FALL PROTECTION PRACTICES ON BUILDING CONSTRUCTION PROJECTS IN PAKISTAN

by

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(2011 – NUST – MS – CE&M – 22)

A thesis submitted in partial fulfillment of
the requirements for the degree of

Master of Science
in
Construction Engineering and Management

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National Institute of Transportation
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National University of Sciences and Technology
Islamabad, Pakistan

(2014)

This is to certify that the

thesis titled

FALL PROTECTION PRACTICES ON BUILDING CONSTRUCTION PROJECTS IN PAKISTAN

submitted by

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has been accepted towards the partial fulfillment

of the requirements for the degree

of

Master of Science in Construction Engineering and Management

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DEDICATED

TO

MY LOVING PARENTS

ACKNOWLEDGEMENT

First and foremost, the successful completion of my research work can only be attributed to Almighty Allah, bestowing upon me countless blessings and giving me strength, for which I am thankful. I would like to pay debt of gratitude and gratefulness to my advisor Dr. Hamza Farooq Gabriel, for making it possible for me to complete my thesis, by dedicating his valuable time for this purpose and my committee members, Dr. Rafiq Muhammad Choudry, Dr. Muhammad Babar Khan and Engineer Zia Ud Din, for their sincere guidance. I would also like to take this opportunity and specially thank Dr. Rafiq Muhammad Choudry, Ex Head of Department, Construction Engineering & Management, who was the source of motivation for pursuing research in safety, and provided guidance at all times whenever the need was felt. Furthermore, I owe my special thanks to the survey respondents, for their dedicated input and valuable contribution in this research, without which it would have been a distant dream. I hope this effort will improve the quality of many peoples' professional life through a better understanding of fall protection. In the end, all my gratitude and appreciation goes to my friends and family for their unwavering support in my difficult times, encouragement to strive against all odds coupled with prayers and patience.

ABSTRACT

The construction industry has witnessed large number of injuries and fatalities, more than any other industrial sector and the construction industry (CI) of Pakistan is also no exception. It is, likewise, the most hazardous industry in the country. Most attributed reason for these accidents has been fall from height. Occupational Safety & Health Administration (OSHA) has specified rules and regulations against fall from ladders, roofs, floor openings, scaffolds and skylights, to reduce accidents and improve the safety performance. The fact is that in spite of this, the accidents still occur, without any significant decrease, speaks in itself that more needs to be done. This study presents the various aspects that need to be taken into account for a proper fall protection mechanism, ranging from the current compliance level in CI of Pakistan to assignment of safety responsibilities, preferred method of fall protection in various activities, accident analysis and perception of professionals regarding issues surrounding fall protection including measures to address it.

The study is undertaken using questionnaire based survey to investigate fall protections in the context of OSHA requirements in the construction industry of Pakistan. For the questionnaire, a detailed study of OSHA regulations and previous research was carried out. Input was sought from contractors, consultants and clients. The main features identified, pertaining to effective enforcement of fall protection, were then incorporated in the questionnaire which will be analyzed to generate credible information. The assessment was made through a set of 20 questions of various nature and length, having it pilot tested first by professionals possessing related knowledge, as the need was felt to get a better understanding of the prevailing scenario. A total of 145 potential respondents were approached, via different means, out of which data was collected from 110 respondents located in different cities of Pakistan, showing a healthy response rate of 75%. The data collected was then analyzed using SPSS-18 and MS Excel.

Results show that fall protection in Pakistani CI is far from satisfactory. Major findings include; absence of a national safety regulatory body, almost no emphasis on safety by clients in contractual agreement resulting in no significant budget allocation, unavailability of fall protection equipment, inadequate training to workers in fall protection methods, casual attitude by supervisors against non-complying workers, resistance of workers towards adoption of fall protection measures and no noteworthy fines/penalties levied on contractors not taking action against unsafe work practices at height on their site. A general unawareness has been found among all quarters regarding appropriate use of fall protection in different work activities and conditions. The core issues requiring emphasis are; (a) architects' training to incorporate safety in their plans, (b) special fall safety training sessions for contractors and sub-contractors, (c) workers′ education in fall hazards they face on site coupled with appropriate protective measures, (d) legal cover to penalize unsafe working on construction sites, and (e) reduce cost of import and promote indigenously built safety products and equipment. The study recommends promulgating a regulatory body on the lines of OSHA which may cater to national needs of occupational safety and health working in collaboration with Pakistan Engineering Council (PEC), providing safety training, evaluating safety performance, ensuring safety compliance and recording occupational injuries and fatalities occurrence.

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LIST OF ABBREVIATIONS

GoP	Government of Pakistan
CI	Construction Industry
BLS	Bureau of Labor Statistics
GDP	Gross Domestic Product
CMSRC	Construction Management & Safety Research Centre
OSHA	Occupational Safety and Health Administration
NEBOSH	National Examination Board in Occupational Safety & Health
NIOSH	National Institute of Occupational Safety & Health
PEC	Pakistan Engineering Council
CAZ	Controlled Access Zones
PPE	Personnel Protective Equipment
EMR	Experience Modification Rating
OHS	Occupational Health & Safety
PFAS	Personal Fall Arrest System
NUST	National University of Sciences & Technology
ILO	International labour organization
SPSS	Statistical Package for Social Sciences
ANOVA	Analysis of Variance
RII	Relative Importance Index

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Chapter 1

INTRODUCTION

1.1 STUDY BACKGROUND

Economy of any nation, developed or developing, comprises of various components with the Construction industry (CI) being a critical one. The activities of this industry have been termed vital to the achievement of laid down national socio-economic goals of providing employment, shelter and infrastructure. Construction sector has the capacity to generate income with a multiplier effect nearly five times the cost of a unit increase in expenditure (World Bank Annual Report, 2008). Many diverse issues, internal and external, have presently plagued the growth of CI. Having relatively lesser control over the external issues, the primary focus is on the internal issues. Among the main internal issues, dismal performance in the field of construction safety is widely accepted to be a cause of concern.

Construction industry (CI) is one of the most hazardous industries all over the world (Hinze, 1997; Kartam, 1997). Construction labor form 7.5% of the world labor force and contributes to 16.4% of total global occupational accidents (Kulkarni 2007). Fatalities in CI are expected to be 60,000 per annum worldwide. Findings of the International Labor Organization reveal that the accident rate in construction is four to five times higher than that of the manufacturing sector on the global scale (CIDC, 2006). Further itemization of the fatalities revealed fall from height to be the prevalent source of the accidents, accounting for almost 35% of construction worker deaths. In the United States, the total number of fatalities in CI in year 2010 were reported to be 774 whereas fatalities from falls amounted to 264, the largest of all other causes (BLS, 2010). Various factors contributed to these fall incidents like oil, cleaning fluid, water, slippery shoes, poor lighting, and objects projecting into the walkway, uneven walking surface and other slippery substances on the walking surface (Andrea, 2004).

Construction companies around the globe are implementing safety, health and environmental management systems to reduce injuries, eliminate illness, and to provide a safe work environment for their employees (Choudhry *et al.*, 2008a). To minimize the injuries resulting from falls, OSHA regulations were promulgated having a significant part of the regulations focused primarily on fall protection. The need for further improvement is still there despite the OSHA regulations owing to the unusually high number of injuries. In Pakistan, *'Government of Pakistan labor policy 2010'* and *'Factories Act 1934 (chapter 3)'* are the main laws governing occupational health and safety. It contains special provisions for all occupations to regulate the working conditions but unfortunately their enforcement due to the negligence of Government regulatory authorities remains below par.

The country's total labor force is projected to amount to 59.21 million, making it the tenth largest country in terms of available human workforce (CIA World Factbook). The CI has a share of only 2.3% in the GDP yet its share in the employed labor force stands disproportionally large at 6.1% (R.A Khan, 2008). Unsafe work-conditions, managerial mistakes, supervisory shortcomings and negligence on the part of workers among other factors leads to accidents happening on work sites as a result of hazards associated with the work. Exposure to hazards are quite high for construction workers, no matter how much specialized they are, compared to workers associated with other occupational activities. The estimates demonstrate the enormous toll that these accidents incur on profitability and productivity of the CI. Informal assessments have identified that safety non-performance has not only led to unsafe project sites but has also resulted in construction delays, cost overruns, poor productivity and poor product and process (Farooqui *et al.,* 2008). Even in the presence of existing safety laws, there is no substantial mechanism in place to ensure implementation and monitoring. Most construction sites are void of any safety practices being carried out. There is no concept or procedure for documentation of hazards and accidents occurring on site. Hence, addressing this issue has become a necessity involving multi-pronged strategy to overcome the dismal state of safety affairs. Enforcement of the Safety policies devised would only be carried out by a strong regulatory body taking all the stakeholders onboard.

In this research, effort has been made to ascertain current safety practices and level of compliance, stakeholder's level of understanding and issues encountered in the implementation of fall prevention system in CI of Pakistan. Based on the statistical analysis of the data obtained, conclusions and recommendations have been drawn for the CI of Pakistan to effectively overcome the hazards causing fall from height accidents.

1.2 RESEARCH SIGNIFICANCE

This research work is an effort in furthering the goals and attaining the objectives of a research project, being held under the auspices of Pak-US Science and Technology Cooperation Program, titled *'Establishment of Construction Management and Safety Research Centre (CMSRC).* This shall act as a center of excellence, pioneering the promotion of construction safety training, education and research in Pakistan. Furthermore, this may serve as a platform for promulgation of an independent national body on the lines of OSHA.

This thesis particularly highlights the fall protection scenario of the CI of Pakistan. Accident from fall has been termed as a leading cause of injuries and fatalities, based upon various studies and data worldwide. Conditions vary regionally. A dire need is there to assess the local trends, behaviors and challenges relating to fall protection. This research is of great importance as it will investigate the fall protection systems, behaviors and attitudes in place at various levels of CI and in different regions.

1.3 RESEARCH OBJECTIVES

The objectives of this research are as follows:-

a. To assess the current status of compliance of the fall protection system.
b. To study various sources of fall accidents in CI of Pakistan.
c. To analyze the causes of non-compliance with fall protection systems.
d. To suggest key measures to improve safety against fall accidents, on the basis of statistical analysis of data obtained from construction projects in Pakistan.

1.4 SCOPE AND LIMITATION

The scope of this study is limited to CI of Pakistan in general, and the small to medium scale construction of buildings, in particular. This includes fresh construction, maintenance and renovation of single-family residences, apartments, townhouses, industrial, commercial and institutional buildings. This limitation has specifically been applied keeping in view the high ratio of fall accidents to total accidents in this category. According to Bureau of Labor Statistic's data (2007), the falls accounted for 50.1% of the total fatalities in this category in which is quite higher compared to 8.8% for Heavy and Civil Engineering construction. The target is to gain the perception of key stakeholders i.e. clients, consultants, contractors/subcontractors and laborers about current practices for fall protection. Due to the limited time and resources, focus is on some construction projects situated in Rawalpindi, Islamabad, Sargodha, Multan and few projects in Lahore and Gujranwala to obtain the data by corresponding with the key personnel by meeting personally or through voice call whereas from other cities mail/email is preferred option.

1.5 ORGANIZATION OF THESIS

The thesis is structured into five chapters which are followed by references and appendices to include supporting material. The sequence is shown in Figure 1.1.

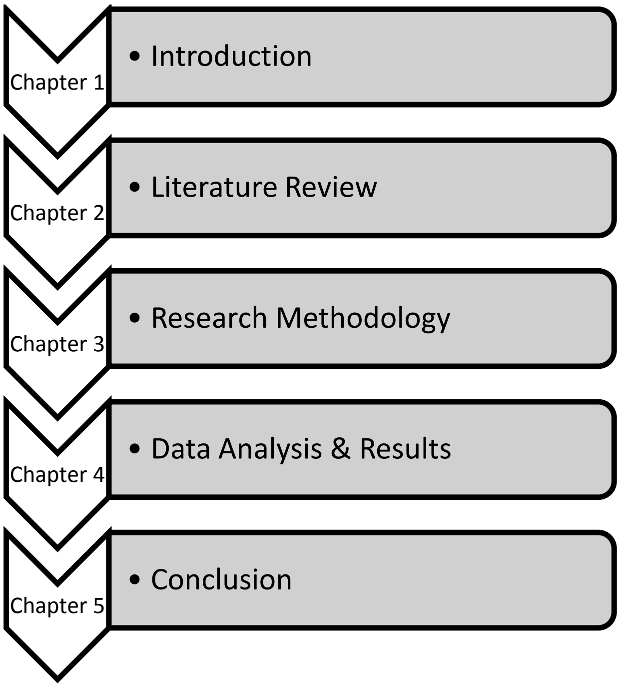


Figure 1.1: Thesis organization

In chapter 1 general background is provided which describes the safety scenario along with the significance of this research, scope and limitations of the thesis. Furthermore, the objectives of this research are also enumerated.

Chapter 2 provides a thorough literature review consisting of CI statistics, OSHA's requirements and regulations for fall protection, conventional fall protection methods, alternative fall protection methods and analysis of construction worker fall accidents.

Chapter 3 covers the adopted research methodology for the studies. It includes the research method for data collection, selection of survey samples, questionnaire development, its designing and finally the collection of data and its analysis. Development of site specific fall protection framework is also included.

Chapter 4 contains the analysis of the data collected through survey and interpretation of the results. For the analysis, different statistical techniques have been used to ensure the veracity of the collected data and effectiveness of the results provided and explained.

Chapter 5 is the culmination of the thesis with conclusions, recommendations, courses of action proposed for implementation and summary for further study.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

According to OSHA studies, among the fatalities occurring in all the industries, construction industry registers the largest share. The construction industry employing the largest labor force has accounted for about 11% of all occupational injuries and 20% deaths resulting from occupational accidents (Arumugam *et al.*, 2007). It is recognized that falls poses a severe problem in the construction industry. Based on the statistics in the US construction industry the most predominant cause of worker fatalities and injuries has been fall from height. From being approximately 20% in 1985 it rose gradually over the years and by year 2006, it had a share of 38% of all the occupational fatalities. A total of 5,657 fatal work injuries occurred in year 2007 (BLS 2009). Of the fatality cases, 847 were associated with falls. In addition, of the 1,078,140 non-fatal occupational injuries and illnesses involving days away from work in 2008, there were 260,610 cases associated with slips and falls (BLS 2010).

Deaths due to falls in construction have risen in the past decade, contrary to national trends of declining mortality from other occupational fatalities [BLS 2007a; Derr 2001]. The number of fatalities is surprisingly high even though the government imposed tougher regulations and OSHA introduced more updated and advanced versions of the fall protection devices. Thus effort needs to be done to comprehend this phenomenon that the advancements didn't have the desired effect in curtailing the increasing fatality rates. Multiple aspects are to be taken into account for explaining this in a much better way.

The course of action may be grouped according to the following:

a. Review of OSHA regulations for their effectiveness in decreasing the rate of falls.
b. Examine role of designers and architects in reducing falls by taking into account worker safety during design process.
c. Assess actions of construction companies and professionals in ensuring control of fall accidents
d. Focus on workers analyzing how their actions and behavior can help in reducing falls and making construction sites safer.

2.2 CONSTRUCTION INDUSTRY STATISTICS

Construction Industry reports the highest incidences of fatalities. In US based on BLS data, the CI employs around 6% of the country's labor force but it accounts for 20% of the fatalities. This ratio is the largest for any industry. From 2003-2007 fall from roofs resulted in 686 fatalities. Later in 2011, falls to lower level caused 553 fatalities. There has been a steady increase from year 1992 to 2003 with fatalities rising from 600 to 809. The following Figure 2.1 shows falls accounted for 34% of the construction fatalities in 2008 and 2009 and 35% of the fatalities since 2005.

FATALITIES	2005	2006	2007	2008	2009
FALLS	394	433	447	332	283
STRUCK BY	130	120	106	108	79
ELECTROCUTIONS	107	126	108	89	89
CAUGHT IN/BETWEEN	111	96	98	92	34

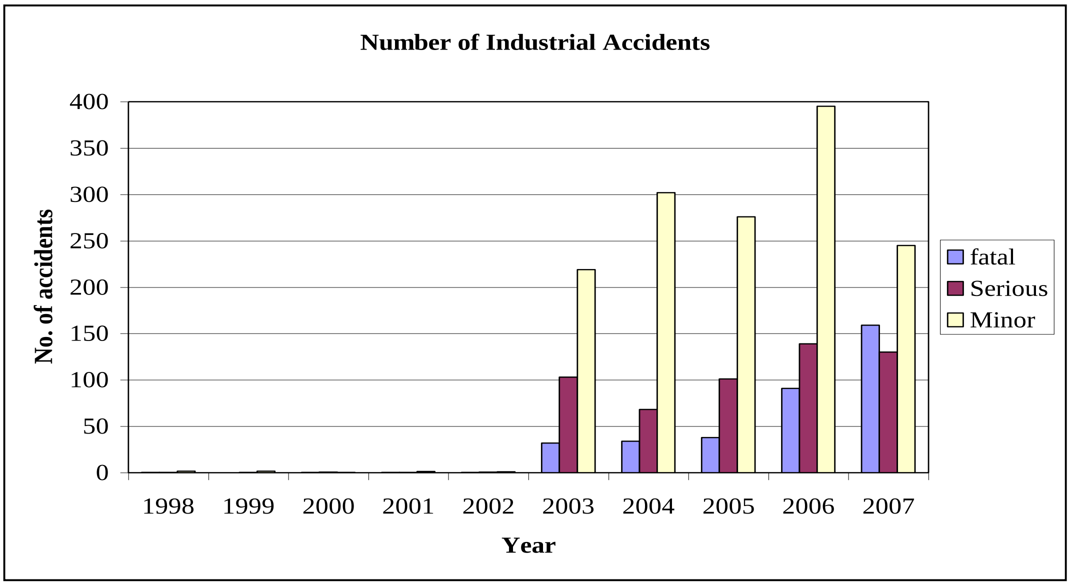
(Source: BLS CFOI Data)

Figure 2.1: Leading cause of construction worker fatalities

In Pakistan, there is no such institution on the lines of Occupational Safety & Health Administration (OSHA), National Institute of Occupational Safety & Health (NIOSH) or National Examination Board in Occupational Safety & Health (NEBOSH) to effectively cater to the challenges of CI and collect reliable statistical data. Even the main regulatory body for the CI i.e. Pakistan Engineering Council (PEC) has yet to lay down safety regulations and laws. Construction is more labor intensive than that of the developed countries, involving 2.5-10 times as many workers per activity (Koehn and Regmi, 1991). This industry has been termed as backward because of its relatively lesser use of modern techniques and tools. In most cases there is no reporting and documenting procedure of accidents even. Thus no reliable data is available which can be of use to gauge the condition of fall hazards and accidents. According to the survey conducted by Farooqui et al. (2007), the major injuries faced by contracting firms in Pakistan on their project sites, in descending order of occurrence, were given as follows:

1. Fall injuries
2. Struck-by injuries
3. Injuries by wastage and raw materials
4. Heat stroke
5. Head injuries
6. Eye injuries
7. Burning cases

The available data for the industrial accidents in Pakistan is shown is Figure 2.2.



(Source: GoP Labor Division Statistics)

Figure 2.2: Number of industrial accidents in Pakistan

If this is to be considered then the rate of increase in fatal accidents is very alarming and warrants prompt, focused and meaningful action to be taken.

2.3 OSHA REQUIREMENTS FOR FALL PROTECTION

Falls causes high number of fatalities. It is evident that efforts are required to reduce fall fatalities. Efforts must include all the stakeholders i.e. contractors, architects, Construction manager, workers and other construction professionals. Identification of fall hazards and planning an appropriate approach for worker's protection is the first step in reducing fall injuries according to OSHA.

To protect workers from falls various ways are adopted. These include the conventional systems such as the safety net system, guardrails system and personal fall protection system (Fall Arrest system, positioning devices and travel restraint system). The use of safe work practices and worker's training is also to be given ample importance. In some area controlled access zones (CAZ), warning signs, designated areas and similar systems are permitted by OSHA depending upon the situation as these provide protection by limiting the number of workers exposed to fall hazards. These alternative systems in some cases are more appropriate than conventional fall systems. During development of comprehensive fall protection plan, proper thinking and planning of fall hazards will help in managing the hazards by focusing attention on the prevention efforts. This can be achieved by adopting a step by step control as follows:

- Elimination and substitution of task leading to fall.
- Implementation of engineering controls and monitoring processes.
- Awareness of workers of fall risks and how to avoid them.
- Usage of appropriate Personal Protective Equipment (PPE).

2.4 FALL PROTECTION REGULATIONS

OSHA's fall protection regulations are specifically devised and formulated for the construction industry. The regulations have been consolidated into 29 CFR §1926.500 to §1926.503 in February 1995. These paragraphs have been collectively termed as Subpart M of the standards for construction safety. Although being widely used, numerous countries have adapted these regulations and tailored it to their own use like AS/NZS 1891 regulations for Australia and New Zealand, ANSI Z359 Fall protection code of American National Standards Institute for USA, CSA Z259.12-11 for Canada and BS EN 795:1997 for United Kingdom notably. A non-profit organization, International Society for Fall Protection, has also been established in 1988 which serves as an international forum for fall protection information exchange.

