FACTORS CONTRIBUTING TO CONSTRUCTION ACCIDENTS IN HIGH-RISE BUILDING PROJECTS, ISLAMABAD

by

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(2009 – NUST – MS – PhD – CE&M – 07)

A thesis submitted in partial fulfillment of

the requirements for the degree of

Master of Science

in

Department of Construction Engineering and Management
National Institute of Transportation
School of Civil and Environmental Engineering
National University of Sciences and Technology
Islamabad, Pakistan

(2011)

This is to certify that the

thesis entitled

FACTORS CONTRIBUTING TO CONSTRUCTION ACCIDENTS IN HIGH-RISE BUILDING PROJECTS, ISLAMABAD

Submitted by

Fahad Anis

has been accepted towards the partial fulfillment

of

the requirements

for

Master of Science in Construction Engineering & Management

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DEDICATED

TO

MY PARENTS, FAMILY

AND

TEACHERS

ACKNOWLEDGEMENT

Foremost, I would like to thanks and praises Almighty Allah who gave the opportunity and enabled me to complete my Master Degree. My heartfelt thanks and sincere gratitude to my advisor Dr Rafiq Muhammad Choudhry for the continuous support of my MS study and research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis.

I would like to thank my thesis committee for their encouragement, insightful comments, and hard questions. I also owe my special thanks to my friends Mr. Jahan Zaib and Mr. Muhammad Bilal Paracha for the guidance and support in every aspect for the completion of this thesis. Lastly I am extremely grateful to my parents for their sincere prayers and to my family for their support during the entire length of my course and research work.

ABSTRACT

In developing countries like Pakistan, construction is one of the most hazardous industrial sectors. Every year, thousands of workers received serious injuries and accidents and this uninterrupted dilemma is growing day by day. Due to this alarming position, there is a need to evaluate the construction accidents along with their causes related to them. This research presents the identification of the factors contributing to construction accidents in two High-Rise Building projects in the capital city of Pakistan (Islamabad) and suggests key prevention measures on the basis of statistical analysis. A survey questionnaire has been developed and used for the data collection. In total, 164 respondents ranging from foreman to unskilled labour were approached and the questionnaires were filled. Response rate was excellent resulting in 143 valid responses. The results were analyzed and ranked by the 'Relative Importance Index' technique. The conclusions suggest that accidents are attributed mainly due to: (a) tool accidents; (b) fall from height; and (c) struck by material. Results indicated that management factors largely contributing to the accidents causation rather than workers factors or social factors and need serious consideration. Based on the results of the analysis, prevention measures are recommended which includes: (i) involvement and commitment of top management; (ii) safety education in terms of training for all managers and supervisors; (iii) awareness and identification of unsafe work practices (iv) necessity of personal protective equipment and first aid equipment; and (v) reporting and maintaining injuries and accident records. This work may be useful for the construction practitioners to minimize the accident rate at High-Rise building construction projects.

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Chapter 1

INTRODUCTION

1.1 BACKGROUND

Construction industry is one of the most hazardous industries all over the world (Kartam 1997; Carter and Smith 2000: Whitlaw 2001). In developed countries, there is strict legal enforcement of safety in the construction industry and also in the implementation of safety management systems which are designed to minimize or eliminate accidents at work places. However, occupational safety in construction industry is very poor in developing countries such as Pakistan. It is commonly known that accidents have serious implications on the construction industry both in financial and in humanitarian terms. Construction accidents may cause many problems, such as demonization of workers; disruption of site activities; delay of project progress; and adversely affecting the overall cost, productivity and reputation of the construction industry. Construction in developing countries is more labor intensive than that in the developed areas of the globe, involving 2.5-10 times as many workers per activity (Koehn et al 1995) and relatively prone to accidents However, care is needed with the choice of classification scheme for the analysis as this can materially affect the outcome (Chi and Wu 1997). Appropriately defined classification categories are also important in forming the basis for effective accident prevention programs (Hinze et al. 1998).Whittington et al. (1992) attempted to analyze the management and organizational factors of construction accidents, but it was realized that the accident data available within most companies were insufficiently detailed to permit a comprehensive analysis. Safety had always been a persistent problem in the construction industry. In the United States, it was reported that construction industry accounted for 20% of all occupational fatalities, when they made up only 5% of the United States' work force (National Safety Council 1997). In Kuwait, the industry accounts for 42% of all occupational fatalities (Kartam and Bouz 1998) and in Hong Kong the industry accounts for more than a third of all

industrial accidents over the last ten years (Tam and Fung 1998). Construction in developing countries, such as Pakistan, is more labor intensive than that in the developed areas of the globe, involving 2.5-10 times as many workers per activity (Koehn et al. 1995) and relative prone to accidents. Construction sites are among the most dangerous sites in our nation. Accident-prevention programs for each project is essential to attain an accident free Jobsite. Construction industry participating with 2.5 GDP playing a vital role in the economy of Pakistan. The construction industry employed 6.29% directly and 30-40% indirectly of the total work force of Pakistan (*Survey of Pakistan 2008)*. According to the federal bureau of statistics the percentage distribution of employed persons 10 years of age and over suffered injuries at the rate of 13.21% in 2006, 14.55% in 2007 and 14.93% in 2008 indicating the increase year after year. The threatening increase in the rate of accidents and occupational injuries in construction has provided the space to investigate the basic cause/reason behind this unsafe working environment.

1.2 JUSTIFICATION FOR SELECTION OF THE TOPIC

It's a fact that large share of construction work being performed by human resources has always proves and led to increased number of site accidents. In developing countries like Pakistan, construction industry has yet to respond to recent technological improvements. Lack of attention to technology, however, has resulted in an unsafe and poor quality construction environment. Since no work yet being done in Pakistan relating to accident analysis and its prevention in construction industry; this research will be of great importance as it identifies the root causes of accidents and their relation to the management, labor and other project related factors. It is also an attempt to study accident patterns (qualitatively) for different building projects and then analyze them by using a quantitative approach. On the basis of the study some appropriate recommendations are suggested that could be helpful in reducing the site accidents.

1.3 RESEARCH OBJECTIVES

The objectives of this research are as follows:-

1. To overview the theories of accidents through past research studies, to acquire basic knowledge.
2. To assess factors contributing to construction accidents in high rise building projects by conducting a questionnaire based survey, to obtain necessary knowledge for analysis.
3. To suggest key prevention measures for construction accidents on the basis of statistical analysis, to improve safety on High Rise building Projects.

1.4 RESEARCH SIGNIFICANCE

Accident analysis or investigations are conducted with prevention in mind. In the past, several research studies have been done on the accident analysis; however they were failed to provide preventive measures. Whittington et al. (1992) attempted to analyse the management and organisational factors of construction accidents, but it was realised that the accident data available within most companies were insufficiently detailed to permit a comprehensive analysis. Most other studies on construction accidents focuses on immediate causes, characteristics of accident victims or accident sequence. (Kartam and Bouz 1998; Cattledge et al. 1996; Jeong 1998; Hinze et al. 1998).

In Pakistan, thousands of construction accidents occur each year. According to Survey of Pakistan, 2008: there is a gradual increase in occupational injuries and disease from 12.54% (2002) to 14.93% (2008) in the construction industry because of lack of safety culture and awareness. Unfortunately, no systematic mechanism is available to report/record the construction accidents, give rise to increase the risk of accidents on the construction projects. This study is an attempt to identify the root causes of accidents occurred on the high-rise building projects. Appropriate recommendations are suggested that can be helpful in the overall process of reducing construction-related accidents and may also be an important step in promoting construction safety culture in Pakistan.

1.5 SCOPE OF THE THESIS

Since the main focus of this research was to analyze the accidents happened on the construction Projects; the records for these accidents were mandatory for the analysis. In this regard, keeping in view the limited time and recourses, ongoing High-rise building projects in the twin cities i.e. Islamabad/ Rawalpindi has been surveyed and two building projects were selected for the research analysis on the basis of accident data available on both these construction Project sites.

1.6 OUTLINE OF THE THESIS

The thesis is divided in to five chapters; the brief of each is as follows,

In Chapter 1 the general background is being provided along with the problem statement and the significance of the study in relation to the national needs. It also includes the research objectives and scope.

Chapter 2 covers the thorough review of the past literature of accident analysis and its prevention in the construction Industry. In the initial part of the chapter the detailed introduction on construction accidents has been elaborated. Basic terminologies along with theories based on accidents are explained in the middle portion and at last description regarding the prevention of accidents in the construction industry is highlighted.

Chapter 3 covers the research methodology adopted for the study. It includes the selection of survey samples, development of a questionnaire, designing of survey and finally the collection of data and its analysis.

Chapter 4 discusses the statistical analysis and results of the survey conducted on the projects. Different statistical techniques have been than employed for the development of results and analysis.

Chapter 5 summarizes the main conclusion. Future recommendations and pictorial prevention measures for construction accidents are also being made based on the findings from the study carried out.

1.7 SUMMARY

Brief summary of the research is introduced in this chapter. Starting by reviewing the past literature that developed a need of this research is highlighted. Significance and important aims & objectives are presented. Scope with outline of the thesis chapters is also discussed.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The construction industry plays a vital role in the social and economic development of all countries. The importance and role of the construction industry in the economy of any country has been confirmed by several studies, including (Coble and Haupt 1999). However, when compared with other (labor intensive) industries, the construction industry has historically experienced a disproportionately high rate of disabling injuries and fatalities for its size (Hinze 1997). Research shows that the major causes of accidents are related to the unique nature of the industry, human behavior, difficult work site conditions, and poor safety management, which result in unsafe work methods, equipment and procedures (Abdelhamid and Everett 2000). Emphasis in both developing and developed countries needs to be placed on training and the utilization of comprehensive safety programs (Koehn et al. 1995). The numbers of fatalities within the industry are only the tip of the iceberg, with thousands of major injuries, and even more minor ones, resulting in lost time (Smallwood 2000). (Kartam and Bouz 1998) identified the advancement in social sciences as having promoted a greater awareness of the sanctity of life and the unacceptability of premature death due to work-related accidents. 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 (King and Hudson 1985; Halender and Holborn 1991). Construction accidents cause many human tragedies, de-motivate workers, disrupt sites, delay project progress, and adversely affect the overall cost, productivity and reputation of the construction industry (Mohamed 1999). The causes of the accidents are not only the carelessness of the workers; sometimes accidents happen due to the failure of control, which is the responsibility of

management. Thus the shift of the focus on the accidents has been driven by the awareness that organizational, managerial and human factors, rather than purely technical failures, are prime cause of accidents (Weiek et al. 1999).

The construction industry differs from most other industries in that it is constantly in flux. Working conditions are very seldom the same from one day to the next, posing many challenges to the workers. The construction industry is considered to be dangerous and of a highly hazardous nature (Hinze and Olbina 2008; Haupt 2001; Rowlinson 2000). Globally the construction industry has one of the highest injury rates, very often second only to the mining sector (Hinze 2006). Many studies, such as (Coble and Haupt 1999) have shown that construction industry reflects the level of economic development within the country. The construction sector everywhere faces problems and challenges. However, in developing countries, these difficulties and challenges are present alongside a general level of socio-economic stress and a lower productivity rate when compared to developed countries (Ofori 2000). (Grimaldi 1970) claimed that accident statistics are insensitive, and cannot reliably measure safety. One major disadvantage of conventional safety measures is that they are retrospective, measuring unsafe behavior after it has occurred (Rockwell and Bhise 1970; Tarrants 1970). It is widely accepted that unsafe behavior is intrinsically linked to workplace accidents. A positive correlation exists between workers' safe behavior and the safety climate within construction site environments. Construction workers' attitudes towards safety are influenced by their perceptions of risk, management, safety rules and procedures.

A further characteristic of the industry, that makes management of this sector more troublesome, is the unfavorably high supervisor-worker ratio. Supervisors who have more a personal and positive relationship with workers have more favorable safety performance records (Hinze 1997; Levitt and Samelson 1993). This relationship is harder to develop if the ratio is too high, which is generally the case within the construction industry (Smallwood 2000). (Rowlinson and Lingard 1996) have attributed the prototype nature of construction projects, the

transient nature of work, low education levels of the workforce and high levels of subcontracting, as major contributing factors to poor safety records within the construction industry worldwide. Traditional measures of safety are after-the-fact measures; namely, that safety is measured after injuries have already occurred. These measures are labeled reactive, trailing, downstream, or lagging indicators because they rely on retrospective data. Focusing on these measures e.g., accident rates and compensation costs often means that the "success of safety is measured by the levels of system failure" (Cohen 2002). In recent years, there has been a movement away from safety measures purely based on retrospective data or ''lagging indicators,'' such as accident rates, toward so-called ''leading indicators'' such as site investigation and measurements of safety climate (Flin et al. 2000). Kothari et al. (1995) found that, in most developing countries, for example like India, Pakistan, Bangladesh, there are: no training programs for staff and workers; therefore, no orientation for new staff or workers is conducted; hazards are not pointed out; and no safety meetings are held. Employees are expected to learn from their own mistakes and experience.

