AN ANALYSIS OF OCCUPATIONAL SAFETY AND HEALTH HAZARDS IN THE HOT END SECTION OF CONTAINER GLASS MANUFACTURING INDUSTRY

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Degree of Master of Science

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Thesis submitted in partial fulfilment of the requirement for the degree Master of Science in Occupational Safety and Health Management

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Table of contents

Chapter One

Chapter Two

Chapter Four

Chapter Five

List of tables

List of figures

List of Appendices

Abbreviations

ACGH	- American Conference of Governmental Industrial Hygienists
TLVs	- Threshold Limits Values
JMO	– Junior Machine In-charge.
LI	– Line In-charge
NIOSH	– National Institute of Occupational Safety and Health
ISM	- Individually sectioned machine
ACGIH	- The American Conference of Government Industrial Hygienists
WBGT	- Wet-bulb globe temperature
WHO	– World Health Organization
SLIDB	– Sri Lanka Industrial Development Board
IARC	- International Agency for Research on Cancer
IJERT	- International Journal of Engineering Research & Technology
OSH	– Occupational safety and Health
RCS	- Respirable crystalline silica
MR	- Metabolic rate
TLV	– Threshold Limit Value
NIHL	- Noise induces hearing loss ()
COSHH	- Control of Substances Hazardous to Health Regulations 2002
GDP	- Gross Domestic Production
COSHH	- Control of Substances Hazardous to Health Regulations 2002
ILO	– International Labour Organizations

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Dedication

This project of dedicated to my beloved mother who wanted me to be the best at all the times

Declaration

"I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning. To the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Signature of the student - ……………………………………………

Date - ……………………………………………

R.D.K Samitha Kumara (149387A)

The above candidate has carried out research for the Masters thesis under my supervision

Signature of the supervisor - ……………………………………………

Date - ……………………………………………

Department of Building Economics

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May 2019

Abstract

The uncontrolled occupational health and safety hazards are hidden issue all over the world. Many people die and sacrifice their lives in short terms and long terms as a result of these uncontrolled and unidentified hazards existing in the working environment. The health care sector of countries have to spent billions of money for medical treatments for the occupations illnesses, in the developing countries. In addition, the contribution of victimized people to the economic development process of a country get limited in various ways and their personal lives get disturbed. Accidents caused in industries making partially disabled, fully disabled people, who are considered as dependents in the society making minimum contribution to the economy.

The glass industry is known as an industry with high concerns of occupational health and safety conditions and with less studies in finding the long lasting solutions and remedies in remedying the hazardous conditions. In this study, preliminary the Sri Lankan glass manufacturing sector was considered and data collection done.

Preliminary in data collection the structured questionnaire was used validated with a questionnaire pilot study with industry experts. In this study, the hot end section was selected in carrying the survey and out of 35 employees; the 32 employees were selected according to the small survey-sampling plan. The demographic data, health and safety hazards according to the criticality, company background of OSH and critical causes for the OSH hazards were collected with interview of employees by the researcher by face-to-face interview. All collected data tabulated and analysed through the excel and RII (Relative Importance Index) was calculated in facilitating the ranking the hazards and the cause. In most of the cases, the hazardous condition had been controlled with PPE applications and engineering controls where as the eliminating and substitution is a challenging initiatives in the glass manufacturing environment. Against the preventive initiatives the controlling of the hazards and exposures are quite unsatisfactory as during the case study the results showed are alarming. This study conducted by emphasizing to develop a better OSH environment in Sri Lankan glass industry.

Key words: Safety Hazards, Container glass, Occupational health

CHAPTER ONE

1.0 Background of Study

Occupational safety and health (OSH) intention to make a safer working environment to its workforce. In working environments varieties of health and safety hazards exists in different modes. All possible identified risks will negatively effect on the level of the productivity and profitability when loose the control (International Labour Organization (ILO), 2010). Workers will daily in touch with opened unidentified un-specified hazardous conditions to improve the working abilities of the workforce. In addition assessing the working environment in terms of giving them a better solution to prevent the condition, inventing ergonomics best practices to be followed through a scientific methodical way creation of safe work place in the industrial environment (Patel, Rao, Asim, 2006).

According to the WHO (World Health Organization), health is defined as the complete physical, mental and social wellbeing of an employee, who is not merely having diseases or infirmity (Cooper and Phillips, 2004). The occupation safety and health concerns plays a vital role in the present day industrial world. The industries had become more complex and compacted rather than they were in 20th century. The degree of hazardous chemicals, material usage had been gone up in rate of double, the mechanized environment had make more vulnerability to the accidents the exposure to the physical chemical and biological hazards are at greater extent (ILO, 2010). Even with the rapid technological advancements in the industries the dependency on the human aspect still at high in the developing countries where the labour rates are comparatively less and labour availability at high extent. Under this condition, most of the developed countries are in trend on locating the hazardous heavy industries in the third world and the poor rated developing countries (ILO, 2002). These conditions are prominent in the developing and under-developed countries as a result of poor health and safety facilities and poor ergonomic facilities conditions badly affecting to the workforce thus in the long term the bad effect are emerging as hindrance to the national productivity, economy and social progress (ILO, 2002). Since the government intervention are at negligible level and having no legal framework in controlling the

OSH infrastructure in industries, the condition had impacted negatively in the most of the scenarios.

