Sudan University of Science and Technology
College of Graduate Studies

Assessment of Site Engineers Safety Culture in Construction Industry in Khartoum State

تقييم ثقافة السلامة لدى مهندسي المواقع في صناعة التشييد بولاية الخرطوم

A thesis submitted to the school of civil Engineering in Partial Fulfillment for requirements of the degree of M.Sc. in civil Engineering
(Construction Management)

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بسم الله الرحمن الرحيم

قال تعالى:

"وإذْ قَالَ إبْرَاهيمُ رَبِّ اجْعَلْ هَذَا الـــبـــلـــدَ آمـــناً وَاجْنُبْني وَبَنِيَّ أَن نَّعْبُدَ الْأَصْنَامَ"

صدق الله العظيم

(سورة ابراهيم الآية:35)

Dedication

To my lovely family for their endless and generous support

Researcher

Acknowledgement

Firstly, sincere gratitude and appreciation is forwarded to my family specially my dearest parents for care, endless support during my research work.

Secondly, I would like to express my deepest gratitude to my supervisor, Dr. Osama Mohammed Ahmed for his generous advice, kind assistance and patiently guidance.

Also I would like to appreciate all the respondents from different construction companies, who generously spent their precious time to participate in the questionnaire survey of this study.

Last but not least, I want to thank my entire friends who directly or indirectly assisted me in this project study.

Researcher

Abstract:

In many countries construction industry plays an important role on economic and social development. In economic and developing countries Safety considered as an essential factor. Because safety rules are not committed in Sudan, construction industry suffers from unsafe situations in safety and health.

This study seeks for evaluating safety culture for site engineers in construction industry in Khartoum state. In order to achieve the aims of the study the following objectives have to be done: First, identify the elements of safety culture. Second, assessment of safety culture for site's engineer's, and finally, developing methodological frame-work to improve safety culture for site's engineer's in construction industry.

The study has been done in three stages: study of the previous literature reviews which have relevant questionnaire survey for data and finally inquiry accurately the findings through applied on (SPSS, 2017) program to analyse data. Data was collected through distributing the questionnaire for hundred constitutes in the field of Sudanese construction industry in Khartoum state. The rate of response is 100% for all questionnaires.

The findings of the study show that site engineers have positive idea for five factors of safety culture which are: Management Commitment, Safety Priority, Safety Rules, Physical Work Environment and Personal appreciation Risk. Also findings explained that safety culture for site engineers is average. Another finding explained that, for improving and developing safety culture must give it priority in company headquarters, investigate causes that lead to accident, check out safety preparations and rotation training when new projects starting.

Finally the study offered recommendations to the competent authorities who has decision and constitutes which work in construction industry sectors in order to improve safety culture.

المستخلص:

تلعب صناعة التشييد دوراً مهما في التنمية الاجتماعية والاقتصادية في العديد من الدول، وتعد السلامة من المواضيع الهامة في الدول الاقتصادية وكذلك الحال بالنسبة للدول النامية، تعاني صناعة التشييد في السودان من ظروف غير آمنة من حيث السلامة نسبة لعدم الالتزام بقوانين السلامة.

يسعى هذا البحث إلى تقييم ثقافة السلامة لدى مهندسي المواقع في صناعة التشييد بولاية الخرطوم لكي يتم تحقيق أهداف البحث، أولاً: تحديد عناصر ثقافة السلامة، ثانياً: تقييم ثقافة السلامة لمهندسي المواقع، وأخيراً تطوير إطار عمل لتحسين ثقافة السلامة لدى مهندسي المواقع في صناعة التشييد.

أجريت هذه الدراسة على ثلاث مراحل: مراجعة الدراسات السابقة ذات الصلة، تلاها بحث ميداني لجمع البيانات من خلال استبيان الدراسة وفي آخر مرحلة من الدراسة تم التحقق من دقة النتائج من خلال تطبيق الأساليب الكمية في تحليل البيانات عن طريق برنامج (SPSS, 2017). تم جمع البيانات بتوزيع إستبيان على مئة مؤسسة في حقل صناعة التشييد السودانية في الخرطوم، وكان معدل الإستجابة 100% لجميع الإستبانات.

أظهرت النتائج أن مهندسي المواقع لديهم نظرة إيجابية إتجاه جميع العوامل الخمسة للسلامة وهي إلتزام الإدارة، أولوية السلامة، قواعد السلامة، بيئة العمل المادية وأخيراً التقدير الشخصي للخطر، وأوضحت النتائج أن ثقافة السلامة لدى مهندسين المواقع متوسطة، وعلى جانب آخر بينت النتائج أنه لتحسين وتطوير ثقافة السلامة يجب التركيز على أن تكون السلامة هي الأولوية الأولى لدى الإدارة العليا للشركة، التدقيق في أسباب وقوع الحادث، عمل فحوصات لتحضيرات السلامة في الموقع بالإضافة إلى الدورات التدريبية في بداية المشاريع الجديدة.

أخيراً، قدمت الدراسة توصيات للسلطات المسئولة، أصحاب القرار والمؤسسات العاملة في قطاع الإنشاءات للعمل على تعزيز ثقافة السلامة.

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List of Abbreviations

Abbreviations	
EU	European Union
US	United States
ILO	International Labour Organization
SPSS	Statistical Package for the Social Sciences
UN	United Nations
HSE	Health and Safety Executive
OSHA	Occupational Safety and Health Administration
INSAG	International Nuclear Safety Advisory Group
IAEA	International Atomic Energy Agency
ACSNI	Advisory Committee on the Safety of Nuclear Installations
SMS	Safety Management System
SS	Supervisor and Supportive
INEEL	Idaho National Engineering and Environmental Laboratory

CHAPTER ONE

INTRODUCTION

Chapter 1: Introduction

1.1General:

The construction industry plays a vital role in the social and economic development of all countries. However, when compared with other (labour intensive) industries, the construction industry has historically experienced a disproportionately high rate of disabling injuries and fatalities for its size among all industries. Construction is a complex activity where various stakeholders are present working under constant challenge by demands of the job. Each job will have several of its safety and risk factors, requiring quality and safety management systems to be established. The construction industry is one of the most hazardous industries. Wherever reliable records are available, construction is found to be one of the worst, and often the worst industry on health and safety criteria, many construction hazards lead to loss of life, injuries, disease and permanent disability. In addition, the direct impacts on the worker of such hazards can include loss of working days due to disease or injury and job loss. These effects generally spill over to the family, community and society around the worker. The International Labour Organization (2005) reported that at least 60,000 fatal accidents occur each year at construction sites worldwide, equivalent to one death every 10 min. Furthermore, one out of every six fatal workplace accidents takes place at a construction site, and this is increased in industrialized countries, where construction site fatalities account for 25– 40% of all workplace fatalities. This industry alone produces 30 % of all fatal industrial accidents across the European Union (EU), yet it employs only 10 % of the working population; in the United States (US), it accounts for 20 % of all fatal accidents and only 5 % of the employed. Dangers to health and safety exist within the construction industry because of its fragmented nature, the uncertain and technically complex nature of construction work, the uncontrollable environment in which production takes place, the employment practices, and

the financial and time pressures imposed upon project participants, an accident can be defined as an unplanned event. The terms undesirable, unexpected, and no controlled have also been used to describe such events, an accident does not necessarily result in an injury. Accidents that results in damage to equipment and materials and especially those that results in injuries receive the greatest attention. A hazard is something with potential to cause harm. The harm will vary in severity; some hazards may cause death, some serious illness or disability, others only cuts and bruises. Risk is the combination of the severity of harm with the likelihood of its occurrence. Constructions accidents because many human tragedies demotivate workers, disrupt sites, delay project progress, and adversely affect the overall cost, productivity and reputation of the construction industry. Costs are incurred whenever an accident occurs on a project and in the absence of injuries, there are no injury costs. Usually, safety efforts will cost a given amount of money while the costs of injuries are incurred only if there is an injury. In addition, injury cost will be high when there is a low emphasis on safety and that injury occurrence will be low when the emphasis on safety is high. (Mohamed, 1999), (Mehta and Agnew, 2010).

1.2 Research Problem:

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. Therefore, these reasons will be a motivated factor to select this topic to study the safety culture in construction industry and to assess the degree of awareness about its components, which include Management commitment, Priority of safety, Safety rules, Education, Training and environment. In addition, enhancement of safety culture in construction industry will also been studied.

1.3 Significant of research:

Every organization is continuously searching for better solutions and environment to sustain. Safety culture attempts to make the workplace of the construction organizations safe for individuals and assets. A good safety culture can also contribute to competitiveness in many ways. Although a focus on safety has often seen as non-productive expenditure demanded by law, it can also contribute to profit by minimizing loss and adding to the capital value of an organization.

Many researchers revealed that the safety culture adopted better work methods which results in reducing absenteeism that contribute to improve organizational performance, while also influencing product quality. Similarly, construction industry studies have shown that projects driven by safety are more likely to be on schedule and within budget. The safety culture has shown a significant effect on progress and completion of the projects.

1.4 Research Aim:

The aim of this research is to assess the safety culture of site engineers in construction industry in Khartoum state.

1.5 Research Objectives:

- Study the safety culture in construction industry and other related topics.
- Identify the components and factors relevant to safety culture.
- Evaluate the existing site engineer's safety culture in construction industry in Khartoum State.
- Identify the responsible bodies to preserve safety.
- Developing framework to improve safety culture in construction industry.

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 Structure of Research:

1.7.1 Chapter 1: Introduction:

This chapter contain background of the thesis and illustrate the research problem and the hypotheses. It also includes the research aim and methodology conducted to complete the research.

1.7.2 Chapter 2: Literature Review, Theory Related:

Chapter two deals with the extant literature. It is an overview of what is the Safety Culture Concept and it is illustrating the Organizational Culture.

Therefore they have been included in the literature review to give the reader enough of an understanding to be able to recognize Safety culture dimensions.

1.7.3 Chapter 3: Research Methodology:

This chapter deals with the design of the research, which was in place at the outset. In addition, it is meant to give the reader an idea of the journey undertaken to complete the research.

1.7.4 Chapter 4: Results and Discussions:

This chapter deals with information collection and analyses the results from the questionnaire, discusses the problems.