In developed countries, recent advancement in technology, on one hand, has contributed positively to industry productivity, but on the other hand, has created a more challenging and unsafe work environment (Farooqui et al. 2007).Rowlinson (2003) reported that between 1989 and 1992, 256 people were fatally injured in the Australian Construction Industry. Statistics revealed that the fatality rate was 10.4 per 100,000 workers, which was similar to the fatality rate for road accidents. In 2000, a study was conducted in China (Huang et al. 2000), which revealed that 3,000 construction workers are killed in work related accidents each year. In Hong Kong, 275 reportable accidents per 1,000 workers per year were recorded in 1994; this figure stood at around 150 in 2000 (Rowlinson 2003). In comparison, 10 construction workers in every 1,000 suffer an injury in a year in Japan, and the figure is around 50 for the United Kingdom (Rowlinson 2003). Whittington *et al.* (1992) attempted to analyse the management and organisational factors of construction accidents, but it was realised that the accident data available within most companies were insufficiently detailed to permit a comprehensive analysis.

Most other studies on construction accidents focuses on immediate causes, characteristics of accident victims or accident sequence (Kartam and Bouz 1998; Cattledge *et al.* 1996; Jeong 1998; Hinze *et al.* 1998).

2.2 THE CONSTRUCTION INDUSTRY

The construction industry is closely linked to the economy of a country and is often a good indicator of the state of that economy (Strassman, 1975; Turin 1969). The Construction Task Force (1998) indicated that the construction sector in the UK projected an economic output of $87 billion in 1998. This constitutes 10% of GDP Gross Domestic Product (Haupt 2001). In China, the economy has been growing since 1979. The construction sector mirrored this growth (Ahmad and Yan 1996). The South African economy has been experiencing consistent growth over the last eight years since 2000 with the construction sector playing an important role in this growth. In Europe the construction sector employs in the region of 7.5% of the total workforce (Haupt 2001). If the construction sector and the economy of a country are so closely linked then it makes sense to effectively manage the human resources active in that industry. No two construction sites are the same even though the physical structure being built may be very similar. The working environment, programme, sequence of construction and workforce will invariably differ. Weather conditions, location, physical conditions, and height constantly change (Haupt, Deacon and Smallwood, 2005; Porteous 1999). Unlike manufacturing and other factory orientated work where conditions remain similar every day and where the workforce is the same, construction does not allow continuity of production since each product is unique (Haupt 2001). This constant change means that construction workers are often faced with unfamiliar situations and are required to find effective solutions to unique problems. Very often these solutions are outside the bounds of recommended methods leading to an increase in health and safety risk (Toole 2002). Another negative factor influencing the management of health & safety during the construction process is one of fragmentation, meaning that there are many role players taking part in the process all with different roles, goals, expertise and skills (Haupt 2001). Fragmentation may have the following results (Haupt 1996):

1. Increased construction costs;
2. Lowered productivity;
3. Poor, ineffective communication between role players;
4. Increased, and often unnecessary, confusing and contradictory documentation;
5. Ineffective and inefficient project management;
6. Unnecessary time delays;
7. Unsatisfactory quality performance;
8. Re-work;
9. Poor levels of safety and health; and
10. Costly, lengthy disputes

2.3 CONSTRUCTION RELATED INJURIES

Injuries can be categorized into first aid injuries; medical injuries (no lost work shifts); disabling injuries (where at least one shift is lost) which can either be permanent or temporary in nature; and fatal injuries (Compensation for Occupational Injuries and Diseases Act, 130 of 1993). The construction industry causes a disproportionately high number of injuries (Hinze 2006). The construction industry employs about 7% of the total industrial workforce 13 in the USA as reported by Dong, Men and Haile in a CPWR report (2005), but accounts for about 21% of all industrial fatalities. (Hinze 2006) supports this finding. Research also concludes that construction workers experience the highest rates of lost workdays (Grubb and Swanson 1999). Further, the construction industry is responsible for the most fatalities worldwide (Pollack and Chowdhury 2001; Suraji et al. 2001; Ngai and Tang 1999; Coble and Haupt 1999). Figure 1 depicts the high rates of work related fatalities in the U.S.A. in 2002. An injury is a result of an accident. It occurs at a fixed time and place and shows an immediate bodily impairment (Haupt 2001). Physical injuries and indeed fatal injuries receive the most attention from employers because of the direct costs associated with them. Not all accidents result in injury or damage to equipment or material. It is in fact the near misses, those

accidents that don't result in injury or damage that hold valuable answers to what the future holds (Hinze 2006).

2.4 ACCIDENT CAUSATION

Accidents and injuries do not just happen - they are caused by varying, factors. The accident causation process is a complex one (Suraji, Duff and Peckitt 2001). Can all accidents be prevented? The most morally acceptable answer would be, "YES'' as put forward by the premise of 'zero injury construction projects' (Hinze 2006).

Several accident causation theories have been developed to explain the causes of accidents. Arguably, policy makers when adopting accident management systems should be familiar with these theories.

The primary categories of accident causes are unsafe acts or behaviors and unsafe conditions or situations (Kartam and Nabil 1997). When it comes to both unsafe conditions and unsafe acts, two elements exist, namely the technical causes leading to the failure and the procedural errors, which allow the faults to occur (Jones 1996). Two studies conducted in the United States arrived at the following results (Haupt 2001; Rowlinson in Coble et al. 2000):

a. National Safety Council

- 88% of accidents were due to unsafe behaviours
- 10% were due to unsafe conditions
- 2% due to unclassified causes

b. Du Pont company study

- 96% of accidents were due to unsafe behaviours
- 4% were due to unsafe conditions

2.5 THEORIES ON ACCIDENTS

2.5.1 The Accident-Proneness theory

It is believed that some individuals will be more likely to be injured than others. They are ‘accident-prone’. This could be due to personal factors and explains that injuries do not just happen by chance. Vernon (1918 in Rowlinson 2000) stated that certain personality traits made certain workers more vulnerable than others. These traits include aggressive tendencies, social maladjustment and outgoingness among others. Studies on groups of workers have shown that certain workers sustain more injuries than others and that chance alone is not a factor (Farmer and Chambers 1929 in Rowlinson 2000). This theory is however under scrutiny and is often not the preferred accident causation theory. Factors like influence by fellow workers and personal problems were never investigated and add to the invalidity of the theory. It is also believed that accident proneness may change with time, that is, one will take less risk when you have a family compared with when you were young and carried less responsibility. From this accepted pattern, it can be deduced that risk taking reduces with age (Hinze 2006). Although accident-prone workers are seen as being ‘high risk’, it was found that workers who attended health and safety training sessions had fewer accidents (Denning 1983). The accident proneness theory does not carry enough evidence and requires more research into exactly what actions lead to accidents, the variances in hazards and whether the accident was due to a fellow worker. The answers to these factors may validate or disprove the theory altogether (Hinze 2006).

2.5.2 The Goals-Freedom-Alertness theory

This accident causation theory suggests that a psychologically rewarding work environment leads to safe work performance (Hinze 2006). The theory explains that an environment that does not stimulate a sense of alertness leads to complacency and low-quality work behavior. Kerr, who first suggested the goals-freedom alertness theory in 1950, alluded to the fact that a worker who knows how to do a job and understands the goals will be well focused on the job at hand and

will be less likely to be injured. Workers should always be involved in problem solving if they are to remain alert and positive. Unfortunately few studies have tried to test this theory and there is little support due to this. Kerr (1950) found that workers in one department of a particular firm sustained more injuries than the other departments. This 'high risk' department happened to have the lowest promotion opportunity and inter-company transfer rates. One could argue however that the more hazardous tasks were being performed in this department. The theory states that companies should train their managers and foremen to make the work more rewarding for their workers. Managerial techniques like participative management, clear task layout, positive encouragement, and goal setting may assist the workforce in acting safer and having less accident.

2.5.3 The Adjustment-Stress theory

The adjustment-stress theory states that a work environment that diverts the attention of workers negatively impacts safe work performance. This was Kerr's second theory and followed on the back of his goals-freedom-alertness theory. Certain unexplained variances left by his first theory would be investigated and explained by the adjustment-stress theory. This theory suggests that "unusual, negative, distracting stress" placed on workers increases their "liability to accident or other low quality behavior" (Kerr 1957). The theory postulates that accident occurrence increases as a result of negative internal environment stresses like fatigue, alcohol consumption, loss of sleep, drugs, disease, worry, personal problems or anxiety. Apart from the internal environment, the external environment also plays a part. Factors like noise, illumination, temperature and excessive physical strain may lead to an increase in the chance of injury. Workers whose attention is diverted during work time will be more susceptible to injury (Hinze 2006). For construction workers, the external diversions are very apparent, add to this some internal diversions and the recipe for an accident may be written. Direct on-the-job stress caused by unrealistic, unattainable goals set by managers and even by the construction client like tight deadlines and cost constraints also increase the risk of injury. The accident-proneness theory is slightly different in

that it states that certain workers are inherently more at risk while the adjustment-stress theory speaks of temporary conditions that affect a worker.

2.5.4 The Distractions theory

Hazards present in the work environment complicate the process of completing a task successfully. Hinze (2006) observed that workers would be more successful in achieving their task goals if distractions from known hazards were less. In other words when workers have to concentrate on existing hazards, they cannot focus on the job at hand, leading to low task achievement. It can therefore be deduced that should productivity be increased, hazards must be eliminated so that less attention is placed on them by the workers. If a hazard exists, the worker potentially at risk should place the necessary attention on avoiding the hazard, this diverts the worker's attention from the real task activities. Quality and productivity are therefore negatively affected. Workers who do not place adequate attention on the hazards may potentially be at higher risk to injury. Thus eliminating hazards should be the primary concern of managers and foremen if they are to achieve better quality products, improved productivity and reduced rates of injury. Hazards are defined as physical conditions with inherent qualities that can cause harm to a person (Hinze 2006). However it may be possible that a person is considered the source of the hazard as he/she is not in the proper state of mind and therefore places themselves at risk. An improper state of mind may be caused by mental distractions such as financial concerns, family disputes, competition at work, and drug or alcohol abuse among others. Even positive distractions like celebrations and parties may pose a threat to the safety of a worker. Evidence has been provided which indicates that mental state of mind plays a prominent role in causing disease (Holmes and Rahe 1967). These stressful events may be negative or positive in nature and can be classified by means of a points system. By adding up the points, one can assess an individual's risk level. The distractions theory consists of two main components namely unsafe physical situations and workers' distractions by sideline issues – these two when put together are purported to have an accident outcome.

2.5.5 The Chain-of-Events theory

As discussed previously when investigating Heinrich's axioms, injury accidents can be due to a sequence of events, one event following on the next, with the final event resulting in an accident or injury. The chain-of-events theory indicates that all the events need to run concurrently for the accident to occur. Should one of the steps be eliminated, there is a good chance that the potential injury will be averted or prevented. When injury investigations are conducted, the focus is all too often placed on the injured worker. The conclusion is usually that the worker was at fault. This perceived 'worker negligence' was however merely the final event in the chain. The steps leading up to the 'worker negligence' were out of his control and could be attributed to factors such as poor working conditions, inadequate management systems and company policies, time constraints, etc. Very often in the chain of events leading to an injury lies a management related failure or oversight leading one to believe that construction managers, top, middle as well as team leaders all have a role in changing the course of a potential accident causing situation. Fine (1975 in Hinze 2006), concluded after conducting an extensive study of management's role in accidents that "all accidents and hazards are indicators of management failures". Management failures can be anything from failure to enforce procedures, failure to train workers, failure to supply competent supervision to incorrect placement of workers and failure to motivate workers and incentives positive health & safety behavior. Following on management shortcomings, and understanding that they have an important role to play, construction managers and foremen must believe that their actions can directly prevent injury accidents. Among other things they need to provide the necessary skills training and health & safety training including training in risk minimization and elimination strategies. They need to introduce programmes like incentives for positive health & safety performance by workers. When looking at injury causation one must also consider the various role players and understand how they are involved in the construction process. Each of them from the owner to the architect, from the site manager right down to the worker carrying out the task plays a role in causing injury accidents. But similarly they also each have the ability to break the chain-of-events leading to an injury. A typical hierarchical

structure on a construction site is shown in Figure 2.5: Owner/developer – project manager/principal agent – professional engineers – architect – principal contractor – contractors – sub-contractors – workers.

