Sudan University of Science &Technology

College of Graduate Studies

“Evaluation of the factors affecting safety performance on Construction Project”

Case study –Khartoum State

تقييم العوامل المؤثرة على أداء السلامة فى مشاريع التشييد

دراسة حالة - ولاية الخرطوم

A Thesis submitted in partial fulfillment of the requirements for the degree of Master in Civil Engineering- Construction Management

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By

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الآية

قال تعالى:

DEDICATION

I would like to dedicate this work to:

- *My father and mother for their unlimited encouragement.*
- *My husband and sons for their enduring support, trust, and patience.*

Hamid Ahmed Osman

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Above all, I would like to thank Allah for blessing me and enabling me to complete this thesis.

Indeed many people contributed time, knowledge, skill, and support to my research, and I am pleased to acknowledge their contributions. I would like to express my gratitude to my supervisor. Dr. Osama Mohammed Ahmed, who was abundantly helpful and offered invaluable assistance, support and guidance that enabled me to conduct my research.

I wish to express love and gratitude to my beloved Parents, Husband and Sons; for their understanding and endless love, through the duration of my research study.

Finally, I must express my sincere thanks to the Contracting and Consulting firm personnel I interviewed for their cooperation and support.

Abstract

Safety in the construction project has always been a major issue. Wherever reliable records are available, construction is found to be one of the most dangerous on safety and health criteria, particularly in developing countries. Sudan is a developing country with a construction project suffers from a poor safety conditions. The hazards of this industry make it very essential to pay more attention to construction safety and to improve the safety performance of construction companies. However, safety is not a luxury but a necessity, and may be considered an important function to be used against unnecessary loss. Little studies have been done in this field in Khartoum state. The objectives of this research are to identify the factors affecting the construction safety and to establish a tool to assess and improve the construction safety of construction companies. Thirty nine sub factors were identified and grouped into ten main factors. In this study, construction companies in the Khartoum State that were qualified and registered in the Sudan Contractors Union (SCU) and classified companies were considered as large companies and had the chance to participate. A field survey was conducted through a questionnaire including 100 construction companies in Khartoum State. The collected data were analyzed to presents statistical measures. Importance index was calculated to rank the safety factors. The Safety Performance Attitude Score (SPAS) and Accidents Frequency Rate (AFR) are used to measure the safety performance and to develop a tool for assessing and improving the construction safety.

It was concluded that the most important main factors affecting the safety performance in Khartoum State are; Administrative & Management Commitment;, Personal Protective Equipment; Emergency planning &

preparation, Signs ,Signals & Barricades,. While the most important sub factors affecting the safety performance are; the Safety awareness of project managers; the Safety inspections by supervisor office; the Safety awareness of company's to management; the Availability a clear company's policy.

. Based on this a tool, which can be easily applied, was developed to assess and improve the safety of the construction companies. Also it was concluded that the knowledge and usage of eighteen of signs, signals and symbols in construction projects site, the result was emphasized there are high level of knowledge with low level of use.

Finally, in order to improve the safety performance of construction companies, a set of recommendations were made and topics for future researches were suggested

الخلاصة

تعتبر مشاريع الإنشاءات دائما من القضايا الاساسية . حيث تعتبر الانشاءات من اخطر الصناعات الموجودة على السلامة والصحة وخاصة فى البلد النامية . يعتبر السودان من الدول النامية التى تعانى الانشاءات فيها من ضعف بيئة السلامة فيها .واصبح من الضرورى إعطاء أهمية قصوى للسلامة المهنية فى هذا القطاع واعتباره عامل مهم لتقليل من الخسائر ، التى يمكن تقليلها ببذل القليل من الجهد ، لذا نعتبر السلامة المهنية فى قطاع التشييد ضرورة وليست ترف كما يتباين للذهن، ورغم أهمية السلامة المهنية إلا أن الأبحاث التى تطرقت لموضوع السلامة فى قطاع التشييد فى ولاية الخرطوم تظل قليلة. ويستعرض هذا البحث العوامل التى تؤثر على السلامة فى ولاية الخرطوم وكذلك إيجاد الية عملية لتقييم أداء السلامة ،واشتملت هذا البحث على تسعة وثلاثون عنصر فرعى تم دمجها فى عشرة عنصر رئيسى. وتم القيام بمسح ميدانى من خلال (100) شركة .

تم تحليل البيانات المتحصل عليها وتمثيل المعايير الإحصائية لهذه البيانات، حيث رتبت العناصر المؤثرة على أداء السلامة بناء على مؤشر الأهمية، وتم مناقشة الارتباط والتوافق بين اراء المشاركين فى هذا البحث، كذلك تم استخدام معيار معدل تكرر الاصابات معيار الادراك الحسي للسلامة،لاستنتاج وسيلة لتقيم وتحسين أداء السلامة فى شركات التقييم.

خلصت الدراسة إلى أن اهم العوامل الرئيسية التى تؤثر على اداء السلامة فى ولاية الخرطوم هى إلتزام الادارة ، استخدام معدات الحماية الشخصية ، التخطيط والتحضير لحالات الطوارئ والكوارث، العلامات والاشارات والمتاريس. بينما كانت أهم العناصر الفرعية المؤثرة على أداء السلامة كالتالى، وعى مدراء المشاريع بالسلامة، تفتيش السلامة بواسطة المكتب الاستشارى، وعى الإدارة العليا للشركة بالسلامة، وجود سياسة واضحة للسلامة بالشركة. تم دراسة مدى إدراك واستخدام الإشارات والعلامات والرموز فى موقع المشاريع الانشائية، وأكدت النتائج أن هناك مستوى كبير فى معرفة مدلولات الإشارات والعلامات والرموز مع مستوى منخفض فى استخدامها.

ختاماً ولتحسين أداء السلامة فى شركات التشييد فى ولاية الخرطوم تم ذكر مجموعة من التوصيات والنتائج والإجراءات الواجب اتخاذها والمواضيع المقترحة للدراسات المستقبلية .

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List of Abbreviations

AFR	Accident Frequency Rate
ANSI	American National Standards Institute
HSE	Health and Safety Excusive
OSHA	Occupational Safety and Health Administration
SCU	Sudan Contractors Union
PPE	Personal Protective Equipment
SPAS	Safety Performance Attitude Score
SPSS	Statistical Package for the Social Sciences
SPL	Safety Performance Level
SPLI	Safety Performance Level Index
UK	United Kingdom
USA	United State of American

Chapter 1

Introduction

1.1 Background

Construction industry are generally complex and sometimes unsafe and also identified as one of the most hazardous industries, due to the nature of the work resulting from integration of materials, tools, environment and various human factors (Haro and Kleiner, 2008. Generally, construction sites are still one of the most dangerous workplaces because of high incidence of accidents, (Teo et al, 2005). The construction industry is characterized by continual changes, bombardment of varying technologies, poor working conditions and need for coordination of different interdependent trades and operations. Due to the hazardous nature of work, safety is a serious problem in the industry, (Tam et al, 2004). Globally, the construction industry has a poor safety record and is disproportionately dangerous compared to other industries, advocated the idea that safety is no luxury but a necessity, (Fung et al, 2005).

The interest in safety awareness among construction companies has greatly increased in the past decade. This increased awareness in safety can be attributed to many factors. As an example, the construction industry has come to recognize the relationship between risk management and return on investment. The ever increasing cost of medical treatment, convalescent care, and the potential for lawsuits all add up to higher insurance premiums, which in turn tend to have a negative impact on a company's profit. In addition, companies with high accident rate are often prohibited from bidding on a certain type of work. It is therefore, in the company's

best interest to take whatever means necessary to manage safety on the work site, (Koehn et al, 1995).

Large size companies tend to more effectively deal with the construction Management and its applications. Thus, safety management will be more applicable with the large construction companies, which have the managerial ability to deal with such issues. In small to medium companies, safety programs are often very informal and unwritten while in large construction companies such programs are better structured and documented, (Tam et al, 2004).

1.2 Problem Statement

The construction project continues to give international poor safety performance. Injuries, diseases, permanent disabilities and ultimately loss of life occur during construction works. The construction industry in Sudan has a very poor site safety record in comparison to other countries. In addition to the weakness of safety culture in construction industry beside other related terms like safety climate, safety behaviour, safety systems, safety program, and safety management are not common in Sudan even in the Arab countries when compared with American or European countries. Furthermore, there are serious commitment problems towards safety of all levels of management.. Safety has always been a persistent problem in the construction industry

This research is an attempt to identify the factors affecting the construction safety in Khartoum State and to provide a tool for assessing the safety of large construction companies and accordingly improve it.

1.3 Significance of the Study

Accidents in any construction projects tend to be costly in both human and financial terms. As safety is concerned with reducing rates of accidents and controlling or eliminating hazards at the work site, preventing accidents must be the first significant step towards safety improvement. There is a need to increase awareness and to exert pressure on companies for safety. Economical, social and governmental regulations are a few factors responsible for this increased pressure. Identification and understanding of accident causation is a prerequisite for improving Safety.

The accident is in turn invariably caused or permitted directly by the unsafe act of a person and a mechanical or physical hazard (i.e. unsafe condition). To avoid accidents it is required to identify and eliminate unsafe acts and unsafe conditions, which could be achieved by regular assessment of safety on site, employee training and inspection.

This study aims at assessing the safety performance including physical and safety climate of the construction companies in Khartoum State. It is to the benefit of construction companies to recognize the situation and identify the factors affecting the construction safety. This will help them to take the necessary precautions to control these factors before they occur and be aware of them when they occur during construction, which will lead to improve the overall performance of the company.

It will help in increasing awareness and in identifying areas of deficiencies in construction safe.

1.4 Research Aim

This research aims to improving safety performance in Khartoum State by evaluating the factors which affecting safety performance, and achieve the

comprehensive goal to get minimum level of accidents and maximum level of benefits for the labors.

1.5 Research Objectives:

The main objectives of the study can be summarized in the following points:

1. Evaluating the level of the safety practice in construction companies.
2. Identify and analyze the most important factors that affect safety performance in construction projects.
3. Assessing the safety signs, signal, and symbols recognitions.
4. Establish a tool to assess and improve the safety of construction companies.

1.6 Research Hypotheses

- Management commitment has a positive significance effect on safety culture.
- Priority of safety has a positive significance effect on safety culture.
- Safety rules have a positive significance effect on safety culture.
- Physical work environment has a positive significant effect on safety climate.
- Personal appreciation of risk has a positive significance effect on safety climate.

1.7 Scope and Limitation

This research will be limited to the following:

1. Construction contractors point view, where the safety is more likely the responsibly of the construction contractors.
2. Buildings, roads and water sewage works construction companies.
3. Large construction companies in Khartoum state that are qualified and registered in the contractors.

1.8 Research Methodology

The study methodology will include steps, which can be summarized in the following points:

1. Perform review of literatures relating to the topic of this study. The objective of the review is to identify the factors that affect the safety performance in large construction companies and the methods of safety performance measurement.
2. Collect data via a questionnaire survey to evaluate the factors that affect the safety performance identified in the literature review.
3. Perform analysis of data using appropriate statistical techniques.
4. Ranking the results according to their importance.
5. Establish a tool to assess the safety of construction companies.
6. Report and discuss results and major findings to introduce conclusions and recommendations.

1.9 Thesis Organization

This thesis is divided into six chapters, references and six appendixes. It includes the following:

- Chapter (1) presents an introduction to the research. It includes the problem statement, the objective, the scope and limitations, and the methodology of the study.
- Chapter (2) presents the literature review and the previous efforts and studies which have been made in the field of safety and the factors affecting the safety performance and of the signs, signals and symbols in the site, and about safety measurement.
- Chapter (3) discusses the research methodology which includes the information about the research design, research population, research location, questionnaire design, questionnaire validity, questionnaire reliability, research structure and statistical data analysis.
- Chapter (4) presents and discusses data analysis, statistical methods used, tables and information deduced from statistical analysis and statistical results. The procedures for assessing and improving the safety performance and practice are discussed.
- Chapter (5) summarizes the results and major finding, to present the conclusions and recommendations of this research.

Chapter 2

Literature Review

2.1 Introduction

Construction in its nature is a problem in ergonomics. Construction sites are busy places with continuous working environmental changes. Usually construction workers are exposed to heavy manual material handling, repetitive movements, awkward postures, contact stress, vibration and forceful exertions (Kramer et al., 2009). Workers in the construction industry face a greater risk of fatality or injury than those in other industries.

Traditionally safety on the construction site is the responsibility of the contractor which reflects the contractor's control over the construction workers, project schedule, work methods and sequence, and the contractual relationships amongst the project team members (Gambatese et al., 2008). Although significant improvements in safety performance have been made in the past few decades, construction workplace accidents still occur with upsetting frequency (Aires et al., 2010). It was found that one of the most important sources of risk is the gap between expected working and real working (Fadier and Garza, 2006)

Safety can be considered as a common sense approach to removing The dictionary agents of injury. Meaning of the word safety is the conditions of being safe freedom from danger or risks, (Baig, 2001).

Safety assessment is a process used to determine a contractor's compliance with or ability to meet specific safety rules and requirements set by the government safety regulations or by safety and environmental

organizations. Safety rules or criteria are needed to accomplish the work with high overall performance. Any deviation from these safety requirements will affect the contractor's overall performance, (Al-Amoudi, 1997).

2.2 History of Safety

As proceed into the Middle Ages, more awareness of the link between the work that people did and the types of injuries and illnesses, which they suffered, was recognized. During this period the first unions began to be organized to try to protect workers from the hazards of the workplace. The only improvement in the 1800s was fire protection because of pressure from insurance companies, (Reese, 2003).

During the first part of the 1900s, workers' compensation laws started appearing and were finally deemed constitutional by the Supreme Court in 1916. Prior to this most employers passed the blame and responsibility to their workers for workplace incidents using what were called "the common laws" which stated:

1. The employer was not responsible when a fellow worker caused your injury due to negligence.
2. The employer was not responsible if the worker was injured due to his/her own negligence.
3. If an employee took a job and knew that it was risky, or knew of the inherent hazards of the work prior to taking the job and was injured, the employer was not responsible.

Under the workers' compensation laws the employers assumed responsibilities for their workplaces' safety and health. They were required

to provide and pay for medical care and lost wages due to on-the-job incidents.

It was during this time that mining catastrophes continued to occur and more laws were passed to protect miners. When 2,000 workers or 50 percent of the work force died from silica exposure at Gauley Bridge, West Virginia, the Walsh-Healey Act was passed that required safety and health measures for any employer receiving a government contract. Some companies began to understand their moral responsibility, (Reese, 2003).

When management found itself in the problem, by legislation, of having to pay for injuries on the job, it decided that it would be financially better to stop the injuries from happening. This decision by the industry all over the world gave birth to the organized industrial safety movement. Management concentrated heavily, if not entirely, on correcting the hazardous physical conditions that exist in the work place in the early years of the safety movement. This showed a significant decline in the death rate (deaths per million man-hours worked) during the first 20 years of the safety movement, (Petersen, 1971).

In December 1970 Congress enacted and President Richard Nixon signed the Wiliiams-Steiger Occupational Safety and Health Act (OSHAct), which became effective on April 28, 1971.

It applied to more than 5 million businesses involved in or affecting interstate commerce and 60 million workers, (Hammer, 1985).

Recently, Safety standards and regulations are published by international and national organizations and are accepted by the construction industry. Among these are the Occupational Safety and Health Administration (OSHA) standards for the construction industry, the US Department of

Energy safety regulations, and US Army Corps of Engineers safety and health requirement manual, (Kartam, et al, 2000).