1.7.5 Chapter 5: Conclusions and recommendations:

This final chapter sets out the conclusions of the research behind this thesis and makes proposals. In addition, the final chapter sets out recommendations for future research that may be necessary to answer some of the questions raised within this thesis that are beyond its direct scope.

CHAPTER TWO

LITERATURE REVIEW

Chapter 2: Literature Review

2.1 Introduction:

This Chapter demonstrates a detailed review on safety culture, its dimensions and other topics like organizational culture, safety climate, behaviour based-safety and safety management, which related to safety on construction sites reviewed.

2.2 Construction accidents:

The construction industry is complex, characterized worldwide by a multitude of trades and occupational groups also with a high share of small businesses (less than 50 employees). Injury rates are high in the industry despite widespread agreement that underreporting of injuries exists. Issues of underreporting work injuries may be particularly relevant in small businesses (Moore et al., 2013 ;).

(Carter and Smith, 2001) were defined accident at work by a sudden event caused by an external reason, resulting in injury or death, which took place in connection with work. In addition, accident defined as unplanned and without control in which the action or reaction of an object, substance, person or radiation results in a personal injury. These two definitions are widely used by researchers. Many authors used the term incident, more than for accident. This includes not only an accident that results in injury but also those accidents that have no injuries involved. The construction industry‘s safety record has always been poor. It remains one of the most dangerous industries in which to work. Statistics from the Health and Safety Executive H.S.E. showed that U.K. construction workers are approximately five times more likely been killed and two times more likely to be seriously injured compared to the average for all industries. U.S. constructions workers are over three times more likely were killed than the all-industry average and one in six construction workers can expect to be injured every year. In Egypt,

13% work-related deaths and 18 % of occupational injuries were recorded among workers in the construction industry. Conditions on construction work sites are not attractive when compared with most other industries. Workers exposed to adverse weather conditions, dirty, and unhygienic work areas, noisy and dusty environments. They have to conduct inherently dangerous and physically demanding jobs often with long work shifts. The impression of the industry is one of being outdated and disorganized and one that does not offer sustainable employment by looking after the interests of its workers (Alazab, 2004).

Accidents occur due to three root causes:

1. Failing to identify an unsafe condition that existed before an activity started or that developed after an activity started.
2. Deciding to proceed with a work activity after the worker identifies an existing unsafe condition.
3. Deciding to act unsafe regardless of initial conditions of the work environment.

(Baxendale and Jones, 2000) stated that careless workers do not cause the majority of accidents but by failures in control, which ultimately is the responsibility of management. Improved health and safety management systems assumed to make good financial sense and should be part of the cost conscious culture of companies dedicated to efficiency and profitability. It has recognized that a reduction in the level of accidents would be the principal quantifiable benefit of new construction design and management regulations. OSHA classifies the causes of most construction accidents into five broad event types. The event types are (1) falls, (2) struck-by incidents, (3) caught-in/between incidents, (4) electrical shock, and (5) other.

2.3 Organizational Culture:

Cultures developed within countries as a product of national patterns of early childhood and formative experiences and education, language, religion and geography. As culture is, a learned behaviour not genetically transformed. Samovar (1981) define culture as the culmination of knowledge, experiences, beliefs, values, attitudes, meanings, hierarchies, religion, timing, roles, and spatial relations, concepts of the universe, and material objects and possessions acquired by a large group of people in the course of generations through individual and group striving. In addition, he argues that there are several important differences between culture ‘as commonly used by an anthropologists and culture ‘as applied to organizations by management consultants. He noted that like many who borrow concepts from other fields, organizational writers have over-simplified matters to such an extent that their concept has lost much of its connection to the usages that are current in the field to which it belongs. "Nevertheless, broader issues including derivation of the notion of culture from social, ethnic or other origins are not emphasized here.

(Guldenmund, 2000) recapitulated that organizational culture consists of the following seven characteristics:

1. Holistic construct.
2. Stable.
3. Multidimensional.
4. Shared by (national culture, corporate culture, organizational culture, departmental culture, group culture and psychological climate).
5. Various aspects (different cultures or a safety culture).
6. Practices (norms and values, ritual, heroes and symbols).
7. Functional the way we do things around here. In the national culture context, visualizes culture as consisting of multiple layers, norms and

values at the central core; the next layer consists of rituals; the following as heroes; and the outer layer of symbols.

(Reiman and Oedewald, 2004) demonstrate that organizational culture is the shared understanding within a given organization. Instead and Grafton Small argue that corporate culture is the term used for a culture devised by management and transmitted, marketed, sold or imposed on the rest of the organization. It has an internal and external image and that it includes actions and belief the rites, rituals, stories, values that offered to organizational members as part of the seductive process of achieving membership and gaining commitment. Organizationalculture is not owned by any group but, is created by all of the organization‘s members, and culture could see as a repertoire of positively and negatively loaded meanings.

They also claims that organizational culture refers to values, norms and underlying assumptions forming over time during the company history and affecting all the company‘s activities and are in turn affected by them'. (Cooper, 2000) portray the notion that organizational culture reflects shared behaviors, beliefs, attitudes and values. They argue that beliefs, attitudes and values about the organization, its function or purpose can vary from division to division, department to department, workgroup to workgroup, and from individual to individual. This notion is in line with the concept that organizations are dynamic, multi-faceted human systems that operate in dynamic environments in which, what exactly suits at one time and one place cannot be generalized into a detailed universal truth'. Because of the tight relationship between safety culture and organization culture, the interplay of people and organization with regard to safety are also reflected in some safety culture models.

2.4 Safety Culture:

2.4.1 Concept of Safety Culture:

Edward, et al. 2013 concluded that in recent year's safety culture has received significant attention in the literature. Despite much research, there is still little consensus as to how to define safety culture and what it is comprised of. Due to the lack of clarity, many researchers forced to redefine safety culture in relation to their specific area of interest, leading to further diversity in the field.

The term of ''safety culture'' was first used by IAEA (IAEA, 1991) for high risks industries. This term is not exclusive to the nuclear industry; the concept is very popular across a broad spectrum of industries with different types of accident hazards, work site activities, and risk scenarios.

Hudson (2007) broadly defines Safety Culture as Who and what we are, what we find important, and how we go about doing things around here; safety culture has described as learned behavior. Those beliefs in the necessity, practicality and effectiveness of controls, attitudes and risk perceptions which makes people think safely and trust in safety measures, oars characteristics and attitudes in organizations which result in safety issues being a priority. The product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management characterized by communications founded on mutual trust, shared perceptions of the importance of safety and by confidence in the efficacy of preventative measures.

Indeed, he was found a significant correlation between safety attitudes and accident rates. It therefore argued that attitudes might change behavior and thus directly and indirectly affect safety culture and accident rates, such influence being greater or less depending on the context, or other psychological factors such as perception of risk. Furthermore, some

researchers view safety culture as a desired state, which rarely attained, whereas others view safety culture as a continuum, whereby organizations placed according to the extent to which safety is a part of their core business and practices (relativist position; e.g., Hudson, 2007).

Pioneer studies such as the International Atomic Energy Agency (IAEA, 1991) Publication Safety Culture: A report by the International Nuclear Safety Advisory Group (INSAG-4) develops the concept of safety culture in detail. It defines safety culture as that assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.‘ This definition highlights two major points: (1) while safety culture is about good safety attitudes, it is also about good safety management established by organizations; (2) good safety culture means assigning the highest priority to safety. The report then explains that safety culture as it relation to both the organization and individuals is attitudinal as well as structural, and concerns the requirements to match all safety issues with appropriate perceptions and actions.‘ The report (INSAG-4) concludes that safety culture is now a commonly used term and that it is important to give practical value to the concept.

(Reiman and Oedewald, 2004) reveal that this conceptual separation of safety culture reduces the term to refer only to factors that clearly connected with safety, such as safety attitudes and safety values. Although it has been widely used for many years, the concept of safety culture is not precisely clear. The report presents the concept of safety culture as it relates to both organization and individuals; however, it provides no link between safety culture and measures of safety performance. The construction of a positive safety culture is not easy, and it is not universal. Something that works well in one organization may not work in another. Adjustments will need to be

made depending on the resources available and the goals of the different organizations.

(ACSNI, 1993) has defined safety culture in a comprehensive manner. In their view; Safety culture is the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to safety, and the life style and proficiency of an organization's health and safety management.

It is interesting to note that the concept of safety culture developed in response to major organizational accidents; however, it is now being more widely applied to explain accidents at the individual level (Moore et al., 2013).

2.4.2 Construction Safety Culture:

Safety culture has identified as a critical concept for organizations in reducing workplace safety incidents. Organizations are investing in defining and improving their safety culture, and increasingly be evaluated by employees and clients on how safety is valued and prioritized in the company. Construction industry organizations' have also recognized the importance of cultural influences on safety performance, in particular through the ability of organizational members to effectively implement and continuously improve relevant safety management systems. The safety culture concept has been amplified beyond classic features of safety management, such as technical attention to hazards, the deployment of operational procedures, and regulatory compliance programs, to incorporate principles of leadership and value-sharing, enhanced communications and organizational learning, and knowledge about the factors which shape individual and group behaviors, construction project safety culture is different from general organization safety culture in terms of scope and components, etc..However, defining safety culture on the basis of accident investigations leads to many differing or ad hoc conceptualizations of safety culture because

organizations differ, each is a continuously evolving complex system, and each accident involves the convergence of a unique combination of contributing factors at a special point in time. As a result, there is no commonly shared or generic concept of safety culture, no consensus model or template that can relied on as conclusive, no textbook method for measuring progress. As a result, conceptualization of safety culture, based on accident analysis may be useful for identifying what could have been done to prevent an accident that had occurred, but it is far less certain that it will be useful for preventing the next accident. In construction, the safety culture is considered the dynamic combinations of management attitudes and activities, worker behavioral peer interaction, and the physical environment of the site. Safety culture is always concerned with the determinants of the ability to manage safety and hence is atop down organizational attribute approach.

