“Dedicated to our beloved Country and our beloved Parents”

ACKNOWLEDGEMENTS

We are thankful to Almighty Allah who gave us the strength and courage to accomplish this research work.

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Most humbly we pay our earnest gratitude with sincere sense of respect to our parents for their extraordinary support, encouragement, prayers and patience.

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ABSTRACT

The Construction Industry (CI) is one of the most accident prone industries of the world, so there is a need to make this industry as safe as possible. There is a different safety management technique which has been used throughout the world especially in developed countries. But most of the countries which are in the development phase like Pakistan lack in this area. There are several reasons behind the high rate of injuries in CI. The first and the most important is the complex nature of this industry. The ignorance in the use of Personal Protective Equipments (PPEs), the shift work and the stress are some of the reasons for such a rate of accidents in CI.

Currently there is no regulatory authority for safety management in Pakistan (like OSHA in USA). The primary construction regulatory body (PEC) has yet to lay down safety laws and regulations, to be adopted by all the stakeholders in CI. Clients demand high speed and high quality of work at the lowest cost. Unsafe conditions exist on many sites and labourers are subjected to numerous hazards. There are no training programs for the staff and workers, hazards are not pointed out and safety meetings are not held on most of the construction sites. These facts not only led to unsafe project sites but have also resulted in construction delays, cost overruns, poor productivity and poor product and process. Hence, there is an urgent need to form a safety regulatory authority, run safety awareness programs; arrange formal and informal education and training in safety for all stakeholders. In addition to it different safety techniques can be used to minimize the risk of injuries. These include the PPEs, Safety policies, pre-task planning and safety guiding sessions. There should be a dedicated department to safety to improve the safety performance at construction sites. The Centaurus is one of the rare projects in Pakistan having such a department. The safety performance of this project is rated relatively high as compare to other projects.

ABBREVAITONS

SBP	State Bank of Pakistan
PEC	Pakistan Engineering Council
SPI	Safety Performance Index
CI	Construction Industry
PPE	Personnel Protective Equipment
ILO	International labour organization
OSHA	Occupational Safety and Health Administration
OHS	Occupational Health and Safety

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Chapter 1

INTRODUCTION

1.1 SAFETY

Safety is a mechanism to prevent the occurrence of an accident (Nugraheni, 2009). In other word it means giving first aid to the uninjured in the form of personal protective equipments.

1.2 CONSTRUCTION SAFETY

Construction safety is the discipline of preserving the health of those who build, operate, maintain, and demolish engineering works and of others affected by those works (Davies and Tomasin, 1990).

1.3 THE CONSTRUCTION INDUSTRY

Construction industry is unique in its nature because of the fact that every construction site is different from the other even if they have the same design for the structure to be built on them. The skill of the labour and the weather conditions also play an important role to make each site a unique one. Due to its uniqueness and complexity, it is one of the most accident prone industries of the world. Lack of automation especially in under developed countries and the use of old techniques which are less safe also adds to its accident proneness nature.

In this document, our main focus is on the safety management techniques and practices which are followed during the construction of the project. Different accidents which occur on the site are due the lack of proper safety and not following the standard method.

Figure 1.1: The Centaurus

1.4 OBJECTIVES

Following are the main objective of the Project report;

- To learn the Safety Management Techniques in Construction Industry (CI) of Pakistan.
- To study the impact of Safety Management on cost of Construction Projects.
- To analyze the present situation and recommend for future improvements.

1.5 JUSTIFICATION FOR SELECTION OF TOPIC

We as a group when study about the different topics from which we have to choose one for our final year project, were surprised to know that Pakistan has not a regulatory authority for construction safety which is the major issue in the Construction industry. So we decided to choose this topic to highlight the importance of safety in construction industry.

1.6 OVERVIEW OF THE PROJECT

Chapter one of the research is the introduction of the research work in which the objective of the research and the justification for selection of topic is mentioned. Chapter 2 is mainly focused on the literature related to the study while Chapter 3 includes the methodology to complete the report. Chapter 4 contains our study related to safety performance at different sites and chapter five contains some recommendations for safety management.

Chapter 2

LITERATURE REVIEW

2.1 ACCIDENT

An accident is defined as an unplanned, unexpected and undersigned (not purposefully caused) event which occurs suddenly and causes:

1-Injury or loss,

2- A decrease in the value of the resources, or

3- An increase in liabilities. ("businessdictionary.com")

2.2 CAUSES OF ACCIDENTS IN CI

Accidents can be avoided if we know the reason behind them. The term accident is usually referred to a personal injury. Even though we do not want accidents to occur, still they occur. Many theories have been introduced addressing this problem.

2.2.1 The Accident Proneness Theory

This theory is based on the personal factors behind the accident. It is based on the assumption that if several people are placed in similar conditions, some will more likely than others to sustain an injury. This theory explains that accidents are not randomly distributed or sustaining an injury is not simply a chance occurrence. Some persons have permanent characteristics that predispose them to a greater probability of being involved in accidents. Some people are more likely to be involved in accidents because of "their innate propensity for accidents" (Shaw and Sichel 1971).

2.2.2 The Chain-of-Events Theory

Accidents are normally the result of a series of events. All the events in the series are linked with each other, every event is followed by the event and in the end the accident occurs. This is known as Chain-of-Events Theory and is also referred to as Domino theory.

The theory states that if any of the events leading to accident had not occurred, the accident would have not been occurring. Every accident is a result of events which are linked with each

other, so these events have to be recognized in order to avoid the occurrence of same accident in future.

2.2.3 The Adjustment-Stress Theory

This theory states that safe performance is compromised by a climate that diverts the attention of workers. This theory contends that "unusual, negative, distracting stress" placed on workers increase their "liability to accident". The major factor in accident occurrence is the work climate. The climate or environmental conditions can be assumed to be either internal or external. According to this theory any negative stress imposed on worker either by internal environment or by external environment will increase accident occurrence. Internal environment include fatigue, alcohol consumption, loss of sleep drugs, disease or such psychological stresses as worry, personal problems, or anxiety. The external environment includes noise, illumination, temperature, or excessive physical strain. If the worker cannot adjust to the stress, the chance of injury is increased. In other words the stress diverts the attention of the worker that leads to the accident.

On construction sites Project managers are the major source of such type of stresses. For example the pressure on worker to keep the cost below to some level that may not be realistic and pressure to meet unrealistically tight deadline.

2.3 GENERAL TREND OF ACCIDENTS IN CI

General perception about the injuries at construction site is this that they occur randomly. However the researchers have shown that they follow a general trend with respect to hour of the day, day of the week, length of the work week, month of the year and some other factors. Following debate will provide justification of this statement.

2.3.1 Hour of the Day

Time period for construction activities at site is generally 8 hours i.e. from 08:00 A.M to 04:30 P.M. most of the construction projects have similar hours. The timing of the injury in a workday can be explained by the levels of work activity taking place at different times. The workday begin at 07:00 or 08:00 A.M. during the first 15-30 minutes, most of the effort is focused on requisitioning tools and material, organizing the work area, and planning the activities to be performed. The pace of the work gradually starts rising. The pace is usually at its peak around

10:00 A.M and then starts going down round about 11:00 A.M to 12:00 P.M as the workers prepare themselves for the lunch break.

After the lunch break the work is resumed at a moderate pace as the query for tools is not there. On some types of work, particularly physically demanding work, pace may not return to the peak level attained during the morning session. The pace may remain at the level for rest of the afternoon. About half of an hour is expended on cleaning up the work area and placing the tools at storage place before the close of the day.

In the light of sequence of work mentioned above, it is quite clear that least productive periods are those immediately after the beginning of the day, just before lunch and just before quitting time. To a lesser degree, similar reduction in work effort occurs in periods proceeding and following any organized and afternoon breaks.

It is most common for accidents to occur in most intense work periods, namely, at midmorning and in the early afternoon. At these times workers are most intent on accomplishing their tasks, so at these time periods accidents are more likely to occur and workers are more likely to be injured. This trend is shown in figure 2.1. The information which is shown in figure was provided by OSHA. The graph of injuries with respect to time show two peaks where greater numbers of injuries occur. The morning peak occurs between 08:00 and 10:00 A.M and the afternoon peak is between 12:00 and 02:00 P.M.

In general the data shows that greater numbers of injuries occur during the morning session than the afternoon session. This shows that fatigue is not an overriding factor for accidents. It is the work load which is the main factor for the accidents to happen. When peak hours of productivity are attained it is important for safety that all the work be carefully planned.

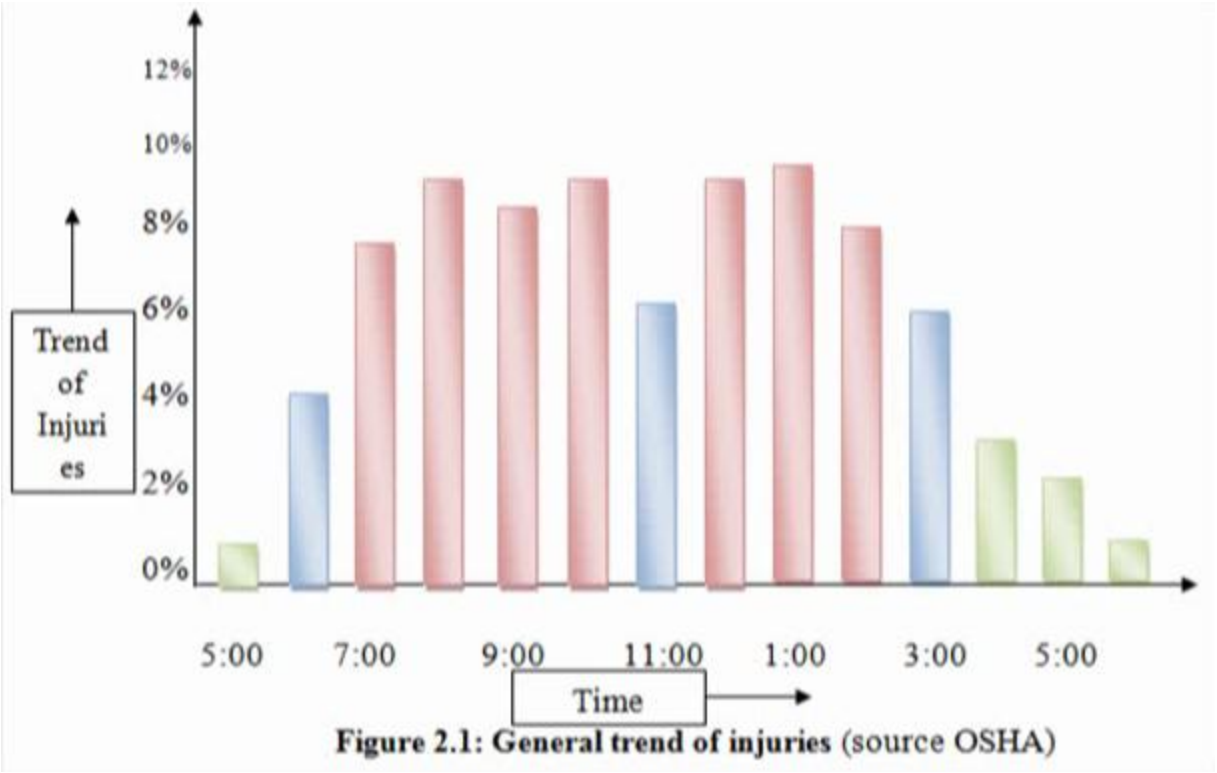


Figure 2.1: General trend of injuries (source OSHA)

2.3.2 Day of the Week

Just as the general pattern of activities vary throughout the day, so too, it changes during the week. Most of the projects work is carried out from Monday to Friday and Monday is the day on which work for the week is planned. The pace of the work builds on the following days and it reaches the peak typically on Wednesday or Thursday. Friday is the day on which work for the week is finished.

As previously proved that work load is the main factor for accidents, one may reasonably expect the greatest number of injuries occur on Wednesday, commonly called "hump day." A review of injury distribution, by day of the week fails to support the expectation (figure 2.2). More injuries tend to occur on Monday than on other days. The trend then gradually decreases till Friday, with few injuries occurring on Saturdays and Sundays. Occurrence of most number of injuries on Mondays is because of the fact that workers must make the greatest mental transition, from the weekend to the workweek, on Monday. That is, workers are mentally least ready to work on Monday. That is why most of the supervisors like to arrange safety meetings on Monday.

