IDENTIFYING THE CRITICAL FACTORS AFFECTING THE WORKERS SAFETY ISSUES DURING NIGHTTIME CONSTRUCTION ACTIVITIES IN PAKISTAN

By

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MY PARENTS

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I owe my special thanks to those representatives of the contractors who participated in the survey and gave their full support and cooperation in completing my thesis. In the end, I pay my earnest gratitude with sincere sense of respect to my parents, and family for their unending support, encouragement, prayers and patience.

(Zohaib Ahmed Khan)

ABSTRACT

Construction Safety has always been a matter of concern especially in the construction industry of Pakistan. The safety conditions are highly dependent on the nature of the work and the commitment of the management towards the implementation of safety practices.

In recent years there has been observed an increased tendency in executing the construction activities during nighttime. It is preferred in order to avoid traffic congestion and other difficulties that commonly arise during daytime as well as for the projects where the completion time of the project is very important. However, construction activities during nighttime introduce some unique and significant hazards that must be proactively addressed to create safe work environment for construction workers.

An in-depth literature review identified six aspects related to nighttime construction hazards. These six aspects were characterized by 76 factors. A questionnaire technique was adopted to identify the significance of factors.

After pilot testing some amendments were made in the questionnaire. The final questionnaire consisted of 62 factors relating the worker safety on night. Hence, the final questionnaire distributed to 150 construction professionals representing Clients, Consultants and Contractors. The 104 respondents were finally selected for analysis. Relative Importance Index was used to check the importance of each factor and based on that the significance of factors and ranking of the factors was carried out.

The overall ranking of the factors showed that safety practices got the least importance in terms of benefit of nighttime construction, the schedule compression being the most important one. Face shield is the only equipment mostly available on site, the availability of all other equipment is rare. The survey results showed that safety supervision was frequently available on site at night. However, the workers' unsafe behavior in terms of wearing safety garments was the main cause of accident. Whereas, insufficient lighting and fall from height were also critical factors which caused an accident at night. The most critical factors in terms of workers safety for nighttime construction in aspect five were that the workers were not giving importance to the safety practices. While, the visibility issue and insufficient lighting are also significant in creating the hazards for the workers working at night. Regarding aspect six the safety supervisor, health and safety consultant and project managers have been identified as the important persons for implementing the safety practices at night.

At the end, it was recommended that the construction companies should provide training to the construction workers about the safety practices at night. And also provide them awareness that what could happen if they do not use the equipment for their protection. The companies should also hire the dedicated and skillful technical person on site in order to enforce the implementation of safety practices at night. A sufficient amount of fund should also be included by the client at the bidding stage, so that the contractor can buy the safety equipments for the workers.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The workers safety in construction industry is a complex issue that can be attributed to a number of factors such as outdoor operations, working on heights, difficulty on site plan and equipment function paired with worker attitude and behaviour towards safety Choudhry (2008).

However, this issue should be taken as an important task to set against the excessive loss of property, fatal accidents and injuries. Avoiding fatal accidents and injuries should be the principle point for all the employees.

Construction industry consists of high risk due to different activities which are performed during construction, alteration and repair. For example, residential building construction, excavation, roadway paving etc. The workers might be exposed to severe hazards, such as electrocutions, falling from roof-, unguarded machinery, being struck by heavy construction equipment, silica dust and asbestos, etc. during construction.

Considering the adverse impacts of accidents, the safety management related to construction industry is a major concern of all investors. The government unions spend a great time to develop legislations, rules and regulations for the improvement of worker safety on the construction sites. But these legislations are not upgraded as the time goes on. Therefore, the hazards in the construction industry increase which ultimately result in accidents.

The aim of this research is to develop a unanimous construction safety framework which can be used by construction companies to implement the safety practices on construction sites especially at night. The construction framework is expected to help improve the safety culture in Pakistani construction industry especially in night-time construction projects.

1.2 PROBLEM STATEMENT

There is an increased trend among transportation agencies and construction companies to execute construction activities during night-time to avoid traffic congestion and other difficulties that commonly arise during daytime. However, night time construction activities introduce certain unique and considerable challenges that must be proactively addressed to create safe work environment for construction workers. This approach can be beneficial for reducing traffic disruptions and other accidents associated with this perception but there are several concerns to construction companies which must be considered simultaneously. There is a perceived loss of productivity in performing a wok at night which can increase the cost of the work and therefore increase the risk for the safety of the employees. Apart from these factors, there are several other elements which specify the need of special framework for proper implementation of nighttime construction on the site.

Approximately 50% facilities of the total construction work occur during night construction Burgess et al. (2007). These statistics demand increased attention of the agencies to evaluate planning and safety issues related to the workers and the general public for night-time construction activity.

Arditi et al. (2007) concluded that construction activities at night are about five times more hazardous than the construction activities at day.

Safety is one of the major concerns of the contractors while working at night and the work may be performed differently from identical daytime operations due to safety reasons Hancher and Taylor (2001).

"Also, in last two decades, the shift from building new transportation facilities to maintain and upgrade existing ones has been on the rise" Al-Kaisy, A. and K. Nassar (2005).

This shift has mainly been caused by the ever-increasing traffic demand on already-congested highway systems and in order to avoid daytime traffic congestion, night-time construction is preferred by transportation agencies. Present study shall focus on current night-time construction practices in Pakistan and further identify the issues which create hazards on site for the workers.

1.3 SIGNIFICANCE OF THE STUDY

Pakistan is facing a number of construction delays. To complete projects within allocated time, the work has to be done in different shifts. But due to economical concerns and safety issues, night-time shift work is discouraged. Therefore, total construction duration cannot be compressed as done in developed countries. This work will provide better understanding of safety needs and regulations during night-time construction and thus will decrease the construction duration resulting in decrease in construction overheads.

There is dearth of research conducted in the area of night-time construction safety in Pakistan and limited construction industry regulations exist for night time construction work. Night-time construction poses unique problems of worker safety; such as visibility issues, temperature variation, lighting condition, worker fatigue etc. Therefore, there is a dire need at national level to investigate the night-time construction safety issues with a view to improve safety of workers.

1.4 RESEARCH OBJECTIVES

The key objectives of the research are:

1. To synthesize the state of art practices in night-time construction.

2. To evaluate the current night-time construction practices in Pakistan.

3. To identify the major issues for night-time construction projects in Pakistan.

4. To develop the site safety framework for night-time construction projects.

1.5 SCOPE OF THESIS

The study covers 15 construction sites. The construction companies which are working on these sites are registered with Pakistan Engineering Council (PEC) in the category of CA, CB, C1, C2, C3, C4 and C5. The questionnaires were distributed to the construction professionals of Pakistan construction industry. The interviews related to questionnaire were also conducted with the senior management including Construction Managers, Planning Engineers, Site Engineers, Project Managers, Project Directors, Safety Managers or Safety Officers of the construction companies at sites and head offices.

1.6 ORGANIZATION OF THESIS

In line with the research practices in vogue, this thesis consist of 05 chapters followed by the references and appendices for accompanying the information, as well as the result of data collection and the analysis, conclusion and recommendation as shown in Figure 1.1 .

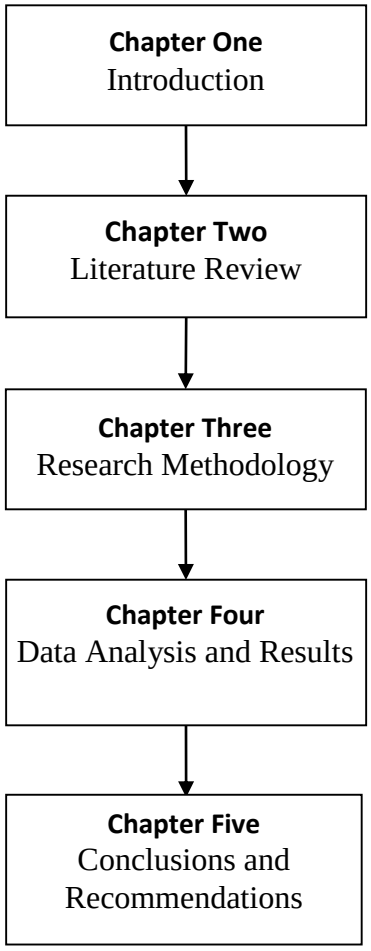


Figure 1.1: Layout of Thesis

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents a brief preview of the major studies conducted on nighttime construction safety issues in developing and developed countries. The main focus of most of the previous studies was on identifying the safety conditions and safety practices in daytime construction and nighttime construction. So in order to implement the safety on sites, the safety framework was developed. This framework will not only enable the construction companies to implement the safety practices on nighttime construction projects but will also encourage the construction workers simultaneously to work more efficiently since there is a framework for their safety .

2.2 CONSTRUCTION INDUSTRY OF PAKISTAN

Since independence till 1971, there were few construction firms which were privately owned in Pakistan. The residential units were constructed by public departments of provincial and central government. Although, most of the laborers employed to undertake those projects were unqualified but they were equally skilled persons. After 1971, the development phases started in Pakistan, when land was made available in Karachi. The government invested larger sums of money to formulate a House Building Finance Corporation (HBFC). Due to surging demand, a number of contractors and consultants came into the construction industry. Some firms had good experience of building construction, while others did not have significant knowledge of the construction operations.

The boost in the construction industry gathered the builders and developers to form an association, called "Association of Builders and Developers" (ABAD) in 1972. The objectives of the association were to improve the state of industry and provide a platform to address the pertinent issues.

In 1975, all the major works, such as the Indus basin replacement work, Warsak dam etc., were executed by the foreign contractor firms. But later in 1975, the government decided to change its policy and decided to procure services of local construction industry for the construction of big projects. Thus, offering massive opportunity to the private sector of Pakistan construction industry

to expand. The most significant construction at that time was that of the Pakistan Steel Mills constructed by Pakistani contractors and inaugurated in (1985).

However, after a short run of Pakistani construction industry in the execution of big project, they remained in the state of depression due to negligence by the government in the form of inadequate policies and insufficient support. Companies that were involved in the big project were now at the verge of closure. During this long time, which was full of depressions for construction industry, they were facing time delays, cost over-run, safety failure and quality issues in the construction of projects.

The present government realized the importance of construction industry as the backbone of the country; therefore they provided sufficient funds for the expansion of basic infrastructure in the country which led to an increase in the demand of construction activity in the country.

As per report of economic survey of Pakistan 2012 – 2013, the GDP of Pakistan construction industry is increasing with a rate of 5.2%. The brisk pace of construction activities in public and private sector escalated the value of construction sector in last year. According to Pakistan bureau of statistics (2013), the growth rate (%) performance of all the stated components of GDP from (2006-07 to 2012-13) is presented in Table 2.1. This data shows the virtual importance of several sectors and sub-sectors and their interrelationship.

Table 2.1: Growth Rate (%) of Sectors and Sub Sectors according to Pakistan Bureau of Statistics 2013

Table 1.2: Growth Rate (%)

Sectors/Sub-Sectors	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-2013(P)
1. Agriculture	**3.4**	**1.8**	**3.5**	**0.2**	**2.0**	**3.5**	**3.3**
Crops	4.4	-1.0	5.2	-4.2	1.0	2.9	3.2
Important Crops	6.5	-4.1	8.4	-3.7	1.5	7.4	2.3
Other Crops	2.1	6.0	0.5	-7.2	2.3	-7.7	6.7
Cotton Ginning	-0.8	-7.0	1.3	7.3	-8.5	13.8	-2.9
-Livestock	2.8	3.6	2.2	3.8	3.4	3.9	3.7
-Forestry	2.7	8.9	2.6	-0.1	4.8	1.7	0.1
-Fishing	0.4	8.5	2.6	1.4	-15.2	3.8	0.7
Industrial Sector	**7.7**	**8.5**	**-5.2**	**3.4**	**4.7**	**2.7**	**3.5**
2. Mining & Quarrying	7.3	3.2	-2.5	2.8	-4.4	4.6	7.6
3. Manufacturing	9.0	6.1	-4.2	1.4	2.5	2.1	3.5
-Large Scale	9.6	6.1	-6	0.4	1.7	1.2	2.8
-Small Scale	8.3	8.3	8.6	8.5	8.5	8.4	8.2
-Slaughtering	3.2	3.3	3.8	3.2	3.7	3.6	3.5
Electricity Generation & Distribution & Gas Distt	-12.8	37.2	-12.1	16.7	66.4	2.7	-3.2
4. Construction	12.9	15.4	-9.9	8.3	-8.6	3.2	5.2
Commodity Producing Sector (A+B)	**5.5**	**5.1**	**-0.9**	**1.8**	**3.3**	**3.1**	**3.4**
Services Sector	**5.6**	**4.9**	**1.3**	**3.2**	**3.9**	**5.3**	**3.7**
7. Wholesale & Retail Trade	5.8	5.7	-3.0	1.8	2.1	1.7	2.5
6.Transport,Storage and Communication	6.9	5.5	5.0	3.0	2.4	8.9	3.4
8. Finance & Insurance	9.1	6.3	-9.6	-3.3	-4.2	1.0	6.6
Housing Services (Ownership of Dwellings	4.0	4.0	4.0	4.0	4.0	4.0	4.0
General Government Services	2.7	0.2	5.6	8.0	14.1	11.1	5.6
Other Private Services	4.6	5.4	6.5	5.8	6.6	6.3	4.0
GDP (fc)	**5.5**	**5.0**	**0.4**	**2.6**	**3.7**	**4.4**	**3.6**

Sources: Pakistan Bureau of Statistics

In Pakistan, roughly there is 6-7 % of the labor force involved in the construction industry. The following Table 2.2 shows that construction is highly intensive and has great potential in creating job opportunities in coming years.

Table 2.2: Employment projection in different Sectors according to Bureau of Labor Statistics (2012)

Table 3. Employment by major industry sector, 2002, 2012, and projected 2022

Industry sector	Thousands of jobs			Change		Percent distribution			Annual growth rate (percent)	
	2002	2012	2022	2002-2012	2012-2022	2002	2012	2022	2002-2012	2012-2022
Total (1)	142,294.9	145,355.8	160,983.7	3,060.9	15,627.9	100.0	100.0	100.0	0.2	1.0
Nonagriculture wage and salary (2)	131,028.3	134,427.6	148,751.3	3,399.3	15,323.7	92.1	92.5	93.0	0.3	1.1
Goods-producing, excluding agriculture	22,486.7	18,360.3	19,554.2	-4126.4	1,193.9	15.8	12.6	12.1	-2.0	0.6
Mining	512.3	800.5	921.7	288.2	121.2	0.4	0.6	0.6	4.6	1.4
Construction	6,715.7	5,640.9	7,263.0	-1074.8	1,622.1	4.7	3.9	4.5	-1.7	2.6
Manufacturing	15,258.7	11,918.9	11,369.4	-3339.8	-549.5	10.7	8.2	7.1	-2.4	-0.5
Services-providing	108,541.6	116,067.3	130,197.1	7,525.7	14,129.8	76.3	79.9	80.9	0.7	1.2
Utilities	596.3	554.2	497.8	-42.1	-56.4	0.4	0.4	0.3	-0.7	-1.1
Wholesale trade	5,652.4	5,672.8	6,143.2	20.4	470.4	4.0	3.9	3.8	0.0	0.8
Retail trade	15,025.1	14,875.3	15,966.2	-149.8	1,090.9	10.6	10.2	9.9	-0.1	0.7
Transportation and warehousing	4,223.8	4,414.7	4,742.0	190.9	327.3	3.0	3.0	2.9	0.4	0.7
Information	3,394.6	2,677.6	2,612.4	-717.0	-65.2	2.4	1.8	1.6	-2.3	-0.2
Financial activities	7,847.1	7,786.3	8,537.3	-60.8	751.0	5.5	5.4	5.3	-0.1	0.9
Professional and business services	15,976.2	17,930.2	21,413.0	1,954.0	3,482.8	11.2	12.3	13.3	1.2	1.8
Educational services	2,642.8	3,346.9	4,022.2	704.1	675.3	1.9	2.3	2.5	2.4	1.9
Health care and social assistance	13,555.6	16,971.8	21,965.9	3,416.2	4,994.1	9.5	11.7	13.6	2.3	2.6
Leisure and hospitality	11,986.0	13,745.8	15,035.0	1,759.8	1,289.2	8.4	9.5	9.3	1.4	0.9
Other services	6,129.0	6,174.5	6,823.4	45.5	648.9	4.3	4.2	4.2	0.1	1.0
Federal government	2,766.0	2,814.0	2,406.5	48.0	-407.5	1.9	1.9	1.5	0.2	-1.6
State and local government	18,746.7	19,103.2	20,032.2	356.5	929.0	13.2	13.1	12.4	0.2	0.5
Agriculture, forestry, fishing, and hunting (3)	2,245.4	2,112.7	1,889.2	-132.7	-223.5	1.6	1.5	1.2	-0.6	-1.1
Agriculture wage and salary	1,217.4	1,306.9	1,281.8	89.5	-25.1	0.9	0.9	0.8	0.7	-0.2
Agriculture self-employed and unpaid family workers	1,028.0	805.8	607.4	-222.2	-198.4	0.7	0.6	0.4	-2.4	-2.8
Nonagriculture self-employed and unpaid family workers	9,021.2	8,815.5	9,343.2	-205.7	527.7	6.3	6.1	5.8	-0.2	0.6

Pakistan now offers a growing market in the construction industry. According to Pakistan vision 2025, the big dam and other infrastructure projects are announced for the feasibility and construction. Construction of two mega projects, like Diamer-Bhasha and Munda dams, had been announced and the construction is projected to complete till 2020.

According to Pakistan infrastructure report 2011, "average forecasted growth of the construction industry of Pakistan is valued at US$3.4bn in 2011 increasing to US$4.6bn by 2015". Increased spending on the development of infrastructure covering the programs related to construction of roads, bridges, dams, etc. is expected to increase the growth of construction in next few years.

2.3 IMPORTANCE OF SAFETY IN CONSTRUCTION

Today's owner faces serious risk when undertaking a construction project. Not only the owners must be worried about the potential risks to their employees, but they should also be worried about the risks which are faced by the contractor himself during implementation/execution phase of construction project. Safety is a perilous item in carrying out a construction projects for numerous reasons, which include protection and welfare of the employees and to provide a safe work environment for performing construction activities and controlling the construction costs.

However, the significance of safety as a measure to control the cost of project is usually ignored by both the owners and the contractors. If these parties reduce the hazards linked with construction safety, it can highly impact the overall cost of project. A devoted commitment to safety by both the client and contractors helps to confirm the success of the project and can also command the bottom-line significantly.

"Client should realize that all the contractor's risks will either add the substantial cost to the contract or may reduce the potential profit of a contractor possible on any specific contract" (Emmons, July/August 2006). Since every contractor is in business to make profit to the bottom-line, overhead would naturally be taken into attention towards the "costs of doing business." Anticipated losses have to be taken into consideration and incorporated in the estimate if the contractor wants to stay in business.

The possibility of an accident causing fatality in the construction industry is five times more expected to occur than in other manufacturing based industry. Hence, it is not only the worker's work which will suffer from an accident on site. But the client/employer, contractor and the public in general will also suffer directly or indirectly. Moreover, accidents on construction site may occur due to lack or insufficient training, lack of insufficient and proper supervision, lack of awareness to carry out the work safely or alternatively, due to a blunder of judgment, sloppiness and laziness. "Studies have revealed that the risks on the construction sites can be reduced and accidents can be prevented through the execution of the safety practices which lead to a sound safety program". Sawacha, et al., (1999); Baig, (2001).

2.4 CONSTRUCTION SAFETY IN PAKISTAN

Pakistan is a developing country in Asia with the ability to attain the strong growth in construction activities. But unfortunately construction activities in Pakistan have remained more

labor-intensive than other countries of the world. "Pakistan contained 2.5-10 times as many workers per activity on job site" Koehn (1995). The labor force in Pakistan typically comes from various places of the country and they are classified into different fractions. Communication problem due to difference in language, culture and religion tend to inhibit safety on work site.

The enforcement of safety rules and regulations in Pakistan is not widespread. Some companies do have the safety policy on paper but the employees do not have any awareness about such policies. Nevertheless, a number of major contractors inside the country exhibit a concern for safety and various safety procedures are formulated to address the same concern. They also provided training to their workers for better implementation of safety practices on site. But majority of the contractors are still concerned to maximize the profit. Due to this reason, unsafe conditions still exist on many sites and labor is subjected to various hazards.

On many sites, there exists no training program for the safety of the worker; no orientation is ever conducted before the start of the work, hazards not identified and pointed out on the site and the safety meetings never held. Thus, such companies leave employees on their own for performing the construction activity. That's why the workers make mistakes and face accidents on site. Farooqui (2008) described the problems which were faced by the construction worker on site:

1) Accident due to the result of cave-in often occur during the excavating of deep trenches.
2) Concreting is done mainly by labor, and cement burns due to the unavailability of protective gloves and boots were common.
3) Workers frequently fall from height due to weak scaffolding and the unavailability of safety belts, safety lanyard & safety harness.
4) Workers sustain injury due to unavailability of PPE.
5) There were improper housekeeping.
6) The labor didn't understand their job on site.

Injuries' recording is unavailable in Pakistan. In most cases, specific medical treatments or compensations are unavailable. In Pakistan, labor on site considers accident as due to their own fault and they accept that the construction is a hazardous occupation. Nevertheless, the accidents, which result in the death of workers, may be reported due to financial expenses and ensuring litigation.

Maintenance of equipment and inspection schedule is not tracked often and only after a cessation, the equipment is repaired. This attitude can cause loss of life, time and ultimately delays

the project. This may also result in damage to the property. Electrocution is also a major issue which can cause accidents on construction site, as the electrical equipment and underground cables are sometimes not up to the standard. The workers who work on those areas do not necessarily follow safety rules or use of PPE (personal protective equipment). The drug testing is also not carried out on the construction site. Farooqui; Arif, et al. (2008).

One of the main reasons that inhibit Pakistan from developing its own construction safety program is persistent corruption. As an example, it can be observed that many accidents happen on site due to lack of safety practices and particularly due to off-the-cuff supervision. The management on the site does not take responsibility for the accident of the worker. Because they know that worker is usually a nonresident of that local area and thus unaware of his rights. That is why no preventive measures are taken on the site Farooqui; Arif, et al. (2008).

On the start of the work, owner and consultant often stress the importance of implementing safety practices, but with the passage of time, the priority of the management is more concerned towards the deadlines and less attention is given to safety. On high building or infrastructure projects, the client may afford some medical facilities at the job site but ultimately implementation of safety practices on site is the responsibility of the contractors. There are various other issues for which management is usually concerned apart from deadline which are created during implementation of the projects such as unavailability of material, error in drawing, cash flows issues, law and order issues, project delays etc.

According to survey conducted by Farooqui (2007), the major injuries faced by Pakistani contractor on the project sites are as follows:

1. Injuries due to fall from height
2. Injuries due to being stuck by machinery or heavy equipment
3. Injuries caused by wastage and raw material
4. Burning cases
5. Eye injuries
6. Head injuries

The author further identified the major reason for safety nonperformance which include lack of professional construction management practices, lack of development of construction industry in the form of mechanization and industrialization, inadequate safety provision which has been unsuccessful to launch safety of the workers as a priority for construction industry, less

incentive which is failed to launch safety as a business survival issue and unfavorable environment in business which can cause confrontational business relationship among stakeholders resulting in disputes, conflict between the parties, claims and litigations. The author concluded that these were the issues which diverted the focus of construction industry away from the implementation of safety practices Farooqui (2007).

The Factories Act, 1934 is the main law enforced for Occupational Health and Safety (OHS) in Pakistan. The Hazardous Occupation Rules (1978) standardize certain occupations as dangerous and comprise special rules and provisions to regulate the working environments in those occupations. Regrettably, construction safety has never been added to such laws or provisions. Further, laws dealing with Occupational Health and Safety are:

1. The Mines Act (1923)
2. Workman's Compensation Act (1923)
3. Dock Laborer Act (1934)
4. Special Security Ordinance (1965)
5. Shop and Establishment Ordinance (1969)

Unfortunately, the safety measures, which were taken in most of the above laws have not modified according to the briskly changing times, conditions and construction industry requirements. Therefore, numerous sectors, with serious Occupational Health and Safety hazards (comprising those with maximum no of the workers), are not protected by these laws, although they have few technical standards. "These occupational laws instantly require revision and updating" Awan, (2001); Ali, (2006). Moreover, due to lack of implementation of Labor law on site in the construction industry, the majority of the accidents are not reported and conveyed to the Labor Department. Generally only those accident are reported that outcome in fatalities. It therefore seems unlikely that available OHS data would be reliable. Hence, without the appropriate information about the basic reasons of accidents and injuries, it is challenging to decrease the occurrences of accidents, or to improve the inclusive safety standards within Pakistani construction industry. Furthermore, as majority of the construction companies in Pakistan belong to the private sector and owing to restricted technical and financial resources, poor working conditions on site are quite common.

The enactment of safety management does not occur in Pakistani construction sites Choudhry et al. (2008). Data relating to fatalities and injuries rates are not easily available in any department and published research on the topic of construction safety in Pakistan is not available

significantly. Both are required to promote the safety awareness in the country. In these situations, the Directorate of Workers Education was established in year 1982 under the Ministry of Labor which is a training and educational organization accountable for increasing the awareness among the workers providing knowledge about their rights, trade union leaders and companies, management representatives and social issues by teaching several courses round the year. However, strict regulations do exist only for child labor and the provision of minimum wage/salary. This minimum salary/wage varies in urban and rural areas. The central/Provincial government periodically revises labor force wages. In summer, the temperature rises up to 40°C in maximum parts of the country. Therefore, on construction projects, workers often work in blistering heat and sickness is common for workers due to heat exhaustion. Therefore, there is a dire need for the contractors to implement the safety, health and environmental management system for various construction operations.