Construction safety culture could be defined as: the product of individual and group behaviors, attitudes, norms and values, perceptions and thoughts that determine the commitment to, and style and proficiency of, an organization‘s system and how its personnel act and react in terms of the company‘s ongoing safety performance in construction site environments etc. (Fang & Haojie, 2013).

The major characteristics of construction projects need to be addressed include the management practice, construction process, temporarily built multi-organizational project team, environmental issues and site management practice, etc. Construction project safety culture therefore should be different from general organization safety culture in terms of scope and components, etc. (Mohamed, 2003).

2.4.3 What is the Difference between Safety Culture and Safety Climate?

Safety culture believed to be a key predictor of safety performance, but remains a concept with no clear definition or measurement. For many years, people have been debating about the definition of and the relationship

between safety culture and safety climate. As a matter of course, such controversy results in the confusion and some kind of misunderstanding of safety culture and safety climate.

There was no such a satisfying model clearly specifying the relationship of both concepts, which brought about problems in the pertinent researches.

Meanwhile, as the definitions and scope are not so clear-cut, researchers also usually use the terms of safety culture, safety climate and perhaps safety management interchangeably. On the other hand, the definition of safety climate and its relationship with safety culture has not reached a universal agreement either; safety climate in each organization was the sum of the common perceptions regarding safety shared by employees. In some cases, it suggested that safety climate should regarded as being more superficial than safety culture in that it involves the current position of a company Safety climate also described as an indicator of the overall safety culture of an organization. In order to reduce conceptual ambiguity and discriminate the difference between policy and practice, (Mohamed, 2007).

Zohar, (2000) pointed out that safety climate should evaluate at the organization level and work group levels as distinct constructs with separate measurement scales. He doesn‘t specifically define Safety Culture but espouses that the dimensions that make up a Safety Climate are:

- Strong management commitment to Safety.
- Emphasis on Safety training.
- The existence of open communication links and frequent contacts between.
- Workers and management.
- General environment control and good housekeeping.
- A stable workforce and older workers.
- Distinctive ways of promoting Safety.

Mohamed (2003) suggested that safety culture is concerned with the determinants of the ability to manage safety (top-down organizational approach); whereas, safety climate is concerned with the workers perceptions of the role safety plays in the workplace (bottom-up perceptional approach). He further stated that safety climate is largely a product of the safety culture, and the two terms should not view as alternatives. Safety climate often understood as the surface expression of safety culture, and is said to been measured directly through the perceptions and attitudes of employees. Safety climate regarded as a manifestation of safety culture in the behavior and expressed attitude of employees. He also define safety climate as an objective measurement of attitudes and perceptions towards health and safety issues. Indeed safety climate, as with organizational climate, can regarded as the surface features of culture derived from a sample of employee's attitudes and perceptions at a particular point in time. Zohar, (2010) found that safety climate operates as a mediating variable between organizational climate and safety performance, which describes individual perceptions of the value of safety within the work environment. Safety climate research typically focuses on employee attitudes and perceptions relating to the structures, processes and procedures used by an organization which bear on safety, and the perceived priority the organization's leadership places on safety.

Zohar, (2010) emphatically distinguishes organizational climate from culture. He divides an organization's social system into:

1. Organizational culture, i.e. beliefs and values about people, work, the organization and the community that are shared by most members within the organization.
2. Social structure, i.e. especially the informal organization.
3. Organizational climate; i.e. common characteristics of behavior and expression of feelings by organizational members.

4. Work relations, i.e. especially the nature of the relationship between management and employees.

Zohar argues that all four segments are mutually related but distinguishable. (Guldenmund, 2000) found in his research that:

1. The concepts of safety culture and safety climate are still ill-defined and not

   Worked out well.
2. The relationship between safety culture and safety climate is unclear.
3. There is considerable confusion about the cause, the content and the consequence of safety culture and climate, i.e.
   - The cause of safety culture and climate has not been addressed seriously
   - There is no consensus on the content of safety culture and climate; and.
   - The consequences of safety culture and climate seldom discussed.
4. There is no satisfying model of safety culture or safety climate; and.
5. The issue of the level of aggregation has not received the attention it warrants.

2.4.4 Safety Culture Dimensions:

There is no universal agreement about the definition or content of the Safety culture. Previous studies have considered safety culture as a multidimensional concept, but without a clear structure and without consensus on the specific dimensions. Empirical efforts trying to operationalize the safety culture concept have been scarce (Ellis, 2004).

In addition to definitional difficulties, the factors that comprise safety culture are also frequently debated in the literature. Early empirical research on safety culture and climate focused on exploring its multi-dimensional nature (Zohar, 1980). In a study with construction workers, two factors were found to provide the best fit: management‘s commitment to safety, and

worker‘s involvement in safety. Later studies on the role of safety leadership and management corroborate this result (Zohar, 2010).

(Mohamed, 2003) concluded that there are six valid and reliable measure of safety culture, which are Management Commitment and Safety Policy, Safety Management System (SMS), Communication, Safety Involvement, Education and Training, and Supervisor and Supportive (SS) Environment. In construction, the safety culture considered the dynamic combinations of management attitudes and activities, worker behavioral peer interaction, and the physical environment of the site. Safety culture is always concerned with the determinants of the ability to manage safety and hence is a top-down organizational attribute approach.

Idaho National Engineering and Environmental Laboratory (INEEL, 2001) notes that eight core components of a total Safety Culture are:

- Management commitment to Safety.
- Job satisfaction.
- Training, equipment, Physical environment.
- Organizational commitment.
- Worker Involvement.
- Co-worker support.
- Performance management.
- Personal accountability.

Fleming (2000) notes that 10 elements of the Safety Culture Maturity Model are:

- Management commitment and visibility.
- Communication.
- Productivity versus Safety.
- Learning organization.
- Safety resources.

- Participation.
- Shared perceptions about Safety.
- Trust.
- Industrial relations and job satisfaction.
- Training.

Due in part to the number of different definitions of safety culture, and to the nature of the specific problem under investigation. Research in this field has focused on a varying number of factors and influences, such as organizational management systems, policies and procedures, job design, work pressures, training, employee involvement in decision making and perceptions and attitudes regarding the work environment (Grote, 2008).

In construction, the safety culture considered the dynamic combinations of management attitudes and activities, worker behavioral peer interaction, and the physical environment of the site. Safety culture is always concerned with the determinants of the ability to manage safety and hence is a top-down organizational attribute approach (Mohamed, 2003). Cooper, (2000) considers that the attitudes, perceptions and beliefs of individuals, their behaviors, and the safety management systems (objective situational features) are elements that combine to form the organization's safety culture.

2.4.5 Safety Culture Models:

The concept of Total Safety Culture required continual attention to three domains namely environment factors, person factors and behavior factors. The three safety related factors were defined as dynamic and interactive, forming a triangle called ''The Safety Triad''. Geller, (1996).

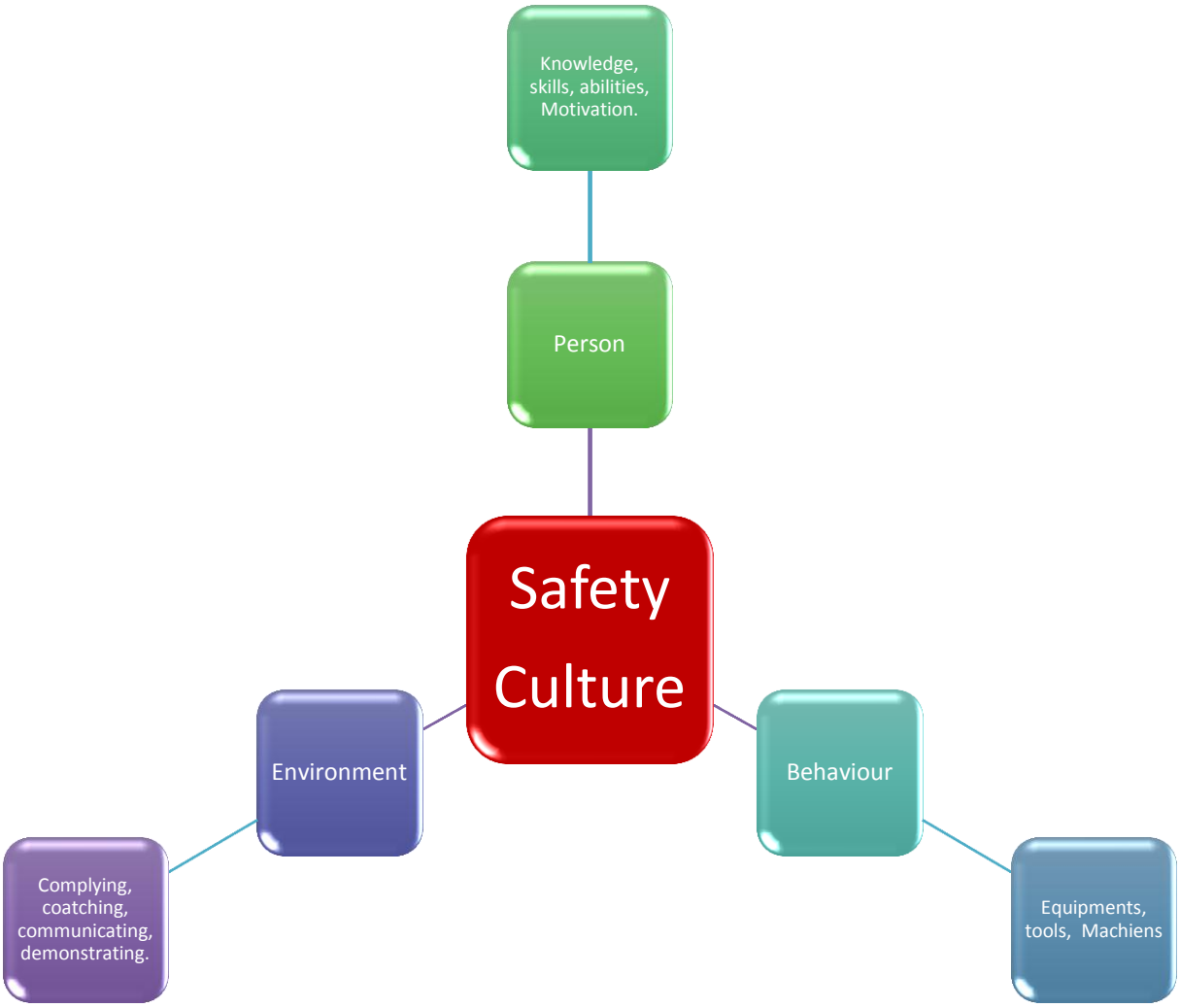


Figure (2.1): Safety Culture model Geller

Cooper, (2000) illustrates the model and provides further information on how the three dimensions defined, measured and related to safety culture specifically, safety climate, the shared employee perceptions and attitudes about safety, reflects safety culture in the workplace and can measured by a questionnaire. Safety behavior (safe or unsafe), representing employee engagement in safety, can be evaluated through behavioral sampling.