2.4.1 Organization of Subpart M

Subpart M contains detailed guidelines, rules and regulations for fall protection. It specifically mentions when and where these regulations apply and how shall they be enforced on the site. The requirements of individual activities are also mentioned. Special activities which are left out are covered separately in their respective Subparts.

These include namely Subpart L – Scaffolds, Subpart N - Cranes and Derricks, Subpart R - Steel Erection, Subpart S – Tunneling, Subpart V - Electric Transmission & Distribution Lines and Subpart X - Stairways and Ladders.

The organization of Subpart M is given in Figure 2.3 as follows:

Title	Description
§1926.500	Scope, application and definitions
§1926.501	Duty to have Fall Protection
§1926.502	Fall protection systems criteria and practices
§1926.503	Training requirements
Appendix A	Determining roof widths
Appendix B	Guardrail systems
Appendix C	Personal fall arrest systems
Appendix D	Positioning device systems
Appendix E	Sample fall protection plans

Figure 2.3: Paragraphs of Subpart M

In addition to the chapters of the Subpart M, it is responsibility of employers to train their workers in recognizing hazards and adopting preventive measures. Subpart M states that employers are bound to take action where workers are exposed to a fall greater than 6 feet. For most of construction activities the Subpart requires the use of positive fall protection measures through safety nets, guardrails and personal fall arrest systems. Whereas in some of construction activities, the contractors are given the option for adopting alternative fall protection measures such as warning line, fall protection plan or safety monitoring system for protecting workers.

2.4.2 Status of Subpart M

Development of present Subpart M began in 1977 by OSHA and after continued and strenuous efforts involving open hearings, written comments and input from various institutes, finished its job in 1994. It was published in the Federal Register, volume 59. The focus of the developers was to use performance-oriented criteria to the utmost, contrary to the specification-oriented approach with protection of worker the primary concern.

OSHA requires positive form of fall protection measures to be adopted wherever feasible. In case, the employer proves that usage of positive form is 'infeasible' or can itself pose a 'greater hazard', then OSHA has allowed usage of alternative form of fall protection measures. The alternative form adopted must be in conformance to paragraph (k) of §1926.502. Being infeasible implies that using positive fall protection system may make the performance of work impossible or it may be technologically impossible to deploy the conventional system. Whereas, greater hazard implies that compliance with the conventional system may create hazards of greater magnitude than with non-compliance. OSHA has categorically denied employers the permission to gain competitive advantage by exposing the workforce to fall hazards. It has laid down that infeasibility and greater hazard doesn't exist at all worksites and at all times, and employers who wish to use the alternative protection methods have to prove infeasibility and/or greater hazard in that very particular instance. OSHA states that employers need to reexamine their traditional methods and, when possible, update them by integrating available fall protection technology and latest design concepts.

Following stringent approach towards fall protection, the Subpart M also provides some relaxation in §1926.501(b)(13) keeping in view various other aspects. It realizes that the small-scale contractors cannot be expected to pursue unprofitable measures. OSHA asserted before that 'infeasibility' and 'greater hazard' cannot be approved on economic justification alone, but later, based on various cases, stated that certain economic justifications can be constituted as infeasibility. This compromise was necessary as protecting the worker's life cannot be at the expense of placing the contractor totally out of business. It continues to maintain that positive form of fall protection is more effective than alternative form and considers that the implementation of fall protection plan has to be the last resort when all other options of fall protection have been exhausted.

2.4.3 Issues regarding Subpart M

The implementation of Subpart M requires the concerns of three major stakeholders namely contractor, labor and the enforcer/regulator to be addressed. Each party works on their own specific agenda. So a resolution of Subpart M can only occur if issues of all the parties are addressed and their satisfaction achieved.

The contractor's primary agenda is to earn a profit. They are in this business to make money. Safety has been found to take time and time costs money. Ensuring protection of every worker will lead to addition of several days to the project completion which is a competitive disadvantage. Some believed regulations are not realistic when they came to know about the requirements. They cannot perceive how fall protection can be applied in certain jobs like installation of trusses or finishing edge of roof. Others asserted that regulations are unnecessarily restrictive when involving lower heights and lighter building materials. Hesitation of workers to use safety harnesses and of subcontractors to buy expensive guardrail and safety net system was also cited by the contractors.

Unions are organized worldwide to safeguard workers' right. Yet in most developing nations they are rare or don't exist at all. It poses a grim scenario. This is due to the fact that employment is 'permanently temporary' and the relation between contractor and labor is short lived. Labors recognize the fact that a safer working environment is to their advantage but yet they don't seem adamant to stick to their stance. They are more interested in job security than personal safety. They fear facing the contractor with this demand as it will get them fired. In their words if the issue is between production and protection, production shall always take precedence. Most of labors engaged in construction are poor and illiterate. They know very less about safe practices and their rights and usually work long hours. To earn more they work overtime which aggravates the problem. Some of them were found to be overconfident, showed casual attitude and laughed it off when the threats related with the falls from height were conversed.

The main purpose of enforcement agency is to protect the workers from the occupational hazards. The rules and regulations they formulate are for a safe working environment but in this fast paced world with cutthroat competition, economic consequences are now found necessary to be considered. The Subpart M was designed keeping the economic consequences in mind and it was asserted that no significant adverse economic impact would result due to compliance and it shall be economically feasible. According to OSHA the estimated cost is placed at 0.5% of the project revenues. However, it was noted that partial compliance in the industry will result in competitive disadvantage of many contractors against those who are not complying. Argument might arise of absence of a level playing field. Research in this regard and effective lawmaking was stressed.

In summary, issues in compliance of Subpart M are widely varied in nature. It is required that each of these issues be addressed and satisfaction of involved parties assured to successfully protect workers from fall hazards. The issues include protection feasibility, comfort and speed, economic factor and accident prevention.

2.4.4 Reasons for Safety Non Performance in Pakistan

A study was conducted by Farooqui *et al*., (2007) in which a few major reasons were identified for safety non-performance. No study is conducted to highlight the reasons for non-performance of safety against fall specifically. The reasons presented are mentioned as follows:

- Non-existence of any regulatory agency for occupational safety.
- Lack of professional construction management and safety practices
- unsatisfactory and incentive-less insurance mechanisms (e.g. EMR mechanism) which could have made safety as a business survival issue
- Unfavorable business environment diverting the focus away from key issues like safety.

2.4.5 Safety laws in Pakistan

Framework of occupational health and safety in Pakistan are fragmented and not enforced widely. Mainly laws governing it are found in the '*Factories Act 1934'*. Other documents which contain laws relating to occupational health & safety are The Mines Act 1923, Workmen's Compensation Act 1923, Dock Laborer Act 1934, Social Security Ordinance 1965 and Shop and Establishment Ordinance 1969.

The rules and regulations found in these documents are now considered to be obsolete considering present era standards and requirements. For some emerging fields, including high rise buildings' construction, posing occupational hazards are not covered in these laws. These laws urgently require revision and updating (Awan, 2001; Ali, T.H., 2006). The enforcement of laws is also a huge issue due to dearth of regulatory agencies actively involved. To formulate effective laws, presence of relevant occupational safety data is necessary but with present scenario where companies avoid accident reporting fearing reputation damage no data can be termed as reliable.

PEC has also incorporated health and safety clauses in the contract document. Unfortunately, these laws are not enforced or stressed upon, resulting in higher rate of occupational injuries and fatalities.

2.4.6 Highlights of Subpart M

- Must protect all workers on walking/working surfaces with unprotected sides or edges 6 ft or more above a lower level
- Limits options of fall protection to the following choices:

  (a) guardrail systems
  (b) safety net systems
  (c) personal fall arrest systems
- Holes & skylights: protection required for those with 6 ft or higher fall distance
- Ramps: protection required for those with 6 ft or higher fall distance
- Wall openings: protection required for those with 6 ft or higher fall distance
- Excavations: protection required for those with 6 ft or higher fall distance
- Overhand bricklaying will have a fourth option of using a controlled access zone, unless bricklayers must reach more than 10" below working surface, in which case (a), (b), or (c) must be used
- Low-sloped roofs (slopes less than or equal to 4 in 12) will have fourth option of warning line system used with safety monitor; fall height starts at 6 ft vice 16 ft
- Steep roofs (slopes greater than 4 in 12) will have only options (a), (b), or (c)
- Precast concrete erection has options of (a), (b), or (c); where infeasible, must implement a "fall protection plan"
- Leading edge work has options of (a), (b), or (c); where infeasible, must implement a "fall protection plan"
- Residential construction work has options of (a), (b), or (c); where infeasible, must implement a "fall protection plan"
- "Fall protection plan" must:

  (1) Be written specifically for the site
  (2) Document why (a), (b), and (c) are infeasible
  (3) Have written discussion of other measures that will be taken to reduce or eliminate the hazard
  (4) Identify each location where (a), (b), and/or (c) cannot be used
  (5) Incorporate, at minimum, a safety monitoring system
  (6) Incorporate a controlled access zone
  (7) Incorporate specific fall protection training for each worker exposed to falls
  (8) Require investigation of fall accidents and implementation of changes to prevent further occurrences

Figure 2.4: Subpart M highlights

(Source: GASPRO/BOC Gases)

2.5 CONVENTIONAL FALL PROTECTION METHODS

Conventional fall protection is also known as positive fall protection. It is authorized by Subpart M and includes guardrails, safety nets and personal fall arrest system. These are being used by construction contractors across the globe but not consistently in all the parts. Each of the mentioned systems has its own advantages and disadvantages. These systems can be applied in developing countries with suitable adjustments depending upon the local scenario.

2.5.1 Guardrails

Guardrails are governed by 29 CFR 1926.502(b). The requirement of OSHA is that the top of rail height should be 39 to 45 inches above the working surface. A intermediate structure, consisting of midrails, is to be 21inches above the walking surface and a toe-board be placed at the floor level. The guardrails are instructed to be surfaced and made from smooth material so as to avoid lacerations and bruises (1926.502(b)(6)). For this, usage of ¼ inch diameter wire or rope is advised. Furthermore, the wire ropes should be flagged at intervals less than 6 feet for ensuring high visibility. Intermediate vertical members between posts shall not be more than 19 inches apart. In the absence of a parapet wall at least 21inches high, the intermediate structure like midrails, screen or mesh is required. The guardrail must withstand 200 pounds of vertical force (1926.502(b)(1) & 1926.502(b)(3)). Other structural members like screens, mesh and midrails must be capable of withstanding a force of 150 pounds (1926.502(b)(2)(i) & 1926.502(b)(5)).

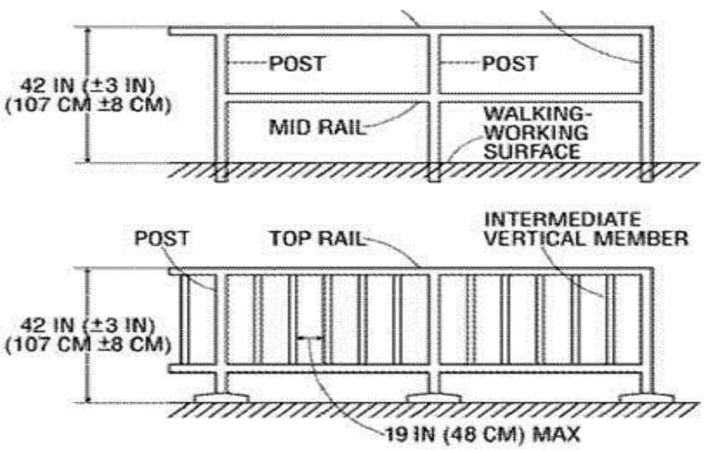


Figure 2.5: Guardrail systems

The guardrails must be installed on all unprotected sides and leading edges in case of being installed around opening or holes. If the holes are being used as a passage for materials supply and other purpose, then not more than 2 sides be installed with removable guardrail sections. When the opening is not in use guardrails shall have to be present on all unprotected sides. Once properly installed, guardrails are sometimes referred to as “passive fall protection.” That means it requires no action by the worker to be safe as long as the system is properly maintained. Whenever there’s a possibility for objects to fall on workers below, installing toe boards is a must. The only disadvantage this system is that it requires relatively more time to get installed which affects the project scheduling in some instances.

2.5.2 Safety Nets

Safety nets is covered in 29 CFR 1926.502(c). Safety nets are required to be positioned as close as practicable under the working surface and in no case more than 30 feet below it (1926.502(c)(1)). The horizontal and vertical characteristics of the netting are shown in Figure 2.5.

Vertical distance from working level to horizontal plane of net	**Minimum required horizontal distance of outer edge of net from the edge of the working surface**
Up to 5 feet	8 feet
5 to 10 feet	10 feet
More than 10 feet	13 feet

Figure 2.6: Horizontal and vertical distances

(Source: 1926.502(c)(2))

The safety nets should be installed ensuring sufficient clearance to prevent contact with surface or structures below (1926.502(c)(3)). They should be drop tested and are expected to withstand a force of 400pounds sand bag being dropped from a height of at least 42 inches (1926.502(c)(4)) and must be examined weekly or after any happening which could affect the net's integrity. The size of each safety net mesh opening should not exceed 36 square inches in area and with any side not longer than 6 inches. Each safety net or section shall have a border rope for webbing possessing a minimum breaking strength of 5,000 pounds. Items that may fall into safety nets such as construction materials, debris, scrap, equipment and tools must be removed at the earliest, surely before the start of next work shift.

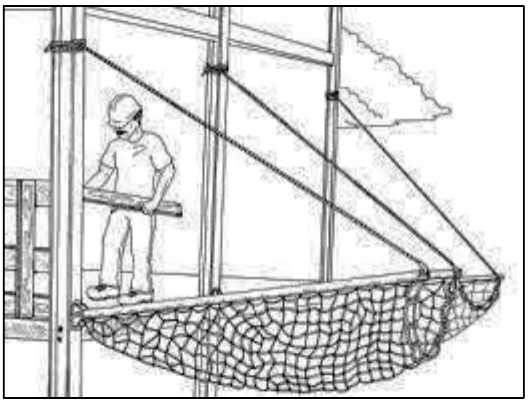


Figure 2.7: Safety net systems

Safety nets are often used in commercial high rise building but not frequently used in residential construction due to small heights and engineering requirements. It is far easier to design fall prevention, like guardrails, than to design fall protection, such as safety nets (Hanson, 1997). These systems also fall under that passive system because when once properly installed and maintained, the workers don't have to do anything with the system to be safe.

2.5.3 Personal Fall Arrest System

The most widely used form of fall protection in construction industry, especially residential construction, is Personal Fall Arrest System (PFAS). It is governed by 29 CFR 1926.502(d). According to the definition OSHA presents, PFAS is a system used to arrest fall of an employee from working level, consisting of an anchorage, connectors, a body belt or body harness, and a lanyard, deceleration device, lifeline, or suitable combination of these. A schematic of the components is shown in Figure 2.6. The requirements that the PFAS should fulfill is as follows:

a. Limit the maximum arresting force to 1800lbs on an employee while using a body harness.
b. Be rigged so that free fall of worker shall not be more than 6 feet or enough to strike any lower working level.
c. Bring worker to complete halt within a maximum deceleration distance of 3.5 feet.
d. Possess strength sufficient to withstand twice the impact energy of a worker free falling a distance of 6 feet or as permitted by the system.

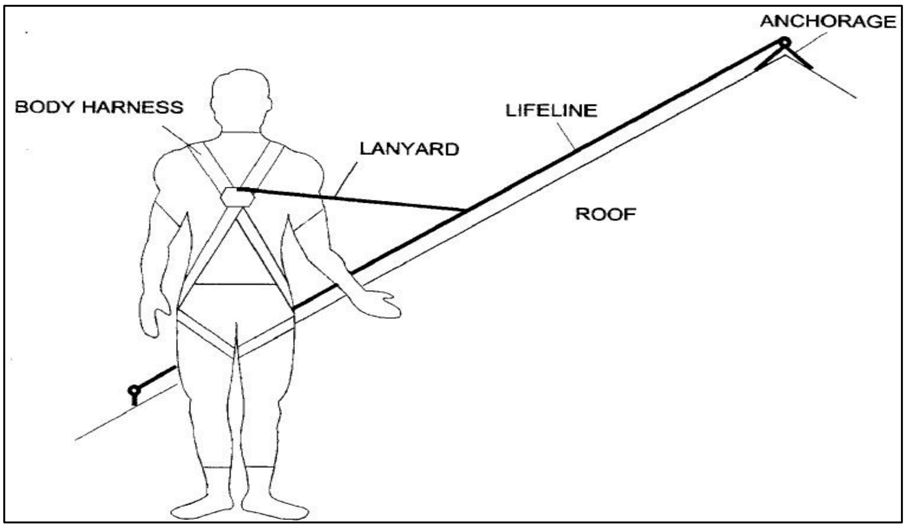


Figure 2.8: Personal fall arrest system

The Dee-rings and snap-hooks must have a minimum tensile strength of 5,000 pounds and the size compatible with member it will be connected to, in a locking configuration. Unless the snap hook is a locking type and designed for the connections, snap hooks shall not be engaged:

a. Directly to webbing, rope or wire rope; (1926.502(d)(6)(i))
b. To each other; (1926.502(d)(6)(ii))
c. To a Dee-ring to which another snap hook or other connector is attached; (1926.502(d)(6)(iii))
d. To a horizontal lifeline; (1926.502(d)(6)(iv)) or,
e. To any object which is incompatibly shaped or dimensioned in relation to the snap hook such that unintentional disengagement could occur by the connected object being able to depress the snap hook keeper and release itself. (1926.502(d)(6)(v))

Lanyards shall have a minimum breaking strength of 5,000 pounds. (1926.502(d)(9)). The self-retracting lifelines and lanyards shall have a minimum tensile strength of 3,000 pounds and able to limit the fall distance to 2 feet or less (1926.502(d)(12)). The anchorage used must be able to sustain a minimum of 5,000 pounds of force per employee and designed with a factor of safety (FOS) of 2 under supervision of a qualified person (1926.502(d)(15). Furthermore, these anchorages must be independent of any other anchorages being used to provide support to platforms.

According to Australian/New Zealand standards another innovation is also presented known as Restraint systems. The worker is tied to a static line attached to an anchorage point at the other end. Its purpose is to limit the horizontal movements of the worker to within safe limits, by totally restraining the worker to reaching a position where a fall is possible. It conforms to AS/NZS 1891 series. This type of system has a limited applicability and on particular conditions, involving steeper slopes and more hazards, the use of PFAS is encouraged.

PFAS are commonly used in both commercial and residential construction activities from sheathing to roofing and finish work. The primary advantage which PFAS provide is its economy. The disadvantage is its restriction of mobility and difficulty in proper implementation.

2.6 ALTERNATIVE FALL PROTECTION METHODS

OSHA permits several forms of alternative fall protection in the construction industry. These include:

a. Safety monitoring systems - A designated worker acts as a monitor watching his co-workers and warns them of hazards.
b. Warning line systems - A flagged line marks the "unsafe area" at a distance of 6 feet from the edge of the roof.
c. Fall protection plans - The employer, after performing a comprehensive analysis of the fall hazards found on the job, outlines the appropriate method of preventing falls for each hazard.

These alternative methods are not positive protection measures due to the fact that there is no device that will be either preventing a fall or protecting the worker from the impact of the fall. Subpart M discusses in more detail each of the above alternatives, including the situations in which the alternative is permitted and the requirements of the alternative.

2.6.1 Safety Monitoring System

It involves the direct observation of the workers by another individual called as the safety monitor. Being a competent person he/she must be capable of identifying hazards in workplace and have been vested authority to take prompt corrective measures. He/she observes all the workers in the area, and subsequently warns them when it appears to him/her that they are unaware of presence of a fall hazard or acting unsafely. Being on the same working surface, the workers should be within sight, and he/she shall be able to communicate orally. Finally, he/she must be free from any other responsibilities that might take his attention away from the monitoring work.

A contractor keen to use an alternative form of protection must at first demonstrate that using a positive form of protection is infeasible or will result in a greater hazard to the workers. However, for low-sloped roofs having slope less than or equal to 1:3, a contractor is not required to demonstrate infeasibility nor greater hazard. According to 29 CFR 1926.501 (b)(10), OSHA allows the usage of alternative forms for low-sloped roofing applications. Roofs being less than 50 feet wide in its smallest dimension, like mostly in residential construction, workers may have a safety monitoring system only.

Advantages of using safety monitoring system include the initial lack of investment required usually for safety equipment. Disadvantage is the loss in productive time by setting aside a worker as the safety monitor which might even outweigh the cost advantage gained of equipment. Additionally, this system is not a positive form of fall protection. Its effectiveness solely depends upon the monitor effectively observing and cautioning a co-worker, and the co-worker responding as a result. This makes it to be the least effective method by OSHA.

2.6.2 Warning line systems

It consists of a flagged rope, wire, or chain, suspended about 34inch to 39inch above the working surface with the help of posts to be placed minimum 6 feet from the edge. No form of fall protection is required for workers within the warning line. In case of work outside the warning line, workers are only allowed outside the warning line if they use either a positive protection method or have a safety monitoring system in place.

