

HEALTH AND SAFETY ASPECTS IN BUILDING CONSTRUCTION INDUSTRY IN SRI LANKA

Dr. R. U. Halwatura

Department of Civil Engineering, University of Moratuwa

rangika@civil.mrt.ac.lk/ rangikauh@gmail.com

T. L. Jayatunga

thushanijayatunga@gmail.com

Abstract

Construction sector in Sri Lanka has tremendously grown in the recent past and construction has developed into an important base of the national economy. However, although being healthy and safe is an important aspect of construction, it remains unsatisfactory in Sri Lankan building construction industry, which takes the foremost share in constructions. Moreover, accidents result heavy loss of time, cost and resources, which are considered as the most valuable assets in the industry. This research was carried out with the intention of identifying the causes and effects of weak health and safety practices and to recognize the areas to be strengthened in this regard. Secondary data on fatal and nonfatal accidents, which have occurred in recent past, were collected to identify trends of the construction industry. Then, it was extended with a questionnaire survey among the professionals in the construction industry to identify the causes for accidents and the ways to mitigate their risk. Gross Domestic Product (GDP) of Sri Lanka clearly shows that the construction is growing at an increasing rate while the number of fatal accidents is also increasing at a higher rate than that. It clearly shows that there is lack of attention is paid on health and safety aspects with the progress of the industry. Through the questionnaire, the key areas which cause accidents and the most significant areas that have to be strengthened in the construction industry in Sri Lanka was identified.

Keywords: Health and safety, construction industry, Relative Importance index, mitigating risk, fatal and nonfatal accidents

1. Introduction

Construction is one of the most hazardous among all industries [1]. In recent years the construction industry has reported a higher number of fatalities and higher injury rate, which is ranked as the 3rd worst nationally among industry groups [2]. Hazards are not only restricted to those who work on sites. Children and other members of the community are also killed or injured due to the inadequate control of construction activities [3]. Reported cost in construction is billions of dollars in an economic loss and the cost exceeds beyond its evidence since the indirect cost of accidents might be as much as six times or more the direct cost [4]. Major causes of accidents are related to the unique nature of the industry, human behavior, difficult work-site conditions, and poor health and safety management, which results unsafe work methods, equipment with procedures. However, health and safety is not a luxury, and may be considered an important function to be used against unnecessary loss of property, injury or death. Preventing occupational injuries and illnesses should be the primary concern of all employers [5]. Previous studies in this area show that accidents occur in almost every construction project and the magnitude and effect of them vary considerably from project to project. Previously reviewed studies in the area can be discussed under several sections as per the research objectives. Other related factors such as studies on causes of poor health and safety aspects and consequences of poor health and safety aspects and mitigation of risk can be also discussed.

Health and safety of workers is a complex state of affairs and the construction is always unsafe due to outdoor operations, work-at heights, complex site plants and equipment operation jointly with workers attitudes and conduct towards health and safety. Situation becomes further aggravated due to the nature of the rapidly changing conditions, associated work hazards, and the characteristics of construction organizations in the construction industry [6]. According to Construction Industry Health and Safety Strategy, 2004-2010, a large number of unskilled and unqualified workers are engaged in the industry and as a result workplace accidents still occur at an unacceptably elevated rate. Davies and Tomasin [7] has identified various bad effects are raised due to various causes of poor health and safety aspects and literature reviewed show that the major effects of poor health and safety aspects are falling down, struck by falling objects, caught in or between objects, contact with electric currents, contact with gasses and fire explosions. In spite of that, Stephen [3] has mentioned that persons being struck by machinery or mobile plant are also identified as an outcome of poor health and safety procedures.

According to the Construction Industry Health and Safety Strategy, 2004-2010, to make the construction project marketable, including accident free culture, quality of the project should be maintained and risk must be mitigated. Both individuals and companies involved in the industry should pay direct attention on the areas which will contribute to continuing reductions in workplace deaths and injuries in order to establish a safety culture, safety strategy in the construction industry.