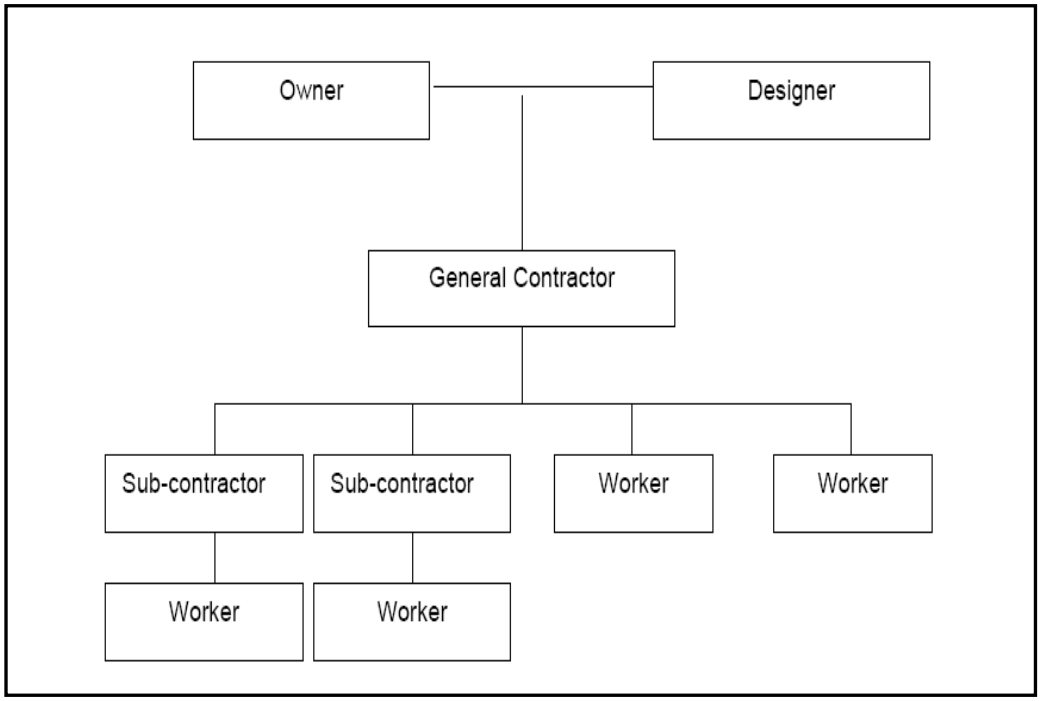


Figure 2.5: Organizational chart on a typical construction project (Adapted from Hinze 2006)

What must be learnt from the various accident causation theories is that accidents are not superficial in nature, merely caused by unsafe acts and/or conditions, but are complex multi-causal situations with their roots often embedded in management policies and approaches. Injury prevention solutions should therefore be found not in the most direct causes of an injury, but in the underlying causes such as a lack of training; ineffective supervision; and communication failures.

2.5.6 Reason's framework for accident causation

Reason's framework, otherwise called "the Tripod model" concentrates on the underlying mechanisms involved in accident causation rather than just looking at the accident scene. Reason called these mechanisms general failure types (Suraji et al. 2001). These general failures included bad design, unsafe hardware,

inadequate procedures, conditions with a high chance of error, poor housekeeping, lack of training, incompatible objectives, unclear communication, bad organization, unscheduled maintenance management, and inadequate defence mechanisms (Suraji et al. 2001). Reason (1990) proposed that accidents, unsafe acts and latent failures were interrelated and that the latent failures in technical systems combined with triggers in the working environment such as human violations and technical faults otherwise termed active failures may lead to the resultant accident. The latent failures actually arise as a result of upstream precursors like bad management decisions, manager incompetence and psychological precursors. These psychological precursors were further defined as being factors like high workload, unfair time frames for carrying out tasks, or inadequate and even non-identification of hazardous situations. It is apparent when studying this model that human failures, whether upstream or downstream are a central cause of accidents

2.5.7 The Constraint-Response theory

This theory or model is based on the notion that each participant in the lead up to an accident experiences constraints on their activity. The responses to these constraints in turn lead to further constraints to subsequent participants in the process. These constraints and associated responses eventually manifest themselves downstream in what Suraji et al. (2001) terms the proximal factors or failures. Instead of latent and active failures as put forward by Reason, the constraint response theory talks of distal and proximal failures as depicted in Figure 3. The dismal failure, such as the failure to conduct an asbestos survey of a building before demolition, ultimately leads to the proximal failure, in this case demolishing a building comprising asbestos containing products. The proximal failure leads directly to the risk exposure or accident involving the worker. Although this theory is based on Reason's framework for accident causation, it includes a practical facet, which allows it to be adapted for effective injury investigation and intervention on construction projects. Suraji et al. (2001), believed that "the effective mitigation of causal factors requires better knowledge of what factors are most influential, who may reasonably be expected to control those factors and how such control may most effectively be achieved".

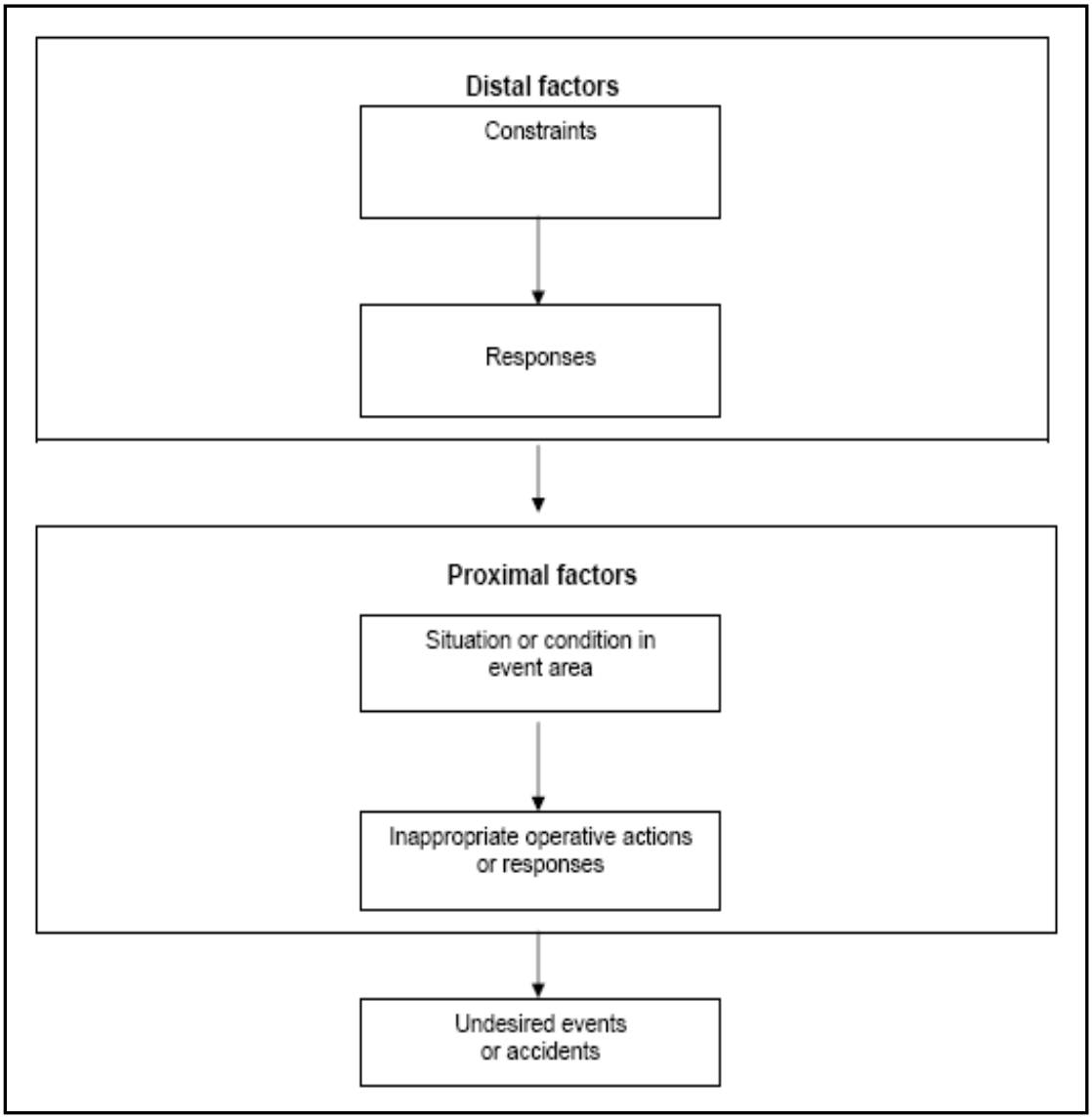


Figure 2.6: Summary of the constraint-response model for accident causation (Adapted from Suraji et al. 2001)

2.6 ANALYZING ACCIDENTS/ INCIDENTS

To analyze an accident it is necessary to know, at a minimum, the type of accident, kind/nature of any personal injury, property damage, or equipment failure. Some examples of accident type include:

1. Struck by
2. Struck against

3. Caught in, under, or between
4. Rubbed or abraded
5. Bodily reaction
6. Overexertion
7. Contact with Electricity
8. Fall from Elevation
9. Contact with radiation
10. Fall from same level

Personal injuries include broken bones, lacerations etc. Property is damaged by fire water collisions, etc. Equipment failure includes hydraulic leaks, metal fatigue, etc. All these have occurs at construction worksite. (Accident Prevention Accident/incident Analysis, National Mine Health and Safety Academy, U.S. DOL, Beckley, WV. 1980.)

2.7 ACCIDENT PREVENTION

Hinze (1997) believes that the answer to effective accident prevention lies in recognizing near misses as potential injury indicators and taking the necessary steps to minimize the associated risk, with the aim of preventing them from occurring again. Preventing accidents on construction sites like in any other occupational environment requires firstly the provision and maintenance of a safe and healthy workplace and secondly the promotion of safe worker behavior (Al-Mufti 1999). So why is it necessary to reduce occupational injuries? There are generally five main reasons why accident prevention in construction is important:

The cost in human suffering; There is a definite impact on the life of the injured person; whether it be physical pain, disability or death as well as on the lives of the family of the injured, disabled of deceased person should this be the case. Moral reasons; this is a developed awareness by the employer into the need for improved health & safety at work also termed ‘good corporate governance. Worker morale; Accidents and injuries weaken worker morale. Legal reasons; Legislation and other legal documentation demand that human life be preserved. Financial; Accidents

result in unplanned costs and are therefore difficult to budget for. Various types of insurance i.e. public liability insurance; workman's compensation cover; and contractors all risk insurance are tools used by contractors. Claims against these insurance policies lead to increased premiums and penalties, which in turn increase the cost to the employer (Holt 2001).

Injury statistics can be useful in comparing injury rates from year to year, from company to company, or even from country to country. However, more often than not statistics are inaccurate and are not based on the same criteria (Holt 2001). Recent studies by the Health & Safety Executive in the UK found that only 55% (1997/98) of 16 all non-reportable injuries in construction were actually reported to the HSE and local authorities. This was however an improvement on previous years (Holt 2001). Nonfatal and less serious injury statistics can therefore only be used as an indicator when determining injury trends. Fatal injuries, however, which are more difficult to ignore seem to be better reported and lead to improved statistical records (Holt 2001).

2.8 SUMMARY

A thorough literature review on existing accident variables taxonomies and classifications was conducted. During the search for suitable categorizations, it was realised that most of the available taxonomies lack a strong underlying accident causation model (Hinze et al. 1998; Kartam and Bouz 1998; Feyer and Williamson 1991; Sawacha et al 1999), this makes the logic structure of the taxonomies harder to grasp. Bird and (Germain 1996), and (Gordon 1998) developed taxonomies that were relatively comprehensive, but they were not tailored to the context of construction industry. Hence, causing difficulty in the classification of accident variables, in particular the job factors. Furthermore, some parts of the taxonomies were split into very fine factors without sub-categorisations, hence causing difficulty in statistical analysis (as the data would be too sparse). Whittington et al. (1992) came up with a taxonomy based in the construction industry, but due to a difference in the underlying accident causation model and research objectives, the taxonomy developed by Whittington *et al.* (1992) could not be fully adopted. Even

though, there was no single taxonomy that can be fully adapted to be used in the research, a compilation of the taxonomies from the literature review was considered a base for the research.

Chapter 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter 3 discusses the research methodology adopted to carry out a comprehensive study and analysis on the site accidents within the Pakistani construction industry. For this purpose quantitative approach is employed and method of field survey is selected for data collection.