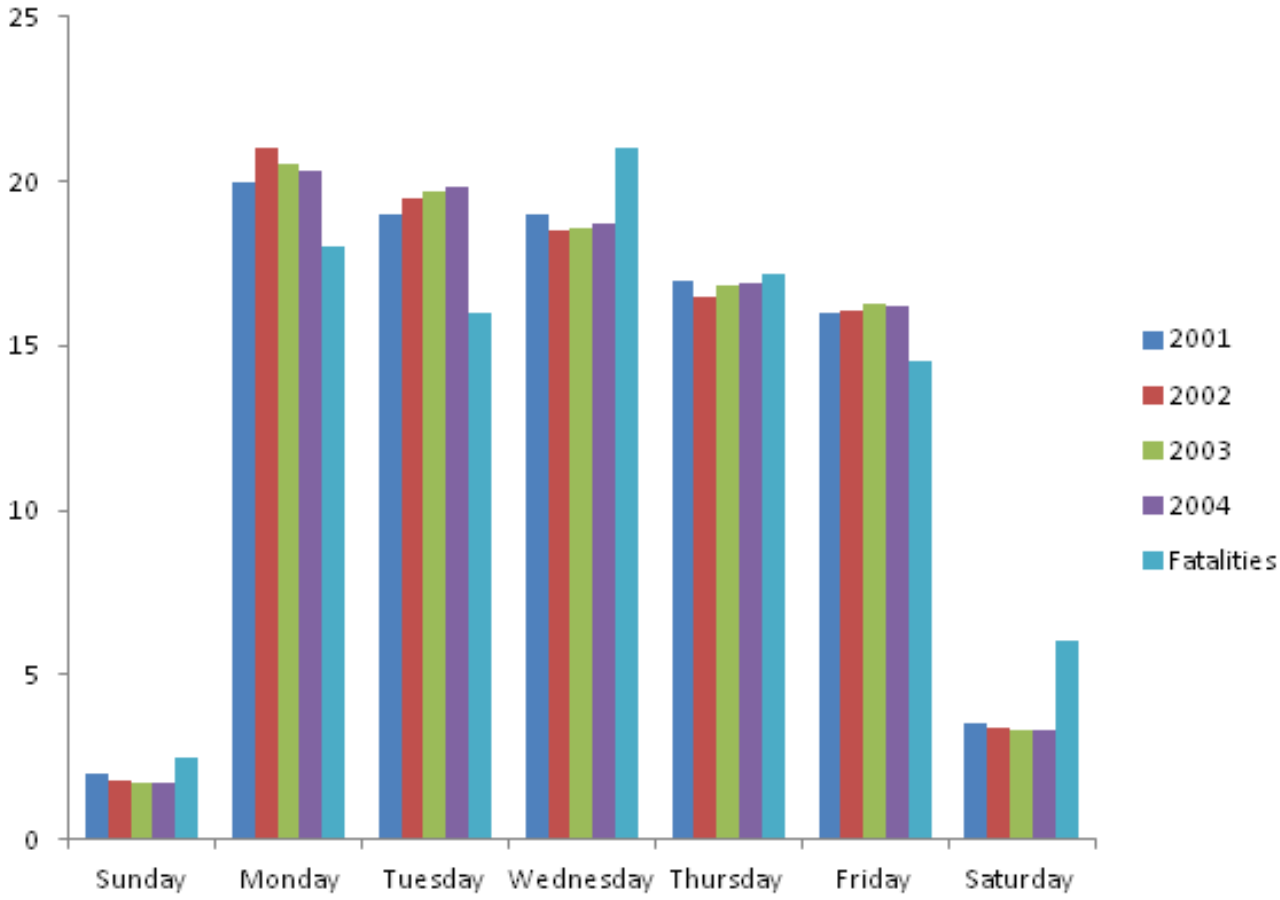


Figure 2.2: Trend of injuries in a week (source: Unpublished data. Concentra Health Services Inc. Fatality data provided by OSHA)

2.3.3 Length of the Workweek

A regular workweek is 40 hours where workers work five eight-hour days. Of course, some projects have different work schedules. For example, in industrial sector of construction industry, it is common for the 40 hours to be worked by working four ten-hour days. Research has found that safety performance is not as good when workweek is extended to six or seven days. On some projects with very tight schedules, work schedule might consist of seven twelve-hour days. The circadian cycle of workers may be affected, but greater concern would be the fatigue resulted from no allowance in schedule for the workers to recuperate. This makes the workers more susceptible to being involved in accidents. The adverse effects are noticeable after working two weeks with such work schedules. (Figure 2.3)

Some studies suggest that productivity is significantly compromised with an extended work schedule especially when this schedule is maintained over a long period of time. It is not evident; however, that safety is compromised if this schedule is maintained for only one or two weeks. Apparently the human body can make adjustments if workweek returns to normal within a week or two.

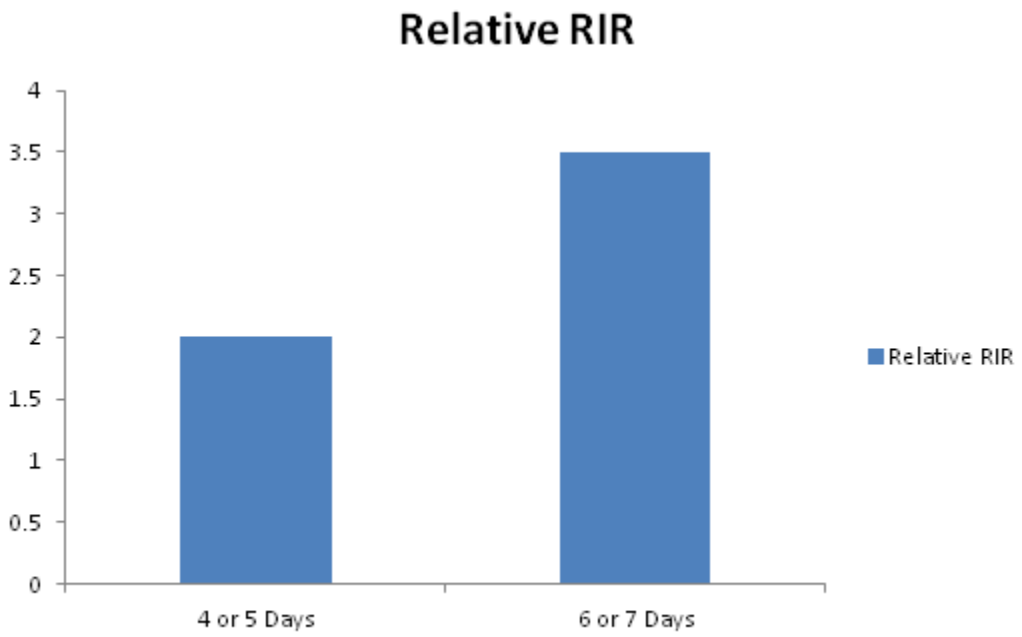


Figure 2.3: Effect of length of workweek (Huang 2003)

2.3.4 Season of the Year

Injuries may also be related to the time of year when work is performed. The weather extremes are of primary concern i.e. extremely cold and hot temperatures. Rainfall may also be of concern especially in regions with flash flooding. Cold weather (especially with precipitation) affects certain tasks. Ice and snow may cause falls and serious injuries.

Most of the outside work is planned during spring and summer months which are drier and hence tend to be more productive. However when hot weather is extreme, it poses great danger of heat exhaustion and dehydration to the workers. It is important therefore, for the workers to have ample drinking water and adequate safety equipment available. These include proper headgear, shirts and long pants at all times.

Injury occurrence is lowest during months of December and February due to slow work as a result of cold weather, and highest in summer months, peaking in August due to increased construction work. (Figure 2.4)

One hypothesis for this fact is that increased employment in summer reflects hiring of unskilled labour. They often have little or no experience and hence are more susceptible to injury. An additional factor may be the stress due to intense construction during summer and less intense during winter months.

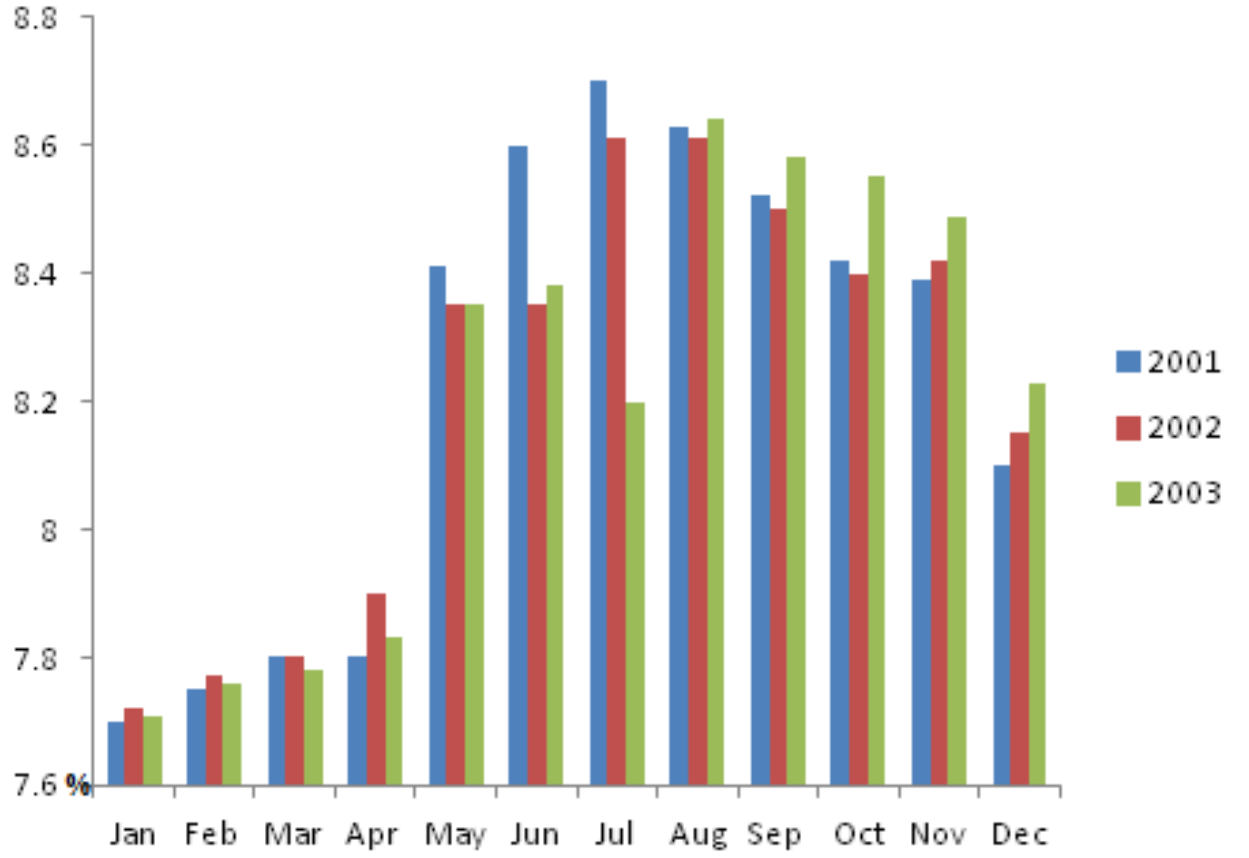


Figure 2.4 Trend of injuries w.r.t months of year (Source: Department of Labour and Industries of the State of Washington)

2.3.5 The Effect of Shift Work

When managers of a company use shift work on a project, they should be aware how circadian rhythms function in human body. Natural biological clocks function in each of us. The 24-hour light-dark cycle entrains the internal biological clock to 24 hours. As long as external stimuli are

maintained this clock performs orderly. The circadian rhythm is synchronized with the 24-hour day, in which the body expects to eat and sleep at given times each day. Changing external environment will upset the cycle. For example people travelling across time zones on jet, experience "jet leg". So they have to make quite an adjustment to the new routine.

Shift work can adversely affect the circadian rhythms of workers. If a regular day shift worker is suddenly asked to work a night shift, his circadian rhythm will be affected. The body wants to stay entrained to the day-and-night cycle, which directs the body to sleep at night. The worker's rhythm will take some time to adjust to the new routine. For many night workers, the circadian cycle is adversely affected on a regular basis. So on weekends day napping is important for them for entrainment.

Managers should not schedule shift work without understanding its affect on circadian rhythm of workers. Workers take some time to adjust to the new shift, so constantly rotating shifts are devastating.

Shift work may be inevitable in some work settings, like under shut down or "turn around" contracts where time is minimal. Also on projects which cannot meet completion dates without acceleration of the work, require shift work. So the adverse effects must not be ignored. So from safety standpoint, shift work may introduce new considerations. As entrainment takes time, it is crucial to stress safety during first few days or after a shift change. Shift work can be stressful so extra precautions are warranted.