It is also highlighted, that all the parties involved in construction should contribute their effort to mitigate the risks associated and mitigation should be done with the involvement of parties at project level and organizational level. The organization is the key party who should have the

commitment on the health and safety aspect which significantly influences on cultivating a positive health and safety culture [8] with the most influential factor which drives health and safety performance in the construction industry while maintaining an expert organizational health and safety policy [9].

Most of the building construction projects in Sri Lanka experience weak health and safety practices, and hence it adversely affects the economy in many ways. Further, this has been identified as a socio-economic problem. Therefore, an urgent rectification is required.

2. Objectives

The main objectives of this study are to identify the main causes and effects of poor safety aspects and to recognize the most significant areas that have to be strengthened in mitigating the prevailing risks.

3. Methodology of the study

This study attempts to disclose the factors influencing the health and safety of building construction in Sri Lanka while identifying how risk can be mitigated. To achieve the above objectives, a prediction about the nature of the population (Building construction industry in Sri Lanka) is made through an analysis of a random sample. The emphasis here is limited to the opinion of clients/consultants and contractors who are involved in C1, C2 and C3 graded construction companies registered under ICTAD (Institute of Construction Training and Development). The preliminary data for this research were collected through a literature review and a questionnaire survey targeted at local contractors engaged in building construction.

Secondary data related to fatal and non-fatal accidents in Sri Lankan construction industry were collected from the Labor Department of Sri Lanka to identify the trend of health and safety conditions in the country. Secondary data related to investment on construction and GDP contribution on construction were collected from Department of Census and Statistics -Sri Lanka, to identify the trend of investment on construction and the trend of construction contribution to the national economy.

Causes and effects of poor health and safety practices in construction industry were examined and identified through a pertinent international literature review. A pilot study that sought advice from experienced building construction practitioners (specialists) in Sri Lanka was conducted. The basic purpose of the pilot study was to verify the validity of the questionnaire in capturing the factors relevant to the situation of Sri Lanka.

A questionnaire was developed to assess the perceptions of clients, consultants and contractors regarding the factors of causes which influence health and safety and effects due to poor health and safety practices of building construction industry in Sri Lanka. All practitioners (specialists) agreed that the questionnaire was sufficient to capture the causes and effects of weak health and safety practices in Sri Lankan building construction sector.

The questionnaire was divided into four parts. The first part requested *background information* of the respondents. The second part of the questionnaire captured the *effects of poor health and*

safety aspects. Here, respondents were allowed to indicate their responses based on 21 well-recognized effects due to poor health and safety practices in building construction industry. These effects were categorized into five major groups of *persons falling down, electricity hazards, fire hazards, persons being struck by machinery and persons being struck by tools and objects*. The third part of the questionnaire focused on *causes of poor health and safety practices*. Here the respondents were allowed to indicate their responses based on 32 well-recognized constructions related risk factors (causes of poor health and safety practices). These causes were categorized into the four major groups of *contractor related, owner/consultant related, worker related, project related and Hazards related* violated responsibilities. The fourth part was designed to obtain the ideas of respondents for mitigating risks in building construction industry in Sri Lanka.

3.1 Justification of Sample Size and Reliability of Data

As per the *Central Limit Theorem*, when the *Sample Size* approaches *thirty*, the *Distribution of Sample Mean* is approximately *Normal* in spite of the *Distribution of Population*. Therefore, in this study a *Random Sample* of *sixty respondents* has been considered for the analysis in order to predict the nature of the *Population*

3.2 Relative Importance Index (RII)

Relative Importance Index (RII) method is used to determine the relative importance of various causes of delays in construction projects [10]. The same method can be used to find the relative importance index of effects and causes of poor health and safety practices in building construction industry in Sri Lanka. The five point likert scale ranged from 0 (not affect) to 4 (extremely affect) was adopted and transferred to relative importance index (RII) for each effects and five point likert scale ranged from 5 (Strongly agree) to 1(Strongly disagree) was adopted and transferred to relative importance index(RII) for each causes as follows.

$$RII = \frac{\sum W}{A \cdot N} \dots\dots\dots (1)$$

“W” is the weighting given to each factor by the respondents, “A” is the highest weight and “N” is the total number of respondents.

4. Analysis

Analysis of the following items are illustrated with regard to the survey carried out based on building construction industry in Sri Lanka that targeted clients/consultants and contractors at the local building construction industry in Sri Lanka.