The Table 2.3, 2.4, 2.5 and Figure 2.1 demonstrates the data available from labor division of Pakistan (LOP) about the accidents occurred in industries:

Table 2.3: Industrial accident occur in Pakistani construction industry

OCCUPATIONAL INJURIES/DISEASES - *DISTRIBUTION OF EMPLOYED PERSONS BY MAJOR INDUSTRY DIVISIONS*

(%)

Major Industry Divisions	2010-11			2012-13		
	Total	Male	Female	Total	Male	Female
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Agriculture, forestry, hunting and fishing	49.8	45.6	88.2	49.1	42.8	92.4
Mining & quarrying	0.2	0.3	-	0.2	0.2	-
Manufacturing	15.8	16.7	7.1	13.3	14.7	3.7
Electricity, gas and water	0.2	0.2	-	0.5	0.6	-
Construction	13.0	14.5	0.3	15.2	17.3	1.0
Wholesale & retail trade and restaurants & hotels	10.3	11.2	2.4	9.2	10.5	0.1
Transport, storage and communication	7.1	7.8	0.2	7.3	8.2	0.6
Financing, insurance, real estate and business services	0.3	0.3	-	0.1	0.1	-
Community, social and personal services	3.3	3.4	1.8	5.1	5.6	2.2

Note:- (-) Stands for no information

Table 2.4: Occupational accident by country Hämäläinen, Leena Saarela, et al. (2009)

Occupational accidents by country in the OAI region

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Afghanistan	10000000		1988	19.9	1046316	1988000	1517158	15172
Bangladesh	56014000	54597000	14403	26.4	7580362	14402689	10991526	20132
Brunei	111955		11	10.0	5913	11235	8574	7658
Cambodia	6000000		1696	28.3	892579	1695900	1294239	21571
Cook Islands	5994		1	11.4	359	682	520	8679
Fiji	235000	235000	48	20.2	25009	47517	36263	15431
Indonesia	91324911	87050000	18220	20.9	9589245	18219565	13904405	15973
Kiribati	7870		2	27.2	1128	2143	1636	20785
Laos	3040041		876	28.8	460886	875684	668285	21983
Malaysia	8569200	8599600	1578	18.3	830314	1577597	1203955	14000
Mongolia	1300000	792500	157	19.9	82816	157351	120084	15153
Myanmar (Burma)	24000000	18359000	4773	26.0	2512284	4773340	3642812	19842
Nepal	11000000		3293	29.9	1733079	3292850	2512964	22845
Pakistan	35230000	35934000	7444	20.7	3917752	7443728	5680740	15809
Papua New Guinea	2000000	2000000	579	29.0	304947	579400	442174	22109
Philippines	53272000	30109000	6019	20.0	3167942	6019090	4593516	15256
Republic of Korea	21604000	19994000	3148	15.7	1656713	3147755	2402234	12015
Singapore	1931800	1869700	183	9.8	96093	182576	139334	7452
Solomon Islands	26842		6	20.8	2941	5587	4264	15885
Sri Lanka	6218304	5946200	1139	18.3	599471	1138995	869233	13979
Thailand	33560100	32140000	7490	23.3	3942225	7490227	5716226	17785
Tonga	35033		8	23.4	4317	8202	6259	17866
Viet Nam	39000000	36994000	9988	27.0	5256847	9988010	7622429	20605
Total	404487050	328673800	83048	21.5	43709538	83048122	63378830	16434

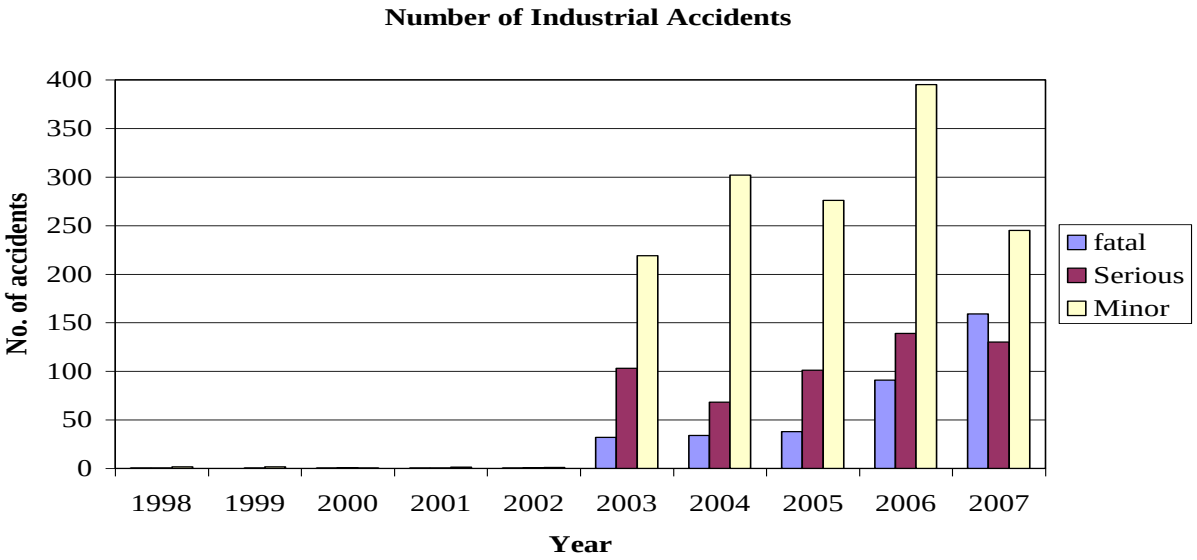


Figure 2.1: Number of industrial accident in Pakistan (Source: Labor Division)

Table 2.5**:** No. of Industrial Accidents under factories act 1934

12.11 Industrial Accidents in Factories Registered under Factories Act-1934

Accident	2004	2005	2006	2007	2008	2009
Total	404	415	438	460	439	326
Fatal	34	38	50	85	108	45
Serious	68	101	106	130	92	62
Minor	302	276	282	245	239	219

Note: The data of Sindh for year 2009 is not available. Source:- Labour & Manpower Division.

Farooqui (2008) measured the safety performance of overall construction industry by investigating the data gathered from site surveys in his paper on the safety performance of Pakistan construction industry. The investigation showed that there are three top safety nonperformance practices at the building construction work sites:

"1. Ear defender are not used specially in noisy environment

2. Protective footwear/shoes are not worn

3. Face mask is not used in dusty condition"

The author further suggests that majority of safety issues belong to the category of self-protection. This suggests that workers were not aware of the importance of these safety practices on the construction sites. From the site inspection, it was concluded that site management was not concerned in the implementation of safety practices on the construction site. The major recommendation from the analysis of this study is that safety rules and regulations need to be first defined, properly documented and then enforced on the construction site. The formal or informal training and education should be arranged for the workers at site. The main limitation of this study is its focus on the multistory construction only. Therefore, the analysis of other sectors of the construction industry needs to be done. The strategic safety management model or framework was not developed for the local construction industry.

Farooqui (2010) presented the paper on the factors which were causing safety dereliction in Pakistani construction industry. The data was gathered through questionnaire survey and interview. The author, contrary to previous findings, concluded that workers were not concerned about the safety practices due to lack of knowledge and proper safety training was not provided to the workers on site. The client also does not take interest in the implementation of safety rules because of the raised preference to complete the project at lower cost. The safety performance in the past was not given importance in the prequalification process. The author recommended that government should make some regulatory authority which should strict contractor to implement the safety practices on the site. There is no denial of the fact that awareness programs are required to be developed and executed and for the same reason the industries should develop attitude for the implementation of safety management. The author also suggests that some appropriate training should be provided to the workers so that they could realize the importance of safety practices on site and this education should be provided in the form of diploma or graduation and career development programs.

2.5 IMPORTANCE OF NIGHTTIME CONSTRUCTION IN PAKISTAN

In Pakistan, there is an increased demand for executing the construction and maintenance related activities at night, especially in the urban areas, to reduce the conflict with the ongoing activities in the city. This approach is very beneficial to reduce the traffic congestion and disruptions. That can also significantly impact on reducing the traffic delays, fuel consumption, traffic accidents, and other activities which are performed during daytime.

2.6 CURRENT NIGHTTIME CONSTRUCTION SAFETY IN PAKISTAN

Pakistan is a developing nation; its construction activity is increasing day by day. So to handle the construction load effectively, the nighttime construction shifts have been adopted by the contractor firms. The nighttime construction helps the contractors to complete their work as per the schedule. This method is especially helpful in fast tracking projects.

But this method can also increase the construction hazards for the workers working at night. Some of the major hazards at nighttime construction projects are as follows:

1) It can be seen from the site that all the steel bars are placed openly which may cause an accident at night.

2) They even do not have proper tools to carry out work. The execution of construction work without proper tools can increase the chances of an accident on site.
3) It can be seen on site that excavation is not closed during night time and the safety net is also not provided to prevent the workers from falling from height. The guardrail is usually not provided around the floor. The material placed on ground can increase the chances of an accident.
4) The nails, placed openly, can increase the chance of an accident especially at night when the light is not sufficient to carry out work.
5) If the light on site is not sufficient to carry out the work at night, it can cause a disaster.
6) Guardrails are rarely provided around the shuttering.
7) The workers on site usually do not have safety dress, safety boots and PPE etc. which must be considered imperative for construction work.
8) The ladder is often not seen up to the standard.
9) Unavailability of management support is the big issue during nighttime construction.
10) Unavailability of skilled labor and safety tools may cause an accident on site.
11) Unwrapped electric wires on site may lead towards fatal accident.
12) The ground is usually not properly sloped to prevent the fall on sites at night.
13) The safety inspection of site is not done regularly.
14) The site management has no accident investigation report.
15) They have no safety glasses for night.

The following picture show the current practices in nighttime construction

- It can be seen that there are no proper marking or signing done on the site to prevent accident.

- This picture shows every aspect of nighttime construction safety. It can be seen that no safety dress is provided to the workers. The excavation is not closed. The safety nets are not provided. The safety helmet, safety belt, safety lanyard and safety boots are not provided. The light is also not sufficient for work. The tools are also not provided to carry out work.

- This picture is taken from metro bus project in Lahore. In this picture you can see that the marking and signing are not done on site to prevent other people from entering the site.

- Lack of training to work at night is the major cause of an accident as evident in this picture.

These are some hazards which show current state of affairs in terms of nighttime construction safety practices in Pakistan. The contractors, who work in night, give least importance to safety of workers.

2.7 NIGHTTIME CONSTRUCTION RULES IN NEIGHBOURING COUNTRIES OF PAKISTAN

Some rules and regulation which are established by neighbouring countries of Pakistan in night-time construction are as follows:

In India, the rules are established by Standards B. O. I. (September 2007) for night time construction operation such as:

At night, all the public sidewalks and walkways should be effectively illuminated and warning lights should be placed at proper sites to ensure the safety of pedestrians and vehicular traffic. In India, it is responsibility of field manager to ensure the safety of pedestrians, worker, equipment etc. from the hazards which are created during nighttime construction operation. The other rules for nighttime construction in India are as follows:

a) Danger signals should be conspicuously posted around the structure as well as at its doors and openings.
b) During night time, red lights should be placed on and around all barricades.
c) Watchman should be posted at entry points.
d) Protective equipment should be supplied to all workers and their use enforced.

e) Electrical wires, telephone lines and water pipes should be switched off when demolition work is in progress.
f) Protected walkways and passageways should be provided for the use of workers and others.
g) No horn shall be used during night time in residential areas except in case of public emergency.
h) Sound producing fire crackers should not be burst during night time.
i) Sound producing construction equipment should not be operated during night time in residential areas and silence zones.
j) Day time construction varies from "6.00 a.m. to 10.00 p.m."
k) Night time construction varies from "10.00 p.m. to 6.00 a.m."
l) Silence zone is an area containing not less than 100 meters around religious places, educational institutions, courts, hospitals or any other area which is acknowledged as such by the competent authority.
m) During house keeping the environment should be well illuminated.

The Table 2.6 shows the limitation for noise emission during construction activity in India.

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Table 2.6: The noise pollution (regulation and control) rules, 2000

The standards which are developed by "construction safety department, i.e. Environmental Health and Safety (EHS) Division, Government of Dubai (2010)" for night time construction safety are as follows:

1) The responsibility of the main contractor is to ensure that adequate safety advisors are available to cover the night time shift.
2) For nighttime construction, workers must be provided with chemical light sticks and the rescue boat must be fitted with high powered search lights.

3) The main contractor will have to ensure that in all construction activities at nighttime (between 8p.m to 7a.m) he shall obtain Environmental Health and Safety (EHS NOC) preceding to commence the nighttime construction activities.
4) The nighttime working emergency plan should be established.
5) It is prohibited to jack hammering and impact pile driving during nighttime hours.

In Dubai the noise level limit for daytime and nighttime construction are as shown in Table 2.7.

Table 2.7: Noise level limit Source: Department, E. P. a. S. S. E. E. (2011)

Table 1: Noise Level Limit-UAE Federal Environment Agency

Receptor Areas	Allowable Limits For Noise, dbA	
	Daytime (7 AM-8 PM)	Nighttime (8 PM - 7 AM)
Residential Areas With Light Traffic	40 - 50	30 - 40
Residential Areas in Downtown	45 - 55	35 - 45
Residential Areas With Some Workshops & Commercial or near Highways	50 - 60	40 - 50
Commercial Areas & Downtown	55 - 65	45 - 55
Industrial Areas (Heavy Industry)	60 - 70	50 - 60

The Department, L. (1989) labor law for nighttime construction in Iran is:

a) Article 56: Workers performing shift work during one month with shifts in the morning and afternoon shall receive 10%, with shifts in the morning and at night, or in the afternoon and at night 22.5% of the wages as shift allowance in addition to the wages.
b) Article 57: Working hours in shift work may exceed 8 hours per day and 44 hours per week, but the total working hours in four consecutive weeks may not exceed 176 hours.
c) Article 58: For every hour of night time work, 35 percent in addition to the wages for normal working hours shall be paid to non-workers only.
d) Article 61: Assignment of overtime work to the workers doing night time work or dangerous, hard and hazardous work is prohibited.

The labor law for Oman in night time construction is:

Night shift working hours: The time stuck between 09:00 p.m. and 05:00 a.m. 2.25% extra salary will be given to employee for overtime working. While 50% extra salary will be given to employee for nighttime construction.

The rules and regulation for nighttime construction in Russia are Daniil, (2010)):

The worker should use new and modern personal protective equipment on site such as:

1. Safety helmets with fixed headphones
2. Vests with reflective strips
3. Special protective footwear

In Russia, the construction sites are checking according to the Table 2.8 for both daytime and nighttime construction:

Table 2.8: Criteria for accounting of violation in Russia Source: Work safety development for Russian construction projects, 2010

TR-observation item	Criteria for accounting of violations	Violations
1. Personal protection equipment of workers	▪ one for each employee	▪ no helmet, goggles, respirator, earphones, gloves ▪ no personal protection equipment from cold (in winter) ▪ lack of fall protection (safety belt)
2. Scaffolding, stairs	▪ one for each device	▪ there are openings in the floor, or not provided the required bearing capacity (large deflections of flooring, etc.) ▪ scaffolding is not attached to the structure ▪ device is installed on uneven ground, or carrying capacity is insufficient
3. Machinery and equipment ▪ welding equipment ▪ hand tools (drills, angle grinders, hammer drills, etc.) ▪ concrete mixers ▪ lifting equipment (cranes, hoists)	▪ one for each device	▪ Lack of earthing for welding equipment ▪ use of uncertified equipment ▪ use of faulty equipment ▪ presence of uninsulated electrical parts
4. Protection against falling ▪ holes in the ceiling ▪ fenceless doorways and stairways ▪ danger zone of the crane	▪ one for each fenceless opening ▪ one for each hole ▪ one for each flight of stairs	▪ presence of fenceless or unclosed openings in the ceiling ▪ lack of fences in places where the difference in height is 1,3 m and more ▪ lack of fencing of the danger zone of the crane
5. Electricity and lighting	▪ one for each uninsulated element ▪ one for each unilluminated area	▪ presence of uninsulated wires ▪ lack of warning signs about high voltage ▪ presence of unlit places in the working area
6. Cleanness on the site and utilization of waste products	▪ one for each littery room ▪ one for each unauthorized sanitary fill ▪ one for each sewer of sewage	▪ presence of littery places ▪ no special area for landfill ▪ availability of illegal sewer of sewage

Chinese developed their own OSHC (Occupational Safety and Health Council) guidelines to ensure the safety of workers on site.

In China, the requirements for lighting energy use and lighting installation methods are a part of energy and building system (including fire) codes and mandatory standards.

GB 50034-2004 is a mandatory standard of lighting design of buildings as it has been merged into many codes. It is administered by the Ministry of Construction.

2.8 INTERNATIONAL RESEARCH ON CONSTRUCTION SAFETY

Construction safety is a major issue considered globally because of high injury and fatality rate. This makes construction industry as one of the most dangerous industry for work. Although remarkable improvements have been made in the area of safety in some countries but the construction industry still continues to lag behind in most of the other industries. As the world has become global village through information technology and through cooperative arrangements. Therefore, the concern of worker safety in construction has become a well-recognized problem and represents a concern that is shared worldwide.

Further international research which is conducted on construction safety is as follows:

Sang Bin Park (2001) developed the decision model which helps the construction professional in decision making related to daytime or nighttime construction activities in OREGON. The author figured out different factors which are important for daytime versus the nighttime construction. In order to determine the importance of each factor, the author adopted questionnaire technique. The data was gathered from Oregon department of transportation and other state. The author concluded that one of the factors which are most important for decision making of nighttime construction is cost such as the cost of construction, maintenance and user cost. The author also concluded from the analysis that majority of the people do not want to work in nighttime construction projects. The main limitation of this research is its narrow focus on transportation industry and not on gathering data from other sectors.

David Arditi (2005) presented the perception of construction professional on the issue of worker visibility and safety vest in nighttime construction activities. The author gathered data with the help of questionnaire survey from construction professionals of the department of transportation of Illinois and the construction professional in other states who were involved in nighttime construction activities. The author concluded from this research that majority of the accidents, caused in nighttime construction, are due to the condition of vehicle operators who drive

outside the work area and also because of the poor visibility for the workers; a large number of these accidents occur in the road construction projects. The main limitation of this research is its focus on the opinion of construction professional of Illinois rather than a national survey which may increase sample size and also provide researchers a broader picture for carrying out extensive statistical analysis of the data.

Donn e hancher (2007) presented paper on the issues of nighttime construction. The author used survey technique to examine the current state of issues, problems and impact of nighttime construction operation. The survey was conducted among different institutions which are state department of transportation, Kentucky transportation cabinet resident engineers and the selected country highway contractors. The survey results report the most important issues which influence the decision making regarding nighttime construction:

1. High daytime traffic
2. Traffic control
3. Road user cost
4. Longer work period
5. Schedule issues
6. Contract incentives
7. Safety
8. Temperature concern

Then the author identified the major problems which were faced largely on nighttime construction operation:

1. Quality
2. Lighting
3. Safety
4. Productivity
5. Public irritation
6. Equipment maintenance
7. Employee morale
8. Traffic control

The author expanded the chart of all the issues that were relevant in Kentucky in nighttime construction operation. Figure 2.2 shows the important factors for nighttime construction.

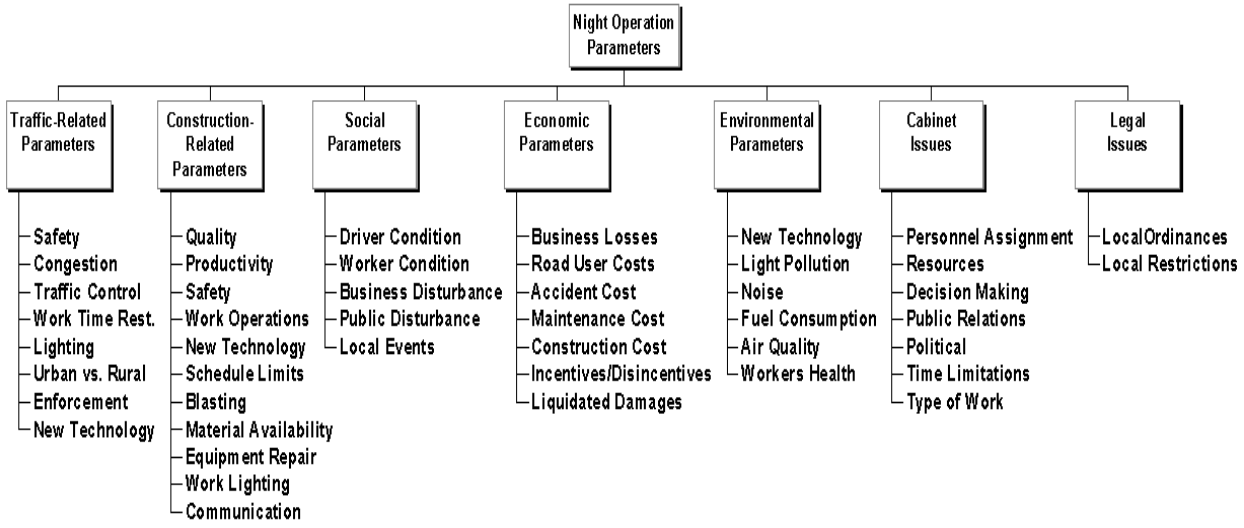


Figure 2.2: Factors affecting nighttime construction

Based upon these issues, the author recommended that detailed nighttime work plan should be established by the contractor before the start of nighttime construction operations. The lane closures on the project of highway should be limited to a maximum of 3 miles with at least 5 miles buffer in between consecutive closures to reduce the negative perception and public's inconvenience. Special signs should be placed in the work zone of nighttime construction regarding double fine area for the violation of traffic. The use of speed measuring and warning devices should be placed at the beginning of the construction zone of highway projects. For reducing the speed of vehicle, temporary thermal plastic speed bumps should be installed. The contractor should ensure that all traffic control devices are in good working order and are maintained properly. The project evaluation form during nighttime should be used during the preliminary planning phases to estimate the feasibility of performing the project at night. The use of balloon lighting for the construction project at night should be further investigated. The main limitation in this survey is relevance to the state of Kentucky and not the coverage of the opinion of other states.

Sawacha (1999) presented the factors which influence safety on construction sites. The author further established that the risk of accident resulting in fatality in the construction industry is five times more expectable than the manufacturing industry while the risk relating to major injury is two and a half times higher. The author established that each year, up to 120 people are killed on the construction sites in UK and almost 300 workers suffer major injuries. Nevertheless, according to the report of HSE, nearly 90% of all the construction accidents leading to death could

be prevented and 70% by action of management positively. Therefore, the author identified the factors which influence mostly on the safety performance of construction sites. The author from the literature review studied 7 groups of factors which influence safety on construction sites. Those factors were historical, economic, psychological, technical, procedural, organizational and the working environment. The author gathered data through questionnaire survey and then analyzed by correlation coefficient. The final conclusion is that the historical variables as a whole had an impact on the safety performance of construction site; in particular the age of operatives. The author further suggests that the most prominent indicators in the economic factors were established as an attitude towards the risk taking induced by the offer of payment (hazard pay) and the incentive bonus pay system in order to increase the productivity. Results also suggest that in psychological factors there is a strong relationship between personal care for safety and the safety performance itself. The most influential technical factor was awareness of hazardous material rather than its handling. Analysis of procedural factors showed that safety performance was not so much related to safety kits. One of the vigorous conclusions the author makes is that safety performance appeared to be significantly influenced by the organizational factor. The author recommends that construction industry needs to review the safety training programs regularly and update the health and safety acts inside the company manual and on the construction sites.

Aksorn (2008) identified the critical success factors which influence the safety program of Thai construction industry. The author acknowledged 16 factors which are critical for the safety program from the literature review and the previous research. These factors are; "good communication, clear and realistic goals, management support, delegation of authority and responsibility, significant resource allocation, personal competency, program evaluation, continuing involvement of employees, personal motivation, effective enforcement scheme, personal attitude, teamwork, safety equipment, positive group norms, appropriate supervision acquisition and maintenance and appropriate safety education and training". The data was gathered from questionnaire technique. After analysis, the author concluded that availability of management support was the most crucial factor in terms of safety implementation in Thai construction industry. Furthermore, using factor analysis technique, these 16 critical success factors were grouped into four dimensions which are:

1. Worker involvement
2. Safety prevention and control system
3. Safety arrangement

4. Management commitment

The author established that workers' participation creates a favorable attitude and the motivation of workers largely depends on participation of the workers and the construction norms of the workgroup. Safety prevention and control required an appropriate supervision, effective enforcement and maintenance and also the qualified person for implementing the safety practices on site. Safety arrangement involved assigning the clear roles and responsibilities to everyone and setting the proper mechanism to disseminate information. Management commitment involved encouraging all employees to achieve their goals through team spirit and setting the realistic safety benchmark which could be accomplished and also implementing the safety program with the support of top management.

Kartam (2000) evaluated the existing safety regulation and the procedures which are adopted by the client, consultant, contractor and the insurance companies. The author also assessed the appropriateness of these procedures and regulation in Kuwait environment and workforce. The author further evaluated the problems which were associated with enforcement of the safety regulation on the construction site. The author adopted questionnaire and interview technique to gather the required data. From the data, the author identified the following problems which adversely affect the safety of the workers:

1. Competitive tendering
2. Lack of safety regulation
3. Small size of most construction firms
4. Extensive use of subcontractor
5. Insignificant accident data
6. Widespread use of foreign labor
7. Unsystematic labor
8. High labor turnover
9. Low significance of safety
10. Seasonal employment and weather effect

The author recommended that for safe construction the general reorganization of the injury report must be undertaken so that the data which is related to hazard is uniformly gathered throughout all government and private agencies and worker compensation program. The author proposed that a competent safety person must be employed to review the construction project and safety plan before the start of the work. The author concluded that improvement in safety of the

workers can be accomplished by better safety planning, safety organization, management commitment towards safety and individual labor behavior. They also suggested that insurance companies must inspect the site to investigate the contractor safety procedure and to examine their past safety performance and the accident records. The owner is ultimately responsible for all the safety aspects of the construction project and should vigorously participate in contractor safety enhancement program. The author also proposed that designer has to pay more attention towards safety factor and make sure that the project is completed and maintained safely. Only the workers which are appropriately trained should be allowed to perform work on construction sites. The author recommended that current safety rules and regulation should be improved and implemented strictly on the construction sites and the contractor should incorporate cost margin for the safety practices in the tender.

Mustafavi (2011) discussed the elements which are important for translating the results related to the safety of worker and safety planning in nighttime highway work zone construction into practice. The author used several tools for translating the result into practice. The data was gathered by dividing the tools for safety recommendation into different categories such as site based and the task based. The site based recommendation consists of construction and maintenance related operations which were further divided into the activities. Whereas, task based consists of three different activities. The output of the safety recommendation is further divided into four categories such as lighting, traffic control, personal protective equipment and general awareness. The safety recommendations were evaluated by the questionnaire. The author concluded that large number of people respond that there is a dire need of improving the lighting on site for improving the safety of workers.

Rafiq (2008) investigated that why workers engage in unsafe work behavior on Hong Kong construction projects. The author further divided this research into 11 factors which are; psychological feature, self-esteem, economic feature, management commitment, safety procedure, perceived risk, job security, experience, performance pressure, working environment and education, orientation and training. The author evaluated these factors by interviewing the construction professionals. The author concluded that availability of management commitment was found to be the most crucial factor for reducing the accident and increasing the safety of workers on site. The study also concluded that on site, production incentives are needed to be applied with good safety performance. The living condition is needed to be improved for reducing

the psychological factor faced by the worker on site. Safety training should be provided to worker for increasing the awareness which can improve the safety on site.

O.a.elrahman (2008) performed a literature review on current nighttime construction practices. The author found that there were no differences between nighttime and daytime operations in terms of safety, severity and the type of accident. The author also concluded that productivity was also same between daytime and nighttime operations. The author evaluated that there was no consensus on whether the construction cost increases or decreases as a result of performing the work at night. The reduction in the traffic delay leads to an improvement in air quality and lower fuel consumption. The work at night can cause noise pollution which can be the big concern of the neighboring community. The author identified some gaps which are needed to be addressed more accurately to quantify the cost of nighttime construction versus the daytime construction. Research also needs to be developed to quantify the environmental benefits of conducting the work at night including improvement in the air quality and the decrease in the fuel consumption.