Safety via OSHA

The Occupational Safety and Health Act of 1970 (OSHA) is a comprehensive set of safety and health regulations, inspection procedures, and record keeping. In the United States, the OSHA is the principal authority in charge for regulating occupational and health issues and also for providing safety related training to contractors, (Ahcom, 2004).

OSHA organizes a series of training institute and education centers, which provides training specifically aimed to train safety professionals. In December 2003, OSHA announced the addition of eight more Training Institute Education Centers. They provide a four-day course, which is designed for those in the private sector interested in teaching the 10-hour construction safety and health outreach program to their employees or other interested parties. The experience shows that many contractors are preferring, employees who have experienced 10-hour OSHA training course. The large and small companies also prefer their employees acquainted with OSHA safety training course, (Ahcom, 2004)

2.3 Importance of Safety

The advancement in social sciences has promoted a greater awareness of the sanctity of life and the unacceptability of premature death due to accidents. Accidents at construction sites are identified as a major problem throughout the world. According to reports published by the construction industry institute, injuries and fatalities occur in the construction industry at a rate more than 50% higher than all other industries, (Kartam and Bouz, 2013). According to Agarwal and Everett (2005), in the United States, the

construction industry employs about 6% of the work force, but accounts for 13% of disabling occupational injuries and 20% of all occupational fatalities. These figures have changed in 2007 to be that construction industry employs about 6% of the work force, but accounts for 10% of occupational injuries and 21% of all occupational fatalities. (Everett, 2013).

Research on risk management perceptions and trends in US construction; shows that safety is considered to be one of the highest risk allocations, and is marked at 8.3 on a 10 point scale. By assigning safety the highest importance rating, contractors believe that they have and will continue to have sole responsibility for this risk in the future, (Kartam, et al, 2012).

In their research on important criteria's for contractor selection, Hatush and Skitmore (2013) establish that, health and safety performance of contractors was among the top four important criteria's. Therefore, safety is a very important element in the success of any construction project. It has a major impact on the contractor, owner, workers, and on the environment. In many countries a contractor safety sheet or performance record is considered one of the items that qualify a contractor for a bid. Furthermore, many public agencies include safety standards as part of the construction contract documents, which then become a contractual obligation as well as a legal one, overall, the contractor must be concerned about the safety for the following reasons, (Bu Khamsin, 2011):

· **Humanitarian Concern:**

The suffering as a result of an accident both to injured parties and their families cannot be measured in economic terms. The contractor should never disregard this, even when the injured parties have been adequately compensated by insurance.

· **Economic Considerations**

The contractor must realize that even with adequate insurance coverage, accidents will reduce company profits through the increased costs of future insurance premiums.

· **Legal Considerations**

OSHA requires that each employer provides to each of his employees a place of employment that is hazard free.

· **Company Image**

A good safety record is a proven means of increasing worker morale and Productivity. This in turn improves the company's public image, and therefore improves the company's bargaining position for negotiating future jobs

2.4 Factors Affecting Safety Performance

The factors that affect safety performance may be encountered in a construction projects were identified. The groups of factors affecting safety performance are shown in following below.

2.4.1. Administrative and management

Top management should consider safety as equally important as other aspects in the organization, such as production and profit. There is also a need for safety awareness of company’s top management. it is crucial for top management to encourage all employees to follow safety procedures and implement initiatives to improve their safety performance. In order to demonstrate their commitment towards safety, top management needs to provide necessary resources, money, tools, and equipment, for employees

to work safely and to monitor safety. Management related factors are listed below:

- Safety awareness of company's top management
- Conduction of safety policy review
- Safety awareness of project managers
- Issuing & implementation of in house safety rules, safety program or manuals including emergency plan & procedure
- Availability a clear company safety policy
- Management's attitude towards employee’s welfare

2.4.2. Project Nature

Project Nature factor in different geographical location may vary in term of producing differential effects on safety performance so organizational also keep updating and response to requirements imposed by the changing environment. Geographical location, weather condition related to poor visibility and night works has a significant impact on work at night. The construction industry is a complex with a number of stakeholders working together to complete the construction project. This complex system also some information being passed from one team (construction) to another, which is need for risk assessment and communication. In the meantime, the physical space, the working procedure (site operation), tools and methods used and resources available are factors influencing risk assessment and communication. Project nature related factors are listed below:

- Size of the project
- Ratio of site area to building area
- Planning and organizing the site (layout) - work environment
- Cost of the project
- Planning and scheduling of the project

- Application of new technology in construction
- Type of owner
- Complexity of the design

2.4.3 Emergency Planning and Preparations

Effective emergency planning requires that workers be familiar with emergency procedures before a crisis it is the responsibilities of the contractors to ensure that all workers are familiar with the proper response to fire and other serious emergencies.

The potential for emergency exits at all construction sites and facilities and their associated costs can be devastating in terms of worker casualties, business interruption, loss of capital of investment, etc. These events cannot be avoided but the contractors can reduce of the frequency of the occurrence and severity of damage with effective preparation and planning. This can be accomplished by developing emergency response plans that address immediate concerns within the contractor's operation. An emergency is an abnormal incident posting a threat to the safety of workers, the environment or property at a facilities or site. The emergency can be brought under control using the resource and procedures for emergency response in place for the facilities or site, (Hislop, 2013).

2.4.4 Signs, Signals and Barricades

The contractors should establish a system of signaling for all operations in which signal are required to prevent danger, as far as practicable a uniform signaling system must be adapted for all constructions. The code of signals should be posted up at suitable places and also made available in the form of a handbook. In order to avoid danger, the contractor should take adequate steps to ensure that workers are familiar with all signals that they should know, (Tam et al, 2011).

2.4.5 Welfare Facilities

The contactor must be provided adequate welfare facilities for his workers usages, to starting the construction activities. The contractors must meet the following in order to prevent construction site accidents. (Permana, 2012):

- Smoking area
- First aid facilities
- Food and drinking water
- Toilets
- Ambulance

2.4.6. Safety Inspections

Regular safety inspections help management that the safe work practices are being maintained. By having your employees assist with the safety inspection, awareness remains high and employees learn more about safety hazards. Construction sites require constant monitoring and observations to keep ahead of safety issues.

The use of safety inspections has been shown to have a positive effect on a company's loss control initiative. In fact companies who perform safety inspections have fewer accidents incidents than companies that do not perform inspections. Safety inspection related factors are listed below:

- Safety inspection by government Authorities
- Safety inspection by management
- Safety inspection by safety supervisor

2.4.7. Safety Meetings, Records and Reports

Safety meetings provide a chance to present new safety training and information. They also offer a chance for workers to review previously

learned information. Without safety meetings, workers can be lulled by routines and slowly decrease their alertness and attention to safety as they perform the same tasks day after day. They benefit from being reminded how to stay safe and why safety methods are needed. And also the information provided through recording and reporting enables the enforcing authorities to identify where and how risks arise, and to investigate serious accidents. Safety Meetings, Records and Reports related factors are listed below:

- Conducting regular toolbox meetings (safety meetings) by safety supervisor
- Conducting safety meeting before each activity begins
- Attendance of Safety meetings by management
- Recording and reporting of daily safety issues

2.4.8. Safety Education and Training

Safety Educating and Training defines as a process that enables people to acquire new knowledge, learn new skills, and perform behaviors in a new way. Further distinguishes between training and development by stating that training refers to the acquisition of ‘specific

Skills or knowledge’, ‘displaying poster’, ‘issuing of safety booklet’ and ‘development refers’ to the improvement of intellectual and emotional ability needed to perform better at a specific work. Safety education and training related factors are listed below:

- Conducting safety training and orientation
- Issuing of safety booklets
- Talk by management on safety
- Displaying safety posters
- Training for first aid for all employee

2.4.9. Personal Protective Equipment (PPE)

Providing appropriate equipment's to avoid the probabilities of accidents to workers, certain things that must be considered and these includes the implementation of PPE which may be uncomfortable to wear or may be an obstruction, strict inspection on proper implementation of PPE; and high cost of providing PPE. There are two categories of PPE. The first must be used safety helmet; safety shoes; and suitable working clothing. In addition, the second category depending kind of work, like eye protection, protective gloves, ear protectors and safety belt, (Jannadi, 2001).

2.4.10. Fire Prevention

Prior to construction stat-up, the contractors must take into account the potential that can be encountered on the construction site by making provisions for the fooling: protection of machinery and equipment, storage of flammable and combustible material, housekeeping, staff training and end-of-shift checks. Each has contractual obligation to provide and maintain adequate, easily accessible fire extinguishers on the job site. There are three types of the extinguishers, which are normally found in construction site: water, carbon dioxide and dry chemical types. Contractors personal should be aware of the fighting equipment available on the site and be familiar with its use, (Hislop, 1999).

2.5 SIGNS, SIGNAL AND SYMBOLS

Warnings in the forms of signs and symbols have been recognized as one of the effective tools to influence behavior and improve the risk perception of recipients. However, there has been no work done on this area concerning construction. Understanding signs will provide valuable information in fine-tuning the safety management strategies for the

construction industry. Safety signs usually contain four components: signal words, hazard statement, noncompliance statement and some instructions, (Edworthy and Adams, 1996).

Ma et al, (1999) has been an untested assumption that symbolic signs can be easily understood by people with different cultural and linguistic backgrounds, which, however, is misleading. Hence, some studies concentrate on the understanding of traffic signs by different user groups. Al-Mandani (2001) investigated the recognition of some traffic signs with different personal characteristics such as age, monthly income, year of education, etc., in five countries by conducting a questionnaire survey.

Short-answer questions were used to identify drivers' characteristics and the multiple choice questions were designed to evaluate the understanding of traffic signs. Results show that the performance of some traffic signs is less effective on young drivers with low income and low education levels. It is recommended that training of traffic signs recognition should concentrate useful for traffic trainers to allocate more resources and concentrate their efforts on female drivers with lower education levels and incomes. Apart from these, Al-Madani and Al-Janahi (2002) recommended that further studies should focus on understanding of signs in attitude behavior aspects. Apart from these, Al-Madani (2000) examined the relationship between the comprehension of traffic symbols and safety related characteristics, such as driving experience, previous accident involvement and seat belt usage, which reveals that driving experiences of respondents are positively correlated to their recognition of traffic symbols. There are many kinds of warnings in the forms of verbal, bells, beep sounds, etc. Among these, safety signs are one of the most common types used in the construction industry. It contains other information-telling observers what can be done and what cannot be done. Normally, safety

signs contain four components: signal words such as caution, a hazard statement, a statement informing the observers what may happen for noncompliance and a statement telling the observers how to avoid the hazard. The major function is to draw observers' attention and convey immediate signals on the level of danger. The design features of safety sings are as follows: (Tam et al, 2003)

2.5.1 Sign Color

Edworthy and Adams (1996) indicated that the color of warning labels should attract the attention of observers. Different colors represent different levels of risk due to cultural influence or physiological responses. Traditionally, red represents the highest level of hazard, followed by orange, yellow, green, blue and white.

2.5.2 Signal Words

Apart from color, warning labels should contain signal words, such as danger, caution and instruction, to identify the levels of hazard. Normally, danger represents the highest level of hazard, caution indicates an intermediate level and instruction (notice) shows the lowest level, (Chapanis, 1994).

2.5.3 Signal Words and Color

Many studies investigate the influence of signal words together with the color in order to ascertain their interrelated outcomes. Edworthy and Adams (1996) expressed that color and signal words tend to interact; for example, the effect of a word associated with a high degree of risk can be weakened by assigning it a color associated with low level of risk. Chapanis (1994) examined the perception of hazard levels by asking the participants to match the three signal words (instruction, caution and

danger) with four background colors (blue, yellow, and red). The findings show that danger with a red background represents the highest level of risk, but there is no significant difference between caution and instruction.

2.6 Safety Performance Measurement

The dictionary meaning of the word Performance is the execution or fulfillment of a duty the performance of a construction organization is a function of the performance of the members of that organization. High performance by individual members of the organization will result in high performance by the organization. Organizational performance, as well as individual performance, is multidimensional. One author has stated that performance consists of seven dimensions: effectiveness, efficiency, quality, productivity, quality of work life, innovation, and profitability. Each of these dimensions must be of interest to the construction

2.6.1 Quantitative Appraisal of Safety Performance

In past several decades many attempts have been made to determine or rate quantitatively the safety level of plant or any industry. The only means so far employed is through accident statistics, which by their very nature are collected after the event, which is unfortunate. For the accident data to be statistically validated, it must be collected either over long periods of time or from a large number of similar activities (Bu-Khamsin 1999).

Accident statistics provide valuable information to insurance companies and regulatory agencies. Regulatory agencies use this data to identify causative factors and to know requirements for additional regulations regarding safety. Insurance companies use this data to determine costs of premiums (Baig 2001).

A number of safety performance indices are now in use, such as a number of disabling injuries, injury frequency rates, injury severity rates, accident costs, number of deaths, number of first aid cases, recordable occupational illnesses, and the ratio of injury severity to injury frequency, and total injury rates (Bu-Khamsin 1999).

Frequency rate:

This can be computed in different ways to determine the frequency of accidents or injuries. The methodology is same for all the cases; however the base may be different (Baig 2001).

The disabling injury frequency rate is based on the total number of death, permanent total, permanent partial, and temporary total disabilities which occur during the period covered by the rate. The rate relates these injuries to hours worked during the period and expresses them in terms of a million-hour unit by use of the following formula (Bu-Khamsin 1999):

$$\text{Disabling Injury Frequency Rate (F)} = \frac{\text{Number of disabling injuries x 106}}{\text{Employee hours of exposure}} \ldots Eq\ 2.1$$

Severity rate:

The frequency rates were not depicting the true picture, so there was a need for severity rates. For example, one industry may have high injury frequency rates, but the injuries are minor. And some other industry may have few injuries and extremely low injury frequency rates and when injuries do occur they are severe. American National Standard Institute (ANSI) has established a means to of measuring severities through the use of time charges. For this method, fatalities and injuries are assigned time charges to be used in to know severity rates. These time charges are based on average experience. For example, each fatality or permanent total disability is assigned a time charge of 6,000 days. This is based on the life

expectancy of the average worker times the number of working days per year (Baig 2001):

$$\text{Disabling Injury Severity Rate (S)} = \frac{\text{Total days charged x 106}}{\text{Employee hours of exposure}} \ldots\ldots Eq\ 2.2$$

Chapter 3

Research Methodology

3.1 Introduction

This chapter discusses research procedure and the method used to conduct the research related to its objectives that has been highlighted in Chapter 1. The method used in this research is quantitative.

The methodology that was adopted for this study is the questionnaire survey. The information or data gathered using questionnaires focus on selected wider spectrum of respondent from construction industry in Khartoum state.

This chapter describes the methodology that was used in this research. The adopted methodology to accomplish this study uses the following techniques: review of literature related to safety performance, the information about the research design, research population, research location, questionnaire design, , questionnaire validity, questionnaire reliability, research structure and statistical data analysis.

3.2 Research Design

The first stage of the research is to identify the aim of this study and to highlight the problems statements and establishment of clear objectives is also specified within the research plan.

The second phase of the research included a summary of the comprehensive literature review. Literatures on safety performance were reviewed.

The third phase of the research included a pilot study which was conducted to assessment of the factors affecting safety performance in construction projects in Khartoum state.