- Investment on construction, values of GDP contribution on construction and number of fatal, nonfatal accidents occurred.
- Respondents' background with respect to representation of the organization, education, occupational level and years of working experience.
- Ranking of factors based on RII

Finally, based on the analysis, the results are discussed upon the effects and causes of poor health and safety aspects of building construction industry in Sri Lanka.

4.1 Construction contribution to national economy and fatal, nonfatal accidents.

Figure 1 illustrates the construction growth which is at an increasing rate (Gradient of 1.7×10^{10}). Figure 2 shows the growth of GDP contribution on construction which is also at an increasing rate (Gradient of 1.02) which is lower than the investment on construction and Figure 3 shows the number of fatal accidents growing with an increasing gradient (Gradient is 1.70) which is higher than the GDP contribution on construction.

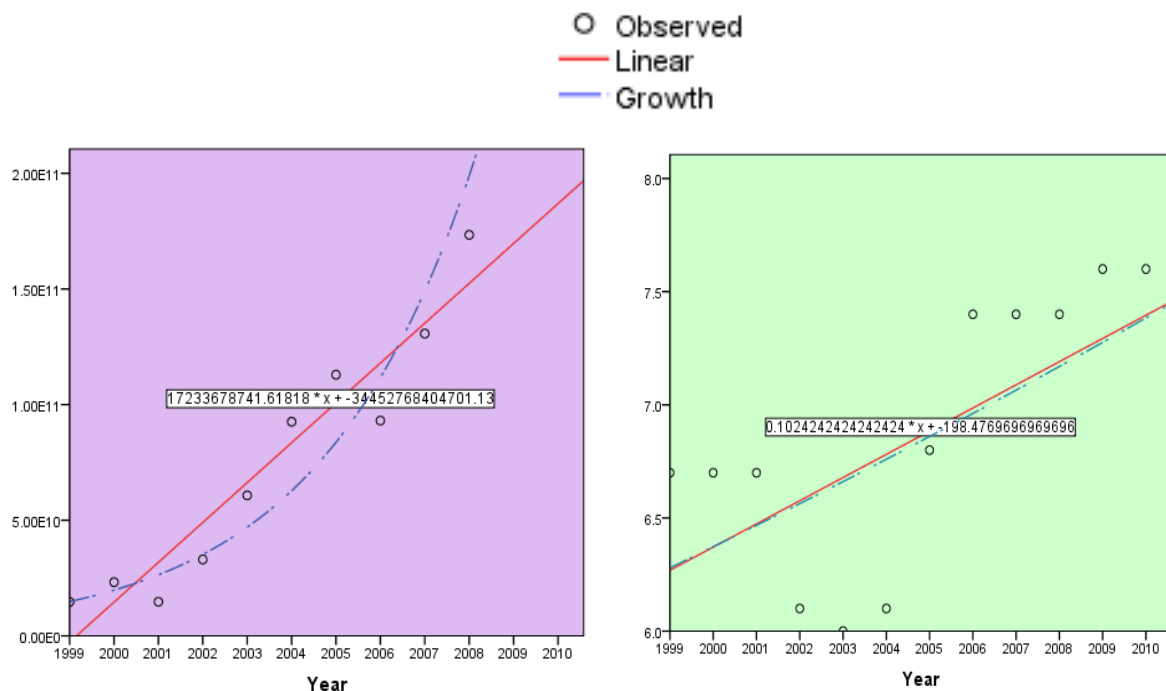


Figure 1- Investment on construction in Sri Lanka

Figure 2- GDB contribution percentage on construction in Sri Lanka

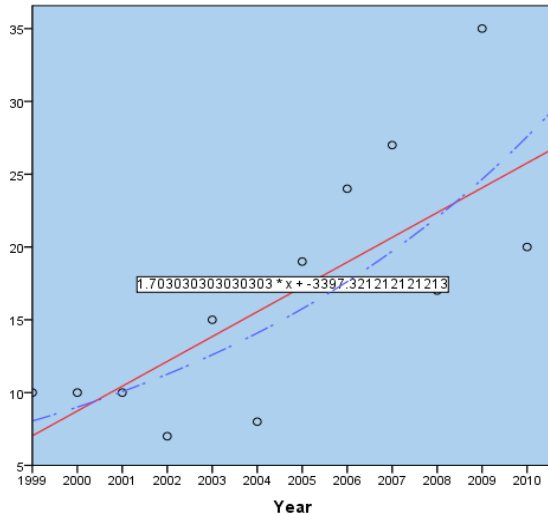


Figure 3 - Number of Fatal accidents in construction industry in Sri Lanka

4.2 Respondents' Background

In this study, 60 respondents were participated representing the building construction industry. Respondents' background was analyzed with respect to the *educational level, the occupational level, and the years of working experience*. The result was analyzed using MS-Excel 2007 statistical package.

As far as their *education* is concerned, 42 % of them had a *diploma*, 40 % of them had a *degree*, and 18 % of them had *postgraduate* qualifications. When their occupational level is concerned, 23% of them are *Project Managers (PM)*, 5% of them are *Resident Engineers (RE)*, 31% of them are *Site Engineers (SE)*, 2% of them are *District Engineers (DE)*, 3% of them are *Chief Engineers* and 36% of them are *Engineering Assistants*. When their *working experience* is concerned, 30 % of them had less than 5 years, 33 % of them had 5-10 years, 12 % of them had 10–15 years, 9 % of them had 15-20 years and 16% of them had *more than 20 years* of working experience.

These demographic statistics of the respondents suggest sufficient exposure to make the information acquired reliable, and thus the opinions are thought to reflect the real situation in the prevailing context of the building construction industry in Sri Lanka.

4.3 Relative Importance Index (RRI) and ranking of causes and effects of poor health and safety aspects

Table 1 below illustrates detailed analysis of Rank (*Main Group, Group and Overall*) bases on *RRI of various causes* of poor health and safety aspects (Risk Factors) with responsibilities violated by different parties involved in building constructions in Sri Lanka. The most significant responsibilities violated are “*worker related responsibilities (Main Group Rank=1)*”. All the other responsibilities are also significant since RIIs of these factors are approximately equal to 1. They are “*contractor related responsibilities violated (Main Group Rank=2)*”, “*project related responsibilities violated (Main Group Rank=3)*”, “*owner/consultant related*