Choudhry (2008) described the site safety management in construction sites based in Hong Kong. The author concluded that there is a dire need to introduce the training programs on computer within the company and each employee and trainee should be tested on the outcome after the training. The contractor is required to prepare site safety plan for each of the construction activity to minimize the hazards on construction site. The author also suggested that safety, health and environment management system needs to be updated regularly to overcome all the weaknesses in the site safety plan and make this plan more practicable. The limitation of this research is that the data was self-reported and collected from only one construction site. Therefore, the results were gathered just from assessing the safety management of that specific project. The result might be useful if data collection was done from different companies and compared with each other and then the broader conclusions were made.

Choudhry (2007) reviewed the literature on safety culture and provided the model on safety culture which can be applied on construction site for improving the safety of workers. The author interpreted from this model that unsafe condition can be identified and improved during the site safety implementation on construction sites. Employees behavior can be measured by the safety behavior through the behavior based safety program. Safety management system can be measured by project and site safety audit. Figure 2.3 shows the model of safety culture:

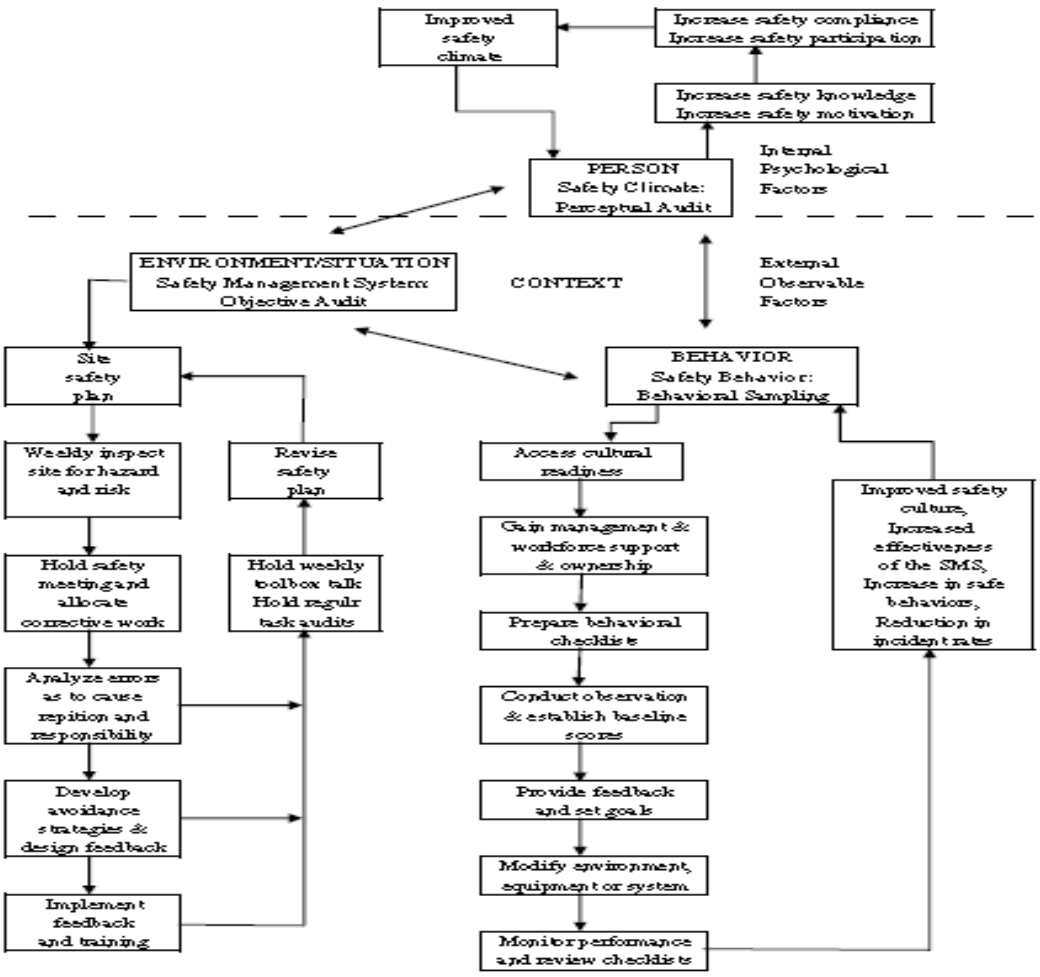


Figure 2.3: Model of safety culture

The author concluded the definition of safety culture as the product of individual and group behavior, norms, attitude and value perceptions and thought that determines the commitment, efficiency and style of an organization as to how it acts and reacts in company ongoing safety performance within construction site environment. The author also suggested that safety culture should not be viewed as an alternative to safety climate because safety climate was a product of safety culture.

Helen (2002) described that first aid training had a very positive effect on reducing the worker's accident on sites. The first aid training helps the workers to improve their behavior for the avoidance of injuries and illness. First aid training also reduces the worker's sense of unrealistic optimism that the accident cannot happen to me. The first aid training also improves the worker's perception about the probability of suffering from injury or illness and, as a result, the worker gives great importance to the risk associated with the construction activities. First aid training also increases the motivation of the worker to avoid injuries.

Permana (2007) identified the key factors of construction safety which are shown in the following Figure 2.4:

Figure 2.4: Key Factors of Construction Safety (Permana 2007)

These practices were mostly followed in most of the developed countries. But these conditions cannot be applied without making the adjustment in the developing countries.

haadir (2011) described the critical success factor for the implementation of safety program among the construction companies of Saudi Arabia. The author identified four factors which were important for the implementation of safety program. These factors were further divided into subparts, as shown in the Figure 2.5:

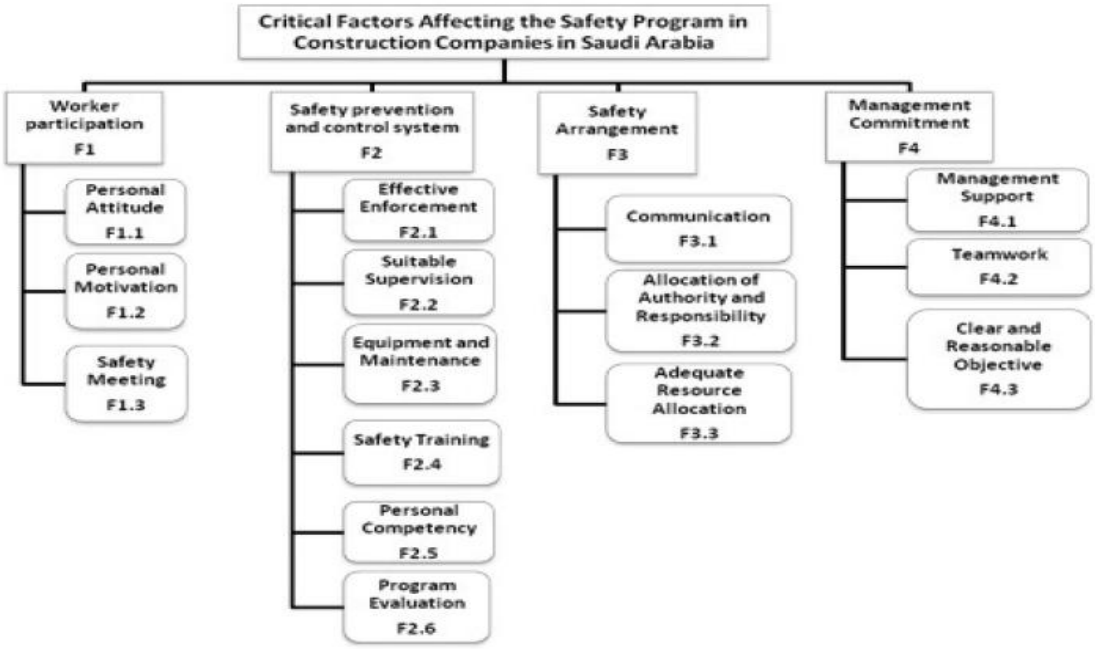


Figure 2.5: Critical factors affecting safety program in Saudi Arabia

The model was used as a basis for developing a questionnaire for collecting data. The author analyzed the data through AHP and concluded that there were seven factors which were important for safety program implementation such as management support, personal attitude, clear and responsible objectives, team work, safety training, effective management and suitable supervision. Therefore, the top management should play a significant role for the implementation of safety program on the construction site.

Ahmed al-kaisy (2003) investigated the construction operations in the nighttime on the project of highway maintenance and reconstruction sites. By using the questionnaire survey technique, the author gathered data for all the issues which are currently important for nighttime construction operation such as traffic related factor, construction related factor, environmental factor and social factor.

The author concluded from the investigation that there is a small percentage of transportation projects that involves nighttime construction operations. The use of dual shift in the transportation projects is comparatively more common than in nighttime shift alone. Further, the author also suggests that nighttime construction projects are less common on the two lane rural road construction projects.

The author also suggests that most important factor for making the decision of nighttime construction is avoiding the daytime traffic which is further followed by traffic safety and the

safety of workers simultaneously. From the result, it is also concluded that the construction related factors like work quality and the productivity are least important for decision making of nighttime construction operations.

The author investigated that most important advantage of nighttime construction operation, as perceived by the state department of transportation, is reducing delay and the congestion. The energy and environmental factors have less significance in the current practices. However, less visibility during nighttime construction operation was found to be the most vital concern in terms of construction safety. From the data, the author found that construction costs at nighttime are higher than daytime in the range of 0% to 25%. The author also suggests that production rates in terms of nighttime construction are slightly impacted. Some of maintenance and construction activities were found more suitable for the construction operation in nighttime than others for instance construction of bituminous structures and pavements, concrete sawing and the work related to shoulder were the three top construction activities.

From the data, the author identified that only 50% of the states reported delay and congestion in making decision of nighttime construction. Traffic control plans during nighttime construction operation were found to include the extra cost than the daytime construction operation.

The author recommended the use of quantitative approach to investigate some more aspects of nighttime construction operation and also to explore the impact. It is preferable to explore the impact of nighttime construction operation on the same projects by controlling other effecting factors. The author also recommended bidding nighttime pay items separately because they may include things like additional money for traffic control, lightning equipment, etc. Bidding nighttime items may help the contractor in better understanding of the prices and may also result in more precise and lower bids. It also provides more effective way for tracking the costs related with nighttime construction operations.

The author also identified the advantages of nighttime construction. He established that nighttime construction can reduce delays and congestion, lower the impact on surrounding business, lane closure on the road can be done freely and finally results in longer work hours and less air pollution. He further established the hazards at nighttime construction such as nighttime construction can cause “visibility issues, higher traffic accident rates, higher worker accident rates, noise pollution, decreased productivity, inferior work quality, material availability problems and equipment maintenance problems”.

Jackson (2005) Identified the current issues of nighttime construction. He established that "poor visibility, inadequate lighting, worker's fatigue and driving conditions cause hazardous situation for pedestrians, drivers and workers".

2.9 FRAMEWORK ON CONSTRUCTION SAFETY

The previous research, which has been conducted for the development of construction safety framework, is as follows:

Misnan (2007) proposed the conceptual framework for the development of safety culture on the construction industry. The author from the literature review scrutinized different factors which were important for the development of safety culture. These factors involve the human behavior, difficulties of work, dangerous machinery, etc. After analyzing the literature review, the author concluded that organizational and contextual factors were important for the variety of outcomes related to workplace safety. The conceptual framework has been developed for construction safety culture which is shown in following Figure 2.6:

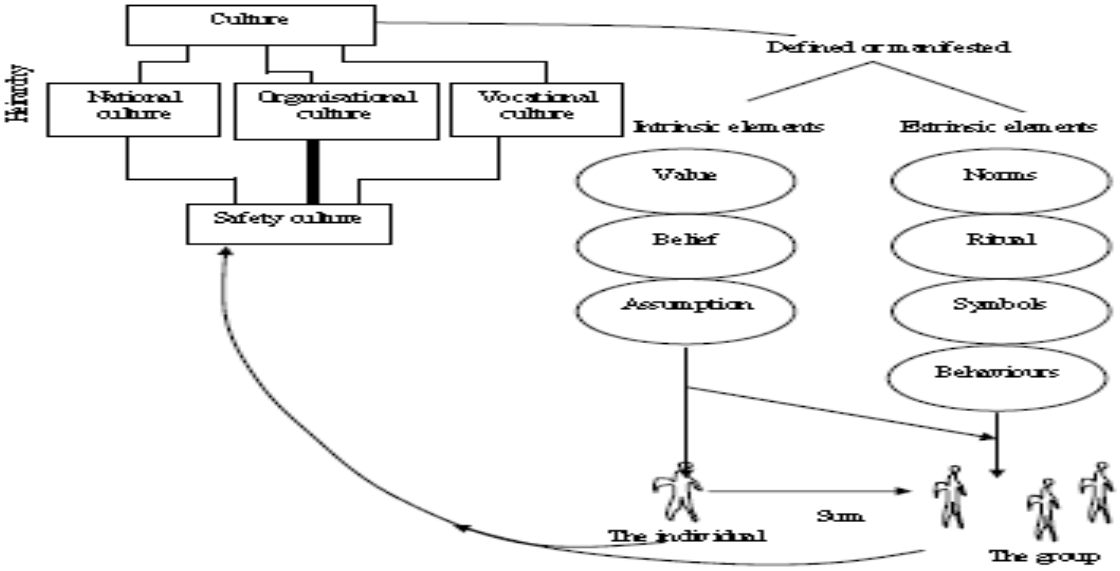


Figure 2.6: Framework of safety culture

The main limitation of this study is that the author reviewed the safety culture without elaborating the most important factors in organization.

Ahmed (2013) studied the factors which are important for implementing the safety on construction sites. The data was gathered from the pilot survey, interview technique and questionnaire. The author visited 55 construction sites and explored the aspects of construction safety management which were "health and safety policy, safety training, safety inspection, safety

organization, personal protective program and the documentation of accident prevention". From statistical analysis, the author concluded that the top management needed to deliberate for the development and the implementation of safety, health and environment management systems. And the top management should take steps to improve the safety condition on construction sites. The author also suggested that there is a dire need in the construction industry to appoint the competent persons for implementing the safety practices on the construction sites. It is also necessary to launch the government agency to control and supervise the execution of safety practices on the construction sites. The framework for construction site safety is as follows in Figure 2.7:

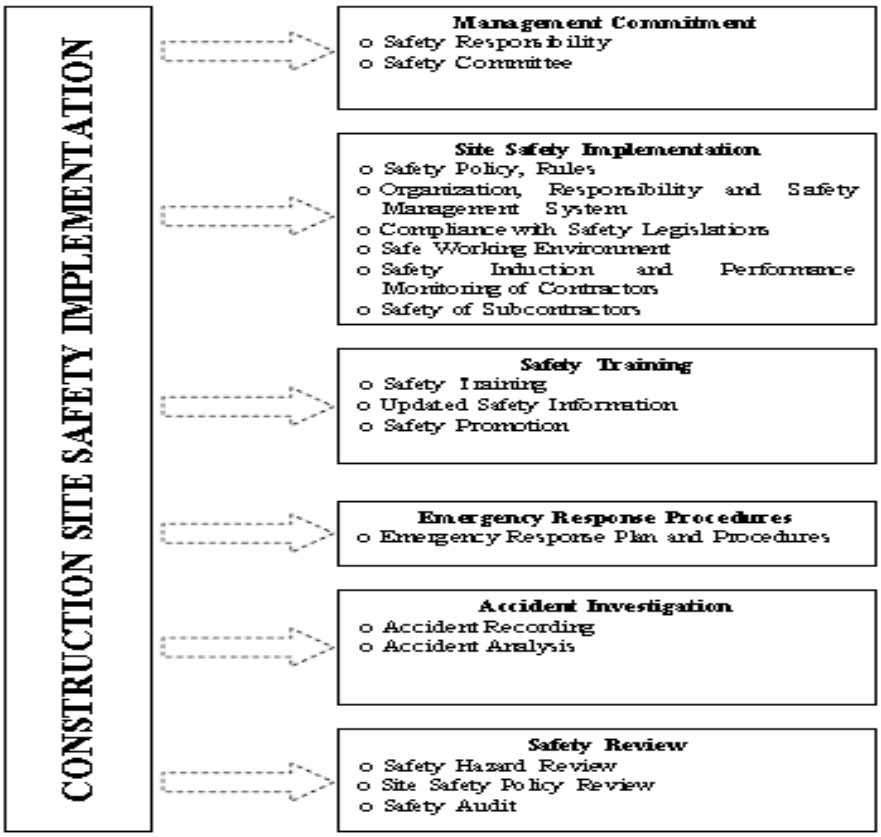


Figure 2.7: Construction Site Safety framework

The author recommended that the sufficient funds are required to be allocated in the contract document so that the contractor can implement the safety practices on construction site.

Teo (2005) proposes a framework which can help project managers for ensuring construction safety. From the literature review, the author identified the factors which may contribute in construction site safety such as policy factor, process factor, personal factor and incentive factor. The author, after analysis, further divides these factors and proposed the

framework for managing the construction site safety in Singapore construction industry which is shown in Figure 2.8 as such:

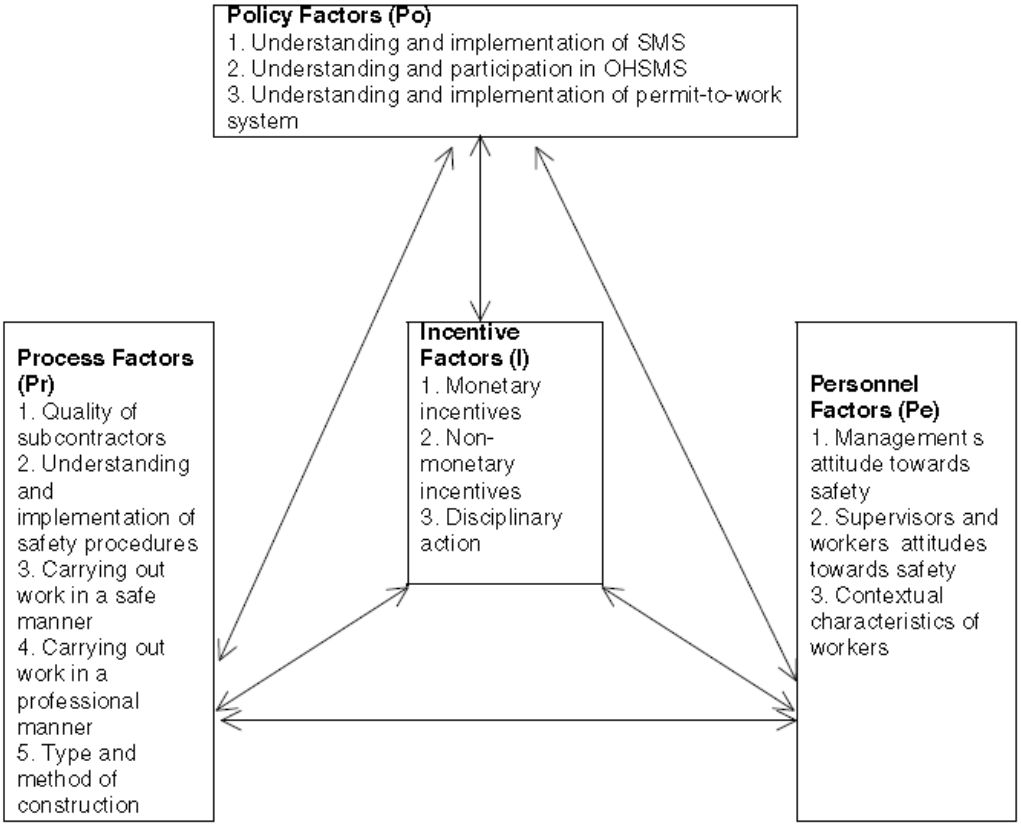


Figure 2.8: Construction site safety framework for Singapore

The main limitation of this study is that the response which was obtained from professional was not enough in number to make any conclusion of the research. Moreover, this study did not identify that how safe the construction operation is at a given time.

Thomas (2005) developed the framework for assessing the safety performance of the construction contractors. The framework was developed by identifying the safety performance factors. There were 13 factors which were related to organizational level as shown in Figure 2.9. And 18 factors which were related to project level are shown in Figure 2.10.

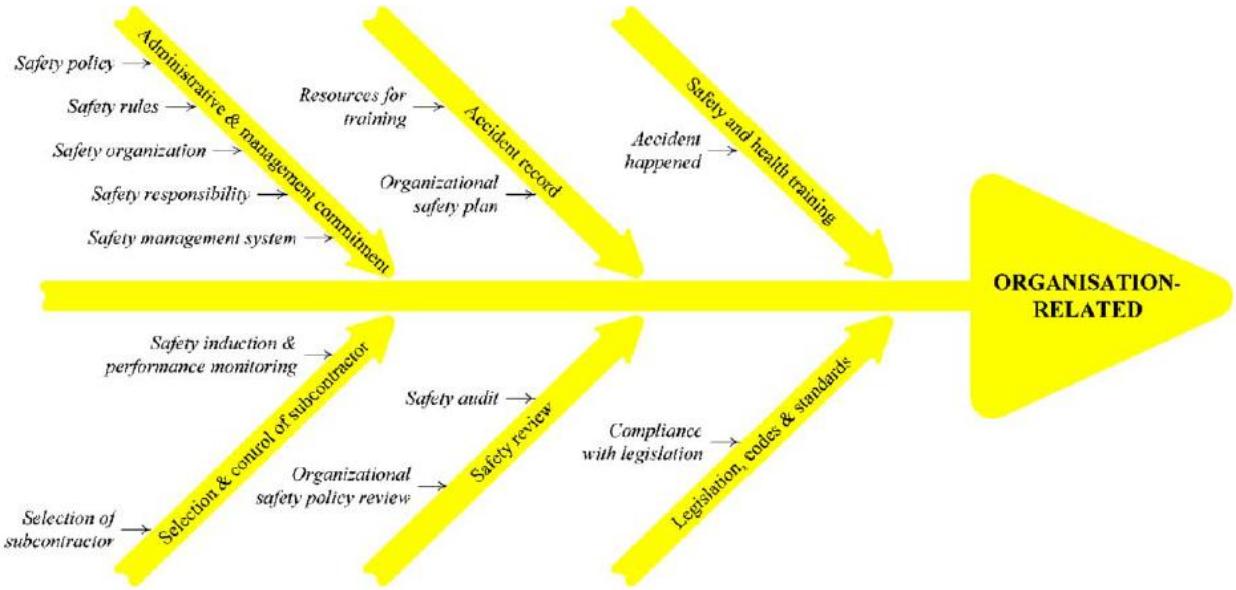


Figure 2.9: Organizational factors of safety performance in construction companies

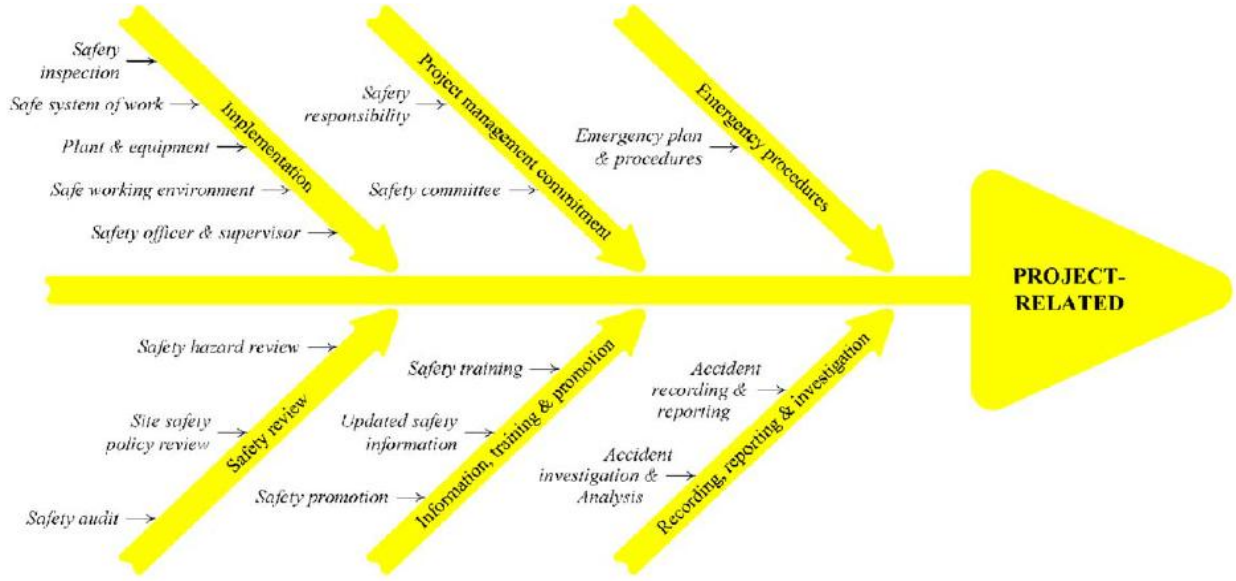


Figure 2.10: Project factors of safety performance in construction companies

A questionnaire technique was adopted to gather the data. The author concluded that on the level of organization, the most important factors were the implementation of the safety management system in accordance with legislation, codes and standard and the compliance with occupational safety and health (OHS) legislation. However, at the project level the most vital safety performance factor was the provision of the working environment.