Warning line systems are often used in the commercial construction. This system is only allowed for protecting workers only on low-sloped roofs having slope less than or equal to 1:3. The advantage of a warning line system is its low cost. It is a passive system, which provides the worker some degree of protection without his involvement. It is not termed as a positive method of fall protection, especially once the worker is outside the line. Its combination with a PFAS or some other positive fall protection method will result in a system that can be exceedingly effective in preventing accidents from fall from height.

2.6.3 Fall protection plans

Fall protection plan is governed under 29 CFR 1926.502(k) of Subpart M. The fall protection plan is authorized for use in when the contractor has proven infeasibility or greater hazard in the use of positive fall protection, only in residential construction. The Australian/New Zealand code refers to the word “so far as is practicable”, wherein ‘practicability’ generally refers to something that is capable of being done. In tandem, the word ‘reasonable’ is used to highlight the availability, cost and suitability of the employed safeguard. In places where the required safeguard is not ‘reasonably practicable’, code states that compliance must be ensured with the minimum requirement. Only a qualified person is allowed to prepare a fall protection plan. By mentioning qualified person it implies that the individual "must have successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project". The plan should be site-specific and covering all fall hazards that exists on the job site. Employer bears the responsibility to implement the fall protection plan. It should include the following:

a. Situation-specific reasons for not being able to use conventional systems showing that they are infeasible or create a greater hazard.
b. Measures undertaken to minimize or eliminate the fall hazards which cannot be prevented using conventional fall protection systems. The minimum measure shall be a safety monitoring system.
c. Locations will be marked as controlled access zones (CAZ) in which conventional methods cannot be used.
d. Identification and naming of individuals authorized in the CAZ.
e. No unauthorized individual being permitted in the CAZ.

The fall protection plan is not an alternative form of fall protection. It only provides a framework for the use of alternative forms of fall protection. These alternative forms may include a safety monitoring system or warning line system. The least protective alternative method to be allowed is the safety monitoring system under a fall protection plan. Fall protection plans are in use throughout residential construction industry. The main advantage of the fall protection plan is its flexibility. If developed fittingly, through a comprehensive inspection of the construction process by the qualified person, fall protection plan will probably lead to changes in construction methods that could eliminate or minimize fall hazards. However, mostly the plan is not developed in the manner outlined in Subpart M but according to the example plans provided in Appendix E to Subpart M which has been adapted to suit individual needs.

2.7 ANALYSIS OF CONSTRUCTION WORKER FALL ACCIDENTS

Construction fall accidents are identified and analyzed according to two specific aspects. The first considers the cause of the fall accidents and the pattern related to them. Second aspect focuses on the regulations by OSHA and how the modifications might have impacted fall prevention in the CI. Recent findings has revealed a steady rise in percentage of fatalities due to falls from 1992 to 2001 with proportion increasing from 34.1% to 38.4% (Hinze, 2003). The reported factors affecting falls were:

- Time of fall occurrence,
- Types of projects
- Fall heights.
- Location of falls

The analyzed falls, over the years, have led to some results being obtained. Accidents showed peak number of occurrences in the summer months and a decline in winter months. This reflects the trend of increase in construction activities during the summer months and also points to the harsh environment for workers. Focusing down on weekly basis revealed a uniform occurrence of falls over the workweek with a significant decrease over the weekends owing to the slow pace of work. Furthermore, focusing down to a single working day reveals a varied trend of fall occurrences, with relatively more falls occurring during the 1000hrs to 1100hrs time bracket and the least during the lunch time 1200hrs to 1400hrs time bracket. Fall accidents also vary with the type and kind of work. New constructions reported the most fall accidents followed by renovation projects and the least in demolition projects. The results also indicated that the number of falls on a project tend to be inversely proportional to the cost and scale of the projects (Hinze, 1997). Height of fall was also found to be related to the number of falls. Most falls occurred at heights lower than 21.35m (70 feet). The average fall height was about 35.4 feet and fall distance was about 34.9 ft.

2.7.1 Causes of Fall

Various reasons have been assigned to the falls occurring on the construction sites. It included as follows:

- Nature of Work Performed
- Locations of Falls and Human Error factors
- Lack of training

- Lack of safety planning
- Negligence on the part of workers

These factors are not collectively exhaustive. Falls, to a significant extent, depend upon human factors like age, gender and ethnicity. The nature of work determines the amount of risk involved. Works like roofing, truss installation, working on scaffolding etc. have their own respective inherent risks to which workers are exposed. Roofing was the major cause reported (33%) followed by employees not being provided with the necessary protective equipment (13.5%), workers involving in non-typical types of tasks and safety not being planned adequately for that particular activity (11%). Location also impact falls. Works done at the roofs causes most accidents (28%) followed by falls from scaffolds (13%) and falls from ladders (11%) (Huang & Hinze, 2003).

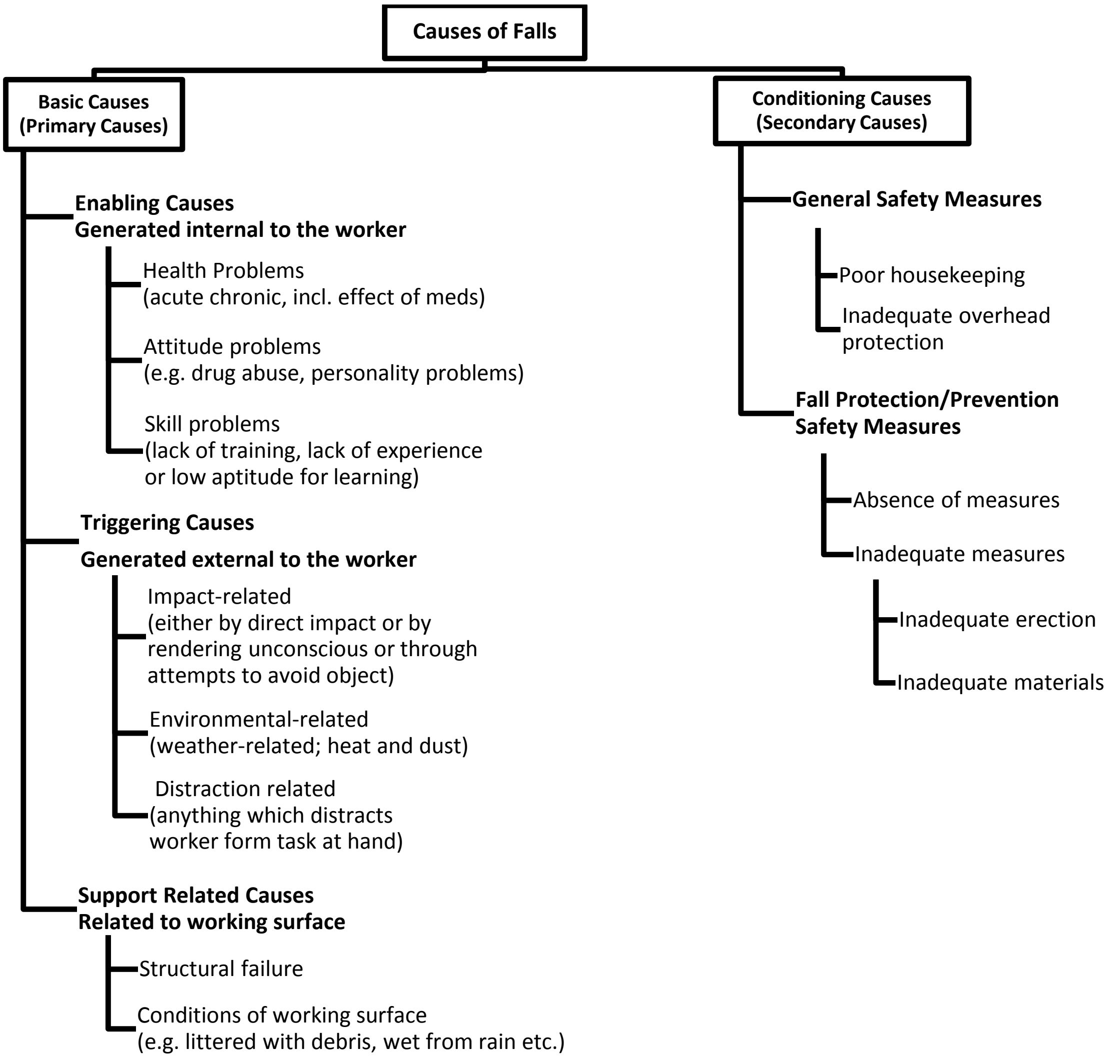


Figure 2.9: Causes of fall

(Source: Vargas, et. al.1996b)

2.7.2 Types of Fall Accidents

The most common sites for the occurrence of fall accidents are as follows:

- Off roof
- Collapse of scaffolding and off scaffolding
- Through the floor opening, sky-lights
- Off ladder
- Through roof opening
- Off edge of floor opening
- Off beam support.

Related percentage of fall fatalities, as reported by BLS, according to the type of fall accidents is represented through a pie chart in Figure 2.10. Fall from roof is reported as the leading type amounting to 23% of all the fall fatalities followed by fall from ladder (16%) and fall from scaffolds (11%).

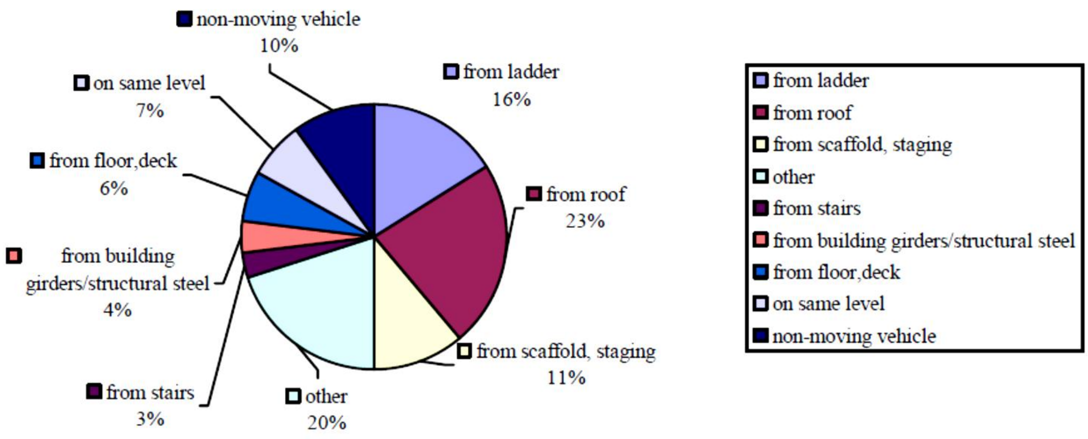


Figure 2.10: Type of fall (NIOSH, 2006)

2.7.3 Time of Fall Occurrence

Research has been carried out to study relationship with occurrence of fall and the timing of the accident on various scales. Occurrence of accidents reaches a peak in summers, with July posting the highest count, while during winters reaches a minimum with February posting the least count. Average proportion of falls during June to August is 9.1% of the total falls in a calendar year whereas during December to January it is 7.6% in the USA as shown in Figure 2.11. This reflects the increased amount of construction activities during the summer months and also the undesirable working conditions.

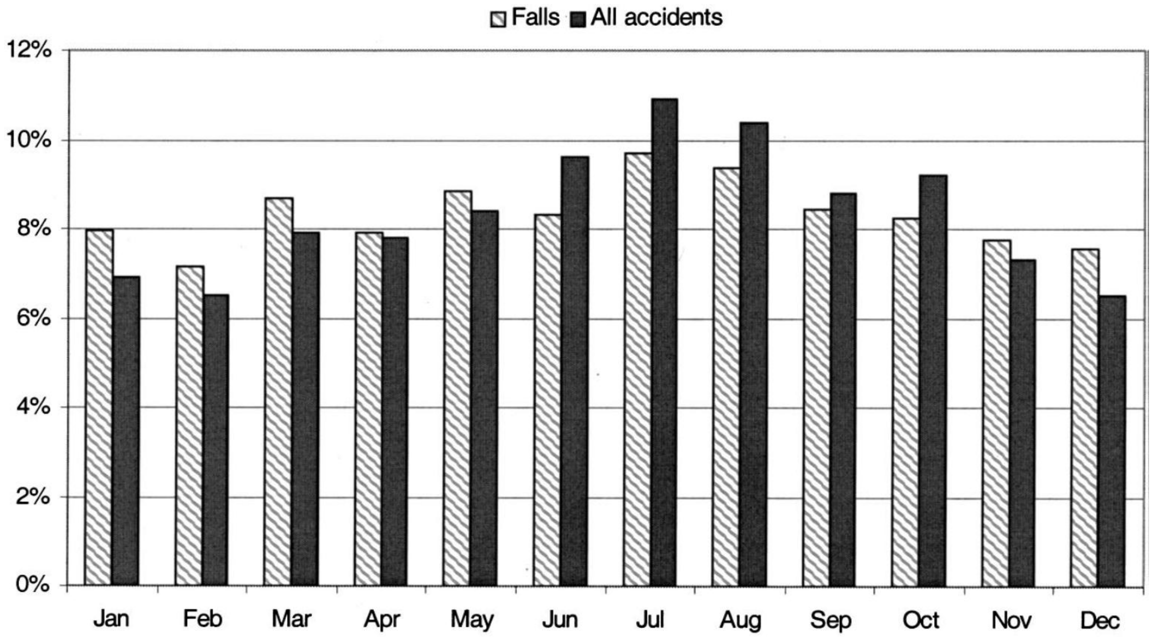


Figure 2.11: Distribution of accidents (Huang, X & Hinze, 2003)

As for the distribution of the accidents by the day of the week, no clear image is obtained with an even distribution of accidents over the week. Only inference is the expected drop over the weekends owing to the little or no construction activity happening. The distribution of falls according to hour of day shows that the least accidents occurs between 1200hrs and 1300hrs and most accidents occurs between 1000hrs to 1100hrs and between 1300hrs and 1400hrs.

2.7.4 Nature of Injuries and Illnesses due to fall

Injury or illness is defined as "the principal physical characteristic of a disabling condition" by Bureau of Labor Statistics. The various types of falls can be fragmented into categories as follows:

- Sprains and strains
- Fractures
- Cuts and punctures
- Bruises
- Heat burns
- Back pain
- All other natures

Strains are the result of overstretched or torn muscles while sprains are the result of ligaments being torn. The significant types of injuries are cuts and punctures (14%) and fractures (11%). In addition to the mentioned injuries, back injuries amounts to 25% of the total injuries, and the other types of injuries included fractures (7%), burns (7%) and eye injuries (5%). If we take into account the age group of the workers involved in the accidents, statistics reveal, as shown in Figure 2.12, most workers are between 31-40 years of age, with accidents declining significantly with increase in age.

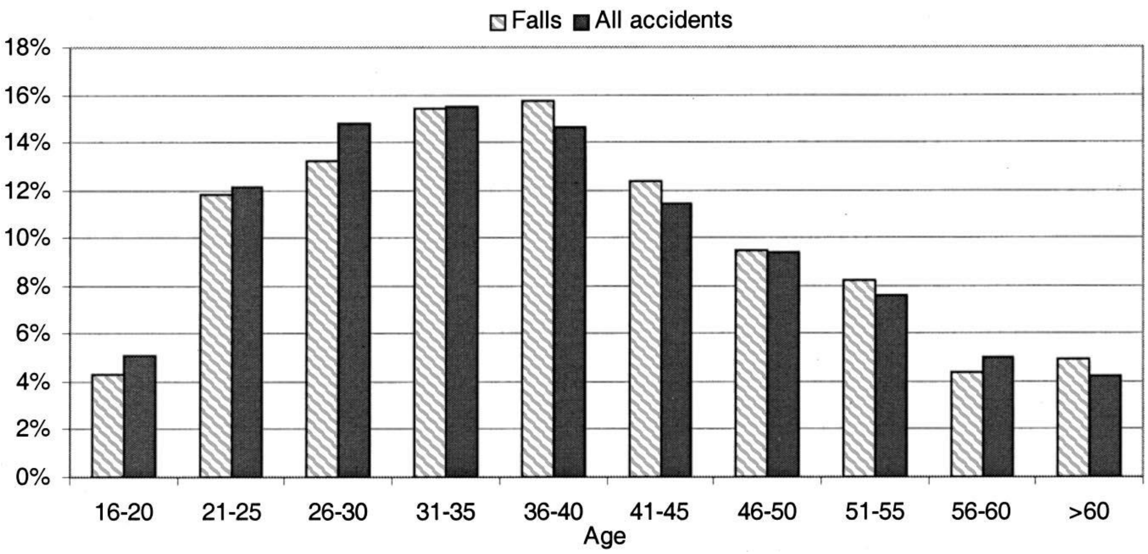


Figure 2.12: Age Distribution of workers (Huang, X & Hinze, 2003)

2.8 DESIGN FOR CONSTRUCTION WORKER SAFETY

Design stage is the ideal time at which fall protection should begin. The designers are duty-bound to have the foresight of providing worker safety while working on the design. Incorporating certain design requirements initiates the plan for providence of safety from the start of the project. Designing for construction safety as an intervention is supported by the hierarchy of controls common to the safety and health professions which identifies designing to eliminate or avoid hazards as the preferable means for reducing risk (Manuele, 1997).

The designers have always kept themselves limited to designing of building or infrastructure conforming to the local building codes, engineering practices and requirements of the owner. The safety of construction workers has always been considered the duty of the contractors. At present studies are being conducted to highlight the role of design professionals in influencing worker safety through modifications in the design and planning stages. This is leading to lesser decisions for the contractors, fewer safety issues to and better safety environment for the workers (Behm, 2005).

In a study conducted in 1991 by the European foundation for the Improvement of Living & Working Conditions it was found that almost 60% of the construction fatalities were as a result of decisions made prior to the project execution. Designers themselves admit that there exists a gap between the on-site construction and the design process. With the passage of time the contractors started giving their inputs to the designer with respect to the design decisions. With the technological advancements three-dimensional visions were found to be extremely beneficial to the designers. Presently, increase in awareness has been witnessed about the necessity for designing for worker safety. Owners also acknowledge the fact that the construction accidents results in a burden to the construction costs. This has led them to become more demanding in ensuring that worker safety provisions are met. This insistence to some extent has proven futile. The designers are still reluctant to focus on worker safety and be a party to the efforts as this might lead to liability issues because of the increased responsibility.

The role of designers is critical and bringing them in the process of worker safety will result in an improved overall safety on the work-site, mitigation of safety hazards and reduction in the number of accidents. Owners have now shown willingness to focus on planning for improved safety provisions on their sites. They require the designers and contractors to work in collaboration developing a comprehensive safety program. This effort has not yet blossomed to the industry-wide scale. For getting maximum results this strategy needs to be taken up by all the parties involved in the construction process.

Designing for Safety (DFS) is a process that incorporates hazard analysis at the beginning of a design (Toole, 2002). It is a step by step process carried out as follows:

a. Identify the hazard
b. Apply engineering measures to eliminate the risk.
c. If not, then apply measures to reduce the risk/hazard by using safety and protective devices.
d. If risk cannot be reduced with the use of safety devices, then reduce risk by warnings, and by providing extra instructions and training to the workers.

Designing for construction safety has many advantages. It can influence design decisions that will eventually eliminate or significantly decrease the requirement for fall protection systems during on site construction. To achieve this, designer should possess the ability to identify potential hazards during the design stage. The skill of the designer is applied to eliminate or significantly reduce the hazard by including the suitable design features.

It is not a new concept to involve designers and engineers in the construction safety efforts. It increases and polishes the skills of the designers who include construction safety while designing. Practice has been to design temporary structures and systems for construction safety. At present, the shift has been towards designing being extended to incorporate the safety features of permanent structures, including maintenance.

Chapter 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Following the literature review, research methodology required for the research work is presented in this chapter. It describes the procedure and the research method adopted, including the details of the data collection. After laying out the objectives of the study a research design was outlined. Questionnaire survey was utilized as the main research instrument. The research questionnaire was unique to the Pakistan construction industry. This research is exploratory in nature and reports the findings of the questionnaire survey of key participants in the CI of Pakistan. The content of the questionnaire is discussed in this chapter. Furthermore, the technique employed for the data analysis is also described.

3.2 RESEARCH DESIGN

Research design discusses appropriately the methods for accomplishing the laid down research objectives at the beginning. This research thesis is designed to study the prevailing fall protection practices in the CI of Pakistan. To proceed in a systematic way four distinct phases are adopted namely preliminary study, collection of data, analysis of data and fall prevention framework. It is also depicted in Figure 3.1.

The first phase of preliminary study involved the following steps:

- Previous research work relating to construction worker falls was studied.
- The current fall protection guidelines and recommendations that have been formulated by various sources were examined for relevance.
- Reliable records of BLS and OSHA were examined to identify a comprehensive list of the common types of falls along with their causes.
- The established requirements for fall prevention as mentioned in Subpart M and other sources were analyzed in detail for each type of fall accident while citing the most common ones.

