) shows manual alarm points by appeal broken glass cover.

S: [www.arabicsafety.com](http://www.arabicsafety.com)



The Figure (3-12) shows manual alarm Call points of running a special key.

S: [www.arabicsafety.com](http://www.arabicsafety.com)

#### Manual alarm system consists of:

- 1 - Button compressor (glass cover or key).
- 2 - An alarm bell.
- 3 - Control Panel.

There are several images for manual alarm devices including:

Telephone transmission alarms,

alarms to evacuate the building, amplifiers or optical signals.



The Figure (3-13) shows Fire alarm sounder and flasher  
[www.arabicsafety.com](http://www.arabicsafety.com), 2016

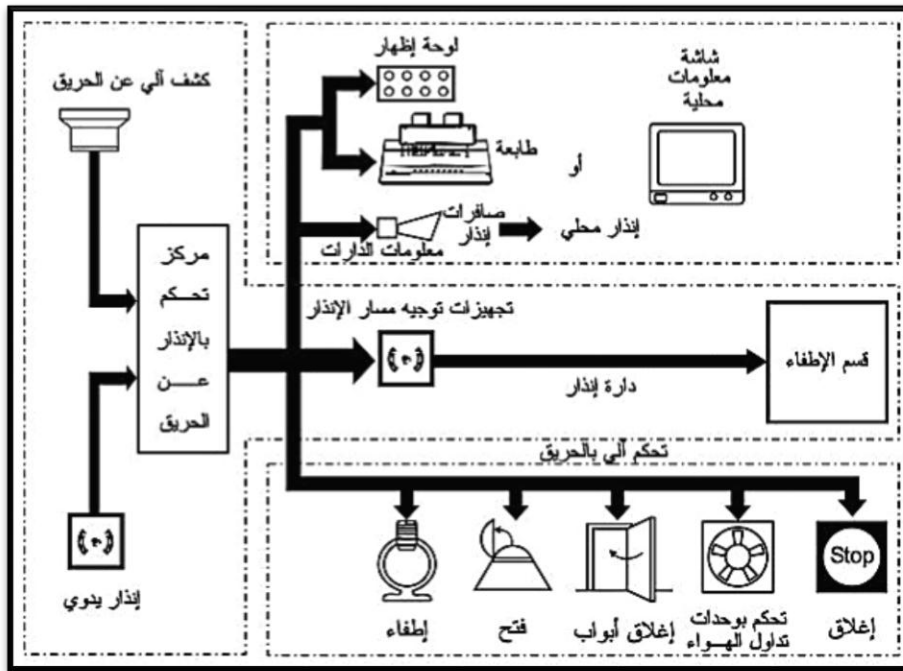
**b- Automatic Warning System:** is a device that works with electric power for sensing the danger of fire and then the alarm.

Automatic Warning System consists of:

1. Fire detectors (smoke - Flame - heat - ..... etc.).
- 2 - An alarm bell.
- 3 - Control Panel.

Frequently use this system in places and spaces that are increasing their chances of fire occurrence (where there is no person to control) and may result in big losses in a short period of time. These systems are working the fire phenomena influenced some of which are affected by the flame or heat, featuring automatic alarms for manual alarms in that it does not rely on person in to turn on it, As well as shortcut period time between the moment of the fire and the moment of discovery, Which give way to intervene quickly and effectively control operations and control the fire and thus reducing the size of the losses.





The Figure (3-14) shows components of fire alarm system  
[www.arabicsafety.com](http://www.arabicsafety.com)

The Table (3– 2) show building type and suitable alarms.

Building type	Sensor type				
	Smoke	Ionized gases	excess heat	Flame	Warning manual
Stores	×××	××	×	×××	×××
Factories	××	××	×	××	×××
Chemical plants	×	×	×××	×	×××

Source: ([www.arabicsafety.com](http://www.arabicsafety.com), 2016).  
 ××× Excellent  
 ×× Medium  
 × Weak

### 3.6.2 Fire extinguishing systems:

Speed control the fire requires a sense of the speed of its guard or workers with an integrated system of amortization in the building, whether manually or automatically, which reduces the loss of lives and damage to property in the shortest possible time. Many of the buildings depends on extinguishing process (suppression) fire especially large buildings on the fire, which is a complement to the system of early warning fire extinguisher system, fire extinguishing systems are divided into: -

-In terms of the material used in

- Sprinkler System: (Fire extinguishing used water).
- Nozzle System: (Fire extinguishing used gas).

-In terms of operation (firefighting equipment):

- Fire extinguishers manual equipment (hand extinguishers, fire hoses).
- Fire extinguishing equipment fixed mechanism: (spraying water or gas automatic system).

### 3.7 Fire extinguishers manual:

Hand tools are mobile "first aid", which are used to fight the fire in the first stages by the ordinary people who are in the building. Of those equipment:

3.7.1 Hand fire extinguishers of different kinds.

3.7.2 Sand and water containers.

3.7.3 Special fire-resistant blankets.

3.7.1 **Manual fire extinguishers:** are light and handy way to extinguish the fire in the early stages of the fire is first aid equipment (see app table 3.I).



The Figure (3-15) shows manual Fire extinguishers  
www.arabicsafety.com

Class	Water Red	Foam off-white	Dry chemical Powder Blue	Carbon Dioxide Black	Wet chemical Powder Yellow
A	YES	YES	YES	NO	YES
B	NO	YES	YES	YES	NO
C	NO	NO	YES	NO	NO
D	NO	NO	NO	NO	NO
E	NO	NO	YES	YES	NO
F	NO	NO	NO	NO	YES

The Figure (3-16) shows class of manual Fire extinguishers  
www.arabicsafety.com

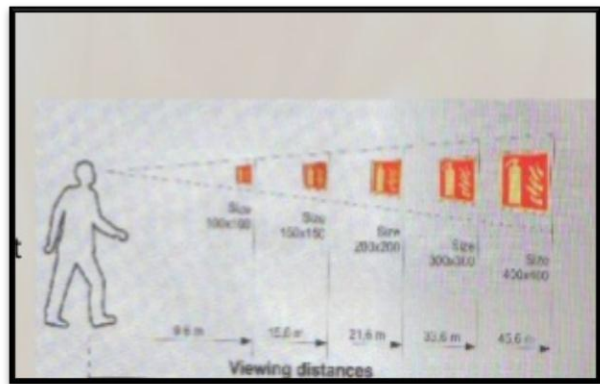
### 3.7.1.1 Distribution of extinguishing fire-fighting manual:

- 1) Distributed in the appropriate places, not far from some more than (20 m) and determines their number one extinguisher per 200 m<sup>2</sup>.
- 2) It must be kept in a cupboard in the wall cavity or a door.



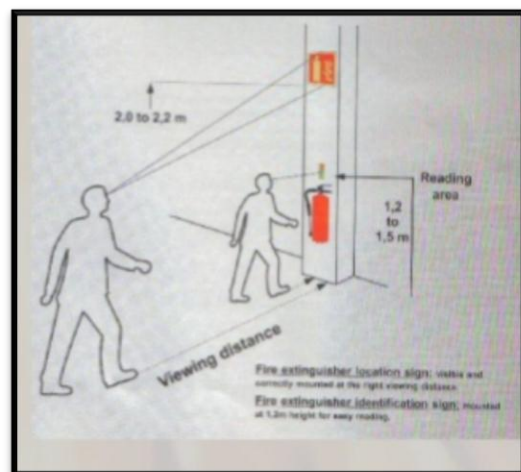
The Figure (3-17) shows manual fire extinguishers  
S: [www.arabicsafety.com](http://www.arabicsafety.com)

- 3) Quench outstanding prove suspending the Stud-meter extinguisher from the base to the surface of the earth.
- 4) You must install the panel's necessary signal to indicate her whereabouts.
- 5) Fire extinguishers are selected site in an accessible place as close as possible to the exits or staircase.



The Figure (3-18) shows viewing distances of manual fire extinguishers  
[www.dr\\_markis@yahoo.com](mailto:www.dr_markis@yahoo.com)

- 6) Signs shall be mounted not less than 2m above floor, or at a height to person of average height and visual acuity approaching the extinguisher.



The Figure (3-19) shows sign of manual fire extinguishers  
[www.dr\\_markis@yahoo.com](http://www.dr_markis@yahoo.com)

### 3.7.2. Fire bucket of sand:

A primitive way and are valid in all times and found in abundance, and used sand in the private firefighting fires fluid and quench metals flaming 1 and not to dig up the sand only after a period of time so as not to ignite other metal visits by stored inside the sand temperature, but it is not used in extinguishing fires electrical connections in the existence of power because the sand is a good conductor of heat, especially if it is accompanied by water moisture.



The Figure (3–20) shows fire Bucket of sand  
[www.dr\\_markis@yahoo.com](http://www.dr_markis@yahoo.com).

### 3.7.3 Fire blanket:

It is a means of fire extinguishers and not from the fire extinguishers, and is used (fire cover (fire blanket) in kitchens and rooms housing workers and workshops, and can be used for household endothelial wetted with water when fire suppression, and operates the blanket to suffocate the fire and prevent. The arrival of oxygen to Article flaming. use: The withdrawal of endothelial (private) from inside the box and open it completely and cover fire to prevent oxygen, must be the top end of the lid near the surface of the material burning, and are moving the blanket from the upper and cautiously to cover the body burning, you must beware of the bottom of the blanket should not be taken away from the flame, lest flame rushes toward the person.



The Figure (3–21) shows Fire blanket  
[www.dr\\_markis@yahoo.com](http://www.dr_markis@yahoo.com).

### 3.8 Firefighting equipment Fixed:

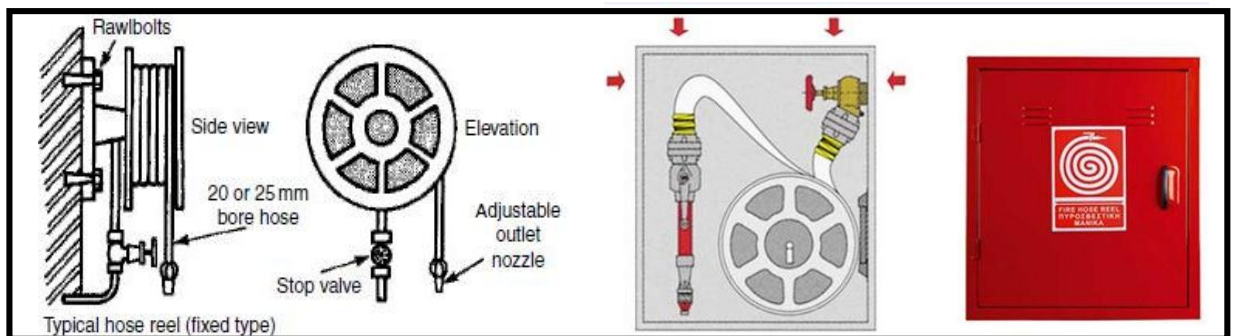
It's extensions of fixed network used to fight fires in the first stage by the ordinary people who's in the building and by those who know like special combat teams or civil defense, divided in terms of their work to the following:

#### 3.8.1 Fire hoses:

It is a means of extinguishing fires used to fight the first type, and is working to reduce the temperature of the base material Flaming, and the material used in the fire is water, and prevents the use of the equipment to combat fires, electrical appliances, and are found in most buildings and facilities, which is one of equipment main and important prevention in different locations.

3.8.1.1 **Water hoses with pulleys:** A rubber hose 25 mm diameter coiled on a reel inside the metal box.

3.8.1.2 **Fire hose reel / 4 "3:** they reel extinguisher fitted with a hose diameter water 4/3 "ready in a metal box red color inside the corridors of the factories and in the floors of public buildings connected ink continuously for water high pressure home, where the hose length of 25 meters according to the specifications and must not exceed the length of the horizontal distance between each reel 50 meters to serve a wheel distance of 25 linear meters in both directions.



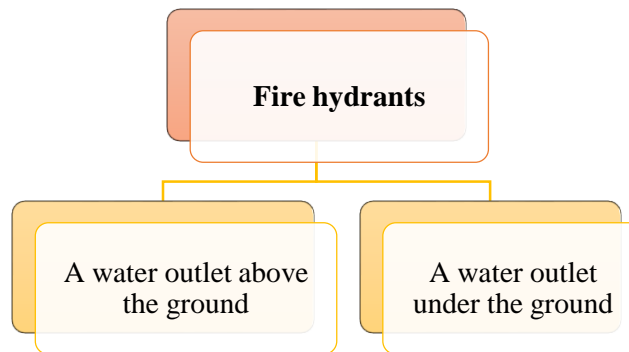
The Figure (3– 22) shows water hoses with pulleys  
[www.arabicsafety.com](http://www.arabicsafety.com)

### 3.8.2 Fire hydrants:

A fixed manual methods and some of it be inside or outside the building and have the standards of different diameters and, the goal of which is to equip fire trucks with water when necessary fire-fighting in the neighboring buildings,



The Figure (3-23) shows fire hydrants.  
[www.dr\\_markis@yahoo.com](http://www.dr_markis@yahoo.com).



The chart (3-6) show fire water out let.  
Design researcher.

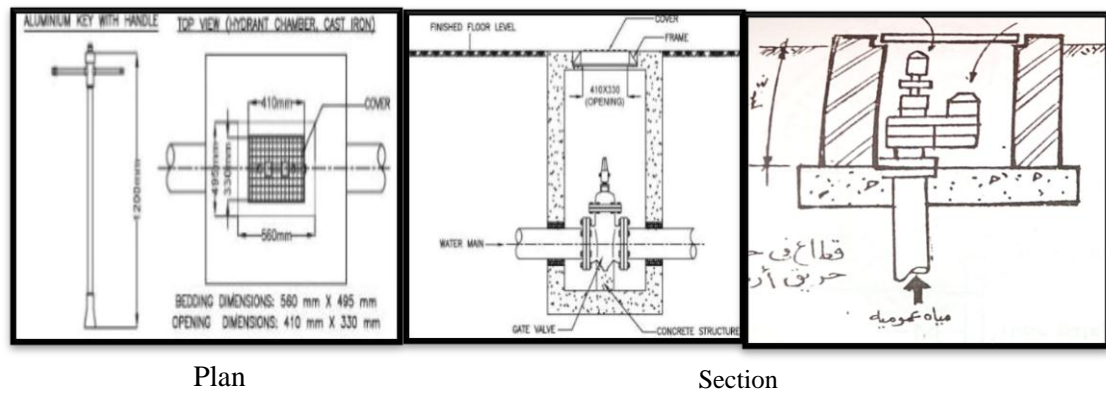
#### 3.8.2.1 Fire hydrants vertical (water outlet above the ground):

A fixed vertical tube highlights the Earth's surface by about 60 cm from the bottom of the feeder connects to the network and it ends above the barrel or more depending on the tube diameter the number of nozzles and their uses and the amount of emerging from water, it is at least 4 inches and not less than any socket for 2.5 inches.



The Figure (3-24) show fire water outlet above the ground.  
[www.arabicsafety.com](http://www.arabicsafety.com).

**3.8.2.2 Fire hydrants ground** (water outlet under the ground): is a proven taps beneath the Earth's natural in cans manufactured from cast iron or brick, have been placed at intervals of not more than 200 meters in places that do not pass by the large loads, is the tube includes a valve and ends with the barrel and kept firefighting water intakes in the inspection pits according to the specifications and conditions of civil defense.



The Figure (3–25) show fire water outlet under the ground  
Sources: [حيدر, 1994]

### 3.9 Firefighting automatic systems:

using automatic fire extinguishing devices in hazardous locations in the spread of the fire, which may not manual or mobile devices to control the fire, automatic systems are used to start the process of fire immediately after the fire, these systems are working to shorten the period of time between the moments of the fire and start the amortization process, which reduces losses

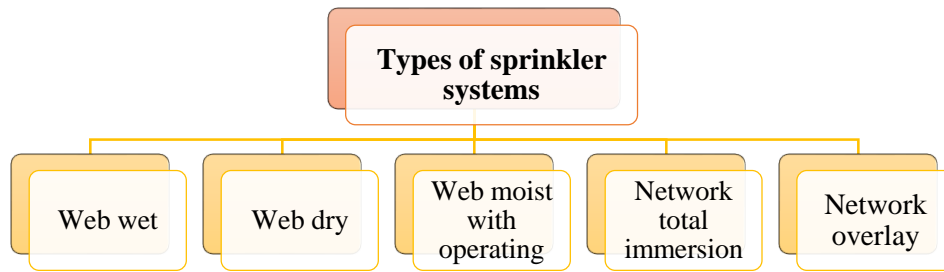
Divided in terms of the materials used in the:

A/Sprinkler System: (firefighters used water).

B/ automatic devices produced other materials for firefighters

#### 3.9.1Sprinkler system:

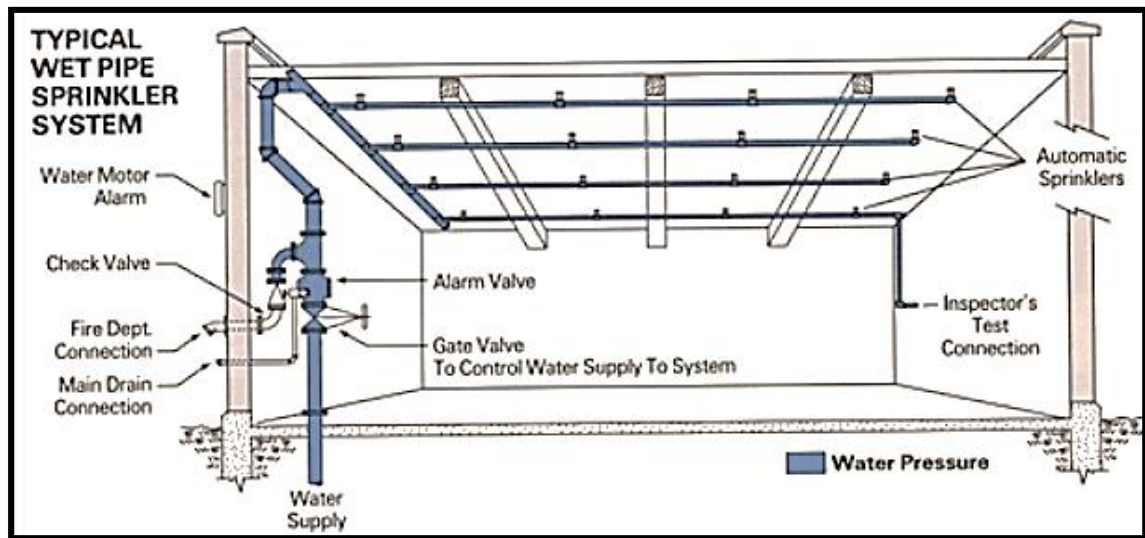
Is a relevant slots distributed network extensions in the desired places protected works automatically by the fire sensor. Taken into account in the design of water network sprinklers dangerous type of fire in the content, such as high, medium or mild dangerous.