There may also be additional factors that play important role and should not be ignored. When evening or night shift is worked, lighting is an issue. In artificial lighting, workers have tendency to have to work in environment with more shadows and in dark areas not in path of artificial lights. So the work should be supervised. Work stoppages may be longer during later shifts, when materials cannot be easily replaced or available until normal working hours. Such disruptions are not good for safety. Another factor affecting safety is that at beginning of each shift work area is altered from how it last was, for the worker. So workers must begin each shift by assessing what work was accomplished during intervening shift(s). If assessment overlooks a serious hazard, there is increased probability of an accident. Figure 2.5 shows the effect of shift work on rate of injuries.(Hinze, 2002)

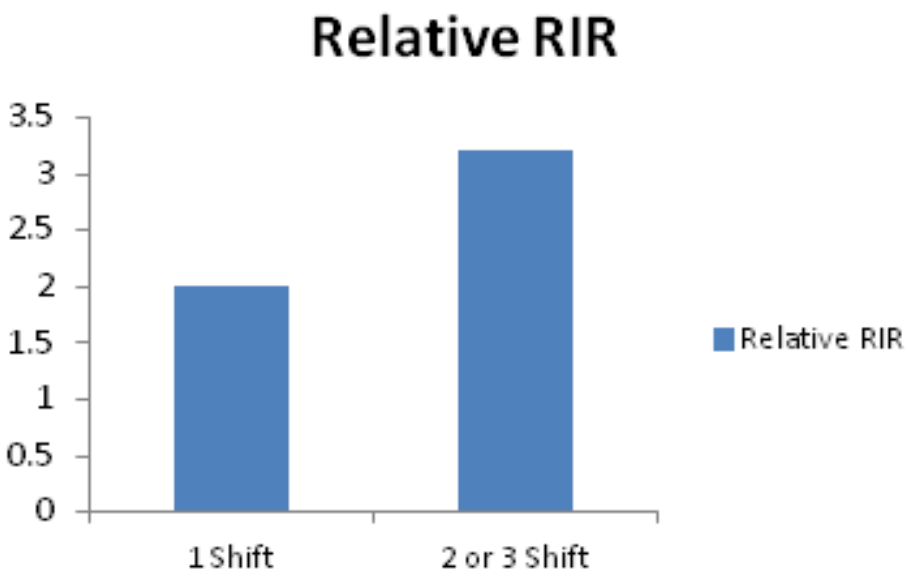


Figure 2.5: Effect of shift work (shift work and Safety Performance (Huang, 2003))

2.4 AN OVER VIEW OF CI IN PAKISTAN

Currently there is no regulatory authority for occupational health and safety management in Pakistan (like OSHA in USA). (Ali T.H., 2006). The primary construction regulatory body (PEC) has yet to lay down safety laws and regulations, to be adopted by all the stakeholders in CI.

Here are some of the statistics related to the CI of Pakistan.

- **CI** contributes **2.5%** to GDP as per State Bank of Pakistan annual report published in 2010-11.
- **6.29%** of total workforce is from CI as per Federal board of Statistics, 2010.
- Occupational injuries and diseases in CI are observed as **20 to 25% of total industry.** (FBSc, 2010; Farooqui et al., 2008)
- Safety Performance Index of CI of Pakistan is observed to be **0.52.** It indicates lack of standard safety management system**(Khan, 2011).**

2.4.1 Safety Laws in Pakistan:

The main laws governing 'Health and Safety' of workers are:

- Factories Act 1934 (chapter 3)
- Government of Pakistan Labour Policy (revised in 2010)
- Health and Safety clauses in PEC's contract documents:
  - Safety, Security and Protection of the Environment
    Clause 19.1 of part-I (General Condition of Contract) of PEC
    Standard Form of Bidding Documents
  - Safety Precautions
    Clause 19.3 of part-II (Particular Conditions of Contract) of PEC
    Standard Form of Bidding Documents **(Khan, 2011).**

2.5 CAUSES OF ACCIDENTS

Clients demand high speed and high quality of work at the lowest cost. Maximizing on profit and saving the time are the prime objectives of majority of contractors. Unsafe conditions exist on many sites and labourers are subjected to numerous hazards. On many sites, no training programs for the staff and workers exist, hazards are not pointed out, and no safety meetings are held. (Farooqui *et al.,* 2008).

Informal assessments have identified that safety non-performance has not only led to unsafe project sites but have also resulted in construction delays, cost overruns, poor productivity and poor product and process (Farooqui *et al.*, 2008). Hence, there is an urgent need to form a safety regulatory authority, run safety awareness programs; arrange formal and informal education and training in safety for all stakeholders. There is also a need to change the mindset of project owners, designers and contractors towards the implementation of safety program in CI. Research (Choudhry *et al*., 2008b) demonstrated that constructors in the developing countries need to implement safety management systems to enhance their safety performance level.

Data records are insufficient for the number of accidents occurring on construction sites. Figure 3.1 shows the available data from labour division of Pakistan about the industrial accidents in factories registered under Factories Act-1934.

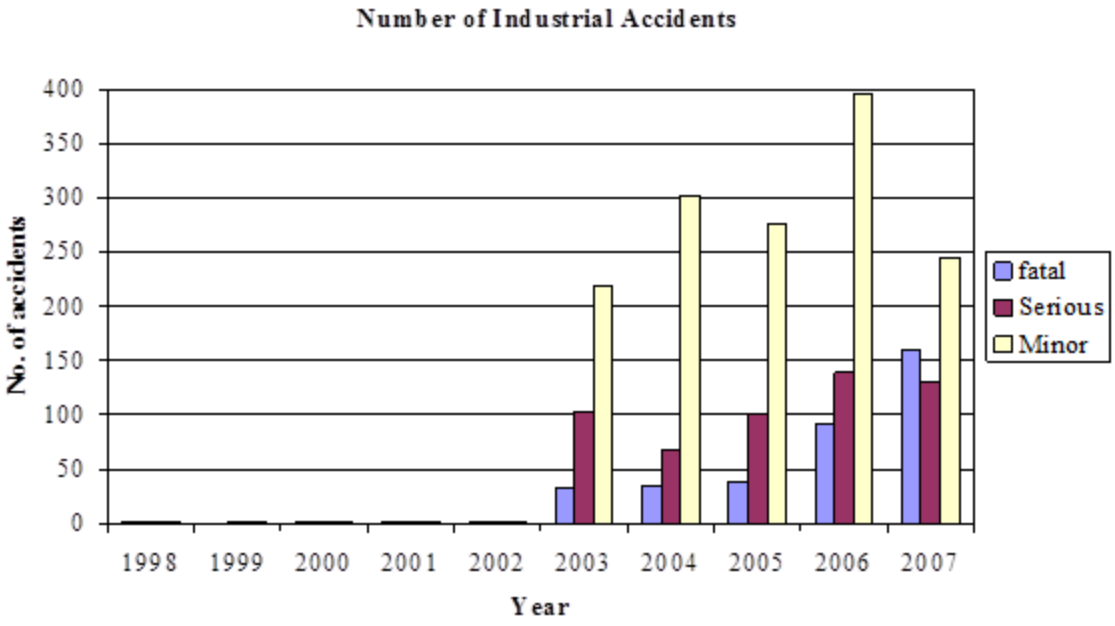


Figure 2.6: No. of industrial accidents in Pakistan,source: labour division (Ahmed, 2010)

Following are some of the main causes of accidents which are observed during construction process**.**

2.5.1 Slips, Trips and Low Falls

These are probably the most common form of accident in construction. Although usually minor, they can lead to many different injuries and ill health outcomes, from musculoskeletal disorders (e.g. strained ankle) to puncture wounds (from falling on sharp materials)

2.5.2 Falls from height

This is the main cause of fatal accidents. These often occur due to:

- Inadequate scaffolding,
- Lack of edge protection,
- Unprotected openings in buildings,
- Lack of edge protection in roof work,
- Dangerous demolition work, and
- Inappropriate use of inappropriate ladders and hoists.

2.5.3 Crush injuries

These occur in unsafe excavations often lead to fatal accidents or serious injuries. They occur when there is inadequate support for trench sides, especially after rainfalls, or when vehicles are operating too close to the edge. Buildings and walls may collapse when supporting structures are undermined.

2.5.4 Being Struck by Falling Objects, Materials or Tools

This is a potentially deadly occurrence. Such falling objects can be due to:

- The lack of toe boards on scaffolding,
- Lack of tool belts for workers,
- Bad storage and stacking, and
- Poor housekeeping.

Injuries may also result from improper use of hoists and cranes, and from being struck, crushed or trapped by vehicles, trucks and machinery.

2.5.5 Electrocutions

This can be due to cable strikes on buried services, or to contact with overhead cables.

2.6 SAFETY PRACTICES DURING CONSTRUCTION

In construction process different practices are exercised to prevent accidents for safe completion of the construction project. Many safety practices are very necessary which should be done during different type of construction projects such as fire safety, safety from electricity accidents, safety from different chemicals materials used during construction and safety of heavy construction material or machinery. Other types of safety are managing the traffic for smooth flow of traffic and completion of under construction project. At construction sites various types of noise produce, cause noise pollution which may disturbed the surrounding. Some of the prominent safety which we are going to discussed below:

- Fire safety
- Safety from electricity
- Traffic management
- Safety from chemicals
- Noise pollution

- Heavy construction material
- Crane safety

In Safety practices, standard methods are followed so that such accidents are to minimize up to great extent.("Safety in Construction Ppt Presentation,")

2.6.1 Fire Safety

On construction sites, labours should be train about fire hazards and train them to use fire fighting equipments; that is what he would do in fire emergency.

2.6.1.1 Requirements for emergency fire exit

There should be an emergency exit point or way in a building even during construction so that if building is on fire every one inside it can exit safely. Exit from building should be properly marked with exit signs. In the Centaurus building design, the exit for upper floors are directly outside the building and not to the corridors ground floor.

2.6.1.2 Fire extinguishers

Fire extinguishers must be placed uniformly on site so that they are easily available in case of a fire and every worker should be trained about its use. Fire extinguishers are very important because it avoid the spread of fire by extinguishing it before it gets spread.

2.6.1.3 ~~E~~quipments for fire fighting

On construction site, if fire start at some place some of the following system may be activate and would be used such as;

- Portable fire extinguishers
- Automatic sprinkler systems
- Fire extinguishing systems, dry chemical
- Fire extinguishing systems, gaseous agent
- Fire extinguishing systems, water spray and foam
- Fire detection systems
- labour alarm systems

("Safety - Armor Automatic Sprinkler | fire sprinkler system, sprinkler automatic fire wholesale, sprinkler automatic fire manufacturer, ceiling fire panel sprinkler, automatic

fire sprinkler, fire sprinkler head, home fire sprinkler, fire sprinkler installation, residential fire sprinkler, fire sprinkler company,")

2.6.2 Safety from Electricity

Electricity can also cause major accidents on construction sites, so for safety proper equipment must worn at all times and places to prevent such type of accidents.

According to OSHA, 150 construction workers are being killed per year in accidents caused by electrocution. Electrical accidents are the third leading cause of fatalities amongst construction workers and nearly half of the deaths caused by electrocution were on the sites of construction jobs.

There are three main category of possibilities due to which electrical accident may occur at construction site. Which are given below;

- Contact with overhead power lines
- Contact with transformers and live wires
- Electrical currents while working with tools, machinery, and other appliances.

2.6.2.1 Contact with overhead power lines

Equipment such as crane and excavator come in contact with nearby power line and cause a major loss of life. To take care and avoid such risks proper safety procedure should be followed.

- Identify overhead power lines and mark safe routes where cranes must repeatedly travel.
- Operate the crane at a slower than normal speed in the vicinity of power lines.
- When working around overhead power lines, de energizes and ground them, or takes other protective measures such as insulating the lines. If the power lines are not de energized, operate cranes in the area only if a safe minimum clearance is maintained.
- Designate a person to observe the clearance and to give immediate warning when the crane approaches the limits of safe clearance.

Safe Distance from Electric Line

While working		In transit	
Line Voltage	Distance	Line Voltage	Distance
50KV or below	10feet	50KV & below	4feet minimum
50KV & higher	10feet+0.4" For each 1KV above 50KV	50KV to 345KV	10feet
		Over 345KV to750KV	16feet

Table 2.1 Safe Distance from Electric Line

To protect against electrical shock, the following procedures are recommended;

- The crane operator should remain inside the cab until the lines have been de energized.
- All other personnel should keep away from the crane, ropes, and load, since the ground around the machine might be energized.
- The crane operator should try to remove the crane from contact by reversing direction.("3 Types of Electrical Accidents on Construction Sites,"), ("EU-OSHA,")("OSHA Construction eTool: Contact with Power Lines - Cranes and Derricks,").

2.6.3 Traffic Management

In any situation of road construction progress, the traffic should be managed so that different type of accidental situation may be avoided. Firstly traffic survey must be of the road would be done and by observing the traffic flow at different times of the day. Through this traffic can be managed at different time of the day. Special plan preparation and coordination with transit and other highway agencies, police and other emergency units, utilities, schools, railroads, etc. may be needed to reduce unexpected and unusual traffic operation situations.