responsibilities violated (Main Group Rank=4)”;The most significant “*worker related responsibilities violated is*” *workers have not been given enough training in respect of health and safety* (Group Rank=1)”.The most significant “*contractor related responsibility violated*” is “*the technical staff has not been given enough training on health and safety*(Group Rank=1)”.The most significant “*project related responsibility violated*” is “*lack of attention on health and safety supervision* (Group Rank=1)”.The most significant “*owner/consultant related responsibility violated is*”” *client has not paid attention to health and safety considerations* (Group Rank =1)”.

Table 1 - Ranking of Risk Factors (Causes of poor health and safety) based on RII

| Risk Factors in Building Construction | Rank | | |
|---|------------|-------|---------|
| | Main Group | Group | Overall |
| Workers related responsibilities violated | 1 | | |
| Workers have not been given enough training in respect of health and safety | | 1 | 2 |
| Workers education background is not enough to understand health and safety | | 2 | 11 |
| The construction workers are reluctant to adopt health and safety measures | | 3 | 14 |
| Contractor related responsibilities violated | 2 | | |
| The technical staff has not been given enough training of health and safety | | 1 | 3 |
| Lack of health and safety instrument | | 2 | 5 |
| Poor site supervision | | 3 | 6 |
| Unawareness of health and safety policy | | 4 | 9 |
| Not keeping health and safety records at the site | | 5 | 14 |
| Project related responsibilities violated | 3 | | |
| Lack of attention on health and safety supervision | | 1 | 1 |
| Day and night shift(regular working of exceeding eight hours) | | 2 | 7 |
| No health and safety audits are conducted | | 3 | 8 |
| Crash project planning | | 4 | 12 |
| Overlapping activities | | 5 | 13 |
| Owner/Consultant related responsibilities violated | 4 | | |
| Client has not paid attention to the health and safety considerations | | 1 | 10 |
| Client considers the lowest value than best value | | 2 | 15 |
| Absence of client’s representative at the site | | 3 | 16 |

Table 2, represents, all the *causes of poor health and safety* ranked upon the *overall rank*, in Table 4.1 with the parties involved in construction industry. According to the calculations, although it is obvious that all the violated responsibilities of workers, contractors, projects and owners/consultants are critical (RII values are approximately equal to 1), only the most significant top 10 factors are highlighted with the relevant party involved in construction industry.