The chart (3-7) show components vertical pipes anchored wet  
Design researcher.

### 3.9.1.1 Vertical pipes anchored wet:

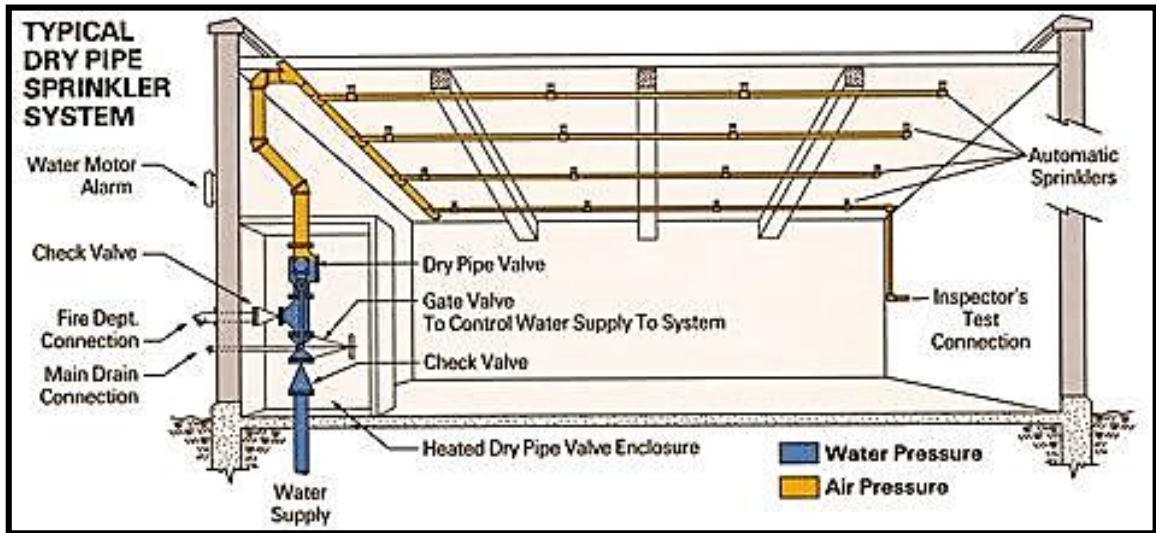
A network extenders fixed with a continuous water source feeding the nozzles of fire extinguishers and water are distributed in places, the crisis of the building and used by civil defense.



The Figure (3-26) shows vertical pipes anchored wet  
[www.arabicsafety.com](http://www.arabicsafety.com)

**3.9.1.2 Fire Vertical pipes anchored dry:** are used in buildings, which consists of five floors above ground, including where or higher 18 m or buildings exceeding two floors if the increased floor area of 1,000 m<sup>2</sup>. Components: Vertical tube, Payment points and Fire nozzles.





The Figure (3-27) shows vertical pipes anchored dry

www.arabicsafety.com

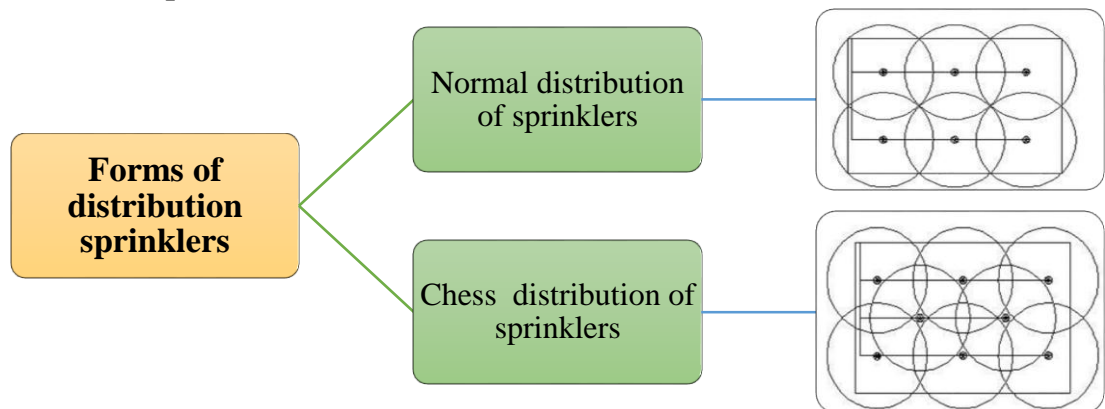
\*Sprinkler heads are distributed according to the seriousness of the fire sprinkler to cover all 15 \_ 12 \_ 8 square meters. (See app 3, G).



The Figure (3-28) shows Sprinkler heads

Source: www.arabicsafety.com

**Distribution of sprinklers:**



The chart (3-8) shows form distribution of sprinklers.

Design researcher

### 3.9.2 Modern systems:

#### \* Low pressure water mist sprinklers system:

Is a fast dotting system and not sprayed, where spin reel sprinkler high speed operating more effectively than system regular sprinklers.



The Figure (3–29) shows low pressure Sprinkler head  
Source: <http://www.eteasicurezzagroup.com>

#### \* System advantages:

\*Consumption is lower of water as much as 80% compared to normal sprinklers systems is the highest pressure where a liter of water covers an area of 60 square meters, compared with 3 square meters ordinary system.

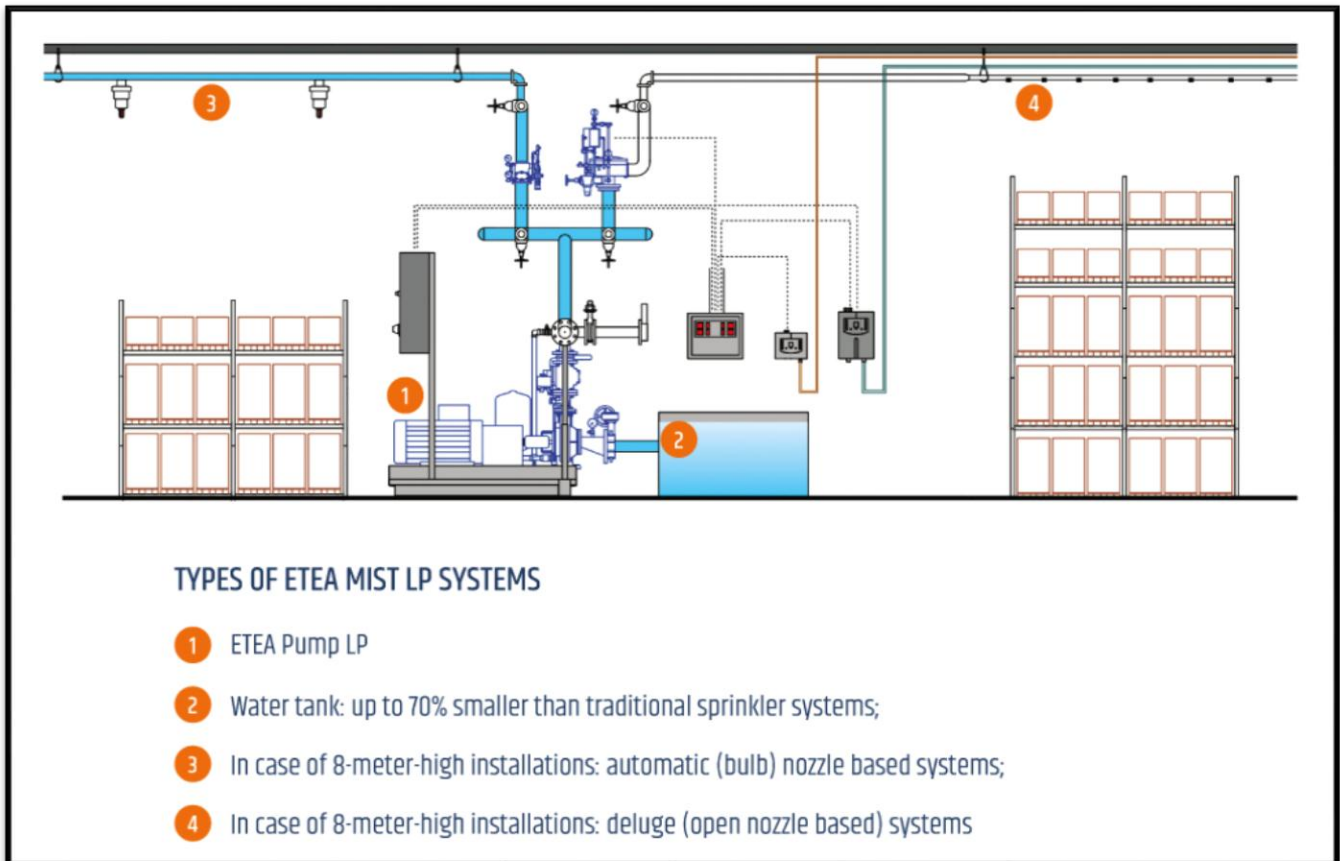
\*The use of low-pressure water, which means there is no need for high-pressure pumps.

\* Maintain appliances and equipment.

\*The system is more sophisticated and less complicated than normal water sprinkler system where the need for a distance less to the pump and connections.



The Figure (3–30) shows Comparison between low pressure Sprinkler and normal sprinklers  
Source: <http://www.eteasicurezzagroup.com>



The figure (3–31) showing the components of the low-pressure sprinklers system and its connections in case of drought or the presence of water.  
 Source: <http://www.eteasicurezzagroup.com>

## *Chapter IV*

### **Situation Currently for factories in Khartoum city.**

#### **4-1 Emergence of factories in Khartoum:**

The industrial sector includes in Khartoum, the food industry, such as candy factories and soda water, mineral water, oil presses and factories of textiles, clothing and printing and leather tanning and other light manufacturing industries as well as oil and mineral industries where there is an oil refinery in the region. There are horse's industrial complex south of Khartoum which manufactures cars, tractors as well as some spare parts, iron and aluminum.

**Industrial development** in Sudan limited consist of various agricultural products processing and light industries that are located in the north of Khartoum. In recent years, the horses industrial complex in the state of the island and vans vehicle assembly, and some heavy military equipment such as armored personnel carriers,

The industry is concentrated in the Sudan in the **manufacturing industries** that depend on agricultural products flourish where each of the textile, sugar and oil industry, where the amount of oil production of about 3 million tons, which deals with the oils, cotton seed, sunflower, peanut and sesame. As well as other manufacturing industries such as manufacturing, In the Kenana Sugar factory. Also it rebounded in Sudan several light and heavy industries such as automotive assembly plant horses in Gezira state industry and aircraft industry in the area and repeat the steel industry iron and many other light industries (Ministry of Industry, 2016).

#### **4-2 Industrial sector in Khartoum:**

The development of the industrial sector and its contribution to the Sudanese economy:

##### **Growing stages:**

The industrial development in the Sudan experience quite similar to the experience of other developing countries is that it can monitor the growth stages as follows:

- The period preceding the political independence and until independence in 1956 which prevailed in simple household manufacturing industry.
- Following the period of independence, until 1960 which saw indirect intervention from the government sector and the introduction of modern industries.
- In sixthly - period 1969 \_ 1960, when the state intervened directly in industrial activity with a view to development in addition to the attention of the private manufacturing sector.

- The 1969-1973 period saw a big action represented - first - in the nationalization and confiscation of private sector and industrial installations - Second cancellation of these procedures.
- The period from the mid-seventies and almost until the end of the 1973- 1978 industrial growth was the result of increased foreign investment in agro-industries
- Finally, the period from the end of the seventies and so far declined during which industrial production, which has affected its economic policies adopted by the State after the entry into the economic concentration and determine the rates of exchange programs that the industry, and the low value of the national currency.

#### **4-3 Classification of industries in Khartoum state:**

1. Food products industry.
2. Spinning, weaving and knitting industry.
3. The chemicals sector industry.
4. Wood products industry sector.
5. Industry paper and printing products.
6. Industry, steel products and aluminum.
7. Leather products industry.
8. Industry, engineering products, machinery and equipment and construction materials.
9. Pharmaceutical industry.

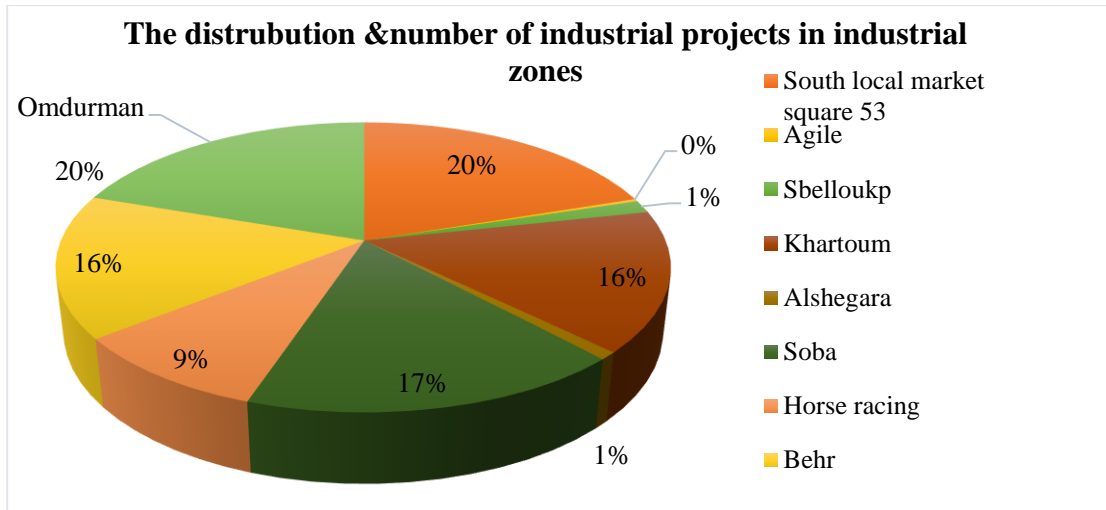
#### **4-4 industrial building in Khartoum:**

Table (4-1) shows statistics numbering of factory in Khartoum state for the year 2015- 2016.

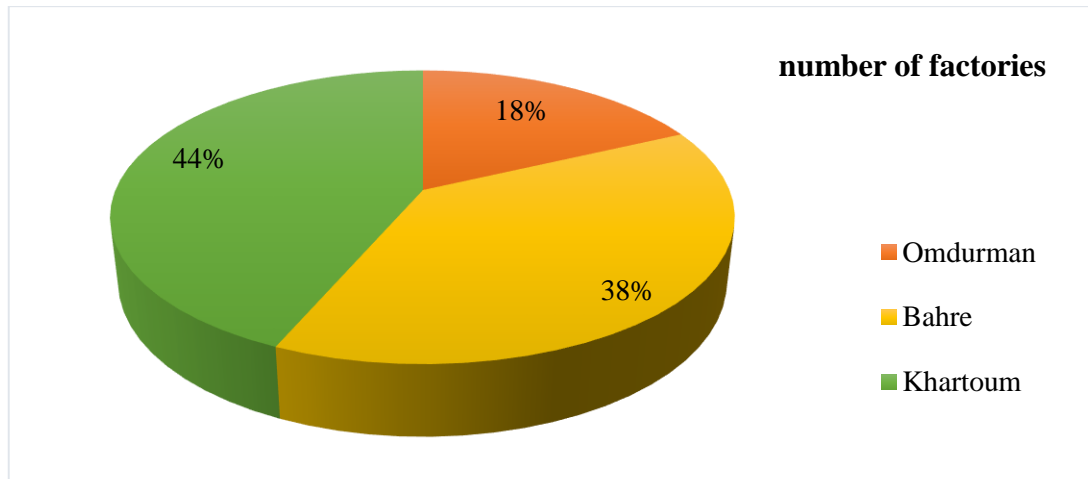
Resource: Ministry of Industry, 2016.

<b>Region</b>	<b>The number of factories</b>	<b>Ratio</b>
South local market square 53	1194	%19.92
Agile	17	%0.28
Sbelloukp	84	%/1.40
Khartoum	937	%15.63
Alshegara	50	%0.83
Soba	1024	%17.08

Horse racing	550	%9.17
Behr	956	%15.95
Omdurman	1183	19.73%
Total	5995	100%



The chart (4-1) Statistics shows factory in Khartoum state for the year 2015- 2016  
Source: Ministry of Industry, 2016



The chart (4-2) Statistics shows number of factories actor and activist in Khartoum  
Source: Ministry of Civil Defense, 2016.

**Result:** Concentrated factories locality Khartoum by 44% (see app 2, F).

#### **4-5 Institutions that are related to the safety of factories in Khartoum:**

Khartoum has shown interest in the industry and put it at the forefront of the development plans, which are implemented in order to strengthen the sources of income and support the private sector, with the development and progress is an urgent need to find a regular salad became a mission to raise the industrial level of security to keep up with the development and the prevention of risk and damage and accidents which led to the emergence of several quarters responsible for security and safety in those industrial installations is:

**4.4.1 Ministry of Interior:** There instabilmente by side or section for security and safety in the industry facilities: a Civil Defense Department, one of the Ministry of Interior Procedures the necessary actions to protect the population and public and private property from fires and disasters and war risks.

**4.4.2 Ministry of Industry:** is the government agency responsible for industry and development and to give licenses for the plant and requires the ministry to factory owners to provide necessary plans for the plant to include industrial and construction, architectural, electrical work and safety schemes.

**4.4.3 The Ministry of Labor:** it falls within the objectives of this ministry and responsibilities of an overall policy to work within the framework inspired by the values and principles in order to achieve work safety and workers together.

**4.4.4 Sudanese Organization for Standardization and Metrology:** a scientific point of control things bother industry and holds the version for determining the specifications for the products and specifications for the standard means of securing the required safety regulations.