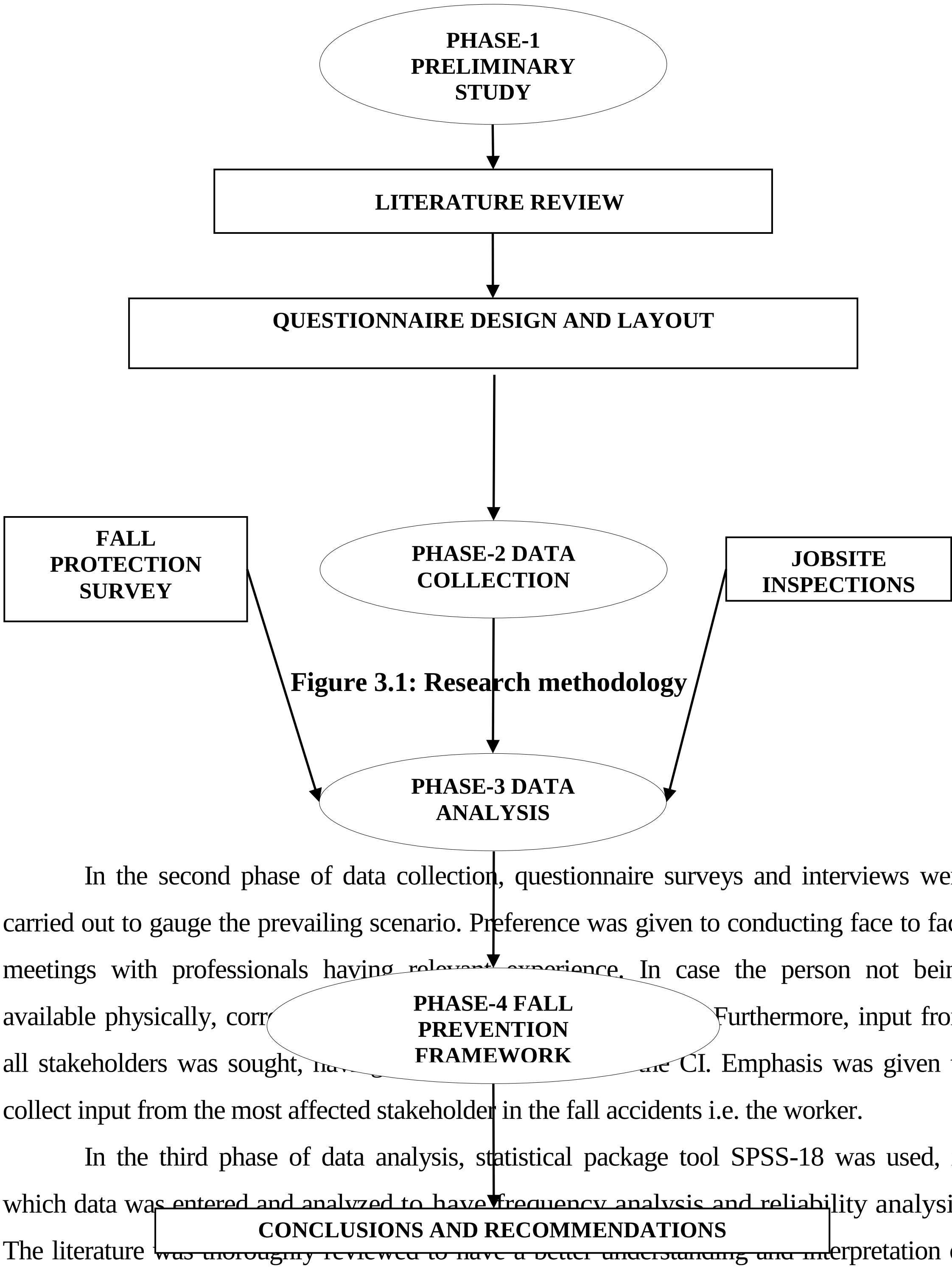


Figure 3.1: Research methodology

In the second phase of data collection, questionnaire surveys and interviews were carried out to gauge the prevailing scenario. Preference was given to conducting face to face meetings with professionals having relevant experience. In case the person not being available physically, corr[illegible] Furthermore, input from all stakeholders was sought, ha[illegible] the CI. Emphasis was given to collect input from the most affected stakeholder in the fall accidents i.e. the worker.

In the third phase of data analysis, statistical package tool SPSS-18 was used, in which data was entered and analyzed to have frequency analysis and reliability analysis. The literature was thoroughly reviewed to have a better understanding and interpretation of the results derived from the statistical software. SPSS-18 was used in combination with MS Excel. The results obtained from the data analysis were made the basis for drawing conclusions and recommendations.

In the fourth and last phase of developing framework, an effort was made to develop a framework, including a policy paper, for implementing effective fall protection measures in the CI of Pakistan. For this purpose, literature was reviewed focusing on studying various types of framework being used in the developed and developing nations. This study combined with the outcome of the data analysis, a framework to be implemented in CI of Pakistan is proposed. This may be adopted by the local construction companies.

3.3 RESEARCH METHOD

The analysis of the questionnaire survey was conducted by Statistical package for Social Sciences (SPSS-18). Available fall protection framework and also reliable statistics on accidents occurring from fall from height were studied. The survey was designed and hard copies along with soft copies were disseminated for feedback. The detailed analysis obtained through SPSS-18 of the data collected is reported in the succeeding chapter.

Interviews were also conducted with the people responsible for ensuring construction worker safety on site. These interviews were coupled with the questionnaire survey, in which the respondent shed light, based on their experiences, on the issues like worker’s safety practices in CI of Pakistan, accident investigation, behavior of worker, site safety plan , worker’s training and role of supervisor and sub-contractor in safety implementation on sites. These comments were recorded separately and reviewed. These shall be highlighted with the data analysis included in the next chapter.

3.3.1 Data Collection

The description of the background of data collection and elaboration of how the research plan was executed is hereby provided in this section. The targeted sample groups comprised of personnel from clients, consultants, and contractors. The data of the research work was obtained from professionals working on construction sites in diverse locations all over Pakistan. Majority of the responses were received from areas like Lahore, Karachi, Islamabad, Rawalpindi, Gujranwala and Multan.

The questionnaire, developed through extensive literature review, was pilot tested to check its applicability in the local environment in Pakistan. People chosen for the pilot test included academic professors, professionals having more than 15 years of experience in execution of building projects and most importantly safety managers belonging to notable construction companies. Opinion of all the individuals was given due weightage and adjusted as far as possible. This led to many prominent changes and brought the questionnaire in tune with local scenario by incorporating the feedbacks. After the pilot testing and necessary amendments, the questionnaire (Appendix I) was disseminated to relevant professionals with methods ranging from face to face meetings to communication via email, to gather feedback. Online version was prepared on Google documents.

The final questionnaire had an introduction to begin with, covering name, qualifications, experience, organization and appointment. At the beginning of the questionnaire subject matter was defined in clear wordings. It included the purpose of the said questionnaire survey, authority by which the survey was held i.e. National University of Sciences and Technology (NUST) and necessary guidelines and assistance for completing the survey. This was followed by 3 main sections comprising of a total number of 20 questions. The sections were namely; organization's safety program, accident and site information and personal opinion on fall protection. In the first section, a set of 6 questions was asked which aimed at determining organizations' maturity towards fall protection by inquiring about their standard operating procedure regarding various aspects of fall safety. In the second section, a set of 4 questions was asked which primarily focused on accidents occurring on site due to fall, including the type of fall occurrence, time of fall occurrence, weather condition at the time of fall and the resulting injury or illness. In the third and last section, which forms the basis of this research, a set of 10 questions was asked. It pertained to the approach, knowledge, exposure and understanding towards fall protection of the respective organizations the professionals are working with. Finally the questions were incorporated with five-point Likert-type scale where applicable, to ease and facilitate the process of statistical analysis.

The sample of this research was selected from a population of civil engineering professionals working on construction sites. The questionnaire was distributed to 145 potential respondents out of which 110 valid responses were returned for final analysis. These included responses from 25 clients, 41 contractors and 44 consultants. Overall response rate comes out to be about 75%. According to Owen and Jones (1994), a 20% response rate is considered satisfactory, whereas, in construction industry, a good response rate is 30% (Black et al. 2000); therefore, the response rate in this research is considered acceptable.

The purpose of statistics is to have summary measure about some characteristics of the population through sampling. For good results sampling should be a true representative of population. According to the PEC data, the number of civil engineer professionals reached to 50,000 in 2010. This was used to obtain the desired sample size by using it as the population size. Confidence level was selected as 95%. Using a fifty-fifty split maximizes the question variance, which requires the largest possible sample to control for the differences among the response options. By applying these values and consulting Table 3.1, for this sample size, Dillman (2000) reported that a sample size of 96 is sufficient with ±10% sampling error and confidence level of 95%. Random sampling is presumed to effective when the population structure shows no significant variation. Hence a sample comprising of 110 respondents is quite reliable for further analysis.

Table 3.1: True Sample Size *(Dillman, 2000)*

Completed sample sizes needed for various population sizes and characteristics at three levels of precision.

	Sample size for the 95% confidence level					
	±10% Sampling Error		±5% Sampling Error		±3% Sampling Error	
Population Size	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	49	38	80	71	92	87
200	65	47	132	111	169	155
400	78	53	196	153	291	253
600	83	56	234	175	384	320
800	86	57	260	188	458	369
1,000	88	58	278	198	517	406
2,000	92	60	322	219	696	509
4,000	94	61	351	232	843	584
6,000	95	61	361	236	906	613
8,000	95	61	367	239	942	629
10,000	95	61	370	240	965	640
20,000	96	61	377	243	1,013	661
40,000	96	61	381	244	1,040	672
100,000	96	61	383	245	1,056	679
1,000,000	96	61	384	246	1,066	683
1,000,000,000	96	61	384	246	1,067	683

3.3.2 Fall Protection Survey

To achieve the research requirements of fall protection survey, comprehensive literature review is conducted and a questionnaire is drafted. During literature review, fall protection mechanism of construction companies in developed nations was studied to examine how it was developed, implemented, monitored and audited. Prior to finalizing the questionnaire, a pilot survey along with the interviews of selected construction experts and academic researchers was carried out which resulted in appropriate modifications in the questionnaire. It ultimately improved the reliability and validity of questionnaire. The data was analyzed using MS excel and SPSS for Windows 18.0 software package through frequency analysis, reliability analysis, normality test and one-way ANOVA or Kruskal-Wallis test for non-parametric data to find out the significant difference between the opinion of owner, consultant and contractors on approach towards and understanding of fall protection.

The duration of the survey was planned to be spanning over a period of eight weeks during which data collection and data collation was done.

3.4 FALL PROTECTION FRAMEWORK DEVELOPMENT

Literature review contained in this study was obtained from international conferences, journals, books, data and previous research from people from developed and developing countries. Mainly the focus remained on the fall protection framework on construction sites developed through previous research studies in developing countries like Malaysia, Indonesia, Philippines, India etc. and successfully implemented on construction sites in these countries. After the extensive literature review and according to the findings of fall protection survey and input from experienced professionals, a framework for implementing fall protection measures on construction sites in Pakistan is proposed in the succeeding chapter.

Chapter 4

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

The need for addressing the safety of construction workers is being felt in all the quarters of CI of Pakistan. Major stakeholders, including clients, consultants and contractors, highlight that there is a tremendous gap in ensuring satisfactory safety performance on construction sites. Yet, they do not give emphasis and priority to safety, whereas all focus is towards reducing cost and time and improving quality. This is the scenario in both sectors, public and private, likewise. The presence of labor laws, as mentioned in Chapter 1, does not amply cover the workers in CI. Its enforcement is next to zero. Worker's right of being provided a safe working environment is being seriously neglected. This has led to severe injuries and fatalities occurring in the CI from fall from height. Major flaw is the worker's lack of knowledge of their rights and ability to detect hazard and act safe. No authority, on the lines of OSHA, is also present which can implement and monitor safety performance on construction projects.

Presently, various construction companies categorized as C-A by PEC, have felt the need for adopting safety culture on their mega projects. Safety is being given importance and is being invested in. Still the importance level is far from satisfactory in most of the cases where some safety mechanism is in place. The practice of appointing an independent safety manager is extremely rare, and in few cases where a safety manager exists, he is assigned with other tasks as well which are not related to safety. According to the contract, contractors are bound to provide safe working environment to their employees. The client makes himself free from this responsibility. Contractors show least concern to this and also the client does not normally insist on safety on site as it will lead to increase in construction cost according to them.

To gather insight and feedback questionnaire survey was carried out as discussed. Data collected was analyzed using MS excel and SPSS-18. The obtained results of the survey have been categorically discussed in the succeeding sections of this chapter.

4.2 CHARACTERISTICS OF RESPONDENTS - FREQUENCIES AND PERCENTAGES

4.2.1 Grouping of the Respondents

There are 110 valid responses out of 145, representing a response rate of 76%. Response by owners is 22.7 %, contractors 37.3% and consultants 40 %. Respective grouping and frequencies of the respondents are shown in Table 4.1 and Figure 4.1:

Table 4.1: Grouping of respondents

Respondents	No of Questionnaires Returned	Percentage	Cumulative Percentage
Owners	25	22.7	22.7
Contractors	41	37.3	60.0
Consultants	44	40.0	100
Total	110	100	-

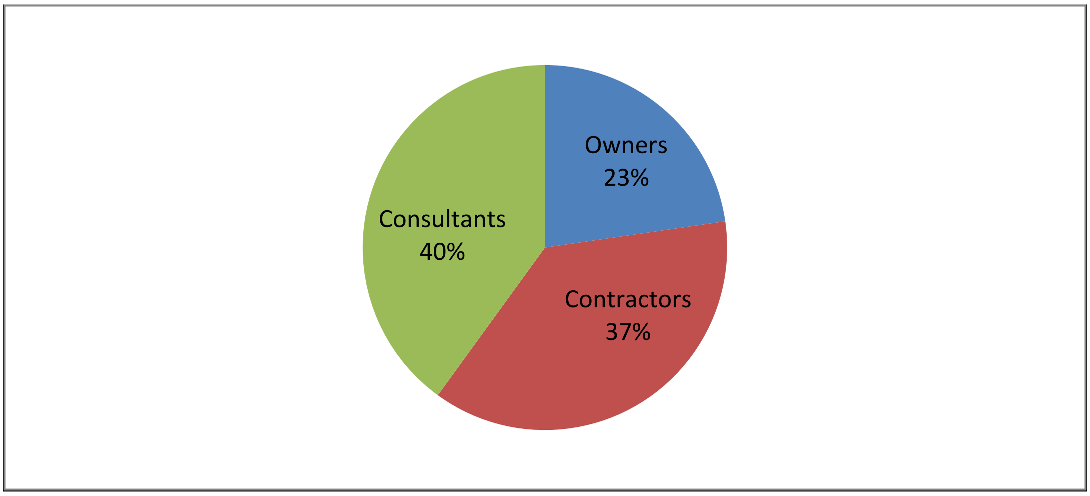


Figure 4.1: Grouping of the respondents

4.2.2 Experience of the Respondents in CI

The respondents possessed varied experience in the CI. It is shown in Table 4.2 and Figure 4.2. Nearly 30.0% (33) of the respondents have accumulated over 10 years of construction experience, 44.6% (49) have construction experience of 6 to 10 years, whereas merely 25.4% (28) have an experience less than 5 years. Therefore, the information provided by these professionals can be considered as authentic and reliable.

Table 4.2: Experience of respondents in construction industry

Experience of Respondents	Frequency of Respondents	Percentage of Respondents	Cumulative Percentage
0-5 years	28	25.4	25.4
6-10 years	49	44.6	70.0
11-15 years	20	18.2	88.2
16-20 years	6	5.5	93.7
20+ years	7	6.3	100.0
Total	110	100.0	-

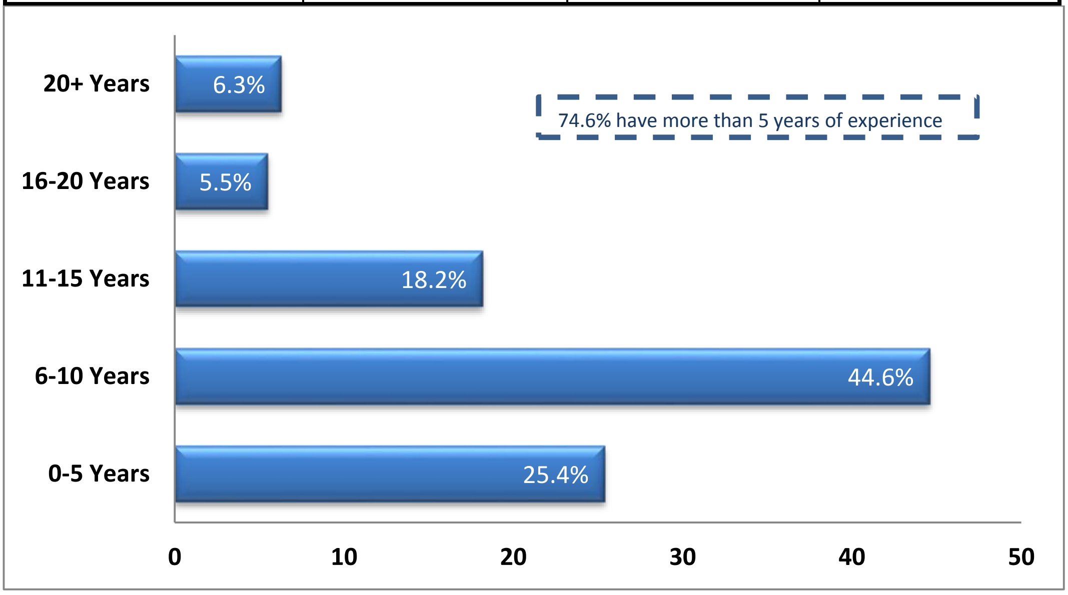


Figure 4.2: Percentage of respondents basing on industry experience

4.2.3 Profession of the Respondent in the CI

Respondents were found to be belonging to different professions in the CI. It is illustrated in Table 4.3 and Figure 4.3 showing the percentages of the various occupations of those who responded to this survey. Nearly 36.7% (37) of the respondents were managers deputed at various levels, 47.3 % (52) are field engineers, 13.5 % (15) are supervisors and 5.5 % (6) are workers.

Table 4.3: Positions of the respondents in construction industry

Positions of the Respondents	Frequency of Respondents	Percentage of Respondents	Cumulative Percentage
Managers	37	33.7	36.7
Field Engineers	52	47.3	81.0
Supervisors	15	13.5	94.5
Workers	6	5.5	100.0
Total	110	100	-

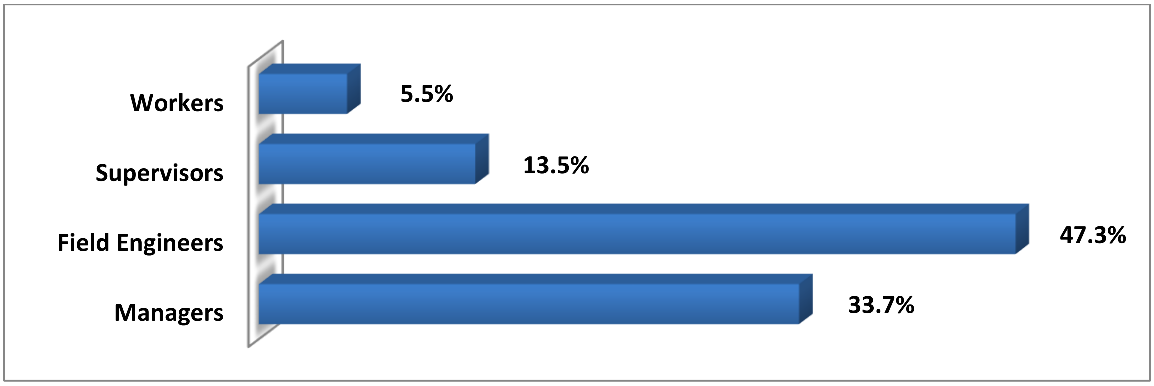


Figure 4.3: Percentage of the respondents basing on their position

4.2.4 PEC Category of the Respondents′ Firms

The responses were received from professionals employed in construction companies involved with various projects. Distribution of the PEC category of respondents' companies is given in Table 4.4. 39.1% (43) of the respondents are employed in companies registered in C-A category with PEC, 8.2% (9) in C-1, 14.5% (16) in C-2, 13.6% (15) in C-3, 10.9% (12) in C-4, 7.3% (8) in C-5 category and 6.4% (7) in C-6 category.

Table 4.4: Frequency of respondents basing on PEC categories

PEC Category	Financial Limit of Each Category	Respondents Frequency	Respondents Percentage	Cumulative Percentage
C-A	No financial limit	43	39.1	39.1
C-1	1800 Million	9	8.2	47.3
C-2	800 Million	16	14.5	61.8
C-3	400 Million	15	13.6	75.4
C-4	150 Million	12	10.9	86.3
C-5	50 Million	8	7.3	93.6
C-6	20 Million	7	6.4	100.0
Total	-	110	100.0	-

4.2.5 Sectors of the Respondents

Respondents were found to be belonging to sectors as shown in Table 4.5.