Hudson‘s (2001) evolution of a Safety Culture, where he notes that there are three main cultural developments, the first of which is ensuring that

training programs, work conditions, procedures and processes comply with regulations (passive compliance).Second is involving workers in the task of regulatory compliance and encouraging them to take personal responsibility (active compliance) and the third teaching individuals to scan for hazards, to focus on the potential injuries and the safe behaviors that can prevent them and to act safely behavioral.

Cooper, (1999) notes that there are three major components of Safety Culture determinism identifying that people are neither deterministically controlled by their environments nor entirely self-determining.

These three major components are the person, situation and behavior; of which person and behavior where the psychological and behavior elements were aligned with the intrinsic and extrinsic elements. Cooper‘s (1999) model has some attractive features in that it combines Zohar‘s Safety Climate dimension in addition to commonly used Safety Management Systems and Behavioral Dimensions, all of which can be measured to various degrees.

Mearns, (1998) articulates the distinction drawn by Cooper, (1999) between the three dimensions when discussing offshore installations and suggests that senior management within individual companies try to create a particular culture with respect to health and safety. The context of the operating environment and the particular activities which the installation is engaged in, determines the prevailing Safety Climate which is of far more relevance to the offshore worker.

Importantly Mearns, (1998) also argues that organizations should pay more attention to how their Safety Culture‘, in the form of norms, values, assumptions and philosophies map into their rules, policies, procedures and how these, in turn, are perceived and enacted by the workforce in a particular environmental context.

Mearns, (1998) appears to be noting that culture is homogenous but captured within context. Using this notion it appears reasonable to conclude that a change in context will lead to a change in culture.

Additionally, Mearns statement accords with Cooper‘s (1999) model in that norms values, assumptions and philosophies equate to the psychological elements, enacted by the workforce equates to the behavioral element and the environment context 'equates to the Safety Management Systems element. The climate within a context appears to be a major determinant of culture. This notion appears to accord with Zohar‘s (1980) work.

Cooper, (1999) whilst noting reciprocal determinism also notes on that the effect of one element on its reciprocal is not necessarily equal to the reciprocated effect. This then accords with the proposition that Safety Climate can be a major determinant of culture.

Hudson, (2001) in contrast, espouses that the culture defines the setting within which the climate operates. Hudson‘s view does not align with others such as Mearns, (1998) and Zohar, (1980, 2000). The wider view appears to be that climate affects culture significantly more than the reciprocal. Cooper‘s (1999) model appears to broadly consider all positions including behavioral, perceptual (climate) and situational (Safety Management Systems) dimensions perhaps not to the depth of the single focus but with the whole in mind.

Environment, including all aspects of an organization‘s safety management system

(SMS) can be assessed by audits or inspections (Mohamed, 2007; Cooper, 2000). Overall, the integrated model and various measurement tools would allow for a multilevel, holistic analysis of construction safety culture. The term environment was added with the situation to represent organization and the safety management system. It contained three elements which

encompassed subjective internal psychological factors, observable ongoing safety-related behaviors and objective situational features Cooper, (2000).

Building upon the development of Total Safety Culture Model and Reciprocal Safety Culture Model, (Mohamed, 2007) proposed a Model of Construction Safety Culture by incorporating the safety climate, safety behavior and safety management systems as three research targets.

2.4.6 Positive safety culture:

The aim of a positive safety culture is to create an atmosphere in which employees are aware of the risks in their workplace, are continually on guard against them, and avoid taking any unsafe actions. Reason proposed that an organization with an effective safety culture:

- Has a safety information system that collects, analyses and disseminates information from incidents and near misses, as well as from regular proactive checks on the system;
- Has a reporting culture where people are prepared to report their errors, mistakes and violations;
- Has a culture of trust where people are encouraged and even rewarded to provide essential safety-related information, but also in which it is clear where the line between acceptable and unacceptable behavior is drawn;
- Is flexible, in terms of the organizational structure in the face of a dynamic and demanding task environment;
- Has the willingness and competence to draw the right conclusions from its safety system, and is willing to implement reform when it is required

The characteristics adopted to describe a strong safety culture, are the established by the International Atomic Energy Agency (IAEA) (IAEA, 2006).These characteristics are:

- Safety is a clearly recognized value.
- Accountability for safety is clear.
- Safety integrated into all the activities in the organization.
- Leadership for safety is clear.
- Safety is learning driven.

Developing and maintaining a positive safety culture can be an effective tool for improving safety within any organization. The challenge is how to develop a culture that is favorable to good safety performance.

Hale (2000) has listed a number of elements for a good safety culture, these include importance to safety; involvement of workers at all levels; role of safety staff; the caring trust (that all parties to have a watchful eye and helping hand to cope with inevitable slips and blunders); openness in communication; belief in safety improvements; and integration of safety into the organization.

2.4.7 Developing positive safety culture:

To develop and further promote a positive safety culture, a review from Vecchio-Sadus and Griffiths, (2004) is given below:

2.4.7.1 Changing attitudes and behaviors:

Safe behaviors can be enhanced by capitalizing on activities such as verbal instructions, training, and warning signs.

2.4.7.2 Management commitment:

Management commitment has been identified commonly in related studies and it is of paramount importance for the development of safety policy as well as the allocation of resources to safety (Mohamed, 2011).

Management plays a key role in promoting a positive safety culture. This can be best demonstrated by allocating resources, time, walk the talk, inspections, by participating in risk assessments and consultative committee meetings, and by completing actions. The managers' commitment concept is measured using two constructs: attitudes and behaviors. (Mearns et al, 2003).

A committed manager who is personally involved in safety activities and who takes an interest in working conditions conveys to the employees a sense of the importance of safety for the organization.

As a result, the employees comply with regulations, take the proper safety measures, and participate actively in meetings and activities designed to promote improvements in their workplace.

Likewise, the management policies, programs, and practices that form the safety management system are regarded in several studies as a precursor of the employees' perceptions about the importance of safety in their organization and so contribute to performing tasks in a safe manner. However, the implementation of the safety management system in the general management of the firm requires the support of managers, who should allocate financial resources to the activities that make up such a system and should be personally involved in them. This is show appositive attitude and total commitment and interest in the issue (Civil Aviation Safety Authority, 2002; Zohar, 1980).management's safety commitment plays an essential role in employees' safety improvement. Management's safety commitment encompasses effective safety communication and the leadership role, such as support, planning, and coordination on safety procedures.

2.4.7.3 Employee Involvement:

Employee involvement reflects the degree of workers' compliance with the safety procedures and the extent to which they participate in improving working conditions, are adapted from the works of Mearns et al. (2003). For a positive safety culture, employees‟ involvement, ownership and commitment is necessary; in particular, empowerment promotes feelings of self-worth, belonging and value. Workers‟ safety attitude can be shaped by norms of peer groups and can be directed by individual motivation. Higher levels of worker‟ motivation towards safety can be strengthened by the degree of their participations in safety-related activities such partaking in activities of the

workplace safety committees, reporting and correcting hazards under their operations, analyzing routine hazards within each step of a task or process, etc. Employees should be involved in training, consultation about noise, machinery isolation, sound barriers, job rotation, and wearing different earmuffs.

Successful safety programs largely depend on employee involvement, as workers tend to support the activities that they themselves help to create. Workers should be given the opportunities to provide input into the design and implementation of safety programs such as being a member of the safety committee, reporting hazards and unsafe practices to supervisors, identifying training needs, investigating accidents, etc. Mearns et al, (2003).

2.4.7.4 Promotional strategies:

In order to enhance safety awareness amongst employees, promotional strategies to be used should include the following:

- Mission statements, slogans and logos;
- Publish materials (library, statistics, newsletters);
- Media (posters, displays, audiovisual, e-mail, Internet).

2.4.7.5 Training and seminars:

Training plans to develop employee competences and skills in safety, training activities should include short talks, group meetings, training for personal fitness, hygiene, workplace stress and responsibilities towards safety (including compliance with rules and regulations, hazard identification and risk assessment, incident investigation and job safety analysis). Safety culture training may be aimed at changing attitudes and it may be effective to some extent in reducing or creating insight into risk taking or facilitating the consideration of different courses of action in response to danger. This is only if it designed to take into account both the social and cultural aspects of risk and the way in which these are communicated. Communication of risk must be integral to a safety culture training program, but it is a complex issue

involving the definition of risk and safety in a highly regulated environment, past experience of risk, multi-attribute risk characterization, level of risk acceptance and risk taking. The view that a positive safety culture comprises five components, which include: management commitment to safety; management concerns for the workforce; mutual trust and credibility between management and employees; workforce empowerment; and lastly continuous monitoring, corrective action, review of system and continual improvements to reflect the safety at the work site (Choudary, 2007).

A large body of empirical research (Zohar, 2002; 2008) supports the thesis that safety leadership has a positive impact on safety culture/climate. Clearly, excellent safety leadership is a key for any organization that wants to create a positive safety culture/climate. Management in turn can also communicate their concerns and priorities of safety to gain employees" compliance and awareness.

2.4.7.6 Special campaigns:

This item should include Health and Safety Week, health promotion, safety inductions, emergency response, incident reporting and investigation, risk assessment, introduction to existing health, safety and environment management systems. This variable measures the extent to which the firm encourages its workers to participate in activities relating to their safety. Risk awareness and risk-taking are highly relevant to safety culture; this is especially so when risk affects intentions indirectly through subjective norms and attitudes associated with behavior, most research on risk perception and risk communication has focused on possible harms, ignoring the cultural context in which hazards are framed and debated, and in which risk-taking and risk perception occur (Carder and Ragan 2003).