3.2 METHODOLOGY

Research strategy shows how the researchers are going to carry out their study to achieve and answering research objectives (Saunders et al. 2003).The methodology adopted for carrying out this research is described below:

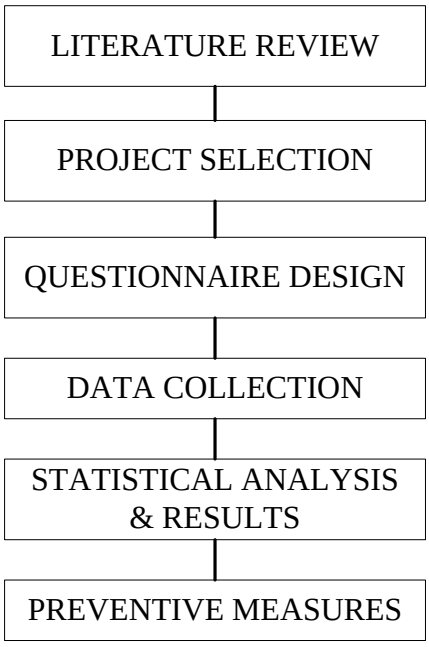


Figure 3.1: Methodology flow chart

3.2.1 Selection of building projects for survey

In order to understand and identify the causes leading to accidents in Pakistan a questionnaire based survey was planned to be conducted. (Bryman 2004) referred surveys as cross-sectional studies and explained that the data collected from the surveys are generally quantitative in nature and can be used to correlate two or more variables. (Dane 1990) also argued that survey research is the most appropriate method for research studies. Furthermore, because surveys rarely involve manipulation of independent variables or the random assignment to conditions, they are not generally used for testing cause-effect hypothesis. In survey research, the participants are asked to answer the questions directly through questionnaires or interviews.

Since the main objective of the study is to identify the root causes of accidents, it was necessary to select those Construction projects where some data accident/incident records are available. For that purpose reconnaissance survey was done in Islamabad and Rawalpindi on various projects and the topic was discussed with the project stockholders regarding accident analysis and its prevention. After conducting the detailed survey, two on-going high-rise building projects (of more than 10 storey's) in Islamabad region were selected for study as on those projects, the site management had maintained and made available to the researcher the accident/incident record.

3.2.3 Questionnaire Layout:

A survey instrument i.e. questionnaire was developed on the basis of detailed literature review. The questionnaire is an efficient data collection mechanism when the researcher knows exactly what is required, and how to measure the variables of interest (Sekaran 1992). The purpose of a pilot survey also known as feasibility survey is to test a questionnaire for its reliability, consistency and validity (Thompson 2010). A feasibility survey was conducted to check the applicability of questionnaire on the selected projects. Ten questionnaires were distributed on both the building projects and were requested to fill in the questionnaire by using the help of experts Construction managers and safety

engineers. After getting response from both the projects, the questionnaire was further discussed with the experts of respective field associated with clients, consultants and contractors on each project. Having made thorough discussions, the questionnaire took its final shape (see Appendix 2). The Questionnaire was designed in such a way that it describes the situation and circumstances surrounding a particular accident which occurred at the construction site. The final part of the questionnaire is divided in to three major sections and are discussed below.

3.2.3.1 Personal data of injured worker

The first section of the questionnaire is concerned with some personal information of the injured worker involved in the accident. It includes the characteristics of an injured person i.e. his age, marital status, job title, education, years of experience and income per day (in Pak rupees).

3.2.3.2 Accidents Category and Site Condition

In section 2 the questionnaire is related to the nature and type of accident that occurred to the injured worker and different site condition that caused that accident on the construction site. The type of accidents includes:

1) Contact with electricity,
2) Crane accident,
3) Gas explosion,
4) Structure failure,
5) Fall from height,
6) Struck by material,
7) Tool accident,
8) Fall from roof opening,
9) Fall from roof opening,
10) Fall from ladder,
11) Falling object from height and others.

This part also includes the time at which accident happened the day time, during breaks, during overtime or during nights the weather condition of the site at the time of the accident (e.g., hot, humid, cold) the season of the year .All these questions were related to the site and conditions that the worker has experienced when he got injured.

3.2.3.3 The Ranking of Factors Contributing To Construction Accidents

The first two parts of the questionnaire is related to the worker and site condition he has faced when the accident happened, the aim of this part is to carefully examine and focus on the roots causes of accidents that occurred on the building projects sites in order to improve safety performances in the construction industry. Factors that can be attributed to construction accidents were adopted from the review of literature and initial pilot survey as mentioned above with the help of site supervisors, site engineers, safety engineers and some other technical workers of the site. In total, 20 causes of accidents were than finalized and they were categorized in to three groups: These are site management related factors; worker related factors; and social and project related factors the detail of each group are as follows.

3.2.3.4 Site Management related factors

In this group, the factors are under the control of site management and that are contributing highly in cause of an accident. These factors are:

i. Appropriate personal safety procedures were not specified
ii. Correct tools were not used for the specific task
iii. Lack of supervision and control on worker's adherence to wear safety items
iv. Safety regulations were not followed
v. No safety engineer at site.
vi. Safety items were not available on site
vii. The management is pushing work regardless of laborer's abilities
viii. No or lack of weekly safety meetings
ix. No training program for the workers to implement the job safely

x. No Safe written/known procedure for the assigned job is available
xi. Lack of appreciation after completion of the task

3.2.3.5 Worker related factors

This group highlights the factors related to the workers, and indicates human and behavioral aspect that are causing or leading to the construction accidents. Six factors are there in this group which is as follows,

i. The worker was suffering from health problems
ii. Physical fatigue caused the accident
iii. Worker was rushing the work
iv. The accident occurred due to misjudgment from the worker
v. The worker had no satisfaction with the nature of the job
vi. Worker was not wearing personal protection items(PPE)

3.2.3.6 Social and project related factor

This final factor comprises of;

i. Unsuitable living, housing and transportation facilities for the worker
ii. Job or task was too difficult to perform.
iii. The worker had not enough sleeping hours

In each group, all the factors were written in form of a statement and each worker is asked to answer in a range from Strongly Agree to Strongly Disagree. (Likert Scale) This range is measured on a scale of 5 with 5 being the highest and 1 being the lowest as shown in the Table 3.1.

Table 3.1: Response Ranges (Likert Scale)

Response	Impact	Ranked
Strongly Disagree	lowest effect	1
Moderate Disagree	low effect	2
Neutral	Neutral	3
Moderate Agree	High effect	4
Strongly Agree	Highest effect	5

3.3 DATA COLLECTION

Since most of the workers were either illiterate or just have the basic reading and writing skills, some of the questionnaires were also interviewed by the researcher personally. On both the projects, special assistance was provided to the researcher by the site engineer and safety supervisors. The main advantage of face-to-face or direct interviews is that the researcher can adapt the questions as necessary, clarify doubts, and ensure that the responses are properly understood by repeating or rephrasing the questions and to acquire maximum feedback. Total 164 workers were approached on both the Projects 143 valid responses out of the whole was achieved for the study analysis.

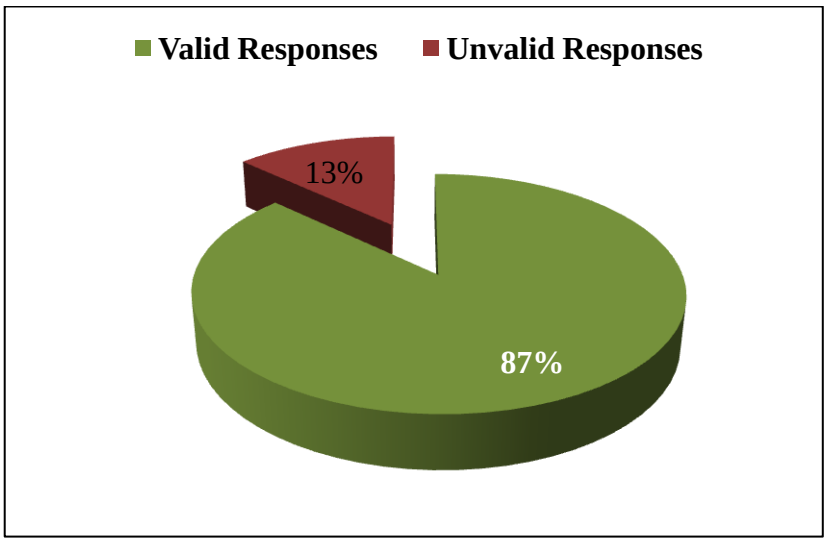


Figure 3.2: Response rate chart

3.4 SUMMARY

In this chapter, research plan (flow chart), data collection, and research methodology was outlined. Research method along with questionnaires for analyzing accidents was discussed. The researcher strives to do innovative construction safety research through data collection and data analysis which is reported in the subsequent chapters.

Chapter 4

RESULTS AND ANALYSIS

4.1 INTRODUCTION

This chapter provides data analysis and results of Construction Accidents in High-Rise Building Projects in Islamabad (Pakistan). Statistical techniques are employed for the analysis of the data collected from the requisite survey conducted by the researcher. Various statistical tools were used to analyze the characteristics of the injured worker and accident site conditions in order to highlight the key safety issues. The factors attributing to site accidents are analyzed on the basis of Likert Scale with range of 1-5 and ranking of different factors were determined by Relative Importance Index (RII) suggested by Kometa et al. (1994). This method has been used by Chan and Kumaraswamy (1997), to rank causes of delay in the construction projects. The ranking of each factor has been analyzed by using the following expression.

$$\text{Relative importance index} = \frac{\sum a_i x_i}{AxN} \qquad \text{.....Eq. (1)}$$

Where a_i is a constant expressing the weight of the i^{th} response and x_i is the frequency of the i^{th} response of the total responses for each cause, i is the response category index where i=1, 2, 3,4 and 5 respectively. In this case 1 is not significant and 5 is extremely significant, A = the highest weight (i.e. A = 5 in this case), and N = total number of respondents (i.e. N = 143 in this case).RII value is ranged between 0 to 1

4.2 SURVEY RESULTS

A total of 143 responses were collected from the workers involved in the accidents from the two prime high rise buildings of Islamabad Pakistan. The survey through face to face interviews was conducted during the period of October, 2010 to April, 2011 with the help of Site Safety supervisors because of language barriers between the Author and the site workers.

4.3 CHARACTERISTICS OF THE INJURED WORKER

The first part deals with the general information about the injured worker, their personal characteristics including (age, marital status, job title etc). Brief of each of these are described as under,

4.3.1 Age wise Distribution

Table 4.1: Accidents in terms of Worker's Age

Question	Criteria	Frequency	Percentage (%)
AGE (Years)	less than 18	14	10
	18-25	44	31
	26-35	52	36
	36-50	23	16
	Above 50	10	7

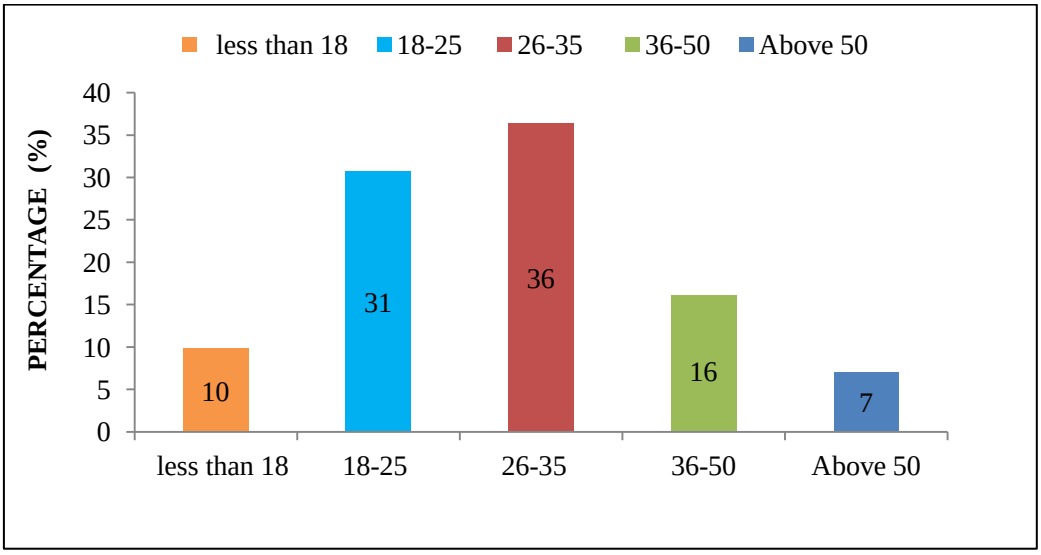


Figure 4.1: Age of the workers

Table 4.1 shows the percentage distribution of the accident in terms of workers ages. 36% of the sample (52 cases) is involved in accidents with an age bracket of 26-35 years old, while 31% (44 cases) are 18-25 years old, 16% (23 cases) are between 36-50 years old, and 10% (14 cases) is younger than 18 years old. The Graphical representation is represented in Fig-4.1 indicating that out of the total sample size the maximum percentage for cases involved were in the middle age ranging from 26-35. It also indicates that 10% of the cases were less than 18 years old. It is pertinent to mention here that according to the labor law of Pakistan workers less than 18 years old are not allowed to work on the construction site, clearly shows the violation of the laws.

4.3.2 Marital Status

As illustrated in the Fig.4.2 57% (81 cases) of the workers involved in accidents are married and 43% (62 cases) are single which is not an unusual trend. However, it should be a concern with a reason that in Pakistan the married workers on the sites have to look his whole family individually.