Improving the site safety is the top priority of the construction companies. Having a positive and mature construction safety culture is becoming significantly important to facilitate such type of improvement. "An anecdotal evidence suggested that in many construction accidents,

the safety management system broke down because of prevalent safety culture in which safety management activities were carried out". Chaudhry, (2007) So to make preventive measures, the model of construction safety culture was developed which is shown as follows in Figure 2.11:

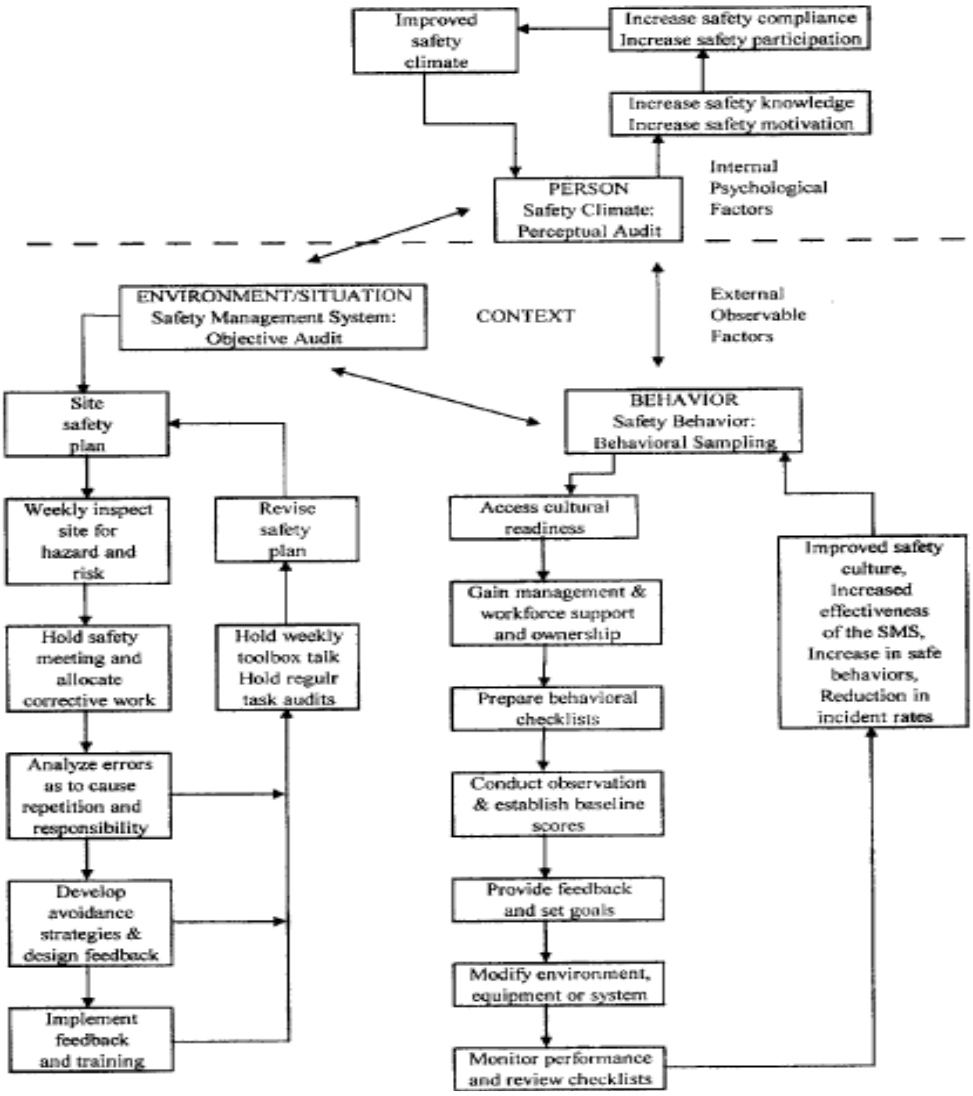


Figure 2.11: Construction Safety Culture

He established that by adopting this model on construction site, construction accidents can be reduced and the safety culture on site can be improved.

So we have the framework for construction safety on site, but we do not have the framework of construction safety relevant to workers' safety hazards at nighttime construction. So this research can help to establish the framework for improving the workers' safety and reducing hazards on construction site at night.

2.10 KEY PARAMETER FOR NIGHTTIME CONSTRUCTION

After conducting the literature review, finally 27 parameters were identified which contribute in causing hazards on site for the workers at night. Table 2.9 shows the key parameters of nighttime construction:

Table 2.9: Key parameter for night-time construction

1.	Lack of training
2.	Temperature variation
3.	Communication gap
4.	Insufficient lighting
5.	Lack of Personal protective equipment
6.	Lack of first aid measures
7.	Lack of safety regulation
8.	Unskilled labor
9.	Less educated workers
10.	Lack of technical guidance
11.	Lack of strict operational procedure
12.	No roads on construction site for material transportation
13.	Lack of teamwork spirit
14.	Excessive overtime work for labor
15.	Marking
16.	Visibility
17.	Unavailability of authorized person in emergency
18.	Poor performance of safety garments
19.	Drug abusers
20.	Lack of modern technology
21.	Sites are not properly sloped to prevent collapse
22.	Unavailability of safety net to prevent fall
23.	Unavailability of safety switches to prevent electrocution
24.	Ladders are not up to the standard
25.	Lack of motivation
26.	Signs are not mentioned on site
27.	Disuse of safety garments

By using these parameters, the construction site safety framework for ensuring the safety of workers at night will be developed.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This following chapter describes the procedure of the research and puts into perspective the method which is used to conduct the research associated to its objectives underlined in the Chapter 1. Includes the details of data collection. The research design is explained first followed by the background of data collection and the detailed research process as well as the research method. A questionnaire technique was adopted and used for data collection. The questionnaire is defined in this chapter. The research method explains the relevance of questionnaire, its implementation towards the data collection and the sample size as well as the assessment techniques used for data analysis.

3.2 RESEARCH DESIGN

The research focus is to identify the critical factors affecting workers' safety issues during nighttime construction activities in Pakistan. The research consists of four phases: preliminary study, data collection, and data analysis and site safety framework development for nighttime construction. The demonstration of theses phases are shown in Figure 3.1.

Preliminary step was the leading stage of the study. This stage was carried out to have the essential knowledge about the topic done in this field. The previous literature relating to thesis topic was searched and studied in detail from different journals and books. On the basis of this study, the objectives of study were developed and finalized along with the development of the preliminary questionnaire. It consists of two main portions: the first part is called as an observatory part, which is used to check the level of awareness of construction industry relevant to nighttime construction in Pakistan; the second portion deals with the main factors contributing to worker safety hazards at night.

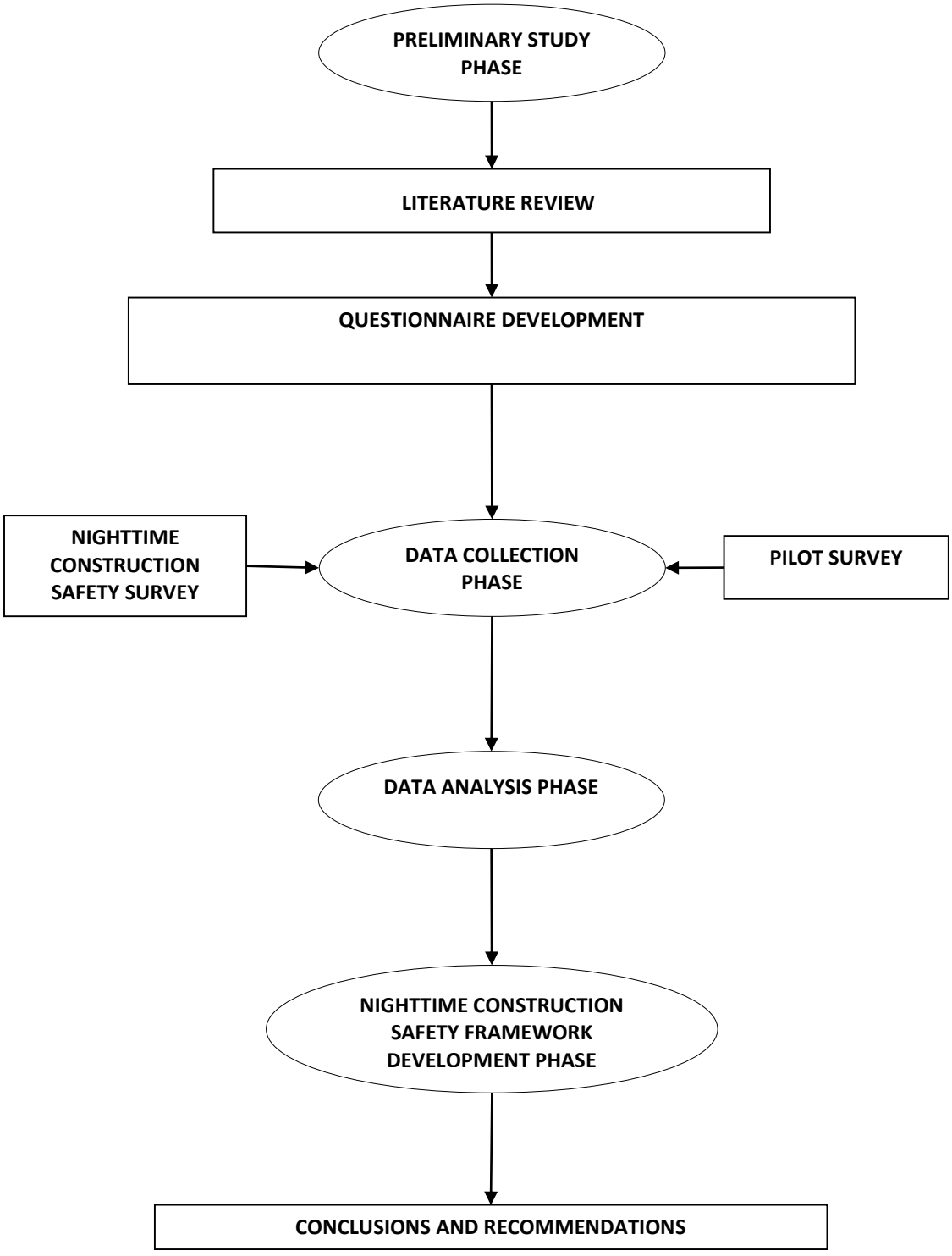


Figure 3.1: Research Methodology

The questionnaire needed some level of agreement from the respondents and it is important to be in ordinal scale range from 1 to 5. Respondents were required to give the score according to their understanding. Questionnaire based on Likert scale of the ordinal measure of agreement towards each statement as in Figure 3.2. The respondents were required to give scoring to these factors as per their importance on Likert scale (1-5) with 1 representing the strongly disagree or seldom and 5 representing the strongly agree or always. The first portion of questionnaire termed as observatory part, is further divided into different aspects such as the benefit of nighttime construction, availability of safety equipment, availability of management support at night and main reasons of accident at night. This portion helps in checking the level of awareness of construction industry for nighttime construction.

The second portion of the questionnaire deals with the two main aspects. First factor called the critical factor causing the worker safety issues at nighttime construction operations. This portion consists of 16 factors, which were extracted from the past literature review (El-Rayes, et al. (2003); Shane, Kandil, et al. (2012); Rebholz., Al-Kaisy, et al. (2004); Back, W. and L. Bell (2004) etc.). The second factors are the main person responsible in implementing the safety practices at night. This aspect is further divided into 11 factors.

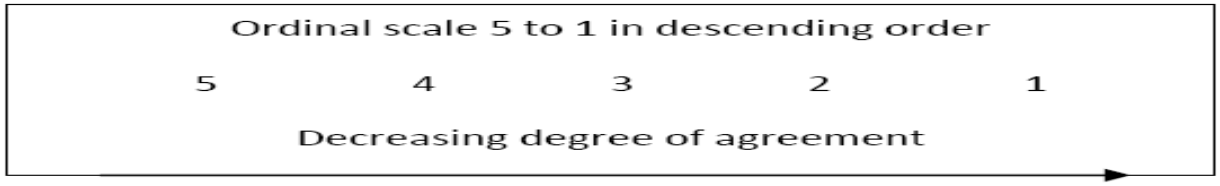


Figure3.2: Likert Scale for Five Ordinal Measurements

Each of the 5 ordinal scales represents the following ratings

Ordinal scale	Level of agreement
5	Strongly agree or Always
4	Agree or Mostly
3	Neutral
2	disagree or Frequently
1	Strongly disagree or Seldom

In the data collection phase, first the pilot survey for nighttime construction safety was conducted by face to face meetings or through email sent to above mentioned company's top management representatives. Initially the pilot survey was conducted to evaluate the implications

of questionnaire on project sites. After finalizing the questionnaire, a full nighttime construction safety survey was carried out. A questionnaire was distributed by face to face meetings or through email to the company's top management representatives on the project sites, i.e. Construction Engineers, Project Directors, Site Supervisors, Project Managers, Safety Officers, Safety Managers, and Site Engineers etc.

In the data analysis phase, the obtained data was entered into the statistical analysis software (Minitab), Excel and then analyzed. Quantitative method is adopted for the analysis of nighttime construction safety survey. To do this, literature is reviewed for the statistical tools, and elaborated as to how the results obtained from Minitab are interpreted. Based on the obtained results of data analysis, the conclusions and recommendations are made.

In the last phase, efforts are made to develop a safety framework for nighttime construction for implementing and executing safety practices on construction sites. To obtain the required objective, literature review was carried out on existing safety frameworks. Which were adopted by the developed or developing countries. So based on the literature review and the results, acquired from above phases, the nighttime construction site safety framework is proposed for the implementation and execution of safety practices on construction sites by the local construction companies.

3.3 Sample Selection

The purpose of statistics is to have summary measure about some characteristics of the population through sampling. "In all cases, a sample has to be drawn from its population. The term 'sample' means a specimen or part of whole (population) which is drawn to show what the rest is like "Tambouris, et al, (2007).

The sample of this research is based on the population of construction enterprises in Pakistan. Hence, According to PEC statistical data, the number of construction establishments registered with PEC until January 2013 reached 30,000 but not all of them are working on construction projects. It's a large population and the selected sample represents several construction professionals from clients/owner, consultants and contractors with a different categories and backgrounds.

The questionnaire was distributed to 150 randomly selected potential respondents. Main focus of the survey was on buildings, infrastructure and roads, and bridges/flyovers projects. Respondents bring higher levels of qualification and engineering experience.

3.4 Sample Size

Factors that should be taken into consideration for determining a suitable sample size are:

Population size

Sampling error

Confidence level

Equation (3-1) provides formula to calculate the sample sizes (Dillman, 2000):

$$Ns = [(Np)\ (P)\ (1-P)]\ /\ [(Np-1)\ (B/C)^2 + (P)\ (1-P)] \quad \text{(3-1)}$$

Where;

Ns: sample size for the desired level of precision

Np: population size i.e. 30,000

P: proportion of the population that is expected to choose one of the responses

Categories (yes/no); P = 0.5

B: acceptable sampling error; (±10% or ±0.10)

C: Z statistic associated with the confidence level

(1.96 corresponds to 95% confidence level)

$Ns = \{(30,000)\ (0.5)\ (1-0.5)\}/\ \{(30,000-1)\ (0.10/1.96)^2 + (0.5)\ (1-0.5)\}$

$Ns = 95.736$

The sample sizes which were acceptable for various populations with different sampling errors for 95% confidence level are given in Table 3.1. These sample sizes can also be calculated by using the formula given in equation (3-1).

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

Table 3.1: True sample size Source: (Dillman, 2000)

Sample size can also be determined by using equation (3-2) (Shash, A. A. and N. H. Abdul-Hadi (1993)):

$$n = n' / (1 + n' / N) \quad \text{(3-2)}$$

Where;

n: sample size from finite population

N: total population

n′: sample size from infinite population, which can be calculated as $n'=S^2 / V^2$

S2: standard error variance of population elements = P (1-P); maximum at P=0.5

V: standard error of sample population = 0.05 for confidence level 95%

$n' = 0.25/0.05^2$

$n' = 100$

$n' = 100(1+100/30000)$

$n' = 99.66$

"There were 104 valid replies out of 150 showing an overall response rate of 70%. In the construction enterprises, a good response rate is around 30%" Black et al., (2000). Hence, the response rate for this research is adequate. The sample size is 104 for this survey, however to determine whether or not the following sample size is truly represents the population, table 3.1 is used which exhibits sample sizes required for various population sizes and characteristics at three level of precision.

Until January 2013, more than 30,000 construction establishments have been registered with PEC. The following number can be used as the population size. The confidence level is selected as 95%. It is also assumed that the answers will be homogeneous and will set the p value to 0.5 (means that probability of occurrence is 50%). Using a fifty-fifty split maximizes the question variance, which needs the largest possible sample to control for the differences among the response options. Hence, by applying these values in equations (3-1) and (3-2), the sample size comes out to be 96 or 100 for a sampling error of ±10%. Hence, a sample comprising of 104 respondents is quite reliable for further analysis.

3.5 RESEARCH METHOD

The analysis of nighttime construction safety survey was conducted by using statistical software, Minitab and Excel. By analyzing the current practices of construction worker at night. The nighttime construction Safety survey was developed and hard copies were distributed for response. The collected data obtained from the valid responses were entered in Minitab and Excel for analysis. Detailed analysis and results of nighttime construction safety survey are reported in the chapter four.

3.5.1 Data Collection

The following section defines the background of the data collection and provides an outlook view of the research plan that was executed. Data for this research was obtained from the construction sites and companies of Rawalpindi, Islamabad, Karachi, Lahore, Muzafrabad, and Peshawar.

Questionnaire was developed after a widespread literature review. The pilot survey was done at the initial stage of the data collection phase. The individuals who participated in the pilot study involved the following site management personnel on four multistory projects in Islamabad: construction manager, planning engineer, project managers and site engineers. Following four projects were selected for pilot testing of questionnaire:

1. Construction of School of Sociology, Islamabad.
2. Construction of new SMME building, Islamabad.
3. Squash court building Construction, Islamabad.
4. Construction of Residential unit, Islamabad

Safety issues associated to the construction projects were discussed with the safety managers or Construction Manager and questionnaire was revised according to the nighttime construction safety practices which were witnessed at the sites. Information of the visited construction sites for nighttime construction safety survey are incorporated in "Appendix IV".

After pilot testing some modifications are made in the questionnaire, the questionnaire ("see Appendix II") in English was provided to the construction managers, planning engineers, project managers, site engineers and safety managers on a construction project sites by face to face meetings after telephonic coordination. Another questionnaire was made in Urdu for the collection of data from the workers relating nighttime construction safety practices. Some questionnaires were distributed via email for different construction professional working on different project sites like Peshawar, Karachi and Lahore, etc. to Construction Managers, Planning Engineers, Site Engineers, Project Managers, Safety Managers and Safety Officers for their response.

3.5.2 Full Scale Survey

Bell (2005) argued that delivering questionnaires to respondents by hand have distinct advantages: respondents can get a better understanding of the research purpose, questionnaires can be filled through face to face communication, any difficulty in the questionnaires can be sorted out easily and high response rate can be obtained. Therefore, projects sites in Islamabad-Rawalpindi

regions were visited and questionnaires were personally delivered to the client, consultant and contractor's representatives and some questionnaires were delivered.

The location of various projects from where response was obtained is shown in the Figure 3.3.

Figure 3.3: Research survey Location Map

3.5.3 Nighttime Construction Safety Survey

To meet the research requirements for the nighttime construction safety survey, extensive literature review was carried out and nighttime construction safety practices of construction companies were studied. The planning for research methodology was setting objectives, designing, reviewing, discussing and finalizing the questionnaire with the construction safety professionals from the construction sites. The questionnaire was filled by a Client, Consultant and Contractor. Obtained data was entered in Excel & Minitab during the analysis.

Nighttime construction safety questionnaire was developed and used to survey the particular construction project sites. Information and data relating to nighttime construction safety was obtained from this survey. Questionnaire was adopted which consists of two part. The first part called as observatory part. This part consist of four Main aspects divide into further factors. The second part of the questionnaire called the main survey part. It consist of two Main aspects. The fifth aspect were further divide into 27 factors of site safety at night. And aspect six were further divided into 14 factors. After pilot testing the questionnaire, some amendments are made in the main part of the questionnaire. The questionnaire after the amendments consists of 16 main factors for aspect five and 11 factors for aspect six.

A covering letter ("see Appendix I") was developed and presented to the construction professional along with the questionnaire to the respondents providing feedback. The Likert scale technique was adopted. The respondents are required to give the answer of the question according to their importance.

Responses from different Client and Consultant with fifteen construction sites were selected for survey. Data collection for this survey was planned to be carried out over a period of eight weeks. The (appendix IV) show the list of surveyed construction project sites.

3.5.4 Construction Site Safety Framework Development

In this phase the mainly focus was on the construction site safety framework developed by the previous research studies in the developing countries like Malaysia, Singapore, and Thailand etc. and effectively implemented and executed on construction sites in these countries. Afterwards an extensive literature review and according to the outcomes of nighttime construction safety survey, the framework for implementing and executing safety practices on construction sites is proposed in Chapter 4.

3.6 DATA ANALYSIS

Once the responses were collected back, they were compiled and analyzed in the data analysis phase. Excel and Minitab are used as a main data compilation and analysis tools in this research study. Data of the above responses was entered into the excel sheet and compiled accordingly so as to make it ready for required analysis.

"The Relative Importance Index (RII) is generally used in a number of studies to find the significance of factors. The RII is a commonly used method in construction to obtain priority ranking of attributes, and it is particularly useful where a structured questionnaire is used to solicit measurements that are subjective in nature" Holt, (1997).

"Cheung et al., (2010) used the following formula to calculate RII".

$$\boldsymbol{RIIa} = \frac{\sum_{i=1}^{n} \boldsymbol{Ra_i}}{\boldsymbol{Mn}} \quad \text{..... (3.3)}$$

In Equation 3.3, "(RIIa) is the relative importance index of attribute (a), (Rai) is rating score against attribute (a) from respondent (i), (M) is the maximum score obtainable and (n) is the number of responses".

"Another formula has been used by Chinyio et al. (2010) to calculate RII which is as under in Equation 3.4":

$$\boldsymbol{RII} = \left(\frac{\sum \boldsymbol{W}}{\boldsymbol{A\ X\ N}}\right) \quad \text{……...…} \quad (3.4)$$

"Where (RII) is the relative importance index, (W) is the respondent's score, (A) is the maximum score obtainable and (N) is the number of responses".

"Similar type of formula has also been used by Kumaraswami and Chan (2010) in their study to calculate RII" in equation 3.5:

$$\boldsymbol{RII} = \frac{\sum \boldsymbol{w}}{\boldsymbol{A\ X\ N}} \quad \text{……..…} \quad (3.5)$$

"Where (RII) is the relative importance index, (w) is the respondent's score, (A) is the maximum score obtainable and (N) is the number of responses". Hence, in this research, the percentage scoring criteria is used to find the significance of each factors affecting the worker safety issues in nighttime construction. It is found just by multiplying the RII with "100". The one factors with more percentage score shows the more significant and lesser percentage score demonstrating the lower significance. The following formula is to calculate the percentage score:

$$\text{\% Age Score} = \frac{\sum \boldsymbol{W}}{\boldsymbol{A\ X\ N}}\ \boldsymbol{X\ 100} \quad \text{…….} \quad (3.6)$$

In Equation 3.6 "the (W) is the score obtained from each respondent, (A) is the maximum score which is 5 in this case and (N) is the total number of respondents for this survey". Using the above mentioned formula, the significance of all the factors affecting the worker safety issues in nighttime construction are found and summarized.

Once the analysis is done, the necessary graphs were plotted by using the Excel. To show the effective representation of the findings.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

In this chapter, detailed analysis of the collected data is presented. For this purpose, Excel & Minitab, was used. In this research, the Client, Consultant, Contractor and Worker, all the four key stake holders who can play an active role in the execution and implementation of safety practices on site gave their perceptions about the critical factors that contribute to create the hazards for the workers in night time construction. Relative Importance Index (RII) method was used for ranking the significance of factors of night time construction safety. The percentage agreement between the four stakeholders was also checked to determine the level of agreement between the parties.

4.2 NIGHTTIME CONSTRUCTION SAFETY SURVEY RESULTS

The nighttime construction safety survey was conducted in fifteen construction sites in the different cities of Pakistan. The survey from Client and Consultant was also carried out to obtain their response. The response rate was good (70%) with 104 valid responses. Figure 4.1 demonstrate the overall response rate pie chart for the survey:

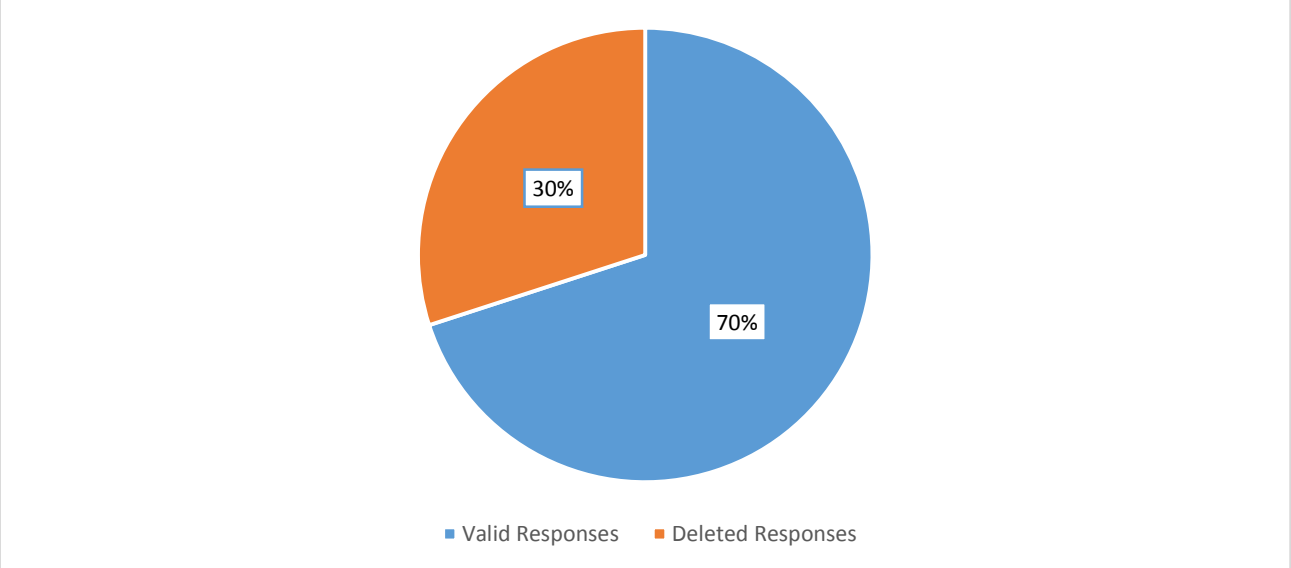


Figure 4.1: Overall Responses Chart

Figure 4.2 shows the respondent's experience distribution chart. The graph shows that 27 % respondents have experience Less than 3 years, 34% Respondent have experience 4-10 Years, 17% Respondent have 11-20 Years' experience and 22% Respondent have greater than 20 Years' experience in the construction industry.