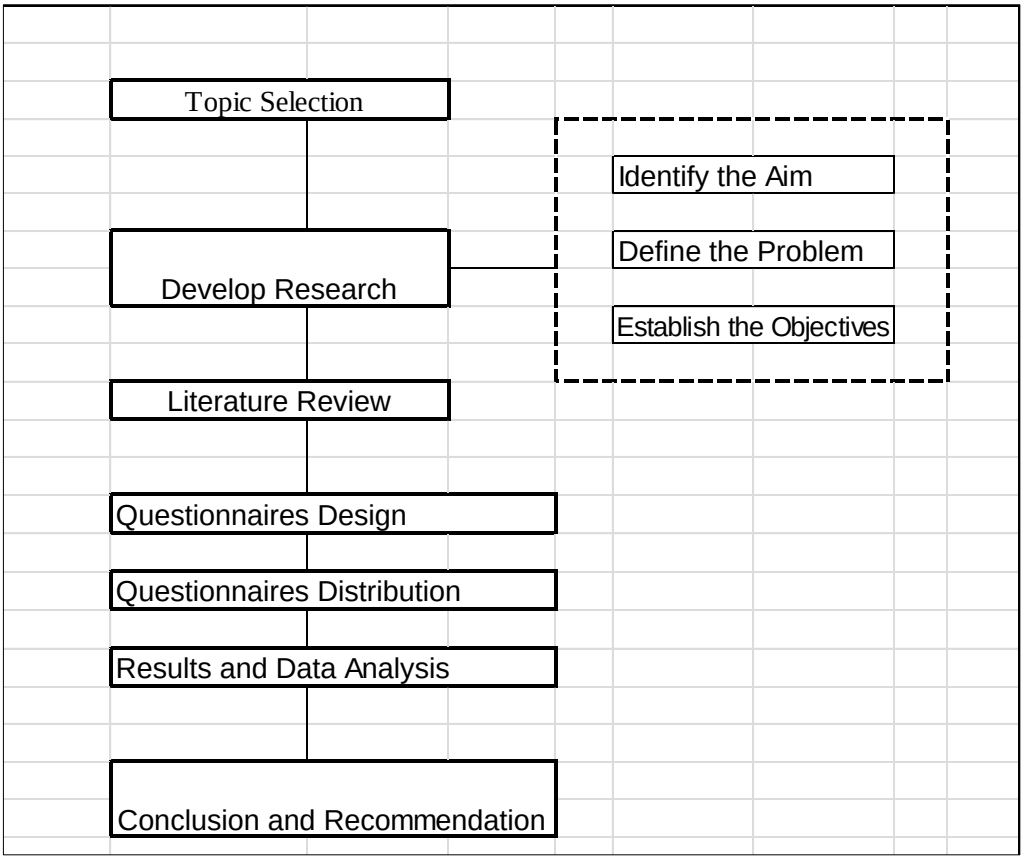


Fig. 3. 1 Flowchart of Research Methodology

3.3 Research Location

This research was conducted in Khartoum state .the questionnaire were distributed to cover the geographical locations over Khartoum state.

3.4 Research Population

This research targeted contractors in various categories building, roads, and water sewage. The studied population was the contractor's companies that have a valid registration in the in Sudan Contracting Union SCU in the following fields: building, roads, and water sewage.

3.5 Questionnaire Design

According to the reviewed of literature and after interviewing experts who were familiar with the safety performance at different levels, all the information that could help in achieving the study objectives were collected, reviewed and formalized to be suitable for the study survey and after many stages of brain storming, consulting, amending, and reviewing executed by the researcher with the supervisor, a questionnaire was developed with closed and open-ended questions.

The questionnaire was designed in the Arabic language (Appendix A-1), to be easily understood. An English version was attached in (Appendix A-2). Unnecessary personal data, complex and duplicated questions were avoided. The questionnaire was provided with a covering letter which explained the purpose of the study, the way of responding, the aim of the research and the security of the information in order to encourage high response. The questionnaire design was composed of forth parts to accomplish the objectives of the research, as follows:

Part A: General Information of Company and Respondent

This part is related to general information about the companies and respondents. The respondents were requested to answer general information pertaining to their classification and experience in construction. This part is used to determine the size, experience of respondents and companies, etc.

Part B: Information of Safety In Company [This part was designed to achieve Objective 1 + Objective 4]

This part is used to determine safety situation (practice) and perception of the respondents and companies. This part contains seven questions to asses

the level of safety practice in the construction company (objectives 1). The last question in this part were used to determine accident frequency rate (AFR) to help to assign the tool to improve safety in construction companies (Objective 4).

Part C: Factors Affecting the Safety Performance in Construction Projects [This part was designed to achieve Objective 2]

This part includes the list of the factors affecting the safety performance in the construction industry. It contains ten groups, and thirty nine factors for measuring the degree of impact on safety performance in construction project. Respondents will be invited to state any other factors that affect safety performance and to rate these factors. The degree of impact is based on a five-point Likert scale. These five points are (very high), (high), (moderate), (low), and (very low).

Factors Affecting the Safety Performance in Construction Projects

Level	**Very High**	**High**	**Moderate**	**Low**	**Very Low**
Scale	**5**	**4**	**3**	**2**	**1**

Part D: Information of Sings, Signals and Symbols [This part was designed to achieve Objective 3]

This part includes the list of the sings, signals and symbols in the construction industry.

It contains eighteen signs, signals and symbols they were listed in questionnaire without indicated about their kind to do not control the respondents in specific trend.,

For each sign, there are two questions were asked, the first was about the knowledge and the second was about the used of these signs in the site. The knowledge and use questions based on a Yes or No as the following:

Level	**Yes**	**No**
Scale	1	2

In analysis these signs were divided into three kinds as following: danger signs; caution signs ; instruction signs and Emergency Sings , represented in table 4-14, 4-15, 4-16 and 4-17 respondents about knowing or using sings, signal and symbols.

3.6 Statistical Manipulation

To achieve the research goal, researcher used the statistical package for the Social Science (SPSS) for manipulating and analyzing the data. The analyzed data include the description analysis shows (frequencies, means,).

Chapter 4

Results And Discussions

4.1 Introduction

This chapter presents and discusses the analyses and results of the collected data. The chapter includes a description of respondents, the classification, experience, size and the safety situation of the respondents and respondent companies. It also, includes the ranking of the factors affecting the safety performance in construction by using mean. The rank concordance and the hypothesis of agreement on ranking have been tested. The safety performance attitude's score (SPAS) and the accidents frequency rate (AFR) are then used to assessing a tool to improves the safety of the companies. However, before discussing the data analyses and results, the characteristics of construction contractors who participated in the survey are introduced.

4.2 Description of the Respondents

This section presents the description of the respondents who participated in this study. The results obtained from the questionnaire shows that, the hundred companies participated in the study located in Khartoum state. The following section will describe the characteristics of the respondents that participated in this survey. These characteristics also include the companies' categories, experience and size of the companies.

4.2.1 Job Title of Respondents

From result, 35 % from the sample was project managers, 53 % from the sample was site engineer, 9 % was executive director while 3 % from the sample was chairperson of the board. Figure 4-1 shows the distribution of each type of respondents.

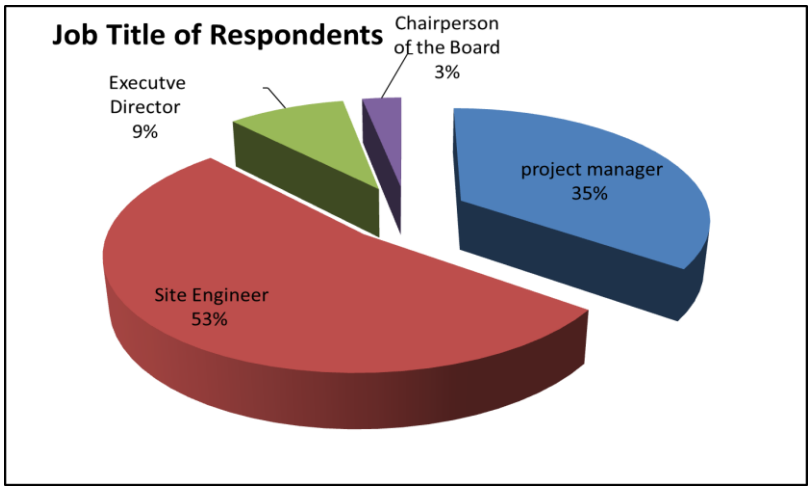


Fig. 4. 1 Job Title of Respondents

4.2.2 Working Experience for Company

Working experience is measured in the number of years a company has been operating in the construction industry. The majority of the surveyed companies "90%" have been practicing the construction business for more than 5 years; it was sum of (25, 41, and 24). Figure 4-2 shows the working experience of companies in the construction field.

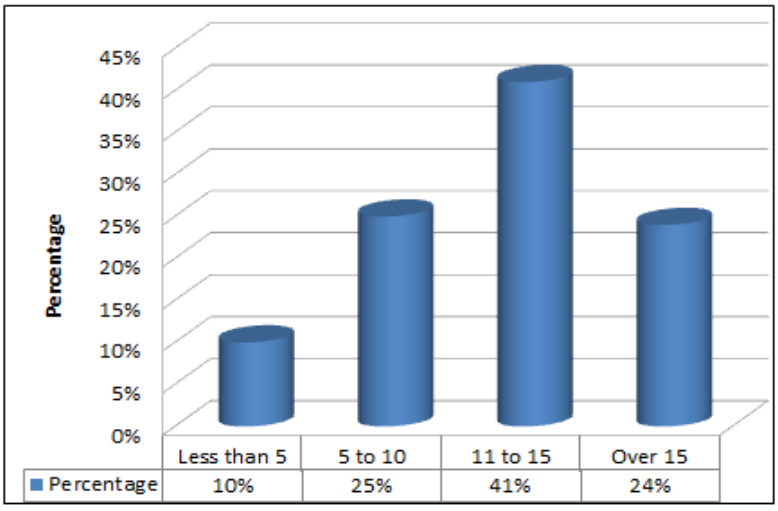


Fig. 4. 2 Company Experience in the Construction Field

4.2.3 Working Experience for Respondent

The years of experience vary from less than 5 years to more than 15 years. Most of the respondents are experienced and 15% from the sample have less than 5 years experience in the construction field, and 85% from the sample have over 5 years experience in the construction field. Figure 4-3 shows the working experience of respondents in the construction field.

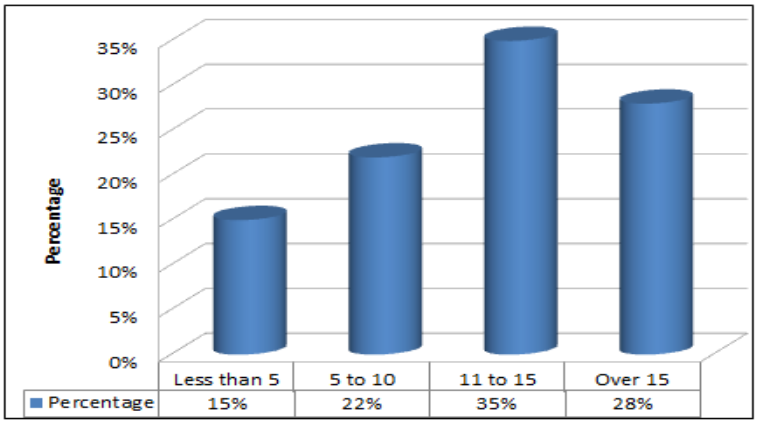


Fig. 4. 3 Worker Experience in the Construction Field

4.2.4 Respondent Age

Figure 4-4 shows that the majority of respondents 55% are of the age between 35 years to 44 years old. This is the appropriate age for a graduate engineer to work and start professional life. Only 15% is more than 45 years old.

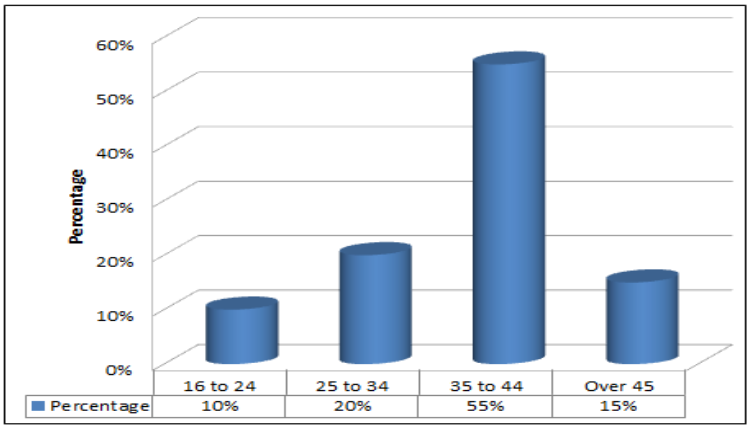


Fig. 4. 4 Respondent Age

4.2.5 Qualification of Respondent

Figure 4-5 shows that the majority of respondents 65% have BSc degree while only 15 % hold Master degree, it is understood that this situation is natural because most of respondents as shown in Figure 4-5 are young (their ages range between 16 to 34).

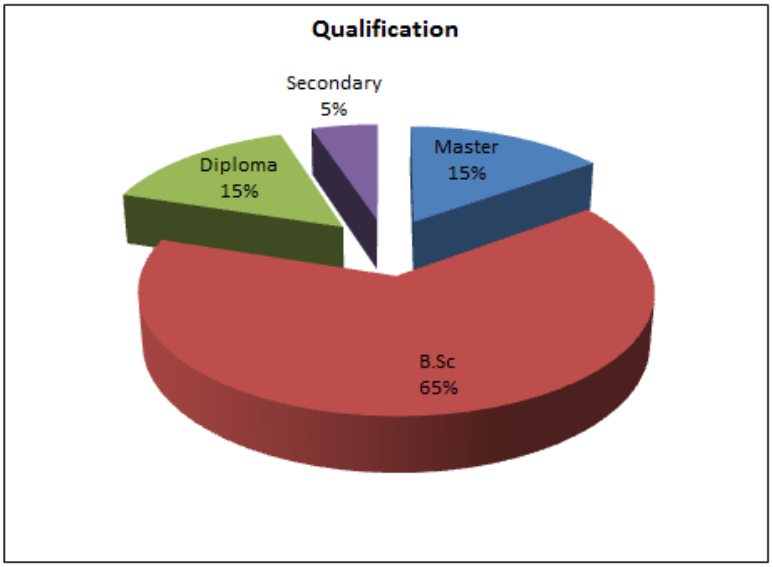


Fig. 4. 5 Qualification of Respondent

4.2.6 Company Size

Company size measured in the number of workers a company is employing. The companies that have less than 50 workers represent 66.7% of the total participated ٦١ companies and that which have more than 300 employees represent 3.9 %. Figure 4-6 shows the size of company in terms of Number of workers.