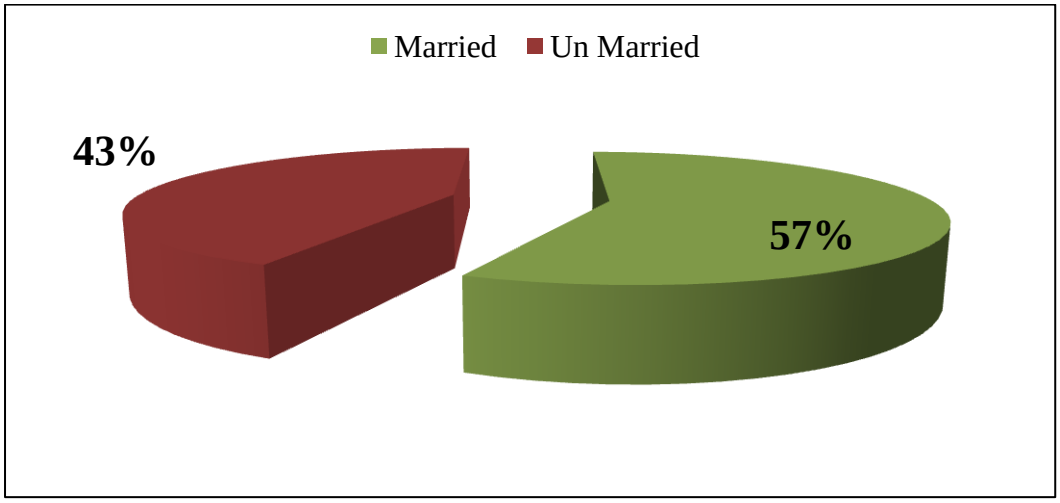


Figure 4.2: Marital status of the workers

4.3.3 Job title

The distribution of the workers in terms of their job that includes Foreman/Technician, Skilled Labor, Unskilled Labor, Helpers, is shown in the following Table 4.2:

Table 4.2: Accidents in terms of Personal Data (Job Title)

Question	Criteria	Frequency	Percentage (%)
Job Title	Foreman/Technician	20	14
	Skilled Labor	46	32
	Unskilled Labor	74	52
	Helper	3	2

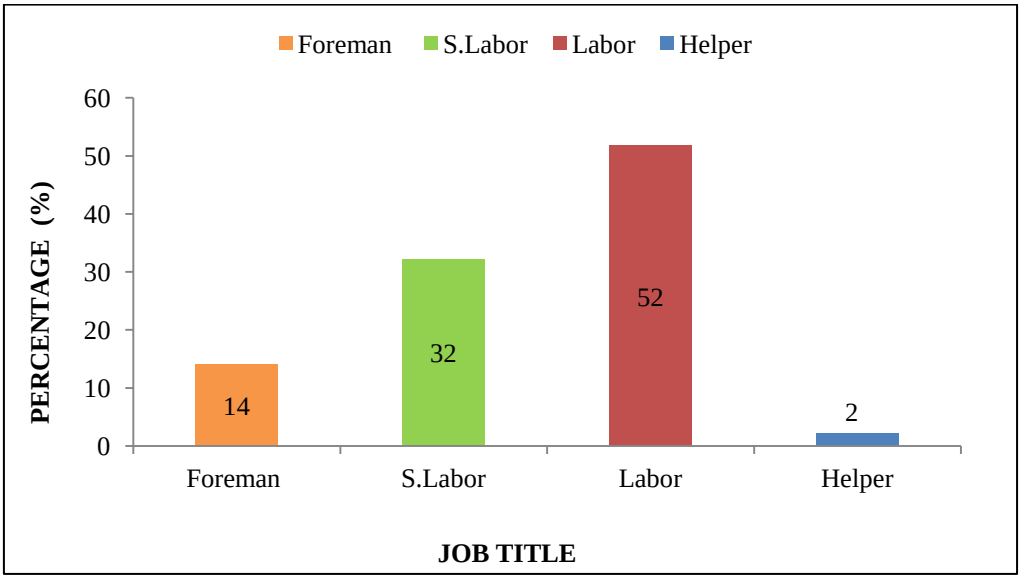


Figure 4.3: Job title of the workers

Table 1b Shows the graphical representation that 74(52%) are unskilled labor while 46(32%) are skilled labor and 20 (14%) are Foremen/Technician and 3(2%) are helpers.

4.3.4 Education

Table 4.3: Accidents in terms of Personal Data (Education)

Question	Criteria	Frequency	Percentage (%)
Education	Illiterate	26	18
	Basic/Primary	48	34
	Secondary	62	43
	Diploma	7	5

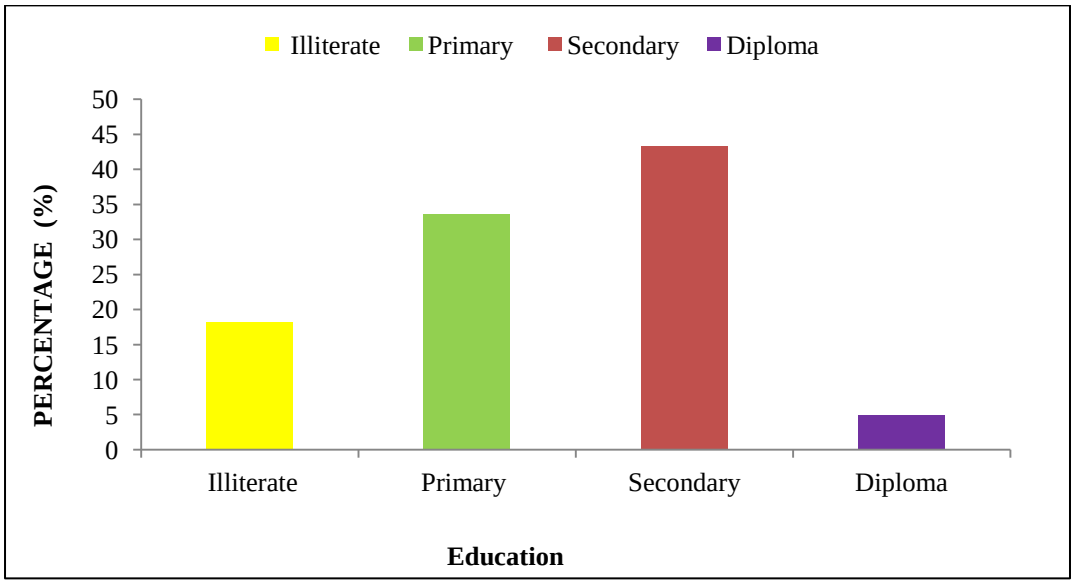


Figure 4.4: Education of the workers

Education plays a vital role in the improvement and decrease of accidents at the sites. As shown in the Table 1-c, the distribution of the data in terms of education indicates that more than 50% of the workers were either illiterate or have only basic primary education up to 4^{th} or 5^{th} standard. This shows that less the education, more will be accidents. Out of the 143 workers, only 5% have diploma degree, which clearly depicts the lack of education on these construction projects. The workers having secondary education(6^{th} Standard to matriculation) were (62) 43%. 48% of the workers of the total sample were educated and have reading and writing skills.

The results illustrated from Fig 4. are very common in developing countries like Pakistan where education for workers is not considered as an important factor rather the focus and emphasis is on the level of skill.

4.3.5 Years of Experience

Table 4.4: Accidents in terms of Personal Data (Years of Experience)

Question	Criteria	Frequency	Percentage (%)
Years of Experience	1-5	28	20
	6-10	61	43
	11-15	25	17
	16-20	12	8
	More than 20	17	12

Table 4.4 indicates that maximum percentage of accidents lies in the criteria between 06-10 years of experiences while 20% of the sample was in the range of 1-5 years experience, 17% in the range of 11-15 years, 12% with workers having experiences more than 20 years and 8% in between 16-20 years experiences. The maximum number of accidents were in the experience range of 1-10 years which is more than 60% of the sample size shows that the less the experience the more will be chances of accident. Also there is gradual decrease in the accident as indicated by the graph in Fig.4 from 6-10 years to 16-20 years (i.e. 43% to 8%) respectively but there is sudden increase to 12% with workers having experience more than 20 years showing that with age 50 or above chances of accidents increases. As elaborated in Fig1.more than 50 years old have a percentage of 7% of the sample along with 16% of workers having ages between 36-50.

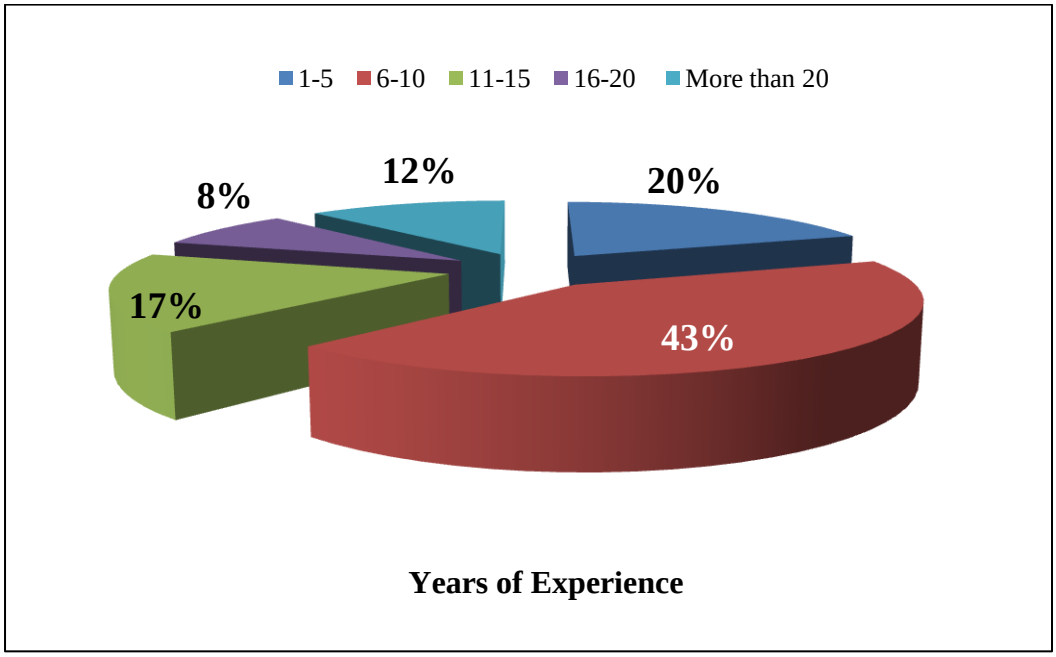


Figure 4.5: Years of experience of the workers

4.3.6 Income Status

Table 1e shows the distribution of the sample in terms of income/day, where 77(54%) of the sample have income/day between 200-350Rs, 52(36%) have (350-500) Rs/day, 10(7%) sample with more than 500 Rs/day and 4(3%) with less than 200 Rs/day.

Table 4.5: Accidents in terms of Personal Data Income/day (Rs.)

Question	Criteria	Frequency	Percentage (%)
Income/day (Rs.)	less than200	4	3
	200-350	77	54
	350-500	52	36
	More than 500	10	7

It is concluded from the above results that the frequency of accidents increase with a decrease in the level of skill. The results also indicate that the max

strength of unskilled labor was there at the two projects conducted by the researcher. Table 1b illustrating that 54% of the sample was unskilled labor having income between 200-350 Rs/day mostly.