Table 3, represents overall and group ranking of risk factors (causes of poor health and safety) according to causes of risks. The most significant causes of risk factors are “*causes of persons falling down* (Main Group rank=1)”, “*causes of striking of tools and objects on people* (Main Group Rank=2)”, “*causes of electrical hazards* (Main Group Rank=3)”, and “*causes of fire*

hazards (Main Group Rank=4)". All the factors are critical (RII values are approximately equal to 1 and most critical 12 factors are highlighted).

Table 2 - Overall Ranking of Risk Factors (Causes of poor health and safety)

| Risk Factors in Building Construction | Party | Overall Rank |
|---|----------------------|--------------|
| Lack of attention on health and safety supervision | Project | 1 |
| Workers have not been given enough training with respect of health and safety | Workers | 2 |
| The technical staff has not been given enough training of health and safety | Contractor | 3 |
| The construction workers are reluctant to adopt health and safety measures | Workers | 4 |
| Lack of health and health and safety instruments | Contractor | 5 |
| Poor site supervision | Contractor | 6 |
| Day and night shift(regular working of more than eight hours) | Project | 7 |
| No health and safety audits are conducted | Project | 8 |
| Unawareness of health and safety policy | Contractor | 9 |
| Client has not put in place safety and health considerations | Owner/ Consultant | 10 |

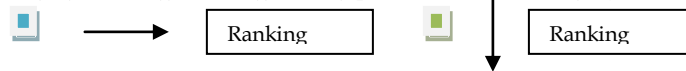
Table 3 - Overall and group ranking of risk factors (causes of poor health and safety) according to causes of risks

| Risk Factors in Building Construction | Rank | | |
|---|------------|-------|---------|
| | Main Group | Group | Overall |
| Causes of persons falling down | 1 | | |
| Presence of unprotected and unfenced edges at higher elevations | | 1 | 1 |
| Absence of regular checking and quality controlling of temporary work | | 2 | 4 |
| Absence of safe working platform and gangway | | 3 | 7 |
| Improper design of form work | | 4 | 13 |
| Causes of persons striking by tools and objects | 2 | | |
| Absence of safety nets | | 1 | 5 |
| Improper ways of keeping material, tools and equipment | | 2 | 6 |
| Absence of safety catch fan (fence to prevent throwing objects) | | 3 | 10 |
| Causes of electrical hazards | 3 | | |
| Unprotected electrical outlets | | 1 | 2 |
| Use of improper and nonstandard ways of electrical cable extensions | | 2 | 3 |
| Working place close to unprotected electrical transmission lines | | 3 | 8 |
| Electrical wiring is done on wet floor | | 4 | 9 |
| Non-availability of proper earth for all panel board and equipment | | 5 | 11 |
| Use of aluminum ladders for electrical wiring purposes | | 6 | 16 |
| Causes of fire hazards | 4 | | |
| Improper usage of flammable substances | | 1 | 12 |
| Hot work operations nearby storage area | | 2 | 14 |
| Hot area(welding/cutting/and grinding) is not separated | | 3 | 15 |