Since initiating, the OSH concepts and ergonomics applications are to be done in priority with basic understanding the concepts of theoretical aspects as well the practical scenarios unless the impractical solution will add only a cost part and no results intended. This marks the obligation of participation third party. The legal authority with sound technical and technological background for the supporting the local and foreign investors in fulfilling the above requirement. A Study done by Ahsan (2000) pointed out that "workers lives in many of these developing countries are often marked with a deficit on the part of their health, safety and hygiene measures. Where the governments spent more on the curing activities in terms of medical expenditure, Hospital facility and infrastructure development for post recover of the industrial hazard exposure victims" (ILO, 2002). This indicated that approximately 4% of GDP disappears in these type countries as a result of OSH losses due to lack of basic health and safety facilities in the workplaces. This will exceed the total investment benefit from the foreign investors to the government. This was creating a pain area in many developing countries. As stated by Takala (1992) "by OHS and ergonomics concerns have a connection with numerous components in the regional economy thus the provision of health, hygiene and safety in the workplace aimed to economic growth processes in a various of ways".

1.1 Identification of research problem

The research on the heavy industries in Sri Lanka are limited to a few numbers and development and sustenance of OSH practices in these industries are limited a traditional generalized approaches (Amarasinghe, 2009). Acquiring the recent technologies in prevention of work related OSH hazards are minimum as a result of this. There are various health and safety hazards associate with glass manufacturing industry. Hazards are causes of potential damage to employee health and wellbeing. In the extreme condition the hazards may damage to properties and environment and these under certain condition can cause accidents or loss of human life. Accidents are also considered as an organizational issue (Lind, Nenonen, Rahnasto, 2008). There is a prerequisite for any industry to see the OSH background of the operation and implement preventive mechanism in operations. The researches on these sectors will certainly allow this objective to be achieve preferably.

Furthermore, below reasons also under consideration before start this project.

I. Minimum academic/ empirical studies research under OSH initiatives of glass industry.
II. None availability of compilation of literature on glass safety and health hazards
III. Health condition of the workers is always important for the development of the industry and national GDP.
IV. No safety frameworks have developed for heavy industries like glass in Sri Lanka.
V. In recent world government workers & industrial environment both national and international level are at increasing trend in getting the coverage and compliance to the labour laws and occupation safety and health (OSH) to the working environments better than past.
VI. A need of improved management systems with better safety standards complying with international standards is day by day rising in Sri Lanka.

1.2 Justification of the problem

The occupation health issues are being subdivided in to the two categories such as long term effective and short term effective (National Institute of Occupational Safety and Health (NIOSH), 2009). In most of the cases, the records are available in most of the statistical sources regarding the short-term effective OSH injuries or ill health conditions but in long term, effective conditions are not recorded.

Due to unavailability of the proper study and empirical data in heavy industries the use of historical evident and literature are minimized. Since the exposures to the conditions & high vulnerability to the hazardous condition in long run are prominent in the scope of the study. The unawareness of the employee and lack of contribution from the management in elimination of the hazardous condition in the workplace propelling this. The advantage of making safety framework will be subsidized to the development of OSH practices in heavy industries, which would finally facilitate a better safer working condition within the facilities.

Furthermore, within this research and its findings will bridge the knowledge gap in the occupation health issues in the container glass manufacturing industry Sri Lankan context and furthermore the research will evaluate the adaptation and integration of the safety measures in to the system.

1.3 Research Aim

To develop a safety framework to minimize the level of impact of hazards to the employees in the hot end section of container glass manufacturing industry.