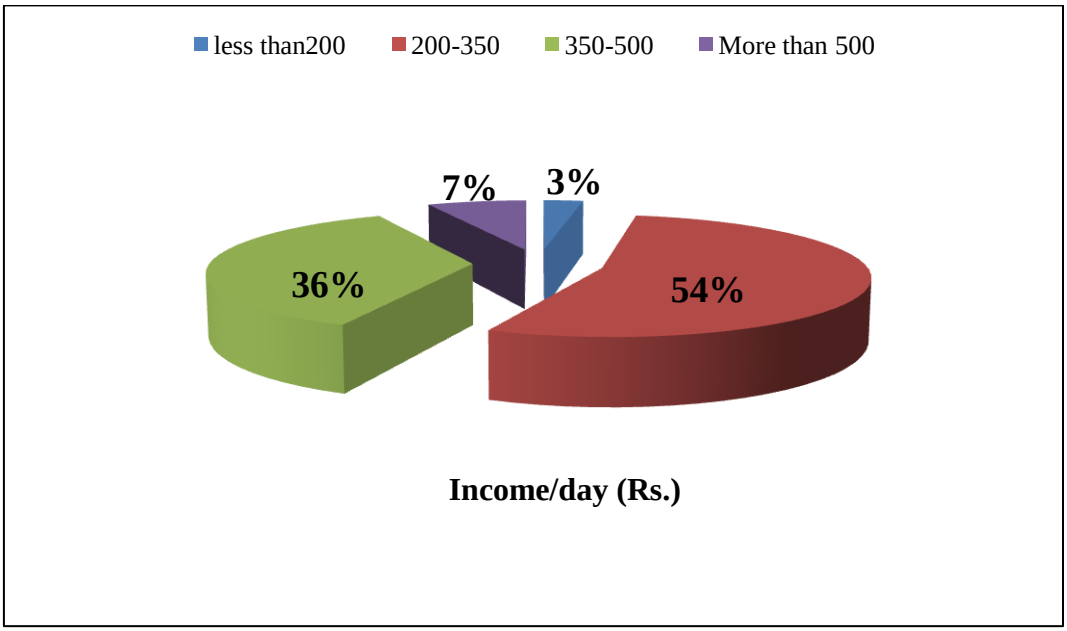


Figure 4.6: Income/day (Rs.) of the workers

4.4 ACCIDENTS AND SITE CONDITION

4.4.1 Types of Accidents

Table 4.6: Accidents Types and Numbers

Question	Criteria	Frequency	Percentage(%)
Income/day (Rs.)	Contact with electricity	7	5
	Crane accident	3	2
	Gas explosion	2	1
	Structure failure	1	1
	Fall from height	30	21
	Struck by material	27	19

Question	Criteria	Frequency	Percentage(%)
	Tool accident	55	38
	Fall from roof opening	4	3
	Fall from ladder	5	3
	Falling object from height	5	3
	Others	3	2

Table 4.6 shows the distribution of accidents types. The maximum percentage of 38% of the sample was accidents due to tools while 21% was fall from height and 19% was injured by struck of material. As shown in Table2 many injuries results from unsafe or improper use of tools, The possible reasons are due to lack of inspection of tools & adherence to site safety procedures or manuals Furthermore, many serious accidents results from fall from (height, roof opening and ladder). This is due to the lack of supervision and control on worker's adherence to wear safety items. In addition to this there is no safety training program for the workers. While interacting with site officials it was revealed that there were no laid down procedure for the assigned job.

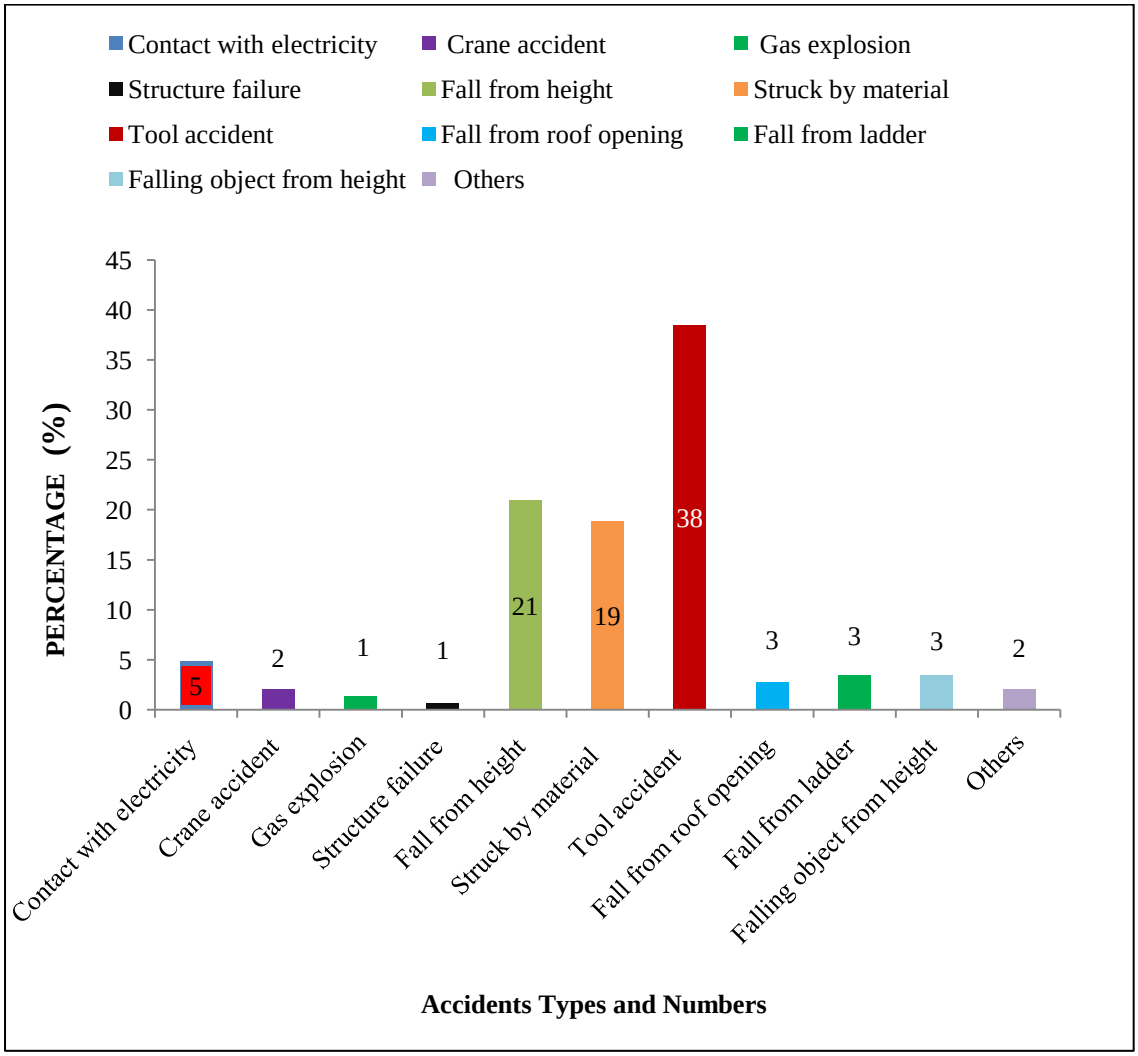


Figure 4.7: Accidents Types and Numbers of the workers

4.4.2 Time of Accidents

Table 4.7: Accident time over a Period (day)

Question	Criteria	Frequency	Percentage(%)
The Injured worker was working	First hour of working	49	34
	During the working day	42	29
	During Breaks	9	6
	Last hours of working	22	15
	During Overtime	21	15

The results of survey showed that injuries took place randomly. Table 3a shows that 49(34%) of the accidents occurred during the first hour of the day while 42(29%) of the construction accidents happened during the normal working hours, 15% of the accidents occurred in the last hours of working and during overtime respectively and 9(6%) of the accidents occurred during breaks. It is most common for construction work to be performed during regular daytime hours, however certain activities such as concrete pouring and some other activities are done during night hours. The results showed that the least productive period is during the start of the day because the workers have to regain their rhythm and momentum of work, which increases the chances of errors and mistakes.

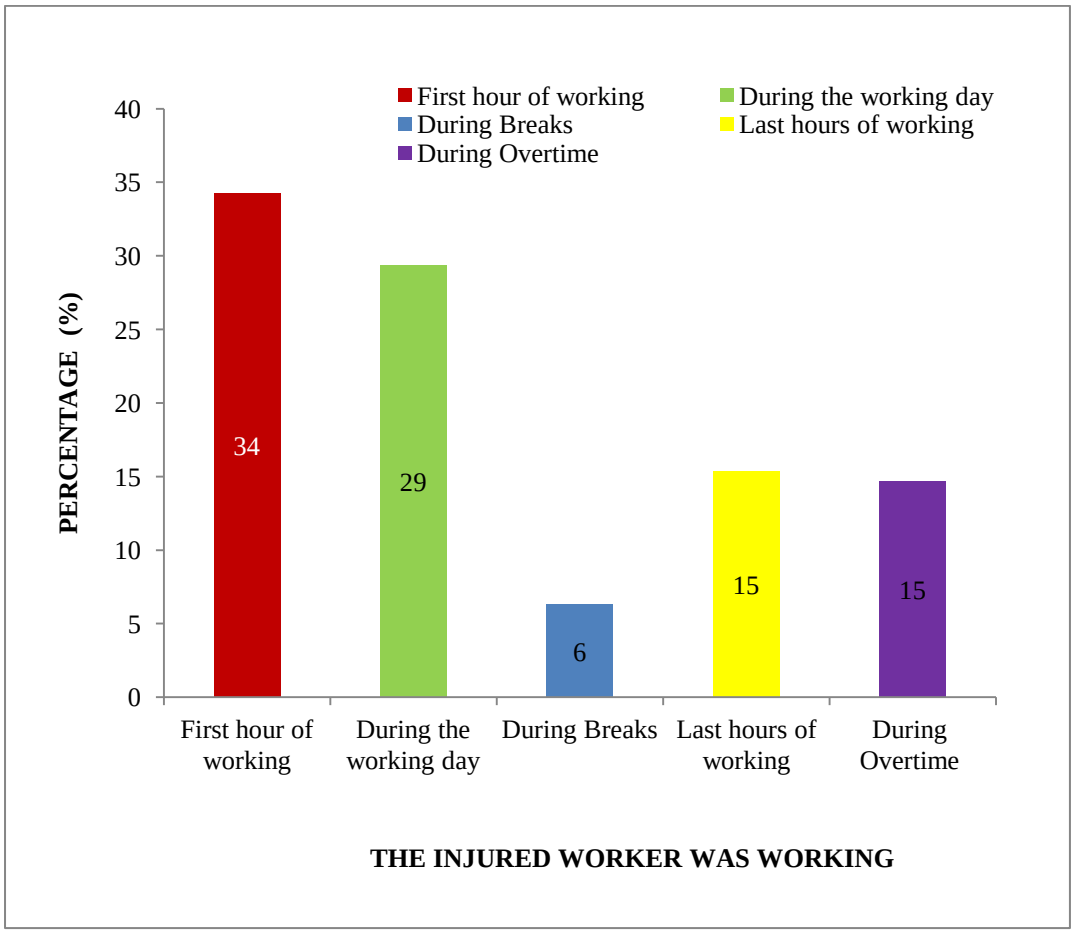


Figure 4.8: Working Time for the Injured Worker

4.4.3 Weather conditions

Table 4.8: Weather Condition

Question	Criteria	Frequency	Percentage(%)
Weather conditions	Hot	88	62
	Cold	34	24
	Humid	8	6
	Rain	13	9

The results in Table 3b illustrates the weather conditions for the occurrence of accidents. The maximum percentage of the accidents occurred in hot weather conditions (Temperature range 34C-50C) i.e. 88(62%) 34(24%) of the workers were effected in the cold climate

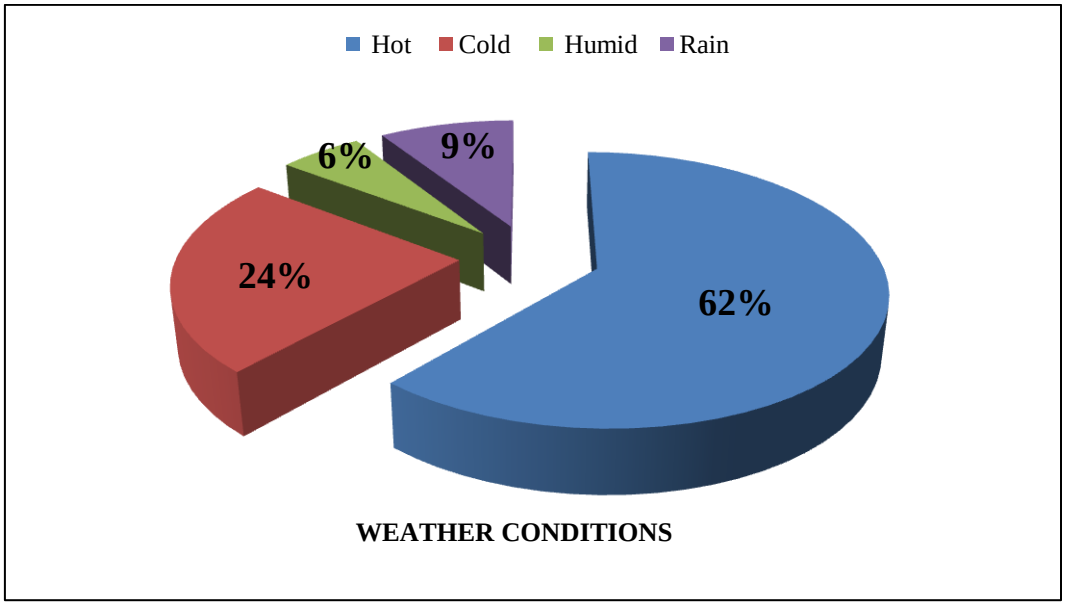


Figure 4.9: Weather Conditions

4.4.4 Season

Table 4.9: Seasons of the Year

Question	Criteria	Frequency	Percentage
Season	Summer	98	69
	Winter	39	27
	Fall	2	1
	Spring	4	3

Table 3c shows that the accident may be related to the season of the year. It shows that the injury occurrence was highest during the summer and winter and was lowest during fall and spring. It shows that 98(69%) of the construction accidents happened in summer, 39(27%) in winter, 2(1%) in fall and 4(3%) in spring respectively. During summers the possible causes which affect the workers health are heat exhaustion and dehydration. Furthermore, cold weather does affect the ability to perform certain tasks, particularly those require considerable manual skills.