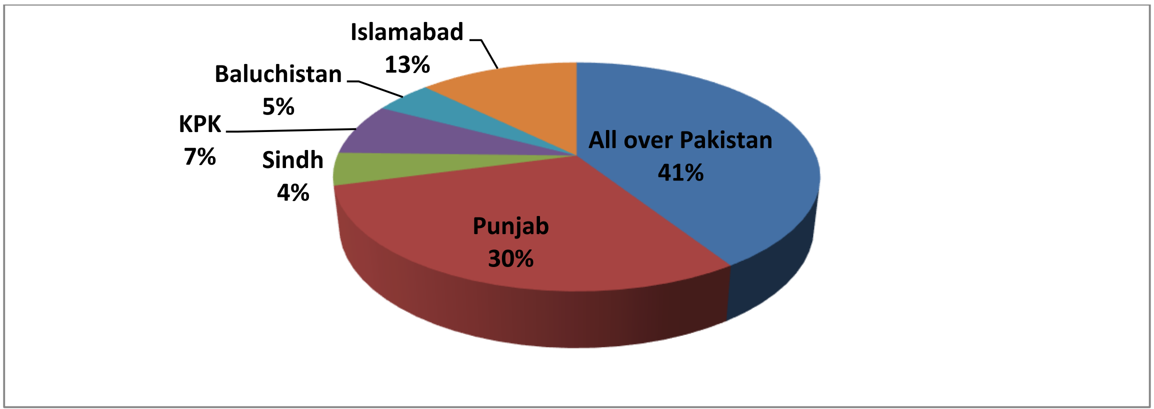
Table 4.5: Frequency of respondents basing on type of sectors

Type of Sectors	Respondents Frequency	Respondents Percentage	Cumulative Percentage
Public	21	19.1	19.1
Private	9	8.2	27.3
Both	80	72.7	100.0

4.2.6 Geographical Location of the Projects undertaken by Respondents

Respondents were found to be working on various projects in different areas of Pakistan. Nearly 40.9% (45) reported their firm undertakes project all over Pakistan, 30% (33) in Punjab, 4.6% (5) in Sindh, 7.3% (8) in KPK, 4.6% (5) in Baluchistan and 12.7% (14) in Islamabad. Projects located in Rawalpindi, Islamabad, Lahore and Gujranwala was visited personally whereas respondents from other areas were contacted through email to register their response. Figure 4.4 shows the geographical location of the projects along with frequencies of the respondents.

Figure 4.4: Current geographical location of projects undertaken by respondents



4.2.7 Respondents' affiliation with construction firms

The construction firms which were mentioned by respondents in this survey are all registered in different categories with PEC. List of the companies/organizations included in the survey is given in Table 4.6.

Table 4.6: Respondents' affiliation

Type of Companies/Organizations	Type of Companies/Organizations
• DESCON	• FWO
• Unicorn Construction	• Izhar Gp of Companies
• Buildfast	• Habib Const Svcs
• Nespak	• Tameer Associates
• SKB	• MeinHardt International
• Paragon Constructors	• Shalimar Construction
• ECSP	• IKAN construction

• Langdon Wilson	• DBH JV
• ATCON-Lahore	• MRC-Lahore
• PAF	• NDC, Nescom
• ICC Pvt Ltd	• LBG
• PLDC	• WAPDA
• Jers Engineering	• C&W Punjab

4.3 STATISTICAL ANALYSIS

4.3.1 Reliability of the Sample

4.3.1.1 Cronbach's Coefficient Alpha Method

The most common measure of internal consistency (reliability) is the Cronbach's Coefficient Alpha method. It is commonly used to check reliability of scale when respondents are asked to mark on likert scale. If Cronbach's Coefficient Alpha value is higher than 0.7, this means that the data is acceptable for analysis whereas if its value is higher than 0.9, this means that the data is excellent for further analysis (Li, 2007). A value of 0.969 is obtained for the collected data using SPSS, as shown in Table 4.7. The higher value represents that the collected data is consistent and reliable for further analysis.

Table 4.7: Reliability statistics

Case Processing Summary				Cronbach's Alpha	0.969
		N	%		
Cases	Valid	110	100.0		
	Excluded	0	0		
	Total	110	100.0	Number of Items	48

4.3.2 Normality Test

Another significant evaluation of the data is to test for the normality of data to analyze whether the data is parametric or non-parametric i.e. the data is normally distributed or not. Shapiro-Wilk test is usually conducted when the available elements are less than 2000. If the significance value is greater than 0.05 it shows that it is non-significant. For sample size greater than 2000 the test used is Kolmogorov-Smirnov. For this study Shapiro-Wilk test is used. Through analysis by normality test, the significance level came out to be somewhat near 0. This showed that the data is not normally distributed and thus for further analysis non-parametric analysis test should be used.

4.4 EXPOSURE TO FALL HAZARDS

On questions regarding fall protection, the first question asked was how long the site personnel are exposed to fall hazards typically in a working day. This was to judge the intensity of activities on construction sites which poses fall hazards. The result obtained is shown in Figure 4.5. A significant amount (40.91%) clearly specified the duration to be between 15min to an hour. The duration is enough to envisage an effective fall protection policy and have it implemented. Further need of it can be concluded from the next highest percentage of respondents (20.91%) specifying the duration to be greater than 4 hours, more than half of a typical working day of 8 hours. It was followed by respondents specifying duration of 2hrs to 4hrs (18.18%), less than 15min (11.82%) and between 1hr-2hrs (8.18%).

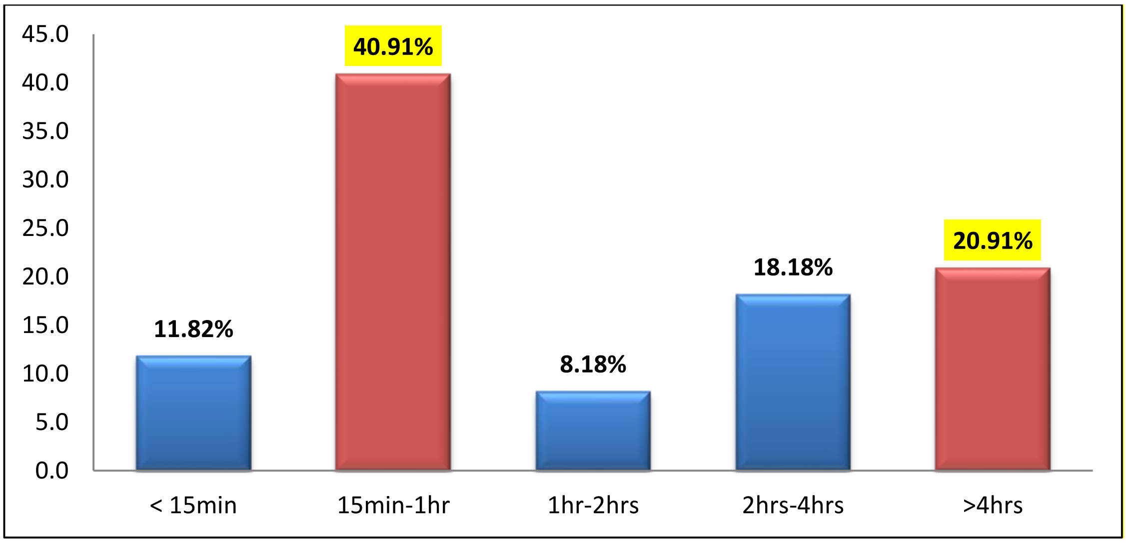


Figure 4.5: Duration of exposure to fall hazards in a working day

4.5 ORGANIZATION’S SAFETY PROGRAM

The CI of Pakistan is a mix of entities, including clients, consultants and contractors, working in different capacities. The governing body over all the contractors is the Pakistan Engineering Council (PEC). It regulates the construction activities and sets the rules and regulations. PEC has a policy of categorizing different contractors based on the financial limit of projects they can undertake. Category C-A, C-B and C-1 usually belongs to large contracting firms, category C-2, C-3 to medium scale firms and category C-4, C-5 and C-6 to small firms. Several factors are there to determine in which category the company falls. The higher the PEC category the more is the company's maturity. Large companies usually tend to have a better safety plan in practice whereas in smaller companies it is often absent. The maturity of the plan lies in the effectiveness of the approach adopted and adherence to international norms and standards.

4.5.1 Enforcement of written Safety Program

Respondents are asked about the enforcement of a written safety program on site they are involved in. The results obtained are grouped into large, medium and small type of company based on the respondent's company PEC category as discussed in Section 4.5. Large firms posted a comparatively healthy response with 46.2% respondents saying company enforces a written safety program, only 9.6% saying no written program is enforced, 15.4% expressing lack of knowledge and the rest showing varied level of enforcement. Medium scale companies depicts an average response, with 29% of respondents saying a written safety program is enforced, but strikingly 25.8% saying no written safety program is enforced. The small companies posts an utterly dismal performance with a meager 11.1% saying a written safety program is enforced, almost 40.7% saying no written safety program is enforced at all whereas only 22.2% saying that sometimes it is enforced. Figure 4.6 draws comparison of the level of enforcement in the three categories of company i.e. large firms, medium firms and small firms.

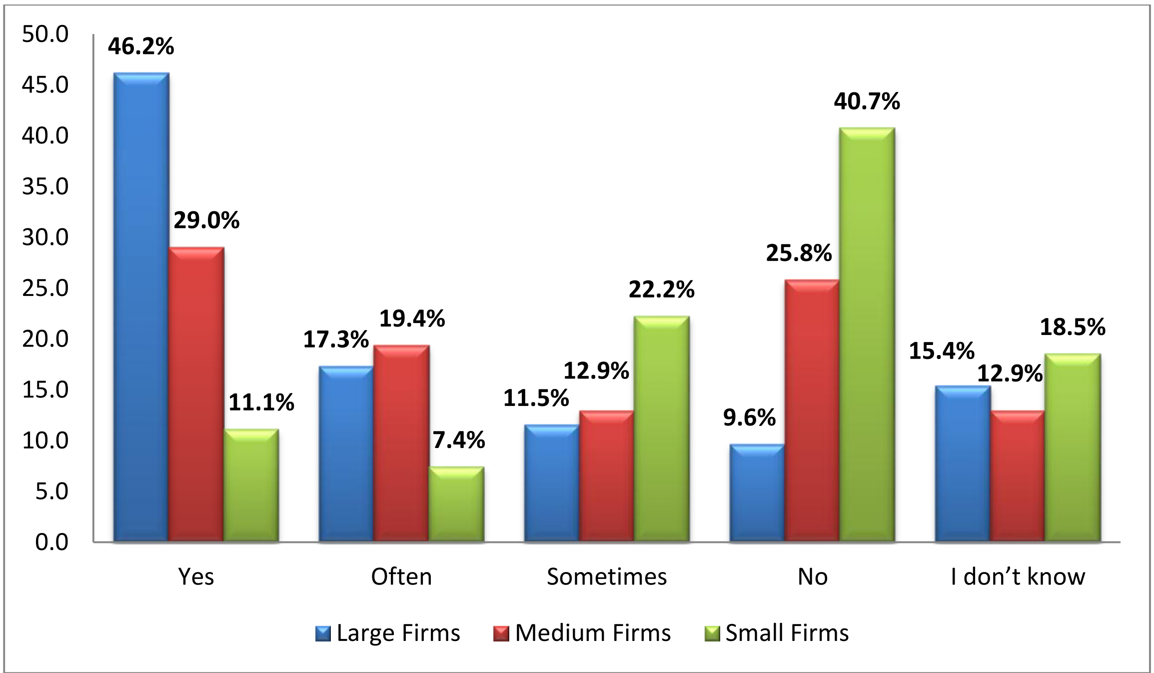


Figure 4.6: Enforcement of written safety program

4.5.2 Enforcement of written Fall Protection program

The respondents are asked next about the enforcement of a written program specifically for fall protection under the umbrella of safety program on the sites they are involved in. The results obtained are grouped into large, medium and small type of companies. All types of firms represent a sorrow picture in this regard.

Large firms represent a slightly better picture with 28.8% of respondents saying a written fall protection program is enforced but on the other hand majority of respondents (48.1%) from large firms says no program is enforced. In medium firms only 12.9% of respondents are saying a written fall protection program is enforced whereas a staggering 64.5% of respondents saying no such program is enforced. While in the small companies there is a totally hopeless picture with mere 7.4% of respondents saying a written fall protection program is enforced while a clear majority of respondents amounting to 88.9% replying in negative.

The results shows that the level of enforcement of written fall protection program in the CI of Pakistan is below par and totally unacceptable based on any international standards. Figure 4.7 draws comparison of the level of enforcement in the three categories of company i.e. large firms, medium firms and small firms.

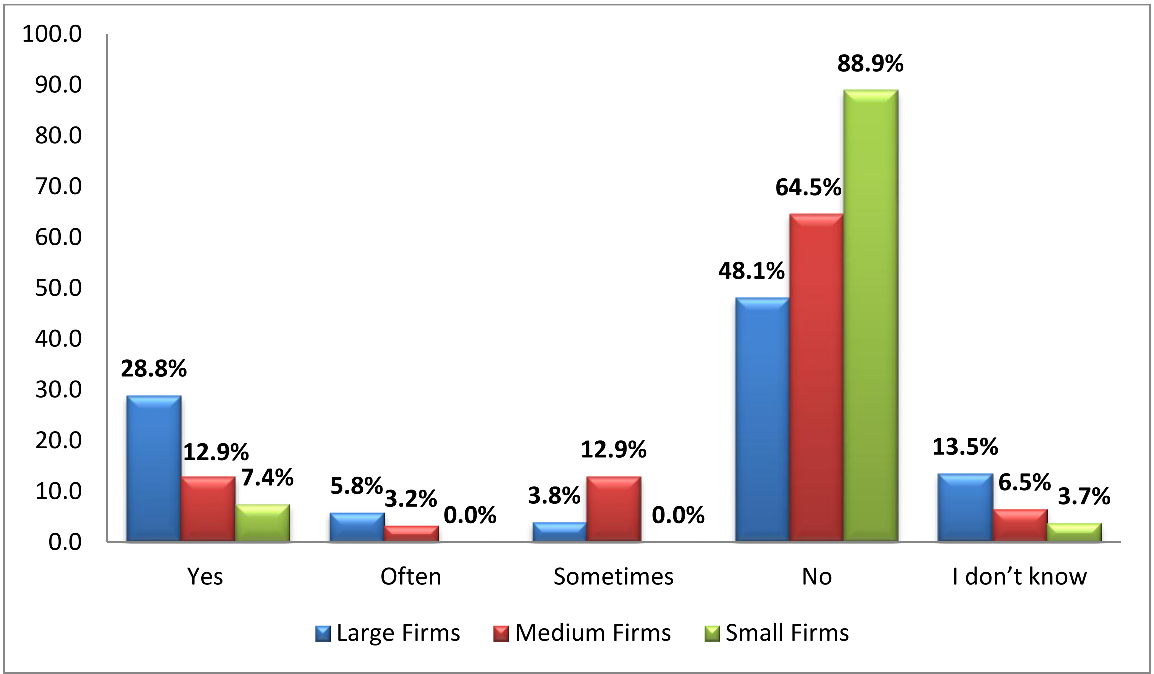


Figure 4.7: Enforcement of written fall protection program

4.5.3 Assignment of Safety responsibilities

Respondents are asked about the designation of the personnel on whom the responsibilities for ensuring safety on work sites rests. Under ideal practices the responsibility should be of the project director to ensure safety and deploy safety staff on work site to assist. The responses are shown in Figure 4.8. 41.8% respondents agree that the Project Manager is responsible for ensuring safety of the employees whereas only 10% of the respondents report that Project Director is responsible. Furthermore, 19.1% respondents report that Project Engineer is responsible, 13.6% says safety manager and 13.6% of respondents express lack of knowledge regarding the assignment of safety responsibilities in their organization. This situation shows the lack of interest of higher management towards ensuring safety on their sites. Change can only be observed if the people at the helm of the affairs are made accountable and, for that to happen, a regulatory body needs to be formed for the CI of Pakistan. This body can then review the practices and introduce frameworks to be followed by organizations for a better safety culture.

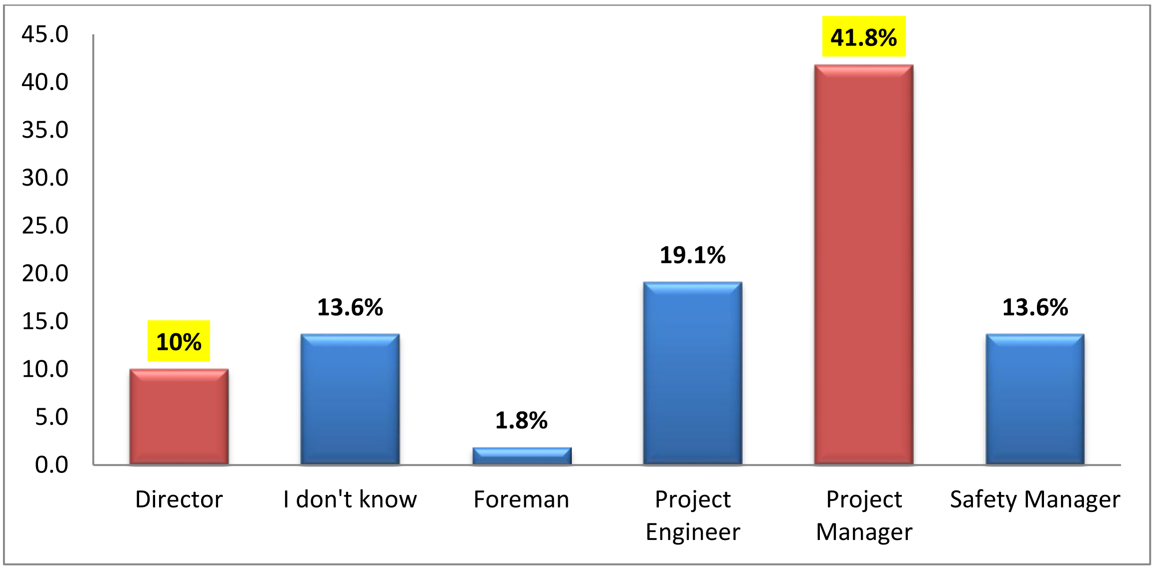


Figure 4.8: Assignment of safety responsibility

4.5.4 Practiced methods of Fall Protection

The respondents are asked which fall protection system they employ or had seen employed by their organization on their work sites. Figure 4.9 shows that the most frequently employed system is the guardrails, with 45.5% of respondents mentioning having it employed on their construction sites. The second most commonly used system is the warning line system with nearly 29.1% having it employed. The remaining fall protection systems including Personal Fall Arrest system (PFAS), safety nets, Controlled Access Zones (CAZ), fall protection plan and safety monitor system. Safety nets usage is the least and rarely used. The companies in Pakistan employ a wide variety of fall protection systems but their usage is not widespread and totally unacceptable based on health and safety standards. This need to be addressed effectively and the usage of fall protection systems must be increased to ensure a safe working environment.

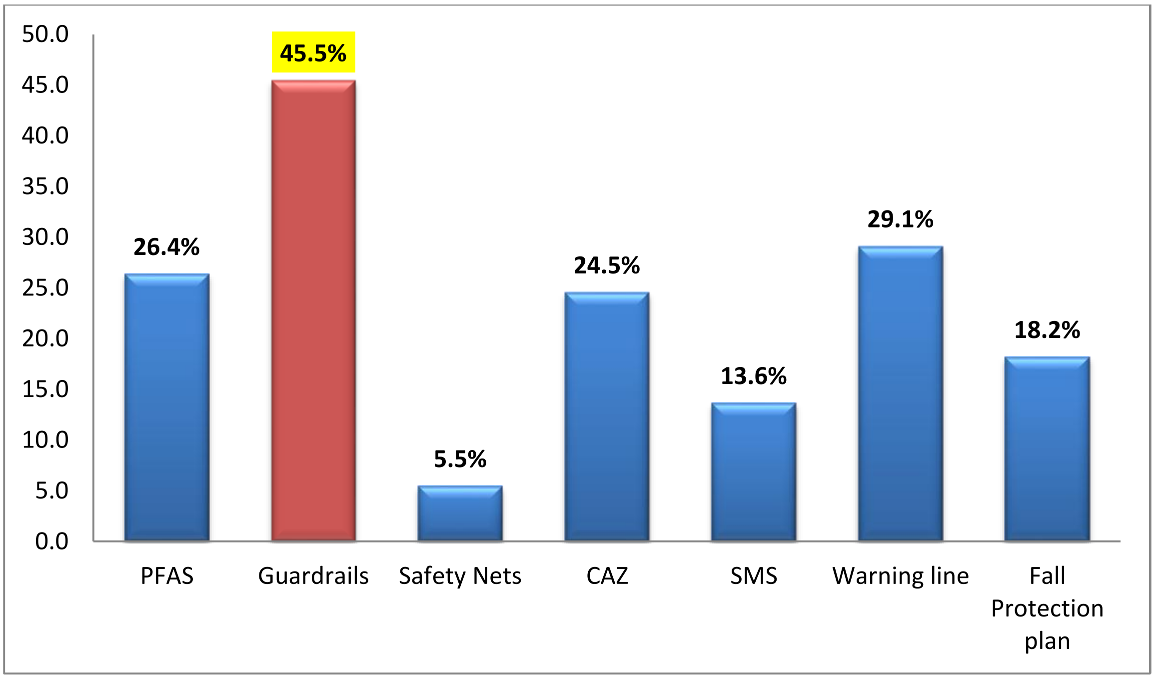


Figure 4.9: Fall protection systems

4.5.5 Training approach employed

Respondents are asked about the effort their respective organizations undertake to train their workers against fall hazards and accustom them with proper usage of fall protection methods. The responses are shown in Figure 4.10. The majority of the candidates, amounting to 49.1%, clearly mentioned that no training of any kind relating to fall protection is provided. The organizations involved mostly belong to small and medium scale setup. The most favored types of training, almost equally in practice, is toolbox meetings conducted by supervisor (20.9%) and on-site training by competent person (21.8%). Other methods like videos (5.5%) and off-site training (2.7%) are very less practiced. Main reason for it is lack of facilities and infrastructure to conduct such methods.