For this proper and standard method should be followed. Side tacking, diversion and the use of flagmen are some of the methods to control such situations. ("Road Traffic Control During Construction,")

2.6.4 Safety from Chemicals

In construction industry different chemicals are used which should be handled properly by workers. So for this we should aware all the workers about the handling, usage and harm in case of accidents. These chemicals are not only flammable but also can damage skin. So to avoid any harm from them the safety guidelines written on the packing should be followed. Some libraries maintain files of material safety data sheets (**MSDS**) for more than 100,000 substances. Exposures to hazardous and toxic substances are addressed in specific standards for the general industry, shipyard employment, and the construction industry.

2.6.5 Noise pollution

On construction site noise pollution is an important problem which can disturb the workers as well as the surrounding people which may object the contractor. So

Some of the following are the site problems which can be handled in a proper manner.

- All machinery and equipment would be well maintained to keep noise to a minimum level.
- All vehicles and equipments would be provided with exhaust silences.
- Blasting would be carried out only with permission of the Engineer.
- Noise level due to the quarrying operations at the boundary of the quarry would be maintained at or below 55dB during working hours.
- All the statutory laws, rules, regulators pertaining to transport, storage, handling and use of explosives would be strictly followed.
- Blasting activities would be carried out during fixed hours as permitted by the Engineer.
- The timing would be made known to all the people within 500m from the blasting area.

2.6.6 Construction Material & Machinery

On construction sites there are number of materials which are being used for construction purpose and which can also cause injuries if proper care is not taken.

The main possible danger to the construction equipment is;

- Falls from equipment, scaffolding, and other high places are dangerous and far too common. All construction sites are required to provide basic fall safety precautions and standards.
- Position of stairs and ladders may cause great damage to the workers as well as to the equipments. Use at an angle where the horizontal distance from the top support to the foot of ladders one fourth the height of ladder is.
- The bad condition of scaffolding also causes falls and if put together improperly can cause injuries and death. Often people think about heavy construction equipment safety with respect to equipment that moves but standstill equipment can be just as dangerous when not used properly.
- Heavy equipment that can shock you, fires, explosions, and electrocution are all present hazards at almost any construction site and precautions and safety standards should be followed. This is one of those hazards that can actually start off a chain reaction of negative events which makes electrical safety even more important.
- Excavation alone account for one percent of all work related deaths. Collapsing walls, electrocution, explosions, deep water drowning, unstable soil, and more all play a part in the high death rate of workers.
  ("Heavy Construction Equipment Safety,")

2.7 WAYS TO IMPROVE SAFETY

Following are the different ways employed to reduce the risk of an injury.

2.7.1 Personal Protective Equipments (PPEs)

These can be defined as the specialized clothing or equipment used by workers for the purpose of personal safety. They may be used to protect specific parts of body, such as eyes, ears, head, feet etc. Sharp edges, falling objects, noise, chemicals etc may be the cause of different injuries and hence PPE should be used to protect workers from these hazards. PPE may include gloves, foot and eye protection, protective hearing devices (earplugs, muffs), hard hats, respirators and full body suits. (See figure 2.7)

Figure 2.7: Personal Protective Equipments (PPEs)

Contact with different chemicals may cause skin diseases such as skin cancer or contact dermatitis. Other potentially harmful things may include exposure to solar radiation, electric sparks and extreme temperatures.

Figure 2.8: Personal Protective Equipments (PPEs)

Employer must train the employees to know that which type off PPE and why is it necessary, how to use it properly and consequently, its limitations. Further different sign boards can also be used for the same purpose as shown in figure 9.

Figure 2.9: Sign boards at site for Personal Protective Equipments (PPEs)

2.7.1.1 Eye and face protection

There are some personal protective equipment that protects workers from threats such as flying particles, molten metal, liquid chemicals, acids, chemical gases, infected material or harmful radiation.

Figure 2.10: Eye protection Personal Protective Equipments (PPEs)

- **Hearing Protection** protects against noise induced loss of hearing and other related threats.

Figure 2.11: Ear plugs

A main reason for occurrence of injuries is the non-compliance of PPE. So, this can be improved by monitoring the employee, improving the existing strategies and developing incentive programs.

The "Occupational Safety & Health Administration" (OSHA) requires all workers to wear PPE to avoid sustaining an injury. Yet majority of workers who sustain an injury, were either not wearing PPE or wearing the wrong one.

- **The excuse for not wearing PPEs**

  Some of the major reasons workers not wear PPE, include

  - The PPEs being uncomfortable
  - Being unattractive
  - Not properly fitting
  - Not being available near the job-site

It is the duty of the employer to keep the size and shape of the employees in mind when purchasing the PPE. Wearing PPE should be a condition of employment.

Another way to improve PPE compliance can be through safety incentives. Many companies give safety awards if an employee goes for a year without any lost-time accident. Whatever the case, the main prize is staying safe throughout the career.

Strategies to get workers to wear PPE

- No exceptions should be allowed when it comes to safety. Everyone should wear PPE.
- Spending money on PPE shows your concern for the safety of workers. The return on investment on PPE is virtually immediate. It shows that you care for your workers.
- Training is the first step in safety. Training sessions should be held to show the employees proper care and handling of the PPE.
- Discipline is necessary. The employer may diminish morale or lose credibility if he is inconsistent with the use of discipline.("WHAT'S YOUR EXCUSE FOR

NOT WEARING YOUR PPE?,")("8 Ways to Get Workers to Wear PPE | SafetyXChange,")

2.7.2 Workers Involvement in the Safety

Another technique that most of the safety officers use for improving safety is that they involve workers in safety process by means of pre-Planning.

2.7.2.1 Pre-task meetings

Workers are valued source to any enlightened supervisor and they can be involved in the safety process by formal means. One such technique is pre-task planning. Pre-task planning is a formalized or standardized system where workers are directly involved in the safety process to the task that are performed at the crew level. ("Construction safety" by Jimmie Hinze 2nd edition) . As the name suggests, this is the planning just before the task is performed and this is done at the crew level. Before a task is undertaken, the crew members will have a "huddle session" in which they will first discuss how the work will be performed. This meeting may be conducted by a foreman or a designated worker. After the crew has a relatively clear understanding of how work is going to be performed, they are then asked to consider the hazards associated with the task. This may result in a change in the work plan in which different tools, equipments, or different work procedures are utilized. After this the hazards are again considered. This iterative process will continue until the crew members are comfortable with safety aspects of the proposed work plan.

If hazards cannot be eliminated, means of worker protection are then considered. Once the hazards are reduced to minimal level the task can then be performed. The main advantage of this technique is that the all the crew members are aware of the work hazards. Secondly, when the crew will see the concern of officials related to their safety, the crew will do the task with full attention and will not ignore the safety plan.

It is common to document the contents of the results of pre-task planning meetings. There are no standardized pre-task planning forms in the construction industry, but some features appear on most of the many forms that are used in the industry. For example, it is common for the form to consist of a many items that can simply be checked off. This reduces the paperwork burden for the scribe who documents the pre-task planning meetings. Most forms will contain information regarding the date, the identity of the individual completing the form, and the task to be

performed as described in a brief narrative. The form may also ask for information about the materials needed to perform the task and the equipment or tools that will be needed to install the materials. The materials may be inherently dangerous and this can generally be ascertained by reviewing the material safety data sheet (MSDS) for each material being installed. A sample pre-task planning form is shown in Figure 2.12. This form is fairly extensive in the type of information that it captures. Most forms that are in use today are shorter and perhaps simpler in format. The form that is shown was developed by examining various pre-task planning forms that are currently being used by various contractors.

2.7.2.2 The post-task assessment

The pre-task plan should be critically analysed after the completion of the task so that any lesson learned can be documented. If any incidents (injuries or near misses) occurred, these should be carefully documented and preventive measure for the task should also be documented so that the same task can be performed in a much safer mode in the future. If better procedures are recognized, these should also be documented (**see Figure** 2.13).

After the task is completed and a post-task evaluation is documented, the pre-task planning forms are filed. The information may still have lasting value, even if the task has been successfully completed. For example, after a few months on a project, several hundred pre-task planning forms may have been accumulated. It may be of some value to evaluate the aggregate pre-task planning forms. For example, certain hazardous materials may be identified in several different forms or there may be repeating notes about improper tools or equipment. When there is a consistent recurrence of these types, some consideration might be given to avoid them in the future. Any comments about lessons learned might also be consolidated to see if there are any consistent patterns that might provide valuable insights.

The pre-task planning meetings have been proven to be effective in reducing workplace injuries. While there are many variations of conducting pre-task planning meetings, the principles that are to be followed are quite similar. The main purpose of a pre-task plan is to involve the workers in the safety process.

Pre-task Planning Checklist

Start Date: _____ Finish Date: _____

Your Name: _____ Job Number: _____

Company: _____ Job Name: _____

Specific Location of Work: _____

Answer the following when evaluating your work		Are any of the following required?	
Have you walked your work area to address lighting, housekeeping, slip & trip hazards etc?	☐ Yes ☐ No ☐ N/A	**Permit?**	**PPE?**
Have all tools and equipment been inspected prior to use?	☐ Yes ☐ No ☐ N/A	☐ Lockout/Tagout	☐ Hard Hat
Are qualified operators certified / trained? (Scissor lift, forklift, crane, power actuated tools etc?)	☐ Yes ☐ No ☐ N/A	☐ Confined Space Permit	☐ Fall Protection
Are materials and tools adequate to perform the job?	☐ Yes ☐ No ☐ N/A	☐ Hot Work Permit	☐ Eye/Face PPE
Has the work plan been coordinated with other crafts in the area?	☐ Yes ☐ No ☐ N/A	☐ Barricade/Signage	☐ Hand / Arm PPE
Does this task require any special permits or procedures?	☐ Yes ☐ No ☐ N/A	☐ Excavation / trenching	☐ Hearing PPE
Have you addressed any barricading requirements appropriate to the task?	☐ Yes ☐ No ☐ N/A	☐ Other	☐ Foot PPE
Are you working around live systems or energized equipment?	☐ Yes ☐ No ☐ N/A		☐ Respirator
Do you need to review MSDS's to proceed with this work?	☐ Yes ☐ No ☐ N/A	Notified of	location of
Have employees been trained in the proper usage and disposal of PPE?	☐ Yes ☐ No ☐ N/A	☐ Emergency Phone Numbers	☐ Emergency exit routes
Have employees been trained in safe ladder usage?	☐ Yes ☐ No ☐ N/A	☐ Fire Extinguisher locations	☐ Eye wash Stations
Are enough people assigned too safely complete the task?	☐ Yes ☐ No ☐ N/A	☐ First aid equipment	☐ Other
Is there a new hire that will need support?	☐ Yes ☐ No ☐ N/A	Other:	
Notification to Owner	☐ Yes ☐ No ☐ N/A		
Other:			
Any item checked on the "CHECKLIST" must be addressed on the "WORKSHEET"			

Figure 2.12: Pre-task planning checklist (continued)

Pre-task Planning Worksheet

Task: _____

A: Steps for Work	B: Hazards	C: Steps Taken to Address Hazards

BACK SAFETY: STRETCH & FLEX ** Proper planning and stretching will help back injuries caused by heavy lifting and exertion**	
Will your work require LIFTING, STRETCHING or BENDING?	☐ Yes ☐ No
Have you completed stretch and flex today?	☐ Yes ☐ No
Have you been trained in proper lifting techniques?	☐ Yes ☐ No
SAFE LIFTING PLAN: Will you need to get help or additional equipment. Define plan below.	

	M	T	W	Th	F	Sat	Sun
Signatures **Date**							
Safety:							
Supervisor:							
Crew:							
Other:							

Figure 2.12 continued

Additional Signature Page

Signatures **Date**	M	T	W	Th	F	Sat	Sun
Safety:							
Supervisor:							
Crew:							
Other:							

Signatures **Date**	M	T	W	Th	F	Sat	Sun
Safety:							
Supervisor:							
Crew:							
Other:							

Signatures **Date**	M	T	W	Th	F	Sat	Sun
Safety:							
Supervisor:							
Crew:							
Other:							

Signatures **Date**	M	T	W	Th	F	Sat	Sun
Safety:							
Supervisor:							
Crew:							
Other:							

Signatures **Date**	M	T	W	Th	F	Sat	Sun
Safety:							
Supervisor:							
Crew:							
Other:							

Figure 2.12: Pre-task planning checklist

Post Task Completion Review

Date: ---------Time: ----------

Task is completed ☐ Yes ☐ No

Work area has been cleaned up: ☐ Yes ☐ No

Locks and tags have been removed: ☐ Yes ☐ No ☐ Not Applicable

Permit has been turned in: ☐ Yes ☐ No ☐ Not Applicable

Comments (if any an answer above is "No", please comment):

_____

_____

Did any incidents occur? ☐ Yes ☐ No

If yes, describe: _____

_____

What should be done differently, if this task is repeated?