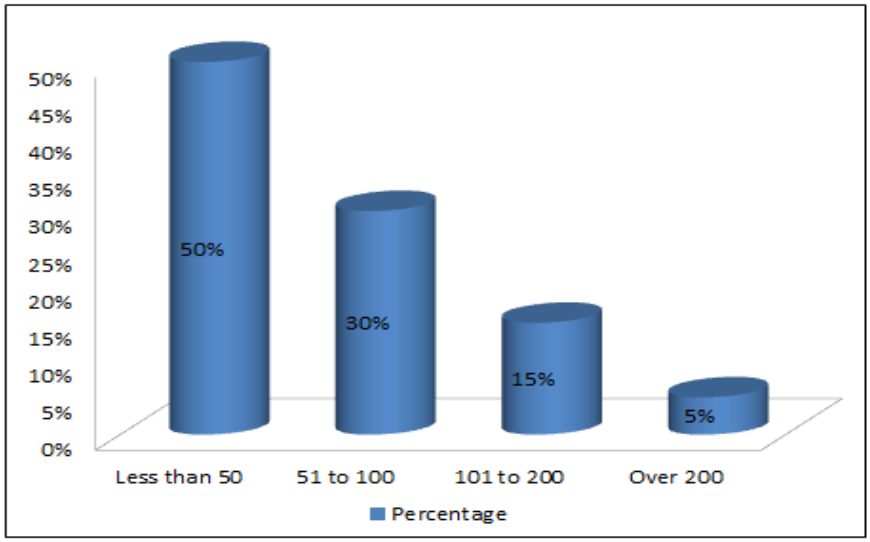


Fig. 4. 6 Company Size

4.3 Respondents Safety Practice and Perception

In this section, the results were concerning respondent's safety practice and perception. The respondents were requested to give information about their perception towards safety.

4.3.1 Availability of Safety Professional / Department

The respondents were asked if their companies have a safety professional and or safety department. 90% of the respondents did not have a safety professional or safety department while the remaining 10% had. The results of the questionnaire are presented in Figure 4-7.

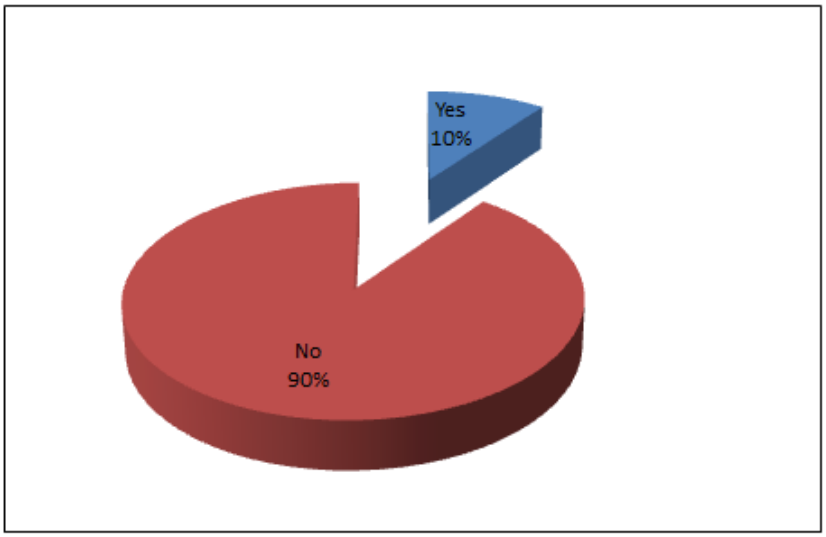


Fig. 4. 7 Availablility of safety Professional Deparement

4.3.2 Using of Safety Program or Manual

The respondents were asked if their companies use a safety program or manual. About 15 % of the respondents are using a safety program or manual. The respondents, which are partially using a program, represented about 20%. The remaining 65% of respondents are not using a safety program at all. The results of the questionnaire are presented in Figure 4-8.

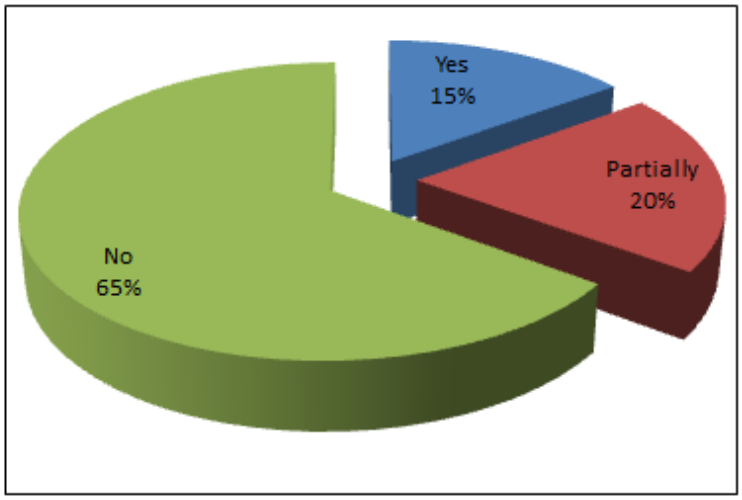


Fig. 4. 8 using of safety prgram or manual

4.3.3 Safety Knowledge

The respondents were asked if they have knowledge about the safety conditions, specifications and provisions. About 40 % of the respondents agree that they have knowledge of safety. While 45 % of the respondents agree that they have partially knowledge of safety. Only 15% of respondents feel that they did not have sufficient knowledge of safety. The results of the questionnaire are presented in Figure 4-9.

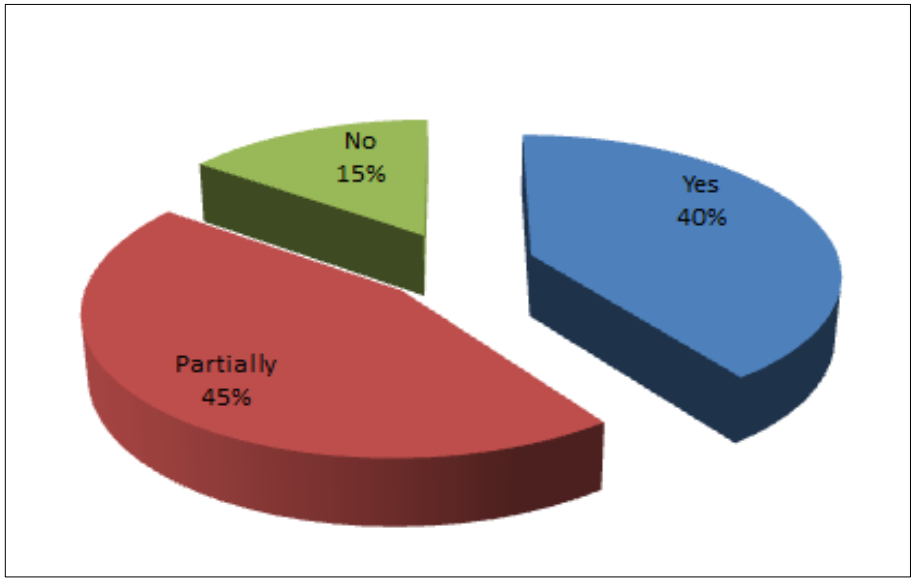


Fig. 4. 9 safety knowledge

4.3.4 Responsibility of Safety Lacking

The respondents were asked about their opinion on responsibility of lacking safety during the construction on site. The parties that have the main responsibility for lacking of safety on site according to the respondents are Engineer (about 30%), Safety engineer (40%) and the management (20%). About 10% of the respondents have view that the worker is responsible for lacking of safety on site. The results of the questionnaire presented in Table 4-10.

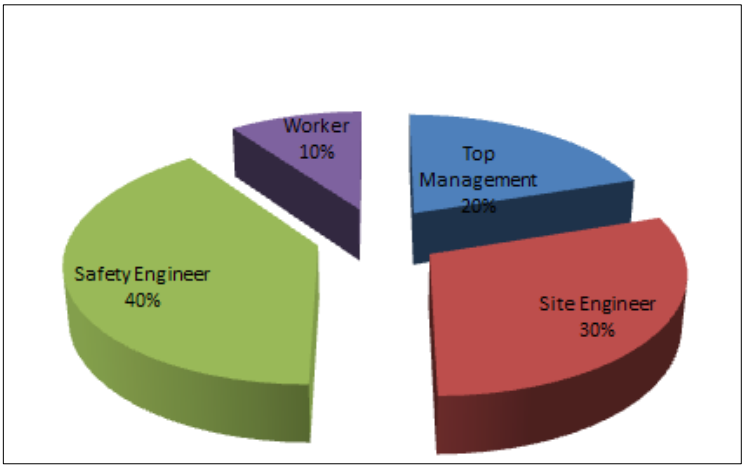


Fig. 4. 10 Responsibility of Safety Lacking

4.3.5 Financial Saving

The respondents were asked if they expected any financial saving by complying with safety provisions. About 50% of the respondents agree that there are savings. Nearly 30% feel that sometimes there are savings. Only 20 % of the respondents disagree that there are financial saving by complying with safety provisions. The results of the questionnaire are presented in Figure 4-11.

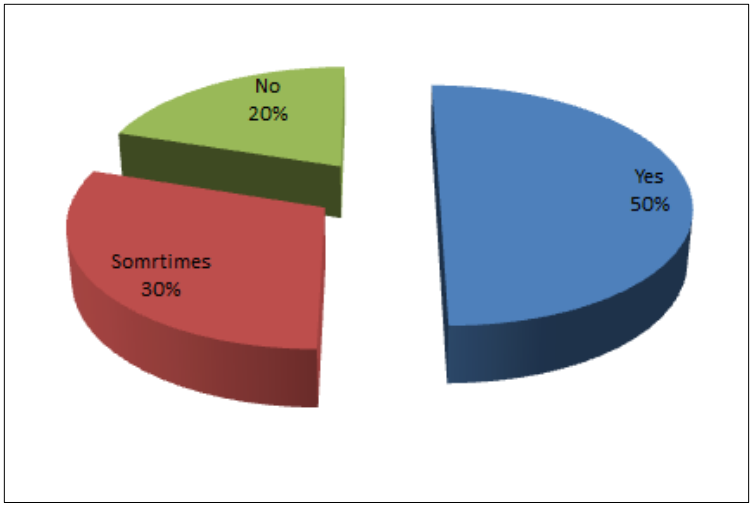


Fig. 4. 11Financial Saving

4.3.6 Impact of Accidents

From Table 4-1, it can be observed that, the highest impact of the accident at the project is shown in the financial direction. The results illustrate that, around 67% (33% + 34%) of the respondent have a strong satisfaction that the accidents will lead to increase the project's cost.

Table 4. 1 Impact of Accidents

Impact of Accidents	Percentage of Occurrence					Mean	Rank
	Very high	High	moderate	Low	Very low		
Increase on cost	33	34	17	10	5	3.77	1
Impairing reputation of companies	14	23	32	23	9	3.13	2
Interrupting project's schedule	13	21	24	30	10	2.91	4

"Impairing reputation of companies" was ranked the harmful impact of the accident rate at the company's reputation. The respondent's satisfaction that more accidents in the project will reflect unstable construction projects, which give warring impales at the project success. This impact at the accident rates at the company's reputation was ranked in the second highest position.

The results reflect also, that, occurrence of rates in construction may influence the schedule arrangement to complete the projects. "Interrupting

project’s schedule” was ranked in a low influence position at the construction projects.

The overall results will show clearly that the highest harmful impact from contractor’s point of view is traced towards the financial direction, which turn influence other areas.

In general, such accidents in construction projects will have negative impact at the sustainability of the project.

4.4 Evaluation of Factors Affecting the Safety Performance

Part (C) of the questionnaire includes the list of factors affecting safety performance in the construction project. It contains ten groups. the groups were administrative and management commitment ; project nature; emergency planning and preparations; signs, signals and barricades; welfare facilities; safety inspections; safety meetings; safety educating and training; personal protective equipment; fire prevention. In the following sections will discussion and interpretation of each factor's groups.

4.4.1 Group 1: Administrative And Management Commitment

This group contains five factors and was ranked in the 1st position respect to other remaining groups (overall 10 groups) with mean (3.12). Table 4-1 shows the administrative and management commitment factors affecting safety performance in construction projects.

Table 4. 2 Rank of Administrative and Management Commitment Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Administrative & Management Commitment	Very high	High	moderate	Low	Very low			
Safety awareness of project managers	30	17	19	26	8	3.35	1	1
Safety awareness of company's to management	29	16	17	30	8	3.28	2	3
Availability a clear company's policy	23	17	25	29	11	3.27	3	4
Conduction of safety policy review	17	22	17	24	20	2.92	4	15
Management's attitude towards workers welfare	22	13	15	21	29	2.78	5	27
Total						3.12		

Within this group, "Safety awareness of project managers" was ranked in the first position and was ranked in the 1st position among overall factor's groups. This could be returned to the following:

1. The project manager has direct responsibilities for the safety performance condition in the site.
2. The project manager is responsible to carry out the safety clauses as mentioned in the contract conditions.
3. The project manager has ethical responsibilities to advise and edify the labors about the safety consideration during the working hours.

"Safety awareness of company's top management" was also ranked in a top position (2nd position). This factor was ranked in the 3rd position among overall factors groups. These results show clearly the essential impact of the top management comments towards the embedding and conducting any policy within the organization. “Management's attitude towards workers welfare " was ranked in the last position (5th) within this group and in the position 27th respect to allover groups. The results reflect that, the contractors are not satisfied the benefit or efficiency of applying policy revision to improve safety performance. This could be traced to the culture of the contractors in Khartoum state, as the conduction of any policy will need huge efforts and attention. This may necessitate a systematic awareness campaign.

4.4.2 Group 2: Project Nature

Table 4-3 shows the respondents opinion about this group affecting the safety performance in construction projects according to mean from high to low.

The group contains seven factors and was ranked in the position 10th respect to overall groups. Relatively, the influence of these factors is not high respect to other groups. Within this group, "Volume of the project” was ranked in the 1st position among project nature group This result reflects that, the contractors satisfied that the Volume of the project is critical to safety conditions. This could integrate specially in the infrastructure works (paving of asphalt spreading base course layers). It is expected also that the. This factor was ranked also in the 10th position respect to overall factors among all groups. “Lighting the site during night working hours " was rank in the second position within this group, and being in 31th position to overall groups. , the contractors satisfied that the lighting condition during the night is critical to safety conditions. It is

expected also that the majority of contractors in Khartoum state extend the working hours to the night periods to complete the project within its planned duration and overcome any a non-controllable conducting like closure or lake of raw materials.

Table 4. 3 Rank of Project Nature Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Project Nature	Very high	High	moderate	Low	Very low			
Volume of the project	9	21	32	30	20	3.05	1	10
Lighting the site during night working hours	9	12	41	18	18	2.70	2	31
Type of owner	7	11	40	28	14	2.69	3	32
Cost of the project	4	23	35	12	26	2.67	4	33
Clear and easy of project design	5	12	37	34	12	2.64	5	35
Arrangement and organization the site	8	11	32	24	24	2.52	6	37
Application of new technology in construction project	7	10	34	23	15	2.38	7	38
Total						2.66		

4.4.3 Group 3: Emergency Planning And Preparations

From Table 4-4, this group contains two factors and was ranked with in 3rd position respect to main factors. Within this group, two factors investigated to read this effect on the safety performance. The results show that the factor of, "Develop a plan to respond to emergencies" was ranked in the first position among project nature group, and ranked in the 5th position among all groups.

These results are relatively close to our results that reflect the importance of the planning stage for the success and safety performance for the construction projects.

Table 4. 4 Rank of Emergency Planning And Preparations Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Emergency planning & preparation	Very high	High	moderate	Low	Very low			
Develop a plan to respond to emergencies	14	26	33	22	6	3.23	1	5
Training worker to respond to emergencies through the exercise	14	16	28	27	13	2.85	2	20
Total						3.04		

Second position within this group of factors and in the 20th position respect to overall groups. These results reflect that, the contractors have not the willingness and the readiness to improve the awareness level of their labor about safety conditions.

4.4.4 Group 3: Signs, Symbol, and Barricades

This group contains five factors and was ranked in the fourth position overall groups, which was revealed the importance of this group respect to safety performance. Table 4-5 shows the results.