1.4 Specific Objectives of the Study

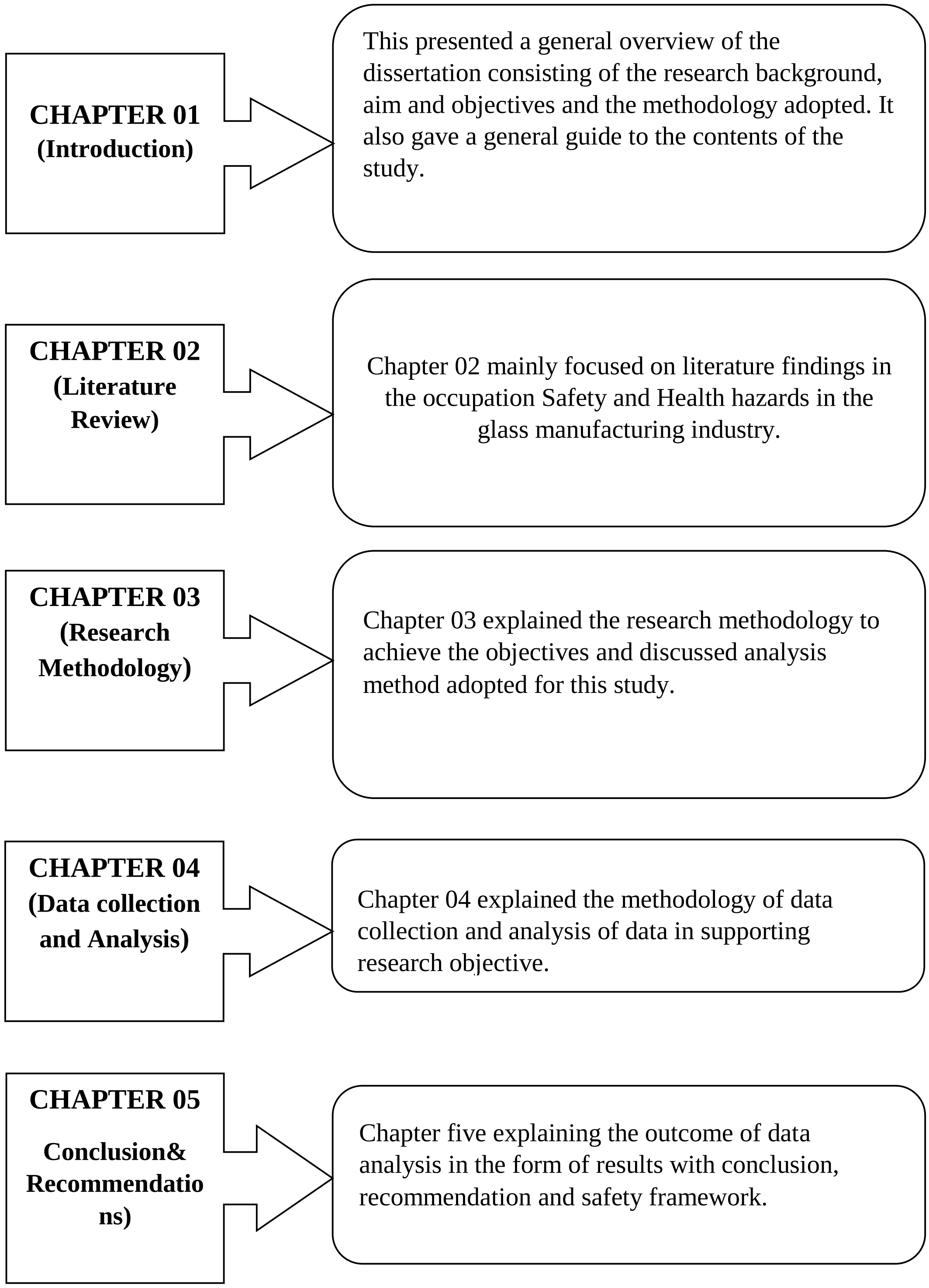
1 Identify the occupational health & safety hazards in work environment of the glass manufacturing industry.
2 Identify the occupational health & safety hazards and seriousness in hot end section of container glass manufacturing industry in the Sri Lankan context.
3 Rank the occupational safety and health hazards & critical causes in the hot end section of container glass manufacturing industry.
4 To propose recommendations based on the findings of the study. To introduce a framework to improve the OSH conditions in the hot end section of the container glass manufacturing industry.

1.5 Significance and Limitations of Study

The glass business in Sri Lanka is a monopoly business and no competitor emerged due to limitation of business, market share and scale of investment (Glass Asia 2013). No similar research had been conducted in relation with the occupation safety and health concerns in the glass industry due to this limitation. Thus, the data collection will be limited to the Sri Lankan region. The total population is will be 35 numbers (Hot End) & evaluation the criticality of the hazards and impact over the employees may have some limitations due to this total population size. The study is limited to the Sir Lankan region and the study was structured as a case study All the outcomes and the research results were limited to the defined segment and the defined area specially manufacturing operation, applicability of the research findings to another field would require several alterations. The general applicability of the research findings would have boundaries and if applied the extent of application will be limited. The conclusions & recommendations will be generalized to the container glass industry.

The research covering only the existing Occupational health Hazards condition and its impact the future assessment of level of impact or change in the state of the conditions will not be studied or assessed, behavioural based safety aspects of the employee in the production department, relation with the level of OSH condition subjected to change. The entire population will not cover in this study as a percentage, it covers more approximately 07% from total population (Total permanent cadre of the company) further the study is on the permanent employee cadre of the company not on the contractual workers which will be approximately 25% out of total population of the factory. The feedback given the questionnaire may not represent the actual situation.

1.6 CHAPTER OUTLINE



CHAPTER TWO

2.0 Literature Synthesis

2.1 Introduction to glass industry

2.1.1 Historical overview

The glass "an inorganic substance" principally the condition getting analogous to the liquid state of substance, and knowing as "super cooled liquid" (Morey, 1938). The glass in nature having high degree of viscosity thus under natural condition state remain solid. The glass "as an inorganic thing of fusion that has cooled to a rigid status without crystallizing" as described by the American Society for Testing Material (de Jong, 1989).