_____

_____

Lessons learned: _____

_____

Completed Form Submitted by: _____

(Signature)_____

Figure 2.13: Post task completion review {**Source:** (Hinze, 2002)}

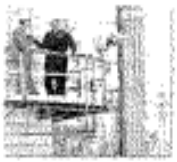
2.8 SAFETY POLICY

A health and safety policy is a written statement of principles and goals embodying the company's commitment to workplace health and safety (CSAO, 1993; Dorji and Hadikusumo, 2006). It demonstrates top management's commitment to ensure safe working methods and environment at the construction sites. Koehn et al. (1995) and Dorji and Hadikusumo (2006) states that in order to reduce financial risk, management support for safety programmes in both developed and developing countries should be considered as an economic necessity since accidents had proved quite costly to the contractor. This is in addition to the ethical and professional responsibility of the management for providing a safe work site for all employees. The safety policy elements which are applicable in Pakistan are written safety policy, proper posting of policy, effective implementation and policy updating.

2.8.1 Safety Policies of Pakistani Construction Companies

Most of the construction companies in Pakistan do not have any safety policy; however some large construction firms registered with PEC in category CA (no limit category) have made their safety policy (see figure 3.10 & 3.11) but it is not implemented in true spirit.(Khan, 2011)

QHSE Policy



Descon's team at all levels shall endeavor to ensure the satisfaction of all stakeholders by providing the best value in every product and service by recognizing that Quality, Health, Safety, Environment and Community responsibilities are an integral part of our operations.

We shall achieve this by:

- Establishing and reviewing QHSE objectives and targets.
- Developing and implementing management structures and procedures.
- Monitoring, evaluating and continually improving our QHSE performance.
- Recognizing that QHSE is everyone's direct responsibility.
- Continually enhancing awareness, skills and systems efficiency.
- Participating in product and process improvement initiatives, risk mitigation and prevention measures.
- Making each team member accountable for QHSE matters.
- Meeting all internal and external commitments.
- Abiding by the applicable legal framework requirements related to QHSE.
- Ensuring that the QHSE systems of our suppliers and subcontractors are compatible with our own commitments.
- Exercising integrity and respect in dealing with each other, customers, suppliers and society at large.
- Communicating this policy to all stakeholders, providing training and encouraging behavior that upholds this policy.

Zakaria

Dr. Salman Zakaria
Chief Executive Officer

DIMS / QHSE Policy
Rev. 02, Jan 01, 2010

Figure 2.14: A Typical Safety Policy (Courtesy DESCON)

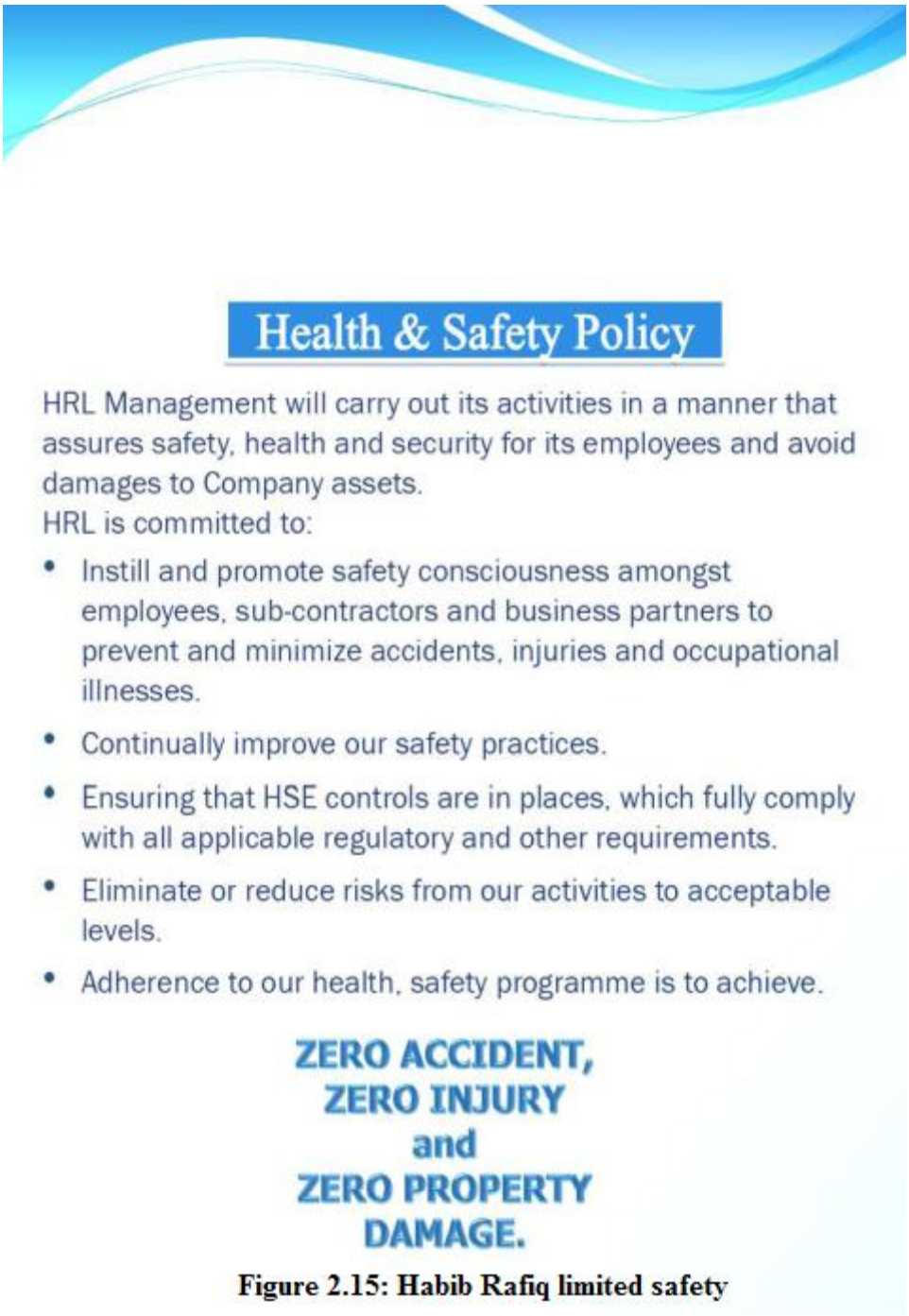


Figure 2.15: Habib Rafiq limited safety

2.9 THE TRUE COSTS OF CONSTRUCTION WORKER INJURIES

There will be a great concern in the management team of the project if they know the economic and performance disturbance due to accidents. This section will highlight the in-depth analysis of cost related worker injuries.

There are two types of cost related to workers injuries which are given below:

- Direct cost of Injuries
- Indirect cost of Injuries

2.9.1 Direct Cost of Injuries

The costs which are associated directly with injuries are direct cost which is generally covered by the worker's compensation insurance policies. Example of such type of cost is medication, hospitalization and disability benefits, including a percentage of the lost of wages of the injured workers. To determine the expenditures of each injury, the historical record can be analyzed. Direct costs are well defined and can be easily calculated and quantified.

2.9.1.2 Worker's compensation

Workers' compensation is an insurance policy of a construction firm for their workers when they are injured on the work site. This policy doesn't works for the workers when they are injured elsewhere.

The premium which is paid by an employer is based on two numbers. The first is the manual rate established for a particular craft in the state which is published in the worker manual. The second is a multiplier or modifying value that shows the past experience of the specific person. The manual rate is stated as the cost of insurance per $100 of payroll or simply as a percentage of payrolls. For example, the workers' compensation manual rate of a carpenter in a particular state might be $18.40 per $100 of payroll while in other state it might be 11.8% of payroll. The manual rate applies uniform to a particular craft in an entire state. The rate may be vary from 5% to 100%depending on the compensation for a trade exceeds the actual cost of wages. The manual rate in the industry is nearly 30%of the cost wages. The calculation of the manual rate is based on the past experience of claims for that craft in that state. The manual rate in a particular craft will be high in a state where several very bad accidents have been incurred by that craft.

Thus the difference in the manual rates between two states may reflect the differing accident history in those states.

One of the cost claims is the compensation paid to workers for their lost wages when they cannot immediately return to work. For example, in one state an injured worker may receive compensation for lost days after losing three days of work while in other state a worker may not receive compensation until he or she has lost five days. State that have longer periods before compensation is due for lost wages have lower claims cost than state that have short periods. For example in one state a worker injured may compensate at 60% of the regular wages while in other state it may be 90%of the regular wages. Such type of many different factors causes the manual rates to differ between states.("Costs of Construction Injuries : Journal of Construction Engineering and Management: Vol. 117, No. 3 (ASCE),").

Experience Modification Rate (EMR)

Experience Modification Rate (EMR) has strong impact upon a business. It is a number used by insurance companies to gauge both past cost of injuries and future chances of risk. The lower the EMR of your business, the lower your worker compensation insurance premiums will be. An EMR of 1.0 is considered the industry average ("EMR -- Experience Modification Rate,").

2.9.2 Indirect (Hidden) Cost of Injuries

The cost related to injuries that is hidden or for which no historical record is kept and for which there is no retrieval mechanism to accurately associate them with injuries is indirect cost of injuries. For example, suppose a concrete wall form is being set by a crane and two Carpenters. As the wall is being adjusted nearly its final location, one of the carpenters, feeling that that form is reasonably secure. When the wall is lifted slightly, it suddenly begins to rotate and strikes the other carpenter. The injury is not serious but the work stopped for about 20 minutes for first aid. During those 20 minutes each of the carpenters is paid at the rate of $22 per hour and similar wage to the crane operator the crane which is rented at a rate of $100 per hour. All those cost calculated by the construction firm and the cost of the 20 minutes would probably be recorded as a part of the cost of forming. The cost should really be applied to the first aid injury. The cost of the injury is hidden. A description of some of the indirect costs of injuries will clarify the types of costs which are hidden.

The best clear example of indirect costs is the injured construction worker. When a worker becomes injured, it is a standard practice for the worker which is injured to be paid while receiving the treatment as well.

Another indirect cost is the cost of transporting the injured worker to a medical facility for treatment. This cost comprises of the cost of use of company vehicle, wages of the staff member or the fellow workers which company to the injured one.

An injury to a worker, have also a negative effect on the other workers which are working around him. Due to an accidental injury of a worker, the whole rhythm of the workers disturb and the whole work stop for sometime due to which the worker loss the moment of the work which they have attained. The works also start discussing the situation of accident.

An injury to a worker also cause the productivity become low due to the crew size become less as compare to before the accident. So to compensate, crew should be arrange which causes the productivity to become low. And if the injured person doesn't return to work or give him another place for working, so another worker should be hired to fill his place.

If an injury is particularly severe or dramatic, it attracts media attention. Dealing with the media consumes considerable supervisory time. If an injury attracts media attention, it will be undoubtedly also attract the attention of regulatory personnel and a lot of time will be wasted in such activity and productivity will become low.

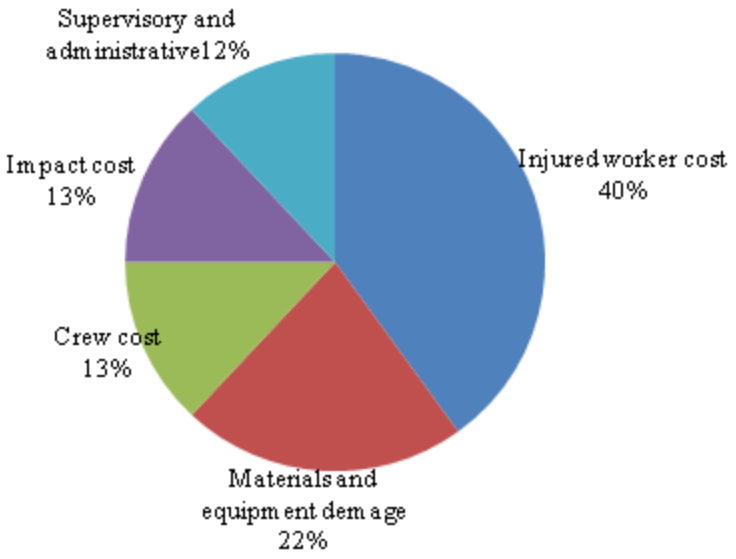
Safety professionals have recognized the presence of indirect or hidden cost, cost of injuries for decades. Some of the indirect costs are stated below:

1. Cost of lost time of injured worker.
2. Cost of lost time of other workers who stop work.
3. Cost of time lost by foreman, supervisor or other executives.
4. Cost of the time spent on the case by first aid attendant and other staff.
5. Cost due to damage to equipments, tools, property and materials.
6. Cost to employer under welfare and benefit systems.
7. Cost to the employer for continuing wages of injured worker.
8. Cost due to loss in profit due to idle equipment.
9. Cost of overhead (utilities, telephone, rent etc.)