Table 4. 5 Rank of Signs, Symbol, and Barricades Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Signs ,Signals & Barricades	Very high	High	moderate	Low	Very low			
The use of barricades to close the site for the pedestrians	17	20	33	24	5	3.17	1	6
The use of danger signs	14	23	32	23	9	3.13	2	7
The use of caution signs	14	22	24	32	7	3.01	3	12
The use of instruction signs	13	21	24	30	10	2.91	4	16
The use of traffic signs	12	17	26	28	19	2.81	5	25
Total						3.01		

From this group of factors, it can be observed that," The use of barricades to close the site for the pedestrians" was ranked in the first position within

this group. The factor was ranked in the 6th position over all groups. This result reveled that “The use of barricades to close the site for the pedestrians". Such signs could protect and guide the labors to take care of the surrounding conditions which inurn protect the labor's life.

From this group of factors, it can be observed that," Using of danger signs” was ranked in the second position within this group .The factor was ranked in the 7th position over all groups. This result reveled that “Use of danger signs" which indicate the red-color, that used in the construction projects has critical influence at the safety performance conditions. Such signs could protect and guide the labors to take care of the surrounding conditions which inurn protect the labor's life.

"The use of caution signs" was ranked in the third position within this group of factors. In addition, it was ranked in the 12th position overall groups. Such sign take a yellow color, which reflect a warning safety conditions. The results reflect that the contractors are satisfied that such signs are critical to reduce the accidents rate in the construction projects. In addition, the results reflect the easiness that such signs have to improve the safety conditions in the site. The results reflect also the importance of these signs for the labors survivals.

“The use of instruction signs " was ranked in the fourth position within this group with and being in the 16th position with overall groups. These results show direct relation between relations the indicators of the safety signs with its effect at the safety performance moreover, the result show the direct relation between the safety sign with its effect at the safety performance, where the most influence was shown are the danger signs then, caution signs and finally the instruction signs. "The use of traffic signals in the site” was ranked in the 5th position within this group and in the 25th within overall groups.

4.4.5 Group 5: Welfare Facilities

From Table 4-6, this group contains three factors and was ranked in the 8th position respect to overall groups. The results show that the contractors are satisfied that (Provision of adequate toilets) is a critical and important factor that affecting safety performance in the construction projects. This factor was ranked in the 1st position within this group of factors and being in the 22 position among overall groups. The result reveal to the fact that, the first aid is the first line defense in case of anybody in the site. So the existence of these kits is critical for safety performance.

“Provision of adequate facilities for first aid treatment " ranked in the second position within this group and ranked in the 28th position respect to overall groups.

Table 4. 6 Rank of Welfare Facilities Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Welfare facilities	Very high	High	moderate	Low	Very low			
Provision of adequate toilets	11	20	26	29	12	2.83	1	22
Provision of adequate facilities for first aid treatment	13	20	23	20	22	2.76	2	28
Provision of an ambulance in the site	10	18	21	34	21	2.74	3	29
Total						2.78		

4.4.6 Group 6: Safety Inspections

This group of factors contains three factors and was ranked in the 6th position overall groups which was revealed the important at this group respect to safety performance. Table 4-7 shows Safety inspections factors affecting safety performance.

This group was ranked in the 6th position respect to overall group. Relatively Within this group, i.e. (Safety inspection), it was shown that, “Safety inspections by supervisor office “was ranked in the 1st position and in the position second respect to overall factors. " Safety inspections by top management “was ranked in the 2nd position and in the position 19th respect to overall factors. These results insure that, the project manager has an important role to attain and adopt the inspection process in the construction project that in turn improves the safety performance. The project manage has his own responsibility towards the daily monitoring for all activities of the project. In addition, the project manager try to perform the project without accidents to increase his reputation for construction process and the project manager it’s the responsible for any accident which happen in the site.

"Safety inspections by insurance companies" was ranked in the 3rd position within safety inspections group and with 39th respect to overall factors. The result shows that insurance companies do not have important rolein the inspection projects because it is difficult to obtain the rights from insurance , in general the inspection action is crucial as a controlling and monitoring tool to achieve the organization's objective orientations policy.

Table 4. 7 and Rank of Safety Inspections Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Safety Inspections	Very high	High	moderate	Low	Very low			
Safety inspections by supervisor office	11	34	24	28	13	3.32	1	2
Safety inspections by top management	12	19	28	27	13	2.87	2	19
Safety inspections by insurance companies	6	19	16	25	33	2.37	3	39
Total						2.86		

4.4.7 Group 7: Safety Meetings

This group of factors "safety meetings" contains three factors and was ranked in the 9th position respect to overall groups with. Table 4-8 shows the factors within this group.

Table 4. 8 Rank of Safety Meetings Group Affecting Safety Performance

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Safety Meetings	Very high	High	moderate	Low	Very low			
Conducting safety meeting in the site by the site engineer	10	17	31	29	13	2.82	1	24
Conducting safety meeting before beginning for each activity	10	19	24	29	16	2.72	2	30
Attendance of safety meetings by top management	9	20	20	30	20	2.65	3	34
Total							2.73	

"Conducting safety meeting in the site by the site engineer" was ranked in the 1st position within this group and in the 24th position respect to all factors over the groups. This rank reflects the important of this factor for construction project. The results indicate that, the site engineer has a crucial responsibility to improve the awareness degree in the safety performance for the labors in construction. The periodical meeting with labors will empower the importance of safety concept and benefit for the labors that in turn enhance their culture in this direction. These results who found the

essential benefit of the weekly meetings for the safety performance improvement.

"Conducting safety meeting before each activity begins" was ranked in the second position, but this factor was ranked in the position 30nd respect to all factors within all groups. These results mean that, it may not be efficient to hold meeting before each activity, this will lead to uncontrollable delay and may lead to disturbance of the managerial works within the site.

"Attendance of safety meetings by top management" was ranked in the 3rd position within this group but with a 34th position within overall group's factors. The overall pictures reflect that, the meeting done by site engineer is the most proper one because such meetings occurred naturally without during the works. This guidance and advices occurred by the site engineer will enhance and improve the awareness and knowledge level for the labors in a simple way.

4.4.8 Group8: Safety Educating and Training

This group of factors i.e. "safety educating and training" contains five factors and was ranked in the 5th position respects to overall all groups with a relative important index . Relatively, this group of factors is not in the critical position to affect safety performance in the construction industry in the Khartoum state in respect to other groups. Table 4-9 summarizes the factors related to Safety educating & training factors affecting safety performance.

Table 4. 9 Rank of Safety Educating and Training Group Affecting Safety Performance Percentage of Occurrence

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Safety Education & Training	Very high	High	moderate	Low	Very low			
Safety seminars held by the management of the project	14	25	18	31	17	3.03	1	11
Guidance and training of worker to safety	18	19	22	23	20	2.98	2	13
Brochures and publications on safety	17	12	29	27	14	2.88	3	18
Safety posters	15	20	14	34	17	2.82	4	23
Training of first aid for all workers	15	17	21	27	20	2.80	5	26
Total						2.9		

With this group of factors," Safety seminars held by the management of the project "was ranked in the 1st position. Although the factor in the first position, it appears with low influence as being around the neutral agreement level. I believe the importance of this factor at the safety performance.

With this group of factors," Guidance and training of workers about safety" was ranked in the 2nd position. Although the factor in the second position, it appears with low influence as being around the neutral agreement level.

The continuous training and awareness campaigns will be useful to develop the labors skills and learning culture about the safety performance.

“Brochures and publications on safety” was ranked in the 3rd position within this group and the factor was ranked in the position 18th respect to overall factors within all groups.

"Safety poster" was ranked in the 4th position within this group and the factor was ranked in the position 23rd respect to overall factors within all groups.

These results revealed the weak influence of this factor at the safety performance during the construction project. To empower and strength such factor it may require showing these posters before the beginning of the projects and precisely in the mobilization stage while the flow of work is relatively tiny. This indicates that this factor has moderate effect on safety performance. The weak influence of this factor may also be traced to contractor's expectation of financial requirements to do such posters.

“Training for first aid for all workers" has also a moderate effect on safety performance. This factor was ranked in the last position but.

Either the results will alarm the decision makers to ask the contractors or the sub-contractors to provide certify showing their understanding of the safety conditions, problems and solutions in construction projects.

4.4.9 Group 9: Personal Protective Equipment

This group contains three factors. Table 4-10 illustrates respondent's opinion regarding the factor measuring safety performance. This group of factors i.e. "Personal Protective Equipment" was ranked in the 2nd position among all other groups. This result emphasizes that the Personal Protective Equipment (PPE) is extremely important for each construction projects.

Moreover, it can be a strong indicator for the safety performance in the project.

Table 4. 10 Rank of Personal Protective Equipment Group Affecting Safety Performance

Factors Description	**Percentage of Occurrence**					Mean	Rank within this Group	Rank within overall Factors
Personal Protective Equipment	Very high	High	moderate	Low	Very low			
The use of protective feet	14	20	37	21	7	3.10	1	8
The use of protective head	23	17	21	23	17	3.09	2	9
The use of gloves and face protection	13	19	25	36	6	2.94	3	14
Total						3.04		

"The use of protective feet" factor ranked in the first position among PPE group also was ranked in the 9th position among all groups factors.

"The use of protective head" factor ranked in the second position among PPE group also was ranked in the 8th position among all groups factors. This result indicates that respondents were to support that PPE.

"The use of gloves and face protection" was ranked in the third position within this group also was ranked in the 14th position among all groups factors. The importance of this factor could be returned to the fact that, protecting the hands and the face from any external harmful materials and

impurity will be critical for the safety conditions for the labors, in additions, the presence of such equipment and materials like (gloves and face protection) will absolutely, means the steadiness of the work without body injuries or human losses.

The results show that, these three factors are too critical for the safety performance measurements.

The reasons could be returned to the fact that the hands, face, and feet are the key enablers for any person to do any task professionally and specially the labors in the construction.

Such deviation between the importance's of these factors could be traced to the fact that using such personal protective equipment in the construction project in the developed countries is a normal issue. Moreover, each labor wear the gloves and face protection normally without any pressure, but in the developing countries and according to the labors culture they may not have the willing to do this normally.

4.4.10 Group 10: Fire Prevention

This group of factor contains three factors. Table 4-11 illustrates respondent's opinion regarding the factor measuring safety performance. This group of factors i.e. "Fire Prevention" was ranked in the 7th position among all other groups.

Table 4. 11 Rank of Fire Prevention Group Affecting Safety Performance Percentage of Occurrence

Factors Description	Percentage of Occurrence					Mean	Rank within this Group	Rank within overall Factors
Fire Prevention	Very high	High	moderate	Low	Very low			
Availability of adequate fire extinguishers in the site	15	12	33	28	12	2.90	1	17
Good storage of flammable liquids combustible materials	15	12	31	26	16	2.84	2	21
Periodical maintenance of fire extinguishers which located in the site	13	11	24	29	23	2.62	3	36
Total						2.79		

"Availability of adequate fire extinguishers in the site " was ranked in the 1st position among this group and 17th among all groups' factors. This result shows that, the contractors who have care about the existence of fire extinguishers will imply a good indicator of the safety performance conditions in the project and it will in turn improve safety performance.

"Good storage of flammable liquids and combustible materials" was ranked in the 2nd position in this group and was ranked in the 21 of overall groups. "Periodical maintenance of fire extinguishers which located in the site" was

ranked in the last position (3rd) within this group and in the position of 36th overall factors in all groups. The result indicated that, contractors put this factor in average rank respect to overall factors. in the construction site represent a critical factor in case of fire problems. Moreover, the good manager should have all arrangements during the mobilization stage to obtain the fire distinguishers and arrange a safe location for the flammable materials. Such arrangements will save not only the cost but also labors lives which is more important that the money.

4.4.11 Summary Ranks of Groups Affecting Safety Performance

Table 4-12 shows the rank of the groups, the ranks were arranged from high affecting safety performance in construction project to low.

The summary figures shown in Table 4-12 illustrated that, group of factors related to" Administrative & Management Commitment " was ranked in the first position among the (10) groups.

Administrative & Safety Management Commitment is regarded as the systematic application of management processes to the hazards faced by an organization. Safety performance management involves assessing and controlling risks, planning activities, detecting latent failures and active failures, and monitoring and review in performance. Therefore success of any action taken to control risks is assessed through appropriate active monitoring, which may involve a range of techniques

Safety management systems have two interrelated main functions: to avoid accidents and improve safety.

The results shown in Table 4-12 illustrated also that group of factors related to "Personal Protective equipment" was ranked in the second position among the ten (10) groups. The importance of this group of factors

could be returned to the fact that such group includes the main equipment that protects the worker from the daily working accidents. The protection of head, eyes, noise, hands and feet are covered in this group factors. This will be considering the first defense line protect the workers and influence the safety performance.

The results shown in Table 4-12 illustrated also that, the group of factors including" Signs, Signals Barricades" was ranked in the 4th position respect to the remaining (10) group of factors. The importance of this group of factors could be returned to the following:

- These signs and signals are easy to be understood and critical to save labors efforts and lives during the working days.
- These signs could arrange the labors conditions and working places, and create preemptive guidance for the pedestrians (not to enter the site) and workers (during the working hours) to draw their attention of the site conditions.
- The work load desire a warning, caution and instruction signs and signals to remain the labors in standing and ready for any unexpected events.

The results shown in Table 4-12 illustrated also that, the group of factors including "welfare facilities" was ranked in the position 8th respect to the remaining (10) groups. Relatively, the influence of this factor at the safety performance is low. From our point of view, the contractors did not consider this factor in the critical position for the following:

- The welfare facilities mean additional expenditures without revenue.
- Our contractor's culture, the contractors believe that more welfare facilities will reduce labors productivity.

The results shown in Table 4-12 illustrated also that, "Project Nature" factors was ranked in the last position respect to all ten (10) groups.

Relatively, our point of view is deferent. We believe the following:

Table 4. 12 Ranks of Groups of Factors Affecting Safety Performance

Groups of factors	**Mean**	**Rank**
Administrative & Management Commitment	3.12	1
Personal Protective Equipment	3.05	2
Emergency planning & preparation	3.04	3
Signs ,Signals & Barricades	3.01	4
Safety Education & Training	2.90	5
Safety Inspections	2.86	6
Fire Prevention	2.79	7
Welfare facilities	2.78	8
Safety Meetings	2.73	9
Project Nature	2.66	10

4.4.12 Summary Ranks of Factors Affecting Safety Performance

Table 4-13 shows the rank of the factors related with their group. The ranks were arranged from high affecting safety performance to low.