The originate of glass to the world is still unknown and in most of the case the glass is being created in the nature abundantly in subjecting to high heat and pressure, in later stages the glass had been identified as one of the most important source of inspiring the development of science and technology to the modern era. Obsidian and pumice are known as most abundant form of natural glass most of the time found in the volcanic dust, further tektite too known as a form of naturally occurring glass. The humans in the Magdalenian period about 25000 ago used the tektites for various uses (de Jong, 1989). In the period of 3500-200 BE the smelting of glass was invented by man and developed rapidly. The development of glass industry started rapidly with the invention of melting techniques (de Jong, 1989).

The melting technology had developed in four stages known as

1. Manufacturing in open pits in 300 BC, blowpipe developed in about 250 BE
2. Using of fire wood mobile "POT" furnaces until the 17^{th} century
3. Loa "POT" furnaces that used coal and firewood (1600-1850).
4. In recent era the glass industry using gas/ petroleum fuel fired/ heated melting Pots or melting tanks since 1860, most recent innovation is electrically heated furnaces since 1910 (de Jong, 1989).

The Romans introduced the blowpipe technique to the glass industry and it is considered as major breakthrough in the glass production (de Jong, 1989).

2.1.2 Diversification of the glass industry

Glass manufacturing is subdivided in to main five categories, (347-348 IAC monographs volume 58) known as

1. Flat glass industry
2. Container glass industry,
3. Art and complementary glass,
4. Special glass (Optical and ophthalmic, electronic)
5. Fibre glass (Not considered here)

Table 2.1- Category wise percentage of Glass production

Sector	Category wise % total GLOBAL production
Container glass	45%
flat glass	33%
Specialty glass	16%
Fiber glass	6%

Source – Glass Asia 2013

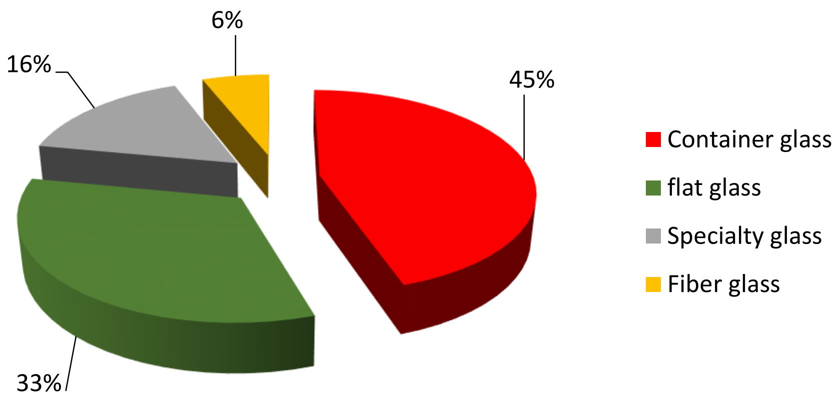


Figure 2.1- Category wise percentage global glass production
Source - Industry research CARE 2018

Table 2.2 - Category wise % of Glass production total Asian region

Sector	Percentage of contribution
Container glass	52
flat glass	28
Specialty & Other glass	15.9
Fiber glass	4.1

Source - Glass Asia 2013

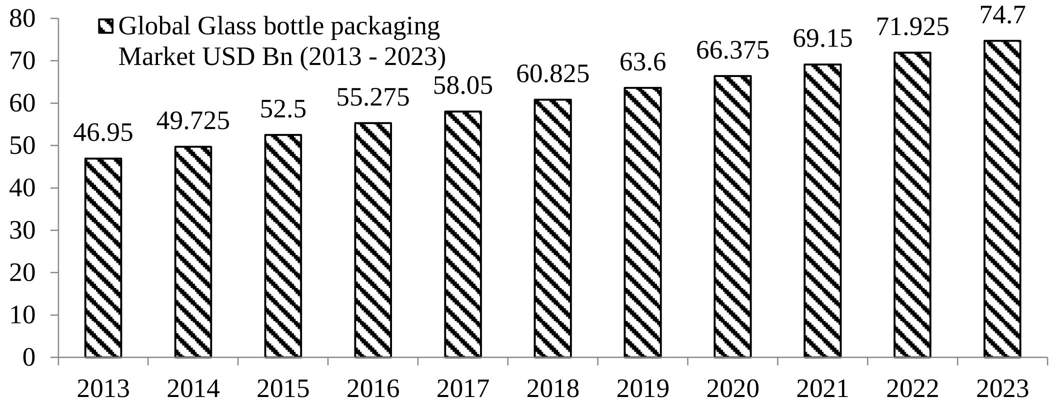
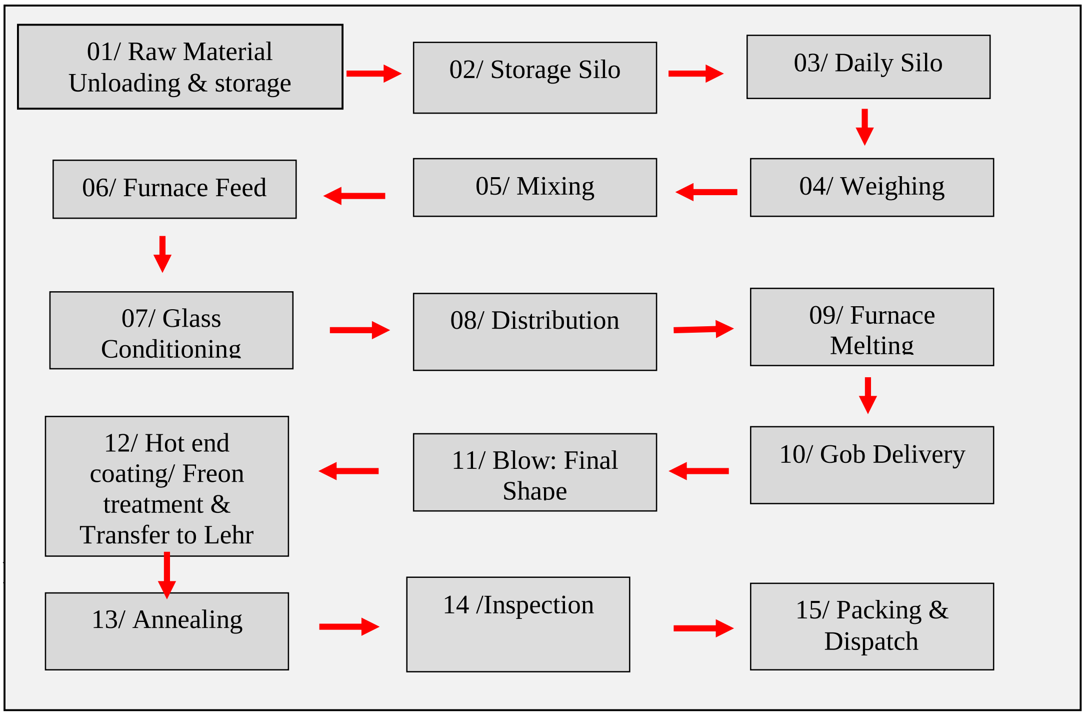