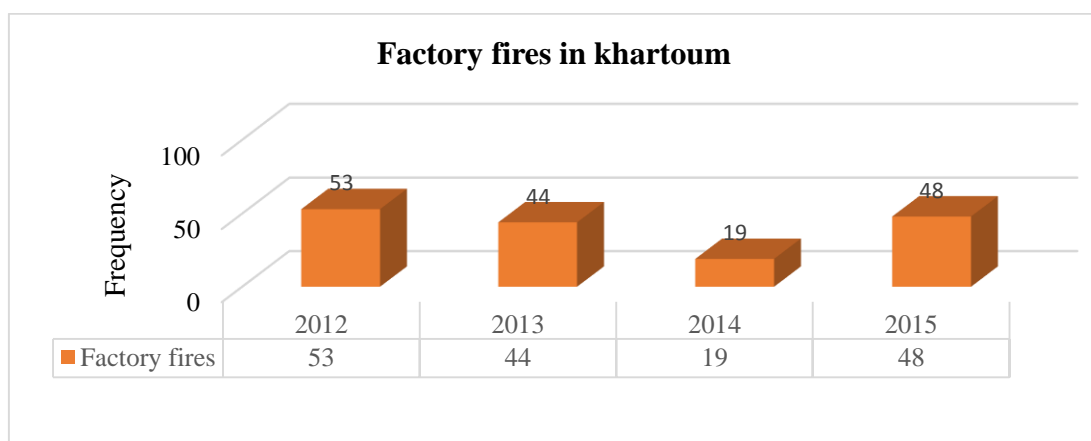
**4.4.5 Research Center and Industrial Consulting in Khartoum:** Center contributes to the development of the industry in Sudan and to provide studies and research, consulting and industrial necessary services and raise the level of awareness to achieve industrial technological and economic progress in the field of industry.

**Table (4-2) shows statistical fires factories incidents in the city of Khartoum.**

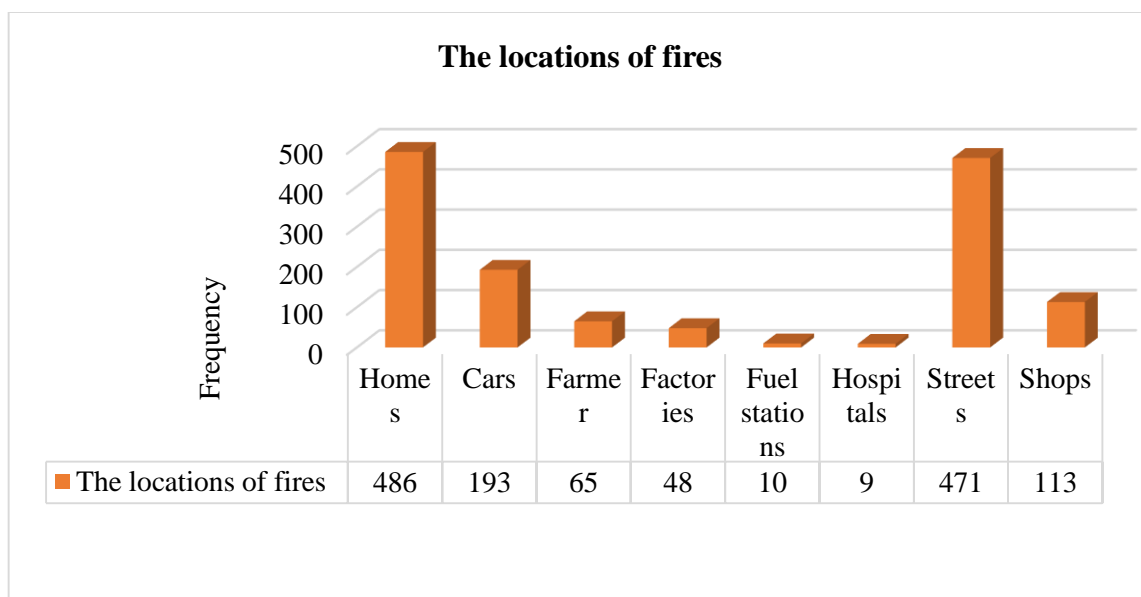
Year	2012	2013	2014	2015
Month				
January	4	1	0	3
February	3	2	0	5
March	11	7	3	1

April	5	9	2	10
May	4	6	3	5
June	5	3	1	7
July	0	1	3	4
August	6	0	2	2
September	8	6	3	1
October	4	4	1	0
November	2	3	1	3
December	1	2	0	7
sum	53	44	19	48

Source: Ministry of Civil Defense, 2016.

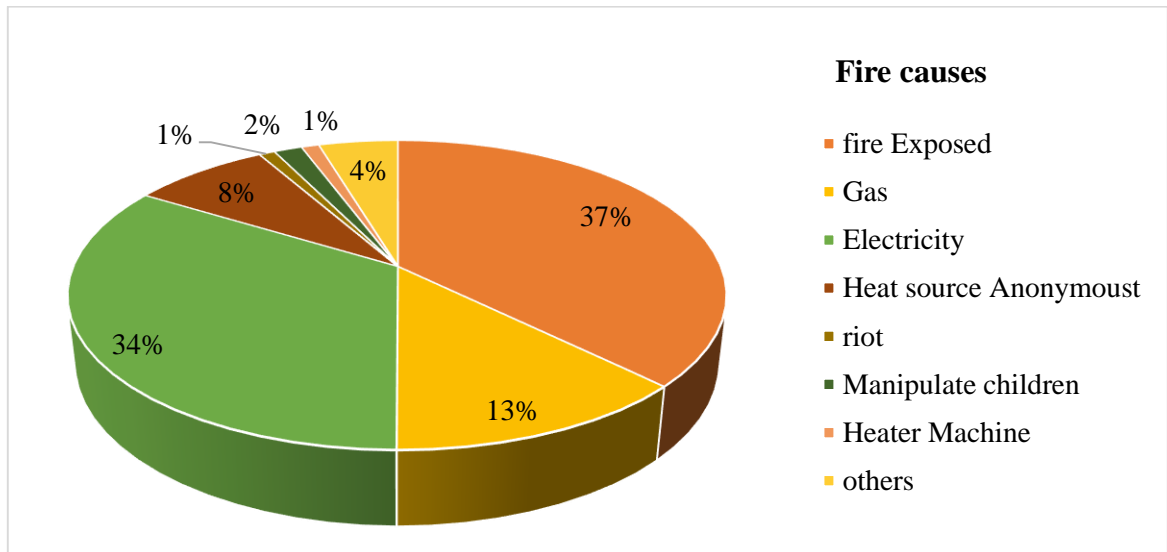


The chart (4-3) shows statistical fires factories incidents in the city of Khartoum  
Source: Ministry of Civil Defense, 2016



The chart (4-4) Statistics shows the locations of fires occurred in the city of Khartoum  
Source: Ministry of Civil Defense, 2016





The chart (4-5) shows statistical causes of fires in the city of Khartoum for 2016.  
Source: Ministry of Civil Defense

#### 4-6 Factories and building code legislation:

I have identified the laws and legislation construction conditions and determinants of private factories and the relationship of repercussions neighborhood, also identified building safety laws to achieve the best means of comfort and follow up its implementation by the competent authorities, and that it has received the factories in the domestic and international cities of interesting and enforce the law, which also ensured periodic follow-up to ensure the maintenance and quality of media the necessary safety, especially fire extinguishers and early warning, , as stipulated in the list of prevention and safety for the year 2007 for the prevention of fire in the factories must be the owner or his representative and the means of safety and prevention maintenance of the fire to keep the good and usable condition when necessary, despite these and other provisions contained in the Local Government Act, which was issued in the year 1994, it did not receive adequate follow-up to the competent authorities which created factories without providing **the means for adequate safety where, for several reasons, including:**

- Not to issue a list of factories safety conditions
- issued the first Code of Civil Defense in 1991 has not issued any regulations organization only in 1994, when the first list was issued under the name of precaution against fire.
- The weakness of the culture of the community and factory workers through safety and their requirements necessary in the building and not knowing how to use the means of fire, such as the extinguisher and hand hoses and others also allocated to the amortization of the

water, the poor state of the media as a result of damage and poor maintenance and follow-up.

The following are the most important laws passed relating to safety and prevention in the factories in the state of Khartoum:

- A list of prevention and safety for the year 2007 (Civil Defense Department).
- To list Organization of construction of Khartoum State for the year 2008 Chapter VIII requirements and specifications for buildings in industrial areas (Ministry of Physical Planning).

**Private acts of prevention and safety legislation:**

- 1 / Civil Defense Act of 2005.
- 2 / list of prevention and safety for 2007 and its annexes.
- 3 / Ministerial Decree No. (509) for the year 1994 and secured the private facilities.
- 4 / Ministerial Decree No. (189) for the year 2004, linking the central alarm and warning systems.
- 5 / Police Force Act of 2008.
- 6 / specifications issued by the Council of Arab Interior Ministers (Building Codes - fire-fighting systems Code).
- 7 / international standards (NFPA).
- 8 / British codes (B.S 1988 -Code of practice).

#### 4-7 Civil Defense centers sites Khartoum State:

Table (4-3) shows Civil Defense centers sites Khartoum State and see App (2-G) too.

N.	Center name	site	Pho. n
<b>Khartoum sector</b>			
1	Presidency of Department of Civil Defense	Khartoum 3, South east, Family Club (Abdel Moneim yard).	0155154229
2	Railway station	East Karkar position and Southeast General Administration of Customs.	0154882443
3	Popular Center (alshapee)	The popular market in Khartoum Friday Market East and West ales lag.	0154882460
4	Local Center (almahaly)	Southwest land port.	0154889085
5	Bore Center	Nasser west along the judicial court.	0154882440
6	Alkalakla Center	West Alkalakla market lap next to electricity management.	0154882452
7	Logistics Center (alemtehad)	Jabra within the public administration buildings to supply police.	0154882351
8	Ten kilometers Center	Madani Street within ten kilometers of the power station.	0154882316
9	Hall Center	Within the premises of the Friendship Hall	0154889026
10	Rescue river branch	Nile Street north of Sixth of April Gardens.	0154882421
11	Prevention and Safety Branch	Khartoum 3, South east, Family Club (Abdel Moneim yard).	0154882301

N.	Center name	site	Pho. n
<b>Omdurman sector</b>			
12	East Center	West Omdurman locality and next to a police station east of East rotary-Tigani Almhe	0154882408
13	Popular Center Omdurman	The popular market Omdurman- neighborhood south of revolutions (athwart) position.	0154882332
14	Libya Centre	Market, Libya, north-east of the market north of the Arab market position	0154882442
15	Revolution Center	Athwar ninth alhara West local karri.	0154882409

Bahri and east of the Nile sector			
16	Industries Center	Industrial zone nautical neighborhood Hajjar factory.	0154882425
17	Shabbats	Southeast nautical rotary Central Market	0154882305
18	almas ad	East of the generator yard	0154889027
19	Fayhaa	East Alaelfon Street - Nile and South Medical School	0154882464
20	Haj Yousef	Six West Market and North Police Department Haj Yousif	0154882448
21	Garri	Garri of the area within the premises of free markets	0154882486

#### **4-8 Summary:**

by viewing of the above explains the researcher the follows:

\*lack of distribution centers of civil defense and long distance between its ,specially Soba industrial zone industrial zones.(see app 2,G).

\*Of observation researcher found that 55% of the factories used Fire extinguisher system manual of the Fire hoses, Fire hydrants.

\*And that 15% of the factories has assembly point for workers and has the official of the security and safety.

## *Chapter V*

### **Display and analysis of the study**

#### **5.1 Introduction:**

This chapter deals with a description of the procedures used by the researcher in the implementation of the study, such as the adoption of this approach, and the community of the study, and the study sample, and study tool used (resolution), and how to prepare and how to build, develop and ensure the constancy and credibility, chapter ends with statistical processes used to analyze the data and draw conclusions.

#### **5.2 Study Approach:**

In order to achieve the objectives of the study, the researcher using descriptive and analytical approach, which tries through which described the phenomenon and reconnaissance factories in Khartoum and known how the application of safety procedures and firefighting in industrial buildings and data analysis, and the relationship between the components to reach conclusions contribute to the understanding of reality and develop it. (عبيدات، وآخرون، 1987م)

#### **5.3 The study population:**

Is defined as all components of the phenomenon studied by a researcher at the problem of the study and its objectives, it consists study population consisted of all the factories in the city of Khartoum and the (5995) factory in Khartoum, according to official statistics of the Ministry of Industry in Khartoum, but most turned off from work due to economic conditions or used as warehouses.

#### **5.4 The study sample:**

Was selected study sample at random from the study population, where the researcher distributed number (100) questionnaire on the respondents (random sample of factories in Khartoum State) and after field application responded (70) factory fully and obtained a researcher on the 70 questionnaire are valid for statistical analysis of any 70 % of the size of the study population, and questionnaires were filled with all the required information by (100%).

#### **5.5 study tool:**

To achieve the objectives of the study, the researcher designed a questionnaire about "firefighting in industrial buildings in Khartoum," included three sections:

**Section I:** personal data, it's a private information for factory workers and contain (6) questions are (function, age, experience in the workplace, the factory site, the number of factory workers, the sector that employs the type of factory).

**Section II:** Questions concerning assumptions: are six hypotheses and containing (48) is at a rate of 8 per phrases hypothesis. (See Appendix 3)

**Section III:** Is about 3 questions revolve around:

- Contact Person of direct fire control.
- Reasons for non-use of automatic systems.
- concerned the application of firefighting from the design stage.

And the questionnaire includes the objectives of the study and urges the sample surveyed to choose the answers that fit their views away from prejudice, and offset each paragraph of the six themes list carrying the following statements: : (agree \_ a neutral \_ dis agree).

#### **5-5-1 Steps to build the questionnaire:**

The researcher going to prepare a study tool to see how the application of fire-fighting factories Khartoum were to follow these steps:

- Identify the main areas covered by the questionnaire.
- Identify the paragraphs that fall under each area.
- Design questionnaire in the primary image.
- Review and filtering the questionnaire with the supervisor.
- View questionnaire on a group of arbitrators with expertise.
- Modification some of questionnaire paragraphs in terms of addition, deletion and modification according to the views and proposals to come out in final form (see Appendix 5).

#### **5-5-2 Reliability and validity study tool:**

a. Stability and honesty study tool:

To make sure the virtual stability of the questionnaire and the validity of her words in terms of drafting, and clarity, the researcher introduced a resolution on the number of arbitrators and academics specialists and the number (6) of the various functional sites and degrees, as has been the questionnaire to a specialist in statistical analysis and after the restoration of the questionnaire were made adjustments as proposals arbitrators. (See Appendix 5, Appendix 7).

## B. Stability and statistical honesty:

Method was used alpha cronbach to measure the stability of the questionnaire for each hypothesis and total average assumptions are shown in Table No. 1 alpha cronbach coefficients, which measure the consistency and reasonableness of the resolution and clarity of the questionnaire.

Table (5-1) shows the alpha cronbach coefficients to measure the stability of the questionnaire phrases

Source: prepared by the researcher based on field survey data for 2016 through Spss program

Hypothesis	Numb of ferries	alpha cronbach coefficients for persistence
The first hypothesis	8	%66
The second assumption	8	%45
The third hypothesis	8	%71
Fourth hypothesis	8	%74
Hypothesis fifth	8	%59
Hypothesis sixth	8	%84
All ferries	48	%67

### **Result:**

It notes the researcher through the table (1) that the sincerity of the questionnaire all is 67% that means questionnaire is very enjoying a strong firming , That means if re-distribution of questionnaires to a similar sample we are going to get almost the same results.

### **5-5-3 Study tool application procedures:**

After getting a letter from the university stating connect researcher graduate studies has been hiring some colleagues in helping to distribute questionnaires to members of the study and asked them returned again and was counted and collected, where the number was 70 questionnaire valid for analysis and took distributed and collected (60 days) was done in a month October and November of 2016.

It was subsequently enter data, and processed statistically computer automated by the Statistical Package for Social Sciences (SPSS) program and analyze the data and extract the results.

## 5.6 Statistical methods used:

The statistical analysis of the responses of the study sample using the following statistical methods:

1. Alpha cronbach coefficient to test the validity and reliability of the questions in the questionnaire used for data collection.
2. Frequencies and percentages to describe the members of the study and determine the proportions of his answers with phrases resolution.
3. Mean and vein to arrange the answers to study individuals for phrases resolution by the degree of approval. (Mean & Mode)
4. The standard deviation to indicate the efficiency of the arithmetic mean in the representation of the data center. (Standard deviation)
5. Chi-square test to test hypotheses and determine the statistical evidence for phrases resolution.

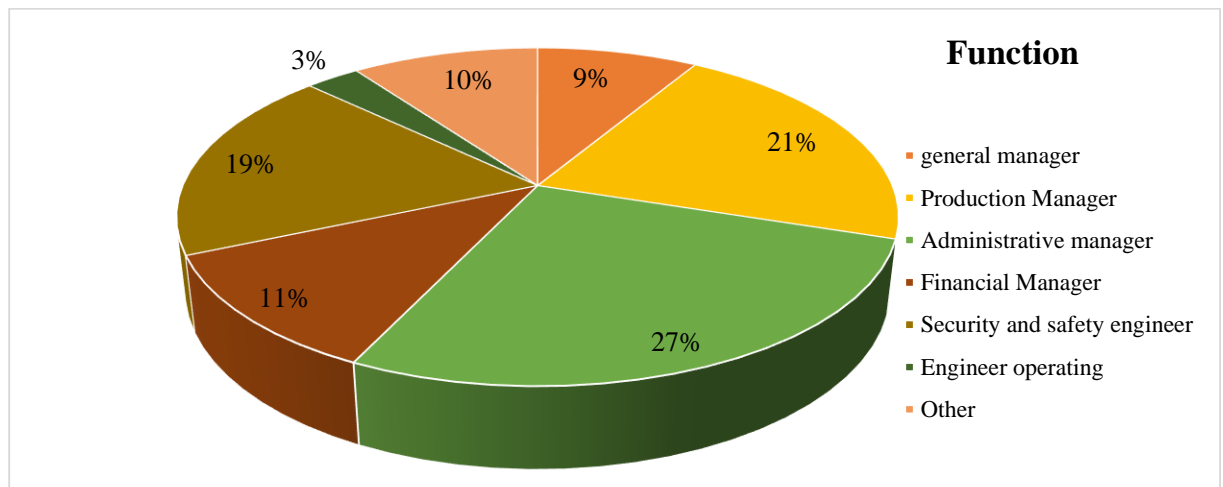
## 5.7 Questionnaire s data analysis and presentation:

Paragraph include a detailed view of the data analysis and review of the most important results of the study that was reached it by the questions of the study, it were used Spss program for analysis and Microsoft Office Excel, to view data in the form of forms.

### 5.7.1 Primary data analysis:

The study based on the number of independent variables related to Functional and personal characteristics for workers in factories. (See Appendix 5).