Table 4. 13 Summaries of Ranks for Factors Affecting Safety Performance Related Group Factors Affecting Safety Performance Rank

Related Group	Factors Affecting Safety Performance	Mean	Rank
Administrative & Management Commitment	Safety awareness of project managers	3.35	1
Safety Inspections	Safety inspections by supervisor office	3.32	2
Administrative & Management Commitment	Safety awareness of company's to management	3.28	3
Administrative & Management Commitment	Availability a clear company's policy	3.27	4
Emergency planning & preparation	Develop a plan to respond to emergencies	3.23	5
Signs ,Signals & Barricades	The use of barricades to close the site for the pedestrians	3.17	6
Signs ,Signals & Barricades	The use of danger signs	3.13	7

Personal Protective Equipment	The use of protective head	3.10	8
Personal Protective Equipment	The use of protective feed	3.09	9
Project Nature	Volume of the project	3.05	10
Safety Education & Training	Safety seminars held by the management of the project	3.03	11
Signs ,Signals & Barricades	The use of caution signs	3.01	12
Safety Education & Training	Guidance and training of worker to safety	2.98	13
Personal Protective Equipment	The use of gloves and face protection	2.94	14
Administrative & Management Commitment	Conduction of safety policy review	2.92	15
Signs ,Signals & Barricades	The use of instruction signs	2.91	16
Fire Prevention	Availability of adequate fire extinguishers in the site	2.90	17
Safety Education & Training	Brochures and publications on safety	2.88	18
Safety Inspections	Safety inspections by top management	2.87	19

Emergency planning & preparation	Training worker to respond to emergencies emergences through the exercise	2.85	20
Fire Prevention	Good storage of flammable liquids combustible materials	2.84	21
Welfare facilities	Provision of adequate toilets	2.83	22
Safety Education & Training	Safety posters	2.82	23
Safety Meetings	Conducting safety meeting in the site by the site engineer	2.82	24
Signs ,Signals & Barricades	The use of traffic signs	2.81	25
Safety Education & Training	Training of first aid for all workers	2.80	26
Administrative & Management Commitment	Management's attitude towards workers welfare	2.78	27
Welfare facilities	Provision of adequate facilities for first aid treatment	2.76	28
Welfare facilities	Provision of an ambulance in the site	2.74	29
Safety Meetings	Conducting safety meeting before beginning for each activity	2.72	30
Project Nature	Lighting the site during night working hours	2.70	31

Project Nature	Type of owner	2.69	32
Project Nature	Cost of the project	2.67	33
Safety Meetings	Attendance of safety meetings by top management	2.65	34
Project Nature	Clear and easy of project design	2.64	35
Fire Prevention	Periodical maintenance of fire extinguishers which located in the site	2.62	36
Project Nature	Arrangement and organization the site	2.52	37
Project Nature	Application of new technology in construction project	2.38	38
Safety Inspections	Safety inspections by insurance companies	2.37	39

The result in table 4-13 depict that the most 4 important factor positively affecting safety performance in construction project in Khartoum state are: The Safety awareness of project managers; the Safety inspections by supervisor office; the Safety awareness of companies to management; the Availability a clear company's policy;

4.5 Knowledge and Usage of Signals and Symbols in the Site

The questionnaire conducted had to focus on four main types of regulatory signs; danger sign, caution sign, emergency sing, and instruction sign in which they were used in this study to measure the knowledge and the usage degree of the said signs in the time of implementing the contracts.

4.5.1 Danger Sings

The result revealed from Table 4-14 shows that, the survey works stated that there are different attitudes between the knowledge of sign and the use of it.

Since the current practice by the contractors and their workers during the implementation of the projects as they assume better to work fast rather being safe. The following points clarify the deviations of contractors' perception between knowledge and practice of danger signs in the site:

- It was noted that the knowledge of signs values were found to be logic in away that reflects the contractors' background.
- The usage values demonstrated lack of credibility by those who filled the questionnaire due to discrepancy in the knowledge and usage values
- The background of the contractors in the degree of knowledge of sing is relatively high which reflects the educational level of the contractors and the continuous presence of such signs in the fields.
- The background of the contractors in the degree of use of sing is relatively low which reflects the educational level of the contractors and the continuous presence of such signs in the fields.

Table 4. 14 Knowledge and Usage of Danger Sings

Sign	Symbol	Sign Knowledge		Sign Usage	
		Yes (%)	No (%)	Yes (%)	No (%)
No smoking		97	3	45	55
- In the event of fire do not use lift		48	52	88	12
Do not use ladder		90	10	58	42
Do not use mobile phones		95	5	40	60

4.5.1.1 Danger Sings Knowledge and usage

The results shown in Table 4-14 revealed that, (97%) of the responded contractors have knowledge of "No smoking" sign, but (45%) of them only use this sign in the construction sites. This result reflects clearly the importance of awareness campaigns for the contractors to consider the sign during the working practices. The failure to fix this sign may lead to a harmful impact at the health and properties of the project. This factor was not shown as critical factor affecting safety performance within the eighty (39) factors shown in Table 4-13.

Using the leader is common in construction projects, but under certain circumstances, it will not be safe to use the ladder due to construction

conditions. (90%) of the respondents understand the meaning of this sign "Do Not Use Ladder" but only 58% of the respondents use it in the sites. This means that, if the situation is critical and not safe to use the ladder no caution is shown.

This will desire drawing the attention for the decision makers to take care of this sign in the site.

The results revealed also that, (48%) of the responded contractors have knowledge of "- In the event of fire do not use lift " sign, but, only (88%) of them use this sign in the construction sites. This result reflects clearly that the contractors have not a strong interest or have not social responsibilities towards their labors or the pedestrians. Tremendously, the result strength the feasibility to set out an awareness campaigns for the contractors to consider this sign during the working practices. The failure to fix this sign may lead to a harmful impact at the labors, contractors' themselves, properties and pedestrians. The importance of this factor was shown in a high position (4th Position) as shown in Table 4-13.

4.5.2 Caution Sings

This Group contains 5 signs, from Table 4-15 show the following:

□□The result concluded from the survey work and related analysis illustrated that there are differences between the knowledge of sign and the use of it caused by the culture of contractor and workers.

- It was noted that the knowledge of sign values were found to be illogic in away that reflects the contractors' background and the use of them.
- The background of the contractors in the degree of knowledge of sing is relatively medium; high and low, values were noticed.

- The background of the contractors in the degree of use of sing is relatively low.

Table 4. 15 Knowledge and Usage of Caution Sings

Sign	Symbol	Sign Knowledge		Sign Usage	
		Yes (%)	No (%)	Yes (%)	No (%)
Toxic		95	5	60	40
Flammable		91	9	45	55
Danger deep excavation		90	10	42	58
Lifting in progress in overhead		95	5	35	65
Warning construction work in progress		88	12	30	70

4.5.2.1Caution Sings Knowledge and Usage

From Table 4-15, it is shown that, all respondents understand the meaning (have knowledge) of the "Toxic" sign, besides, (70%) responded positively as using this sign in the site.

This sign was the only one that obtains a percentage more than 50% in the usage at the site. All remaining signs have weak usage in the sites (less than 40%). The reason for such knowledge and usage for the "Toxic" sign could be traced to the direct meaning of the sign and the simplicity of design such sign. In addition, the contractors became familiars with this sign in many places not only in the construction projects.

Relatively, low respondents understand or use the sign of “Warning construction work in progress "only, 30% have knowledge of this sign while use it in the site. Besides, the respondents have low knowledge or usage of the "Noise, Lifting in progress in overhead and Warning construction work in progress”. This truly indicate the ignorance of our contractors in using these signs as a safety tool complying with the safety standards and requirements during the implementation, as this can't be applied in our areas, since no critical points was noticed in the working areas. Although these percentages are low, I believe the importance to show up the importance of such sign after the harmful impact in the site of construction project.

4.5.3 Instruction Sings

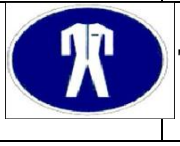
The result concluded from Table 4-16 show that the survey work and related analysis illustrated that there are differences between the knowledge of sign and the use of it caused by the culture of contractor and workers and the type of needed signs and their availability in the implementation phase.

- The result concluded depends on knowing of signs by contractor.
- The types and the shapes of signs to be used are not familiar by our local contractors, yet some of the signs should be re-shaped or formatted most factors, which are affecting on the result that the

sign, which are, used it in our survey works are no familiar to used in our country.

- It was noted that the knowledge of sign values were found to be relatively high.
- About the knowledge of sign we found that the degree of knowledge of singe are nearly and that is due to not use of it in our country and unfamiliar of it by contractor

Table 4. 16 Knowledge and Usage of Instruction Sings

Sign	Symbol	Sign Knowledge		Sign Usage	
		Yes (%)	No (%)	Yes (%)	No (%)
Gloves must be worn		90	10	75	25
Safety helmet must be Worn		97	3	36	64
Eye protection must be worn		80	20	35	65
Ear protection must be worn		75	25	25	75
Foot protection must be worn		85	15	38	62
Wearing uniforms Shield		73	27	30	70

4.5.3.1 Instruction Sings Knowledge and Usage

Table 4-16 shows that the contractors' knowledge and usage for the sign of “Gloves must be worn” was relatively high. The knowledge of sign and usage of it could be traced to the fact that these signs carry the instructions besides being informative.

"Wearing uniform shield" was shown in a low level of understood and usage by respondents. This means that the respondents are not familiar to the meaning of it. In addition, this is not practical and logical at the same time. It might be the sign or the shape of the working suit that need to be illustrated to the contractors and workers later on.

4.5.3.2 Instruction Sings Usage

“Safety helmet must be worn” was shown in a low level of understood and usage by respondents. For knowledge of sign and use of it as well and that is due to the importance of the sign referred in the table and to the instructions related by the supervisors as well as the insurance terms and conditions.

"Ear Protection and Wearing uniform shield" was shown in a low level of understood and usage by respondents. Due to that is not familiar to the meaning of it. Yet the working customs practiced by the workers felt no restrictions on ground to make them wear it. Most of the workers feel uncomfortable of wearing such customs thus it will not be noticed.

Yet the working customs practiced by the workers felt no restrictions on ground to make them wear it. Most of the workers feel uncomfortable of wearing such customs thus it will not be noticed.

4.5.4 Emergency Sings

This Group contains 3 signs, from Table 4-17 show the following:

- The result concluded from the survey work and related analysis illustrated that there are differences between the knowledge of sign and the use of it caused by the culture of contractor and workers.
- It was noted that the knowledge of sign values were found to be illogic in away that reflects the contractors' background and the use of them.
- The background of the contractors in the degree of knowledge of sing is relatively medium; high and low, values were noticed.
- The background of the contractors in the degree of use of sing is relatively low.

Table 4. 17 Knowledge and Usage of Emergency Sings

Sign	Symbol	Sign Knowledge		Sign Usage	
		Yes (%)	No (%)	Yes (%)	No (%)
Emergency exit		60	40	40	60
First Aid		55	45	30	70
Emergency Assembly Area		35	65	25	75

4.5.4.1 Emergency Sings Knowledge and usage

The results shown in Table 4-17 revealed that, (60%) of the responded contractors have knowledge of “Emergency exit " sign, but (40%) of them only use this sign in the construction sites. This result reflects clearly the importance of awareness campaigns for the contractors to consider the sign during the working practices. The failure to fix this sign may lead to a harmful impact at the health and properties of the project.

The results revealed also that, (55%) of the responded contractors have knowledge of “First Aid” sign, but, only (30%) of them use this sign in the construction sites. This result reflects clearly that the contractors have not a strong interest or have not social responsibilities towards their labors or the pedestrians. Tremendously, the result strength the feasibility to set out awareness campaigns for the contractors to consider this sign during the working practices.

“Emergency Assembly Area " was shown in a low level of understood and usage by respondents. Due to that is not familiar to the meaning of it. In the event of an emergency, it is imperative clear signage is displayed to assist with an evacuation. These can include fire exit signs, fire safety nots. Most of the workers feel, fire safety notices

4.5.5 Summary of Knowledge and Usage of Signs in the Site

For Table 4-18 illustrated general percent of the opinion of the respondents about knowing sings in the construction site the in Khartoum State equal 73 % and the percent of using these three kinds of signs was 27 %.

Table 4. 18 Summary of Knowledge and Usage of Signs in the Site

Sign	Indicate	Color	Sign Knowledge		Sign Usage	
			Yes (%)	No (%)	Yes (%)	No (%)
Prohibition	Danger	Red	80	20	30	70
Limitation	Notice	Blue	75	25	33	67
Mandatory	Caution	Yellow	64	36	18	82
Total			73	27	27	73

From Table 4-18, it is observed that the danger signs (prohibition) were shown in the highest position as being understood and used in the construction projects.

(80%) of the respondents has a knowledge of this sign. while 30% of respondents use it in the sign in the site which is relatively low percentage respect to its value (importance effect). The high level of understanding for the danger signs could be returned to the easiness of understanding the signs and symbols in addition to the simple meaning of sins and attractive and influential impact of red color.

The instruction signs (blue colored) were shown in the second highest level of being understood (75%) and usage (%33) in the sites. Although the caution signs (yellow colored) are more critical in meaning and guidance than the instruction signs (blue), the blue signs were higher in level to be understood and used. The reason could be returned either to the sign and symbol design or the attractiveness of the colors. Such results may require

thorough review and critique for the signs and contractors cultures, awareness and level of learning.

The caution signs (yellow colored) were shown in the lowest level of being understood (64%) and usage (%18) in the sites. Although the caution signs (yellow colored) include critical signs like "Toxic" that was shown in the highest level of being understood and used in the sites (as shown in Table 4-15), the overall signs were lower in the degree of understanding and usage in the construction sites. This means that the workers and contractors are familiar with some symbols and signs than other and highlighting the critical signs and symbols in this study will benefit the safety conditions in the construction projects.

4.6 Safety Performance Measurement

To measure the safety performance of the companies, the Accidents Frequency Rates (AFR) and Safety Performance Attitude Scores (SPAS) were used. Out of 100 companies participated in this study, I chose 10 company from the companies that own provided complete information about their injuries and total of man-hour worked last year.

4.6.1 Calculation of Accident Frequency Rates (AFR)

To measure the safety performance, accidents frequency rates provide a good statistic. It measures the safety performance in terms of number of accidents.

Frequency rates are usually used as quantitative indicators to evaluate changes, measure safety progress and warn of the potential hazards.

Frequency rates are considered as a tool to assess and reflect company safety performance. It is used to compare accident statistics either within the industry or within the organization. The formula given in equation (4-1)

was used to calculate the accidents frequency rates. Table 4-19 represent the accidents frequency rate for the 10 companies mentioned above.

$$\text{Disabling injuries frequency rate (F)} = \frac{\text{No. of disabling injuries } X\ 10^6}{\text{No. of worked man – hour}} \ldots\ldots Eq\ 4.1$$

From Table 4-19, accidents frequency rates vary from 2.38 to 44.44. The average of accidents frequency rate was 16.96 and the standard deviation was 9.78. Three companies out of the total 10 investigated companies were above the average.

Table 4. 19 Accidents Frequency Rate

Company No.	No. of disabling injury	No. of worked Man –Hour	Accidents frequency rate
1	4	240000	16.67
2	2	178000	11.24
3	6	150000	40.00
4	1	420000	2.38
5	3	135000	22.22
6	2	320000	6.25
7	8	180000	44.44
8	1	80000	12.50
9	5	580000	8.62
10	7	260000	26.92

4.6.2 Company's Safety Performance Attitude Score (SPAS)

The company's safety performance attitude score was calculated for each company to reflect the degree of safety performance. It is the sum of the actual occurrence scores of the safety sub-factors evaluated by the particular company.

The safety performance attitude score for the 10 companies mentioned above are listed in Table 4-20.

Table 4. 20 Safety Performance Attitude Score

Company No.	SPAS
1	324
2	290
3	335
4	321
5	304
6	320
7	295
8	315
9	299
10	322

Safety performance's attitude score varies from 290 to 335. The average safety performance's attitude score was 312.5. Four companies out of the total 10 investigated companies were below the average.