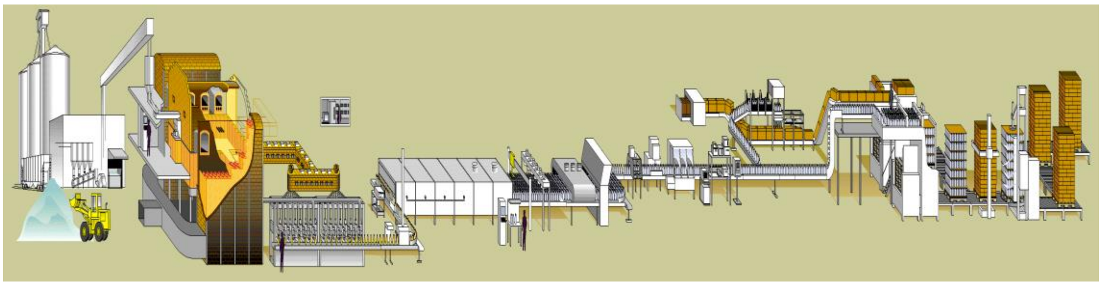
Figure 2.2- Global Glass bottle packaging Market USD Bn, (2013 - 2023)
(Source –Glass Asia 2013)

Figure 2.3, showing the steps of container glass manufacturing. The modern glass production facilities with mostly high tech and automated manufacturing processes with electrically heated gas fired tank furnaces, in which the glass is melted. The batches are continuously feeding to the furnace proceed with the float process (Grundy, 1990). The container glass manufacturing too having the same process until the furnace and rest of the part is significantly different from the foal glass manufacturing process. The container glass manufacturing is highly mechanized with modern technology (Grundy, 1990). Production of art glass and special glass involve modern and traditional mixed techniques from manual blowing to mechanize forming (Grundy, 1990).

2.1.3 Glass manufacturing process



Raw Material RM testing storage - Silos	Furnace Feeding, Melting Distributio n Heat recovery	Fore-hearth Cooling, Equalising, Conditioning Gob forming	Printing, Colouri ng	Engineering Electrical, Instrument, Utility Mechanical Civil ,Project	Mould Eng. Design, MFG, Inspection, Repairs. Storage



Batch House Day Silos Weighing, Mixing Storing	IS Machine Delivery, Blank side Invert, Blow side, Transportation	Annealing Lehr Hot Zone, Open Lehr Single liners	100 % Inspection Limit samples, AQL, SQC, QA	Packing Stretch wrapping Box Packing Palletizing Clearance Ware House

Figure 2.3 - steps in container glass manufacturing

The main ingredient to the glass is Silica sand or Quartz (Silicon Dioxide SiO_2). There are several other key ingredients in the glass batch other than Silica. The final batch composite of virgin material of 55% to 65% with recyclable glass pieces called cullet of 35% to 45 % from factory originated and collected island wide. The glass industry is known as high-energy consuming industry when compared to other (Patel *et. al,* 2006).