Table 4 illustrates the detailed analysis of *Rank (Group and Overall)* based on *RII* of various effects which could occur due to *poor health and safety aspects (Risk Effects)*. The most significant effects are “*persons being struck by machinery (Main Group Rank=1)*”, “*Electric hazards (Main Group Rank=2)*”, “*persons falling down (Main Group Rank=3)*”, “*fire hazards (Main Group Rank=4)*” and “*persons being struck by tools and objects (Main Group Rank=5)*”. The most significant effect related to “*persons being struck by machinery*” is “*by material lifting machinery (Group Rank=1)*”. The most significant effect related to “*electricity Hazards*” is “*electrocution (Group Rank=1)*”. The most significant effect related to “*persons falling down*” are “*falling down upper floors (Group Rank=1)*” and “*falling down from scaffoldings (Group Rank=2)*”. The most significant effects related to “*Fire hazards are*” due to “*flammable gasses or materials (Group Rank=1)*” and due to “*electrical shortages (Group Rank=2)*”. The most significant effects related to “*persons being struck by tools and objects*” is “*tools and objects fall from upper floors (Group Rank=1)*”. The most significant factors that affect *death* are “*persons being struck by machinery (Rank=1)*” and “*persons falling down (Rank=2)*”. The most significant factors that affect “*permanent disabilities*” are “*persons being struck by machinery (Rank=1)*” and “*persons falling down (Rank=2)*”. The most significant factors that affect “*recoverable injuries*” are “*persons being struck by machinery (Rank=1)*”. The most significant factors that affect “*damage to properties*” is “*fire hazards (Rank =1)*”.

Table 5, illustrates overall ranking of risk effects (Effects of poor health and safety) based on *Relative Important Index (RII)*. The most critical Risk Effects are “*persons falling down from upper floors (Overall Rank=1)*” and “*persons being struck by material lifting machinery (Overall Rank=2)*”.

Table 4 - Group Ranking of Risk Effects (Effects of poor health and safety) based on RII



| Risk Effects | Main Group Rank | Group Rank | Overall Rank | Death Rank | | Permanent Disabilities Rank | | Recoverable Injuries Rank | | Damage to Property Rank | |
|---|-----------------|------------|--------------|------------|---|-----------------------------|---|---------------------------|---|-------------------------|---|
| | | | | | | | | | | | |
| Persons being struck by machinery by | 1 | | | 2 | 1 | 1 | 1 | 3 | 1 | 4 | 3 |
| Material lifting machinery | | 1 | 2 | 2 | 2 | 1 | 1 | 3 | 1 | 4 | 1 |
| Earth moving machinery | | 2 | 4 | 1 | 1 | 2 | 3 | 3 | 2 | 4 | 3 |
| Material moving machinery | | 3 | 5 | 2 | 3 | 1 | 2 | 3 | 3 | 4 | 2 |
| Electric Hazards due to | 2 | | | 1 | 3 | 2 | 3 | 3 | 2 | 4 | 2 |
| Electrocution | | 1 | 3 | 1 | 1 | 2 | 1 | 3 | 3 | 4 | 3 |
| Electric shock | | 2 | 7 | 1 | 2 | 2 | 1 | 3 | 4 | 4 | 4 |
| Burns | | 3 | 9 | 1 | 3 | 3 | 3 | 2 | 1 | 4 | 1 |
| Electrical shortages | | 4 | 12 | 4 | 4 | 3 | 2 | 1 | | 2 | 2 |
| Persons Falling down | 3 | | | 2 | 2 | 1 | 2 | 3 | 3 | 4 | 5 |
| From upper floors | | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 4 | 1 |
| From scaffolding, | | 2 | 6 | 2 | 2 | 1 | 2 | 3 | 3 | 4 | 2 |
| From unfinished window facade | | 3 | 13 | 2 | 3 | 1 | 3 | 3 | 4 | 4 | 4 |
| From ladders | | 4 | 15 | 3 | 6 | 2 | 5 | 1 | 1 | 4 | 4 |
| From staircases | | 5 | 16 | 2 | 5 | 1 | 3 | 2 | 4 | 3 | 3 |
| Into the excavation | | 6 | 20 | 2 | 4 | 1 | 4 | 3 | 5 | 4 | 5 |
| Fire Hazards due to | 4 | | | 3 | 5 | 1 | 5 | 2 | 4 | 4 | 1 |
| Flammable gasses or materials | | 1 | 8 | 2 | 1 | 1 | 1 | 4 | 3 | 3 | 1 |
| Electrical shortages | | 2 | 14 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 |
| Welding sparks | | 3 | 17 | 4 | 3 | 2 | 3 | 1 | 1 | 3 | 3 |
| Persons being struck by tools and objects | 5 | | | 2 | 4 | 1 | 4 | 4 | 3 | 4 | 4 |
| Falling down from upper floors | | 1 | 10 | 1 | 1 | 2 | 1 | 3 | 1 | 4 | 1 |
| Falling down from scaffoldings | | 2 | 11 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 2 |
| Falling down from top of the excavation | | 3 | 18 | 3 | 3 | 2 | 4 | 1 | 3 | 4 | 5 |
| Falling down from staircases | | 4 | 19 | 2 | 4 | 1 | 3 | 3 | 4 | 4 | 3 |
| Falling down from ladders | | 5 | 21 | 1 | 3 | 2 | 5 | 3 | 5 | 4 | 4 |