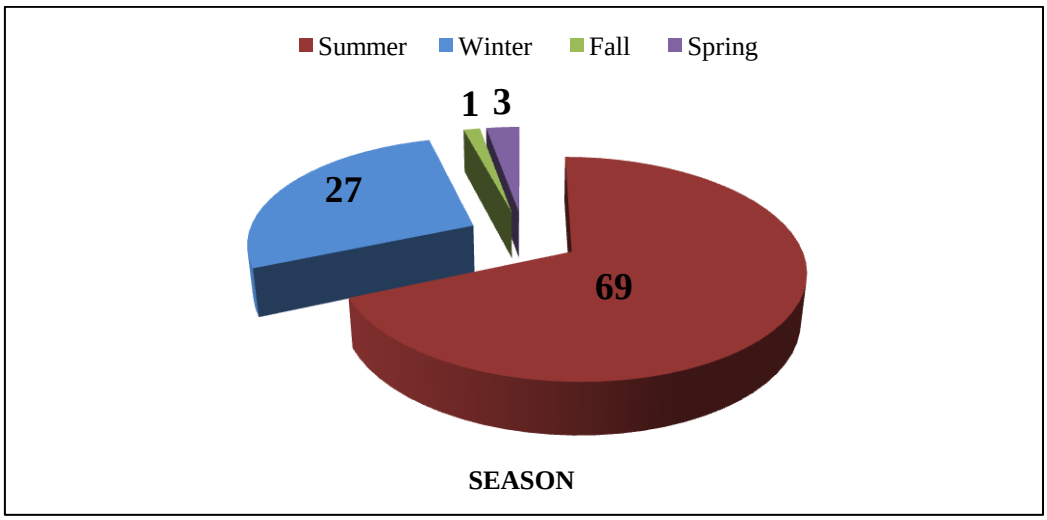


Figure 4.10: Seasons of the Year

4.5 THE RANKING OF FACTORS CONTRIBUTING TO CONSTRUCTION ACCIDENTS

Table 4.10: The Ranking of Factors Contributing To Construction Accidents.

The Ranking of Factors Contributing To Construction Accidents									
Accident Factors			**Highly Disagree (Lowest effect)**	**Moderate Disagree**	**Neutral**	**Moderate Agree**	**Highly Agree (Highest effect)**	**RII**	**Rank**
Management Related Factors	**1**	Appropriate personal safety procedures were not specified	17	30	23	48	25	0.648	8
	2	Correct tools were not used for the specific task	9	36	21	52	25	0.667	6
	3	Lack of supervision and control on worker's adherence to wear safety items.	8	22	29	45	39	0.719	2
	4	Safety regulations were not followed	12	29	43	32	27	0.646	9
	5	No safety engineer at site.	32	38	36	28	9	0.522	11
	6	Safety items were not available on site	24	37	33	36	13	0.568	17
	7	The management is pushing work regardless of laborer's abilities	13	29	27	44	30	0.669	5

The Ranking of Factors Contributing To Construction Accidents									
Accident Factors			**Highly Disagree (Lowest effect)**	**Moderate Disagree**	**Neutral**	**Moderate Agree**	**Highly Agree (Highest effect)**	**RII**	**Rank**
	8	No or lack of weekly safety meetings	27	42	35	28	11	0.536	18
	9	No training program for the worker to implement the job	10	32	56	35	10	0.604	13
	10	No written/known procedure for the assigned job is available	6	25	24	46	42	0.730	1
	11	Lack of appreciation after completion of the task	8	33	30	39	33	0.678	4
Worker Related Factors	**12**	The worker was suffering from health problems	7	25	33	52	26	0.691	3
	13	Physical fatigue caused the accident	15	36	37	38	17	0.608	12
	14	Worker was rushing the work	16	25	33	39	30	0.659	7
	15	The accident occurred due to misjudgment from the worker	19	38	31	39	16	0.593	15
	16	The worker had no satisfaction with the nature of the job	15	37	41	34	16	0.599	14
	17	Worker was not wearing personal protection items(PPE)	13	35	36	32	27	0.635	10

The Ranking of Factors Contributing To Construction Accidents									
Accident Factors			**Highly Disagree (Lowest effect)**	**Moderate Disagree**	**Neutral**	**Moderate Agree**	**Highly Agree (Highest effect)**	**RII**	**Rank**
Job & Social Factors	**18**	Unsuitable living, housing and transportation facilities for the worker	24	33	40	33	13	0.569	16
	19	Job or task was too difficult to perform.	28	50	40	18	7	0.497	19
	20	The worker had not enough sleeping hours	49	55	22	13	4	0.415	20

Table shows the Relative Importance Indices (RII) and Rank of the accidents factors as postulated by the workers at the construction sites located in Islamabad Pakistan. Seven of the top ten factors relate to site Management group, while three factors were related to the Workers.

1.	No written/known procedure for the assigned job is available	0.73
2.	Lack of supervision and control on worker's adherence to wear safety items.	0.719
3.	The worker was suffering from health problems	0.691
4.	Lack of appreciation after completion of the task	0.678
5.	The management is pushing work regardless of laborer's abilities	0.669
6.	Correct tools were not used for the specific task	0.667
7.	Worker was rushing the work	0.659
8.	Appropriate personal safety procedures were not specified	0.648
9.	Safety regulations were not followed	0.646
10.	Worker was not wearing personal protection items(PPE)	0.635

As discussed earlier in Chapter 3, a total of 20 causes of accidents were categorized into three groups: site management related factors, workers related factors and job and social factors. A discussion of the results on each of the three different groups of accidents concluded from this table, as:

4.5.1 Management Related Factors

This group of accident factors were ranked high by the respondents, as seven of the top ten factors causing accidents lied in this category. The top cause of the accidents in this group was considered to “No written/known procedure for the assigned job is available”. In order to address this issue, employers need to have a written safety policy for their enterprise setting out the safety and health standards being implemented across the world. The safety policy should deal with the arrangements for training at all levels. Particular attention needs to be given to key workers such as scaffolders and crane operators whose mistakes can be catastrophic.

The workers also indicated that the contractors are weak on enforcing safety issues and requirements at the construction sites. Factors like Lack of supervision and control on worker's adherence to wear safety items. The top factor showing the lack of interest of the contractor is that “personal safety procedures were not specified. It is evident that the workers are calling for the contractors to fulfill their duties by providing safety instructions and training programs as necessary steps to ensure safety at site.

Another factor that workers attributed to be a high cause of accident is the high work load, the contractor pushes the workers on sites and the main focus is to complete the work without giving importance to the health and safety of the workers.

Despite the fact there were safety engineers on both the sites and certain trainings and safety programs for the guidance of the workers but these were just to satisfy the general procedures.

Safety should form part of all trainings for construction activities. Furthermore safety meetings should be used as a tool to review the effectiveness of the project safety efforts, to resolve current health and safety problems, to provide a forum for planning safe construction activities, to plan ahead new or changed operations, and to update the accident prevention programs.

4.5.2 Workers related factors

The ranking related to workers were comparatively low. The main factors that can be attributed to causing accidents are, the worker was suffering from health problems, Worker was rushing the work, and Worker was not wearing personal protective equipment (PPE). On both the projects surveyed, one thing was noticed that there were no such measures for illness, small accidents that often happen at the working Site therefore many of the workers complain that they are not physically fit but still have to perform the activities because of the immense pressure on them to meet the deadlines. This resulted in lack of their performance and sometimes due to inactiveness ultimately causing accidents to them. Despite the fact that there is arrangement for first aid treatment on the construction projects and most of the workers are using this facility but at the same time they were also forced to work, as the concerned contractor gives least importance to health & safety issues. The other factor was that the workers were not wearing personal protective equipment. This could be related to the education level and the mind sets of many of these workers who have different educational, social & financial backgrounds.

Table 1c that more than 50% of the workers were either illiterate or have only basic reading and writing abilities so it’s not easy on them to wear PPE as most of them considered it as burden on them and feel uncomfortable working with them. Some workers were of the opinion that they were working for many years without using PPE so it’s now very difficult for them to work wearing it. On the other hand most of them agreed that wearing protective clothing and the use of safety tools reduce the intensity & frequency of accidents many folds.

4.5.3 Social related factors

The ranking related to Social factors were also comparatively low. The main factors that can be attributed to causing accidents were, Unsuitable living, housing and transportation facilities for the worker, Job or task was too difficult to perform, the worker had not enough sleeping hours. On both the projects surveyed, one thing was noticed that there was no major concern regarding the social issues that is the reason the impact is very low in comparison to the Management related factor and worker related factor. One major reason for these factor was the education level and the mind sets of many of these workers, also most of them don't know there basic rights of housing, living and transportation.

4.6 SUMMARY

In this chapter the detail analysis has been described, a total no 164 questionnaire were collected from the workers involved in the accidents out of which 143 valid responses were analyzed. The first and the second part of the questionnaire were analyzed using the statistical technique to describe the main characteristics surrounding accidents in High Rise building projects. To determine the ranking of the different factors or attribute causing construction accidents as outlined in the third part, the relative importance Index (RII) was adopted.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The primary goal of this research was to study the different accident theories in construction thus to acquire the basic knowledge about the construction accidents and to find out the root causes of accidents at building projects (High Rise), by conducting a questionnaire based survey, so that the industry practioner may get the necessary knowledge. Statistical analysis was employed to understand the characteristics and determine the leading factors that contribute to construction accidents. The following results were obtained

- The most common type of accidents in are the tool accidents (38%), fall from height (21%) and Struck by material (19%).
- Most of the accidents occurred during the first hours of the day and during the summer season.
- Most of the workers involved in the accidents were unskilled labor and there literacy rate was very low
- The main cause of Construction accidents in Pakistan are related to Management and Project nature factors, while the workers and job and social factors were having no large affect, which is an unexpected result. Both workers and supervisors agreed on the ranking of the accident factors.

From the statistical technique (RII), the main causes for top ten factors contributing to the accidents discussed in brief:

RANK: 1 No written/known procedure for the assigned job is available.

- No Safety Training
- Involvement of Top Management

RANK: 2 Lack of supervision and control on worker's adherence to wear safety items.

- Insufficient Site Safety Supervisory staff
- Lack of technical safety knowledge

RANK: 3 The worker was suffering from health problems.

- Negligent & Casual behavior towards health
- High work load

RANK: 4 Lack of appreciation after completion of the task.

- Motivation & Encouragement
- Incentives

RANK: 5 The management is pushing work regardless of laborer’s abilities.

- Rushing towards progress
- Lack of professionalism

RANK: 6 Correct tools were not used for the specific task.

- Inspection of tools
- Unsafe or Improper use of tools

RANK: 7 Worker was rushing the work.

- To meet deadline
- Unsafe work

RANK: 8 Appropriate personal safety procedures were not specified.

- Involvement of Top Management
- No written Safety policy

RANK: 9 Safety regulations were not followed.

- Safety importance
- Lack of Interest

RANK: 10 Worker was not wearing personal protection items (PPE).

- Irresponsible Attitude
- Non user Friendly
- Self-Esteem

5.2 RECOMMENDATIONS

On the basis of study, some key recommendations and pictorial prevention measures for construction accidents are made in the context of Pakistani construction industry. These are tools which can be applied on the construction projects to minimize & avoid future accidents.

5.2.1 Defective tools

Defective tools can cause serious and painful injuries. If a tool is defective in some way, it should not be used for the purpose of construction, there can be defects like, chisels and wedges with mushroomed heads, chipped or broken drill bits, wrenches with worn out jaws, tools which are not complete, such as files without handles all these defects becomes the cause of accident thus in order to ensure safety following prevention should be taken,

- never use a defective tool,
- double check all tools prior to use; and
- ensure defective tools are repaired

5.2.2 Power tools

Air, gasoline or electric power tools, require skill and complete attention on the part of the user even when they are in good condition. Don't use power tools when they are defective in any way. Watch for problems like:

- broken or inoperative guards,
- cracked tool blade,
- insufficient of improper grounding due to dame on double insulated tools
- on/off switch not in good working order

5.2.2 Welding Work

Work involving welding, cutting and burning can increase the fire and breathing hazard on any job, and the following should be considered prior to the start of work.

- Always ensure that adequate ventilation is supplied since hazardous fumes can be created during welding, cutting or burning
- Check the work area and remove any combustible material and possible flammable vapors before starting work.
- Never weld or cut lines, drums, tanks, etc. that have been in service without making sure that all precautions have been carried out and permits obtained.

5.2.3 Safety and Health Management

- Safety and Health Management should be considered from the design inception, through the Bid process, the Contract Award and the Initial Start.
- Top management should involve them and develop written construction-related safety policies for the worksites and should implement to avoid accidents/incidents.
- Management should encourage the workers to develop awareness and execute safety culture on their respective construction projects.