4.6.3 Safety Performance Level Index

The company's safety performance level is a computed value used to measure the variation of safety performance among different construction companies, based on the accident frequency rate and the safety performance's attitude score. The safety performance level (SPL) was computed by the following formula, (Baig 2001, Al- Amoudi 1997):

$$\text{SPL} = \frac{SPAS}{AFR} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eq.4.2$$

Where;

SPL = Safety Performance Level

SPAS = Safety Performance Attitude Score (From table 4-20)

AFR = Accident Frequency Rate (From table 4-19)

The safety performance level of the 10 companies mentioned above is calculated by equation (4-3) and listed in table 4-21. The safety performance level index was computed by the following formula, (Baig 2001, Al-Amoudi 1997):

$$\text{SPLI} = \frac{\text{SPAS}}{\text{Max SPL}} 100 \quad \ldots\ldots\ldots\ldots \text{Eq } 4.3$$

The maximum value of safety performance level as calculated in Table 4-21 was 134.87. This value will be considered as a benchmark in which other values of company safety performance levels will compare to it. Table 4-21 shows the variation of safety among the participated companies.

Table 4. 21 Safety Performance Level Index

Company No.	AFR	SPAS	SPL	SPLI
1	16.67	324	19.43	14.41
2	11.24	290	25.80	19.12
3	40.00	335	8.37	6.20
4	2.38	321	134.87	100
5	22.22	304	13.68	10.14
6	6.25	320	51.20	37.96
7	44.44	295	6.63	4.92
8	12.50	315	25.20	18.68
9	8.62	299	34.68	25.71
10	26.92	322	11.96	8.86

Safety performance level varies from 4.92 to 100.00. The Average Safety performance level was 26.60. The results that the safety performance of the construction companies seems to be poor to the company No.4, which had a better safety performance of companies participating in this study. Such a conclusion cannot be neglected even that the limited sample size available.

Chapter 5

Conclusions And Recommendations

5.1 Conclusions

A literatures review was conducted to identify the factors affecting the safety performance in construction sites and to measure the construction safety of that companies. The objectives of this research are to identify the factors affecting the construction safety in Khartoum state and to provide a tool for assessing the safety of construction companies and accordingly improve it.

Thirty nine factors were identified and grouped into ten groups. These factors were introduced via a questionnaire which was carefully designed to achieve the research objectives. The degree of impact of the factors on safety performance in the respondents company were evaluated based on a five point Liker scale. The sample size was hundred construction companies in Khartoum state which participated in this study. These companies were qualified and registered in the SCU and classified as categories at building and roads and water sewages. The gathered data through the questionnaires were statistically analyzed to calculate the importance index of each factor presented on the questionnaire for the companies, accordingly these factors were ranked. The rank concordance and the hypothesis of agreement on ranking between the elements of study have been tested. The safety performance of participated companies was measured and graphs were drawn for assessing the safety of a company relative to other construction companies. The procedure for identifying the areas of improvement was discussed with an illustrative example. The results of this study could be used by the construction companies to

evaluate and assess their safety performance and practice relative to other construction companies, determine the reasons of success or failure, locate and identify the problem areas and determine the level of remedial effort to be applied.

The Main Conclusions That Could be Driven from the Study Are ;

1. The majority of the companies that were analyzed have not a professional safety and/or department, while the other has such position or section. On the same line, the participated companies that are not using a safety program or manual represented. It can be concluded that the companies, which have not safety professional or department, are unnecessary mean that are not using a partially safety program or manual.
2. The parties that have the main responsibility of lacking safety during the construction in site according to the respondents are management, site engineer and safety engineer respectively. Worker came after the above parties in responsibility of safety lacking.
3. The majority of the respondents agree that there is a financial saving by complying with safety provisions. On the other hand, the most significant impact of site accidents on construction companies is increase on cost. The other significant are impairing reputation of companies, imposing psychological burden on workers and interrupting project's schedule that means the respondents were in general more concerned about the cost, rather than internal distress of company image, the morale and the humanitarian aspect, and time.
4. The most important groups affecting the safety performance agreed by large construction companies in Khartoum state are; personal protective equipment; signs, signals and barricades; In addition,

those for factors are; the use of gloves and face protection; the use of barricades to prevent collapse of soil during work; the use of protective head; the use of protective feet and No excessive overtime work for worker respectively.

5. Results from this study indicate that the effectiveness of some safety sings, signals and symbols is high among the low use of these signs in the site.
6. Knowing the meaning of sign and the needed of use it was the big affect for ranked the signs.
7. A safety performance tool developed in this study can be considered as practical technique to assess and improve the company's safety performance. It is used to compare the company safety performance and practice with that of other construction companies in order to identify the areas need to be considered to improve the construction safety. This tool is available in this research and can be easily applied by construction companies.
8. The accidents data of the most companies are either not properly documented or that data are considered as confidential and not allowed to others, as they feared a bad reputation or further legal responsibility even though these data were for scientific research only.

5.2 Recommendation

5.2.1 General Recommendations

Based on the conclusions identified previously, and the results obtained from this research, the following points can be recommended:

1. It is recommended to strengthen the awareness and attitude of the top management and project managers towards the importance of safety. The managements of the company must establish and enforce safety polices for workers and should develop their activities by including more monitoring of safety performance at the site and by giving more reliable feedback about the consequences that take place. Companies should hold their project management accountable for accidents.
2. It is recommended for the concerned government authorities to hire qualified, competent and certified engineers to conduct regular site inspections.
3. It is recommended for the company's management to conduct clear safety policy and periodically random safety inspections for technical works like, fie prevention, crane lifting and scaffolding to ensure the implementation of safety provisions and conditions.
4. It is recommended to increase the efficiency of site safety inspections by using more qualified safety engineer with specific job description .
5. It is recommended to conduct formal safety meetings with all parties, such meetings are necessary for communicating safety information to all parties. Special meetings can be conducted before each new activity begins.

6. It is recommended that only experienced workers should be allowed to perform risky tasks, especially when using heavy machinery or powered tools and drive should be provided for new workers since they are the ones who are exposed to the danger of daily job hazards.
7. Emphases should be laid on investigation the indirect costs of accidents. These costs in addition of being grater than the direct costs, which are usually covered by insurance, they buried into project costs, increasing the cost of construction. The costs of accidents present a serious drain of company's profit. Therefore more attention will be paid to the economic investment in safety if the contractor realizes the fact that the costs of accidents are higher than the cost of safety.
8. It is recommended for the company to implement a system for safety incentive for the workers. It may not necessarily be the best tool to enhance safety performance of work site, but some form of incentive is important.
9. The safety history of the construction company should be considered within classification of the companies by the SCU and in the pre-qualification process.
10. The government and the engineering societies should play a major role to apply the safety rules by issuing the regulations, standards and codes and legally enforced the companies to follow them with adequate strict penalties for noncompliance. Safety performance indicator for the construction companies identified by this study should be adopted and such indicators should be established for other different grades with regular updating.
11. The concept of safety, in its broadest sense, should be taught in all stage of education. All media should pay attention to safety rules in all fields.

12. The owners and the engineer should enforce the contractor to comply with the safety requirements.
13. A safety provision should be stated in construction contracts. It should also be taken into consideration in the tendering stage. An adequate budget should be assessed to safety implementation.
14. The quantitative appraisal of safety performance should be applied for construction companies to permit comparing different companies performances.
15. Awareness campaign should be established to widen up the understanding of such signs and the importance of using it in various construction building, roads and water sewage projects.
16. Tender documents should enclose the safety measures and the signs ought to be used during implementation. Clients should be tight in applying the safety measures and the no. of signs to be used during the implementation phase of any project.

5.2.2 Recommended Future Work

1. Research can be conducted to find out the role of the owners and the consultants to avoid or mitigate the accidents in construction sites.
2. Additional research on the factors affecting contractor safety performance from the perspective of owners should be conducted. Such research will provide the owners with a mean to review a contractor's safety plan and monitor performance during construction.
3. Research can be conducted the quantitative appraisal of study's factors (when these factors applied in the site) with accidents frequency rate (safety practices) for construction companies to permit comparing different companies performances.

4. Research can be conducted to estimate the cost of safety and to correlate this cost with the cost of accidents to encourage the companies to take safety seriously.
5. Typical research can be conducted for other categories of companies i.e., medium and small sized companies. Also such research can be conducted to find the factors affecting the safety performance of specialty contractors such as tile contractors, plastering contractors.
6. Research can be conducted to find out the effect of applying some form of incentives on the construction safety performance.

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APPENDIX

APPENDIX-A.1

SAMPLE OF QUESTIONNAIRE USED FOR

SURVEY (Arabic)

بسم الله الرحمن الرحيم

السادة شركة /.....

المحترمين،،

السلام عليكم ورحمة الله وبركاته

الموضوع / المشاركة فى تعبئة استبيان

أود ان افيدكم باننى احد طلاب الدراسات العليا فى جامعة السودان للعلوم والتكنولوجيا ومقدم للحصول على شهادة ماجستير فى ادارة التشييد وقد تقدمت ببحث تكميلى بعنوان .

تقييم العوامل المؤثرة على اداء السلامة فى مشاريع التشييد فى ولاية الخرطوم

الغرض من هذه الدراسة هو تحديد وتحليل العومل التى تؤثر على اداء السلامة فى مشاريع التشييد فى ولاية الخرطوم ومن المتوقع ان تكون نتائج هذه الدراسة ذات اثر كبير على صناعة التشييد ، وستقدم نتائج مفيده للجميع باذن الله تعالى.

وبصفتكم إحدى الشركات العاملة فى مجال التشييد نرجو منكم التكرم بالمشاركة فى تعبئة الاستبيان المرفق بالمعلومات المطلوبة والتى تشكل عنصرا مهما فى نجاح البحث.

نرجو منكم تعبئة الاستبيان بالمعلومات المطلوبه ، علما بان جميع المعلومات المتحصل عليها سوف يتم تحليلها بصورتها الاجمالية وستعامل بسرية تامه وعلى ان تستخدم لغرض البحث العلمى فقط دون ان يتم التطرق الى اسم شركتكم.

شاكر لكم كريم تعاونكم معنا وتقبلوا تحياتى،،،،

الباحث / حامد احمد عثمان

بسم الله الرحمن الرحيم

الرجاء كتابة او اختيار الاجابة الاكثر ملائمة من وجهة نظركم:

القسم الاول : معلومات عامة عن الشركة وعن الشخص الذى سوف يقوم بتعبية الاستبيان

1- اسم الشركة التى تعمل نها (اختيارى) .....

2- ماهو المسمى الوظيفى لك فى الشركة .....

3- كم عدد سنوات تواجد الشركة فى مجال التشييد

☐ اكثر من 15 سنة ☐ من 11 الى 15سنة ☐ من 5 الى 11 سنوات ☐ اقل من 5سنوات

4- كم عدد سنوات تواجدك فى مجال التشييد

☐ اكثر من 15 سنة ☐ من 11 الى 15سنة ☐ من 5 الى 11 سنوات ☐ اقل من 5سنوات

5- كم هو عمرك

☐ اكثر من 45 سنة ☐ من 35الى 44سنة ☐ من 25الى 34 سنوات ☐ من 16الى 24سنة

6- ما هى درجتك العلمية

☐ ماجستير ☐ بكالوريوس ☐ دبلوم ☐ ثانوى

7- ماهو عدد عمال الشركة

☐ اكثر من 200 ☐ من 101الى 200 ☐ من 50الى 100 ☐ اقل من 50

القسم الثانى : معلومات عن السلامة فى شركتكم

8- هل يوجد لدى الشركة مهندس / قسم للسلامة ؟

☐ لا ☐ نعم

9- هل يوجد لدى الشركة برنامج او مرجع للسلامة ؟

☐ لا ☐ جزئيا ☐ نعم

10- هل لديك إلمام بشروط ومواصفات وبنود السلامة ؟

لا ☐ جزئيا ☐ نعم ☐

11- على من تقع مسئولية القصور فى تطبيق شروط ومواصفات وبنود السلامة فى موقع العمل ؟

ادارة المشروع ☐ مهندس الموقع ☐ مهندس السلامة ان وجد ☐ العامل ☐

12- هل تتوقع اى توفير مالى فى حالة تطبيق شروط ومواصفات وبنود السلامة فى موقع العمل؟

لا ☐ جزئيا ☐ نعم ☐

13- ماهو تاثير اصابات العمل على شركات التشيد

	موافق بشدة	موافق	لا اعلم	غير موافق	غير موافق بشدة
ا – زيادة التكاليف	☐	☐	☐	☐	☐
ب- اضعاف سمعة الشركة	☐	☐	☐	☐	☐
ج – اختلال جدولة المشروع	☐	☐	☐	☐	☐

14-ما اجمالى عدد حالات اصابات العمل فى الشركة خلال اخر سنة عمل للشركة.....

القسم الثالث :العوامل المؤثرة على اداء السلامة فى مشاريع التشييد

الرجاء التكرم بالاجابة على الاسئلة التالية وذلك بوضع علامة (√) مقابل الاجابه الاكثر ملائمة من وجهة نظركم لكل من هذه العوامل وماهى درجة تاثير العامل على اداء السلامة فى مشاريع التشييد.

البند	وصف العمل	درجة التاثير				
1	**التزام الادارة**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
1.1	وعى الادارة العليا للشركة بالسلامة	☐	☐	☐	☐	☐
1.2	وعى مدراء المشاريع بالسلامة	☐	☐	☐	☐	☐
1.3	وجود سياسة واضحة للسلامة بالشركة	☐	☐	☐	☐	☐
1.4	اجراء مراجعة لسياسة تطبيق عوامل السلامة	☐	☐	☐	☐	☐
1.5	موقف الادارة نحو رفع مستوى العمل (ارضاء العامل)	☐	☐	☐	☐	☐
2	**طبيعة المشروع**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
.12	كمية الاعمال المطلوبة لانجاذ المشروع (حجم المشروع)	☐	☐	☐	☐	☐
2.2	ميزانية الاعمال المطلوبة لانجاذ العمل(تكلفة المشروع)	☐	☐	☐	☐	☐
2.3	ترتيب وتنظيم موقع العمل (بيئة العمل)	☐	☐	☐	☐	☐

2.4	تخطيط وجدولة الاعمال لانجاز المشروع	☐	☐	☐	☐	☐
2.5	نوع المالك (طبيعة المالك)	☐	☐	☐	☐	☐
2.6	سهولة و وضوح التصميم	☐	☐	☐	☐	☐
2.7	انارة موقع العمل فى اوقات العمل الليلة	☐	☐	☐	☐	☐
3	**التخطيط والتحضير لحالات الطوارئ والكوارث**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
3.1	وضع خطة للاستجابة لحالات الطوارئ	☐	☐	☐	☐	☐
3.2	تدريب العمال على الاستجابة لحالات الطوارئ عن طريق التمارين	☐	☐	☐	☐	☐
4	**العلامات والاشارات والمتاريس**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
4.1	استخدام علامات الخطر	☐	☐	☐	☐	☐
4.2	استخدام علامات الحذر	☐	☐	☐	☐	☐
4.3	استخدام علامات التنبيه	☐	☐	☐	☐	☐
4.4	استخدام الاشارات الخاصة بحركة المرور داخل الموقع	☐	☐	☐	☐	☐

4.5	استخدام المتاريس لاغلاق موقع العمل لعدم السماح للمواطنين بالدخول	☐	☐	☐	☐	☐
5	**مرافق الرعاية**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
5.1	توفير وسائل الاسعافات الاولية	☐	☐	☐	☐	☐
5.2	توفير سيارة اسعاف	☐	☐	☐	☐	☐
5.3	توفير دورات مياة مناسبة	☐	☐	☐	☐	☐
6	**التفتيش**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
6.1	تفتيش السلامة بواسطة المكتب الاستشارى	☐	☐	☐	☐	☐
6.2	تفتيش السلامة بواسطة ادارة المشروع	☐	☐	☐	☐	☐
6.3	تفتيش السلامة بواسطة شركات التامين	☐	☐	☐	☐	☐
7	**الاجتماعات**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
7.1	عقد اجتماعات دورية للسلامة بواسطة مهندس الموقع	☐	☐	☐	☐	☐
7.2	عقد اجتماعات للسلامة قبل بداية كل نشاط فى المشروع	☐	☐	☐	☐	☐