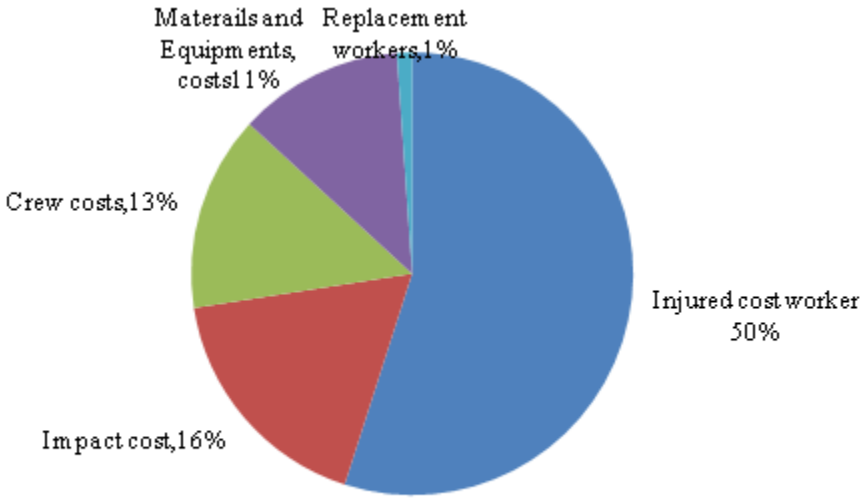
Few researchers try to calculate the true cost of workers' injuries. Most researchers have compared the indirect cost with the direct costs and calculate ratio of indirect cost to direct cost. The first such estimate was made by H.W Heinrich in 1941. He determined the ratio of indirect cost of injuries to that of direct cost and found this ratio approximately equal to four. It is a value widely and frequently quoted. With rapid increase in health care (direct cost), so it might be expected that the value become low now. Some other researchers showed that the ratio may be ten (10) or high as fifty (50) which were showed by Sheriff (1980) and Loftus (1976) respectively. (Hinze, 2002)

2.9.3 Costs of Injuries Quantified

A study of over hundred construction projects has contributed towards costs of injuries quantification. These projects provide all type of injuries cost data from somewhat 185 construction industries in thirty four different states. All the projects which were studied were in cost range of $1million to $500million. All the projects were of three to four types. Some of the projects were fixed price or unit price, maintenance projects, renovation projects and some were new construction projects. A survey was held and completed which showed that 834 construction worker injuries happened. Half of the injuries were of pipe fitters, labourers and carpenters.



Graph 2.1: Job-site cost breakdown of medical-case injuries



Graph 2.2: Job-site Cost breakdown of restricted-activity or lost workday cases

Data of medical case and lost workday

Source of injury	Medical case	Lost workday
Injured worker	176.93	815.58
Workers crow	51.4	178.90
Crew in vicinity	4.19	34.27
Replace. Worker	0.71	21.74
Admin. Staff	51.3	135.90
Damage prop.	100.80	174.62
Total field Indirect cost	442.40	1613.21
Others & Claims	57.07+171.20	252.20+12,610
Total Indirect cost	613.60	14,233.36
Total Direct cost	519.15	6,910

Table 2.2: Data of medical case and lost workday

The analysis of the data was divided into two types of Injuries i.e. one is that which medical case injuries and the other is lost work day cases. In the first case worker is attended by the on doctor and after that the worker return to work. In the second case i.e. lost day work case, the worker could not return to work the following work day and the work had to be assigned to another worker because of injury. For the first case the total indirect cost was $613.60 and total direct

cost was $519.15 while that for lost-workday cases, the total Indirect cost was $14233.36 and total direct cost was $6909.98. (See graph 2.1 & 2.2 and table 2.1)

For the two categories, the value of ratio of total indirect to total direct costs were computed which is 1.182 and 2.058 for medical case injuries and lost work day case respectively (Hinze, 2002).

2.10 ACCIDENTS INVESTIGATION AND RECORDING

Following are the proper steps according to which the accidents may investigate and recorded:

- Report formation
- Investigation reports
- Summary analysis forms
- Statistical analysis
- Summary reports for management

2.10.1 Report Formation

Use of a suitable standard report form allows the collection of information in a uniform way. The design of the report form is important. As the forms will usually be completed at the site level it will assist site staff if they are only asked to give information which is likely to be readily available to them. Whatever detail is asked for, and whatever the final design of report form is, it will be helpful to require at least those answers to be given which are required by local or national authorities.

Report forms should not send the following information:

- Assigning blame for the incident
- Make comments from your own side which is not asked by the authority
- Draw conclusion about the situation

The reason is that these are legal proceeding evidences where liability is an issue and this type of statement may be found to constitute an admission of liability where none was intended.

2.10.2 Investigation Reports

The person or team carrying out an investigation of an incident should record their comments in writing. This may or may not involve the completion of an internal investigation report form. Again care should be taken to avoid making statements or comments which are not factual. Recommendation to prevent a recurrence should be made in the form of a letter attachment rather than on a report form, again for legal reasons.

The report should be arranged by keeping in mind that the reader who will read is not aware of anything. For this reason no assumption should be made about the level of knowledge possessed by the report's readership. Sketches, plans, drawing are included to amplify the written report.

The clarity of thoughts will be assist by the report layout and format which will help in proper investigation of the situation happened.

2.10.3 Summary Analysis Forms

The system of performance measurement needs a way of recording the types of incidents and their consequences so that common casual can be isolated, future problem areas can be predicted, training can be focused and trends assessed. Depending on the size of organization, it may be necessary to collect data from site by safety manager and present it in monthly executive summary report.

2.10.4 Statistical Analysis

It is always tempting to compare with national or industry data but the relative size of the samples must be remembered when doing so. Also industry frequency and severity rates, where published are often based on guesswork on the hours worked and can take no account of under-reporting of injuries to the authorities. Generally, the best comparison to use is a previous time period within the same business or benchmarking partners.

2.10.5 Summary Reports for Management

Monthly summaries of injury figures should be presented in a format which makes valid comparisons easy. The use of pie charts and other presentation aids should be considered. It is important that the person designated should be competent person for the purposes of the management of the health and Safety. A solid amount of statistics alone rarely provides enough meaningful information for the senior management. A written summary of lessons learned,

action taken and the current status of the organisation's rolling safety programme should also be included.

YOURCO INITIAL ACCIDENT REPORT — SUMMARY

Project Name:	Report distribution (the day after accident): Project Manager Area/Senior Manager Safety Manager

1. Name of the injured person	
2. Date and time of the accident	
3. Where on site did the accident happen?	
4. Injured person's nationality	
5. Employer of the injured person (state if self-employed)	
6. Trade or occupation	
7. Details of what happened and the injury as known at this time:	
8. Witnesses: [give their names, location and employers' details].	
9. What action has been taken to investigate and prevent a recurrence, and by whom?	
10. Have local procedures been complied with? [All necessary authorities, insurers and the like have been informed]	
11. Name and status of the person sending this Report	
12. Signature	
13. Date of this Report:	Day Month Year

Figure 2.16(a): Initial Accident Report Source: "Principal of Construction Safety"

YOURCO

DETAILED ACCIDENT REPORT

(Sheet 1 of 2)

Accident Report No: Date Received:	Project Name:	Distribution: Project Manager Senior Manager Safety Manager

INJURED PERSON

1. Name:
2. Nationality:
3. Address:
4. Employer:
5. Age:
6. Married ☐ Single ☐

ACCIDENT

	Day	Month	Year	Time
7. Date and time of accident:				

8. Exact location on site:
9. What time did the injured person start work the day of the accident?

10. When did they stop work as a result of the accident?	Day	Month	Year	Time

11. What was the injured person doing at the time of the accident?
12. On what level was the injured person working?

Excavation	Basement	Ground	Roof	Upper Level	Other	*

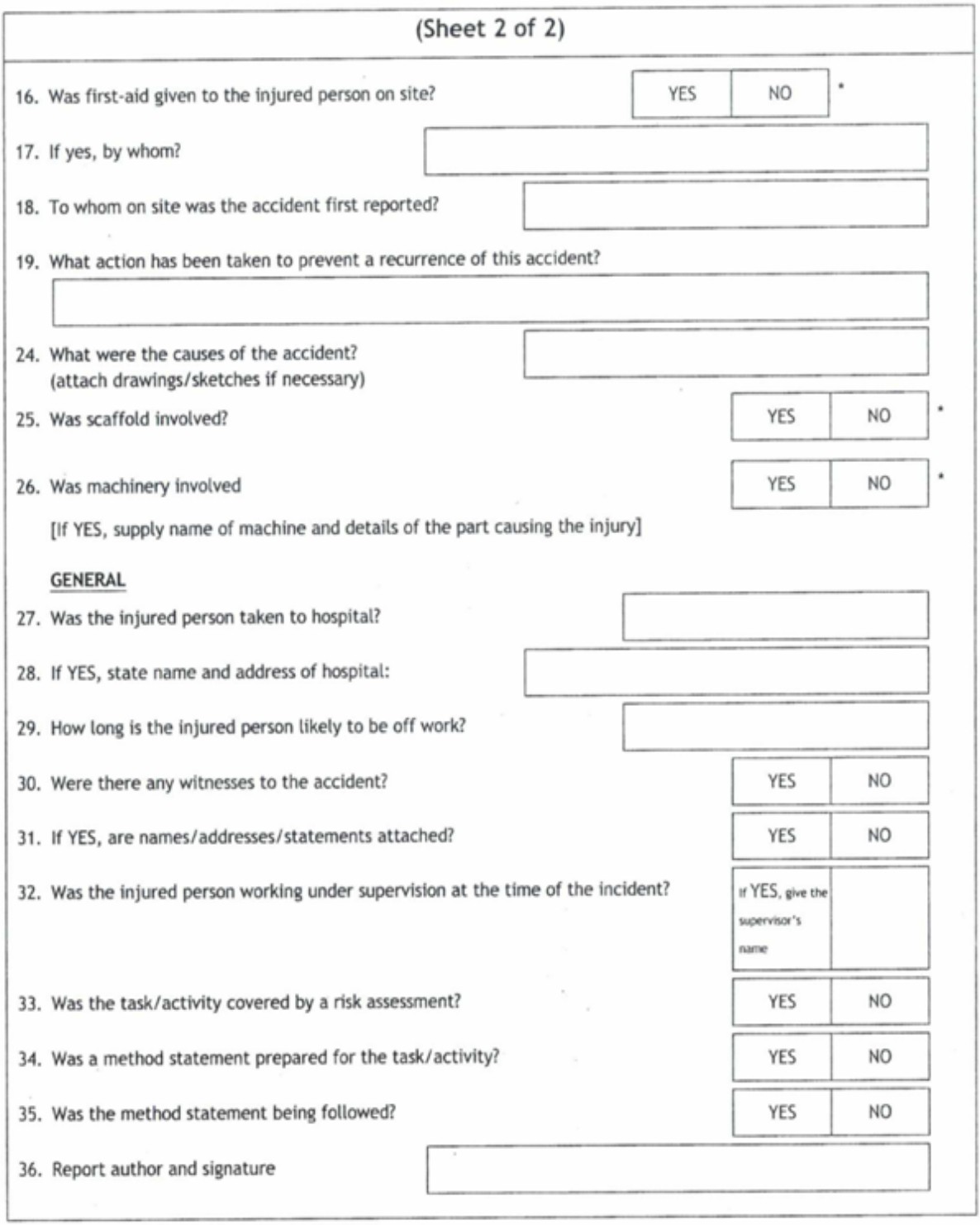
13. Was this the injured person's authorised work?

YES	NO	*

14. Nature and extent of injury: (state exact parts of body injured)
15. If injured person fell, or an object fell on them, state the height of the fall:

* – Delete as appropriate

Figure 2.17(b): Detailed Accident Report Source: "Principal of Construction Safety"



(Sheet 2 of 2)

16. Was first-aid given to the injured person on site? YES | NO *

17. If yes, by whom?

18. To whom on site was the accident first reported?

19. What action has been taken to prevent a recurrence of this accident?

24. What were the causes of the accident? (attach drawings/sketches if necessary)

25. Was scaffold involved? YES | NO *

26. Was machinery involved YES | NO *

[If YES, supply name of machine and details of the part causing the injury]

GENERAL

27. Was the injured person taken to hospital?

28. If YES, state name and address of hospital:

29. How long is the injured person likely to be off work?

30. Were there any witnesses to the accident? YES | NO

31. If YES, are names/addresses/statements attached? YES | NO

32. Was the injured person working under supervision at the time of the incident? If YES, give the supervisor's name

33. Was the task/activity covered by a risk assessment? YES | NO

34. Was a method statement prepared for the task/activity? YES | NO

35. Was the method statement being followed? YES | NO

36. Report author and signature

Figure 2.17(b): Detailed Accident Report Source: "Principal of Construction Safety"

2.11 SAFETY IN BUILT STRUCTURES

Safety is not only of prime concern during construction but also it was kept in mind while designing building especially high rise buildings. A building should be safe for the residents in case of any emergency like a wild fire.