2.4.8 Safety Culture Assessment:

A safety culture assessment provides an organization with a basic understanding of the safety related perceptions and attitudes of its managers and staff. Safety culture measures can use as diagnostic tools to identify areas

for improvement. Because there are many potential starting points for improvement efforts, a safety culture assessment and help an organization to identify areas that are considered more problematic than others.

Cultural issues that identified as problematic can provide material for further analysis of underlying root cause ‘‘and for generating Improvement ideas from staff directly involved in the issues. Safety culture assessment can also launch an organizations patient safety program.

Assessing patient safety culture has a corollary effect, intended or not, of raising awareness levels about the role of culture in promoting a safer patient environment.

Assessments communicate what is important to an organization, what are desirable end states, and what factors viewed as leading to those end states. Safety culture assessments can function as symbolic communications that focus attention on cultural priorities and establish a common vocabulary and set of goals to rally behind. In this way, assessment in itself may regard as a patient safety intervention.

Safety culture can be assessed using both qualitative (e.g., observations, focus group discussions, case studies and quantitative methods (e.g., interviews, surveys, Q-sorts in which participants can assess a statement using a subjective weighed approach). So far, questionnaire surveys have been the most widely used assessment tool due to their practicality in time, cost and ease of implementation (Mearns & Flin, 2003).

(Zohar, 2000), Survey questions are usually categorized into multiple safety culture dimensions such as management attitude toward safety, perceived importance of safety training, safety communication and worker involvement.

2.5 Safety Management System (SMS):

Specifically, the senior management should approve and publicize safety policy, regularly review safety performance, and create appropriate incentives for middle management; those who are both highly caring and

highly controlling are the most effective leaders. The management can play three roles in creating a strong safety culture in the workplace: collection of information; dissemination of information; and creating an open environment in which safety issues can be discussed. This system is considered as the set of integrated mechanisms in the organization, comprising policies, strategies, and procedures, designed to control the risks that may affect employees' health and safety (Cooper, 2000).

According to the Federal Aviation Administration (2010), an SMS is a systematic and comprehensive business approach to managing safety risks. It includes organizational structures, accountabilities, policies, procedures and other workplace safety elements. Previous research has debated the content of this management system, and many authors have stressed its importance. But few empirical works evaluate the psychometric properties of the scales proposed to measure the SMS concept, and no consensus has been reached about the specific dimensions making up the system, an adequate safety management system must contain six key dimensions: safety policy, incentives for employee participation, training, communication, planning, and control.

CHAPTER THREE

METHODOLOGY

Chapter 3: Methodology

3.1 Introduction:

This chapter describes the methodology followed for this research to achieve the aim. The methodology includes information about the research design, population, sample size, data collection, questionnaire design, questionnaire content, instrument validity, and the method of data processing and analysis. The approach undertaken for this research comprised two components, a literature review, discussed in the previous chapter, and questionnaire survey.

3.2 Research Design:

This research aimed to investigate safety culture in construction industry in Khartoum State. The research was been divided into six phases: preliminary study phase, data collection phase, data analysis phase and report writing phase. The details of the phases described in the research plan as below:

- ✓ **Preliminary phase** is for identifying and defining the problems and establishment of the objectives of the study and development of research plan.
- ✓ **The second phase of the research** includes literature review. Appropriate literature has searched from Google search engine and books in order to gather background data.
- ✓ **The third phase of the research** includes the questionnaire design, through distributing the questionnaire. A detailed study was undertaken by participating expert construction professionals to pre-test the survey and subsequently modified before a final version was produced. The purpose of this study was to test and prove that the questionnaire

questions are clear to be answered in a way that help to achieve the objectives of the study.

- ✓ **The fourth phase of the research** was questionnaire distribution. In this phase of the survey, a quantitative approach utilized as the main statistical component in the study, to obtain qualitative data through a self-administered questionnaire by Khartoum State construction site engineers. In order to obtain reliable and representative quantitative data.
- ✓ **The fifth phase of the research** focused on data analysis and discussion. The Statistical Package for the Social Sciences (SPSS, 2017) used to perform the required analysis.
- ✓ **The Sixth phase of the research** was the results and analysis obtained in the quantitative survey their diagrams drown by Excel 2013 and explained. Then the conclusions and recommendations had been written.

3.3 Research Sample:

All types of Construction Companies in Khartoum State were chosen as the statistical population of the study. The organizations that the research subject contains many fields. It includes construction companies and consultant companies.

The sampling was done through the purposive sampling method, one of the non-probabilistic techniques. Proportional stratified sampling of 20% from five hundred organization and simple random sampling method were utilized.

3.4 Data Collection:

Data was collected using a structured questionnaire contributed on one hundred selected construction industry organizations operating in Khartoum, Sudan. Follow-up efforts including telephone calls and reminders on some of

the respondents with repeat visits were made. In the process all questionnaires were received. The response rate to the questionnaire was 100%. This is judged to be a high rate of response which can be attributed to the follow-up efforts.

3.5 Research period:

The research considered the time period between Augusts 2016 to April 2017.

3.6 Research location:

This research conducted in construction organizations of Sudan, Khartoum.

3.7 Questionnaire design:

A questionnaire is a preformatted written set of questions to which respondents record their answers. The questionnaire is an effective data collection mechanism where the researcher knows exactly what is required, and how to measure the variables of interest. When the survey is conducted personally administering, the questionnaires is the best way to collect the data. Moreover, any misunderstanding and doubts arising from the survey questions clarified immediately and the researcher can have honest answers from respondents.

The questionnaire initially designed based on the extensive literature review of previous studies.

The questionnaire divided into 3 main parts, which included (I) personal information, (II) safety culture dimensions, and (III) improvement of site engineer's safety culture. This first questionnaire draft was designed to be reviewed by experts and based on the results, the questionnaire framework was modified.

(I) Personal information: The first part of the questionnaire consists of the personal information of the respondents. This included demographics such as age. In addition, respondents asked to indicate their highest level of education, working experience in the construction field and the type of the company in which they are working in.

(II) Safety Culture dimensions: the second part of the questionnaire which is the main part consists of five components**:** Management commitment, Priority of safety, Safety rules, Physical work environment and Personal appreciation of risk.

(III) Improvement Safety Culture: The last part consists of proposed solutions to improve site engineer's safety culture.

3.8 Data Analysis:

The primary concern of this research was assessing the applicability of the Safety rules and regulations in Khartoum Construction organizations, also the blocks to improve the safety culture in these organizations. Data analyses were performed with SPSS 2017 and the diagrams drown by Excel 2017.

CHAPTER FOUR

RESULTS & DISCUSSION

Chapter 4: Results and discussions

4.1 Introduction:

This chapter included analysis and discussion of the results that have been collected from field surveys. Data was analysed using SPSS 2017 including descriptive statistical tools. Hundred questionnaires respondents from construction firms were considered. This chapter included the personal information and profile of the respondents, quantitative analysis of questionnaire field survey, and finally the summary framework of the results.

4.2 Statistical analysis:

4.2.1 Statistical methods used:

To achieve the objectives of the study and to verify hypotheses, statistical methods were used the following:

1. Charts.
2. Frequency distribution of the answers.
3. Percentages.
4. Alpha equation, to calculate the reliability coefficient.
5. Median.
6. Chi-square test for the significance of differences between the answers.

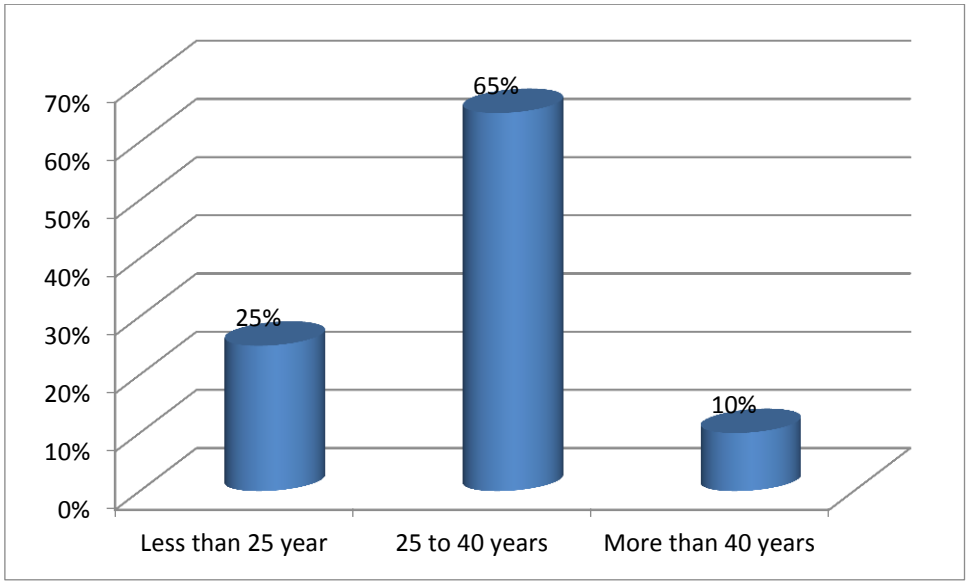
To get results as accurate as possible, statistical software (SPSS) has been used which indicates a shortcut to Statistical Package for Social Sciences.