7.3	حضور الادارة العليا لاجتماعات السلامة	☐	☐	☐	☐	☐
8	**التدريب والتعليم عن السلامة**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
8.1	توجيه وتدريب العمال على السلامة	☐	☐	☐	☐	☐
8.2	اصدار كتيبات ومنشورات عن السلامة	☐	☐	☐	☐	☐
8.3	عقد ندوات عن السلامة بواسطة ادارة المشروع	☐	☐	☐	☐	☐
8.4	عرض ملصغات للسلامة (بوستارات)	☐	☐	☐	☐	☐
8.5	تدريب العمال على الاسعافات الاولية	☐	☐	☐	☐	☐
9	**معدات الحماية الشخصية**	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
9.1	استخدام واقى الراس	☐	☐	☐	☐	☐
9.2	استخدام واقى القدمين	☐	☐	☐	☐	☐
9.3	استخدام قفزات اليدين و واقى الوجه	☐	☐	☐	☐	☐

10	الوقاية من الحريق	مرتفعة جدا	مرتفعة	متوسط	منخفضة	منخفضة جدا
10.1	توفير اسطوانات كافيةلاطفاء اى حريق ينشب بالموقع	☐	☐	☐	☐	☐
10.2	تخزين السوائل القابلة للاشتعال والمواد القابلة للاحتراق	☐	☐	☐	☐	☐
10.3	الصيانة الدورية للطفايات الحريق المتواجدة داخل الموقع	☐	☐	☐	☐	☐

القسم الرابع : الاشارات والعلامات داخل الموقع

الرجاء التكرم باالاجابة على السؤالين التاليين وذلك بوضع علامة (√) مقابل الاجابة الاكثر ملائمة تحت كل سؤال من وجهة نظركم لكل من هذه الاشارات

هل تعرفها؟		هل تستخدم فى الموقع؟
7- خطر الحريق مواد سريعة الاشتعال		
نعم ☐ لا ☐		نعم ☐ لا ☐
8- خطر مواد سامة		
نعم ☐ لا ☐		نعم ☐ لا ☐
9- ارتداء الزى الواقى		
نعم ☐ لا ☐		نعم ☐ لا ☐
10- عدم التدخين فى المكان		
نعم ☐ لا ☐		نعم ☐ لا ☐
11- ممنوع استخدام المصعد لرفع وإنزال الأشخاص		

هل تعرفها؟		هل تستخدم فى الموقع؟
1- ارتداء النظارة لوقاية العيون		
نعم ☐ لا ☐		نعم ☐ لا ☐
2- ارتداء الخوذة لوقاية الراس		
نعم ☐ لا ☐		نعم ☐ لا ☐
3- ارتداء واقى الاذن		
نعم ☐ لا ☐		نعم ☐ لا ☐
4- ارتداء الحذاء لحماية القدمين		
نعم ☐ لا ☐		نعم ☐ لا ☐
5 - يجب استخدام القفازات الواقية		

نعم ☐ لا ☐		نعم ☐ لا ☐
12- عدم استخدام السلالم		
نعم ☐ لا ☐		نعم ☐ لا ☐
هل تعرفها؟	هل تستخدم فى الموقع؟	
14- مخرج طوارئ إلى اليمين		
نعم ☐ لا ☐		نعم ☐ لا ☐
16- نقطة (مكان التجمع)		
نعم ☐ لا ☐		نعم ☐ لا ☐
18- ممنوع استخدام الموبايل		
نعم ☐ لا ☐		نعم ☐ لا ☐

نعم ☐ لا ☐		نعم ☐ لا ☐
6- انتباه امكانية السقوط من الاعلى		
نعم ☐ لا ☐		نعم ☐ لا ☐
هل تعرفها؟	هل تستخدم فى الموقع؟	
13- خطر امكانية سقوط حمل		
نعم ☐ لا ☐		نعم ☐ لا ☐
15- انتباه خطوره		
نعم ☐ لا ☐		نعم ☐ لا ☐
17- صندوق الإسعاف الأولي		
نعم ☐ لا ☐		نعم ☐ لا ☐

APPENDIX-A.2

SAMPLE OF QUESTIONNAIRE USED FOR SURVEY (English)

Dear Sir

I am a graduate student at Sudan University of Science &Technology College of Graduate Studies. I am now preparing a master thesis in the construction management program. The title of the thesis is:

Assessment of the Factors Affecting Safety Performance on Construction Projects in Gaza Strip

The purpose of the study is to identify and analyze the factors, which affect the safety performance in construction projects in Khartoum State. The results of the study will be of great help to the industry and offering valuable results for all.

As you are one of the large organizations working in this field in Khartoum, we are kindly inviting you to participate in filling this questionnaire with the required data which is an important element in this study.

Please let your safety personnel or project manager provide the required information requested in this questionnaire. The information provided by you will be analyzed as whole, and we ensure you that this information will be held in strict confidence and used for the scientific research purpose only without mentioning the name of your organization.

Thank you for your anticipated cooperation.

Best regards.

Yours Sincerely,

PART A: GENERAL INFORMATION

Please write or check the most appropriate answer for the following questions

1- Name of your company (optional) ……

2- What is your job title ……

3-How many years have your company in the construction field ?

☐ Less than 5years ☐ 5 to 10 years ☐ 10 to 15 years ☐ Over 15 years

4-How many years you have in the construction field ?

☐ Less than 5years ☐ 5 to 10 years ☐ 10 to 15 years ☐ Over 15 years

5-How old are you?

☐ 16 to24years ☐ 25 to 34 years ☐ 35 to 44 years ☐ Over 45 years

6-What is your scientific qualification ?

☐ Secondary ☐ Diploma ☐ B.Sc. ☐ Master

7-How many Workers in your company ?

☐ Less than 50 ☐ 51 to 100 ☐ 100 to 300 years ☐ Over 300 years

PART B: INFORMATION OF SAFETY

8-Does your company have a safety professional / department?

☐ Yes ☐ No

9-Does your company use safety program or manual?

☐ Yes ☐ Partially ☐ No

10-Do you have knowledge of the safety conditions specifications and provisions?

☐ Yes ☐ Partially ☐ No

11-In your opinion ,how should responsible for lacking of safety during construction on site ?

☐ Worker ☐ Safety Engineer ☐ Site Engineer ☐ Management ☐ Government

12-Do you expect any financial saving by complying with safety conditions specifications and provisions?

☐ Yes ☐ sometimes ☐ No

13- What is the most significant impact of site accidents on construction companies?

	Very high	High	Moderate	Low	Very Low
1- Increase cost	☐	☐	☐	☐	☐
2- Impairing reputation companies	☐	☐	☐	☐	☐
3- Interrupting project schedule	☐	☐	☐	☐	☐

14- Total number of disabling injuries last work year are ……..

PART C : FACTORS AFFECTING THE SAFETY PERFORMANCE IN CONSTRUCTION PROJECTS

The list below includes the factors that affecting the safety performance in construction industry for each of these factors you are kindly requested express your opinion by answering the following question and placing (×) in the appropriate box what is degree of impact of the factor on safety performance in construction project ?

No.	Factors Description	Degree of impact				
1	**Administrative & Management Commitment**	Very high	High	moderate	Low	Very low
1.1	Safety awareness of company's to management	☐	☐	☐	☐	☐
1.2	Safety awareness of project managers	☐	☐	☐	☐	☐
1.3	Availability a clear company's policy	☐	☐	☐	☐	☐
1.4	Conduction of safety policy review	☐	☐	☐	☐	☐
1.5	Management's attitude towards workers welfare	☐	☐	☐	☐	☐
2	**Project Nature**	Very high	High	moderate	Low	Very low
2.1	Volume of the project	☐	☐	☐	☐	☐
2.2	Cost of the project	☐	☐	☐	☐	☐
2.3	Arrangement and organization the site	☐	☐	☐	☐	☐
2.4	Application of new technology in construction project	☐	☐	☐	☐	☐

2.5	Type of owner	☐	☐	☐	☐	☐
2.6	Clear and easy of project design	☐	☐	☐	☐	☐
2.7	Lighting the site during night working hours	☐	☐	☐	☐	☐
3	**Emergency planning & preparation**	Very high	High	moderate	Low	Very low
3.1	Develop a plan to respond to emergencies	☐	☐	☐	☐	☐
3.2	Training worker to respond to emergencies emergences through the exercise	☐	☐	☐	☐	☐
4	Signs ,Signals & Barricades	Very high	High	moderate	Low	Very low
4.1	The use of danger signs	☐	☐	☐	☐	☐
4.2	The use of caution signs	☐	☐	☐	☐	☐
4.3	The use of instruction signs	☐	☐	☐	☐	☐
4.4	The use of traffic signs	☐	☐	☐	☐	☐
4.5	The use of barricades to close the site for the pedestrians	☐	☐	☐	☐	☐
5	**Welfare facilities**	Very high	High	moderate	Low	Very low
5.1	Provision of adequate facilities for first aid treatment	☐	☐	☐	☐	☐
5.2	Provision of an ambulance in the site	☐	☐	☐	☐	☐
5.3	Provision of adequate toilets	☐	☐	☐	☐	☐
6	Safety Inspections	Very high	High	moderate	Low	Very

						low
6.1	Safety inspections by supervisor office	☐	☐	☐	☐	☐
6.2	Safety inspections by top management	☐	☐	☐	☐	☐
6.3	Safety inspections by insurance companies	☐	☐	☐	☐	☐
7	**Safety Meetings**	Very high	High	moderate	Low	Very low
7.1	Conducting safety meeting in the site by the site engineer	☐	☐	☐	☐	☐
7.2	Conducting safety meeting before beginning for each activity	☐	☐	☐	☐	☐
7.3	Attendance of safety meetings by top management	☐	☐	☐	☐	☐
8	**Safety Education & Training**	Very high	High	moderate	Low	Very low
8.1	Guidance and training of worker to safety	☐	☐	☐	☐	☐
8.2	Brochures and publications on safety	☐	☐	☐	☐	☐
8.3	Safety seminars held by the management of the project	☐	☐	☐	☐	☐
8.4	Safety posters	☐	☐	☐	☐	☐
8.5	Training of first aid for all workers	☐	☐	☐	☐	☐
9	**Personal Protective Equipment**	Very high	High	moderate	Low	Very low
9.1	The use of protective head	☐	☐	☐	☐	☐

9.2	The use of protective head	☐	☐	☐	☐	☐
9.3	The use of gloves and face protection	☐	☐	☐	☐	☐
10	**Fire Prevention**	Very high	High	moderate	Low	Very low
10.1	Availability of adequate fire extinguishers in the site	☐	☐	☐	☐	☐
10.2	Good storage of flammable liquids combustible materials	☐	☐	☐	☐	☐
10.3	Periodical maintenance of fire extinguishers which located in the site	☐	☐	☐	☐	☐

PART D : Sings, Signals &Symbols in the Site

Please cheek (√) fronts an appropriate answer for following questions

Do you know it?		Did used it in the site?
1-Eye protection must be worn		
Yes ☐ No ☐		Yes ☐ No ☐
2-Safety helmet protection must be worn		
Yes ☐ No ☐		Yes ☐ No ☐
3-Ear protection must be worn		
Yes ☐ No ☐		Yes ☐ No ☐
4-Foot protection must be worn		
Yes ☐ No ☐		Yes ☐ No ☐
5-Gloves must be worn		

Do you know it?		Did used it in the site?
7-Flammable		
Yes ☐ No ☐		Yes ☐ No ☐
8- Toxic		
Yes ☐ No ☐		Yes ☐ No ☐
9-Wearing uniforms shield		
Yes ☐ No ☐		Yes ☐ No ☐
10-No smoking		
Yes ☐ No ☐		Yes ☐ No ☐
11- In the event of fire do not use lift		

Yes ☐ No ☐		Yes ☐ No ☐
6-Warning deep excavation		
Yes ☐ No ☐		Yes ☐ No ☐
Do you know it?	Did used it it in the site?	
13- Lifting in progress in overhead		
Yes ☐ No ☐		Yes ☐ No ☐
14- Warning construction work in progress		
Yes ☐ No ☐		Yes ☐ No ☐
15- First aid		
Yes ☐ No ☐		Yes ☐ No ☐

Yes ☐ No ☐		Yes ☐ No ☐
12-Do not use ladder		
Yes ☐ No ☐		Yes ☐ No ☐
Do you know it?	Did used it in the site?	
16- Fire Exit		
Yes ☐ No ☐		Yes ☐ No ☐
17- Assembly point		
Yes ☐ No ☐		Yes ☐ No ☐
18- Do not use mobile phones		
Yes ☐ No ☐		Yes ☐ No ☐

APPENDIX-B

THE MEAN OF THE

OCCURRENCE SCORES OF THE FACTORS AFFECTING

THE SAFETY PERFORMANCE

Factors Description	Mean	Rank within this Group
Safety awareness of company's to management	3.28	2
Safety awareness of project managers	3.35	1
Availability a clear company's policy	3.27	3
Conduction of safety policy review	2.92	4
Management's attitude towards workers welfare	2.78	5
Project Nature	Mean	Rank within this Group
Volume of the project	3.05	1
Cost of the project	2.67	4
Arrangement and organization the site	2.52	6
Application of new technology in construction project	2.38	7
Type of owner	2.69	3
Clear and easy of project design	2.64	5
Lighting the site during night working hours	2.70	2
Emergency planning & preparation	Mean	Rank within this Group

Develop a plan to respond to emergencies	3.23	1
Training worker to respond to emergencies emergences through the exercise	2.85	2
Signs ,Signals & Barricades	Mean	Rank within this Group
The use of danger signs	3.13	2
The use of caution signs	3.01	3
The use of instruction signs	2.91	4
The use of traffic signs	2.81	5
The use of barricades to close the site for the pedestrians	3.17	1
Welfare facilities	Mean	Rank within this Group
Provision of adequate facilities for first aid treatment	2.76	2
Provision of an ambulance in the site	2.74	3
Provision of adequate toilets	2.83	1
Safety Inspections	Mean	Rank within this Group
Safety inspections by supervisor office	3.32	1

Safety inspections by top management	2.87	2
Safety inspections by insurance companies	2.37	3
Safety Meetings	Mean	
Conducting safety meeting in the site by the site engineer	2.82	1
Conducting safety meeting before beginning for each activity	2.72	2
Attendance of safety meetings by top management	2.65	3
Safety Education & Training	Mean	Rank within this Group
Guidance and training of worker to safety	2.98	2
Brochures and publications on safety	2.88	3
Safety seminars held by the management of the project	3.03	1
Safety posters	2.82	4
Training of first aid for all workers	2.80	5
Personal Protective Equipment	Mean	Rank within this Group
The use of protective feed	3.09	2
The use of protective head	3.10	1

The use of gloves and face protection	2.94	3
Fire Prevention	Mean	
Availability of adequate fire extinguishers in the site	2.90	1
Good storage of flammable liquids combustible materials	2.84	2
Periodical maintenance of fire extinguishers which located in the site	2.62	3

APPENDIX-C

IMAGES OF SAFETY PROBLEMS FROM MISCELLANEOUS SITES