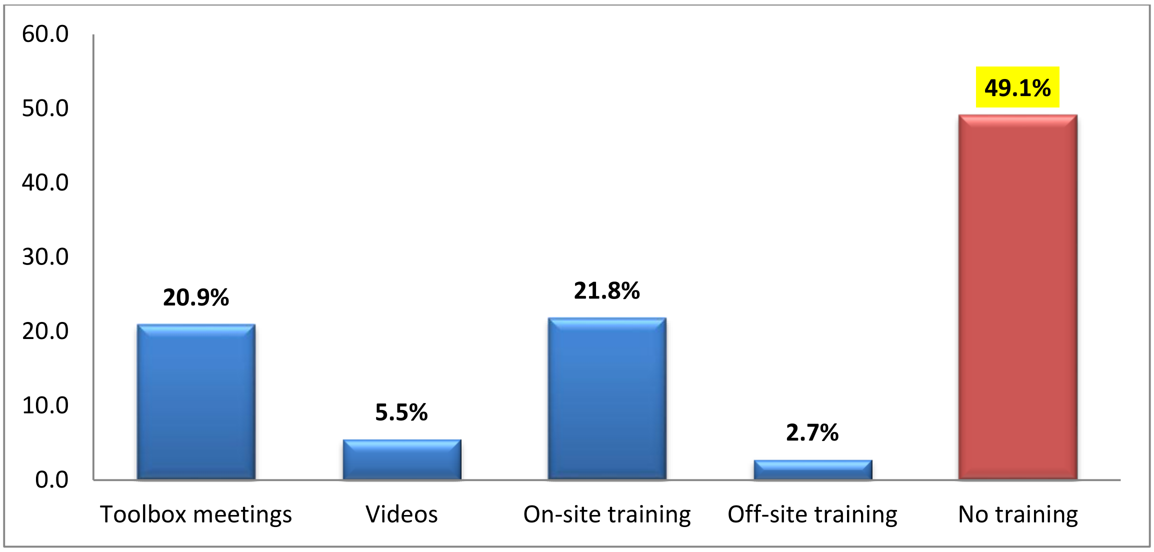


Figure 4.10: Fall protection training

4.6 ACCIDENT AND SITE INFORMATION

Accidents are a collateral consequence of behavior or lack of it, and the environment (Atlas, 2007). Accidents are known to have quite a serious implication on construction activities, both in financial and in humanitarian terms. The problems includes disruption of work activities, delay in progress of project, increase in overall cost, decrease in productivity and damage to repute of construction industry. To better safeguard the workers and to formulate prevention methods against fall, effort has to be made to understand types of fall accidents occurring, their respective frequency of occurrence, the probable time of occurrence, weather condition at time of accident and type of resulting injury from the fall accident. Since no documented and authentic data relating to fall accidents is available, the approach employed is to ask the respondents and judge the prevailing scenario based on their knowledge and experiences.

4.6.1 Cause of Fall Accident

The respondents are asked to assess the different causes of fall accidents enlisted and mention the most likely percentage of the said cause among all types of accidents occurring on the construction sites. A total of 7 causes were provided. Means, percentages, Relative Importance Indexes (RIIs) and ranking of 7 causes is calculated and provided in Table 4.8. Out of the 7 causes of fall accidents, the cause *'off roof'* has the highest value of RII (0.6924) whereas *'off edge of floor opening'* has the lowest value of RII (0.3258). It implies that the major cause of fall accidents in the CI of Pakistan is workers falling off roof followed by falls off ladder and through roof opening, whereas the least cause is off edge of floor opening.

Table 4.8: Mean, percentage, RIIs and ranking of causes of fall

S.No	Cause of Fall (7)	Mean of Causes	Percentage of Fall relative to mean	RII of Cause of Fall	Overall ranking
1	Off roof	4.15	21.5%	0.6924	**1**
2	Collapse of scaffolding and off scaffolding	2.33	6.7%	0.3879	6
3	Off beam support	2.05	5.25%	0.3409	4
4	Through floor openings, skylights	2.04	5.24%	0.3394	5
5	Off ladder	3.31	13.1%	0.5515	**2**
6	Through roof opening	2.84	9.2%	0.4727	**3**
7	Off edge of floor opening	1.95	4.75%	0.3258	7

Figure 4.11 shows the ranking of all the 7 causes of fall accidents basing on the RIIs. The critical causes are highlighted in red color whereas the moderate causes and the normal causes are highlighted in green and yellow color respectively.

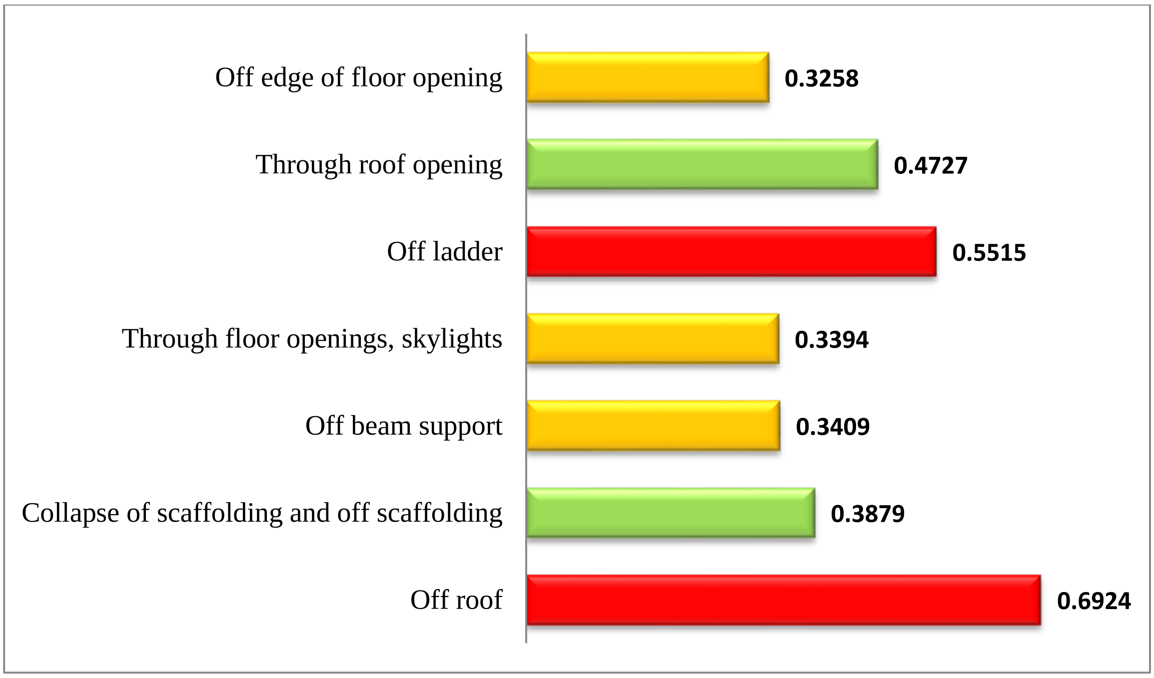


Figure 4.11: Ranking of causes of fall accidents (basing on RIIs)

4.6.2 Time of fall occurrence

Respondents are asked about the most probable time of a fall occurrence in a typical working day based upon their actual experience or knowledge in this regard. The results are shown in Figure 4.12. Most fall relating accidents, as indicated by the respondents, occurs during the overtime (33.6%). This shows lack of concentration of construction workers involved in activities at height during the overtime period, with tiredness taking its toll and they being not as much active to fully conduct themselves against fall hazards. Accidents during the working day (26.4%) comes next, probably because most construction activities happen in this time frame, whereas accidents during last hour of working (20.9%) also points towards the tiredness of the construction worker. The results showed that overtime of the workers involved in activities at height and exposed to significant fall hazards must be discouraged to control the accident rate. The fitness of the worker must also be monitored to verify whether he is capable or not of performing efficiently for a full working duration in a day.

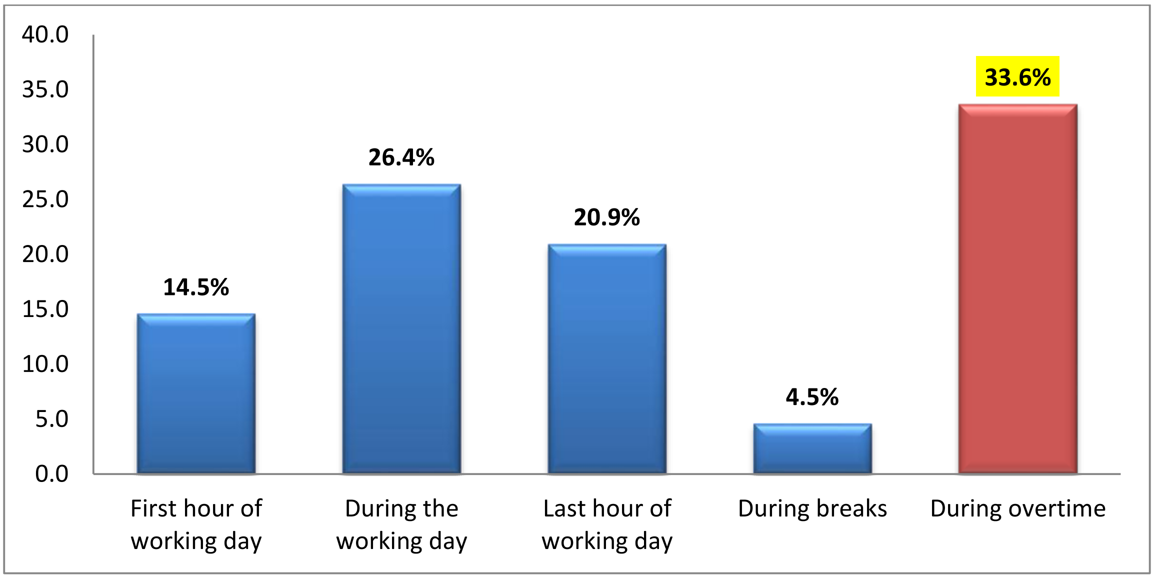


Figure 4.12: Time of fall occurrence

4.6.3 Weather condition

Injuries can also be related to the prevailing weather conditions. The extreme hot and cold temperatures, and in tropical areas, rainfall is a major concern. Cold temperatures tend to reduce dexterity of workers and hot and humid temperature makes them exhausted and dehydrated. Rainy weather results in an unsafe working environment susceptible to fall and trips. The respondents are asked as what type of prevailing weather condition tends to triggers fall accident. Results are shown in Figure 4.13. Most fall accidents are triggered due to the hot weather condition (49%). Pakistan is a semi-arid country having hot summers and mild winters. Summers are long as compared to winters. The hot temperatures have been found to have caused workers to get sunstroke, become unconscious and dehydrated. Fall accident from rainy weather condition is next with 35% of respondents stating it to be the most probable reason. Rainy weather causes the working surface to become slippery and as majority of workers don't use appropriate footwear they are more likely to be involved in fall accident. Other weather conditions are humid (11%) and cold (5%).

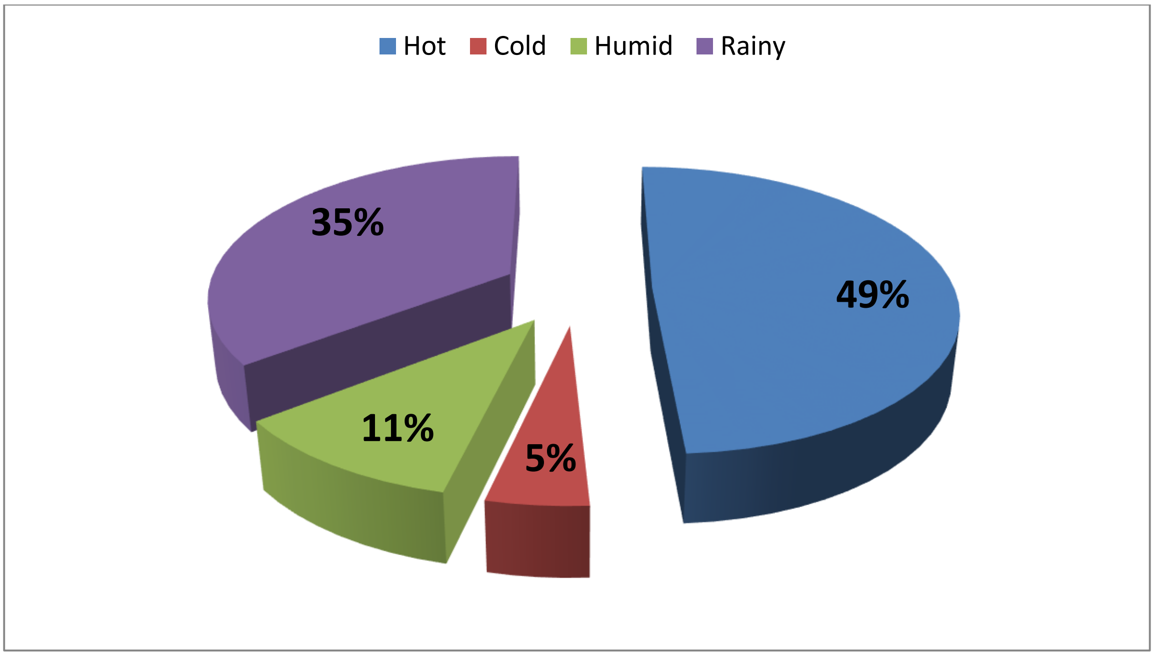


Figure 4.13: Weather condition

4.6.4 Nature of Injury or Illness

Construction workers do not want to get injured as a consequence of their job. Yet accidents do happen bringing along pain and agony to the affected worker. Working at height is considered a dangerous job which has, in past, led to many fatalities and critical injuries. Respondents are asked about the nature of injury that they may have witnessed or possessed knowledge of fall accident happening. Results are shown in Figure 4.14. Most common nature of injury, sadly, is fractures (54%). Fractures tend to make the worker handicapped and can end his professional career making him unable to do work. His family suffers too with him as the number of dependents in Pakistani society is very high due to large families. Occurrence of fatality due to fall accident comes next reported by 19% of the respondents which is a cause for concern. Both the major causes results in serious social and economic grievances. Thus, fall from height must be prevented at all cost. Other injuries include sprains and strains (11%), bruises, cuts and punctures (11%) and back pains (5%).

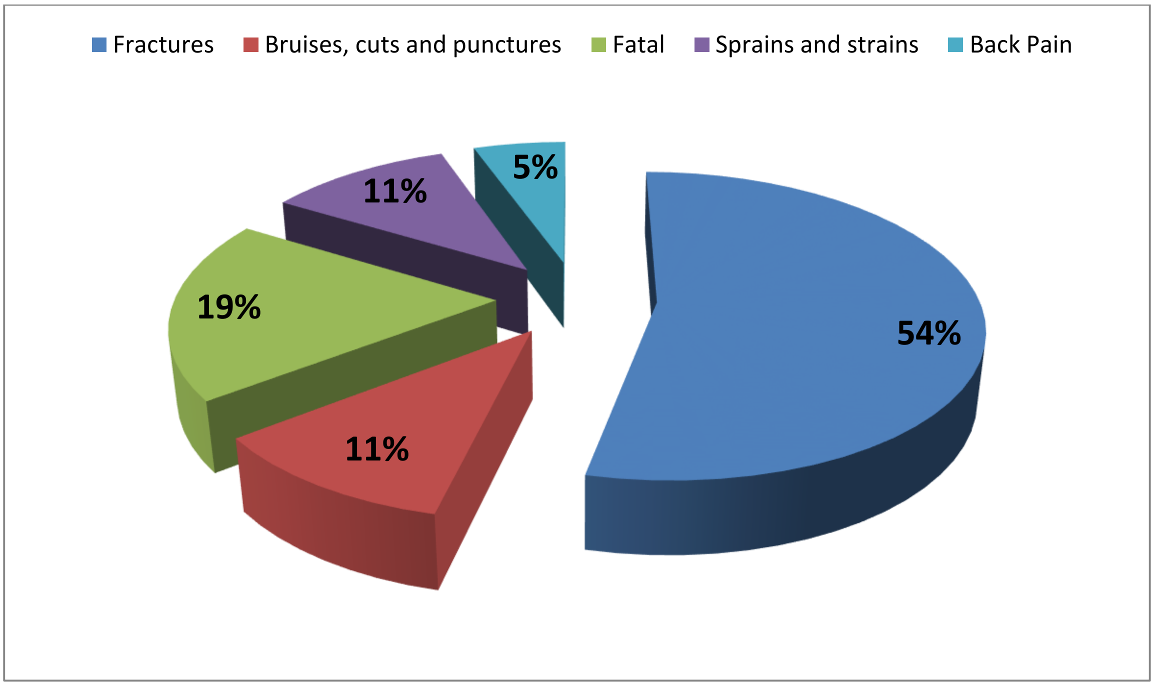


Figure 4.14: Nature of injury

4.7 OPINION ON FALL PROTECTION

Fall protection often involves the use of Personal Protective Equipment (PPE). Depending on workers to make the 'right' decision whether to wear or not the personal protective equipment has been shown to have unsatisfactory outcomes. The workers tend to overlook, decide not to use it in cases when the expected exposure time is small, or do not wear it properly. To better understand the whole scenario, effort needs to be done at first to understand the various stages and aspects in fall prevention, which influences the construction method. Advice, opinion and knowledge of professionals in the construction field needs to be sought and taken into account, if a successful outcome is to be achieved, to better the current situation as portrayed in the preceding sections.

4.7.1 Necessity of Positive Fall Protection

Positive form of fall protection, also known as conventional fall protection, is a widely used type of fall protection and is considered quite effective if used properly. It includes the use of PFAS, guardrails, safety nets etc. To gauge the level of usage in CI of Pakistan, respondents are asked how often positive form of fall protection is used. The results are shown in Figure 4.15. Frequency distribution shows that 16.4% respondents said that it is never used, 14.5% said seldom, while 41.8% said that it is sometimes used, frequently was said by 5.5% and always by 21.8% of the respondents. It means that only 27.3% respondents shows that positive form of fall protection is being used in the CI of Pakistan at an acceptable level whereas 72.7% respondents shows that the usage of fall protection in the CI of Pakistan is not satisfactory. Hence, there is a need to improve upon the acceptance and usage of positive fall protection in CI of Pakistan.

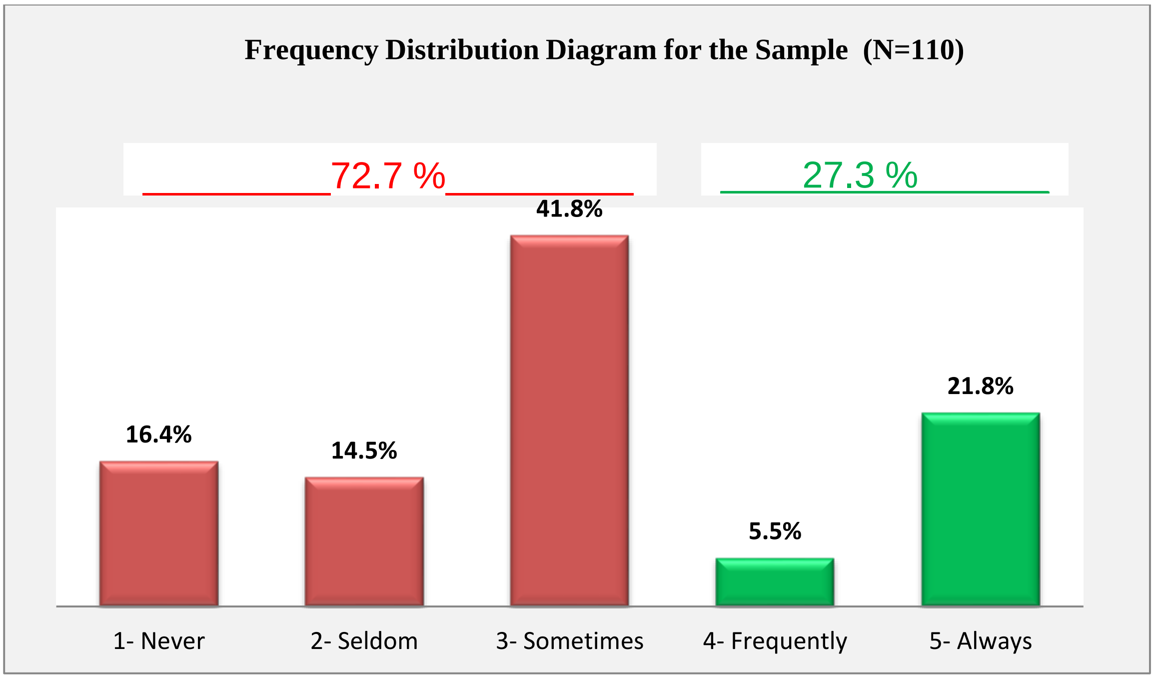


Figure 4.15: Usage of positive fall protection

In continuation, after determining the frequency of usage of positive fall protection, respondents are asked at what slope, according to them, the usage of positive fall protection system is necessitated. This is to analyze the knowledge of professionals towards positive fall protection. Results are shown in Figure 4.16. Ideally, majority of the respondents (40.0%) have rightly said positive fall protection must always be used. But the numbers are not enough. Moving further, it is noted that 31.8% of respondents pointed that positive fall protection is to be used for slopes greater than 2:3, 20% said to use between slopes greater than 1:3 and 2:3 and 2.7% said to use in slopes upto 1:3. Interestingly 5.5% of respondents said that positive fall protection is never required and they consider passive form of fall protection to be more advantageous. For lower slopes trend is towards the use of other fall protection methods which changes to the use of positive fall protection as the slope increases. This shows a shift towards more positive and less passive. Efforts need to be done to educate the professionals in all the risks and hazards that may cause fall accident on roof and slope surfaces, and the mitigation strategy to address the issue.