2.11.1 Safety in High Rise Buildings

Safety in high rise buildings is an important thing. The design of high rise building safety should be safe in context of evacuation, because sometimes there is a need of full scale evacuation and the people of building need to act quickly for their safety. Emergency evacuation plan will help people in emergency situation and they will act quickly in these situations like fire, smoke or other emergency situations. When the full scale evacuation is required these things will help people.

2.11.1.1 Evacuation systems for high-rise buildings

Evacuation systems are very necessary for high rise buildings. Fire prevention, fire protection, evacuation programming and planning and complete rehearsal for survival are needed to minimize the losses in the event of a fire.

Fire will cause many losses, so there should be an emergency evacuation plan for the safety of high rise buildings. Each building presents unique problems in emergency evacuation due to difference in its design, structure, fire resistant qualities, height and occupancy. So each building should have its own evacuation plan.("High Rise Life Safety Program,")

2.11.1.2 Efficient evacuation

Efficient evacuation depends on pre-planning, organization and supervision. This planning includes:

1. Evacuation policy and plans.
2. Detection and reporting of fire or hazard.
3. Evacuation program coordination.
4. Communication to direct movement and evacuation.
5. Inspection and evaluation.

2.11.1.3 Emergency evacuation plan

The emergency evacuation plan should include: An outline of the emergency evacuation organization plan and agreed-upon priorities, including responsibilities and authorities.

2.11.1.4 Evacuation routes

Building's emergency evacuation plan should include drawings, diagrams and evacuation routes. Floor numbering and direction of movement should be included in stairwells.

2.11.1.5 Central control

The building's emergency evacuation plan should indicate how central control will function in the event of a fire and the need to move and evacuate persons.

2.11.1.6 Floor evacuation teams

There should be floor evacuation teams on each floor which will help people in evacuation and a proper communication system should be there between these teams for swift and safe evacuation.

2.11.1.7 Evacuation drills

There should be a schedule of programmed fire and evacuation drills in emergency evacuation plan may twice a year. These drills are very important because in case of an emergency they do help people in safe evacuation and reduce the panic level.

2.11.1.8 Detection system

There should be detection, automatic alarm system and water sprinkler system in fire protection program. If fire is detected then by the alarm system, occupants of the building will become alert and the water sprinkler system will act as a fire resistant.

2.11.1.9 Means of evacuation

Emergency evacuation plan should contain the safest and most efficient means of evacuation. This decision should be made by the floor evacuation control teams.

2.11.1.10 Exiting

The direction of movement should be made by the floor evacuation teams to make sure that traffic flows out and away from the building at all exit terminal points. There should be the safe way to exit. Exit plan is also made by the evacuation teams.

2.11.1.11 Use of stairwells

Evacuation must be done by the means of fire stairwells. There should be the direction of movement on each floor and there should be the floor numbers.

2.11.1.12 Bomb-threat emergencies

Bomb threat emergency evacuation is the same as that of fire emergency evacuation plan except there is also use of elevators in bomb threat emergency. The decision of evacuation is made by the police or bomb-squad team. Communication channels should be provided for direct and accessible reporting.

2.11.1.13 Methods of communication

Communication systems include personal wireless pagers, loud speakers and telephones. These systems are used for the communication in emergency situations. Fire call stations are located on each floor. Alarm systems also used as communication system in emergency situation.("Drills : Safety : The University of Melbourne,")("How To Illuminate Stairs – Step Lights,")("High Rise Life Safety Program,").

2.11.2 Fundamental of High Rise Building Fire Safety

Modern high rise buildings have fire protection systems installed by default.

2.11.2.1 Fire breaks glass alarm (B.G.A.)

Fire break glass alarm allows occupants to activate the fire alarm system and alert the fire brigade easily. This is located on walls of the buildings in red panel that when depressed will contact fire brigade automatically. The glass material is easy to break with fist, elbow or pen.

Figure 2.18: Fire Break Glass Alarm

2.11.2.2 Fire control systems

Some buildings are fitted with automatically water sprinkler heads. They are temperature sensitive and each sprinkler is activated when it senses the critical temperature. It works when there is fire in the room or any part of the building throwing water sprinkles on the fire which stops the fire to spread. Flood systems are used to extinguish the fire in special risk locations like flammable liquid store rooms and computer rooms.

Figure 2.19: Fire sprinkler

2.11.2.3 Fire indicator panel (F.I.P.)

This is the hub of fire alarm system in the building. The panel is located in the cabinet or on the wall. There is number of lights and buttons on the panels. The lights indicates the which floor is under fire. And it will automatically notify the fire brigade by the alarm.

Figure 2.20: Fire indicator panel

2.11.2.4 Fire doors

The fire doors are installed to minimize the spread of fire. These doors are operated by the heat activated mechanism and smoke detectors. Fire doors may be automatically operated by heat activated mechanisms or smoke detectors. The securing of fire doors must be such that persons leaving an area via the fire door can do so without the use of keys or similar at all times. Fire doors must not be wedged open.

2.11.2.5 Smoke and thermal fire detectors

These detectors are used for fire detection. They sense heat and smoke and are used for the early warning of a fire. These detectors are also used for the activation of fire doors.

Figure 2.21: Fire sensor

2.11.2.6 Fire extinguishers

These are the portable fire-fighting equipment. The fire extinguishers should be provided on each floor of building to eliminate the spread of fire.

Figure 2.20: Fire extinguishers

2.11.2.7 The use of fire-rated glass in high rise construction

Fire-rated glass provides interesting clear views inside and outside of the building, allows natural day lighting to stimulate the people who use the building where there otherwise would have been an opaque wall. They keep the fire with in a compartment and do not allow the fire to spread. ("Safety - Armor Automatic Sprinkler | fire sprinkler system, sprinkler automatic fire wholesale, sprinkler automatic fire manufacturer, ceiling fire panel sprinkler, automatic fire sprinkler, fire sprinkler head, home fire sprinkler, fire sprinkler installation, residential fire sprinkler, fire sprinkler company,")("How To Illuminate Stairs – Step Lights,")

Chapter 3

METHODOLOGY

3.1 PROJECT SCHEDULE

We have prepared a proposal in the sixth semester and also prepared a report addressing the problem areas in the construction industry. Figure 3.1 shows the schedule of our project.

3.2 METHODOLOGY

We have completed our proposal for our project in the sixth semester and in the seventh semester we have completed our Problem Study Report going through six phases. First we gain the basic concepts of Safety management, and then we went through the detailed Literature review. After this each member prepare a report containing the topics assigned to him by the Group Leader. Combining these reports we prepare an initial report comprises of Introduction and the literature review. After this the group visited different sites recommended by the project advisor and got some documents related to safety management.(see APPENDIX A). We also study some Thesis of MS related to safety and got some data from them in addition we observed the safety performance at sites. We then analyzed the data and in the end prepared the final report with some recommendations.

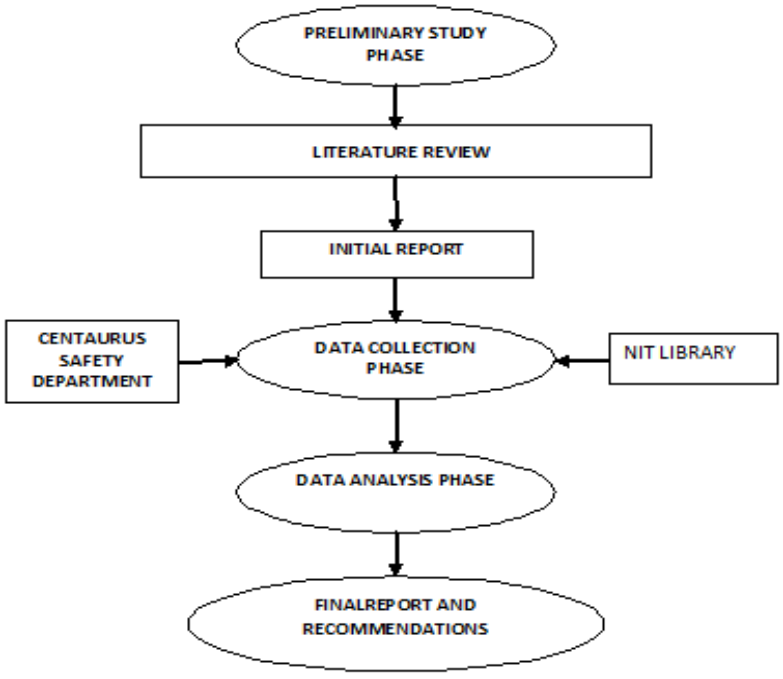


Figure 3.1: Methodology

Chapter 4

FIELD STUDY

4.1 SITES UNDER STUDY

We have visited seven construction projects to study the safety performance. These are listed below;

- Benazir Bhutto International Airport Fatehjung
- Parliament lodges Islamabad
- Road extension project Marirh Chowk Rawalpindi
- Canal road extension from Abdullahpur to Gutwala, Faisalabad
- The Centaurus Islamabad
- Pirwadhai flyover and underpass Rawalpindi
- Ali Trust Tower Rawalpindi

Out of all these projects, we have found that the safety performance of The Centaurus is better than others. The Centaurus is a building project currently under construction in Islamabad, Pakistan. Designed by British architects WS Atkins, it will comprise three skyscrapers, containing corporate offices, residential apartments and a 5-star hotel. The tallest skyscraper will have 41 storey and all three will be linked by a shopping mall. The Centaurus Hotel, the symbol of New and Modern Pakistan is currently under construction in Islamabad, Pakistan. Its estimated cost is $350 million USD.

Following are some of the safety management techniques which are being used there at site.

Figure 4.1: The Centaurus

4.2 SAFETY TECHNIQUES

We as a group have observed the following safety practices in the Centaurus project. According to the contract, the owner is responsible for the safety of the people at site.

4.2.1 The Fire Stands

The safety officer is very keen to protect the labourer from any sort of accident. The management has installed a number of fire stands consisting of sand buckets and fire extinguishers. The labourer is very much aware of its use and they are properly placed. Every labourer is trained for the use of fire extinguisher at individual level.

Figure 4.2: Fire Extinguisher & Sand Bucket

4.2.2 The Helmet

The use of helmet is compulsory once you enter the site and there is no compromise on it. The safety management has assigned a colour code for helmets that indicates the field with which the person wearing the belongs. For example blue helmet are given to the mechanical department. Following is the colour code for helmet at the Centaurus:

Colour code for Helmet

Colour	Department
Red	Safety
White	Civil
Blue	Mechanical
Green	Glass fixing
Yellow	Labourer

Table 4.1: Colour code for helmet at Centaurus

Figure 4.3: Helmet

4.2.3 The Shoes

A person not wearing the shoes is not allowed to enter the Centaurus site. This is because of the fact that the pointed things like pieces of glass can harm you so it is mandatory to wear shoes on the site

Figure 4.4: Safety Boots

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4.2.4 Reflecting jackets

Reflecting jacket is also in practice at the site. It is meant for the safety of workers and the staff. It also gives the better visibility and helps the crane driver to safely operate the crane**.** The operator can see a person clearly from the height due to this jacket.

Figure 4.5: Reflecting jackets

4.2.5 Electricity Hazard

The workers working there are well aware of the electricity hazard and they are using proper plugs for tight connections and circuit breakers are installed in order to avoid any electric shock. This is the most dangerous thing to control during construction because workers have to move around for electric work handling the electric boards.

4.2.6 Noise Pollution

The generators and other machinery producing noise are kept in basement in order to avoid noise pollution. The use of ear plugs is minimal because of the fact that there is not very much of the noise due to construction work which can harm workers.

4.2.7 The Goggles

Workers involved in the welding process are well guided to use goggles in order to protect their eyes. Those who are fixing the glass also use goggles to protect their eyes.

Figure 4.6: Goggles

4.2.7 Garbage Collection

Safety officer has specially made a team to collect the garbage and the broken or extra pieces of construction material in order to avoid any injury. We have not seen any extra material during our visit. This shows the concern of the safety officer about the safety of the labourer and staff.

4.2.8 The Guiding Sessions

Safety officer held a number of sessions with the labourer about the safety practices in order to keep a concern in them about the safety. Every new worker that joins the work is properly trained by the safety department.