2.1.3.1 Batch Processing (Batch House)

The batch house is a storage and making of glass batches for the furnace melting. It contain huge Silos, in which the silica and other material stored and releasing time to time for batch mixer according to the recipe. Typically, the plant is designed in multi storage facility with gravity flow and mechanical flow mechanism. Typically heavy dusty and floors made of steel can slipping and tripping happen (Cooper *et.al*, 2004) and dust can cause respiratory injuries in long term exposures (Patel *et. al*, 2006)

Table 2.3 –Key Raw Material of glass production

Symbol	**Name**	**Old Name**
SiO_2	Silicon dioxide	Quartz sand
PbP	Lead oxide	Litharge
K_2CO_2	Potassium carbonate	Potash
$NaCO_3$	Sodium carbonate	Soda
KNO_3	Potassium nitrate	Saltpeter
$Sb2O_3$	Antimony trioxide	
$BaCO_3$	Barium carbonate	
ZnO	Zinc oxide	
Na_2B4O_7 * $5H_2O$	Sodium tetra borate Penta-hydrate	Borax
$CaCO_3$	Calcium carbonate	Calcite
Na_2SO_4	Sodium sulfate	

2.1.3.2 Melting in Furnace

The mixing and melting done in three steps,

- Melting
- Fining
- Homogenizing

The ingredients mixed in batch house transfer to furnace and melted at 1450 ^{0}C – 1650 ^{0}C De-carbonization, desulfurization, and dehydration are the three key chemical process involved in the initial phase. Silicate formation occurs at the about 500 – 800 ^{0}C. The most important process is fining the molten batch, that is done through, (I)/ by addition of chemical fining agents (II), varying the furnace temperatures. In molten batch the bubble, creating is controlled by controlling the batch viscosity. Low viscosity allows bubble to release more rapidly this process called batch homogenizing.

With technological development the glass furnace technology undergone rapid development in melting and homogenizing (Srivastava, Kumar, Joseph, Kumar 2000). Today world tank furnaces can melt and homogenize large volume of glass at a time. The tanks are subdivided in to mainly two sections either by a refractory wall or by bridge. The first part is called melting end, to where the cold batch load and the opposite side to melting end called working (refining) end. These two sections play a critical role in glass melting and homogenizing. Fuel based on fossil fuels or natural gas. The glass furnaces emit high volume of hazardous gases like NO_x / CO/ SO_x, CO_2 / Particulate matter (Abbasi, Fleming, (1988). The recent technological advancements use electrical boosting to get the melting efficiency and low emissions during melting process (Patel *et. al,* 2006).

2.1.3.3 Forming the glass

The core process in the glass manufacturing is the forming the glass in to a desired design, that involve blowing, pressing, casting mechanically or manually. In large sale commercial production is taken place with the machineries were, as low demanded complicate designs are yet producing with hand or manual process. Even though the large-scale commercial production process is done with mechanical operations, the human intervention is must in completing the full process. Most harmful stage out of entire glass processing will be hot handling. So called glass forming (Patel *et. al,* 2006).

2.1.3.4 Surface coatings and anti-weathering agent treatment

The hot end coating is widely used in the container glass manufacturing process in order to get the bottle outer surface more scratch resistance and get low in friction. The hot end coating main ingredient is identified as mono-Butyltintricloride (MBTC) plus stabilizer, highly corrosive and toxic material that can cause respiratory difficulties, irritating to the upper respiratory tract and Deleterious effects in long term exposures (Arkema, 2002).

2.1.3.5 Annealing

Annealing is a process of reduction of internal stress by means of uniform heating the glass after production around its melting point of 560 ^{0}C, avoiding deformation and cooled slowly in preventing formation of stress in the layers. The annealing process is needed for any glass product in order use in general (Patel *et. al*, 2006). The annealing is done through the chamber called annealing lehrs, through which the glass products are travelling with gradual temperature increase and dropping. Heat source will be electrical or gas fired. The Annealing lehrs contributing in emission of high heat loads to the normal environment as the exhaust system direct to outside with all flue gases (Patel, *et al* 2006).

2.2 Exposures in the workplace

Glass industry is known as high potential industry for exposure of occupations safety and health hazards (Patel, *et. al*, 2006). Among them Silica dust, certain metallic compounds, hazardous gaseous compounds, heat, dusty environment, extreme sound are prominent (International Agency for Research on Cancer (IARC), 1987b). As per the OSHA, 2009 showed out the glass industry have the higher average of incidents injuries or illnesses than the whole manufacturing, and higher than the cumulative figure of all industrial sector (OSHA, 2009).

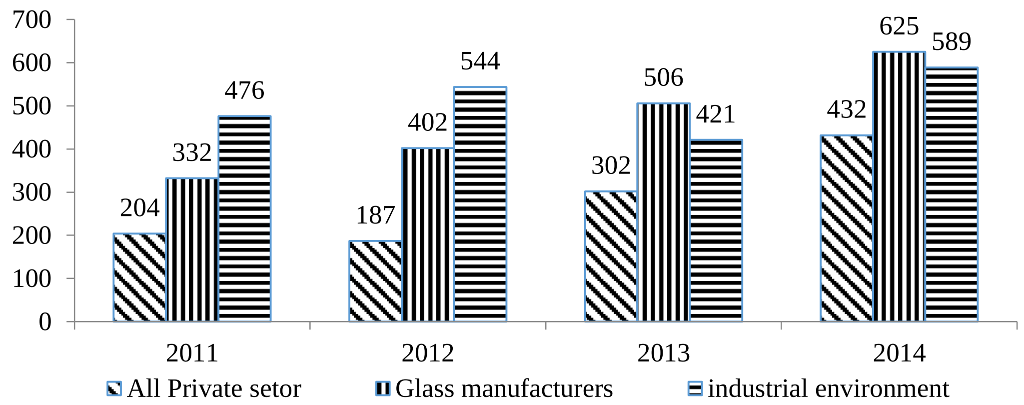


Figure 2.4 - Incidence rate of injuries in the Asian glass sector, 2011, 2012, 2013 & 2014. Source: Glass Magazine, 2015, from BLS