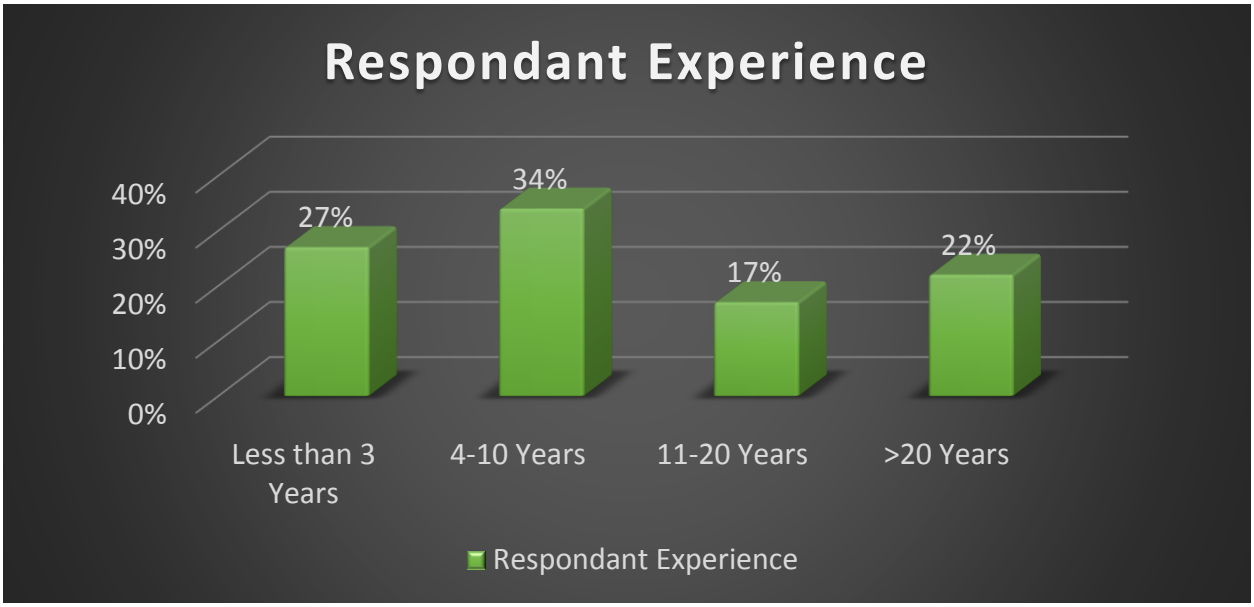


Figure 4.2: Respondent's Experience Percentage Distribution Chart

Following Figure 4.3 shows the breakdown of respondents in terms of nature of their employment organization i.e. Client, Consultant and Contractor. The worker in this chart has also been taken as a separate category for obtaining a better result for nighttime construction safety. Fig: 4.03, shows that 40% of the respondents were working with a contractor, 30% with client, 23% with consultant and 7% are the workers working on site.

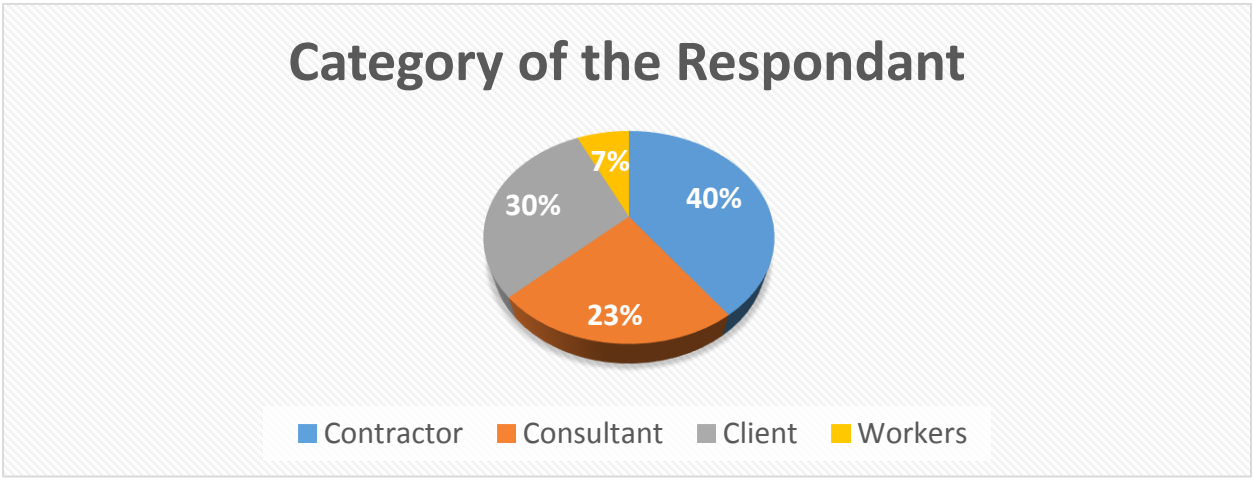


Figure 4.3: Category of the Respondents

4.3 RESPONDENTS POSITION IN FIRM

Table 4.1 indicates the positions of respondents in their firms. It is evident from the table that responses have been collected from people working on various, but important positions and all of them, other than laboureres, are usually in responsible positions dealing with workers' safety measures during night time constructions.

Table 4.1: Respondents position in Firm or Organization

Respondents position in organization/Firm	Client	Consultant	Contractor	Frequency of Respondents	Percentage of Respondents	Cumulative
Project Manager/ Director	2	1	10	13	12.5	12.5
Deputy Project director/ Assistant Director	2	0	1	3	2.9	15.4
Civil/ Principal/ Associate/ Assistant Manager Civil Engineer	9	5	6	20	19.2	34.6
Safety Engineer	2	4	7	13	12.5	47.1
Construction Manager/ Coordination Engineer	0	0	3	4	3.8	50.9
Assistant/Structure Design Engineer	1	6	2	9	8.7	59.6
Professor/Assistant Professor/Lecturer	6	0	0	6	5.8	65.4
Planning Engineer/ Quantity Surveyor/ Site Engineer & Supervisor/ Sub Eng.	4	6	8	18	17.3	82.7
Petroleum/ Chemical / Drilling Engineer	1	1	1	3	2.9	85.6
Labour	0	0	8	8	7.7	93.3
Resident Engineer/ Management Executive/ General Manager	4	2	1	7	6.7	100
Total				104	100	

4.4 CODING THE ASPECTS & FACTORS

To conduct statistical analysis, different aspects which are further divided into the factors are extracted from the past literature review. Therefore each aspects and factor is given a unique coding. Which are shown in appendix 5.

4.5 SIGNIFICANCE OF FACTORS IN NIGHTTIME CONSTRUCTION

The six different aspects which were obtained from literature review and discussion with the industry experts are incorporated in the questionnaire to find their effectiveness. Total six main aspects which were further divided into factors are incorporated in the questionnaire for which the respondents were required to give scoring on likert scale (1-5) (Please see Questionnaire on Appendix II). The data collected from the filled questionnaires for this portion was entered and compiled in the excel sheet. Once the data was compiled, percentage scoring was calculated for each of the factor which identifies its effectiveness.

The factor with greater percentage score represents the higher effectiveness and vice versa. The percentage score is calculated using the following formula in Eq. 4.1 as already discussed in the previous chapter:

$$\% \text{ Age Score} = \frac{\sum W}{A \, X \, N} \; X \; 100 \; \ldots\ldots\ldots\ldots \; (4.1)$$

Where "W" is the score obtained from each respondent, "A" is the maximum score which is "5" in this case and "N" is the total number of respondents 104 for this survey. The compiled data of all the 104 questionnaires is shown in the Appendix 6 which represents the responses of all the respondents, the total score obtained and the percentage score obtained by each of the factor are shown. Once the percentage score was calculated, the significant factors for different factors were identified.

4.6 SIGNIFICANCE FACTORS FOR NIGHTTIME CONSTRUCTION (OVERALL)

The relative importance index (RII) method was used to signify the factors for nighttime construction operation. The obtained data and calculation is shown in Appendix 6. The results are represented graphically in Fig. 4.4 to 4.9.

4.6.1 Analysis of Questions Related to Benefits of Night Time Construction

Figure 4.4 shows that 80% of the respondents think that schedule compression in term of first tracking projects is the most significant factors for nighttime construction. While 78.8% respondents think that longer work periods in night are the important benefit for nighttime construction. But the factor related to safety practices is one negatively affected. More than half of the respondents (54.2%) believe that situation of safety practices deteriorates in night time construction

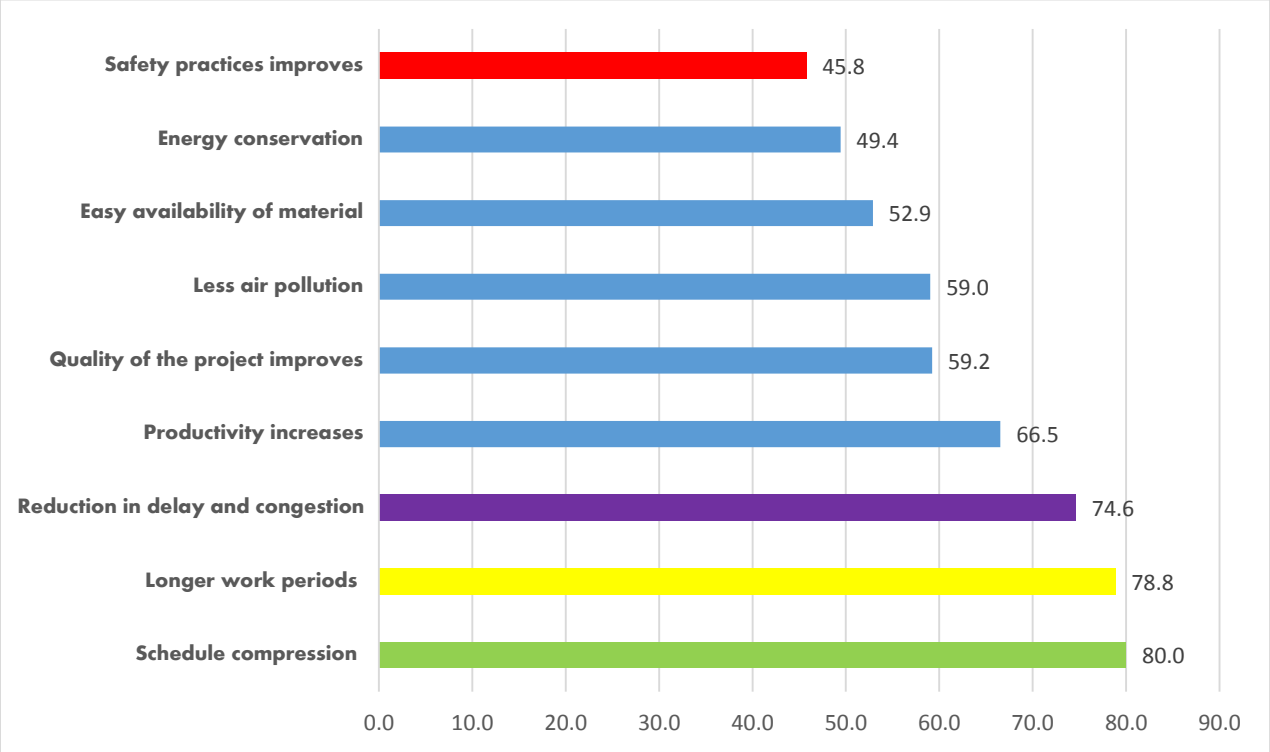


Figure 4.4: Benefit of Night time Construction

4.6.2 Analysis of Questions Related to Safety Equipment

The responses of the stakeholders in connection with availability of safety equipment's are shown in Figure 4.5. A majority of respondents (63.7%) think that face shield is the equipment mostly available on site, while, respirator is the equipment that is unavailable most of the times. As the percentage showed in the graph it suggest that all the safety tools are not available mostly on site.

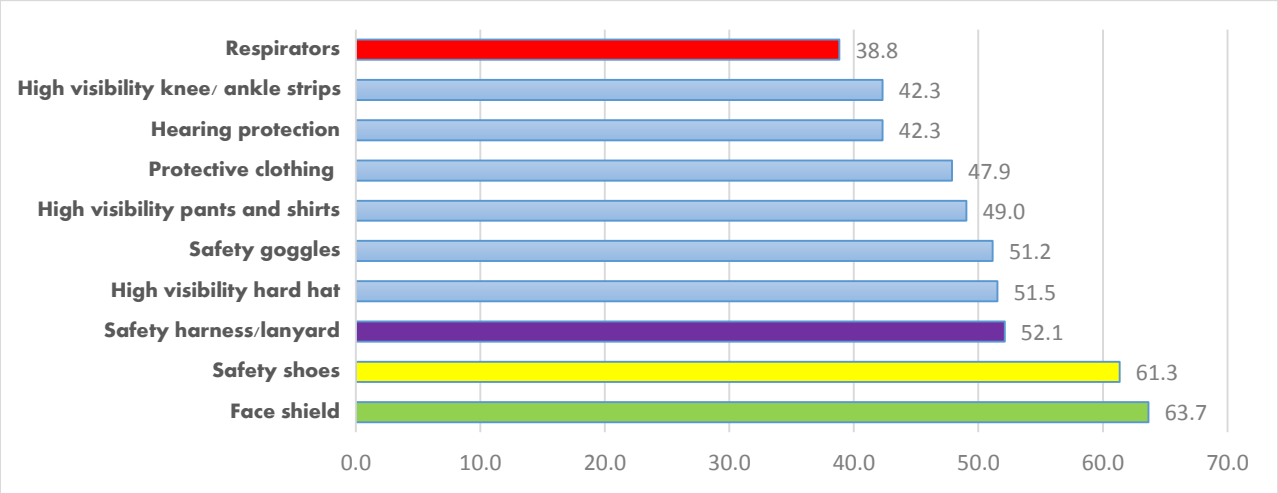


Figure 4.5: Availability of safety equipment

4.6.3 Analysis of Questions Related to Management Support

Figure 4.6 shows that safety supervision is significantly available on site but the obtained score shows that it's available seldom on site. Hence tool box meeting doesn't arrange on site. Hence only 48.3% respondents think that safety manual and procedure were established on site.

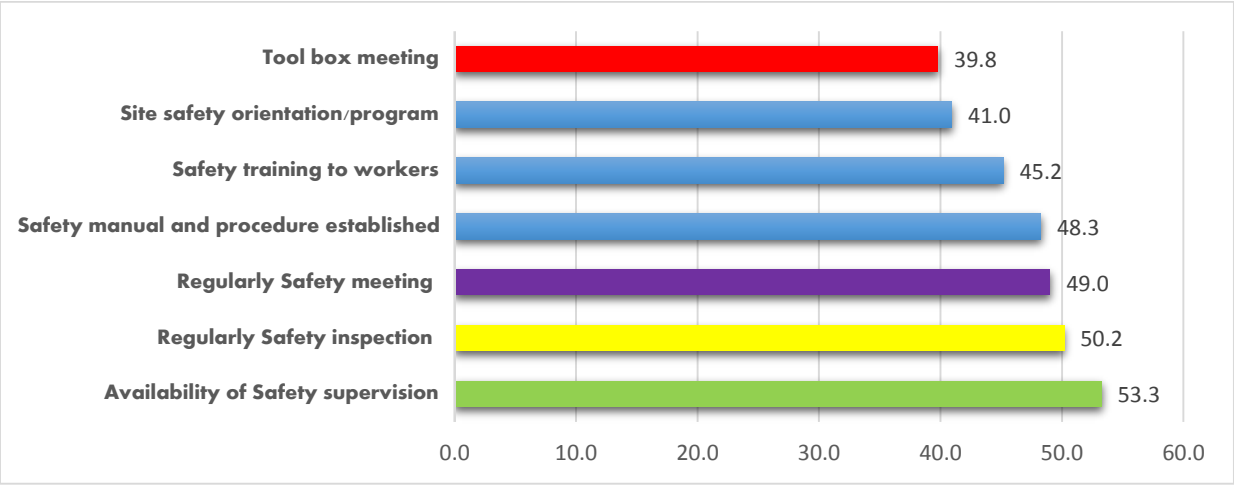


Figure 4.6: Availability of Management support

4.6.4 Analysis of Questions Related to Reasons of Accidents at Night Time Construction

Figure 4.7 shows that 83.7% of the respondents point out that workers themselves are responsible for accidents because they usually don't wear the safety equipment's by themselves, perhaps, because of lack of awareness and lack of any training/education about safety practices. 83.1% of respondents are of the view that insufficient lighting is the big cause of accidents at night. As pointed out by 82.3% of the respondents, fall from height comes out the third key reason for accidents during night time construction.

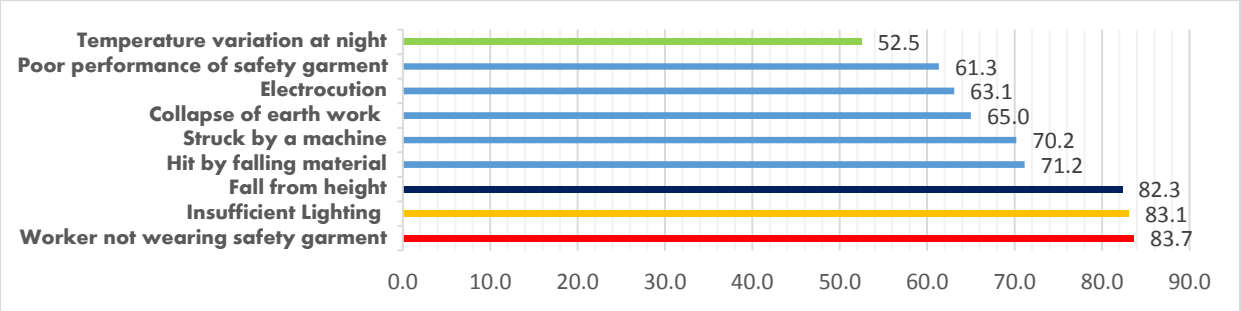


Figure 4.7: Main reason of Accident at night

4.6.5 Analysis of Questions Related to Critical Factors Causing Hazards at Night Time Construction

Figure 4.8 shows that 87.5% of the respondents said that workers because of unsafe behaviour don't bother about the hazards which – are present on site. Whereas 86% said that less visibility on night are the main factor which create hazards on site at night especially on road construction projects. 84.2% respondent identified that insufficient lighting condition are also the big cause of creating the hazards for workers on site. Whereas 59.6% of the respondent said that temperature variation is the least factor which can cause hazards on site at night in Pakistan.

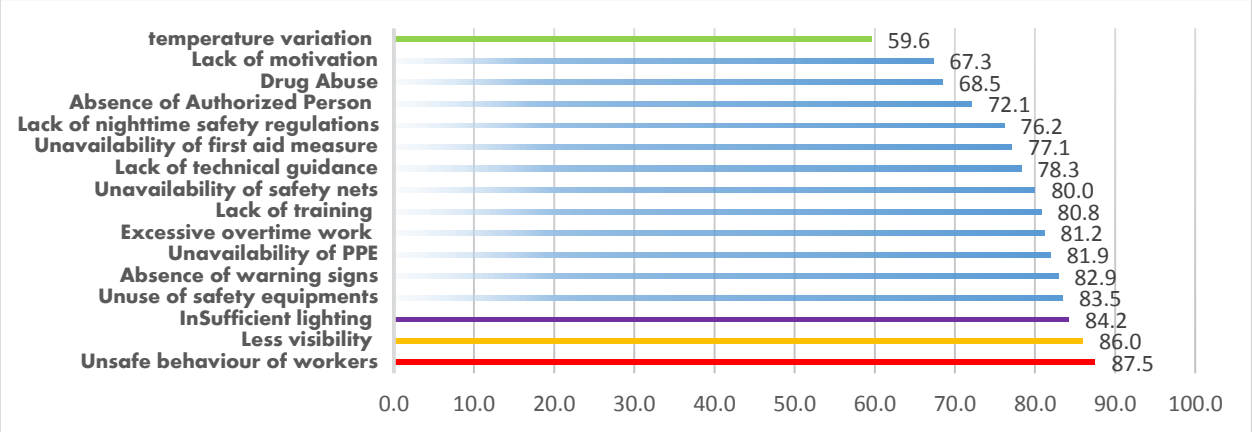


Figure 4.8: Critical factors causing worker safety hazards at night

4.6.6 Analysis of Questions Related to Persons Responsible for Implementing Safety Practices

Figure 4.9 identifies the persons who are responsible for implementing safety practices on site at night. Although each and every one responsible position holder in an organization has been held responsible for ensuring implementation of safety practices. But the result shows that safety supervisor, Health and safety consultant & project manager are the key persons responsible for implementing the safety practices at night. While, the contract administrator comes out the least responsible person.

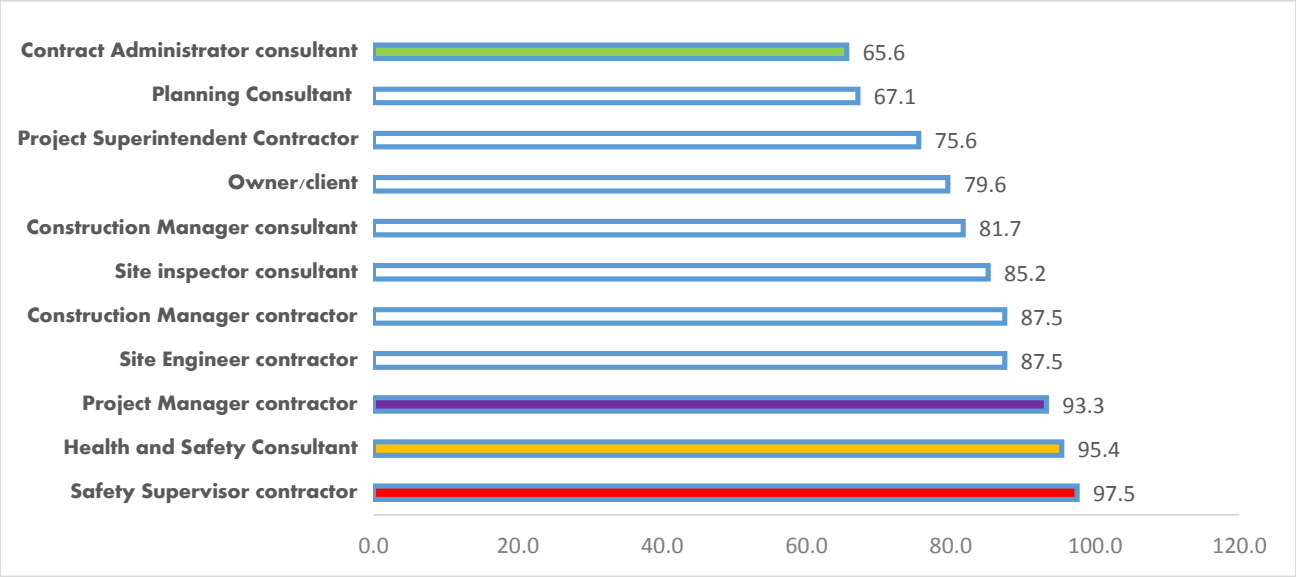


Figure 4.9: Person responsible for implementing safety practices at night

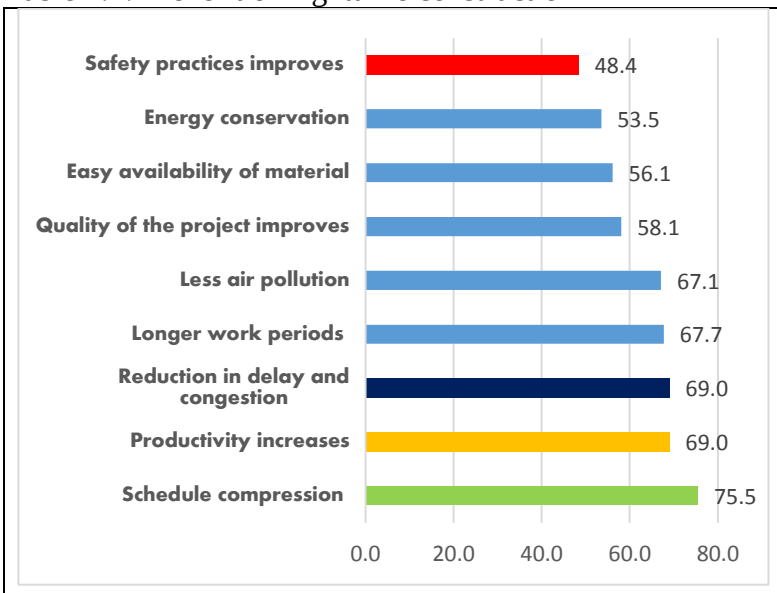
4.7 RANKING OF THE FACTORS FOR EACH STAKEHOLDER

By using the previous method the RII's corresponding to all the key stake holders, client, consultant, contractor and workers for each factor of night time construction were computed. Which are shown in Appendix 7.

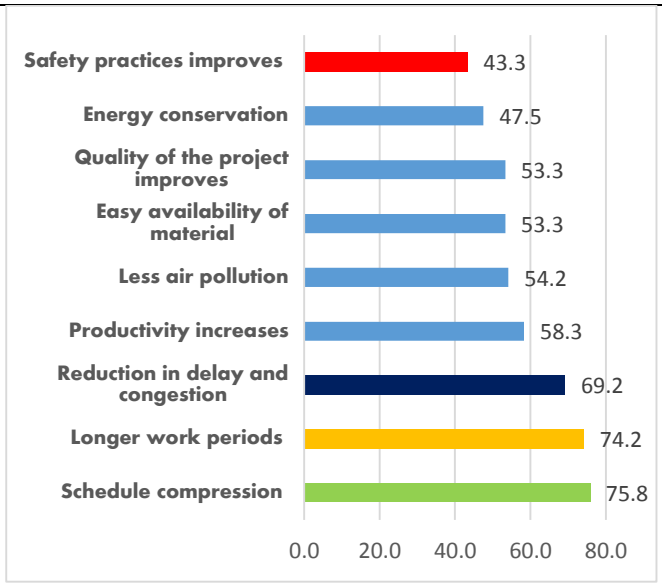
4.7.1 Analysis of Questions Related to Benefits of Night Time Construction for each Stakeholder

By using previous relative importance index method the significant factors for all stakeholder can be determine. Table 4.2 shows the significance of factors for different stakeholders. The result suggest that schedule compression are the most important benefit of nighttime construction for client & consultant, But for constructor and workers the longer period for working at night are the most important benefit. Whereas, all stakeholder on the same point the safety practices was the least factors that were improved at night.

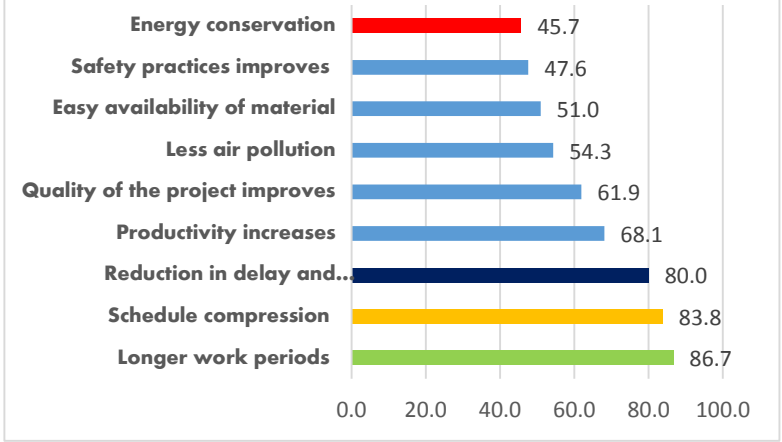
Table 4.2: Benefit of nighttime construction



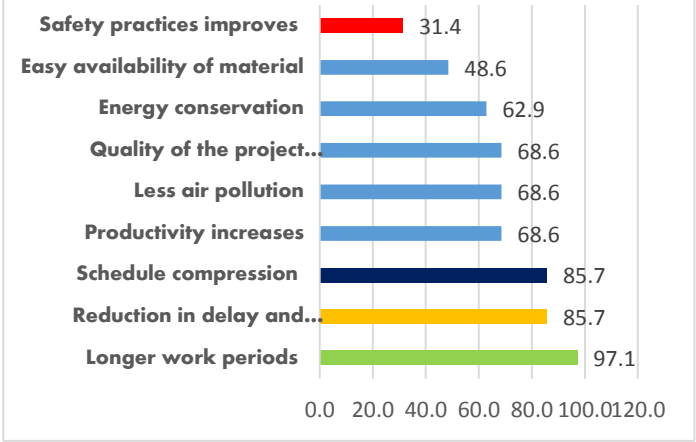
Client



Consultant



Contractor



Workers

4.7.2 Analysis of Questions Related to Safety Equipment for each Stakeholder

Table 4.3 shows the result of the availability of the safety equipment on site at night. The result suggest that for client face shield for wielding work was always available on site. Whereas, for consultant and contractor said the safety shoes was mostly available on site. Thus, the worker said that safety harness for working at height is usually available on site. But the percentage suggest that these all equipment all not available always on site especially at night.