Table 5 - Overall Ranking of Risk Effects (Effects of poor health and safety) based on RII

| Risk Effects | Risk Category | Rank |
|--|--|------|
| From upper floors | Persons falling down | 1 |
| Material lifting machinery | Person being struck by machinery | 2 |
| Electrocution | Electric Hazards | 3 |
| Earth moving machinery | Person being struck by machinery | 4 |
| Material moving machinery | Person being struck by machinery | 5 |
| From scaffoldings | Persons falling down | 6 |
| Electric shock | Electric Hazards | 7 |
| Flammable gasses or materials | Fire Hazards | 8 |
| Burns | Electric Hazards | 9 |
| Tools and objects fall from upper floors | Person being struck by tools and objects | 10 |

5. Discussion

GDP contribution on construction is also increasing but in a lesser gradient when compared to investment of construction and the variation of number in fatal accidents are increasing at a higher rate compared to GDP contribution on construction. Therefore, the situation in construction industry in Sri Lanka is alarming. Therefore a formal attempt was made to reveal the areas of risks and accidents that could happen (effects due to poor health and safety) and factors which influence health and safety (causes of poor health and safety) and to identify the areas to be strengthened and mitigated with respect to health and safety.

According to the findings, violation of worker related responsibilities is the most influencing factor in causing unsafe work conditions in building construction industry in Sri Lanka. The finding revealed that the workers have not obtained enough training on health and safety, and their educational background is not adequate to realize the importance of health and safety. As a result the construction workers are reluctant to adopt health and safety measures. Violation of contractor related responsibilities is the next critical factor. It is apparent that the technical staff has not been given enough training on health and safety. Lack of health and safety instruments, poor site supervision, unawareness of health and safety policy and not keeping health and safety records at the site are witnessed. As a violation of project related responsibilities; lack of attention on health and safety supervision, regular working of exceeding eight hours, not conducting health and safety audits, crash project planning and overlapping activities can be considered as the next critical factors. The factor with a minimum influence is the violation of owner/consultant related responsibilities which include; lack of attention of the client regarding health and safety consideration, the client considering the lowest value than the best value and absence of client's representative at the site.

Finally, this study found that most critical factors which cause violation of health and safety are: lack of attention on health and safety supervision, workers not been given enough training with respect of health and safety, the technical staff not been given enough training with respect of health and safety, reluctance of the construction workers to adopt health and safety measures, lack of health and safety instruments, poor site supervision, day and night shifts (regular working of more than eight hours), absence of health and safety audits, lack of awareness on health and safety policy, client has not paid attention to health and safety considerations and low educational background of workers which prevents them from understanding the necessity of health and safety in the building construction industry in Sri Lanka.

As a result of this study (considering causes of poor health and safety aspects), emphasis has to be drawn for the following focusing areas in order to mitigate the risks in building construction industry in Sri Lanka.

1. **Areas where persons may fall down:** It was found, presence of unprotected and unfenced edges at higher elevations, absence of regular checking and quality controlling of

temporary work, absence of safe working platform and gangway and improper design of formwork can be seen in Sri Lankan building constructions.

2. Areas where persons can be struck by tools and objects: Absence of safety nets, improper ways of keeping material, tools and equipment, absence of safety catch fan (fence to prevent throwing objects were found as significant areas.