1. **Age:**

Table (4.1): Age information of site engineers

Answer	Frequency	Percentage
Less than 25 year	25	25%
25 to 40 years	65	65%
More than 40 years	10	10%
Total	**100**	**100%**

Source: prepared by researcher, using SPSS, 2017



Source: prepared by researcher, using Excel, 2017

Figure (4.1): Age information of site engineers

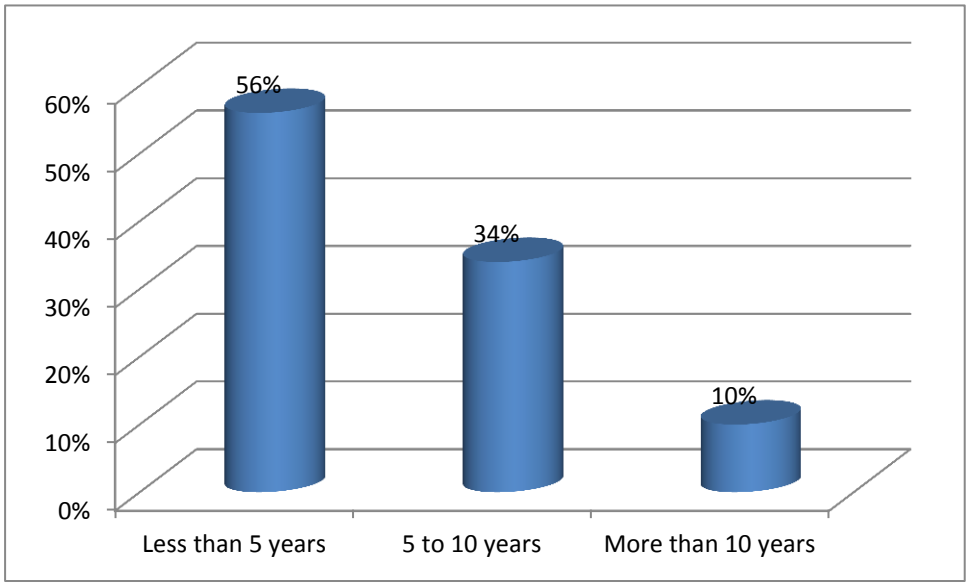
From table (4.1) and figure (4.1) we note that the age of most of the individuals study are (25 to 40 years) by (65) and with percentage (65%).

2. Experience:

Table (4.2): Experience information of site engineers

Answer	Frequency	Percentage
Less than 5 years	56	56%
5 to 10 years	34	34%
More than 10 years	10	10%
Total	**100**	**100%**

Source: prepared by researcher, using SPSS, 2017



Source: prepared by researcher, using Excel, 2017

Figure (4.2): Experience information of site engineers

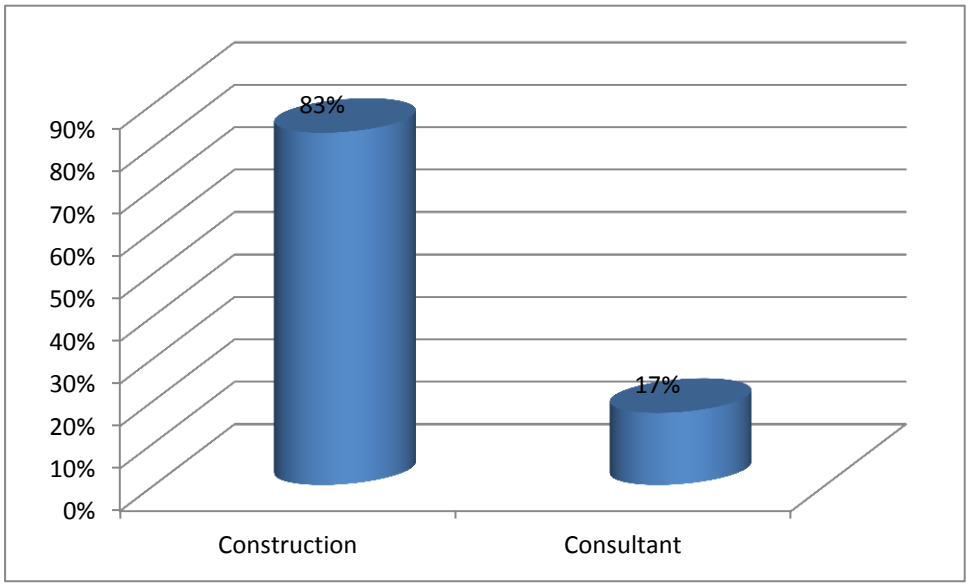
From table (4.2) and figure (4.2) we note that the Experience of most of the individuals study are(Less than 5 years) by (56) and with percentage (56%).

3. Organization:

Table (4.3): Organization information of site engineers

Answer	Frequency	Percentage
Construction	83	83%
Consultant	17	17%
Total	**100**	**100%**

Source: prepared by researcher, using SPSS, 2017



Source: prepared by researcher, using Excel, 2017

Figure (4.3): Organization information of site engineers

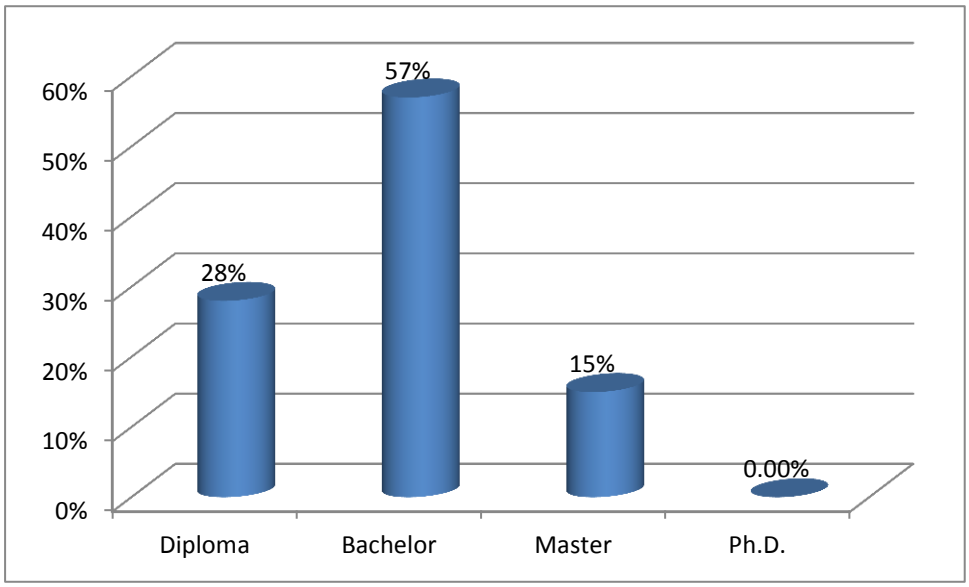
From table (4.3) and figure (4.3) we note that the Organization type of most of the individuals study are (Construction) by (83) and with percentage (83%).

4. Education level:

Table (4.4): Education information of site engineers

Answer	Frequency	Percentage
Diploma	28	28%
Bachelor	57	57%
Master	15	15%
Ph.D.	0	0.0%
Total	**100**	**100%**

Source: prepared by researcher, using SPSS, 2017



Source: prepared by researcher, using Excel, 2017

Figure (4.4): Education information of site engineers

From table (4.4) and figure (4.4) we note that the Education level of most of the individuals study are(Bachelor) by (57) and with percentage (57%).

4.3 Test hypotheses:

To answer the questions of the study and verification of hypotheses will be calculated median for each of the phrases in the questionnaire and which show views of individuals the study, which was given Grade (5) as a weight for each answer "Strongly agree", and grade (4) as a weight for each answer "agree" grade (3) as a weight for each answer "neutral", grade (2) as a weight for each answer, " disagree" and grade (1) as a weight for each answer "strongly Disagree".

To know Trends answer, by calculated median. Then it will use the Chi-square test to know the significance of differences in answers.

4.3.1 Discussion of the first hypothesis: ''Management commitment has a positive significance effect on safety culture.''

Table (4.5): Frequency distribution of the first hypothesis phrases Answers

No.	Phrases	Frequency and percentages%				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Management clearly considers the safety of employees of great importance.	70 70%	21 21%	3 3%	4 4%	2 2%
2	In my workplace management acts quickly to correct safety problems.	53 53%	28 28%	10 10%	6 6%	3 3%
3	Management acts only after accidents have occurred.	40 40%	31 31%	14 14%	9 9%	6 6%
4	Management remind engineers &workers about safety on the job.	30 30%	67 67%	3 3%	0 0.0%	0 0.0%
5	Management provide training for engineers & workers at the start of new projects.	34 34%	46 46%	10 10%	2 2%	8 8%

Source: prepared by researcher, using SPSS, 2017

Table (4.6): Chi-square test results

No.	Phrases	Chi-square value	P-value	Median	Trend
1	Management clearly considers the safety of employees of great importance.	1.765	0.002	5	Strongly agree
2	In my workplace management acts quickly to correct safety problems.	1.733	0.001	5	Strongly agree
3	Management acts only after accidents have occurred.	1.539	0.000	5	Strongly agree
4	Management remind engineers &workers about safety on the job.	1.624	0.000	4	Agree
5	Management provide training for engineers & workers at the start of new projects.	1.770	0.002	4	Agree
Hypothesis		**1.637**	**0.003**	**4**	**Agree**

Source: prepared by researcher, using SPSS, 2017

From the table above:

- The value of chi-square for the first phrase is (1.765) with (p-value=0.002 < 0.05), and depending on the table (4.5), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the second phrase is (1.733) with (p-value=0.001 < 0.05), and depending on the table (4.5), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the third phrase is (1.539) with (p-value=0.000 < 0.05), and depending on the table (4.5), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

- The value of chi-square for the fourth phrase is (1.624) with (p-value=0.000 < 0.05), and depending on the table (4.5), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the fifth phrase is (1.770) with (p-value=0.002 < 0.05), and depending on the table (4.5), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

The value of chi-square for all phrases in the first hypothesis (1.637), with (p-value =0.003 < 0.05) and depending on the table (4.5) this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

We conclude from the above that the first hypothesis "**Management commitment has a positive significance effect on safety culture** "has been achieved and in favour of agree.