Table 4.3: Availability of safety equipment at night

4.7.3 Analysis of Questions Related to Management Support for each Stakeholder

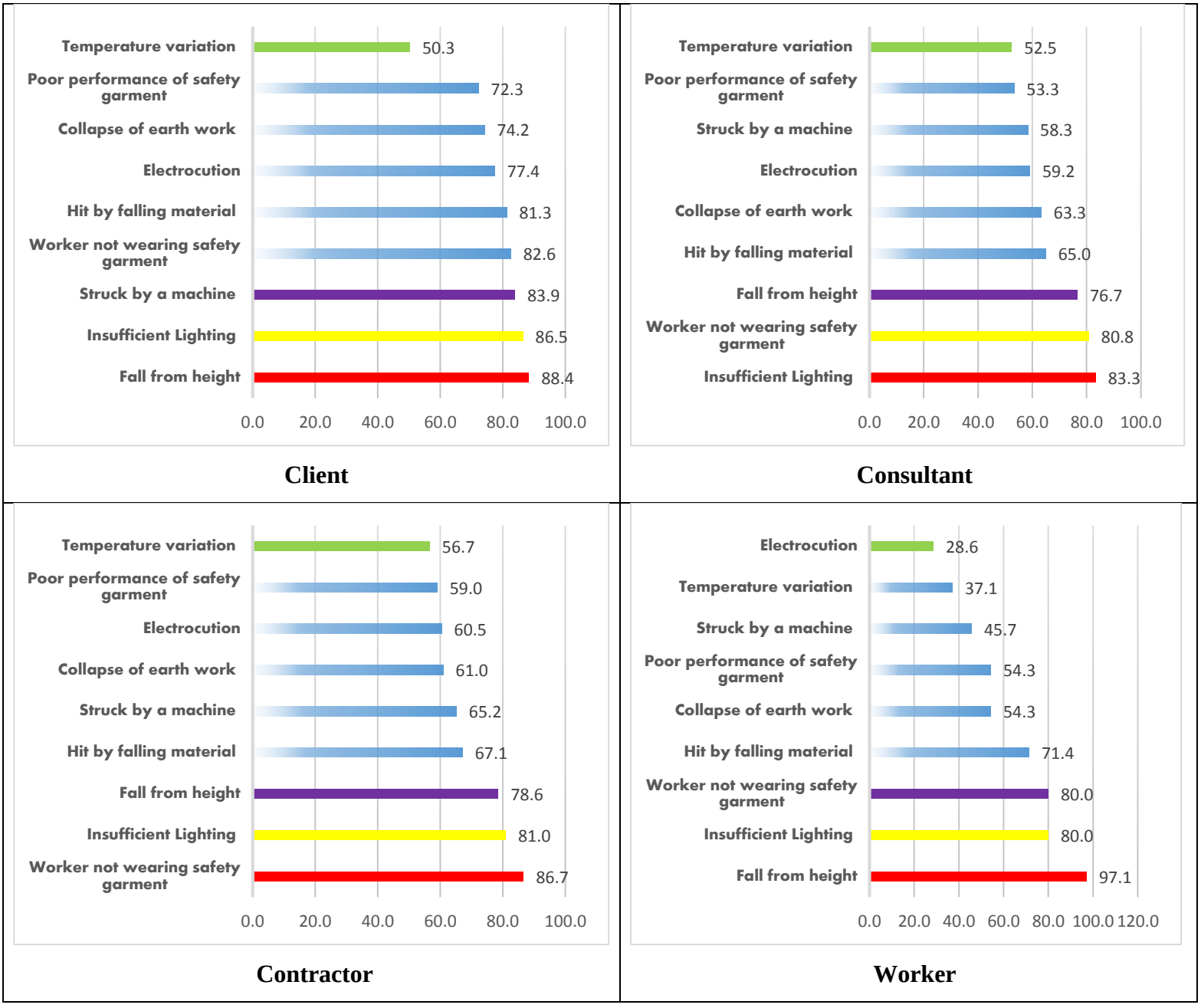
Table 4.4 shows the result of the analysis of the availability of the management support at night. The result conclude that for client safety inspection of the site at night was done frequently. Whereas, consultant & contractor on the same point that safety supervision is usually available on site to implement the safety practices. The workers suggest that safety training is usually provided to them on site at night before the start of the work. Hence the site safety orientation and the tool box meeting was the least factors which provided by the companies on site. In this factors the obtained percentage from all the perimeter showed that these management support was not available on site in Pakistani construction industry.

Table 4.4: Availability of management support

4.7.4 Analysis of Questions Related to Reasons of Accidents at Night Time Construction for each Stakeholder

Table 4.5 shows the main reason of accident at night. The result concluded that fall from height, unsafe workers behavior & insufficient lighting are the key factors which cause the accident at night. Whereas, the temperature variation in Pakistan was not the major factors that cause an accident at night.

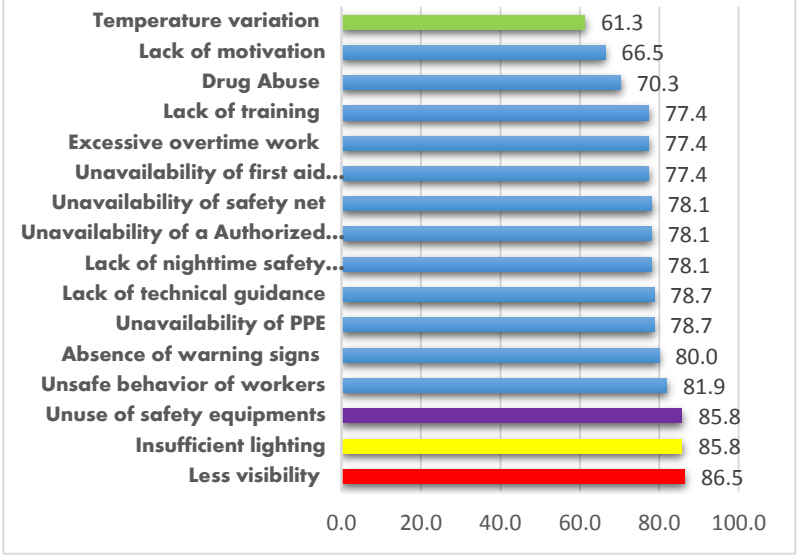
Table 4.5: Main reason of accident



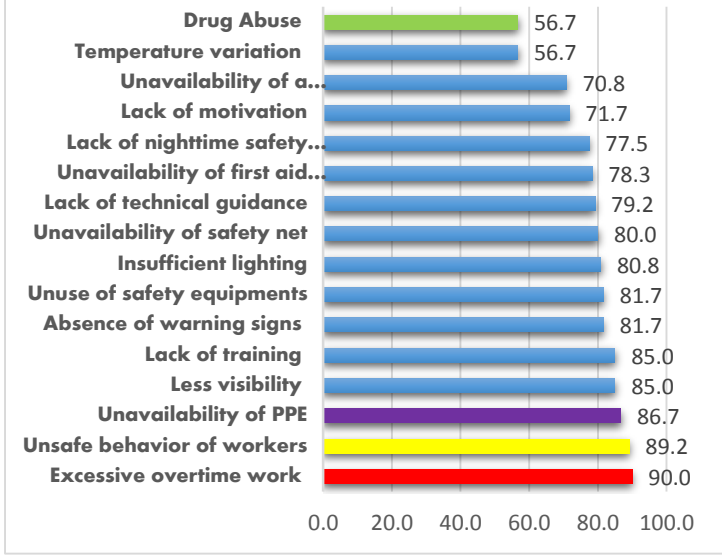
4.7.5 Analysis of Questions Related to Critical Factors Causing Hazards at Night Time Construction for each Stakeholder

Table 4.6 suggest that less visibility, insufficient lighting, unsafe worker behavior, unavailability of safety nets and excessive overtime are the critical factors which cause the hazards for workers at nighttime construction operation. Whereas, client, contractor & workers on the same point that temperature variation was not contributing in creating the hazards for workers on site. Hence, for consulting the drug abuse is the least factor which cause hazards at night.

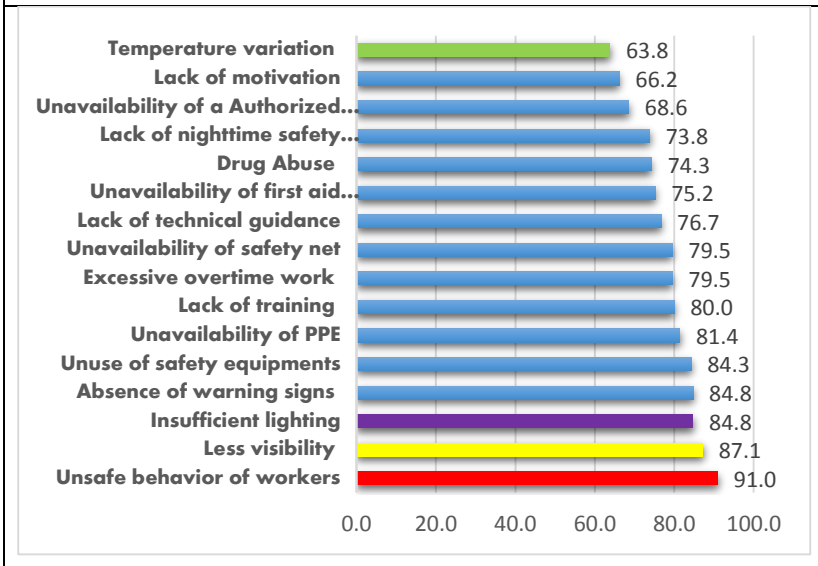
Table 4.6: Critical factors causing workers safety issues at night



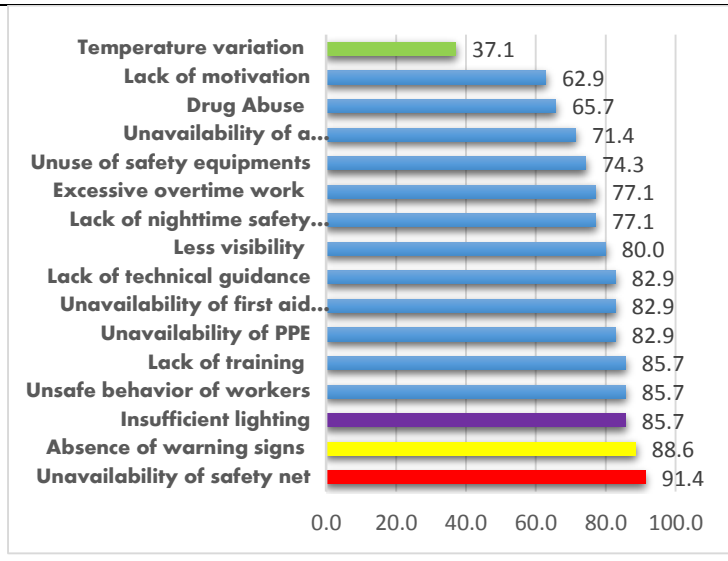
Client



Consultant



Contractor



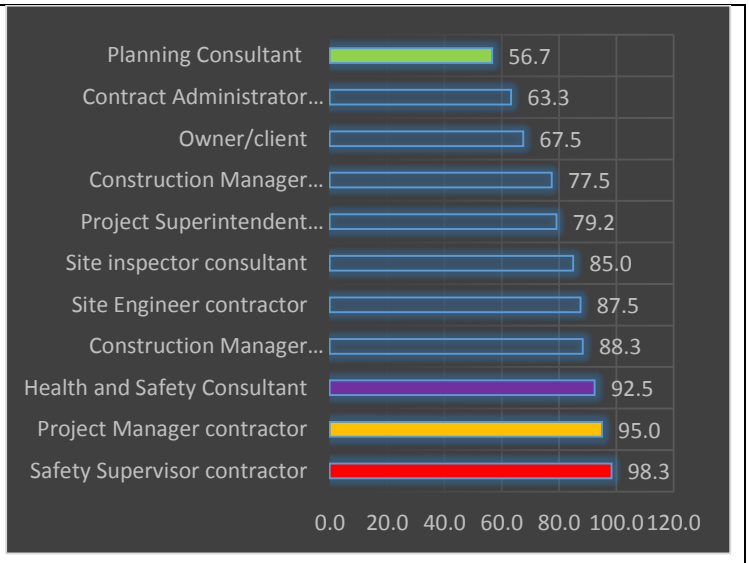
Worker

4.7.6 Analysis of Questions Related to Persons Responsible for Implementing Safety Practices

Table 4.7 shows the result of the person who are responsible for implementing the safety practices at site on night. The result depict that safety supervisor, health and safety consultant and project manager are the most significant person who are responsible for nighttime construction on site. Whereas, contract administrator, planning consultant and project superintendent are the least responsible person for nighttime construction operation.

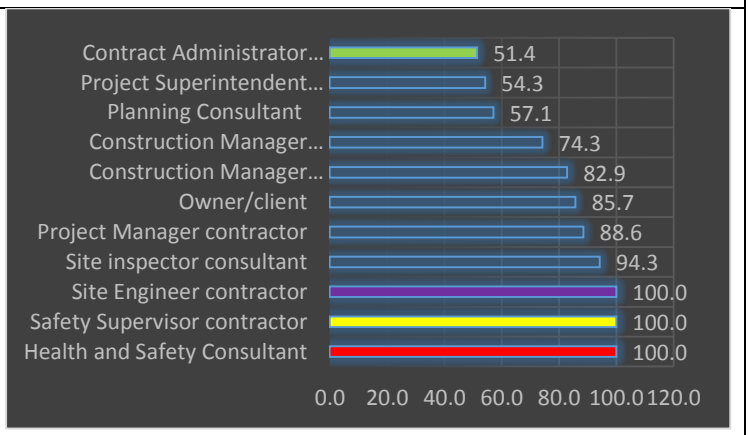
Table 4.7: Person responsible for implementing the safety practices

Client



Consultant

Contractor



Worker

4.8 RANK AGREEMENT FACTORS & PERCENTAGE AGREEMENT

Rank Agreement Factors (RAF) & Percentage agreement (PA) were next calculated with the help of the formula and method described by Okpala and Aniekwu (1988) to calculate the level of agreement among different stakeholder who are involve in implementation of safety practices on site at night such as, client, consultant, contractors and workers. The RAF value 0 indicates perfect agreement while a higher value indicates disagreement. The percentage disagreement and percentage agreement are also calculated through formulae. Formulas related to these calculations are as under:

Absolute Difference = Di = | Ri1-Ri2| …….....…..... (4.2)

Where,

Ri1 is the ranking of First Group;

Ri2 is the ranking of Second Group.

Maximum Absolute Difference = Dmax = | Rj1-Rj2|..……..…..... (4.3)

Where,

Rj1 is the ranking;

Rj2 is the ranking with absolute maximum difference.

Rank Agreement Factor = RAF = ∑D/N …….....…..... (4.4)

Where,

D is the absolute difference;

N is the number of Categories.

$$\text{Percentage Disagreement} = \frac{PD}{RAFmax} = \frac{RAF}{Dmax/N} \text{ or } Di/N \quad \text{..... (4.5)}$$

Percentage Agreement = PA = 100% - PD..……..…..... (4.6)

These above formulae were used to establish the percentage agreement between all the four key stake holders, who are involve in project and have major responsibility for the implementation and execution of safety practices on site i.e., client, consultant, contractor and workers. While ranking of Significance factors at night outlined using RII.

The results of percentage agreement between different key stakeholders are shown below:

4.8.1 Percentage Agreement (Pa) Between Client & Consultant

The percentage agreement between client and consultant are shown in appendix 8. The result shows that 84% of the respondent have a same opinion relating the benefit of night time construction operation. 75% people are agreed on the point of Unavailability of safety equipment at night. 73% of the people have agreement on the different perimeter on the availability of management support at night. 74% respondent are agreed on the issue of main cause of accident at night. That 96% of the respondent are agreed on the critical factor which are causing the hazard on site at night. 95% of the people are agreed on the person which are responsible of implementing safety on site at night.

While the percentage agreement between other stakeholder such as (Client & Contractor, Client & Worker, Consultant & Contractor, Consultant & Worker, Contractor & Worker) are calculated in the same way as previous. The overall result of percentage agreement between parties are showed in table 4.8.

4.8.2 Percentage Agreement (Pa) of All Stakeholder

By using previous method percentage agreement between the other parties such as client & contractor, client & worker, consultant & contractor, consultant & worker and contractor & worker are also calculated in the same way. Which is shown in Table 4.8.

Table 4.8: Percentage Agreement (PA) between Key Stake Holders

Parties	Type of Result	Benefit of nighttime construction	Availability of safety equipment	Availability of management support at night	Main reason of accident at night	Critical factors causing worker safety issues at night	Person responsible for implementing safety practices at night
Client & Consultant	Agreement	84%	75%	73%	71%	91%	93%
Client & Contractor	Agreement	74%	76%	64%	75%	88%	96%
Client & Worker	Agreement	74%	80%	68%	72%	91%	96%
Contractor & Consultant	Agreement	82%	77%	67%	83%	87%	95%
Contractor & Worker	Agreement	80%	75%	69%	71%	90%	95%
Consultant & Worker	Agreement	77%	84%	68%	75%	91%	96%
Average	Agreement	79%	78%	68%	75%	90%	95%

The average percentage agreement in all the main aspects of night-time construction are also shown by using Figure 4.10.

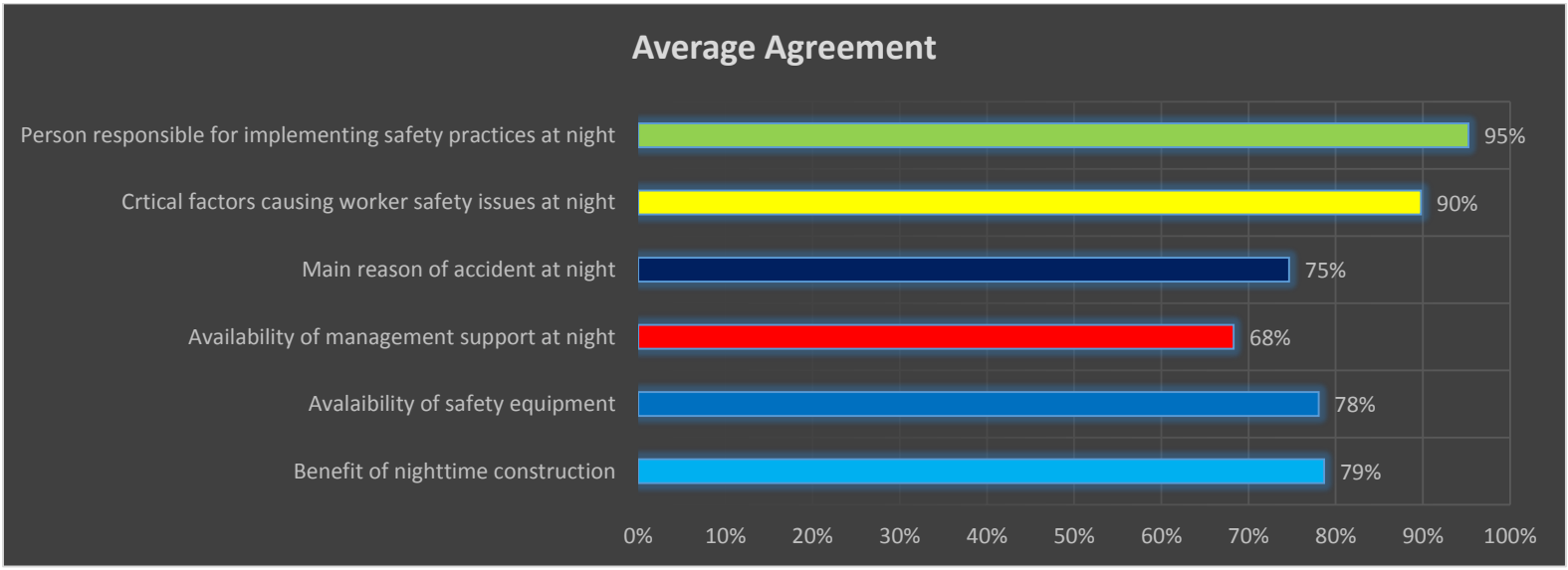


Figure 4.10: Average Percentage agreement on all the main factors between key stakeholders

After obtaining the Percentage Agreement (PA) between all the key stake holders. It was observed that the highest percentage agreement was on factor 6. Which is the person who are responsible for implementing the safety practices on site at night. 95% of the respondents among the different category have average agreement on that factor. Whereas, the least average percentage agreement was found on the availability of management support. Just 68% of the respondents among the different category having an agreement on that factor.

4.9 FRAMEWORK FOR NIGHTTIME CONSTRUCTION SAFETY

After finding the critical factors which cause the hazards for the workers at nighttime construction. I developed the site safety framework for night time construction operation. By adopting this framework the construction hazards on site can be reduced at night. Therefore, the workers can work safely on site at night. Hence, this framework can also help to achieve the zero accident phenomena on site. (Zero accident is the phenomena at which the company considers that there will be no accident on site). This framework is depend on the critical factors which I gathered after analysis. This framework was develop by using the suggestions which the construction professional give for nighttime construction operation. So this framework help to overcome the majority of the critical factors causing worker safety issues at night. The framework for implementing safety practices at night are shown in Figure 4.11.

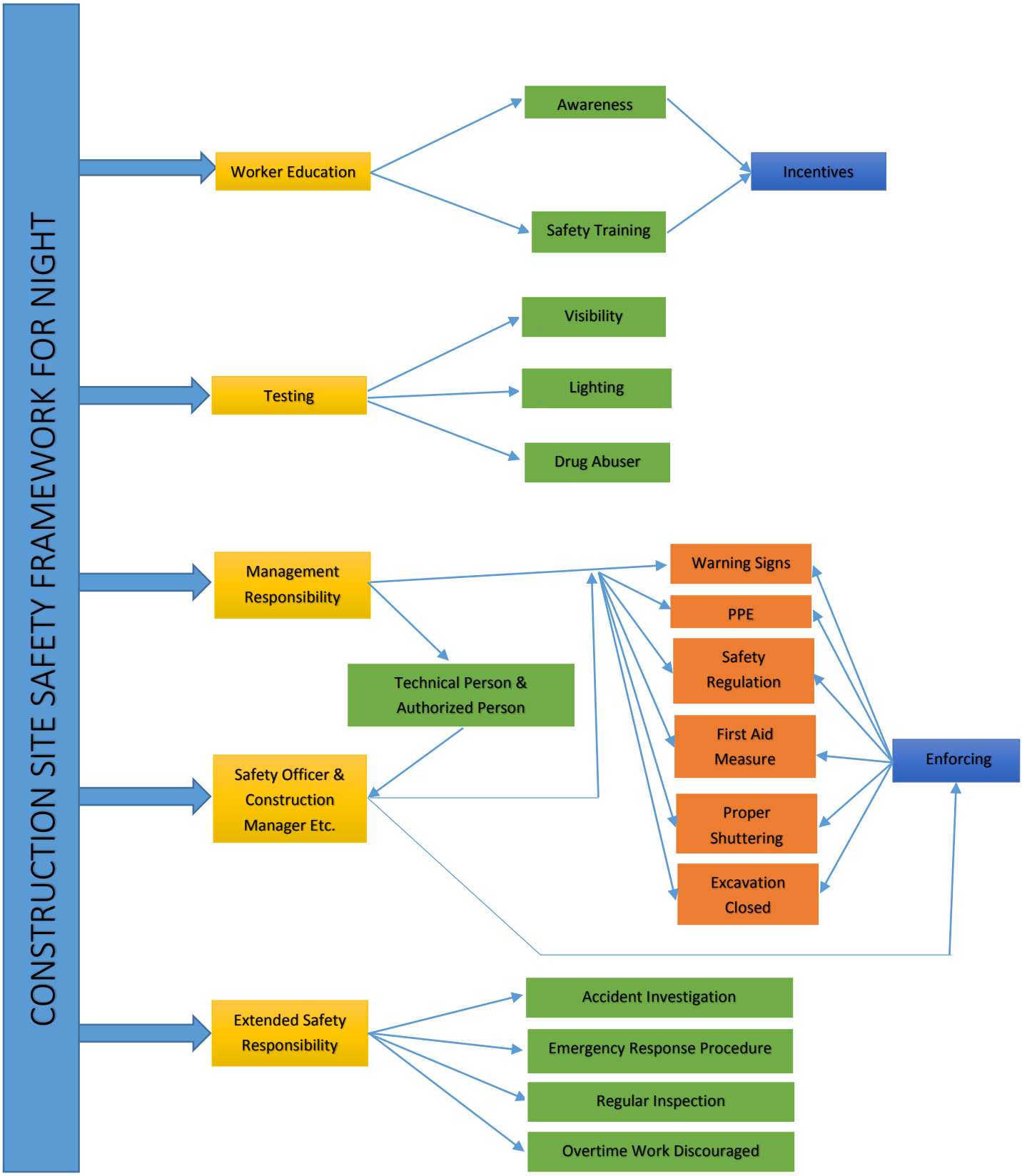


Figure 4.11: Construction Site Safety Framework for Night

4.9.1 Worker Education

The most important factor for the implementation of safety practices on site is worker's education. It's very important to educate the worker about the safety practices by providing him a safety training. The important topics for safety or orientation training are:

- Introduction of key personnel
- Information about company policies
- Information about general and specific safety policies for the project
- Overall scope of project
- Project schedule
- Project layout
- Accident prevention and emergency response
- Personal protective equipment
- Safety practices
- Equipment and machinery
- Chemical and hazardous material safety
- Notification of the dangerous area on the work site

But the other aspect which is very important for the implementation of safety practices is to provide awareness to the workers. So that they will know that what can happen if they'll not use these equipment for their own safety. And also give him awareness that the use of these tools can't effect their productivity. Partners, H. (April 2013)) "Although there are some comments that productivity can be at the expense of workers' health and safety, research findings generally support that health and safety measures have a positive impact not only on safety and health performance but also on company productivity".