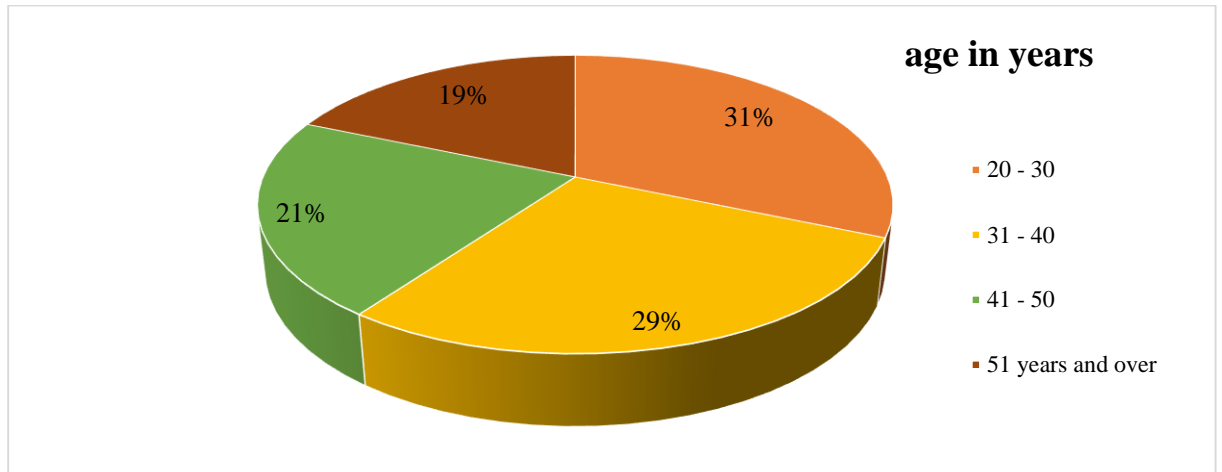
### 1. Function:



The chart (5-1) shows the distribution of the sample by function  
Source: prepared by the researcher based on field study data 2016 by SPSS program.

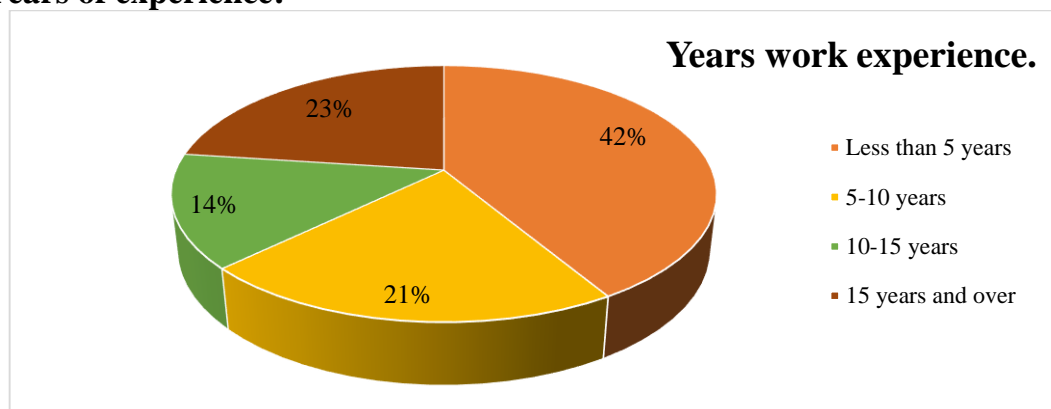


## 2. Age:



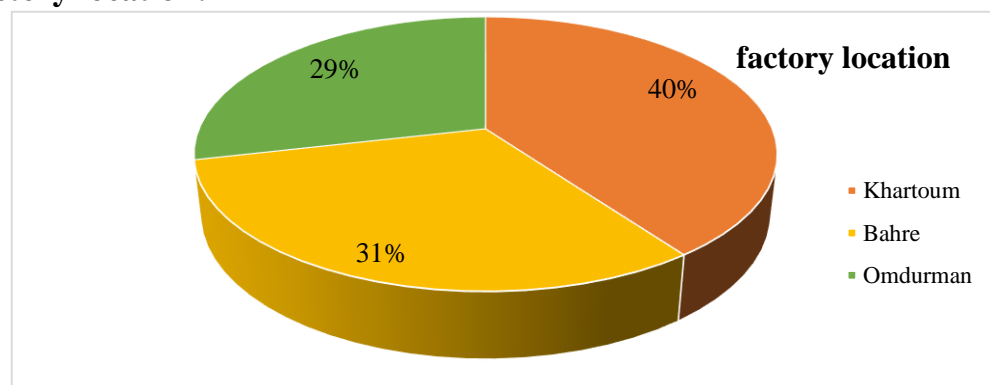
The chart (5.2) shows the distribution of the sample by age in years.  
Source: prepared by the researcher based on field study data 2016 through Spss program.

## 3. Years of experience:



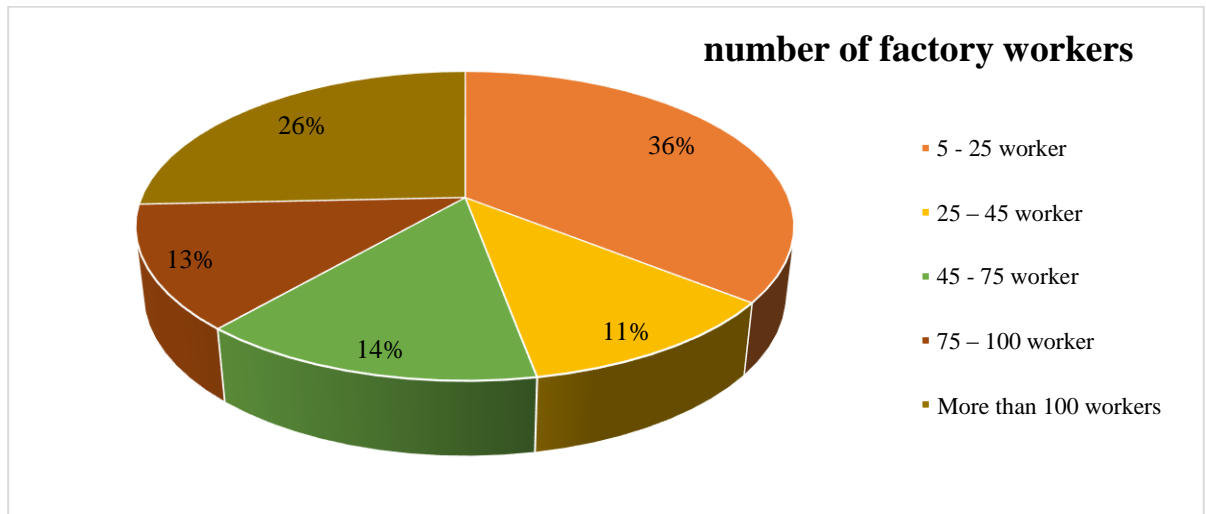
The chart (5-3) shows the distribution of the sample by years' work experience.  
Source: prepared by the researcher based on field study data in 2016 through Spss program.

## 4. Factory location:



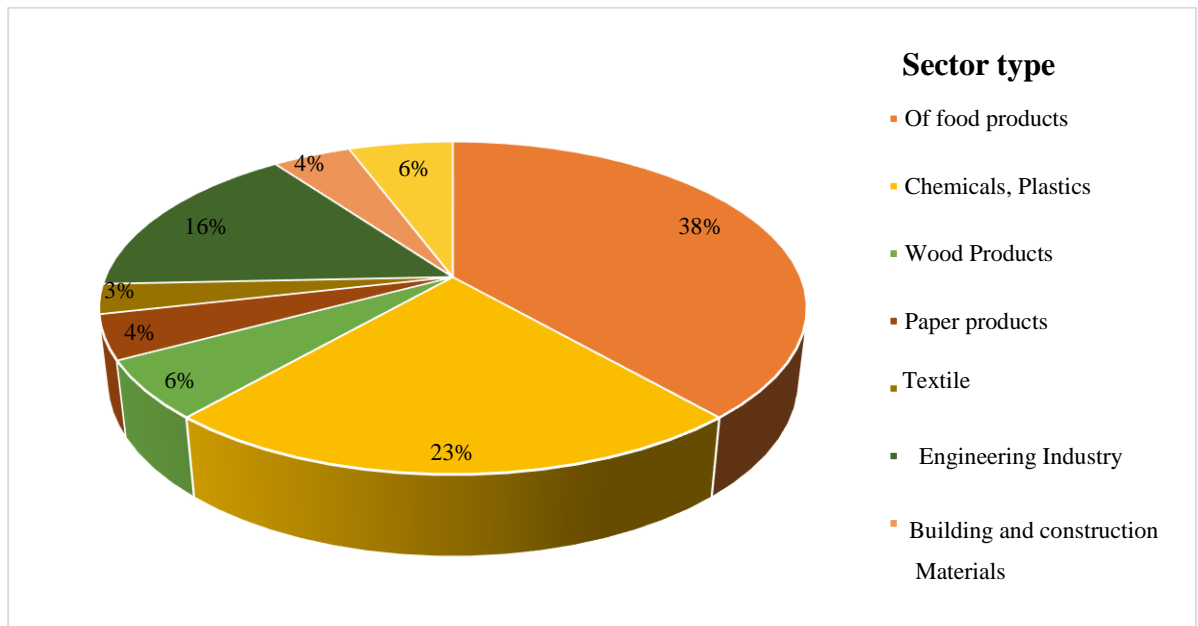
The chart (5- 4) shows the distribution of the sample according to the factory location.  
Source: prepared by the researcher based on field study data in 2016 through Spss program

## 5. Numbers of workers:



The chart (5-5) shows the distribution of the sample by singling out the number of factory workers  
Source: prepared by the researcher based on field study data in 2016 through Spss program.

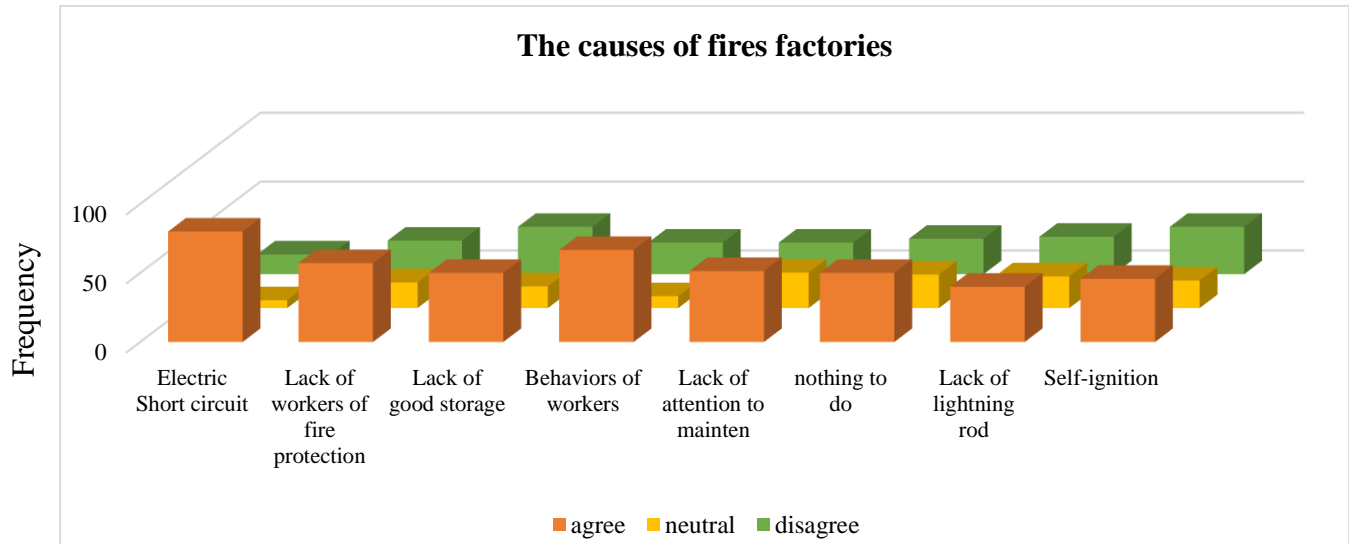
## 6. Sector type:



The chart (5-6) shows the distribution of the sample individuals by sector type  
Source: prepared by the researcher based on field study data in 2016 through Spss program.

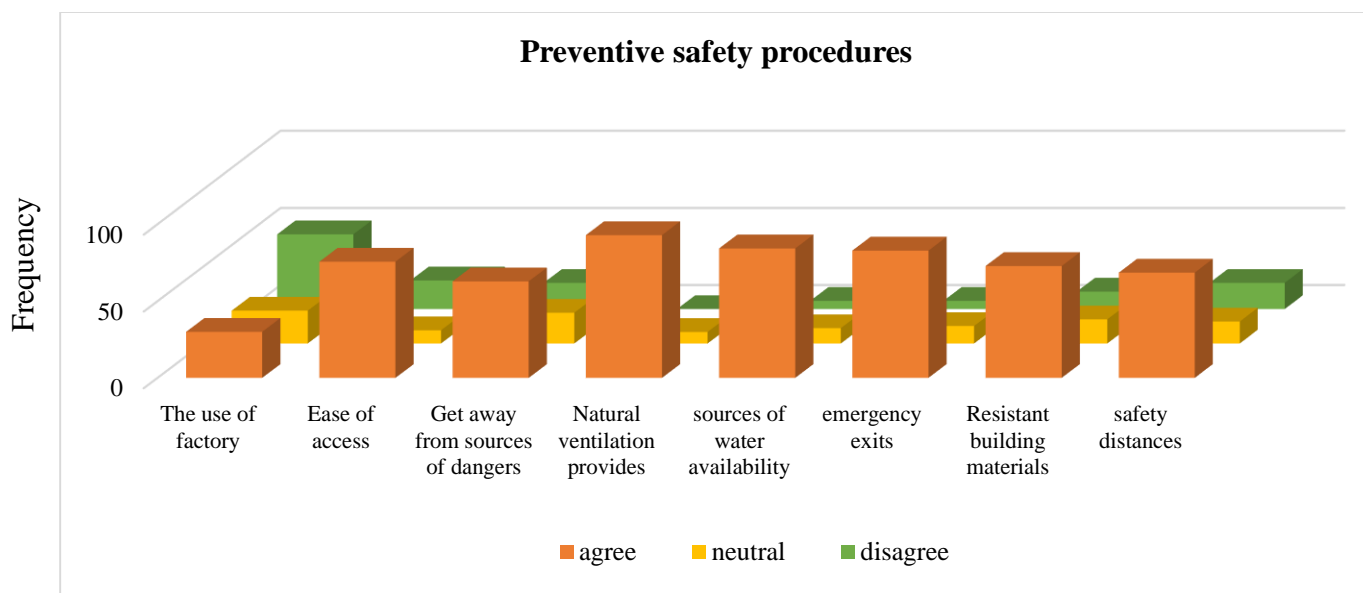
### 5-7-2 Basic data analysis:

**The first hypothesis**, which states (reasons that lead to the occurrence of accidents, fires factories in Khartoum)



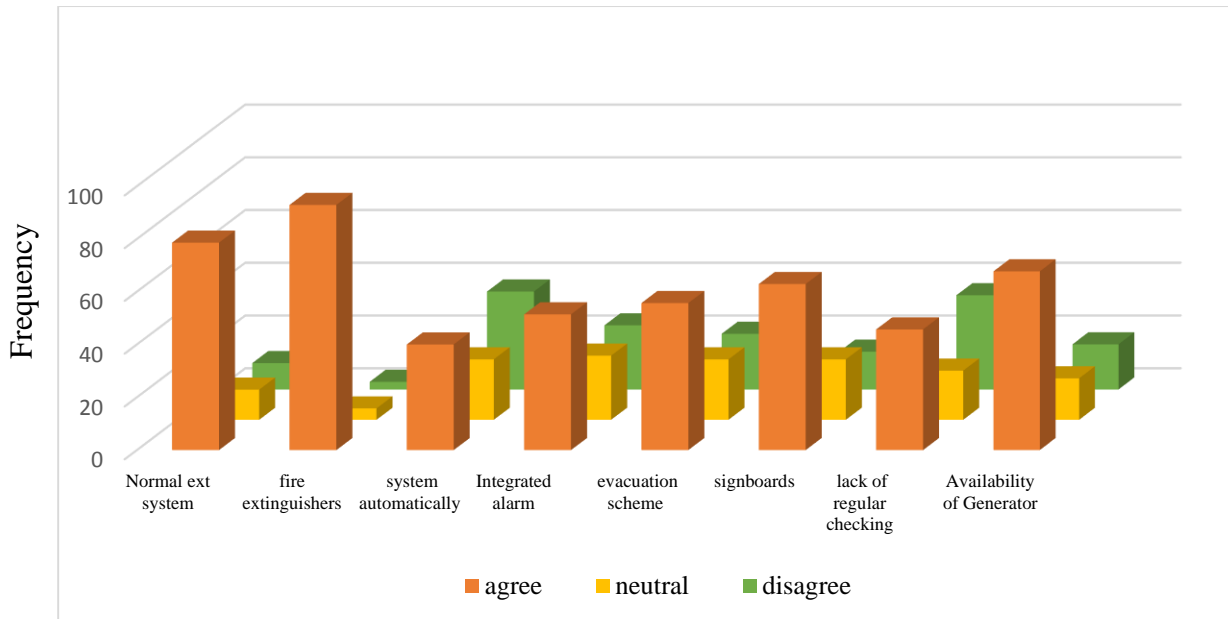
The chart (5-7) show reasons that lead to the occurrence of fire accidents factories in Khartoum. Source: prepared by the researcher based on field study data in 2016 through Spss program

**The second hypothesis**, which states (the availability of preventive safety measures in factories in Khartoum).



The chart (5-8) show the availability of preventive safety measures in factories in Khartoum Source: prepared by the researcher based on field study data in 2016 through Spss program

**The third hypothesis:** which states (the effectiveness of the safety system of the factory)



The chart (5-9) show the effectiveness of the safety system of the factory  
Source: prepared by the researcher based on field study data in 2016 through Spss program

**Fourth hypothesis,** which states (extent of attention factory administration the application of safety procedures measures)

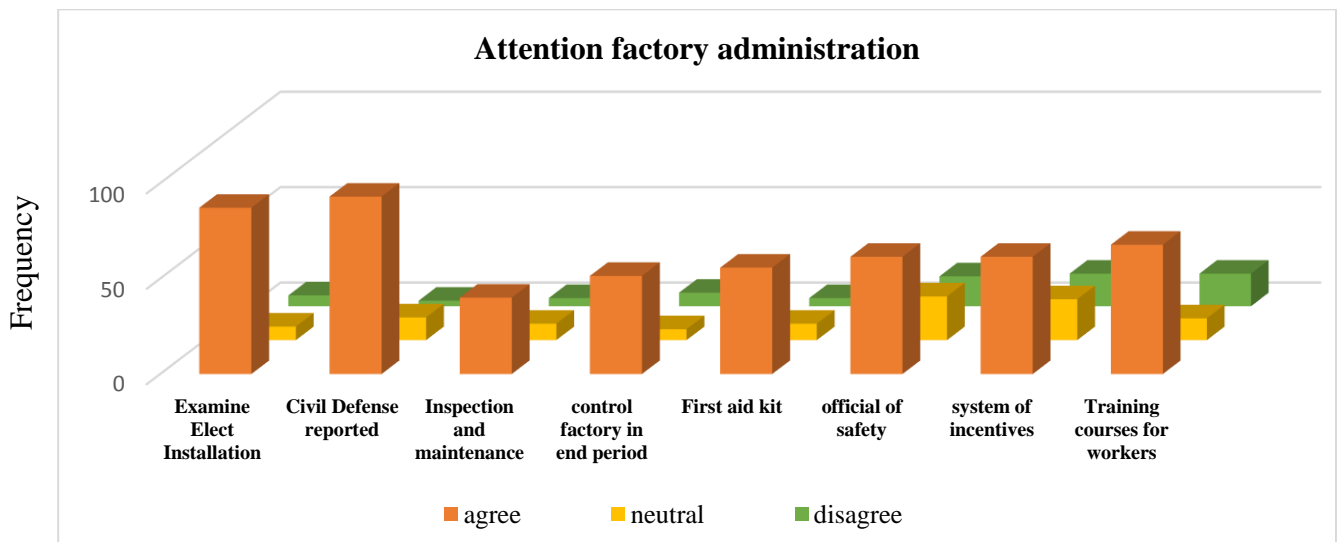


Figure (5-10) shows the ratios of attention extent of factory management.  
Source: prepared by the researcher based on field study data 2016 through Spss program.