4.3.2 Discussion of the second hypothesis: ''Priority of safety has a positive significance effect on safety culture.''

Table (4.7): Frequency distribution of the second hypothesis phrases Answers

No.	Phrases	Frequency and percentages%				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Safety is the number one priority in my mind when completing job.	30 30%	40 40%	12 %12	9 %9	9 9%
2	I follow all of the safety procedures for the jobs that I perform.	46 46%	32 32%	10 %10	8 8%	4 4%
3	Management considers safety equally as important as production.	47 %47	24 %24	17 %17	4 4%	8 8%
4	I feel that acting safe is a natural part of everyday life.	44 44%	23 23%	14 %14	8 %8	11 11%
5	Safety is taken into account in the planning of the work.	30 30%	40 40%	12 %12	9 %9	9 9%

Source: prepared by researcher, using SPSS, 2017

Table (4.8): Chi-square test results

No.	Phrases	Chi-square value	P-value	Median	Trend
1	Safety is the number one priority in my mind when completing job.	40.3	0.000	4	Agree
2	I follow all of the safety procedures for the jobs that I perform.	66	0.000	5	Strongly agree
3	Management considers safety equally as important as production.	57.7	0.000	5	Strongly Agree
4	I feel that acting safe is a natural part of everyday life.	42.3	0.000	4	Agree
5	Safety is taken into account in the planning of the work.	62.7	0.000	4	Agree
Hypothesis		**32.8**	**0.000**	**4**	**Agree**

Source: prepared by researcher, using SPSS, 2017

From the table above:

- The value of chi-square for the first phrase is (40.3) with (p-value=0.000 < 0.05), and depending on the table (4.7), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the second phrase is (66) with (p-value=0.000 < 0.05), and depending on the table (4.7), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the third phrase is (57.7) with (p-value=0.000 < 0.05), and depending on the table (4.7), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

- The value of chi-square for the fourth phrase is (42.3) with (p-value=0.000 < 0.05), and depending on the table (4.7), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the fifth phrase is (62.7) with (p-value=0.000< 0.05), and depending on the table (4.7), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

The value of chi-square for all phrases in the first hypothesis (32.8), with (p-value =0.000 < 0.05) and depending on the table (4.7) this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

We conclude from the above that the Second hypothesis **"Priority of safety has a positive significance effect on safety culture** "has been achieved and in favour of agree.

4.3.3 Discussion of the third hypothesis: ''Safety rules have a positive significance effect on safety culture.''

Table (4.9): Frequency distribution of the third hypothesis phrases Answers

No.	Phrases	Frequency and percentages%				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	There are too many safety procedures/ instructions/ rules helped to reduce the real risks of the jobs for which you are responsible.	29 29%	41 %41	17 %17	11 11%	2 2%
2	Some health and safety rules and procedures are not practical.	30 30%	41 41%	16 %16	6 %6	7 %7
3	Sometimes it is necessary to depart from safety requirements for Production's sake.	52 52%	36 %36	10 %10	2 2%	0 %0
4	Safety assessments are done periodically.	24 24%	28 28%	24 %24	12 %12	12 %12
5	Accidents are thoroughly investigated.	41 %41	29 %29	17 %17	2 2%	11 11%

Source: prepared by researcher, using SPSS, 2017

Table (4.10): Chi-square test results

No.	Phrases	Chi-square value	P-value	Median	Trend
1	There are too many safety procedures/ instructions/ rules helped to reduce the real risks of the jobs for which you are responsible.	46.8	0.000	4	Agree
2	Some health and safety rules and procedures are not practical.	46.1	0.000	4	Agree
3	Sometimes it is necessary to depart from safety requirements for Production's sake.	64.16	0.000	5	Strongly Agree
4	Safety assessments are done periodically.	11.2	0.024	4	Agree
5	Accidents are thoroughly investigated.	428.	0.040	4	Agree
Hypothesis		**29.71**	**0.000**	**4**	**Agree**

Source: prepared by researcher, using SPSS, 2017

From the table above:

- The value of chi-square for the first phrase is (46.8) with (p-value=0.000 < 0.05), and depending on the table (4.9), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the second phrase is (46.1) with (p-value=0.000 < 0.05), and depending on the table (4.9), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the third phrase is (64.16) with (p-value=0.000 < 0.05), and depending on the table (4.9), this indicates that there is

significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

- The value of chi-square for the fourth phrase is (11.2) with (p-value=0.024 < 0.05), and depending on the table (4.9), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the fifth phrase is (8.24) with (p-value=0.040 < 0.05), and depending on the table (4.9), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

The value of chi-square for all phrases in the first hypothesis (29.71), with (p-value =0.003 < 0.05) and depending on the table (4.9) this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

We conclude from the above that the third hypothesis **"Safety rules have a positive significance effect on safety culture**" has been achieved and in favour of agree.

4.3.4 Discussion the fourth hypothesis: ''Physical work environment has a positive significant effect on safety climate''

Table (4.11): Frequency distribution of the fourth hypothesis phrases Answers

No.	Phrases	Frequency and percentages%				
		Strongly agree	**agree**	**Neutral**	**Disagree**	**Strongly disagree**
1	There are some physical conditions at the workplace restrict ability to work safely.	27 27%	42 42%	15 %15	10 %10	6 %6
2	Sometimes I am not given enough time to get the job done safely.	12 12%	31 31%	19 19%	33 33%	5 5%
3	There are always enough people available to get the job done safely.	25 %25	26 %26	13 13%	19 19%	17 17%
4	I always get the equipment I need to do the job safely.	30 30%	31 31%	17 17%	13 13%	9 9%
5	Work stopped when there are unsuitable weather conditions.	42 42%	27 27%	15 15%	10 10%	6 6%

Source: prepared by researcher, using SPSS, 2017

Table (4.12): Chi-square test results

No.	Phrases	Chi-square value	P-value	Median	Trend
1	There are some physical conditions at the workplace restrict ability to work safely.	42.7	0.000	4	Agree
2	Sometimes I am not given enough time to get the job done safely.	29.1	0.000	4	Agree
3	There are always enough people available to get the job done safely.	6.72	0.019	4	Agree
4	I always get the equipment I need to do the job safely.	30.1	0.000	4	Agree
5	Work stopped when there are unsuitable weather conditions.	49.2	0.000	5	Strongly Agree
Hypothesis		**57.9**	**0.000**	**4**	**Agree**

Source: prepared by researcher, using SPSS, 2017

From the table above:

- The value of chi-square for the first phrase is (42.7) with (p-value=0.000 < 0.05), and depending on the table (4.11), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the second phrase is (29.1) with (p-value=0.000 < 0.05), and depending on the table (4.11), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the third phrase is (26.7) with (p-value=0.000 < 0.05), and depending on the table (4.11), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

- The value of chi-square for the fourth phrase is (30.1) with (p-value=0.000 < 0.05), and depending on the table (4.11), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the fifth phrase is (49.2) with (p-value=0.000< 0.05), and depending on the table (4.11), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

The value of chi-square for all phrases in the first hypothesis (57.9), with (p-value =0.000 < 0.05) and depending on the table (4.11) this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

We conclude from the above that the fourth hypothesis "" **Physical work environment has a positive significant effect on safety climate**" has been achieved and in favour of strongly agree.

4.3.5 Discussion the fifth hypothesis: ''Personal appreciation of risk has a positive significance effect on safety climate''

Table (4.13): Frequency distribution of the fifth hypothesis phrases Answers

No.	Phrases	Frequency and percentages%				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	I am sure it is only a matter of time before I am involved in an accident.	32 %32	42 %42	13 %13	6 %6	7 %7
2	I get the job done better by ignoring some of the safety rules.	34 %34	48 %48	10 %10	5 %5	3 %3
3	I am rarely worried about being injured on the job.	33 %33	44 %44	13 %13	7 %7	3 %3
4	People who work in my company sometimes take risks at work, which I could not take.	32 %32	44 %44	15 %15	5 %5	4 %4
5	I follow safety procedures even if there is deference in (nature, duration, and budget) of the project.	42 %42	32 %32	13 %13	7 %7	6 %6

Source: prepared by researcher, using SPSS, 2017

Table (4.14): Chi-square test results

No.	Phrases	Chi-square value	P-value	Median	Trend
1	I am sure it is only a matter of time before I am involved in an accident.	52.4	0.001	4	Agree
2	I get the job done better by ignoring some of the safety rules.	79.7	0.000	4	Agree
3	I am rarely worried about being injured on the job.	62.6	0.000	4	Agree
4	People who work in my company sometimes take risks at work, which I could not take.	61.3	0.000	4	Agree
5	I follow safety procedures even if there is deference in (nature, duration, and budget) of the project.	43.8	0.000	5	Strongly Agree
Hypothesis		**50.3**	**0.000**	**4**	**Agree**

Source: prepared by researcher, using SPSS, 2017

From the table above:

- (767 The value of chi-square for the first phrase is (52.4) with (p-value=0.001< 0.05), and depending on the table (4.13), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the second phrase is (79.7) with (p-value=0.000 < 0.05), and depending on the table (4.13), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the third phrase is (62.6) with (p-value=0.000 < 0.05), and depending on the table (4.13), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

- The value of chi-square for the fourth phrase is (61.3) with (p-value=0.000 < 0.05), and depending on the table (4.13), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the fifth phrase is (43.8) with (p-value=0.000< 0.05), and depending on the table (4.13), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

The value of chi-square for all phrases in the fifth hypothesis (50.3), with (p-value =0.000 < 0.05) and depending on the table (4.13) this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

We conclude from the above that the fifth hypothesis **‘‘Personal appreciation of risk has a positive significance effect on safety climate”** has been achieved and in favour of agree.

4.4 Discussion the third part: ''To what degree do you think can contribute to each of the following to improve the safety culture at the site engineers‘‘?