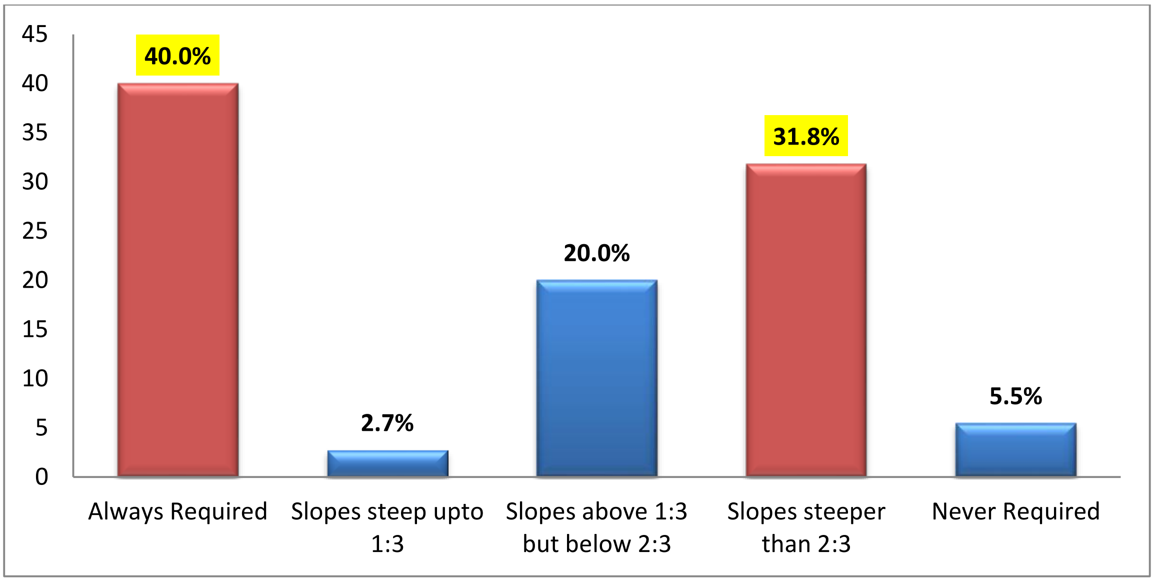


Figure 4.16: Slope to necessitate positive fall protection

4.7.2 Form of Fall Protection in Construction Applications

Respondents are asked targeted questions relating to the form of fall protection they consider as being most appropriate in certain construction phases. The phases mentioned are truss installation, roof sheathing, and roofing at slopes less than 1:3, between 1:3 and 2:3 and greater than 1:3. It shall be helpful in determining the appropriate use of different forms according to the professionals. Results are shown in Table 4.9. Personal Fall Arrest System (55.45%) is felt to be the most appropriate form of fall protection followed by Fall Protection Plan (23.64%). For roof sheathing, PFAS (35.45%) and guardrails (24.55%) are preferred closely. For slopes below 1:3, respondents identified many options whereas the preferred option was Warning Line system (28.18%) followed almost equally by Fall Protection Plan (27.27%). A quite significant amount of respondents identified Safety Monitoring System too (11.82%) which is non-existent in other applications. This shows respondents preferring cost effective methods over the expensive options of PFAS, Guardrails and safety nets in low slope and less hazardous places. For slopes between 1:3 and 2:3, SMS was no longer cited and the preferred option was guardrail (28.18%) and Safety net (26.36%). For slopes above 2:3 Warning Line System and SMS are no longer preferred by any respondent, and the major method of protecting workers comes out to be overwhelmingly the PFAS (45.45%).

Table 4.9: Form of fall protection in construction applications

S.No	Applications (5)	PFAS	Guard rail	Safety net	CAZ	SMS	Warning Line System	Fall Protection Plan	None
1	Truss Installation	**55.45%** **Rank 1**	4.55%	13.64%	0.00%	0.00%	0.00%	**23.64%** **Rank 2**	2.73%
2	Roof Sheathing	**35.45%** **Rank 1**	**24.55%** **Rank 2**	18.18%	2.73%	0.00%	0.00%	13.64%	5.45%
3	Roofing, slope 1:3 or less	2.73%	10.91%	0.00%	0.00%	11.82%	**28.18%** **Rank 1**	**27.27%** **Rank 2**	19.9%
4	Roofing, slope 1:3 to 2:3	13.64%	**28.18%** **Rank 1**	**26.36%** **Rank 2**	23.64%	0.00%	2.73%	0.00%	5.45%
5	Roofing slope 2:3 or more	**45.45%** **Rank 1**	13.64%	**27.27%** **Rank 2**	2.73%	0.00%	0.00%	10.91%	0.00%

4.7.3 Problems encountered with compliance

The respondents are asked how frequently they encounter problems that making it difficult for them to comply with the fall protection regulations. The result is shown in Figure 4.17. A cumulative 53.64% of respondents mentioned that they encounter problems frequently or all of the time, rendering it difficult to employ fall protection. 23.64% mentioned they encountered problems sometimes, 16.36% said seldom and 6.36% of respondents said that they never encountered problems on site pertaining to the enforcement of fall protection. The relatively high frequency of problems and non-compliance, as shown, indicates that the fall protection regulations are not known properly and understood by the professionals in CI of Pakistan.

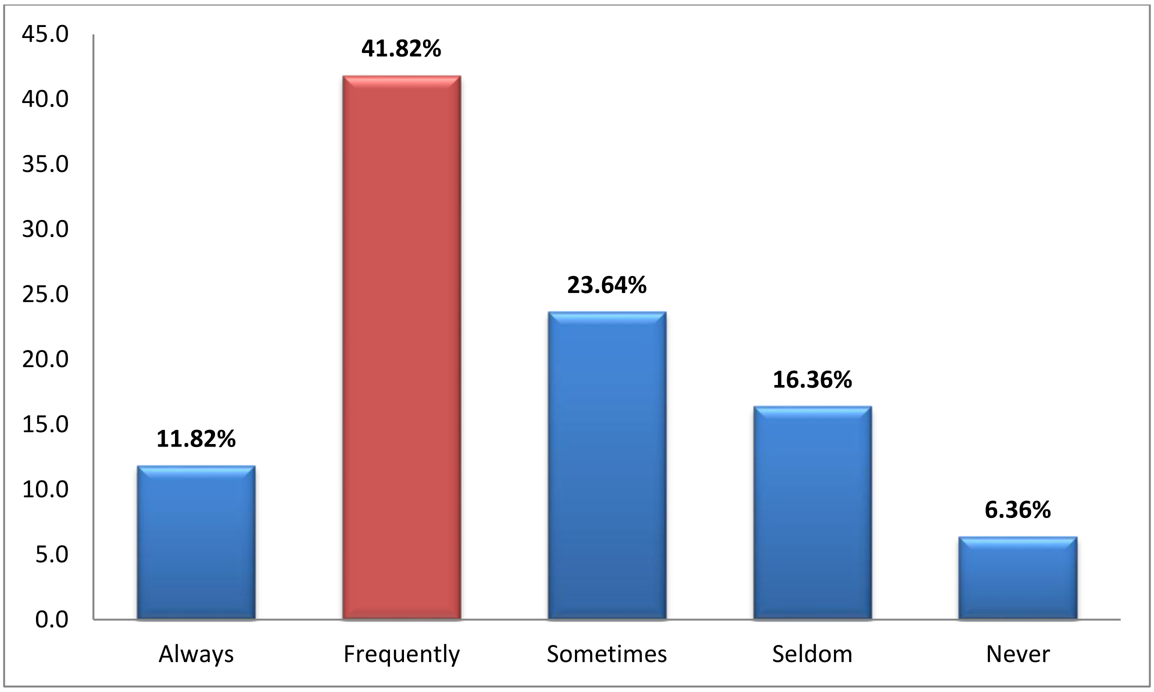


Figure 4.17: Frequency of problem encountered

To have a better insight, the respondents are asked to comparatively rank common problems associated with implementation of fall protection. Results are tabulated in Table 4.10. The most significant problem, mentioned by 80.36% of respondents, is the inadequate availability of fall protection on site, followed by Inadequate training regarding proper use of fall protection equipment, cited by 74.77% of respondents. This shows the lack of investment and cost input in the safety aspects of projects. It needs to be dealt with and proper fall protection equipment on site must be made compulsory. Regulatory authorities must ensure this and also keep check of workers' training requirements. Other problems reported by the respondents are decrease in productivity, unavailability of anchorage point showing lack of incorporation of safety aspects in the design process and sometimes fall protection themselves increasing the chances of slip and trip. These problems can also be effectively dealt through providence of adequate training.

Table 4.10: Characterization of problems of fall protection

S. No	Problems (5)	Mean	Percentage	RII	Overall Ranking
1	Suitable anchorage point unavailable	2.59	51.89%	0.5164	4
2	Availability of fall protection equipment inadequate	4.02	80.36%	0.8018	1
3	Decrease in productivity by increase in time required for task completion	2.77	55.32%	0.5527	3
4	Inadequate training regarding proper use of fall protection equipment	3.74	74.77%	0.7527	2
5	Use of fall protection in itself creating more hazard (slip/trip hazard)	1.88	37.66%	0.3764	5

4.7.4 Worker Behavior

The respondents are asked regarding reasons behind the workers' behavior. It is due to the fact that worker behavior is the primary source of non-compliance. Therefore, it must be established why workers would or would not comply to fall protection. The results are tabulated in Table 4.11 and Table 4.12. The primary reason for the compliance of workers has been cited as employer's requirement. It is the principal motivator for safe worker behavior. Management's concern towards safety matters and their willingness towards having a safe working environment by earmarking resources for it is necessary for this. Next reason is worker's own concern for his security and safety followed by supervisor's enforcement. Fellow safety-conscious worker's pressure comes last and is least cited.

Table 4.11: Reasons for worker compliance

S. No	Reasons (4)	Mean	Percentage	RII	Overall Ranking
1	Personal security and safety	2.85	71.6%	0.7159	2
2	Employer's requirement	3.04	75.7%	0.7568	1
3	Supervisor's enforcement	2.85	71.1%	0.7114	3
4	Fellow safety-conscious worker's pressure	1.27	31.6%	0.3159	4

The primary reason for non-compliance was again management-centered, with 90.8% believing that fall protection not being a compulsory requirement by employer is the major reason for non-compliance. Employers usually shy away from making it compulsory as it may also demand extra cost for such measures. Next reasons are mostly worker-centered with fall protection being considered as uncomfortable (62.3%) and slowing down the worker and affecting the overall productivity (60.2%). Lag in enforcement by supervisors (58.3%) also relaxes the workers giving them chance to avoid using fall protection. To address these issues and change the workers' attitude towards identification of hazards and proper usage, training must be held by competent persons and a check must be placed on supervisors to effectively enforce it on site.

Table 4.12: Reasons for worker non-compliance

S. No	Reasons (6)	Mean	Percentage	RII	Overall Ranking
1	Believing that fall will not occur	3.03	50.5%	0.5045	5
2	Not a compulsory requirement by employer	5.45	90.8%	0.9076	1
3	Uncomfortable	3.74	62.3%	0.6227	2
4	Slowing down and affecting productivity	3.61	60.2%	0.6015	3
5	Not enforced by supervisor	3.50	58.3%	0.5833	4
6	Pressure from fellow workers to not use fall protection	1.68	28.0%	0.2803	6

4.7.5 Worker compliance and organization enforcement level

The respondents are asked to assess the levels of organization enforcement and worker compliance on site. The findings are presented in Figure 4.18 and Figure 4.19. As shown in Figure 4.18 the organization enforcement is quite poor. Only 2.73% respondents stated "always enforced" and 15.45% respondents stating their organization enforces most of the time. It accumulated to mere 18.18% responses in acceptable limits. Whereas, 36.36% stated it to be sometimes enforced, 29.09% said seldom enforced and nearly 16.36% saying it to be never enforced by the organizations. If the scores are assessed by ranging it on a scale of 1-5, with the highest value i.e. 5 representing 'always comply' and representing 'never comply', the means of both the factors can be established for comparison. By this way the mean of organization enforcement comes out to be 2.59 which is in the mid of sometimes enforced and seldom enforced.

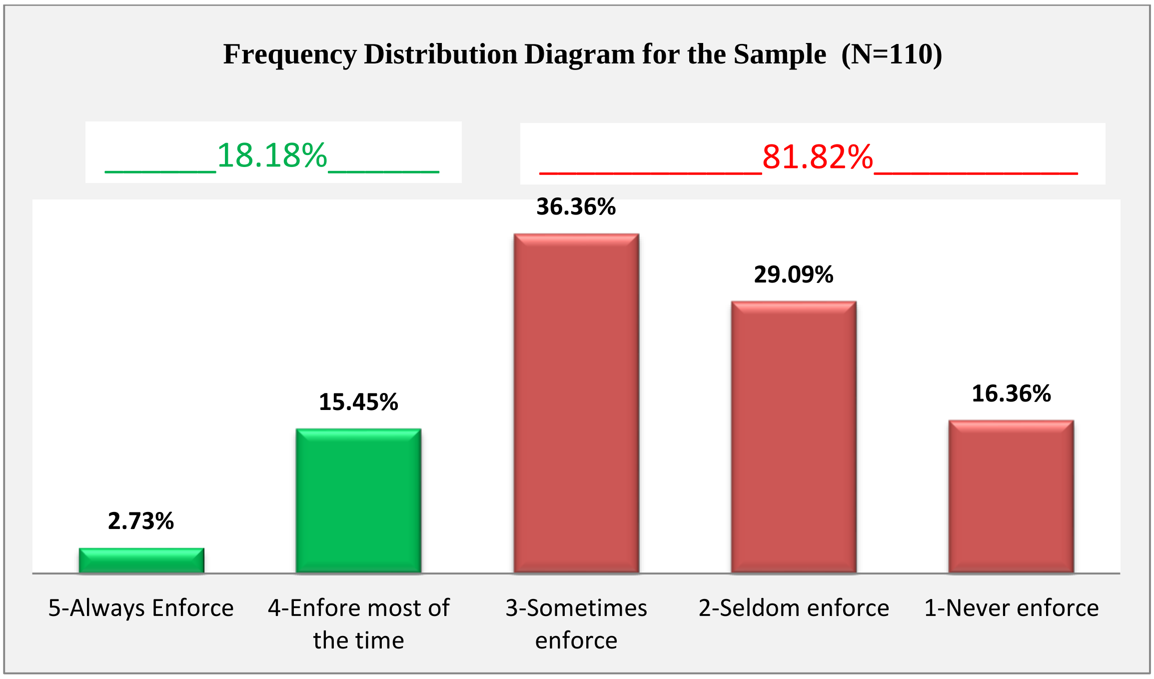


Figure 4.18: Level of organization enforcement

The worker compliance is very poor even if compared to the organization enforcement. Absolutely no respondents mentioned workers always comply and a meager 2.73% said workers comply most of the time. A cumulative of only 2.73% assessed the worker compliance to be above the level of "sometimes" while a staggering 97.27% were below this level. Whereas, 22.73% stated it to be sometimes complied, a maximum of 42.73% said it to be seldom complied and a significant 31.82% stated that there is never worker's compliance towards fall protection on construction site. Assessing the means of score which comes to be 1.96, it shows that the compliance lies between seldom comply and never comply. These results point towards lack of knowledge related to the proper usage and implementation of fall protection regulations in CI of Pakistan, which might be the result of complexity or dearth of related regulations. No necessity is felt by organization to effectively comply with fall regulations but, surprisingly, more alarming situation is worker not feeling the necessity to comply for their own personal safety and security.

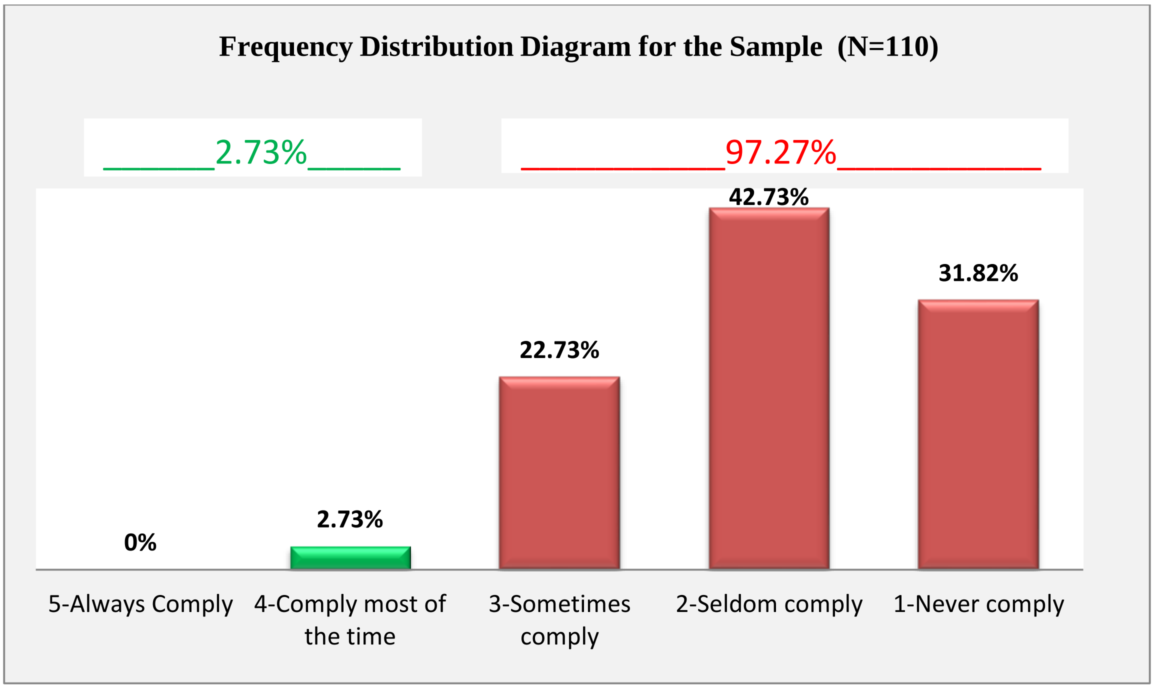


Figure 4.19: Level of worker's compliance

4.8 ACTIONS TO INCREASE WORKER PROTECTION

Preventing fall accidents of workers from height is a major area of concern in the construction industry as it has resulted in significant amount of fatalities worldwide. Attributing fall protection to any single method is not possible and considering such method to stop and prevent all falls from height is immature. It needs a proper regulatory framework in addition to the awareness of those involved directly in the construction activities and involvement of the stakeholders.

The final question asked on the survey dealt with analyzing the appropriate and possible actions that may lead to increase in worker protection. The popular solutions as notified by various professionals and academia were listed in this question. The respondents are then asked whether they feel the possible actions as proposed would encourage or discourage compliance to fall regulations. The responses were assessed based upon Likert scale, with 'strongly encourage' given the maximum score and 'strongly discourage' getting the least score. Remaining options were scored relatively. The means and RII were then calculated for each mentioned action as provided in following Table 4.13.