**Fifth hypothesis**, which states (extent of attention factory workers to apply preventive safety measures)

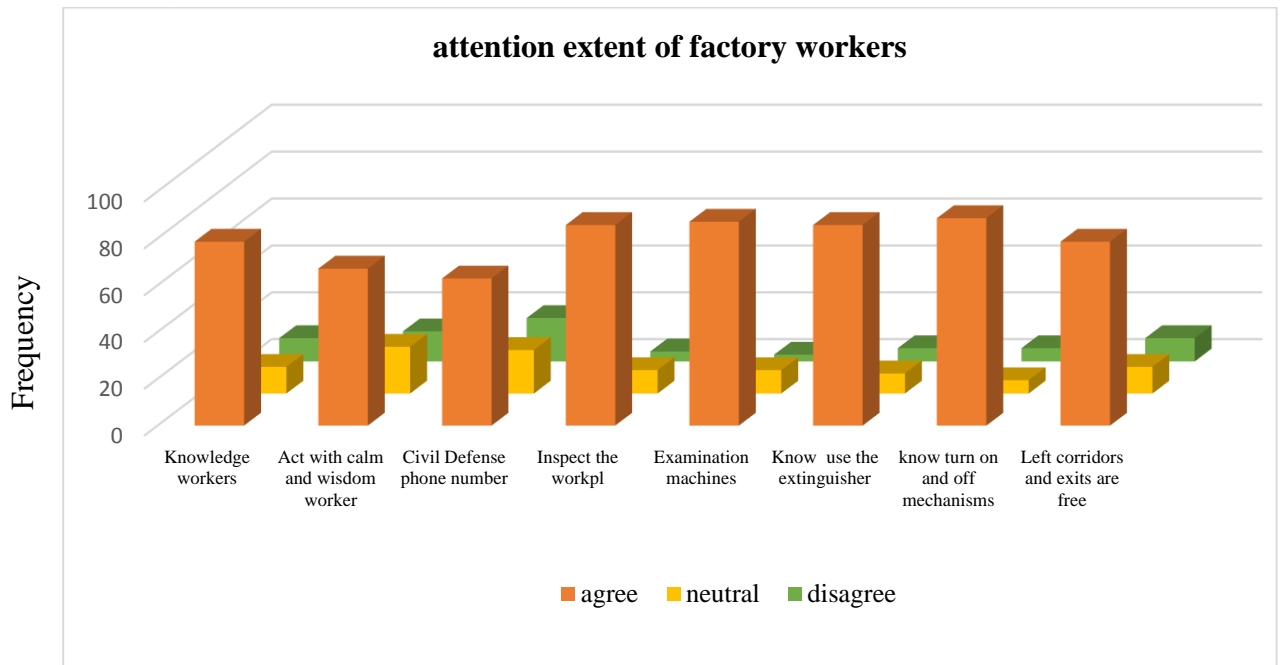


Chart (5-11) shows the ratios and occurrences of attention extent of factory workers.  
Source: prepared by the researcher based on field study data 2016 through Spss program.

**Sixth hypothesis**, which states (What are the obstacles that limit the effectiveness of fire-fighting in the factories)

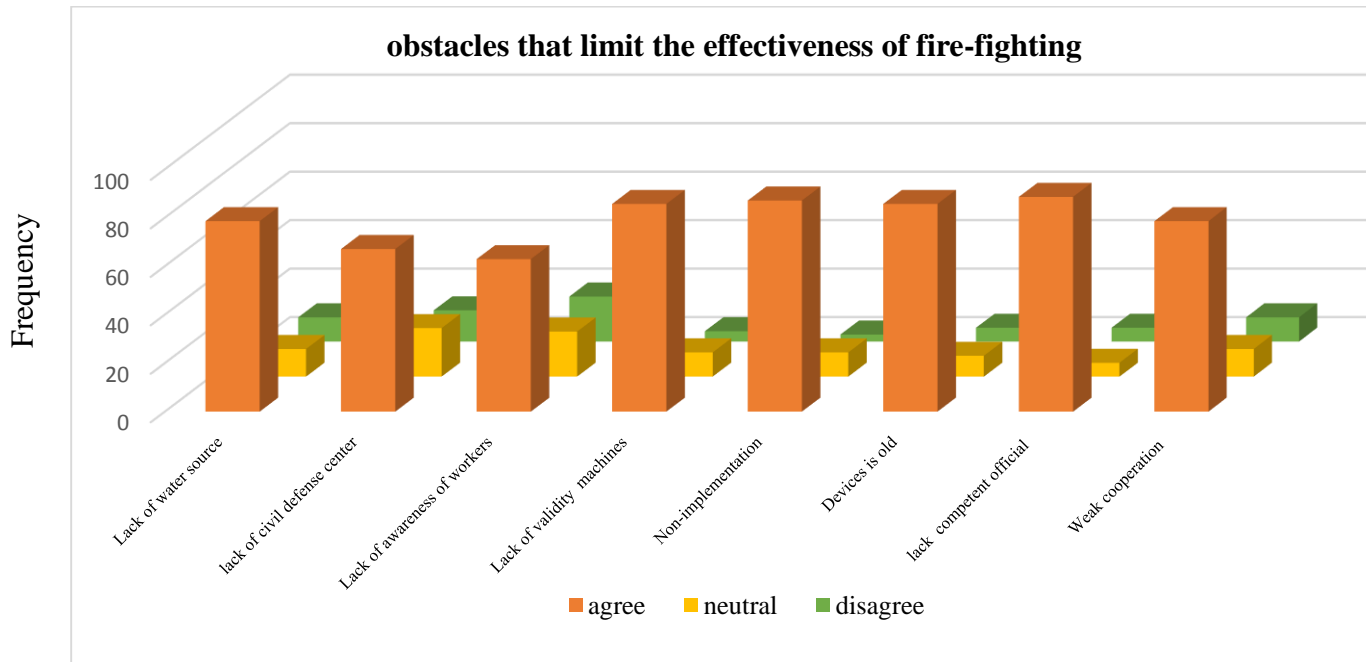
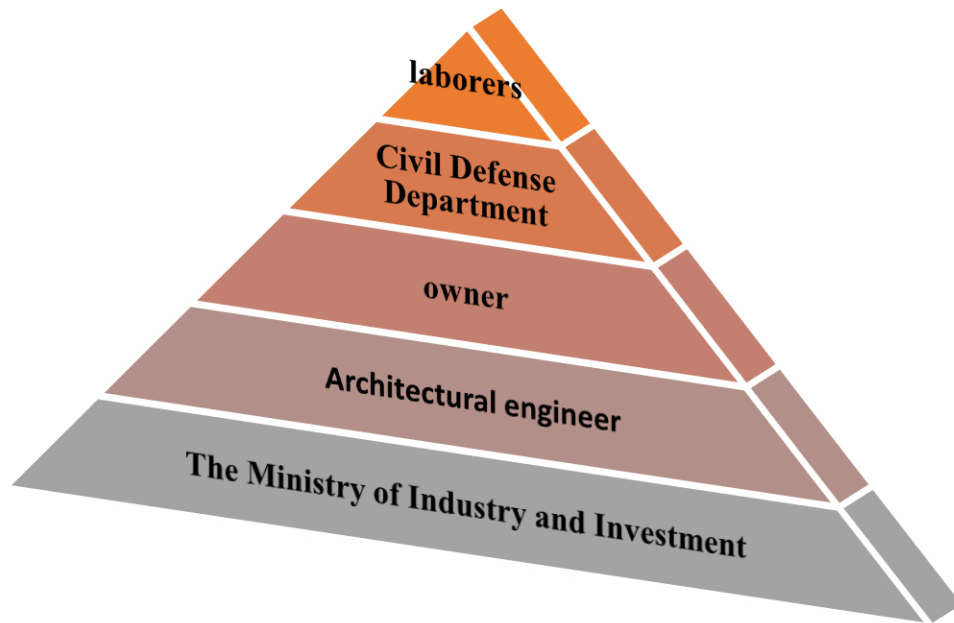


Chart (5-12) shows the ratios and occurrences of obstacles that limit the effectiveness of the fight against the fire.  
Source: prepared by the researcher based on field study data 2016 through Spss program.

**Seventh hypothesis:**

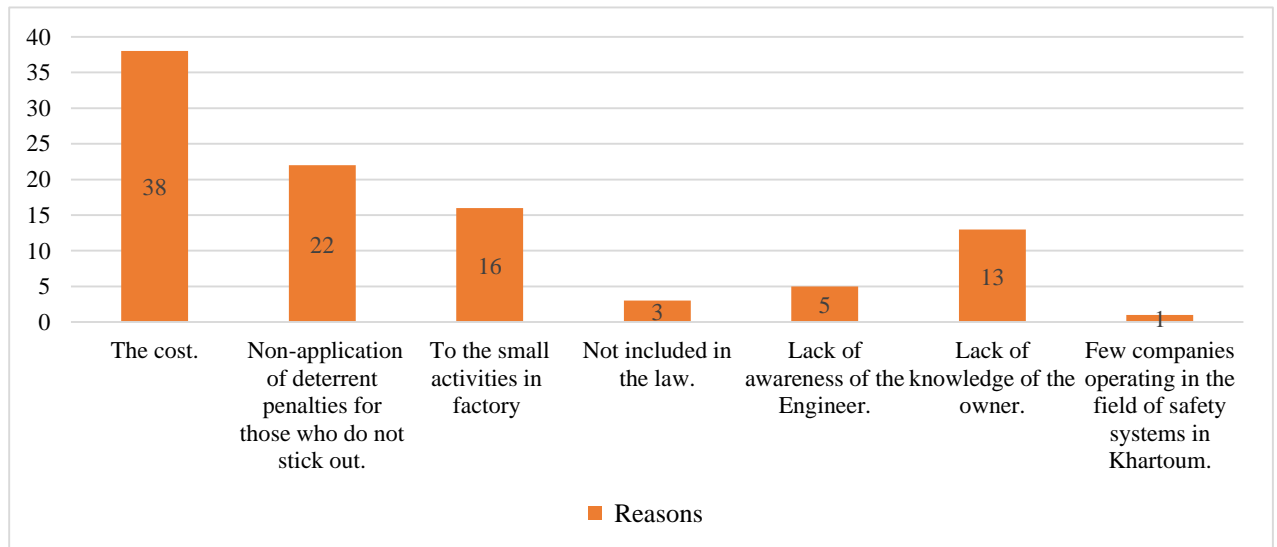
Chart (5-13) show the hierarchy of phrases, which states (in your view of the direct charge of the fight against the fires in factories in Khartoum?)



Source: (design researcher, 2016).

**Eighth hypothesis:**

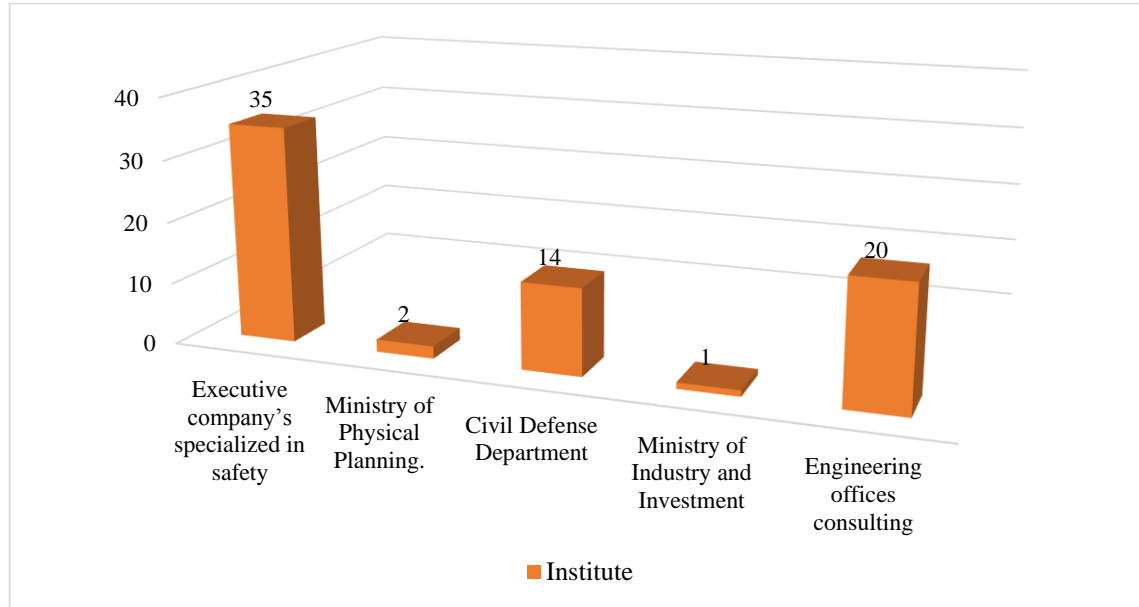
The chart (5-14) shows the percentages and duplicates for phrases, which states (When you are not using automatic fire systems in Khartoum factories it due to several reasons):



Source: (design researcher, 2016).

### **Ninth hypothesis:**

The chart (5-15) shows the percentages and duplicates for phrases, which states (If the owner wanted to design a factory applied firefighting according to specifications, he should go to:



**Source: (design researcher, 2016).**

### **5-8 Analysis of the questionnaire results and discussion:**

It was reached to results of the study after the answer the study questions and a researcher will clarification of the results of each axis separately:

#### **5-8-1the personal data of members of the sample:**

**5.8.1.1. Function:** we find 6 individuals and 8.6% were general managers of the factories and the number of 15 individual and 21.4% are production managers and the number of 19 individual and 27.1% are from the Managing Directors, while the number 8 individuals and 11.4% are Financial Officer and 13 individual and 18.6% are engineers, safety and security and the number two person and 2.9% are engineers operating and the number of 7 persons and 10% were other functions that operate factories.

**5.8.1.2. Age:** The researcher observe (22) individual and by 31.4% between the ages of 20 to 30 years and the number (20) individual and by 28.6% aged between 31 to 40 years and

the number (15) individual and by 21.4% between the ages of 41 years to 50 years and the number (13) individual and 18.6% aged over 51 years.

**5.8.1.3. Years of Experience:** researcher find (29) individual at 41.4% of their terms in less than five years and the number of service (15) individual and by 21.4% between their terms to work from 5 to 10 years and the number of (10) individuals and 14.3% work in their terms ranging from 10 to 15 years and the number (16) individual and by 22.9% working in this field for more than 15 years.

**5.8.1.4. Factory location:** The researcher observe is Khartoum area progressing areas at (29) factory by 40%, while the Bahre area at (22) factory and represents 31.4 percent and finally Omdurman at (20) factory and 28.6%.

**5.8.1.5. the number of factory workers:** we find about (25) factory by 35.7% of the small factories that range from the number of workers in each factory from 5 to 25 workers and the number (8) factories and by 11.4% ranging from the number of workers in each factory them between 25 to 45 workers and the number (10) factories and by 14.3% between the number of workers at each plant them between 45 to 75 workers and the number (9) factory and by 12.9% between the number of workers at each factory them between 75 to 100 workers and 18 factory and by 25.7% is one of the large factories employing more than 100 workers.

**5.8.1.6. sector type:** we find the number (27) factory and by 38.6% of the food industry and number (16) factory and by 22.9% working in the field of chemicals (drugs and plastic) and a number (4 ) factories and by 5.7% working industry, wood products and the number (3) factories and a 4.3% working in the field of paper products industry and the number (2) factory and a 2.9% working in the textile industry and the number (11) factory and by 15.7% working in the field of engineering industries and the number ( 3) factories and 4.3% working in the industry of building materials and construction, and (2) factory and 5.7% work in the metal industry products.

## **5.8.2 The second axis: study questions:**

### **5.8.2.1. What are the reasons that lead to the occurrence of accidents, fires factories in Khartoum?**

The study showed that there is approval on the phrases the premise that short circuit and neglect electrical connections and in an estimated 80%, and behaviors of workers from



smoking and threw cigarette butts estimated 66%, and lack of commitment to workers the instructions of fire prevention an estimated 57%, and lack of attention to the maintenance and operation of the follow-up mechanisms and neglect of an estimated 51%, and the lack of good storage and fatalism nothing to do for a person in their occurrence is estimated at 50%, and self-ignition of materials and lack of lightning rod an estimated 40%.

### **5.8.2.2 What extent the availability of preventive safety measures in factories in Khartoum?**

The study showed that there is approval on the phrases the premise that the terms and availability of natural ventilation openings is estimated at 92.9%, and that water sources are available and can be allocated a quota for fire-fighting and an estimated 84%, and that the emergency exits are available

When fit the numerical workers increased by 82.9%, and that the factories did not change in its use (formerly Workshop) and by 75.7%, and that the construction materials used to build the factory resistant to fire, and by 72.9%.