3. Electric hazardous areas: Unprotected electrical outlets, use of improper and nonstandard ways of electrical cable extensions, working place close to unprotected electrical transmission lines, electrical wiring is done on wet floor, non-availability of proper earth for all panel board and equipment and use aluminum ladders for electrical wiring purposes.

4. Fire hazardous areas: Improper usage of flammable substances, hot areas (welding/cutting/and grinding) is not separated, hot work operations are nearby storage area.

Further, this study found that Sri Lankan construction industry experiences various significant effects due to poor health and safety culture in the industry. They are: Persons being struck by material moving machinery, earth-moving machinery and material lifting machinery, Electrical hazards due to electrocution, electric shock and burns, Persons falling down from upper flows, scaffoldings, unfinished window façade, ladders, staircases and Persons falling down into excavation, person being struck by tools and objects falling from upper flows, scaffoldings, top of the excavations, staircases and ladders.

Further, the most critical factors (effects due to poor health and safety aspects) that this study found can be described respectively : Persons falling down from upper floors, Persons being struck by material lifting machinery, Electrocution, Persons being struck by earth moving machinery, material moving machinery, People fall from scaffoldings, Electric shock, Fire hazards due to flammable gasses or materials, Burns due to electricity, Persons being struck by tools and objects fallen from upper flows.

This study revealed that the most critical factors that affect both death and permanent disabilities respectively: persons being struck by machinery, persons falling down, electricity hazards, person being struck by tools and objects and fire hazards.

The most critical factors that affect recoverable injuries respectively: persons being struck by machinery, electricity hazards, persons falling down, persons being struck by tools and objects and fire hazards.

The most critical factors that affects property to damage respectively: fire hazards, electricity hazards, persons being struck by machinery, persons being struck by tools and objects and persons falling down.

6. Conclusion and recommendations

This study revealed that health and safety is weak in every aspect in building construction industry in Sri Lanka. Further, it was found that persons being struck by machinery, electric hazards, persons falling down, fire hazards and persons being struck by tools and objects are the effects of poor health and safety practices in building construction industry in Sri Lanka. However, the most critical accidents occurred by persons being struck by machinery and electricity hazards. The major reasons for both death and permanent disabilities are persons being struck by material lifting machinery and persons falling down from upper floors. The major reasons for recoverable injuries are person being struck by material lifting machinery and electric hazards due to electric shock. Property damages mostly occur due to fire hazards by flammable gases or materials and electric shortages. The findings further illustrate that the violation of health and safety considerations is mainly done by workers. Further, this study found,

- Following unsafe areas, which exist in the building construction industry in Sri Lanka, respectively : Presence of unprotected and unfenced edges at higher elevations, Unprotected electrical outlets, Use of improper and nonstandard ways of electrical cable extensions, Absence of regular checking and quality controlling of temporary work, Absence of safety nets, Improper ways of keeping material, tools and equipment, Absence of safe working platform and gangway, Working place close to unprotected electrical transmission lines, Electrical wiring done on wet floor, Absence of safety catch fan (fence to prevent throwing objects)
- Following kinds of violations of responsibilities are existing in building construction industry in Sri Lanka, respectively : Lack of attention on health and safety supervision, Workers have not been given enough training with respect to health and safety, The technical staff has not been given enough training on health and safety, The construction workers are reluctant to adopt health and safety measures, Lack of health and safety instruments, Poor site supervision, Day and night shift(regular working of more than eight hours), No health and safety audits are conducted, Unawareness of health and safety policy, Client has not put in place safety and health considerations, Workers education background is insufficient to understand the health and safety.

Based on the conclusion and discussions of the study, recommendations can be suggested in order to mitigate the causes and effects of poor health and safety in building construction industry in Sri Lanka : A combination of sound and formal system and relationship should be kept among client/ consultant, contractor and management and workers, Co-ordinate activities of projects ensuring health and safety management should be done under supervision, Contractor should provide enough training on health and safety to both workers and technical staff, Management should adopt health and safety measures to adopt health and safety measures, Contractor should provide adequate health and safety instruments to workers. The organization should plan the site considering the health and safety, establish rules, monitor performance routinely by special health and safety audits as appropriate. Government should setup proper rules and regulations to adopt health and safety measures in building construction industry in Sri Lanka.

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