Glass production utilize numerous kinds of metals, usually as oxides. Approximately almost all elementary chemical are being used in the glass industry either on glass refining process, coloring or gaining the ease of workability (de Jong, 1989). In production of high-end crystal glass in batch preparation consist of approximately 30% of lead and semi crystal glass 10%, which known as hazardous source of occupational exposure (ILO, 2010). In additional antimony, arsenic, cadmium manganese, selenium, nickel and chromium are a few varieties of chemicals widely used in glass industry known as hazardous to expose (Anderson, Wingren, Axelson 1990). Exposed to dust, fumes, smoke, heat, sound are prominent among workers (Anderson *et al*, 1990).

Table 2.4: Category of health and safety hazards in glass industry

Category	**Hazards**
Health Hazards	Physical
	Chemical
	Biological
	Ergonomics
Safety Hazards	Fire
	Explosion
	Accidents
	Machinery
	Electrical

2.3 Health Hazards

2.3.1 Physical Hazards

I. Exposure for particulate matter and dust (crystalline silica/ metal dust) & respiratory hazards
II. High heat conditions
III. Burn hazards
IV. Cut injuries
V. Extreme Noise conditions
VI. Ergonomics & related hazards

2.3.2 Chemical Hazards

I. Toxic open Fumes/ smoke of fossil fuels
II. Ionized air/ Radiation

III. Hydrocarbon fumes rich with sulfur compounds
IV. Toxic chemicals compounds
V. Toxic metals (heavy) / Solids direct contact
VI. Toxic Vapors emissions
VII. Acids/ corrosive materials

2.3.3 Biological Hazards

2.4 Safety Hazards

I. Fire related
II. Explosions
III. Accidents by slipping and tripping
IV. Unsafe machine
V. Electrical hazards

Glass manufacturing has a large number of chemical compositions (Boyd & Thompson, 1980). That is depend upon three types of glass and the manufacturing method. Widely used glass type is Soda lime glass in the food and beverage industry and Borosilicate glass for laboratory glassware and Lead potash glass for high crystal glass (Anderson *et al*, 1990). The Batch house mix all the major and minor chemicals and transfer to furnace, in which the batch is placed in the tank and melted at 1450 ^{0}C – 1650 ^{0}C. De-carbonation, Desulfurization and dehydration are the key initial steps in furnace before the batch going to melt. The process consumes heavy energy volumes from various sources. The main energy sources in past was the coal and crude oils, but in nowadays the modern type of furnaces using furnace oil with electrical boosting (Patel *et. al*, 2006). The furnace mainly emits many hazardous substance to the environment all flu glass include heavy unburnt particulate matter, CO, CO_2, H_2S and SF, SO_2 and NO_x. (Abbasi, Fleming, (1988). In addition, the furnace emits ionized air and radiation to the outside environment. Exposure may occur to polycyclic aromatic hydrocarbons in most of the cases within the work placed due to these emissions (Cameron, Hill, Parmeggiani 1983).

The main sources of exposure in work place Silica dust and crystalline metallic compounds. The working environments of the glass processing facilities are hot and most of the heat through the radiant (Cameron *et.al*, 1983). Most of the heat issues arise during maintenance & the emergency repair work, temperatures in the area of routine maintenance work is around 120 ^{0}C to 160 ^{0}C , under emergency it can reach up to 200 ^{0}C (Cameron *et.al*, 1983). The burn hazards are proven in specially in the production environment as the most of the glass contacting surfaces are hot and exceeding the 400 ^{0}C to 750 ^{0}C. The human skin cannot bear with this level of high temperature and in contact the burning the surface occur with varying degree (Patel *et. al*, 2006). In the forming section the IS (Individually Sections) machine operation with pneumatic power and the mould cooling air known as vertiflow makes heavy noise during operation. In most of the glass facilities exceed the sound level of 85 dB to 100 dB (OSHA, 2009). The factory issues the ear protection and safety appliances but there is no proper study in identifying & evaluation of suitability of these safety gears and prevention methods (Anderson *et al*, 1990). In the production floor typically in the glass industry known as hot end used number of hazardous substances as production aids and treatments (Patel, *et al*, 2006). Among them the hot end coating, anti-weathering agents and glass mould lubricants increases the hazard level in the production floors. The mould lubricants causes heavy fumes emissions rich with Sulphur causes acute respiratory difficulties and in long term exposure it can lead up to chronic respiratory syndromes (NIOSH, 2009). More condition & exposures that consider as hazardous are discussing under the literature synthesis in chapter two.