It is noteworthy researcher having safety distances between the factory and neighboring buildings by 68.6%, and 62.9% percent are estimated to factories after the sources of risk.

### **5.8.2.3 What is the effectiveness of the safety systems for fire-fighting in factory? (See app 1).**

Note from the researcher and conducting the study has created a 92.9% ratio to provide a sufficient number of fire well and distributed extinguishers, and 78.6% of the sample of the study show that there is a provider extinguishing system with water hoses, 67.7 % of the factories provide Backup Generator to the work of lighting, and 62.9% lack of regular checking and maintenance and follow-up to the work of warning and fire extinguishers, and the proportion of 51.5% of the factories provide integrated and linked alarm network surveillance cameras, and 50% of the study sample does not provide a private plot of evacuation and signboards for emergency exits factory.

The automatic extinguishing system (sprinklers system) is available at 40% of the study sample.

#### **5.8.2.4. What is the interest the factory administration to apply preventive safety measures?**

The study showed that 87.1% of the study sample the factory control end of working and provide aid fund primary and inform the civil defense of all accidents, and 71.4 of the sample you make the workers training in fire-fighting, first aid, and that 61.4% of the factories are applied incentives system after positive and negative scans and monitor the electrical wiring and the availability of the official of the safety of factory and examine and maintenance of safety systems periodically.

#### **5.8.2.5. What interest over the factory workers to apply preventive safety measures?**

The study showed that there is approval on the premise phrases and that 87.9% of the study sample proportion are running machinery and the way to stop and were checking machines and mechanisms before and during the work, and the proportion of 85.7% inspect the workplace before departure and arranged and are keen to disconnect the power before leaving the factory and see how use the fire extinguisher, and their locations, and that 78.6% of the study sample are leaving to escape corridors and emergency exits free of inhibitions and they have knowledge of safety procedures, and that 65% of the study sample are acting calmly and wisely and know the time of the fire civil defense emergency phone number.

#### **5.8.2.6. What are the obstacles that limit the effectiveness of fire-fighting in the factories?**

The study showed that after the civil defense centers and few in number of obstacles and is estimated at 70% and that the lack of awareness of workers and their awareness of the seriousness of the incidents of fire and weak cooperation between the factory management and the competent authorities is estimated at 58.6%. And 53.6% of the study sample proportion believes that the lack of a source of water for fire-fighting and lack of implementation of defense instructions semen of obstacles. And 41.5% of the opinion that the absence of the official of the safety specialist to conduct screening and detection League for fire protection, and that 35% of the sample of the study says that the lack of mechanisms validity and non-compliance with the specifications and that the systems used to combat old and modern of obstacles to the fight against the fire.

#### **5.8.2.7. In your opinion of the direct charge of the fight against the fires in factories in Khartoum?**

70% of the sample believes that the collective responsibility shared responsibility among all parties (workers and staff and the owner and the Department of Civil Defense and the architect and the Ministry of Industry).

And 30% believe it is an individual responsibility, (5% believe it is the responsibility of the owner, 18% see it as the responsibility of the Department of Civil Defense, and 5% believe it is the responsibility of the workers and the architect and the Ministry of Industry.

#### **5.8.2.8. Reasons for non-use of anti-automatic and automatic plants Khartoum systems?**

The study showed 38% of the sample believes that is the cost of the most important reasons, and 22% believe that the non-application of deterrent penalties for those who do not abide by them, and that 16% believe that the lack of the owner's knowledge systems and that 5% believe that the lack of knowledge of the engineer and his experience from systems and that 3% believe it is not present in the laws and regulations and 1% believe that the small companies working in the field of safety systems in Khartoum.

#### **5.8.2.9. Those who go to the owner when designing factories firefighting applied according to the specifications?**

The study showed that 35% of respondents go executive for companies specialized safety, and that 20% believe that consulting engineering firms are best suited.

And 14% say that the Civil Defense Department is the appropriate body, and 2.5% believe that the Ministry of Physical Planning hand is designing factories to combat the fire according to the specifications and to 0.5% believe that the Ministry of Industry and Investment.

Of this part determine the causes of the problem and stand on finding solutions and recommend implementation.

### **5.9 Summary results of the questionnaire:**

In this chapter the survey analysis and access to the results, the researcher using a clear methodology described subject of the study, analysis of data and displayed on graphs for easier access to the results, which indicate:

- 5.9.1 Most of the factories are concentrated in Khartoum region in the industrial zone.
- 5.9.2 Considered for the food sector of the sectors most prevalent, followed by chemicals and plastics.
- 5.9.3. Inadequate laws and stipulations used and the lack of follow-up implementation.
- 5.9.4. Lack of awareness of the concept of safety and fire-fighting with the factory owners and the community in Khartoum state.
- 5.9.5. Considered after civil defense centers and the lack of special industrial zones of the biggest obstacles that limit the fight against the fire.
- 5.9.6. Workers' behavior and their awareness has a big role in fighting the fire and the absence of fire.
- 5.9.7. The responsibility of fire-fighting collective responsibility involving all parties.
- 5.9.8. Considered electricity is the main reason why most of the fire incidents.
- 5.9.9. Most quench handicrafts factories with limited capacity and are not subject to maintenance and replacement distributed.
- 5.9.10. Lack of cooperation from service institutions such as power management and other.... to carry out the separation of power when a fire occurs.
- 5.9.11. Increased loads on the cables and wiring harnesses.
- 5.9.12. High cost of systems and features such as firefighting (sprinklers system).
- 13. Weak oversight and coordination between the relevant agencies and departments of the factories which hinders control.
- 5.9.14. Lack of keeping up and considerations for the future expansion of the plant and increase prevention and control devices.
- 5.9.15. Proportion of workers' education and training Medium
- 5.9.16. Not to impose deterrent penalties for those who do not abide by the directives of prevention and safety.
- 5.9.17. 45% of the city of Khartoum factories applied fire-fighting of the existence of manual systems such as: (a fire extinguisher and hoses and fire and hydrant).
- 5.9.18. Poor documentation of information and statistics

## *Chapter VI*

### **Conclusions and Recommendation**

#### **6.1 Epilogue**

It was not this research that goes out of Without preferred to God and to reconcile, then efforts who provided me all the useful information valuable, rewarded God everyone the best reward, and not least in the modern, this topic needs more study and exploration due to For further study and exploration because of occupies the importance of preserving the lives of people, and property , and by this research is only the an attempt to open this door for scientific research, if was in it from the goodness and rightness of it is God's grace upon us,, and if it was a shortage and a defect it for myself and the devil ,I Hope with God to acceptance and Rashad.

#### **6.2 Extract Summary results of the study:**

The study concluded that there is a Shortening clear in follow the industrial buildings, and that the neglect of maintenance of Electrical connections is Main cause of the outbreak of fires factories ,and lack of commitment to the application of safety requirements necessary for fire protection poses great danger to The lives of workers and employees in factory. And the behavior of the workers has a significant role in the failure of the fire and prevent its spread, combat, and responsibility that is the responsibility of the owner to provide the means necessary for building protection.

#### **6.3 Recommendations:**

Through what is shown by the results, the study recommends the following:

6.3.1 The need to modify and update the laws and requirements necessary for the safety of workers.

6.3.2 The enactment of laws and impose deterrent penalties on violators, because the penalties are not a deterrent.

6.3.3 Spread the concept of safety and firefighting across different media.

6.3.4 Attention to regular maintenance, machinery and carry out inspections and follow-up.

6.3.5 Providing the means and fire extinguishing systems are reduced charges as relatively, and therefore companies exemption from customs duties.

6.3.6 Action Line connecting satisfied both machinery and paintings main power to unload excess cargo.

6.3.7 Private boycotted the work of all the supply line fed by a series of electrical appliances factory.

6.3.8 Providing a hand extinguishers different with extinguishing material commensurate with the type of burning the plant material sizes.

6.3.9 Worker training and work experiences of evacuation plans

6.3.10 the need to take action on a field inspection of existing plants and inspect the systems and means.

6.3.11 the use of intelligent systems to monitor factory fire extinguishing systems (direct alarm system operations)

6.3.12 appropriate distribution units firefighters Hand.



The figure (6–1) show intelligent systems to monitor the extinguishing systems in factory.  
(Direct alarm system operation)

Source: [www.24x7dcd.ae](http://www.24x7dcd.ae) & [www.albayan.ae](http://www.albayan.ae).

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Dubai Civil Defense

# List of Appendixes

## Appendixes (1):

### Definition of some important terminology

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

Heat transfer:-

1-Conduction.

2- Convection.

3- Radiation.

**1-7-2 what is Flame?** Is the visible, gaseous part of a fire, it is caused by a highly exothermic reaction taking place in a thin zone, is actually a vapor phase chemical reaction between fuel vapor and oxygen

**What is smoke?** Smoke is a collection of airborne solid and liquid particulates and gases emitted when a material undergoes combustion or pyrolysis, together with the quantity of air that is entrained or otherwise mixed into the mass

Although smoke can contain hundreds of different chemicals and fumes, visible smoke is mostly carbon (soot), tar, oils and ash.

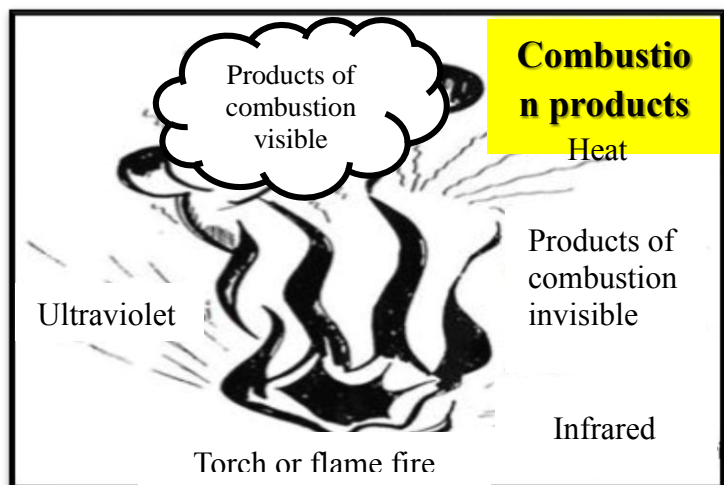
**What is the Combustion?** is a continuous process requiring continuous supply of new fuel and new oxidizer in the flame zone.

**Combustion products:** vary depending on the quality and composition of the material and cause burning of these products and the risk of damage to living organisms and the environment is the most

important outcomes:

the heat

- Combustion gases
- Flame
- Smoke
- Soot
- Ash and debris (the remnants of the burning material)



The figure shows Combustion products.  
Source: [www.arabic safety](http://www.arabic safety)

Appendixes (2): **Photos**



A. The fire extinguishing manual



B. Manual alarm system in factory.



C. Show the emergence exit



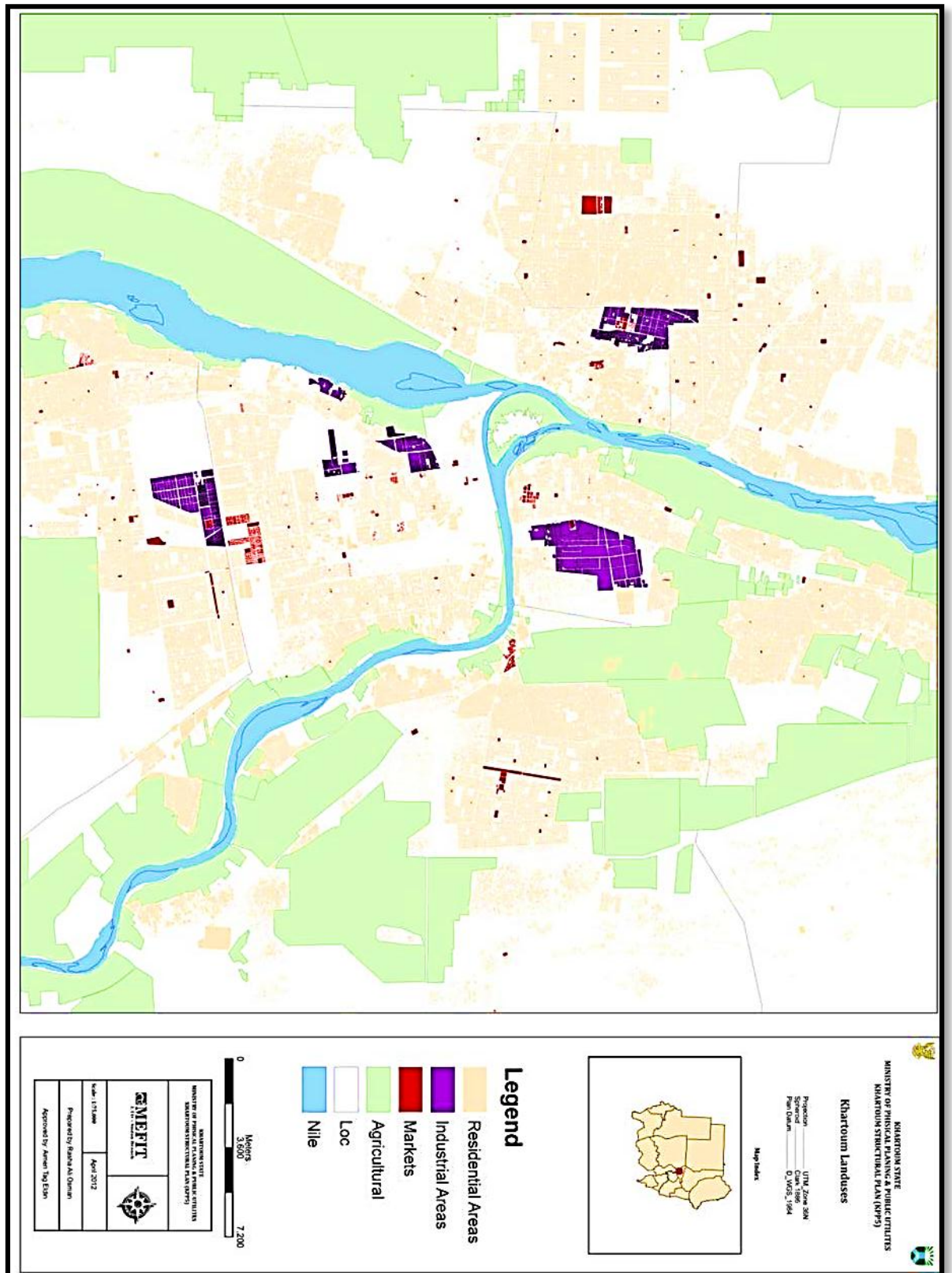
D. The natural ventilation by opening



E. Show the exhaust fan

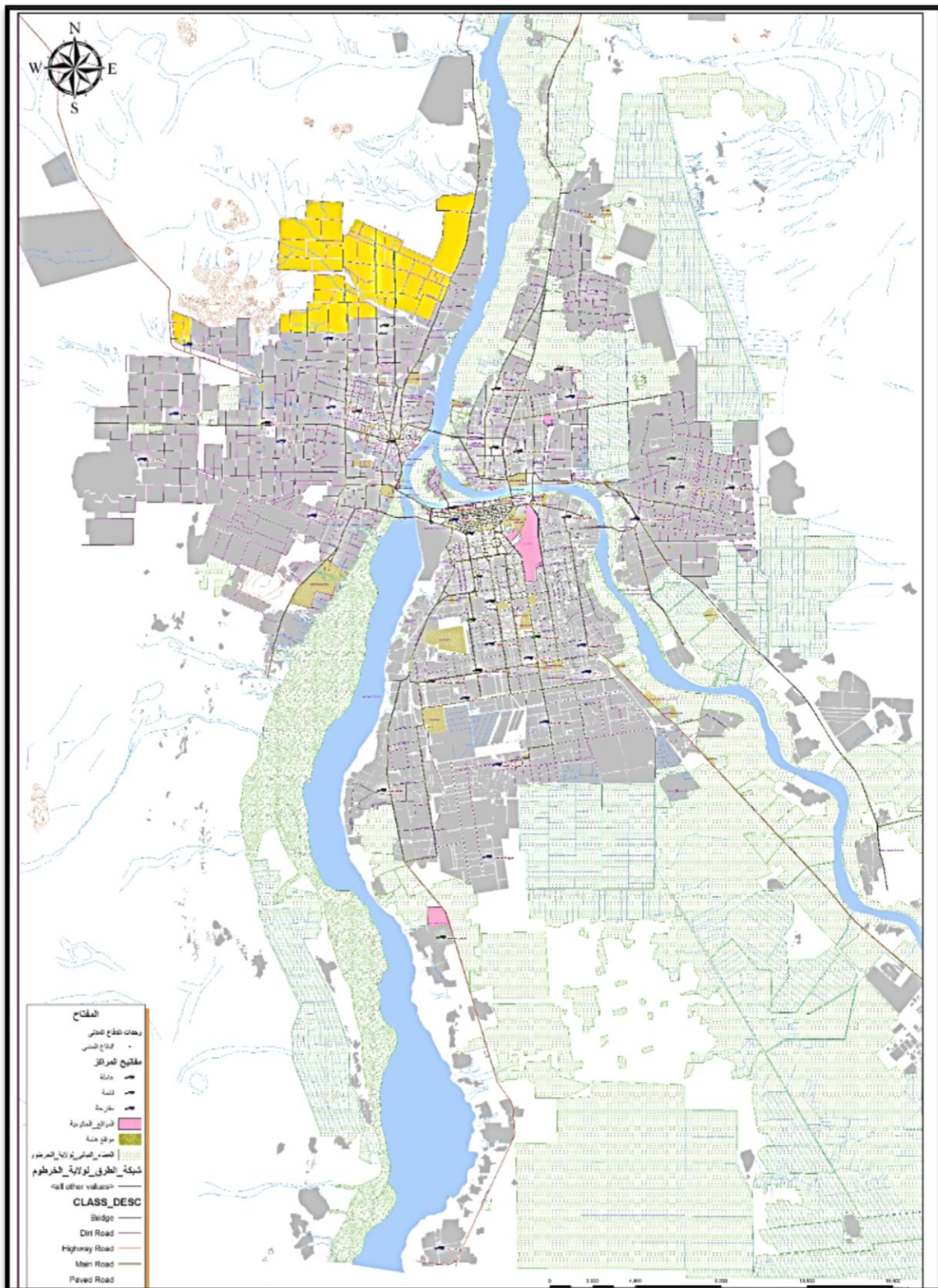
## F. The distribution of industrial area in Khartoum State

Source: Ministry of Physical Planning, May, 2016.