After considering both the things it's very important to enforce these things on the construction site. It can be enforce by providing the worker some incentives. So that they will be happy to use these equipment's. It can also be enforced by fining them on breaking the rules.

4.9.2 Testing

The second factor is testing the requirements which are important for nighttime construction such as

- **Visibility**
- **Lighting**
- **Drug abuser**

Visibility:

The test for the minimum visibility during nighttime construction should be done before the start of the work. According to OSHA visibility requirement the night-time warning clothes must be visible at least from 1,000 feet, especially on road construction Projects.

OSHA regulations require workers to wear Class Two or Three ANSI/ISEA 107-2004 personal protective safety apparel. The Figure 4.12 shows the descriptions of safety vest for nighttime construction.

Conspicuity Class	Use Description	
1		• Worker can give full and undivided attention to approaching traffic. • Ample separation between worker and vehicular traffic. • Background is not too complex. • Vehicle/equipment speeds do not exceed 25 mph.
2		• Greater visibility is desired during inclement weather. • Complex backgrounds are present. • Employees perform tasks that divert attention away from approaching vehicles. • Vehicle/equipment speeds exceed 25 mph, but less than 50 mph. • Work activities take place in or near vehicle traffic space.
3		• Vehicle/equipment speeds exceed 50 mph. • Worker and vehicle operator have high task loads. • Wearer must be conspicuous through the full range of body motions at a minimum of a ¼ mile (390 m) and must be identifiable as a person.

Figure 4.12: Safety apparel Source: Council, C. S. (2008)

Lighting:

The test for the minimum requirement of lux during construction activities at nighttime should be conducted before the start of the work. The following Table 4.9 are HSE document for the minimum requirement of lux during nighttime construction activities are:

Table 4.9: HSE document HSG38 (Lighting at Work)

Activity	*Work Location*	*Average (lux) requirement*	*Minimum (lux) requirement*
Public place, machines and vehicles.	Lorry park, corridors, circulation routes.	20	5
Public place, machines and vehicles in the hazardous areas; rough work not requiring any perception of detail.	Excavation, Construction site clearance and soil work, loading bays, bottling and canning plants.	50	20
Work which requiring limited perception of detail.	Kitchens, factories assembling large components and potteries.	100	50
Work which requiring perception of detail.	Offices, sheet metal work and book binding.	200	100
Work which requiring perception of fine detail.	Drawing offices, factories assembling electronic components and textile production.	500	200

Drug abuser testing:

Testing for drug abuser should be done before the start of the work. So that it can minimize the chance of accident at night.

➲ **Prescreening:**

This type of testing is done when the worker is being employed by the employer before the start of the work.

➲ **Random testing:**

The random testing is done for all the workers or the selected worker working on site at night to ensure that he is not involved in taking drugs.

➲ **Post-accident drug testing:**

Test the worker that was injured and any other workers who may have been in a position to contribute to the accident.

➲ **Reasonable cause drug testing:**

This cause of testing is based on worker's behaviour and physical health.

➲ **Blanket or periodic testing:**

Every worker working on site being test periodically.

So conducting these type of test before the start of the work help to ensure that the safety requirement should be imposed on site especially on nighttime operation.

4.9.3 Management Responsibility

The first and foremost responsibility of management is the selection and recruitment of skillful and technically qualified person for the position of safety officer, construction manager etc. these technical persons can inspect the site according to the construction safety requirements. So this practice will help to reduce on site construction accident.

The second responsibility is to ensure that safety regulations have been develop for night and all required tools & equipment's are available for the safety of the workers during night time construction such as:

- ❖ Warning signs
- ❖ PPE(Personal Protective Equipment)
- ❖ Nighttime Safety regulation
- ❖ First aid measure
- ❖ Proper shuttering with guardrails
- ❖ Excavation closed
- ❖ Safety nets etc.

4.9.4 Safety Officer or Construction Manager

The job requirement of safety officer or construction manager is to ensure that all the measure which are necessary for implementing the safety practices on site are available practically. And the safety equipment should be in good quality.

The other requirement which is important for the safety of the workers on site is to enforce all the workers on site to use these safety tools. So that the accident on the site can be prevented. These things can be enforce by providing the workers some incentives or applying fines.

4.9.5 Extended Safety Responsibility

If an accident happens on site it is the responsibility of safety officer to ensure that proper investigation is done to determine the main reason of accident, and identify the way that it can be prevented in future. The accident investigation should include near misses, non-injury accident like damage to equipment or machinery. The accident investigation process involves the following steps:

- Report the occurrence of the accident to a designated person within the firm or organization.
- Provide the first aid training to injured person and prevent further injuries and damages.
- Investigate the accident.
- Identify the causes of an accident.
- Report the finding to the management.
- Develop a plan for corrective action.
- Implement the plan.
- Evaluate the effectiveness of the corrective action on site.
- Make changes for continuous improvement in plan.

The emergency response procedure should also be established on site. So that in case of emergency the proper treatment should be given to the workers on site. The emergency response procedure should be taught to the workers. So that they will know that what should be done in case of emergency. The emergency response procedure should be established for:

- Confined places
- Fire hazards
- Handling of hazardous material

- Excavation purpose
- Mean of egress etc.

The aims of safety inspections on site are:

• To identify the hazards and risk associated with environment, equipment, machinery, processes etc. which may have arisen since the previous inspection.

• To provide a measure of the effectiveness of safety management within the Institute.

• To provide a measure of how the Institute is performing in relation to its annual safety objectives.

The other responsibility of the safety officer on site is to ensure that overtime work is not allowed to workers during nighttime. So the workers fatigue relating the construction work can be reduce and therefore decrease the chance of accident on site. It has been observed that workers who are engaged with overtime schedules face 61% higher injury hazard rate compared to those workers who do not work overtime Dembe; Erickson, et al., (2005).

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this Chapter, conclusions and recommendations are presented. The conclusions have been made on the basis of results obtained in Chapter 4. The analysis was done for identifying the critical factors affecting worker safety issues on nighttime construction in construction industry of Pakistan.

5.2 REVIEW OF OBJECTIVES

The research objectives are as follows:-

1. To synthesize the state of art practices in night-time construction.

2. To evaluate the current night-time construction practices in Pakistan.

3. To identify the major issues for night-time construction projects in Pakistan.

4. To develop the site safety framework for night-time construction projects.

The first objective was achieved by analyzing the previous studies which have been conducted on nighttime construction operation in different countries. The details of night time construction practices in those countries have been described in chapter 02 (section 2.8, 2.9).

The second objective was achieved by visiting the various sites in Rawalpindi and Islamabad. Where construction work was being carried out during night. After evaluating the current practices some of the key issues face by workers during night have been identified. Extensive literature review were also carried out to identify other issue which were contributing in creating the hazards at night. So these identified issues (See chapter 2, section 2.10, for further details), were used as benchmark and night time construction practices in Pakistan have been evaluated against the benchmark.

The study focuses on the following six key aspects of night time construction

1. Benefit of nighttime construction

2. Availability of safety equipment at night

3. Availability of management support at night.

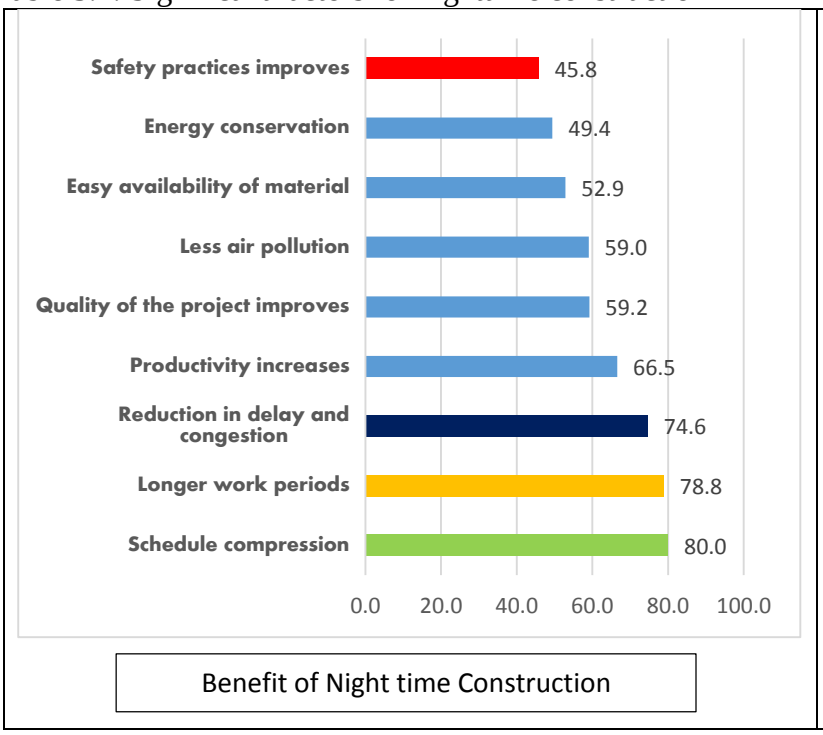
4. Main reasons of accident at night.

5. Critical factors affecting worker safety at night

6. Main person responsible for implementing the safety practices at night.

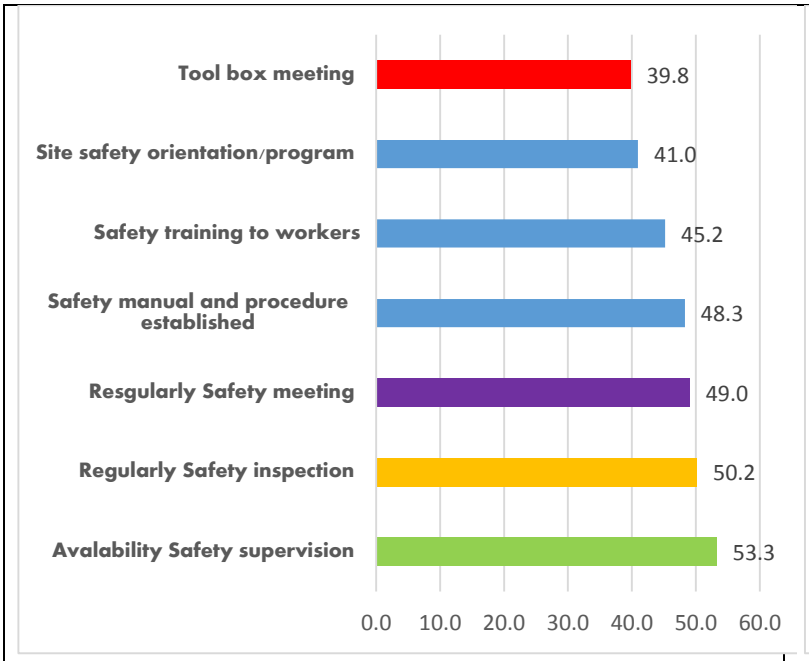
A number of factors associated with each of the above mentioned key aspects were identified through literature review and questions related to each aspects were asked to the respondents. To achieve the third objective the analysis were made on the obtained data to determine the overall ranking of the factors for all the stakeholders. The overall ranking of factors for different aspects for all the stakeholder are shown Table 5.1.

Table 5.1: Significant factors for nighttime construction

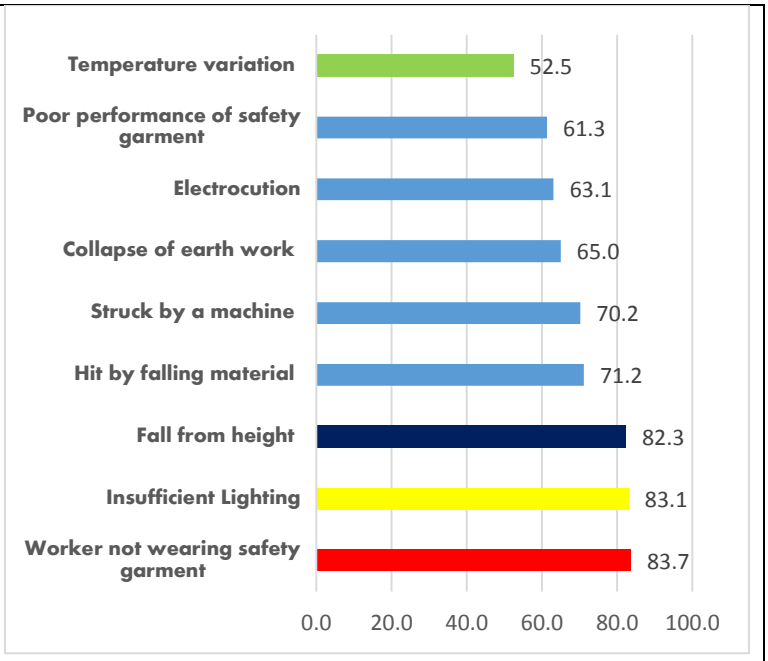


Benefit of Night time Construction

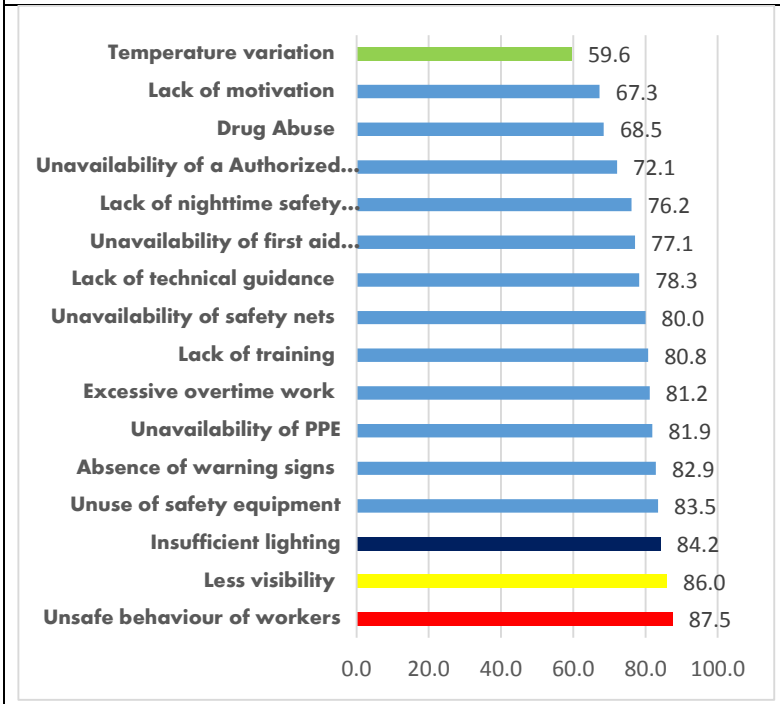
Availability of safety equipment



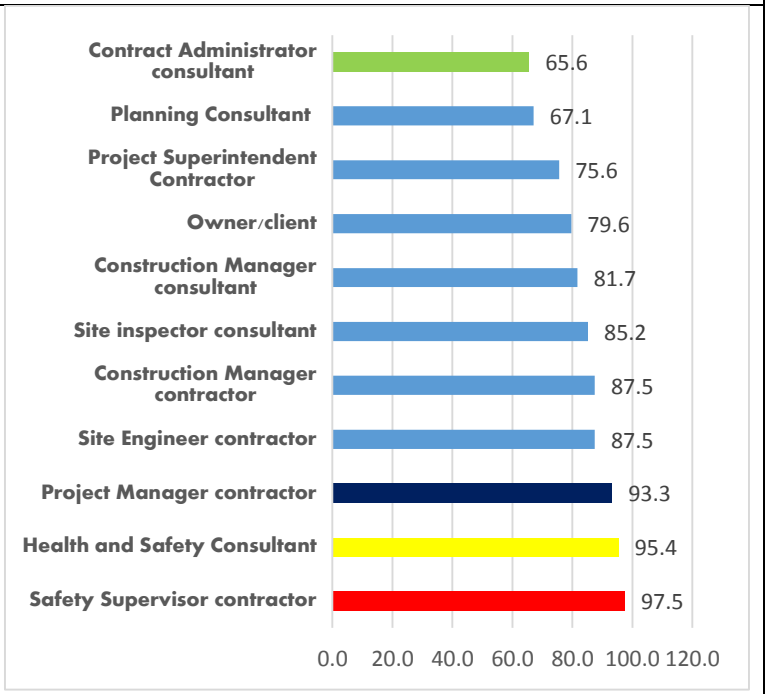
Availability of Management support



Main reason of Accident at night



Critical factors causing worker safety hazards at night



Person responsible for implementing safety practices at night

The separate ranking of factors for client, consultant, contractor and workers are shown in Appendix VII.

After identifying the critical factors of the nighttime construction. The agreement factors method was used to determine the level of agreement between the different stakeholders on the main factors. Later on this agreement factor was converted to average percentage agreement for all the main factors. Figure 4.35 shows the average percentage agreement on all the main factors between the key stakeholders.

The fourth primary objective was met by developing a construction site safety implementation framework through the findings obtained by signifying the critical factors of worker safety on site. Following things are required for site safety implementation at night identified in the developed framework are, safety training, safety awareness, PPE, Warning signs, visibility testing, lighting testing, drug testing, safety nets etc. and the extended safety officer responsibility is to investigate the accident, develop emergency response procedure, regular site inspection, discouraged overtime work on site. The additional information about the site safety framework for night has been provided in chapter 04.

5.3 CONCLUSIONS

After signifying the critical factor of the observatory part of the questionnaire for all the stakeholder it was concluded that:

1) Benefits for night time construction:
   - Out of ten factors related to benefits of night time construction, schedule compression comes out to be most important factor, while majority of the respondents say that the situation of safety practices does not improve in night time construction.
   - The parameters related to the safety practices are of least importance in terms of benefit of nighttime construction.
2) Availability of safety equipment:
   - Whereas, the scores obtained from the stakeholders for the second parameter show that most of the safety equipment's are rarely available on site at night, except the face shield and safety shoes.

3) Availability of management support at night:
   - Inspection and supervision for ensuring safety is of critical importance, but the obtained percentage show that least attention is paid to this factor.
   - Tool box meeting are also held rarely on site.
4) Main reason of accident at night:
   - Lack of education and awareness of the worker are the main cause of accident at night.
   - Insufficient lighting and visibility are also among the big causes for higher number of accidents on site at night.
   - Temperature variation are of least importance in term of main reason of accident at night.

The second part of the questionnaire called main survey part**.** After signifying the critical factor of worker safety at night for all the stakeholder, we conclude that on fifth aspect:

5) Critical factor causing worker safety issues at night:
   - Workers are not aware of their rights to work only under 'safe work environment'.
   - No budget is assigned for safety of the workers by the client (interview).
   - Accidents are reported some time but they are mostly not investigated and no one is held responsible for accident (interview).
   - Tool box meetings are generally not held on site in nighttime construction operation.
   - No incentives are declared by the management for the workers for doing the job safely.
   - Guardrails for scaffolding are mostly found missing on site (current practice).
   - Workers are not worried about their safety due to lack of knowledge.
   - Proper safety trainings are missing at sites which make the workers vulnerable to the hidden risks that they may have to face on new sites.
   - Workers themselves are unaware about the significance of personnel safety practices and they also don't want to use the personal protective equipment as they consider that it cause a hindrance in their work productivity.
   - Reckless operations on site also cause hazards in nighttime construction operation (interview).
   - Less visibility also the important cause of accident at night especially in night.
   - Insufficient lighting also the critical factor in creating the hazards on site at night.
   - Warning sign are also not present mostly on site to prevent accident.

- Unavailability of personal protective also the big cause of accident at night.
- Excessive overtime work cause worker fatigue and contributing in creating the hazards at night.
- 80% of the people think that unavailability of safety nets are contributing in increasing the accident in term from fall from height.
- A large number of people think that lack of technical guidance, unavailability of first aid measure, lack of nighttime safety regulation, unavailability of authorized person, drug abuser, lack of motivation and temperature variation are the important factors that cause accidents at night.
- The site management seemed least-interested in stressing the need of personnel safety practices among their workers (visiting site).

6) Main person responsible for implementing the safety practices at night:
   - The safety supervisor, health and safety consultant and project manager are the main persons who are responsible for implementing the safety practices on site.
   - As the score shows that site engineer and construction manager are also very important person in implementing the safety practices at night.

5.4 RECOMMENDATIONS

Some recommendations are enlisted below based on the research findings and conclusions.

- Training session on construction site should be launched. So that the workers will be aware about the efficient use of PPE'S on the project site. The workers should also be provided with awareness that how they can do the work safely. Safety should be listed as a separate item in Bill of Quantities (BOQ).
- Competent safety staff should be selected for the implementation and execution of safety practices on site.
- Testing for adequate visibility and sufficient lighting should be conducted before the start of the work.
- Safety inspections of site need to be done at regular intervals from the client or safety officer on site.
- Safety performance of workers needs to be monitored at regular intervals for conducting safety audits.

- The project must not be allowed to start unless the personal protective equipment's are available on the site.
- The registration criteria of contractor should be linked with the safety record. So by this way we encourage the contractor to pay his full attention to the safety of the project.
- In standard contract document the specific percentage of the project price should be allocated towards safety of workers.
- The research institutes along with regulatory offices should launch an awareness campaign to make the owners and contractors aware about the relationship between injuries and cost of the project. This will encourage the stakeholders to improve the safety performance at construction sites.
- The warning sign should be placed on site to prevent the accident especially on night.
- Safety should be recommended as one of critical criteria for procurement of public projects.
- Tool box meeting should be held regularly on site.
- Proper guardrail around shuttering and safety nets should be available on site for preventing the accidents due to fall from height.
- In Pakistan, Government of Pakistan has formulated labour laws, and PEC has incorporated safety clauses in the contract documents but they are not implemented due to the absence of a regulatory authority like OSHA. Therefore the primary consideration is to develop the regulatory authority like POSRB (Pakistan occupation safety regulatory body) in Pakistan. So the construction accident in Pakistan can be investigated and reduced.
- The top management of a construction company needs to contemplate the development and application of safety, health and environmental management systems on site.
- The health and safety training plan, and financial budget to safety are the important factors that need consideration by the management of the company.
- The documentation of safety record and accident prevention policy/plan also requires the attention of top management.
- Provision for sufficient amount of funds needs be allocated in the contract, so that contractor can implement and execute the safety practices more efficiently on site.

- Contractor should be bound to submit 'safety plan' before start of each task.
- Launch media campaign for the awareness of workers for their rights. Use of media can also play a vigorous role in implementing safety practices on construction projects in Pakistan.
- Safety is an important factor on a construction project and should be given significant weightage in the prequalification process (general observation).
- The site management should take part in highlighting the need of personnel safety practices among their workers.
- Pakistan Engineering Council should force the clients as well other stakeholder to maintain zero accident policy on their sites
- It would be suitable to arrange some form of formal or informal training and education for the workers on site working in night. These could be associated with the bonuses and other incentives on completion of such trainings.

5.5 FUTURE DIRECTIONS

- The future research avenues to be explored could be identifying the number of nighttime construction accidents in Pakistan and finding the effects of these accidents on the project cost.
- The effect of nighttime construction accident on project duration should also be determine.
- The no of respondent from other industry should also be include in the survey.
- This study may be repeated with a larger sample size covering all cities of Pakistan.

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Appendix I: Cover Letter of Safety Management Questionnaire

To: _____

Subject: **SAFETY MANAGEMENT RESEARCH QUESIONNAIRE**

Respected Sir,

Department of Construction Engineering and Management at School of Civil and Environmental Engineering (NUST) Islamabad is conducting a Research Survey on Nighttime construction safety in the construction industry of Pakistan.

The construction industry is one of the most important sectors in any nation's development. The volume of construction is an indicator of a nation's progress and economic prosperity. What is happening to the construction industry may be a matter of national concern. This research is important in the construction sector for its future improvement.

We are interested to find out how you feel about safety practices and principles in your construction site environments. We are conducting confidential surveys. To help with task, we would like you to complete the attached questionnaire – confidentiality is assured. The questionnaire is relatively simple to complete and ask about your attitudes to safety issues; as well as any suggestion you might have to ensure safe working condition on construction sites.

It is important for you to be completely honest about your feelings. All responses will be treated in strict confidence. This will assist us with analysis and interpretation of results.

We thank you for your assistance and cooperation in advance.

Yours sincerely,

ZOHAIB AHMED KHAN
Post Graduate Student – Construction Engineering & Management

DR. Muhammad Jamaluddin Thaheem (PhD)
Assistant Professor & Head
Department of Construction Engineering & Management
National Institute of Engineering
School of Civil & Environmental Engineering
Sector H-12, NUST, Islamabad.