Table (4.15): Frequency distribution of the third part phrases Answers

No.	Phrases	Frequency and percentages%				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Safety is the first priority for management.	42 %42	26 %26	17 %17	9 %9	6 %6
2	Training at the start of new projects.	33 %33	28 %28	24 %24	10 %10	5 %5
3	Incentives (financial &morale).	28 %28	33 %33	24 %24	10 %10	5 %5
4	Involvement in meetings for safety issues.	33 %33	37 %37	13 %13	10 %10	7 %7
5	Periodic reports concerning safety matters for management.	27 %27	33 %33	20 %20	9 %9	11 %11
6	Continuous communications	26 %26	38 %38	20 %20	11 %11	5 %5
7	Dissemination of safety-related topics in various media (radio, newspapers, Internet etc.)	42 42%	27 27%	15 %15	10 %10	6 %6
8	Holding (workshops, conferences, and seminars) related to safety by responsible bodies.	26 %26	25 %25	13 13%	19 %19	17 %17
9	Safety assessments are done periodically.	31 31%	12 %12	19 %19	33 %33	5 %5
10	Accidents are thoroughly investigated.	30 %30	31 %31	17 %17	13 13%	9 9%

Source: prepared by researcher, using SPSS, 2017

Table (4.16): Chi-square test results

No.	Phrases	Chi-square value	P-value	Median	Trend
1	Safety is the first priority for management.	42.3	0.000	5	Strongly Agree
2	Training at the start of new projects.	97.2	0.000	5	Strongly Agree
3	Incentives (financial &morale).	28.7	0.000	4	Agree
4	Involvement in meetings for safety issues.	38.8	0.000	4	Agree
5	Periodic reports concerning safety matters for management.	21.2	0.001	4	Agree
6	Continuous communications	33.3	0.000	4	Agree
7	Dissemination of safety-related topics in various media (radio, newspapers, Internet etc.)	81.2	0.000	5	Strongly Agree
8	Holding (workshops, conferences, and seminars) related to safety by responsible bodies.	53.7	0.000	4	Agree
9	Safety assessments are done periodically.	61.5	0.000	5	Strongly Agree
10	Accidents are thoroughly investigated.	68.4	0.000	5	Strongly Agree
Hypothesis		**51.4**	**0.000**	**5**	**Strongly Agree**

Source: prepared by researcher, using SPSS, 2017

From the table above:

- The value of chi-square for the first phrase is (42.3) with (p-value=0.001< 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.

- The value of chi-square for the second phrase is (97.2) with (p-value=0.000 < 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the third phrase is (28.7) with (p-value=0.000 < 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the fourth phrase is (38.8) with (p-value=0.000 < 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the fifth phrase is (21.2) with (p-value=0.001< 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the sixth phrase is (33.3) with (p-value=0.000< 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the seventh phrase is (81.2) with (p-value=0.000 < 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.
- The value of chi-square for the eighth phrase is (53.7) with (p-value=0.000 < 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

- The value of chi-square for the ninth phrase is (61.5) with (p-value=0.000 < 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of agree.
- The value of chi-square for the tenth phrase is (68.4) with (p-value=0.000< 0.05), and depending on the table (4.15), this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

The value of chi-square for all phrases in the third part (51.4), with (p-value =0.000 < 0.05) and depending on the table (4.15) this indicates that there is significant differences at the level (5%) between answers of study individuals and in favour of strongly agree.

We conclude from the above that the third part**' 'To what degree do you think can contribute to each of the following to improve the safety culture at the site engineers"** has been achieved and in favour of strongly agree.

CHAPTER FIVE

CONCULOSION & RECOMMENDATIONS

Chapter 5: Conclusions and recommendations

5.1 Introduction:

This chapter included the conclusions and several recommendations suggested to individual in Khartoum state construction organizations and the various stakeholders in the construction industry in order to improve site engineer's safety culture.

The main objectives of this study were to assess site engineer's safety culture in construction industry in Khartoum state. This aim was achieved by accomplishing specific objectives. The first and second objectives were achieved through extensive literature review, while the others objectives were achieved by the analysis of questionnaire and several recommendations.

5.2 Conclusion:

In this section, the main findings of this research will be discussed and presented as an outcome of the study.

- Most of site engineers are between (25 – 40) years old, Most of them have experience less than five years, Also the vast majority of them are employed by construction companies, In addition, most of the site engineers hold a bachelor's degree.
- Most site engineers respond positively to the safety aspects of culture including Management commitment, priority to safety, safety rules, physical work environment and personal appreciation of the risk.
- The results analysis showed that construction site engineers have a moderate safety culture.
- The results also show that in order to improve site engineers safety culture the following items should be highly considered" Safety is the first priority for management"," Training at the start of new projects", " Dissemination of safety related topics in various media like radio,

newspapers, Internet etc. ", "Safety assessments are done periodically", "Accidents are thoroughly investigated".

5.3 Recommendations:

Recommendations will suggest the role of each party including government, construction companies, consultants (owners/designers), Contractors associations, Universities and Associations of Engineers, which could lead to improve safety culture in construction industry in Khartoum state.

5.3.1 Ministry of Labour, Public Service and Human Resources Development in Khartoum state:

Ministry of labour should activate the role of safety department in the ministry to have the following responsibilities:

- Developing a national framework to enhance safety culture in construction industry with the cooperation of all stakeholders and decision makers.
- Update the Sudanese safety rules, regulations according to the international criteria to preserve the rights of all construction workers.
- Working on the formation and activation of specialized committees, which will work on periodic safety assessment and accidents investigation.
- Work on the imposition of a law forcing all institutions (owners - consultants - companies - contractors) to put a safety terms and conditions as one of the terms of the contract in all construction projects.
- Developing a law to fine all offenders of safety rules and regulations.

- Holding (workshops, conferences, and seminars) related to safety in cooperation with Consultants, construction companies, associations of engineers.
- Developing a periodic safety magazine in cooperation with construction companies, academic institutions, consultants, associations of engineers so that it will include safety (news, statistics, accident investigations and any other related issues).

5.3.2 Construction companies:

According to the results analysis, in order to have an excellent safety culture construction companies should:

- Consider safety as high priority.
- Respect Ministry of labour safety regulations and rules.
- Have a good safety communications (Periodic Safety assessments, accident investigation, encourage report unsafe conditions).
- Provide safety-training courses specifically at the beginning of the new projects.
- Penalties for employees who disrespect safety regulations.
- Cooperate with Ministry of labour, Consultants, and associations of engineers and others in holding workshops, conferences, and seminars related to safety.

5.3.3 Academic institutions:

Academic institutions should have a guidance role by including at least one safety course to all Engineering faculty students.

5.3.4 Consultants:

Consultants have a key role towards improving safety culture in the construction Consultants responsibilities are:

- Take safety in consideration from design process.
- Put safety terms and conditions in project specifications.
- Taking safety in consideration during contract awarding process.
- Reviewing the safety history of the contractors and subcontractors and excluding all contractors and subcontractors who have bad safety reputation.
- Periodic safety assessments.
- Provide construction companies with feedback from investigation and assessment to prevent accidents reoccurrence.

5.3.5 Associations of engineers:

Should provide safety trainings, holding seminars, workshops and studying days to increase the awareness of engineers towards safety.

5.3.6 Recommendations for Further Research:

- This study focuses on a site engineer's class only; further research should include all categories of construction in order to obtain a comprehensive assessment of safety culture.
- This study was conducted in Khartoum state only. You can conduct the same study in the rest of Sudan states to achieve a comprehensive perspective of the development of safety culture in Sudan.
- Further research is recommended in other Arabic and third world countries for comparison purpose.

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APPENDICES

Questionnaire

Assessment of site engineer's Safety Culture in Construction Industry in Khartoum State

After Greetings,

Please fill in the questionnaire attached to the information requested, which aims to assess the safety culture among engineers in construction sites in the state of Khartoum, note that this study is a complementary research for a master's degree in construction management.

I appreciate your effort to answer the questions posed in the questionnaire ،knowing that all information that is obtained from Your Excellency will be used for the purpose of scientific study aimed at the development, and will be treated confidentially..

Many thanks for your time.

Researcher

Part 1: (basic personal information):

Name (optional): _____

Age:

- Less than 25 years ( ) - 25 to 40 years ( )
- More than 40 years ( )

Experience:

- Less than 5 years ( ) - 5 to 10 years ( )
- More than 10 years ( )

Organization:

- Construction ( ) - Consultant ( )

Education Level:

- Diploma ( ) - Bachelor ( )
- Master ( ) - Ph.D. ( )

Part 2:

To what extent do you agree or disagree with the following statements affecting safety in your job?

Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
1	**2**	**3**	**4**	**5**

Item		**1**	**2**	**3**	**4**	**5**
1. Management commitment has a positive significance effect on safety culture.						
1.1	Management clearly considers the safety of employees of great importance.					
1.2	In my workplace management acts quickly to correct safety problems.					
1.3	Management acts only after accidents have occurred.					
1.4	Management remind engineers &workers about safety on the job.					
1.5	Management provide training for engineers & workers at the start of new projects.					
2. Priority of safety has a positive significance effect on safety culture.						
2.1	Safety is the number one priority in my mind when completing job.					
2.2	I follow all of the safety procedures for the jobs that I perform.					
2.3	Management considers safety equally as important as production.					
2.4	I feel that acting safe is a natural part of everyday life.					

2.5	Safety is taken into account in the planning of the work.					
3. Safety rules have a positive significance effect on safety culture.						
3.1	There are too many safety procedures/ instructions/ rules helped to reduce the real risks of the jobs for which you are responsible.					
3.2	Some health and safety rules and procedures are not practical.					
3.3	Sometimes it is necessary to depart from safety requirements for Production's sake.					
3.4	Safety assessments are done periodically.					
3.5	Accidents are thoroughly investigated.					
4. Physical work environment has a positive significant effect on safety climate.						
4.1	There are some physical conditions at the workplace restrict ability to work safely.					
4.2	Sometimes I am not given enough time to get the job done safely.					
4.3	There are always enough people available to get the job done safely.					
4.4	I always get the equipment I need to do the job safely.					
4.5	Work stopped when there are unsuitable weather conditions.					
5. Personal appreciation of risk has a positive significance effect on safety climate.						
5.1	I am sure it is only a matter of time before I am involved in an accident.					
5.2	I get the job done better by ignoring some of the safety rules.					

5.3	I am rarely worried about being injured on the job.					
5.4	People who work in my company sometimes take risks at work, which I could not take.					
5.5	I follow safety procedures even if there is deference in (nature, duration, and budget) of the project.					

Part 3:

To what degree do you think can contribute to each of the following to improve the safety culture at the site engineers?

Item		**1**	**2**	**3**	**4**	**5**
1	Safety is the first priority for management.					
2	Training at the start of new projects.					
3	Incentives (financial &morale).					
4	Involvement in meetings for safety issues.					
5	Periodic reports concerning safety matters for management.					
6	Continuous communications					
7	Dissemination of safety-related topics in various media (radio, newspapers, Internet etc.)					
8	Holding (workshops, conferences, and seminars) related to safety by responsible bodies.					
9	Safety assessments are done periodically.					
10	Accidents are thoroughly investigated.					