## G. The distribution of industrial area in Khartoum State

Source: Ministry of Physical Planning, May, 2016.



### Appendixes (3): the tables

**A. the Table show distances required between the buildings and the limits of the earth by building height and area of the holes on the exterior**

Space openings for space facade	Building height in meters		
	8	8 - 24	24 and above
	The distance in meters		
zero	No requirement		
Less than 50%	3	5	10
More than 50%	3	7.5	15
100%	3	7.5	15

Source: 2003 – متطلبات الوقاية من الحريق في المباني

**B. A table showing Fire sector area in industrial buildings depending on the seriousness of its.**

Dangerous industrial type buildings	Fire sector area (m <sup>2</sup> ) According Floor	
	Ground floor	Basement and the upper floors
Medium-risk buildings	5000 m <sup>2</sup>	1500 m <sup>2</sup>
High-risk buildings	1000 m <sup>2</sup>	500 m <sup>2</sup>

Source: 2003 – متطلبات الوقاية من الحريق في المباني

**C. the table show rate fire – resistance periods of the earth by building height and area of the holes on the exterior**

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hour	3 hour	2 hour	1 hour
1. Brick of clay or shale	1-1.1	Solid brick of clay or shale <sup>c</sup> .	6	4.9	3.8	2.7
	1-1.2	Hollow brick, not filled.	5.0	4.3	3.4	2.3
	1-1.3	Hollow brick unit wall, grout or filled with perlite vermiculite or expanded shale aggregate.	6.6	5.5	4.4	3.0
	1-2.1	4" nominal thick units at least 75 percent solid backed with a hat-shaped metal furring channel 3/4" thick formed from 0.021" sheet metal attached to the brick wall on 24" centers with approved fasteners, and 1/2" Type X gypsum wallboard attached to the metal furring strips with 1"-long Type S screws spaced 8" on center.	—	—	5 <sup>d</sup>	—
2. Combination of clay brick and load-bearing hollow clay tile	2-1.1	4" solid brick and 4" tile (at least 40 percent solid).	—	8	—	—
	2-1.2	4" solid brick and 8" tile (at least 40 percent solid).	12	—	—	—
3. Concrete masonry units	3-1.1 <sup>f,g</sup>	Expanded slag or pumice.	4.7	4.0	3.2	2.1
	3-1.2 <sup>f,g</sup>	Expanded clay, shale or slate.	5.1	4.4	3.6	2.6
	3-1.3 <sup>f</sup>	Limestone, cinders or air-cooled slag.	5.9	5.0	4.0	2.7
	3-1.4 <sup>f,g</sup>	Calcareous or siliceous gravel.	6.2	5.3	4.2	2.8
4. Solid concrete <sup>h,i</sup>	4-1.1	Siliceous aggregate concrete.	7.0	6.2	5.0	3.5
		Carbonate aggregate concrete.	6.6	5.7	4.6	3.2
		Sand-lightweight concrete.	5.4	4.6	3.8	2.7
		Lightweight concrete.	5.1	4.4	3.6	2.5

Source: تكنولوجيا تشييد المباني – فاروق عباس حيدر

**D. the Table show the required degree of fire resistance of the structure of construction**

Elements of structure	Residential buildings, commercial multi-story	Industrial buildings and warehouses
Columns, Beams and Floor slabs	2 hours	4 hours
Interior walls and interior partitions	2 hours	4 hours
The outer walls and the interval for the neighborhood or from hazardous sections of the building	4 hours	4 hours
Partitions for the way out (including the staircase) and a well elevator and skylight and horizontal and vertical conduits and other services	2 hours	4 hours
Note: It can increase the degree of fire resistance of columns and beams rate at the discretion of Civil Defense in the case of using the building for more than one purpose		

متطلبات الوقاية من الحريق في المباني – 2003 Source:

**E. a table showing the distances emergency exits:**

location or site	Dangerous type	floor	
		Ground	Basement
Direct distance within the department	medium	15	10
	high	7.5	7.5
Transport distances to exit or protected stairs	medium	40	20
	high	20	10
Closed endings	medium	7.5	7.5
	high	cannot be	cannot be

متطلبات الوقاية من الحريق في المباني – 2003 Source:

**F. Number and dimensions of the emergency exits, depending on the number of users is taken from the table (2-17) below:**

The number of people	Number of exits	The minimum width of exit
A maximum of 200 people	2	90cm
A maximum of 300 people	2	122cm
A maximum of 500 people	2	152cm
A maximum of 750 people	3	152cm
A maximum of 1000people	4	152cm

متطلبات الوقاية من الحريق في المباني – 2003 Source:

**G. a table showing the distances between the sprinklers:**

Hazard category	Max. spacing (s) of sprinkler heads (m)	Max. floor area covered by one sprinkler head (m <sup>2</sup> )
Light	4.6	21
Ordinary	4.0 (standard)	12
	4.6 (staggered)*	12
High	3.7	9

Source: Time saver book







**H. Table show Fire-fighting equipment for industrial buildings by category, the height and the structural classification.**

Type	Required cases	
Fire extinguishing equipment Hand	Hand extinguishers	All floors
Fixed installations	Rubber hoses Network	All floors
	Network dry nozzles	More than four floors (ground + three floors) and at altitudes of less than 28 m, or two floors with a total area of over 1,000m <sup>2</sup> .
	Network nozzles moist	Rise higher than 28 meters, or more than two floors with an area of over 1,000 m <sup>2</sup> per floor.
	Network external nozzles	In high-risk industrial buildings
	Network automatic sprinklers for firefighting water	In all industrial buildings, civil defense may be medium-risk buildings exception.
Automatic fixed systems	Network automatic sprinklers and other materials	Private -risk places where water cannot be used.
Fire alarm Equipment	Manual alarm network	All floors
	Network automatic alarm	In high-risk industrial facilities, or Places of high risk in the medium-risk industrial buildings.

Source: [www.998gov.sa](http://www.998gov.sa)



I. the Table show manual fire extinguishers.

Type	Fire class	color	The principle of extinction	Advantages	dis Advantages
Extinguisher carbon dioxide	B E		Strangulation and cooling	<ul style="list-style-type: none"> <li>• Stable gas</li> <li>• Non-electrically conductive</li> <li>• do not leave residues</li> <li>• nontoxic but lead to suffocation</li> </ul>	<ul style="list-style-type: none"> <li>• Obscures vision</li> <li>• cause difficulty breathing</li> <li>• occurrence of high VOTE</li> <li>• unhelpful in foreign uses (wind)</li> </ul>
Dry chemical extinguisher powder	AB C E		Strangulation	<ul style="list-style-type: none"> <li>• eliminate the flame quickly</li> <li>• Good to extinguish oil</li> <li>• Non-electrically conductive</li> </ul>	<ul style="list-style-type: none"> <li>• Obscures vision</li> <li>• renewal of the fire can be extinguished after</li> <li>• Do not function as cooling</li> </ul>
Extinguisher foam	A B		Strangulation and cooling	<ul style="list-style-type: none"> <li>• easy to use</li> <li>• High temperature resistant</li> <li>• Easy mixing with water</li> <li>• Capable of expansion</li> </ul>	<ul style="list-style-type: none"> <li>• You need to protect against freezing</li> <li>• conducts electricity</li> <li>• Do not use electricity to extinguish fires</li> </ul>
Water extinguisher	A		cooling	<ul style="list-style-type: none"> <li>• Easy to use and packing</li> <li>• Lightweight</li> <li>• easy maintenance</li> <li>• Low cost - • non-toxic</li> </ul>	<ul style="list-style-type: none"> <li>• conducts electricity</li> <li>• viable steel</li> <li>• need to protect against freezing</li> <li>• Not suitable only fires Category A</li> </ul>
Wet chemical extinguisher powder	A		Strangulation and cooling	<ul style="list-style-type: none"> <li>• Used to extinguish fires resulting from vegetable cooking oils and grease and animal fats</li> </ul>	<ul style="list-style-type: none"> <li>• Do not use for fire appliances and electrical equipment fires</li> </ul>
Holon extinguisher	-		strangulation	<ul style="list-style-type: none"> <li>• Eliminate flame quickly</li> <li>• Good to extinguish ongoing oils</li> <li>• Non-electrically conductive</li> <li>• Oxygen mask for fire</li> </ul>	<ul style="list-style-type: none"> <li>• Obscures vision</li> <li>• The fire can be renewed after blowing</li> <li>• Do not function as cooling</li> <li>• Harmful and poisonous with high exposure</li> <li>• Harm the ozone layer</li> </ul>

Appendixes (4):

ملحق لائحة تنظيم البناء

الفصل الثامن

الاشتراطات والمواصفات الخاصة بالمباني في المناطق الصناعية

الضوابط والمعايير الخاصة بالمباني في المناطق الصناعية

(21) 1/ نسب التغطية:

- (أ) القطع التي تقل مساحتها من 200 م<sup>2</sup>، يسمح باستغلال كل المساحة لمباني الورش الصغيرة وورش الحرفيين مراعاة التهوية والتصاميم الإنشائية.
- (ب) القطع التي مساحتها أكثر من 200 م<sup>2</sup>، وأقل من 400 م<sup>2</sup> يسمح ببناء حد أقصى 85% من مساحة القطعة الصناعية.
- (ج) القطع التي تزيد مساحتها عن 400 م<sup>2</sup> لا يسمح ببناء أكثر من 75% ولا يقل عن 30% من مساحة القطعة الصناعية باستثناء بعض الصناعات التي تحدد نسبة تشييدها وفق الجدول أدناه:

نسب البناء من المساحة	نوع الصناعة
لا يقل 15%	صناعة مواد البناء (خرسانات جاهزة، بلوكات خرسانية، طوب، ... الخ)
لا يقل 15%	أعمال الإنشاءات والمقاولات
لا يقل 10%	الطرق والجسور والحفريات
لا يقل 10%	النقل والترحيلات والليموزين
لا يقل 15%	ورش صيانة الآليات والسيارات

(د) يجوز استغلال المساحة المسموح بها لبناء طابق تحت الأرض إذا كانت مساحة القطعة 400 م<sup>2</sup> فأقل.

(هـ) يجوز استغلال مساحة أكثر من المسموح بها تحت الأرض (بدرون) إذا كانت مساحة القطعة أكثر من 400 م<sup>2</sup> على أن لا يقل بعده عن 2.5 متر عن أي جار ملاصق.

2/ الارتفاعات ومناسيب الطوابق:

- (أ) القطع التي مساحتها 200 م<sup>2</sup> فأقل يسمح ببناء طابق أرضي + طابق أول فقط.
- (ب) القطع التي مساحتها 400 م<sup>2</sup> فأقل يسمح ببناء طابق أرضي + 2 طابق.
- (ج) القطع التي تزيد مساحتها عن 400 م<sup>2</sup> يسمح ببناء طابق أرضي + 3 طابق على أن تستخدم تلك الطوابق في الغرض الذي صدقت له أو كمباني إدارية.
- (د) ارتفاع السور لا يقل عن 4 أمتار.
- (هـ) منسوب أرضية الفناء بالقطعة لا يقل عن 0.15 متر فوق منسوب الرصيف و0.3 متر فوق منسوب منتصف الشارع المسفلت.
- (و) منسوب أرضية الطابق الأرضي لا يقل عن 0.3 متر فوق منسوب الرصيف.
- (ز) صافي ارتفاع السرداب لا يقل عن 2.6 متر.

- (ح) المباني الإدارية ينطبق عليها ما ينطبق على المباني في المناطق التجارية بالنسبة لارتفاعات الطوابق.
- (ط) صافي ارتفاع الطابق الأرضي بدون طابق مسروق لا يقل عن 4 متر لمبنى المصنع.
- (ي) صافي ارتفاع الطابق الأرضي بطابق مسروق لا يقل عن 6.8 متر لمبنى المصنع.
- (ك) صافي ارتفاع الطابق المسروق لا يقل عن 2.6 متر ولا يزيد نسبة الطابق المسروق عن 75% من مساحة الدور الأرضي للمبنى الإداري.
- (ل) صافي ارتفاع الطوابق العليا لا يقل عن 2.8 متر.

### 3/ الارتدادات:

- (أ) في القطع التي تزيد مساحتها عن 200 م<sup>2</sup> وتقل عن 400 م<sup>2</sup> يجوز البناء على حد واحد فقط مع جار شرقي أو غربي على أن ترتد المباني عن الحد الآخر بما لا يقل عن 1.5 متر على أن لا يقل الارتداد عن الجارين الشمالي والجنوبي عن 2 متر.
- (ب) جدول الارتدادات للمساحات التي تبلغ 400 م<sup>2</sup> فأكثر:-

الوضع من الشارع	الارتداد من الجار بالمتر	مساحة القطعة بالمتر المربع
يمكن البناء على الحد	2	1000 – 400
يمكن البناء على الحد	3	5000 – 1001
لا يقل الارتداد عن 5 متر	5	10000 – 5001
لا يقل الارتداد عن 10 متر	5	10000 فأكثر

### 4/ البروزات:

- (أ) يسمح بالبروز في الطابق الأول والطوابق التي تعلوه في المباني الإدارية على طول أو جزء من واجهة المبنى المشيدة على حد قطعة الأرض المطلة على طريق وذلك وفقاً لما يلي:
- بروز بمقدار 1.8 متر إذا كان عرض الطريق 20 متر فأكثر.
  - بروز بمقدار 1.5 متر إذا كان عرض الطريق 15 متر فأكثر.
  - بروز بمقدار 1.2 متر إذا كان عرض الطريق 10 متر فأكثر.
  - لا يسمح بأي بروز على الطريق الذي يقل عرضه عن 10 متر باستثناء البروزات الجمالية غير المستغلة شرط أن لا تزيد عن 0.4 متر.
- (ب) لا يجوز عمل بروز في الدور المسروق في كل الواجهات.

### 5/ التهوية والإضاءة:

- (أ) المباني الإدارية 8% من مساحة الغرفة.
- (ب) للورش والأعمال الثقيلة 12% من مساحة الورشة.
- (ج) لورش الأعمال الدقيقة 20% من مساحة الورشة.
- (د) بالنسبة للمباني التي يزيد عرضها عن 15 متر يجب توفير إضاءة وتهوية طبيعية من السقف.

## 6/ مواقف السيارات:

- (أ) يجب توفير مواقف بواقع موقف سيارة واحدة لكل 250م<sup>2</sup> من المساحة المشيدة للمصنع الذي تتراوح مساحته من 1000 – 10000 م<sup>2</sup>.
- (ب) يجب توفير مواقف سيارات للموظفين وحافلات العمال والزوار بمعدل موقف لكل 250م<sup>2</sup> من المساحة المشيدة للمصانع التي تزيد مساحتها عن 10000م<sup>2</sup>. وتوفير مواقف للشحن والتفريغ حسب طبيعة المصنع وحجم الشاحنات.

## 7/ شروط خاصة:

- (أ) لا يجوز ممارسة أي نشاط داخل القطعة الصناعية غير المرخص به.
- (ب) يجب توفير مطعم للعاملين بالمصانع التي يزيد عدد العمال فيها عن 50 عامل.
- (ج) يجب توفير دورات مياه وحمامات بمعدل حمام لكل 20 عامل أو لكل 250م<sup>2</sup>.
- (د) توفير غرفة للعناية الصحية والإسعافات الأولية وذلك في حالة المصانع التي يزيد عدد الموظفين والعمال فيها عن 25 عامل.
- (هـ) يسمح بسكن للعاملين داخل القطعة الصناعية التي تزيد مساحتها عن 5000 م<sup>2</sup> في حدود 5% من المساحة الكلية للقطعة وبعدد طوابق لا يتعدى أرضي+طابقين. ويراعى فيه مواصفات المباني السكنية. مع مراعاة وسائل الأمن والسلامة والصحة.
- (و) لا يجوز استخدام الموكيت أو السجاد في الأرضيات في مباني سكن العاملين مع توفير أجهزة التكييف والإنارة.

Appendixes (5):

Appendix the questionnaire in primary form



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



أخى الكريم .....

السلام عليكم ورحمة الله وبركاته.....

يسرني أن أقدم هذه الاستبيان بين يديك وهي أداة لدراسة ميدانية موضوعها (نظم مكافحة الحرائق فى المباني الصناعية بمدينة الخرطوم) ضمن مشروع بحث لاستكمال متطلبات الحصول على درجة الماجستير فى هندسة العمارة والتخطيط تخصص خدمات مباني من جامعه السودان للعلوم والتكنولوجيا .  
أرجو أن تحظى هذه الإستبيانة باهتمامكم والتكرم بالإجابة على أسئلتها بكل وضوح وشفافية حتى تتحقق الفائدة العلمية من هذه الدراسة ، مؤكداً أن هذه المعلومات لن تستخدم إلا لأغراض البحث العلمى. وتقبلو فائق الإحترام والتقدير لحسن استجابتك وتعاونتك وتخصيصك جزءاً من وقتك، و السلام عليكم.....

الباحثة

م/ تسنيم عبدالله نورالدين

البيانات الأولية:

فضلاً أكمل البيانات الآتية وضع علامة (√) أمام الإختيار المناسب لكل عبارة من العبارات التالية:

1- الوظيفة:

مدير عام ( ) مدير إنتاج ( ) مدير إدارى ( )  
مدير مالى ( ) م/أمن وسلامة ( ) م/تشغيل ( )

2- العمر:

30-20 ( ) 40-31 ( )  
50-41 ( ) 51 سنة فأكثر ( )

3- الخبرة فى مكان العمل:

10-5 سنة ( ) 4 سنة ( )  
2 سنة ( ) تعيين جديد ( )

4- موقع المصنع:

الخرطوم ( ) بحرى ( )  
أمدردان ( )

5- عدد العمال بالمصنع:

15-10 ( ) 25-15 ( )  
45-35 ( ) 100-45 ( )

البيانات الأساسية: محاور الدراسة

(ضع علامة (√) أمام الإختيار المناسب لكل عبارة)

1- ماهى أسباب وقوع حوادث الحرائق فى المصانع بمدينة الخرطوم؟

لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة	الأسباب
					1- إلتماس كهربائى واهمال فى التوصيلات الكهربائية.
					2- عدم إلتزام العاملين بتعليمات الوقاية من الحريق.
					3- الإهمال فى تخزين المواد سريعة الاشتعال .
					4- سلوكيات العمال المسببة لحوادث الحرائق(التدخين،رمى أعقاب السجائر،.....)
					5- عدم صيانة ومتابعة تشغيل الآليات والماكينات (تسرب الزيوت،قطع الغيار،....).
					6- قدرية (عرضية) لاعلاقة للإنسان فى وقوعها.
					7- عدم توفر تأريض للألات والماكينات.
					8- عدم توفر مانعه للصواعق.
					9- الإشتعال ذاتى للمواد بسبب العوامل الجوية.