4.2.9 First Aid Centre

In order to tackle any emergency situation, a first aid centre is established there at site.

4.2.3 The Crane Safety

The crane operator is well trained and is given the support of a well trained Rigger. Rigger is the person who guides the operator standing on ground using wireless.

4.2.4 The Sign Boards

There is an extensive use of sign boards related to safety at sight so that everyone the aspect of safety in mind while sent on site

Figure 4.6: Safety sign boards at The Centaurus

4.2.5 Safety Management Department

Mr Ali Kashif is appointed as safety manager at the site and there are three safety officers along with 14 co-workers are under his super vision. The safety crew is responsible for any accident at the site that is why there is a strict check of PPE at sight. When we ask Mr Ali about the success of him in making the labourer to use safety equipments, he just says that the communication

factor with the workers play an important role in his success. He said if I caught any worker not using his safety equipment at site I will politely request him. If the same person do the same thing second time around I will order him to use it and the third time I will give him minor punishment like I will take his ID card for some time so that he might bear a little stress in his mind and not try to be smart in the future. Mr Kashif said that in most of the cases the order of mine do it for me. He has maintained a good environment between the workers and a worker working at second floor is in constant touch with the one on third floor and on the first floor. So in this way things move quit swiftly and safely.

In spite of the fact that the safety manager is trying his best to maintain a safe environment still a very sad accident occurs at the site when some workers were manoeuvring a heavy cylinder at one of the upper storey. When they were moving it one of them felt headache and lost the grip at the cylinder. The remaining workers were not able to hold it and the cylinder felt over two workers sitting in the lift two or three storey below. One of them died on the way to the hospital and the other one died after a month in the hospital.

4.2.6 Budget Allocated to Safety

According to the safety manager, about 4-5 lac per month is dedicated to the safety management of the site. This is the main reason why there is a relatively better performance of safety department as compare to other projects. The figure 4.7 shows the study related to budget allocation to safety in Pakistan.

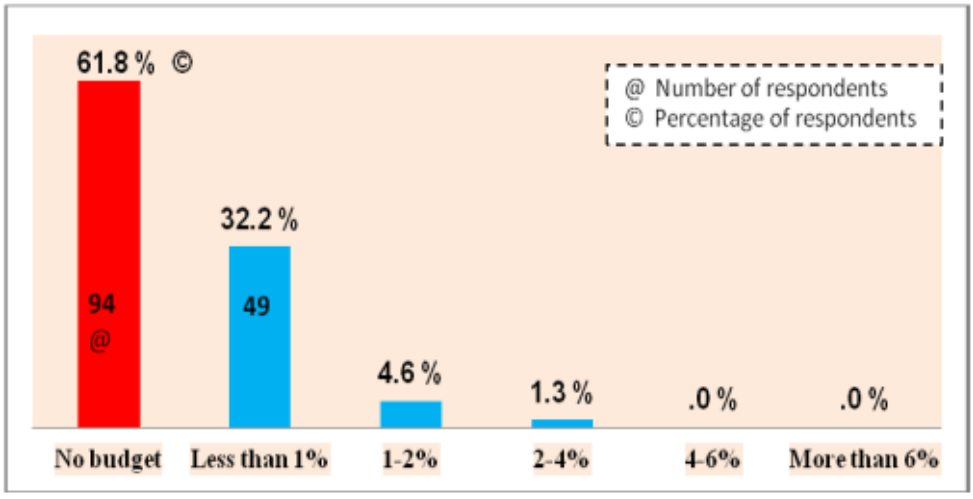


Figure 4.7: Allocation of safety budget in CI of Pakistan

Source: MS Thesis Hafiz Zahoor Ahmad Khan

4.2.7 The Checklists

There are at least 8 check lists to help the safety crew checking safety status of the site. The checklists are present in Appendix A. Fire Alarms are checked regularly and fire hydrants are also checked on regular basis. Because of this performance of safety department Centaurus is ranked highest in safety department in eight of the most recent projects of Pakistan.

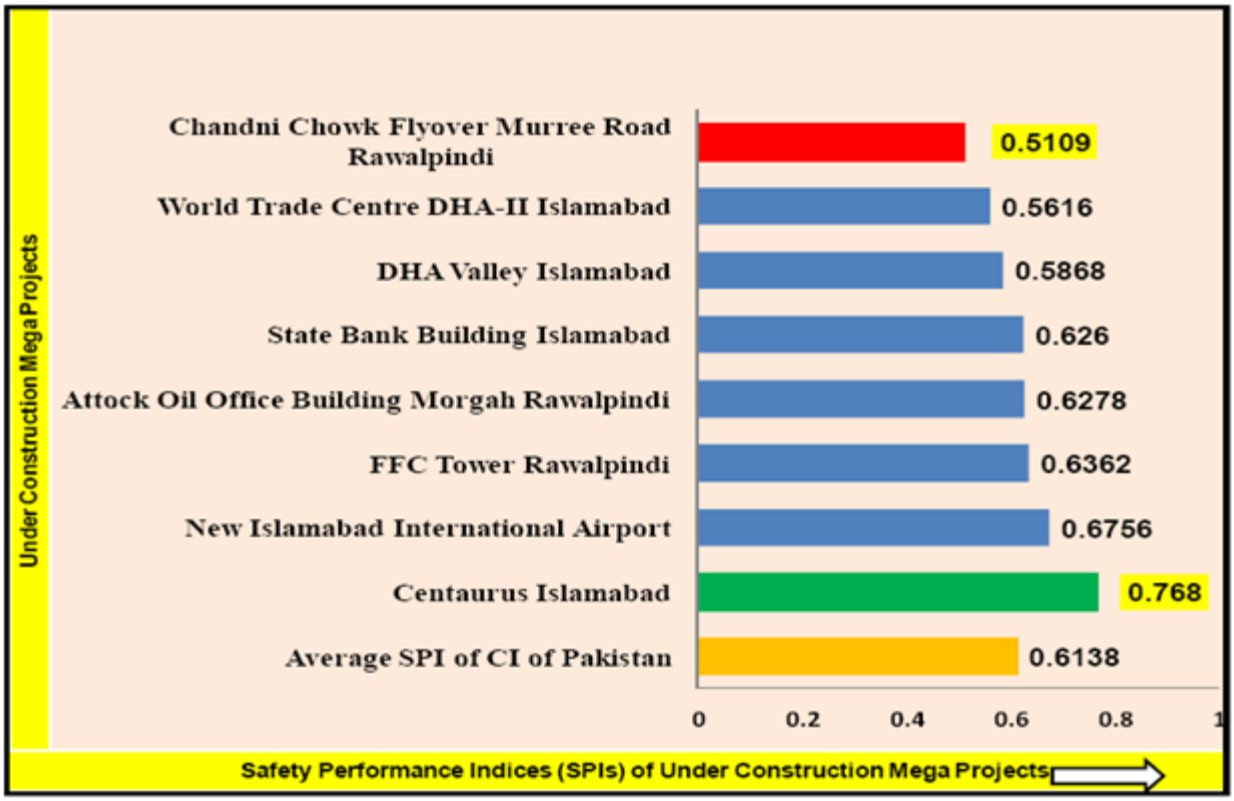


Figure 4.8 Ranking on the basis of safety performance

Source: MS Thesis Hafiz Zahoor Ahmad Khan

4.3 THE ROLE OF CDA

The Capital Development Authority (CDA) is responsible for check on safety practices in all construction projects including Centaurus project. The representatives of CDA visit the site randomly to have a check on the safety practices.

A generator was disturbing the inhabitants of nearby houses. The CDA take the action and ask the concern officials at site to operate it in the basement. This shows that the CDA has a close eye on the safety practices and the environment safety at The Centaures site.

ISO also visit the site to see if safety standards are met or not.

4.4 SAFETY COMPARISON OF DIFFERENT PROJECTS

We have visited the other sites which are mentioned at the start of this chapter and observe the safety performance. These sites are evaluated on the basis of following safety management techniques.

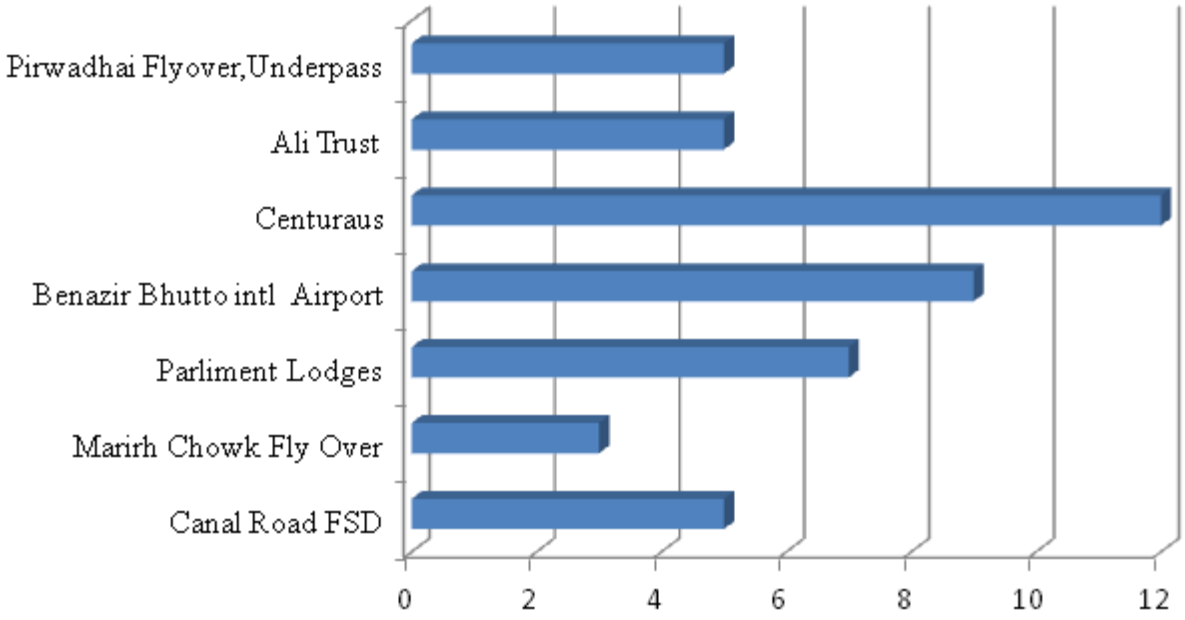
- Helmet
- Safety Harness
- Bracing
- Diversion
- Equipment Safety

We have allocated marks for each safety technique on the basis of its importance to keep a worker in safe environment, for example we have allocated highest marks to helmet because it protects the most sensitive part of the human body i.e. brain. We gave each site marks out of allocated marks purely on the basis of our observations.

Project	**Helmet 4**	**Safety Harness 3**	**Diversion 3**	**Bracing 3**	**Equipment 2**	**Total score 15**
Benazir Bhutto International Airport	4	0	0	3	2	9
The Centaurus	4	2	1	3	2	12
Canal Road Extension Faisalabad	0	0	3	0	2	5
Parliament Lodges	2	0	0	3	2	7
Pirwadhai Flyover, Underpass	2	0	3	0	0	5
Marirh Chowk Flyover	0	0	3	0	0	3
Ali Trust Tower	0	0	0	3	2	5

Table 4.2 Safety performance comparison

The safety performance of these sites is shown in the graph below.



Graph 4.1: Safety comparison of different projects

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

After visiting different sites, various types of data relating to safety have been collected and analyzed. From this analysis we have derived our conclusion and gave suggestions which are as follows;

5.1 CONCLUSIONS

After visiting and observing different construction sites we have drawn the following conclusions;

- Laws are present related to safety of workers but they are not enforced.
- Workers are unaware of their right to work under safe environment.
- Safety is a big issue especially at small projects. This is due to the fact that there is a bit of accountability procedure from development authorities for large projects only while the smaller projects like a simple three storey building are not inspected by the authorities
- There is a desperate need for a dedicated authority towards Construction safety.

5.2 RECOMMENDATIONS

We as a group after doing all the study would suggest the following

- Contractor category registration should be linked to safety record. By doing this we can encourage contractors to pay attention towards safety on projects and improve their safety performance to remain in a superior category.
- Specific percentage of the project price should be allocated towards safety in Standard Contract documents to make sure that the project would be safe.
- Awareness campaign should be launched by research institutes like NUST to make the owners and contractors aware about the link between injuries and cost of the project. This will encourage the stakeholders to improve the safety performance at construction sites.
- Short teaching sessions at construction sites could be launched to make the workers aware of the efficient use of personal protective equipments and the other procedures for doing the work safely.

- Safety should be listed as a separate item in Bill of Quantities (BOQ).
- Safety should be used as one of main criteria for procurement of public projects.

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APPENDIX A