Appendix II: Safety Management Questionnaire

Appendix III: List of Construction Sites for Safety Management Survey

Sites	Construction Company Name	Construction Site Name	Location
01	Izhar Construction (Pvt) Ltd	School of Sociology	H-12 Islamabad
02	SKB	Construction of School of Medical Sciences	H-12 Islamabad
03	Mionsons	Construction of Residential Apartment	H-12 Islamabad
04	ZKB	Construction of new SMME building	H-12 Islamabad
05	JV	Kashmir Highway Project	G-11, Islamabad
06	BNP (Grand Hyatt)	Construction of Grand Hyatt hotel project	Constitution Avenue, Islamabad
07	Habib Rafiq (Pvt) Ltd	Construction of Pakistan Parliament Lodges	Parliament Lodges, Islamabad
08	Habib Rafiq (Pvt) Ltd	Construction of Metro bus Project	9th Avenue, Islamabad
09	Nespak	Construction of Metro bus Project	Muree road, Rawalpindi
10	Maqbool Associates	Construction of Metro bus Project	Blue Area, Islamabad
11	Sultan Builder.	Construction of table tennis course building	H-12 Islamabad
12	M/S Uni build associates	Construction of intermediate board	Morgah Road Rawalpindi.
13	BAHRIA TOWN	Construction of Bharia Icon	Karachi
14	Primaco	Construction of Multi story Building	Kashmir Highway, Islamabad
14	Sir Syed university	Construction of Civil engineering lab Project	University Road, Karachi
15	Projacs International	Construction of Bharia Golf City	Near Muree

Appendix IV: List of Respondent's Companies, Experiences and Position

Respondent	Construction Company Name	Experience	Position
1	Khalid Naseem Contractor	>20 yrs.	**Project Manager**
2	M/S Darwish Engineering	>20 yrs.	**Project Manager**
3	Badar Karachi Builder	>20 yrs.	**Project Manager**
4	Tahir builders	<3 yrs.	**Site Supervisor**
5	ICPL	11-20 yrs.	**Project Manager**
6	ICPL	>20 yrs.	**Construction Manager**
7	Bauer International	4-10 yrs.	**Drilling Engineer**
8	Tahir builders	4-10 yrs.	**Project Manager**
9	Bajaur Construction Company	4-10 yrs.	**Senior Civil Engineer**
10	M/S Moinsons Pvt Ltd	4-10 yrs.	**Quantity Surveyor**
11	M/S Moinsons Pvt Ltd	>20 yrs.	**Project Manager**
12	NMCP DTE	>20 yrs.	**Project Manager**
13	NUST P.M.O	>20 yrs.	**Project Manager**
14	M/S Uni Build Associate	<3 yrs.	**Planning Engineer**
15	M/S Uni Build Associate	>20 yrs.	**Project Manager**
16	JV	>20 yrs.	**Resident Engineer**
17	NUST P.M.O	>20 yrs.	**Assistant Director (C&M)**
18	NUST P.M.O	4-10 yrs.	**Assistant Director**
19	ICPL	11-20 yrs.	**Skilled Labour**
20	A.S.K Construction	4-10 yrs.	**Project Manager**
21	Primaco	4-10 yrs.	**Associate Engineer Civil**
22	Zeeruk Consultant	4-10 yrs.	**Project Manager**
23	Sohail Ali Khan Associates	4-10 yrs.	**Site Supervisor**
24	Sohail Ali Khan Associates	<3 yrs.	**Site Engineer**
25	PPAF	4-10 yrs.	**Site Engineer**
26	Arif Consulting Engineers	>20 yrs.	**Principal Engineer**
27	Arif Consulting Engineers	4-10 yrs.	**Structure Design Eng.**
28	Arif Consulting Engineers	<3 yrs.	**Structure Design Eng.**
29	PPAF	11-20 yrs.	**Senior Civil Engineer**
30	Nescom	<3 yrs.	**Assistant Manager Civil**
31	Qavi Engineers	<3 yrs.	**Junior Civil Engineer**
32	Habib Rafique Pvt Ltd	10-20 yrs.	**Site Engineer**
33	Anwar Ali Associates	10-20 yrs.	**Resident Engineer**
34	Habib Rafique Pvt Ltd	>20 yrs.	**Construction Manager**
35	Arif Consulting Engineers	<3 yrs.	**Structure Design Eng.**
36	PPAF	4-10 yrs.	**Management Executive**
37	Anwar Ali Associates	4-10 yrs.	**Planning Engineer**
38	Mughal Steel Construction	4-10 yrs.	**Skilled Labour**
39	BNP Pvt Ltd	>20 yrs.	**Project Director**
40	PPAF	11-20 yrs.	**Senior Executive**
41	Habib Rafique Pvt Ltd	>20 yrs.	**General Manager**
42	BNP Pvt Ltd	4-10 yrs.	**Skilled Labour**
43	Nespak	>20 yrs.	**Resident Engineer**

44	ZKB	>20 yrs.	**Project Manager**
45	Reliable Engineering Services	<3 yrs.	**Structure Design Eng.**
46	PPAF	4-10 yrs.	**Management Executive**
47	BNP Pvt Ltd	20+ yrs.	**Deputy Project Director**
48	ZKB	<3 yrs.	**Site Engineer**
49	Limak Reliable (JV)	4-10 yrs.	**Asst. Structure Engineer**
50	Kestral SPD Pvt Ltd	<3 yrs.	**Planning Engineer**
51	AJK University	<3 yrs.	**Assistant Civil Engineer**
52	Symbol Engineering Services	>20 yrs.	**Safety Engineer**
53	Limak Reliable (JV)	<3 yrs.	**Planning Engineer**
54	ZKB	<3 yrs.	**Site Engineer**
55	Kestral SPD Pvt Ltd	<3 yrs.	**Coordination Engineer**
56	Sultan Builders	<3 yrs.	**Unskilled Labour**
57	Moinsons	4-10 yrs.	**Skilled Labour**
58	Meinhard	<3 yrs.	**Planning Engineer**
59	Sultan Builders	4-10 yrs.	**Skilled Labour**
60	Moinsons	<3 yrs.	**Unskilled Labour**
61	Nust	<3 yrs.	**Structure Design Eng.**
62	Sultan Builders	4-10 yrs.	**Skilled Labour**
63	Nust	<3 yrs.	**Planning Engineer**
64	PAK Safety Solutions	11-20 yrs.	**Safety Engineer**
65	alfanar Construction Riyadh	4-10 yrs.	**Safety Engineer**
66	AEC	4-10 yrs.	**Civil Engineer**
67	NJHPC, WAPDA	<3 yrs.	**Planning Engineer**
68	Pearl Real Estate Holding Ltd	4-10 yrs.	**Civil Engineer**
69	Albarrak	4-10 yrs.	**Chemical Engineer**
70	Haydon ME Contractor	<3 yrs.	**Safety Eng. (NEBOSH)**
71	FWO	4-10 yrs.	**Safety Engineer**
72	SSUET	4-10 yrs.	**Professor Project Mangt.**
73	SCET	<3 yrs.	**Lecturer CM**
74	University of Peshawar	11-20 yrs.	**Assistant Professor**
75	Paragon Pvt Ltd	<3 yrs.	**Civil Engineer**
76	Global Energy	11-20 yrs.	**Planning Engineer**
77	Advance marine solutions llc	11-20 yrs.	**Civil Engineer**
78	Microsoft college of timergara	<3 yrs.	**Lecturer**
79	Projacs International	>20 yrs.	**Planning Engineer**
80	Facility Logistics & Operations	11-20 yrs.	**Safety Engineer**
81	McCarthy improvements	>20 yrs.	**Safety Engineer**
82	al aryn	<3 yrs.	**Civil Engineer**
83	SSUET	4-10 yrs.	**Assistant Professor**
84	Nust (C & M)	11-20 yrs.	**Sub Engineer**
85	Milestone Builders	11-20 yrs.	**Safety Engineer**
86	ACE	<3 yrs.	**Safety Engineer**
87	Arif & Associates	>20 yrs.	**Structure Design Eng.**
88	GKG	<3 yrs.	**Safety Engineer**

89	OGDCL	>20 yrs.	**Safety Engineer**
90	Nust	<3 yrs.	**Assistant Professor**
91	Eni Pakistan	11-20 yrs.	**Civil Engineer**
92	Saudi electricity company KSA	11-20 yrs.	**Safety Engineer**
93	Contractors	4-10 yrs.	**Construction Manager**
94	OMV Pakistan	4-10 yrs.	**Civil Engineer**
95	MES	11-20 yrs.	**Civil Engineer**
96	BAHRIA TOWN	11-20 yrs.	**Civil Engineer**
97	Arif & Associates	>20 yrs.	**Structure Design Eng.**
98	Nespak	4-10 yrs.	**Civil Engineer**
99	Arif & Associates	<3 yrs.	**Structure Design Eng.**
100	BNP (grand Hyatt)	4-10 yrs.	**Civil Engineer**
101	Consultant	>20 yrs.	**Civil Engineer**
102	Sultan Builder	11-20 yrs.	**Civil Engineer**
103	NBTC	4-10 yrs.	**Petroleum Engineer**
104	Power Professional Engineers	4-10 yrs.	**Safety Engineer**

Appendix V: Coding of Aspects and Factors

Perimeter no	Aspects	Factors	Coding
1	Prioritize the perimeters in term of their benefit for Nighttime Construction (Strongly agree=5 & Strongly disagree=1)		
		Quality of the project improves	1.01
		Productivity increases	1.02
		Safety practices improves at night	1.03
		Reduction in delay and congestion	1.04
		Less air pollution	1.05
		Energy conservation	1.06
		Longer work periods specially in road construction	1.07
		Easy availability of material	1.08
		Schedule compression make the duration of the project shorthorn	1.09
2	Prioritize the type of workers safety equipment which are not available for Nighttime Construction operation in Pakistan (Always =5 & Seldom=1) FIGURE 1: Show the Picture of Personal Protective Safety		
		Safety shoes during construction activities at night	2.01
		Safety goggles during welding and concreting	2.02
		Hearing protection during the heavy machinery construction activities at night	2.03
		Protective clothing to eliminate the construction hazard	2.04

		Safety harness/lanyard when work at height on night	2.05
		Face shield for welding work	2.06
		High visibility pants and shirts	2.07
		High visibility knee/ ankle strips	2.08
		Respirator during construction at night	2.09
		High visibility hard hat	2.10
3	What type of management support is available on site for Nighttime Construction Operation in Pakistan (Always=5 & Seldom=1)		
		Safety supervision is available to implement the safety practices on site	3.01
		Safety meeting is done to analyze the safety practices from the past	3.02
		Safety inspection is done on site	3.03
		Safety training were provided to the worker	3.04
		Site safety orientation/program provided for the workers on site	3.05
		Safety manual and procedure were established	3.06
		Tool box meeting carried out weekly or monthly	3.07
4	Prioritize the main reason that caused an accident in Nighttime Construction Activities (Strongly agree=5 & Strongly disagree=1)		
		Electrocution	4.01
		Struck by a machine on site	4.02
		Collapse of earth work during digging	4.03
		Hit by falling material during lifting	4.04
		Fall from height during work	4.05
		Temperature variation at night caused an accident	4.06
		Insufficient Lighting condition compromise the workers safety	4.07
		Worker not wearing safety garment	4.08
		Poor performance of safety garment	4.09
5	Please rank the factors in terms of their importance affecting the worker safety during Nighttime Construction Operation (Strongly agree=5 & Strongly disagree=1)		
		Lack of training make the worker incapable to work at night	5.01
		The temperature variation affect badly on worker in nighttime construction	5.02
		Sufficient lighting is not available on site at night	5.03
		The unavailability of Personal Protective Equipment can also effect worker safety at night	5.04
		The unavailability of first aid measures on site to deal with accident at night	5.05

		The lack of nighttime safety regulations can jeopardize the worker safety	5.06
		The workers don't give importance to safety hazards at nighttime due to lack of awareness	5.07
		Lack of technical guidance can also cause the worker safety issue at night	5.08
		Excessive overtime work can increase the worker fatigue therefore cause an accident	5.09
		Absence of warning signs on site	5.10
		Less visibility also causes the accident at night	5.11
		Unavailability of an Authorized Person on site in case of emergency	5.12
		The worker were not wearing the safety equipment during construction at night	5.13
		Unavailability of safety nets to prevent fall	5.14
		The lack of motivation compromised the worker safety issues at night	5.15
		Drug Abuse during night may cause an accident	5.16
6	Prioritize the factors for the person responsible for implementing safety practices at night (Strongly agree=5 & Strongly disagree=1)		
		Owner/client	6.01
		Planning Consultant	6.02
		Construction Manager consultant	6.03
		Health and Safety Consultant	6.04
		Contract Administrator consultant	6.05
		Site inspector consultant	6.06
		Project Manager contractor	6.07
		Project Superintendent Contractor	6.08
		Safety Supervisor contractor	6.09
		Site Engineer contractor	6.10
		Construction Manager contractor	6.11

Appendix VI: Significance of factors in nighttime construction (overall)

Perimeter NO.	Factor No.	Importance of ways (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree)					Total No. of Responses	Total Score	Relative Importance Index(RII)	%age Score	Rank
		1	2	3	4	5					
1	1.01	9	35	25	21	14	104	308	0.59	59.2	5
	1.02	2	24	32	30	16	104	346	0.67	66.5	4
	1.03	32	38	12	16	6	104	238	0.46	45.8	9
	1.04	2	9	25	47	21	104	388	0.75	74.6	3
	1.05	12	31	22	28	11	104	307	0.59	59.0	6
	1.06	31	26	20	21	6	104	257	0.49	49.4	8
	1.07	3	8	17	40	36	104	410	0.79	78.8	2
	1.08	21	33	21	20	9	104	275	0.53	52.9	7
	1.09	1	8	16	44	35	104	416	0.80	80	1
2	2.01	19	17	21	32	15	104	319	0.61	61.3	2
	2.02	34	25	13	17	15	104	266	0.51	51.2	5
	2.03	50	18	15	16	5	104	220	0.42	42.3	8
	2.04	38	21	17	22	6	104	249	0.48	47.9	7
	2.05	28	23	22	24	7	104	271	0.52	52.1	3
	2.06	15	17	25	28	19	104	331	0.64	63.7	1
	2.07	40	14	21	21	8	104	255	0.49	49.0	6
	2.08	54	9	20	17	4	104	220	0.42	42.3	8
	2.09	56	18	13	14	3	104	202	0.39	38.8	10
	2.10	33	22	19	16	14	104	268	0.52	51.5	4
3	3.01	28	22	20	25	9	104	277	0.53	53.3	1
	3.02	28	32	18	21	5	104	255	0.49	49.0	3
	3.03	31	30	13	19	11	104	261	0.50	50.2	2
	3.04	33	33	19	16	3	104	235	0.45	45.2	5
	3.05	46	23	21	12	2	104	213	0.41	41.0	6
	3.06	30	29	23	16	6	104	251	0.48	48.3	4
	3.07	57	11	18	16	2	104	207	0.40	39.8	7
4	4.01	12	21	22	37	12	104	328	0.63	63.1	7
	4.02	3	21	19	42	19	104	365	0.70	70.2	5
	4.03	6	22	30	32	14	104	338	0.65	65	6
	4.04	1	21	22	39	21	104	370	0.71	71.2	4
	4.05	3	6	15	32	48	104	428	0.82	82.3	3

	4.06	18	36	26	15	9	104	273	0.53	52.5	9
	4.07	4	3	11	41	45	104	432	0.83	83.1	2
	4.08	3	5	10	38	48	104	435	0.84	83.7	1
	4.09	14	23	22	32	13	104	319	0.61	61.3	8
5	5.01	2	8	11	46	37	104	420	0.81	80.8	8
	5.02	12	24	35	20	13	104	310	0.60	59.6	16
	5.03	2	6	8	40	48	104	438	0.84	84.2	3
	5.04	3	6	11	42	42	104	426	0.82	81.9	6
	5.05	2	11	20	38	33	104	401	0.77	77.1	11
	5.06	4	9	18	45	28	104	396	0.76	76.2	12
	5.07	1	8	2	33	60	104	455	0.88	87.5	1
	5.08	1	8	16	53	26	104	407	0.78	78.3	10
	5.09	5	9	10	31	49	104	422	0.81	81.2	7
	5.10	3	7	7	42	45	104	431	0.83	82.9	5
	5.11	3	2	7	41	51	104	447	0.86	86.0	2
	5.12	3	11	28	44	18	104	375	0.72	72.1	13
	5.13	1	4	11	48	40	104	434	0.83	83.5	4
	5.14	3	7	14	43	37	104	416	0.80	80	9
	5.15	9	17	22	39	17	104	350	0.67	67.3	15
	5.16	11	16	20	32	25	104	356	0.68	68.5	14
6	6.01	5	11	12	29	47	104	414	0.80	79.6	8
	6.02	8	14	28	41	13	104	349	0.67	67.1	10
	6.03	3	4	6	59	32	104	425	0.82	81.7	7
	6.04	0	0	3	18	83	104	496	0.95	95.4	2
	6.05	6	19	32	34	13	104	341	0.66	65.6	11
	6.06	0	1	15	44	44	104	443	0.85	85.2	6
	6.07	1	0	6	19	78	104	485	0.93	93.3	3
	6.08	3	4	28	47	22	104	393	0.76	75.6	9
	6.09	1	0	2	5	96	104	507	0.98	97.5	1
	6.10	1	0	11	39	53	104	455	0.88	87.5	4
	6.11	0	1	11	40	52	104	455	0.88	87.5	4

Appendix VII: Ranking of Factors for nighttime construction (All Key Stake Holders)

Coding	Aspects	Safety factors	Client	Rank	Contractor	Rank	Consultant	Rank	Worker	Rank
(1). 1.01	Benefit of night time construction	Quality of the project improves	58. 1	6	61. 9	5	53. 3	6	68. 6	4
1.02		Productivity increases	69. 0	2	68. 1	4	58. 3	4	68. 6	4
1.03		Safety practices improves at night	48. 4	9	47. 6	8	43. 3	9	31. 4	9
1.04		Reduction in delay and congestion	69. 0	2	80. 0	3	69. 2	3	85. 7	2
1.05		Less air pollution	67. 1	5	54. 3	6	54. 2	5	68. 6	4
1.06		Energy conservation	53. 5	8	45. 7	9	47. 5	8	62. 9	7
1.07		Longer work periods specially in road construction	67. 7	4	86. 7	1	74. 2	2	97. 1	1
1.08		Easy availability of material	56. 1	7	51. 0	7	53. 3	6	48. 6	8
1.09		Schedule compression make the duration of the project shorthern	75. 5	1	83. 8	2	75. 8	1	85. 7	2
(2). 2.01	Type of safety equipment not available in night	Safety shoes during construction activities at night	53. 5	3	68. 6	1	60. 0	1	65. 7	2
2.02		Safety goggles during welding and concreting	50. 3	4	54. 8	4	50. 8	3	34. 3	8
2.03		Hearing protection during the heavy machinery	36. 1	10	46. 7	8	45. 8	7	31. 4	9

		construction activities at night								
2.04		Protective clothing to eliminate the construction hazard	41. 3	7	53. 8	5	44. 2	9	54. 3	4
2.05		Safety harness/lanyard when work at height on night	45. 2	6	57. 6	3	45. 8	7	71. 4	1
2.06		Face shield for welding work	61. 9	1	67. 1	2	59. 2	2	62. 9	3
2.07		High visibility pants and shirts	47. 1	5	53. 8	5	46. 7	5	42. 9	5
2.08		High visibility knee/ ankle strips	40. 6	8	45. 7	9	43. 3	10	37. 1	7
2.09		Respirator during construction at night	40. 6	8	37. 1	10	46. 7	5	31. 4	9
2.10		High visibility hard hat	56. 8	2	51. 0	7	49. 2	4	40. 0	6
(3). 3.01	Availability of management support at night	Safety supervision is available to implement the safety practices on site	51. 6	2	53. 8	1	56. 7	1	45. 7	2
3.02		Safety meeting is done to analyze the safety practices from the past	49. 7	5	50. 0	3	49. 2	2	40. 0	4
3.03		Safety inspection is done on site	53. 5	1	50. 0	3	49. 2	2	40. 0	4
3.04		Safety training were provided to the worker	49. 7	5	43. 3	5	41. 7	4	48. 6	1
3.05		Site safety orientation/program provided for the workers on site	43. 2	7	40. 5	6	41. 7	4	31. 4	6

3.06		Safety manual and procedure were established	50. 3	3	51. 9	2	40. 8	6	42. 9	3
3.07		Tool box meeting carried out weekly or monthly	50. 3	3	35. 7	7	39. 2	7	20. 0	7
(4). 4.01	Main reason of accident at night	Electrocution	77. 4	6	60. 5	7	59. 2	6	28. 6	9
4.02		Struck by a machine on site	83. 9	3	65. 2	5	58. 3	7	45. 7	7
4.03		Collapse of earth work during digging	74. 2	7	61. 0	6	63. 3	5	54. 3	5
4.04		Hit by falling material during lifting	81. 3	5	67. 1	4	65. 0	4	71. 4	4
4.05		Fall from height during work	88. 4	1	78. 6	3	76. 7	3	97. 1	1
4.06		Temperature variation at night caused an accident	50. 3	9	56. 7	9	52. 5	9	37. 1	8
4.07		Insufficient Lighting condition compromise the workers safety	86. 5	2	81. 0	2	83. 3	1	80. 0	2
4.08		Worker not wearing safety garment	82. 6	4	86. 7	1	80. 8	2	80. 0	2
4.09		Poor performance of safety garment	72. 3	8	59. 0	8	53. 3	8	54. 3	5
(5). 5.01	Factors affecting worker safety issues at night	Lack of training make the worker incapable to work at night	77. 4	11	80. 0	7	85. 0	4	85. 7	3
5.02		The temperature variation affect badly on worker in nighttime construction	61. 3	16	63. 8	16	56. 7	15	37. 1	16

5.03		Sufficient lighting is not available on site at night	85. 8	2	84. 8	3	80. 8	8	85. 7	3
5.04		The unavailability of Personal Protective Equipment can also effect worker safety at night	78. 7	6	81. 4	6	86. 7	3	82. 9	6
5.05		The unavailability of first aid measures on site to deal with accident at night	77. 4	11	75. 2	11	78. 3	11	82. 9	6
5.06		The lack of nighttime safety regulations can jeopardize the worker safety	78. 1	8	73. 8	13	77. 5	12	77. 1	10
5.07		The workers don't give importance to safety hazards at nighttime due to lack of awareness	81. 9	4	91. 0	1	89. 2	2	85. 7	3
5.08		Lack of technical guidance can also cause the worker safety issue at night	78. 7	6	76. 7	10	79. 2	10	82. 9	6
5.09		Excessive overtime work can increase the worker fatigue therefore cause an accident	77. 4	11	79. 5	8	90. 0	1	77. 1	10
5.10		Absence of warning signs on site	80. 0	5	84. 8	3	81. 7	6	88. 6	2
5.11		Less visibility also causes the accident at night	86. 5	1	87. 1	2	85. 0	4	80. 0	9
5.12		Unavailability of an Authorized Person on site in case of emergency	78. 1	8	68. 6	14	70. 8	14	71. 4	13
5.13		The worker were not wearing the safety equipment	85. 8	2	84. 3	5	81. 7	6	74. 3	12

		during construction at night								
5.14		Unavailability of safety nets to prevent fall	78. 1	8	79. 5	8	80. 0	9	91. 4	1
5.15		The lack of motivation compromised the worker safety issues at night	66. 5	15	66. 2	15	71. 7	13	62. 9	15
5.16		Drug Abuse during night may cause an accident	70. 3	14	74. 3	12	56. 7	15	65. 7	14
(6). 6.01	Person responsible for implementing safety practices at night	Owner/client	80. 0	6	85. 2	7	67. 5	9	85. 7	6
6.02		Planning Consultant	73. 5	10	70. 0	10	56. 7	11	57. 1	9
6.03		Construction Manager consultant	80. 0	6	85. 2	7	77. 5	8	82. 9	7
6.04		Health and Safety Consultant	94. 8	2	96. 7	1	92. 5	3	100. 0	1
6.05		Contract Administrator consultant	65. 8	11	68. 1	11	63. 3	10	51. 4	11
6.06		Site inspector consultant	78. 1	8	89. 0	4	85. 0	6	94. 3	4
6.07		Project Manager contractor	92. 9	3	93. 3	3	95. 0	2	88. 6	5
6.08		Project Superintendent Contractor	78. 1	8	75. 2	9	79. 2	7	54. 3	10
6.09		Safety Supervisor contractor	99. 4	1	95. 2	2	98. 3	1	100. 0	1

6.10		Site Engineer contractor	83. 9	5	88. 1	5	87. 5	5	100. 0	1
6.11		Construction Manager contractor	89. 7	4	87. 6	6	88. 3	4	74. 3	8

Appendix VIII: Percentage agreement between client and consultant (Aspects 1)

FACTOR NO.	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS		
		CLIENT	CONSULTANT		Rj1	Rj2			
1	1.01	6	6	0	6	0	6		
	1.02	2	4	2	2	4	2		
	1.03	9	9	0	9	3	6		
	1.04	2	3	1	2	4	2		
	1.05	5	5	0	5	1	4		
	1.06	8	8	0	8	2	6		
	1.07	4	2	2	4	2	2		
	1.08	7	6	1	7	1	6		
	1.09	1	1	0	1	5	4		
			Di=	**6**	**Dmax=**		**38**		
Di/N	0.666667					Dmax/N	4.222222		
Percentage Disagreement			16%			Percentage Agreement			84%

(Aspects 2)

FACTOR NO.	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS		
		CLIENT (Ri1)	CONSULTANT (Ri2)		Rj1	Rj2			
2	2.01	3	1	2	3	14	11		
	2.02	4	3	1	4	13	9		
	2.03	10	7	3	10	7	3		
	2.04	7	9	2	7	10	3		
	2.05	6	7	1	6	11	5		
	2.06	1	2	1	1	16	15		
	2.07	5	5	0	5	12	7		
	2.08	8	10	2	8	9	1		
	2.09	8	5	3	8	9	1		
	2.10	2	4	2	2	15	13		
			Di=	**17**	**Dmax=**		**68**		
Di/N	1.7					Dmax/N	6.8		
Percentage Disagreement			25%			Percentage Agreement			75.00%

(Aspects 3)

FACTOR NO.	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS		
		CLIENT	CONSULTANT		Rj1	Rj2			
3	3.01	2	1	1	2	14	12		
	3.02	5	2	3	5	11	6		
	3.03	1	2	1	1	15	14		
	3.04	5	4	1	5	11	6		
	3.05	7	4	3	7	9	2		
	3.06	3	6	3	3	13	10		
	3.07	3	7	4	3	13	10		
			Di=	**16**	**Dmax=**		**60**		
Di/N	2.285714					Dmax/N	8.571429		
Percentage Disagreement			27%			Percentage Agreement			73%

(Aspects 4)

FACTOR NO.	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS		
		CLIENT	CONSULTANT		Rj1	Rj2			
4	4.01	6	6	0	6	6	0		
	4.02	3	7	4	3	9	6		
	4.03	7	5	2	7	5	2		
	4.04	5	4	1	5	7	2		
	4.05	1	3	2	1	11	10		
	4.06	9	9	0	9	3	6		
	4.07	2	1	1	2	10	8		
	4.08	4	2	2	4	8	4		
	4.09	8	8	0	8	4	3		
			Di=	**12**	**Dmax=**		**41**		
Di/N	1.2					Dmax/N	4.1		
Percentage Disagreement			29%			Percentage Agreement			71%

(Aspects 5)

FACTOR NO.	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS		
		CLIENT	CONSULTANT		Rj1	Rj2			
5	5.01	11	4	7	11	40	29		
	5.02	16	15	1	16	35	19		
	5.03	2	8	6	2	49	47		
	5.04	6	3	3	6	45	39		
	5.05	11	11	0	11	40	29		
	5.06	8	12	4	8	43	35		
	5.07	4	2	2	4	47	43		
	5.08	6	10	4	6	45	39		
	5.09	11	1	10	11	40	29		
	5.10	5	6	-1	5	46	41		
	5.11	1	4	3	1	50	49		
	5.12	8	14	6	8	43	35		
	5.13	2	6	4	2	49	47		
	5.14	8	9	-1	8	43	35		
	5.15	15	13	2	15	36	21		
	5.16	14	15	1	14	37	23		
Di=				**51**	**Dmax=**		**560**		
Di/N	1.7					Dmax/N	18.66667		
Percentage Disagreement			9%			Percentage Agreement			91%

(Aspects 6)

FACTOR NO.	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS		
		CLIENT	CONSULTANT		Rj1	Rj2			
6	6.01	6	9	3	6	6	0		
	6.02	10	11	1	10	2	3		
	6.03	6	8	2	6	6	0		
	6.04	2	3	1	2	10	-8		
	6.05	11	10	1	11	1	7		
	6.06	8	6	2	8	4	4		
	6.07	3	2	1	3	9	-6		
	6.08	8	7	1	8	4	4		
	6.09	1	1	0	1	11	-10		
	6.10	5	5	0	5	7	-2		
	6.11	4	4	0	4	8	-4		
			Di=	**12**	**Dmax=**		**162.9**		
Di/N	0.857143					Dmax/N	11.63571		
Percentage Disagreement			7%			Percentage Agreement			93%