2- ما مدى توافر اجراءات السلامة الوقائية فى المصانع بمدينة الخرطوم؟(الموقع،الانشاء،التشطيب)

لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة	الاجراءات
					1- تصميم المبنى فى الأساس كمصنع أم انها كانت ورشة وتم تغيير استعمالها الى مصنع.
					2- سهوله وصول عربات الدفاع المدنى الى موقع المصنع ودخولها .
					3- بعد المصانع عن مصادر الأخطار المسببة للحريق.
					4- توفر التهوية الطبيعية بالمصنع بوجود الفتحات (فتحات عليا ونوافذ)
					5- توفر مصادر مياه كافية ومخصصة للحريق (خزان أو مصدر قريب من المصنع).
					6- وجود مخارج طوارئ تناسب عدد العمال.
					سهولة تنفيذ عمليات الاخلاء عند الحريق فى كل الأقسام.
					7- تقسيم كل قطاع فى المصنع الى عدة فواصل للحريق لمنع انتشار الحريق.
					8- مقاومة مواد البناء المستخدمة فى انشاء المصنع للحريق (الأعمدة والسقف من الحديد والأبواب والنوافذ).
					9- وجود تباعد بين المصنع و المبانى المجاورة.

### 3-مدى فاعلية أنظمة السلامة لمكافحة الحريق بالمصانع؟

الانظمة	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1- توفر نظام اطفاء عادى مزود بخراطيم للمياه.					
2- توفر طفايات حريق بعدد كافي وموزعه جيد.					
3- توفر نظام إطفاء آلى تلقائى (رشاشات مياه) لمكافحة الحريق.					
4- توفر شبكة انذار متكاملة (كواشف حريق ،كواشف دخان،كواشف حرارة وأجراس إنذار) موزعه جيدا وواضحة ترتبط بلوحة تحكم.					
5- وجود لوحة خاصه بمخطط الاخلاء موزعه على صاله الانتاج واماكن تواجد العمال.					
6-وجود لوحات ارشادية مضاءة تدل على مخارج الطوارئ.					
7- عدم وجود فحص دورى وصيانه ومتابعه لعمل أجهزة الانذار و الاطفاء.					
8-توفر مولد كهربائى احتياطى لإنارة وعمل نظام الرشاشات.					
9-توفر صندوق اسعافات أولية بالمصنع.					

### 4-مدى اهتمام ادارة المصنع بتطبيق اجراءات السلامة الوقائية؟

الاهتمام	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1- مراقبة وفحص التمديدات الكهربائية والتجهيزات الفنية بالمصنع.					
2-ابلاغ الدفاع المدنى بجميع حوادث الحريق التى تحدث بالمصنع.					
3-اجراء فحص وصيانة دورية لأنظمة ووسائل السلامة ومكافحة الحريق.					
4-اجراء مراقبة للمصنع بعد انتهاء الدوام للتأكد من خلوه مما قد يتسبب فى الحريق.					
5-تقديم الارشادات عن السلامة الوقائية للعمال وتوعيتهم.					
6-تطبيق نظام الحوافز الإيجابية والسلبية ( بتقيد العمال بإجراءات السلامة الوقائية).					
7-توفر مسؤل للسلامة بالمصنع.					
8-اجراء دورات تدريبية للعمال فى المصنع فى مجال السلامة ومكافحة الحريق.					
9- الحصول على ترخيص الأمن والسلامة.					

5- ما مدى اهتمام عمال المصانع بتطبيق إجراءات السلامة الوقائية؟

الاهتمام	أوافق بشدة	أوافق	محايد	لا أوافق بشدة	لا أوافق بشدة
1- معرفة العمال بإجراءات السلامة الوقائية وكيفية مكافحة الحريق.					
2- التصرف بهدوء وحكمة وقت الحريق.					
3- حفظ العمال لرقم هاتف الدفاع المدني للطوارئ.					
4- تفقد مكان العمل قبل المغادرة وترتيبه.					
5- فحص الماكينات والاليات قبل وأثناء العمل.					
6- معرفة كيفية استخدام طفاية الحريق وتواجدها بصالة الانتاج والمخازن.					
7- الحرص على فصل التيار قبل الخروج من المصنع.					
8- معرفة طريقة تشغيل الاليات والماكينات وطريقة إيقافها.					
9- عدم التخزين بممرات الهروب ومخارج الطوارئ.					

6- ماهي المعوقات التي تحد من فعالية مكافحة الحريق فى المصانع؟

المعوقات	أوافق بشدة	أوافق	محايد	لا أوافق بشدة	لا أوافق بشدة
1- عدم توفر مصدر لمياه مكافحة الحريق					
2- قلة مراكز الدفاع المدني وبعدها عن المصانع					
3- عدم وعى العمال وادراكهم لخطورة حوادث الحريق					
4- قلة الشركات العاملة فى مجال توفير أنظمة السلامة بمدينة الخرطوم.					
5- عدم صلاحية الألات ومطابقتها للمواصفات القياسية والمعتمدة.					
6- عدم تنفيذ تعليمات الدفاع المدني الخاصة بحماية المنشآت وسلامتها					
7- الأنظمة المستخدمة لمكافحة الحريق بالمصانع قديمة وغير حديثة					
8- عدم وجود مسؤول مختص عن إجراء الكشف الدورى الوقائى على أنظمة السلامة بالمصنع.					
9- ضعف التعاون بين إدارة المصنع والجهات ذات الإختصاص (تدريب العمال)					



7- فى نظرك من المسؤول المباشر فى مكافحة الحرائق فى المصانع بالخرطوم؟  
(رتب حسب الأولوية من وجهة نظرك)

البند	أولاً	ثانياً	ثالثاً	رابعاً	خامساً
العمال والموظفين بالمصنع.					
إدارة الدفاع المدنى.					
المهندس المعمارى.					
وزارة الصناعة.					
المالك.					

8- عندما لا يتم استخدام أنظمة مكافحة أتماتيكية وتلقائية بمصانع الخرطوم فإن ذلك يعود الى عدة أسباب:

التكلفة	قلة وعى المهندس
عدم معرفة المالك	لصغر نشاط المصانع
عدم تضمينها فى القوانين.	عدم تطبيق عقوبات رادعة لمن لايلتزم بها.

9- اذا أراد المالك تصميم مصنع تصميمًا يطبق المكافحة من الحرائق حسب المواصفات فعليه أن يتوجه الى:

شركات المتخصصة بالسلامة.	وزارة الصناعة والاستثمار
وزارة التخطيط العمرانى	مكاتب هندسية.

Appendixes (6):

### Questionnaire Arbitration Committee

N	The name	job description	Date of arbitration
1	D//Esam abaker Isaac	Dean of the Faculty of Engineering and Technology industries, Sudan University of Science and Technology.	10/Oct
2	Colonel /Muataz Abbas Ibrahim	Consultant safety systems, in the General Directorate of Civil Defense.	20/ Oct
3	T/ Walid Mansour	President of Technology Department of Architecture - Sudan University of Science and Technology	29/ Oct
4	D /Mustafa Mohammed Saleh	Manager of General Department of the Ministry of Industry and Investment	1/Nov
5	A/Muhles Osman Saleh	A statistical analyst, in the ministry of Industry and Investment.	27/ Oct

Appendixes (7):

Appendix the questionnaire in final form



جامعة السودان للعلوم والتكنولوجيا  
كلية الدراسات العليا - هندسة العمارة والتخطيط  
برنامج ماجستير تخصص خدمات مبانى



أخى الكريم ، السلام عليكم ورحمة الله وبركاته.....

يسرنى أن أقدم هذه الاستبانة بين يديك وهى أداة لدراسة ميدانية موضوعها (تطبيق مكافحة الحرائق فى المباني الصناعية بمدينة الخرطوم) بحث لإستكمال الحصول على درجة الماجستير فى هندسة العمارة والتخطيط ، تخصص خدمات مباني بجامعة السودان للعلوم والتكنولوجيا.

أرجو أن تحظى بإهتمامكم والتكرم بالإجابة على أسئلتها بوضوح وشفافية حتى نتحقق الفائدة العلمية من هذه الدراسة ، مؤكداً أن هذه المعلومات لن تستخدم إلا لأغراض البحث العلمى،ولكم جزيل الشكر والتقدير لتعاونكم وتخصيصكم جزءاً من وقتكم ، والسلام عليكم...

الباحثة : م/ تسنيم عبدالله نورالدين

أولاً: البيانات الأولية:

فضلاً أكمل البيانات الآتية وضع علامة (√) أمام الإختيار المناسب لكل عبارة من العبارات التالية:

1- الوظيفة:

- |                        |                |     |                   |     |               |
|------------------------|----------------|-----|-------------------|-----|---------------|
| ( )                    | (3) مدير إدارى | ( ) | (2) مدير إنتاج    | ( ) | (1) مدير عام  |
| ( )                    | (6) م/ تشغيل   | ( ) | (5) م/ أمن وسلامة | ( ) | (4) مدير مالى |
| (7) أخرى، أنكرها ..... |                |     |                   |     |               |

2- العمر:

- |     |                  |     |           |
|-----|------------------|-----|-----------|
| ( ) | (2) 40-31        | ( ) | (1) 30-20 |
| ( ) | (4) 51 سنة فأكثر | ( ) | (3) 50-41 |

3- الخبرة فى مكان العمل:

- |     |                  |     |               |
|-----|------------------|-----|---------------|
| ( ) | (2) 10-5 سنة     | ( ) | (1) 5-0 سنة   |
| ( ) | (4) 15 سنة فأكثر | ( ) | (3) 15-10 سنة |

4- موقع المصنع:

- |     |                           |     |                           |     |             |
|-----|---------------------------|-----|---------------------------|-----|-------------|
| ( ) | (3) أمدرمان               | ( ) | (2) بحرى                  | ( ) | (1) الخرطوم |
| ( ) | (5) خارج المنطقة الصناعية | ( ) | (4) داخل المنطقة الصناعية |     |             |

5- عدد العمال بالمصنع:

- |                          |                 |     |                |  |  |
|--------------------------|-----------------|-----|----------------|--|--|
| ( )                      | (2) 45-25 عامل  | ( ) | (1) 25 -5 عامل |  |  |
| ( )                      | (4) 100-75 عامل | ( ) | (3) 75-45 عامل |  |  |
| (5) أكثر من 100 عامل ( ) |                 |     |                |  |  |

## 6- نوع القطاع:

- (1) الغذائية ( ) (2) الكيماويات ( ) (3) المنتجات الخشبية ( )  
 (4) المنتجات الورقية والورق ( ) (5) المنتجات الجلدية والجلود ( ) (6) الغزل والنسيج والتريكو ( )  
 (7) الصناعات الهندسية ( ) (8) مواد البناء والتشييد ( ) (9) المنتجات المعدنية ( )

ثانيا: البيانات الأساسية: محاور الدراسة

### 1- ماهى الأسباب التى تؤدى إلى وقوع حوادث حرائق المصانع بمدينة الخرطوم؟

الأسباب	أوافق	محايد	لاأوافق
1- إلتماس كهربائى وإهمال فى التوصيلات الكهربائية الداخلية بالمصنع.			
2- عدم إلتزام العاملين بتعليمات الوقاية من الحريق داخل المصانع.			
3- إنعدام التخزين الجيد للمواد سريعة الاشتعال داخل المصنع .			
4- سلوكيات العمال المسببة لحوادث الحرائق (التدخين، رمى أعقاب السجائر،.....)			
5- عدم الإهتمام بصيانة ومتابعة تشغيل الآليات والماكينات (تسرب الزيوت، قطع الغيار،.....).			
6- قدرية (عرضية) لاعلاقة للإنسان فى وقوعها.			
7- عدم توفر مانعه للصواعق .			
8- الإشتعال الذاتى للمواد بسبب العوامل الجوية.			

### 2- ما مدى توافر اجراءات السلامة الوقائية فى المصانع بمدينة الخرطوم؟ (الموقع،الانشاء،التشطيب)

الاجراءات	أوافق	محايد	لاأوافق
1- أستخدم المصنع كورشة سابقا.			
2- سهوله وصول عربات الدفاع المدنى الى موقع المصنع ودخولها .			
3- بعد المصانع عن مصادر الأخطار المسببة للحريق.			
4- توفر التهوية الطبيعية بالمصنع بوجود الفتحات (فتحات عليا ونوافذ)			
5- توفر مصادر مياه كافية ومخصصة للحريق (خزان أو مصدر قريب من المصنع).			
6- وجود مخارج طوارئ تناسب عدد العمال (سهولة تنفيذ عمليات الاخلاء عند الحريق فى كل الأقسام).			
7- مقاومة مواد البناء المستخدمة فى انشاء المصنع للحريق(الأعمدة والسقف من الحديد والأبواب والنوافذ).			
8- وجود تباعد بين المصنع و المبانى المجاورة (مسافات الأمان).			

### 3-مدى فاعلية أنظمة السلامة لمكافحة الحريق بالمصانع؟

الأنظمة	أوافق	محايد	لاأوافق
1- توفر نظام إطفاء عادي مزود بخراطيم للمياه.			
2- توفر طفايات حريق بعدد كافي وموزعه جيد.			
3- توفر نظام إطفاء آلي تلقائي (رشاشات مياه) لمكافحة الحريق.			
4- توفر شبكة إنذار متكاملة وموزعة جيدا (كواشف حريق، دخان، حرارة ، أجراس انذار) وترتبط بلوحة تحكم.			
5- وجود لوحة خاصة بمخطط الإخلاء موزعة على صالة الإنتاج وأماكن تواجد العمال.			
6-وجود لوحات إرشادية مضاءة تدل على مخارج الطوارئ.			
7- عدم وجود فحص دوري وصيانة ومتابعة لعمل أجهزة الإنذار والاطفاء.			
8-توفر مولد كهربائى إحتياطي لإنارة وعمل نظام الرشاشات.			

### 4-مدى إهتمام إدارة المصنع بتطبيق إجراءات السلامة الوقائية؟

الإهتمام	أوافق	محايد	لا أوافق
1- معرفة العمال بإجراءات السلامة الوقائية وكيفية مكافحة الجيدة.			
2- التصرف بهدوء وحكمة وقت الحريق.			
3- إلمام العمال برقم هاتف طوارئ الدفاع المدني.			
4- تفقد مكان العمل قبل المغادرة وترتيبه والحرص على فصل التيار قبل الخروج من المصنع.			
5- فحص الماكينات والاليات قبل وأثناء العمل.			
6- معرفة كيفية استخدام طفاية الحريق وأماكن تواجدها بصالة الإنتاج والمخازن.			
7- معرفة طريقة تشغيل الاليات والماكينات وطريقة إيقافها.			
8- ترك ممرات الهروب ومخارج الطوارئ خالية من الموانع.			

5- ما مدى إهتمام عمال المصانع بتطبيق إجراءات السلامة الوقائية؟

الإهتمام	أوافق	محايد	لاأوافق
1- مراقبة وفحص التمديدات الكهربائية والتجهيزات الفنية بالمصنع.			
2- إبلاغ الدفاع المدني بجميع حوادث الحريق التي تحدث بالمصنع.			
3- إجراء فحص وصيانة دورية لأنظمة ووسائل السلامة ومكافحة الحريق.			
4- مراقبة المصنع بعد إنتهاء الدوام للتأكد من خلوه مما قد يتسبب فى الحريق.			
5- توفر صندوق إسعافات أولية بالمصنع.			
6- توفر مسؤل للسلامة بالمصنع.			
7- تطبيق نظام الحوافز الإيجابية والسلبية ( بتقيد العمال بإجراءات السلامة الوقائية).			
8- إجراء دورات تدريبية للعمال فى مجال السلامة ومكافحة الحريق والإسعافات الأولية.			

6- ماهى المعوقات التى تحد من فعالية مكافحة الحريق فى المصانع؟

المعوقات	أوافق	محايد	لا أوافق
1- عدم توفر مصدر لمياه مكافحة الحريق.			
2- قلة مراكز الدفاع المدنى وبعدها عن المصانع.			
3- عدم وعى العمال وادراكهم لخطورة حوادث الحريق.			
4- عدم صلاحية الألات ومطابقتها للمواصفات القياسية والمعتمدة.			
5- عدم تنفيذ تعليمات الدفاع المدنى الخاصة بحماية المنشآت وسلامتها.			
6- الأنظمة المستخدمة لمكافحة الحريق بالمصانع قديمة وغير حديثة.			
7- عدم وجود مسؤل مختص عن إجراء الكشف الدورى الوقائى على أنظمة السلامة بالمصنع.			
8- ضعف التعاون بين إدارة المصنع والجهات ذات الإختصاص (تدريب العمال ، تنفيذ خطط إخلاء)			

7- فى نظرك من المسئول المباشر فى مكافحة الحرائق فى المصانع بالخرطوم؟  
(رتب حسب الأولوية من وجهة نظرك)

البند	أولا	ثانيا	ثالثا	رابعا	خامسا
العمال والموظفين بالمصنع.					
إدارة الدفاع المدنى.					
المهندس المعمارى.					
وزارة الصناعة.					
المالك.					

8- عندما لا يتم استخدام أنظمة مكافحة أتماتيكية وتلقائية بمصانع الخرطوم فإن ذلك يعود الى عدة أسباب:

(ضع علامة (√) أمام ما يناسبك و يمكن إختيار أكثر من إجابة واحدة)

- ( ) التكلفة.
- ( ) قلة وعى المهندس.
- ( ) عدم معرفة المالك.
- ( ) لصغر نشاط المصانع.
- ( ) عدم تضمينها فى القوانين.
- ( ) قلة الشركات العاملة فى مجال توفير أنظمة السلامة بمدينة الخرطوم.
- ( ) عدم تطبيق عقوبات رادعة لمن لايلتزم بها.

9- إذا أراد المالك تصميم مصنع تصميمًا يطبق مكافحة الحرائق حسب المواصفات فعليه أن يتوجه الى:

- ( ) شركات تنفيذية متخصصة بالسلامة.
- ( ) وزارة الصناعة والاستثمار.
- ( ) وزارة التخطيط العمرانى.
- ( ) مكاتب هندسية إستشارية.
- ( ) إدارة الدفاع المدنى.

شكرا لحسن تعاونكم معنا.

الباحثة.