Table 4.13: Actions to increase worker protection

S. No	Proposed Actions (7)	Mean	Percentage	RII	Overall Ranking
1	Promulgation of safety body POSHA on the model of OSHA in Pakistan	4.54	90.7%	0.9073	1
2	Harsher regulations, enforcement, inspection	4.17	83.5%	0.8345	4
3	Safety evaluation of a company during bidding process	4.45	88.9%	0.8891	3
4	Increased training for workers in proper fall protection methods	4.51	90.2%	0.9018	2
5	Lowering or subsidizing the cost of fall protection equipment	3.57	71.5%	0.7145	6
6	More cooperation with safety consultants	3.44	68.7%	0.6873	7
7	Innovative methods of fall protection which are less restrictive	4.05	81.1%	0.8109	5

The primary solution as according to the respondents favored by 90.7% of them was towards promulgation of a national safety body with a proposed name of POSHA on the lines of OSHA. This shall be a statutory body governing all aspects of safety in every occupation and carry out research work to enhance safety in the working environment serving as a foundation for all other steps to follow. Next important option considered by 90.2% of respondents was an increase in training of workers in proper fall protection methods as they are the direct victims of fall accidents. Respondents placed the present level of workers' awareness towards fall protection as inadequate and totally unacceptable.

To have a better sense of responsibility towards fall protection by the contractors 88.9% of respondents preferred safety evaluation of a company during bidding as the next preferred option. At this present era of cutthroat competition, contractors try their best to win a tender and this may manipulate them to actually change their attitude towards safety. Other options which were ranked included harsher regulations, enforcement and inspection (83.5%), introduction of innovative methods of fall protection which are less restrictive (81.1%), lowering or subsidizing the cost of fall protection equipment (71.5%).

The least preferred option mentioned by only 68.7% of the respondents was increase in cooperation with safety consultants. The role of specific consultants dedicated entirely to ensuring safety on construction sites is not yet fully realized by the professionals with many not sure of existence of such consultants even.

4.9 SUMMARY OF FINDINGS

The findings from the questionnaire survey filled by professionals can be summarized as follows:

(1) The professionals in the construction industry employ a wide variety of fall protection systems, but they are mostly familiar with and frequently employ PFAS, guardrails and warning line system. According to the professionals every type of fall protection system provides a unique benefit and can be used appropriately according to the requirement.

(2) The professionals are split on their opinion relating to the need for positive form of fall protection on various slopes. A slight majority (40%) feels that positive form is always required. Additionally 31.8% feels that it should be employed with slope steeper than 8:12, with the percentage falling as the slope is decreased followed by 5.5% that it is never required.

(3) Preference has been shown towards the usage of positive form over passive form of fall protection. The alternative systems are not found to substantially cater to the needs of workers as compared to the protection provided by conventional systems.

(4) The usage of fall protection, as mentioned in survey, has been found higher when comparing to the percentages of different positive form of fall protection employed and also comparing to the actual visits. This indicates lack of proper knowledge of governing Subpart M which relates to fall protection.

(5) The level of compliance has been found to increase when the enforcement of fall protection was increased. This shows that compliance tends to increase when external supervision and audit is increased. Improved state of compliance was observed on the private developments where there was a higher degree of oversight and owner’s involvement.

(6) The primary issue mentioned relating to usage of fall protection can be termed as management-oriented. The professionals feel that primarily workers comply to

fall regulations due to the fact that it is employer's requirement. On the other hand, the primary reason for non-compliance has been stated as fall regulation not being a compulsory requirement by employer. These two findings directly reinforce each other. Further findings reveal the issue to be worker-oriented. The professionals felt that the second reason for compliance shall be the fact that workers show concern for their own personal security and safety. On the other hand, reasons for non-compliance are due to the worker's perception that the fall protection is a hindrance in their work with it being uncomfortable and slowing down and affecting productivity.

(7) The professionals felt that the most important action to that needs to be taken to enhance fall protection is to form a regulatory body on the lines of OSHA which may cater to national needs. Absence of such institution shall result in all other steps to be useless. Increasing worker training to improve worker protection was also felt as an important action. Various other alternative actions were also ranked by the professionals, signifying that the problem with the current state of fall protection is a multi-faceted one which involves all parties in construction. A broad-based strategy and approach is required to address the problems being faced by workers and contractors.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 REVIEW OF RESEARCH OBJECTIVES

The objectives of this study are as follows:

e. Assess the current status of compliance of the fall protection system.
f. To study various sources of fall accidents in CI of Pakistan.
g. Analyze the causes of non-compliance with fall protection systems.
h. Suggest key measures to improve safety against fall accidents, on the basis of statistical analysis of data obtained from construction projects in Pakistan.

The first objective is achieved by collecting data through a questionnaire survey from 110 respondents, employed in over 26 companies working in different cities of Pakistan and further analyzing the data using SPSS-19. Second objective is achieved by identifying various sources of fall accidents and analyzing its occurrence in the CI of Pakistan. Third objective is achieved by drawing a comparison of sources of non-compliance with the relative importance of each source attained by taking in account all the statistics and then identifying the fall protection requirements specific to the CI of Pakistan in addition to examining the fall protection systems already employed. Finally the fourth objective is accomplished by suggesting measures addressing the issues pertaining to fall protection which has come into light after the statistical analysis of the data.

5.2 REQUIREMENTS OF CI OF PAKISTAN

The information obtained through survey and interviews has been helpful and formed as the basis for highlighting the issues and interests of the various parties. In developing an appropriate fall protection system specific to a site following issues and interests are considered paramount:

(1) The cost incurred in deploying the fall protection system should not be found exceeding the benefits it may reap. Otherwise, this may compel the contractor not to utilize the system. This can be termed as degree of economy.

(2) Flexibility of the system must be ensured so that it can be utilized in all the weather condition that the site may experience over the course of construction. System must also take into account the diverse phases of construction and the various working surfaces encountered. This can be termed as degree of flexibility.

(3) The system must be able to be deployed in all types of designs using standard construction methods. Availability of the equipment must be on the job site and care must be taken not to deploy such system of which the supporting equipment is not available. This can be termed as degree of feasibility.

(4) The system may preferably be passive in nature where possible as the active form of fall protection has not been well accepted by the construction workers. They have reported them to be uncomfortable and disrupting the pace of their work and often cited as a greater hazard. This can be termed as degree of passivity.

(5) The preferred system must be easy to understand and comprehend by all the personnel present at job site. Its training must be quick and simple to ensure system is correctly implemented. Normally a safety representative should be present on the job site to understand all the requirement of regulations. Absence of safety representative on majority of sites in Pakistan spells the need for the regulations to be comprehensible for a normal contractor even. This can be termed as degree of simplicity.

(6) Last but not the least, system must fulfill the basic criteria of ensuring protection of worker effectively protecting him from fall hazards as per mentioned in the regulations of Subpart M. This can be termed as degree of protection

The requirements mentioned above must be totally taken into consideration in the interest of all the parties involved in construction like workers, managers and enforcement officials. After satisfying the mentioned criterion the fall protection system proposal may be considered as acceptable for utilization on the job site.

5.3 CONCLUSIONS

Keeping in view the findings presented in previous chapter and the requirements deduced in this chapter, following conclusions can be drawn from this research:

(1) Falls have remained a serious issue on a construction site concerning all the involved parties. Protection of workers from fall hazards has been termed as vital. Workers themselves show concern that a form of fall protection system is needed while working at height especially on slopes.

(2) The present state of compliance towards any fall protection measure has been found as absent or negligible. Visual inspection of sites shows it to be poor and unsatisfactory. Some high rise buildings involving private entities showed interest towards ensuring safety on site whereas small scale projects showed little or no concern at all. Whereas, public projects were found to be lagging far behind in ensuring safety on site reason being lack of knowledge and interest by public organizations and the absence of proper mechanism that may ensure the contractor of a reward in case of ensuring safety. Contractors are hesitant to comply with safety regulations on their own without the interest and involvement of client as safety is believed to be a burden on their profit margin.

(3) The factors of non-compliance which were found included:

- Degree of competition characterized by cut-throat struggle to keep cost minimum and productivity at the maximum level possible, mostly at the expense of safety.
- Resistance by worker in adopting the fall protection measures, mostly reporting them to be uncomfortable and a hindrance to the pace of their work. There was less concern of personal safety and more concern towards speed, agility and comfort.
- Job area difficulties where fall protection measures were either not enforceable or resulted in a greater hazard to the workers.
- Lack of knowledge and understanding of both contractors and workers towards fall protection methods and regulations.

(4) The governing regulation for fall protection, Subpart M of OSHA standards, has been found lagging in catering to local needs and conditions. Other aspect is it being difficult to comprehend and understand by local workers and contractors due to them being mostly uneducated and illiterate.

(5) The steps needed and considered important by the professionals working in the CI of Pakistan are as follows:

- Increasing the level of contractor and worker training.
- Removing import duties on safety equipment and subsidizing the cost.
- Forming a regulatory body like OSHA.
- Changing the safety culture in construction industry.
- Hardening enforcement and inspection level.
- Promoting safety consultants

(6) Present methodology towards fall protection needs to be refined and a hierarchal approach should be introduced. It should first start with emphasis being on elimination of fall hazards followed by preventing fall from occurrence and then arresting the fall in case prevention is not possible and fall can occur. Last resort shall be posting warning signs at relevant places.

(7) The characteristics which ideal fall protection method is believed to possess are being simple, feasible, flexible, passive, simple and protective. In reality no single method has been found to possess all these characteristics applicable in every situation. Thus, the method which comes closest to meeting all these characteristics is to be preferred.

5.4 GENERAL RECOMMENDATIONS FOR IMPROVING FALL IN CONSTRUCTION INDUSTRY OF PAKISTAN

Based on the requirements expressed and the conclusions made and presented above, following recommendations are hence proposed, after deep consideration, to be implemented in order to improve the protection of construction workers from fall:

(1) The regulations presented in OSHA Subpart M have been found as difficult and complex to be applied in local conditions. A simpler version of the regulations, in conformance to local needs and individual for all type of major construction types like residential, commercial, high rise etc., is required which can be effectively implemented without any hurdle or major changes. A fall protection plan in line with conventional construction methods needs to be formulated which must be including a fall hazard analysis form for the contractors to use it.

(2) The fall protection plan must be made as a compulsory requirement on all sites and shall be prepared by a qualified person specifically for the site. It may

include analysis of the hazards and discussion on it. The plan shall have an outline which reads the course of action to eliminate and reduce hazards before moving on to proposing conventional or alternative fall protection methods.

(3) The architects and structural engineers be trained to examine their designs in accordance with the hazards that it may pose during construction. Usually ambitious designs have been found difficult to construct and led to more unsafe working conditions. Thus, it must be included in their duties to review their designs in order that hazards be at minimum.

(4) Introducing fall protection requires providing attractive incentives which may entice contractors to adopt it. The contractors are hesitant to incur extra expenditures. The incentives may include increased cooperation, fall protection subsidies, availability of equipment in local market, and so on.

(5) Introduce a widely recognized certification for contractors who demonstrate commitment to safety and follow a comprehensive safety program on their sites. The holders of these certifications may be entitled to benefits in term of preference in award of contract and in some cases the certification can be made as a necessary requirement on projects.

(6) Ensure that the workers are being provided appropriate footwear after proper evaluation of surface on which they are working. Presently there is no site in Pakistan which follows such practice. The likelihood of fall accidents shall significantly be reduced if cleaning of surfaces be ensured and footwear be provided after careful selection.

(7) Levy fines on those contractors involved in unsafe construction practices after rigorously inspecting them. To change the safety culture environment, the fines must be set at such a level which makes cost of non-compliance higher than cost of compliance. The contractors will not be compelled if cost of compliance is higher than cost of non-compliance.

(8) Keeping in view the level of education and illiteracy among contractors and workers alike, develop a comprehensive education program containing material in local language, preferably diagrammatic in nature, which can be easily understood. This program may include all aspects from training in hazard analysis and hierarchy fall protection to preventing and arresting falls.

(9) Improve the safety culture at all levels beginning from the worker to the architects, consultants, contractors and owners. To motivate safe behavior the key

is to make them personally feel concern for safety. This can be achieved by spreading the word about dangers of falling from height and possible repercussions. The medium can be posters, short films and advertisements on the local television. In addition to fall at construction sites the general public shall also gain knowledge regarding fall hazards they face in their daily life.

(10) Finally, develop innovative methods of protecting workers suited to local conditions. As discussed before, no single method can be termed as totally reliable. Therefore, stress shall be on conducting hazard analysis for each unique phase of construction in order to appropriately determine the best fall protection method correspondingly.

5.4 KNOWLEDGE CONTRIBUTION

This research study is an attempt to document guidelines for fall prevention and assess the current state of fall protection practices in Pakistan. Rather than focusing on safety in general, this is a specialized effort focusing on an aspect of safety which has accounted for the highest number of injuries and fatalities in the CI of Pakistan and also worldwide. It will certainly aid the stakeholders of CI to start taking practical steps for the protection of workers at the site. Authorities can also take this as a reference and use the findings and conclusions to devise plans for a better and safer working environment. The recommendations can be effective and offer significant improvements to the current scenario. This will result in stamping down the “business as usual” and reducing the number of fall accidents drastically. Realizing the importance of fall protection in the CI, mindset of all stakeholders shall change and they will take it more as a responsibility than a liability. Lastly, CI will start taking into account the welfare of workers for both the workers’ and their own benefit as well.

5.5 RECOMMENDATIONS FOR FURTHER STUDY

a. The fall protection methods need to be discussed in accordance with specific fall hazards found on construction sites and analyze the proposed methods depending on its effectiveness in catering to the needs. This study shall first conduct job safety analysis, separately for each task, before proposing a relevant method so that the stakeholders may directly know which method to use in what condition. This can then eventually serve the purpose of a guideline to decide situation-specific appropriate method.

b. A detailed study needs to be carried out on the issues which results in workers behaving unsafely on job site. Their actions and attitudes should be presented in light of the external factors affecting them. This may include supervisor's role, management's interest and client's awareness. After studying the issues a strategy can be devised which effectively addresses the problems and thus results in an improved safety culture.

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APPENDIX-I

Q u e s t i o n n a i r e

National University of Sciences and Technology, Islamabad

QUESTIONNAIRE SURVEY

Subject: Fall Protection Practices on Building Construction Projects in Pakistan

The following questionnaire survey deals with the fall protection for construction activities in Pakistan. This is designed to gather information about your views on fall protection regulations in construction. It may help us in formulating specifically rules, regulations, policies and methods of protecting construction workers from falls tailored to the needs of construction industry in Pakistan. This research is supported by the Construction Management & Safety Research Centre, NIT, School of Civil & Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Islamabad.

The regulations for fall protection in construction are usually referred to and found in the OSHA regulations, 29 CFR Part 1926, Subpart M (1926.500 to 1926.503). For your information and assistance in completing this survey, you may visit http://www.osha.gov/stopfalls/index.html.

Your participation in this survey is fully voluntary. The information you provide will be kept strictly confidential. Please feel free to contact through email at bilaltariq48@gmail.com any time if you have any questions regarding this survey. Please make sure you have completed the questionnaire to the best of your knowledge and submitted it to the researcher.

General Information about the Respondent	
Personal Details:	*(All the details will be kept confidential)*
Name:	
Name of Organization:	
Telephone: (Optional)	
Email: (Optional)	
Please encircle appropriate category for each question below.	
Age (years)	1. Under 18 2. 18-25 3. 25-35 4. 35-50 5. 50+
Gender	1. Male 2. Female
You belong to which stakeholder organization?	1. Owner 2. Contractor 3. Consultant 4. Subcontractor
PEC Category	1. C-A 2. C-1 3. C-2 4. C-3 5. C-4 6. C-5 7.C-6
Type of projects undertaken?(check all that apply)	1. Roads/Infrastructure 2. Buildings 3. Bridges 4. Dams 5. Transmission lines

Geographical location of projects undertaken?	1. Punjab 2. KPK 3. Sindh 4. Baluchistan 5. AJK 6. Islamabad 7. All over Pakistan
Major Clients	1. Public 2. Private 3. Both Public and private
Position/Appointment	1. Manager 2. Field Engineer 3. Safety official 4. Worker 5. Supervisor 6. Other
Experience in Construction (years)	1. 0-5 2. 6-10 3. 11-15 4. 16-20 5. 20+
Education	1. Primary/Secondary 2. Certificate/Diploma 3. Bachelors 4. Masters 5. Doctorate
How long is exposure to fall hazards during a typical workday?	1. <15min 2. 15min – 1Hr 3. 1Hr – 2Hrs 4. 2Hr – 4Hrs 5. > 4Hrs

- **ORGANIZATION'S SAFETY PROGRAM**:

1. *Does your organization enforce a written safety program?*

(a) Yes (b) Often (c) Sometimes (d) No (e) I don't know

2. *Does your organization enforce a written fall protection program?*

(a) Yes (b) Often (c) Sometimes (d) No (e) I don't know

3. *How many employees work for your organization?*

(a) 1-10 (b) 11-50 (c) 51-100 (d) 101-500 (e) > 500

4. *Who is assigned safety responsibilities at your organization? (Check just one)*

(a) Director (b) Project Manager (c) Project Engineer (d) Safety Manager

(e) Foreman (f) I don't know

5. *Which methods of fall protection does your organization use on site? (Check all that apply)*

(a) Personal fall arrest system (safety harness, lanyard, & anchorage system)

(b) Guardrails

(c) Safety nets

(d) Controlled access zone (only competent worker allowed in fall hazard area)

(e) Safety monitoring systems (one employee acts as a safety observer)

(f) Warning line systems

(g) Fall protection plans

(h) Other (Specify____)

6. *Training approach employed by organization on fall protection methods?*

(a) "Toolbox" or stand-up meetings, by supervisor

(b) Videos

(c) On-site training by competent person

(d) Off-site training by competent person

(e) No training on fall protection

- **ACCIDENT AND SITE INFORMATION:**

7. *Cause of fall accident encountered on project site?*

	0-5 %	5-10 %	10-20 %	20-30%	30-40%	>40%
Off roof						
Collapse of scaffolding and off scaffolding						
Off beam support						
Through floor openings, skylights						
Off ladder						
Through roof opening						
Off edge of floor opening						

8. *Most probable time of fall occurrence?*

(a) First hour of working (b) During the working day (c) Last hour of working day

(d) During breaks (e) During overtime

9. *Most probable weather condition triggering the fall accident?*

(a) Hot (b) Cold (c) Humid (d) Rainy

10. *Most probable nature of injury or illness resulting from the fall accident?*

(a) Fatal (b) Bruises, cuts and punctures (c) Fractures

(d) Back pain (e) Sprains and strains

- **<u>YOUR PERSONAL OPINION ON FALL PROTECTION</u>**:

11. *During the time of exposure to fall hazards, how often positive form of fall protection is used (such as safety harness, guardrails, safety nets etc.)?*

(a) Always (b) Frequently (c) Sometimes (d) Seldom (e) Never

12. *While working on roof, at what slope do you feel positive form of fall protection system (i.e. personal fall arrest system, guardrail, or safety net) is required?*

(a) Always Required (b) Slopes steep upto 4:12 (c) Slopes above 4:12 but below 8:12

(d) Slopes steeper than 8:12 (e) Never Required

13. *Which of the following fall protection forms do you prefer in the roof construction applications mentioned? (Check only one for each application)*

Application	Personal fall arrest system	Guard rail	Safety net	Controlled access zones	Safety monitor system	Warning line system	Fall Protection Plan	None
Truss installation								
Roof Sheathing								
Roofing, slope 4:12 or less								
Roofing, slope 4:12 and 8:12								
Roofing, slope 8:12 or more								

14. *How often problems are encountered which make utilization of fall protection difficult on construction site?*

(a) Always (b) Frequently (c) Sometimes (d) Seldom (e) Never

15. *How would you comparatively characterize these problems? (Please rank from most frequent (1) to least frequent (5) the following mentioned common problems.)*

Suitable anchorage point unavailable	
Availability of fall protection equipment inadequate	
Decrease in productivity by increase in time required for task completion	
Inadequate training regarding proper use of fall protection equipment	
Use of fall protection in itself creating more hazard (slip/trip hazard)	

16. *Why, according to you, fall protection on site shall be used? (Please rank from most frequent (1) to least frequent (4) the following mentioned common reasons.)*

Personal security and safety	
Employer's requirement	
Supervisor's enforcement	
Fellow safety-conscious worker's pressure	

17. *Why, according to you, fall protection on site shall not be used? (Please rank from most frequent (1) to least frequent (6) the following mentioned common reasons.)*

Believing that fall will not occur	
Not a compulsory requirement by employer	
Uncomfortable	
Slowing down and affecting productivity	
Not enforced by supervisor	
Pressure from fellow workers to not use fall protection	

18. *How often your organization enforces the use of fall protection on construction site?*

(a) Always (b) Frequently (c) Sometimes (d) Seldom (e) Never

19. *How would you characterize the level of compliance with regards to using fall protection?*

(a) Always comply (b) Frequently comply (c) Sometimes comply

(d) Seldom comply (e) Never

***20.** What is your opinion regarding the following actions, whether they would encourage or discourage, the use of fall protection?*

Actions	Strongly encourage	Somewhat encourage	Neither encourage nor discourage	Somewhat discourage	Strongly discourage
Promulgation of safety body(POSHA) on the model of OSHA in Pakistan					
Harsher regulations, enforcement and inspection					
Safety evaluation of a company during bidding process					
Increased training for workers in proper fall protection methods					
Lowering the cost of fall protection equipment					
More cooperation with safety consultants					
Innovative methods of fall protection which are less restrictive					