Figure 5.1 Safety Signs (http://www.google.com.pk/search)

Figure 5.2 Accident in Construction (http://www.google.com.pk/search)

5.2.4 Safety Communications

- Communication is the key to occupational safety and health.
- The accident reporting/recording is imperative to accidents prevention. They should be properly recorded & maintained at construction sites.
- Techniques like constant reminders in the form of message boards, newsletters, posters, face to face encounter can be used.

Figure 5.3 PPE (http://www.google.com.pk/search)

5.2.5 Toolbox Talks

- Safety talks are especially important to the supervisors on the jobsite as they have an opportunity to convey in timely manner, an important information to the workers.
- Although toolbox talks are short, these types of talks should not become just a routine part of the workday.
- In order to be effective, they must cover current concerns or information, be relevant to the job, and have value to the workers.

Figure 5.4 Safety Trainings in Construction
(http://www.google.com.pk/search)

5.2.6 Training

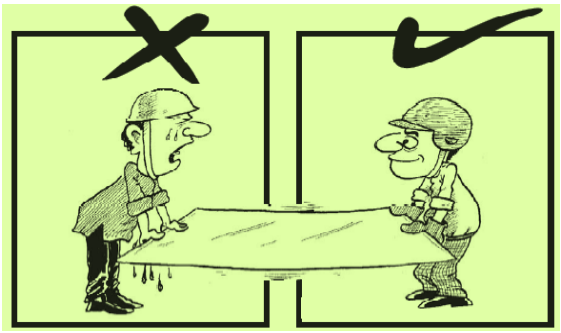
- In Pakistan, due to illiteracy of workers, safety training/guidance should be in local language i.e. Urdu for better understanding & implementing safety practices by the workforce in a more appropriate way.
- If a worker has not been trained to do his job in a productive and safe manner, a real problem/disaster may occur.
- Training should be purposeful or objective driven. An organized approach to on-the-job safety and health will yield the proper ammunition to determine the real training needs.

5.3 PICTORIAL PREVENTION MEASURES FOR CONSTRUCTION ACCIDENTS

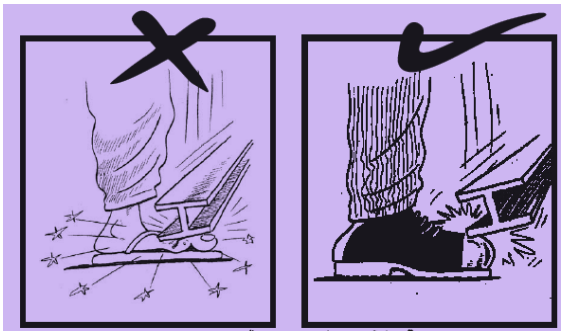
مرکز برائے بہتری حالات کار و ماحول، محکمہ محنت و انسانی وسائل، حکومت پنجاب

مرکز برائے بہتری حالات کار و ماحول، محکمہ محنت و انسانی وسائل، حکومت پنجاب

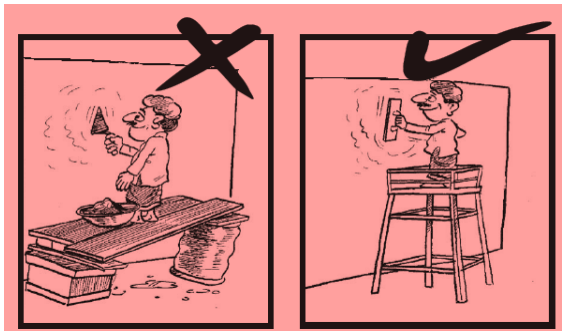
مرکز برائے بہتری حالات کار و ماحول، محکمہ محنت و انسانی وسائل، حکومت پنجاب



تیز دھار اشیاء کو اٹھاتے وقت حفاظتی دستانے استعمال کریں۔

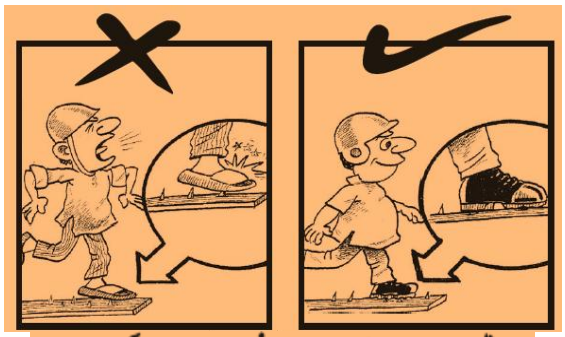


تعمیرات کی جگہوں پر پاؤں کی حفاظت کے لئے حفاظتی جوتے استعمال کریں۔



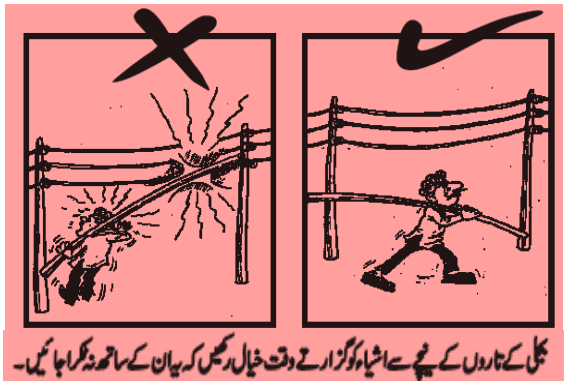
غیر متوازن تختوں پر کھڑے ہو کر کام کرنے کی بجائے متوازن سہارے استعمال کریں۔

تعمیرات کے کام کے دوران حفاظتی ہلمٹ کا استعمال ضروری ہے۔

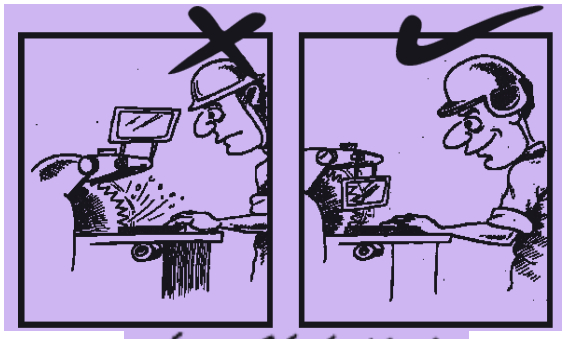


حفاظتی جوتوں کے استعمال سے پاؤں کے زخمی ہونے کا خطرہ بہت کم ہو جاتا ہے۔

وزن اٹھانے کا صحیح طریقہ (کمر کی بجائے ٹانگوں کے پٹھوں کی طاقت استعمال کریں۔)

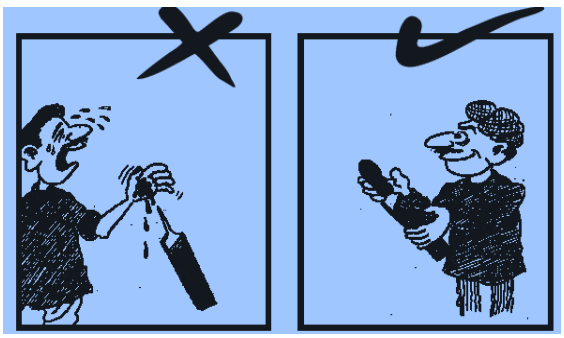


بجلی کے تاروں کے نیچے سے اشیاء کو گزارتے وقت خیال رکھیں کہ یہ ان کے ساتھ نہ ٹکرا جائیں۔



مشینری کے گارڈز کو ان کی جگہ سے نہ ہٹائیں۔

کام کی جگہ پر بکھری ہوئی اشیاء کو اٹھا کر مناسب جگہ سٹور کر دیں تا کہ ان کی وجہ سے حادثات نہ ہوں۔



نوکیلے اوزاروں کو بغیر دستے کے استعمال نہ کریں۔

5.4 ACCIDENT INVESTIGATION

An accident investigation is one of the most important features for analyzing an accident and based on that any prevention measure can be taken. Thus there must be proper accident investigation reporting at site. When an accident investigation is received, the report should contain itemized information about the accident. As a minimum, the accident report should include the,

- Location
- Date
- Time
- Name(s) of injured
- Accident/ incident type
- Description of accident/ incident
- List of Property Damage
- List of Equipment Involved
- Causes of Accidents
- Future Prevention measures

On the basis of the research and with the help of Construction Site experts an accident Investigation form has been proposed keeping in view of the Pakistani construction environment This form is an internal accident investigation document to facilitate, change, and improve the work environment. See Appendix 3 for Accident Investigation Form.

5.5 FUTURE DIRECTIONS

High Rise Building Projects of the capital (Islamabad) being considered in this study. Researchers are encouraged to examine and study the accident factors of high rise building projects in other parts of the country. Studies in the other regions of the country will identify the factors that are contributing to Construction Accidents in High- Rise building projects and will be very much beneficial in improving the level of safety in Pakistan.

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APPENDICES

Appendix 1: Cover Letter

Identifying Factors Contributing To Construction Accidents in High-Rise Building Projects, Islamabad

To:_____

Subject: **Accident Analysis Questionnaire**

Respected Sir,

Department of Construction Engineering and Management at School of Civil and Environmental Engineering (NUST) Islamabad is conducting a Research Survey to identify the factors contributing to Construction Accident in High-Rise Building projects, Islamabad.

A survey analysis will be done, aimed to discover the key issues regarding the construction accidents. To help with this task, we would like you to help us in completing the attached questionnaire. All responses will be treated in strict confidence. The questionnaire is relatively simple and will be filled from the workforce at your Construction Site.

We appreciate your participation in this survey.

Yours Sincerely,

FAHAD ANIS
Post Graduate Student
Construction Engineering & Management

DR. RAFIQ MUHAMMAD CHOUDHRY
Associate Professor and Head,
Department of Construction Engineering and Management
National Institute of Transportation
School of Civil and Environmental Engineering
National University of Sciences and Technology
Sector H 12, Islamabad.

Appendix 2: Accident Analysis Survey

Personal Data:

1. Name: _____
2. Age: ☐ less than 18 ☐ 18-25 ☐ 26-35 ☐ 36-50 ☐ Above 50
3. Marital status: ☐ Married ☐ Single
4. Job Title: ☐ Foreman ☐ S.Labor ☐ Labour ☐ Helper
5. Education: ☐ Illiterate ☐ Primary ☐ Secondary ☐ Diploma
6. Years of Experience: ☐ 1-5 ☐ 06-10 ☐ 11-15 ☐ 16-20 ☐ More than 20
7. Income/day (Rs.) ☐ less than200 ☐ 200-350 ☐ 350-500 ☐ More than 500

Accident and Site Information:

8. Type of Accident
   ☐ Contact with electricity ☐ Crane accident ☐ Gas explosion
   ☐ Structure failure ☐ Fall from height ☐ Struck by material
   ☐ Tool accident ☐ Fall from roof opening ☐ Fall from ladder
   ☐ Falling object from height ☐ Other (Give details)
9. The Injured worker was working
   ☐ First hour of working ☐ During the working day ☐ During Breaks
   ☐ Last hours of working ☐ During Overtime
10. Weather conditions ☐ Hot ☐ Cold ☐ Humid ☐ Rainy
11. Season ☐ Summer ☐ Winter ☐ Fall ☐ Spring

How much the followings factors contribute to construction accidents?

S.No	Description	Highly Agree	Moderate Agree	Neutral	Moderate Disagree	High Disagree
		5	4	3	2	1
1	Appropriate personal safety procedures were not specified					
2	Correct tools were not used for the specific task					
3	Lack of supervision and control on worker's adherence to wear safety items.					
4	Safety regulations were not followed					
5	No safety engineer at site.					
6	Safety items were not available on site					
7	The management is pushing work regardless of laborer's abilities					
8	No or lack of weekly safety meetings					
9	No training program for the worker to implement the job					
10	No written/known procedure for the assigned job is available					
11	Lack of appreciation after completion of the task					
12	The worker was suffering from health problems					
13	Physical fatigue caused the accident.					
14	Worker was rushing the work					
15	The accident occurred due to misjudgment from the worker					
16	The worker had no satisfaction with the nature of the job					
17	Worker was not wearing personal protection items(PPE)					
18	Unsuitable living, housing and transportation facilities for the worker					
19	Job or task was too difficult to perform.					
20	The worker had not enough sleeping hours					

Appendix 3: Accident Investigation Form

General Information

Name _____

Designation _____

Description of Accident

What happened at the time of the accident?

_____
_____
_____

What Was The Cause Of The Accident?

Determine the cause by analyzing all the contributing factors if a person, machine, or other physical condition was involved. Find out HOW and WHY.

A. Describe any *unsafe* acts:

_____
_____
_____

B. Describe any *unsafe* conditions:

_____
_____
_____

C. Describe the *Fundamental Accident Cause*:

_____
_____
_____

What Corrective Actions Will Be Taken?

What have you done or what do you recommend to change or modify to prevent recurrence of a similar accident?

_____
_____
_____

Has it been done? Yes No If Not, Why? Explain _____