2.5 Sri Lankan Glass manufacturing industry

The glass manufacturing history of Sri Lanka is not driven much past. Only having 60 -70 years of history (Sri Lanka Industrial Development Board (SLIDB), 2014). In this study, gathering the OSH data in limited to the Sri Lankan context. In Sir Lanka, glass manufacturing is only limited to container glass manufacturing. The sheet glass and other types of glass manufacturing is not exist. The glass company selected in this study is accredited with ISO 9001-2008 / ISO 22000:2005. Certification and with manufacturing excellence initiative. Sri Lanka glass bottle requirement annual varies from 3.5 to 4.2 US$ Millions and the industry showing high fluctuating all around the year.

The factory, under OSH management initiatives had accredited OSHAS 18000:2007 and (ISO 45000:2018 is being currently implementing) certified in the 2011. The factory whole process covered by the OSHAS system procedures and protocols starting from the receiving raw material silica sand and the other batch ingredient to the final finished good dispatch from the factory premises. Under the OSHAS the HR department conducting outside training development programs, workshops, online training, on the job training, mistake proofing and external third party audits for the safety and Health concerns in the company. The annual training plans & budgeting including the acquiring of the external knowledge to the company the company issue all required PPE (Personal Protecting Equipment) to all layers of the company employees according to the identified requirement. The annual cost of providing the PPEs to the employees will be 2.1 million LKR (Annual report of the company, 2010).

Occupational Health and Safety is defined as OHSAS 18001 - (2007), as "conditions & Factors which affects, or may impact to the health and safety of worker or other workers , visitors or any person in the workplace".

According to the Dorland's Exemplified Medical Dictionary (1988), "health has been distinct as a state of optimal physical / mental & social well-being, and not just the absence of disease and infirmity". The encyclopaedia of occupational health and safety (1998) explains the term job safety as the inter-relationship between people and work, equipment and machinery, material, environmental, and economic considerations such as productivity. Even though the terms health and safety can be defined separately as every day words, they are considered together in the occupational context.

Workplace is a physical place in which work related actions are performed under the control of the organization (NIOSH, 2009). Occupation is the job or profession someone is involved in (World Health Organizations (WHO), 1963). A person can involve in the same occupation at different workplaces. In the 1950, the World Health Organization (1963:3) defined the objectives of the Occupational Health.

As per the WHO, (1963) defined "The OSH is the maintenance and promotion of the highest degree of physical, mental and social wellbeing in an occupations. The prevention among workers of departures from heath caused by their working condition. Protection of workers in their employment from risk resulting from factors adverse to health. Placing and maintenance of worker in an occupational environment adopted to his physiological and psychological conditions"

This chapter is preliminary synthesis of available literature on OSH hazards in the container glass manufacturing industry in globally. It is a discussion of the hazardous condition and elimination protocols from the sources and importance of controlling the OSH hazards to the industry and preventive mechanisms prevailing.

2.6 Hazards at workplace

The health can be explained as, "state of complete physical, mental and Social wellbeing" of a person in the industrial environment (Cooper *et.al,* 2004). Safety Hazards are generally emerged in the working environment causing violent injury as a result of nonstandard usage of equipment and physical environment. The safety hazards are more likely to be the explosive nature of chemicals rather than their toxicology or long-term effect (Naruse, 1976). In the case of high noise in the work area, hearing loss is the major concern rather than the resultant stress related disease (Naruse, 1976). Specific hazards presently existing are Noise pollutions, High heat exposure, dust exposure, fire explosions, Electrical hazards, Machinery and tool injuries etc. (Naruse, 1976). In addition, OH&S management system (2001) say a hazard is an inherent potential to cause injury or damage to health of employees. However ILO (2010) defines the OSH condition as a discipline in a broad scope involving in many of specialized fields, which should always focus on the maintaining of higher degree of physical, mental & social well-being of all levels of employee, prevention the adverse effects of health condition that can cause by any of working condition (ILO, 2010). Further Cooper *et.al* (2004) explained OSH as direct link measures of safety environment and actual behaviour of safety culture.

Table 2.5:- The Risks in workplace

Risk Factors - Work Environment related	Risk factors - Employee related	Unsafe acts
- Exposure to heat - Exposure to noise - Exposure to respiratory hazards - Physical Hazards - Chemical hazards - Ergonomic hazards - Electrical /electrocution hazards - Falling from heights - Stuck by falling objective - Accidents due to operation of moving machine part - Fire explosion - Failure of temporary structures	- Missing safety gears - None-compliance - Violation of regulations - Negligence - Un awareness of hazards - Unawareness of safety practices - Forget to follow given OSH guidelines	- None use of PPE - Conscious / Un-conscious Risk Taking - Risk relating to Ergonomics (Poor working postures) - Defects in safety attitudes.

2.7 OSH Hazards in glass industry

As it described in the previous section the glass industry creates number of safety and health issues compared to other industries, and in practice, achieving the safe and healthy workplace in the glass industry is big challenge (ILO, 2013). It seems to have higher incidents accident injury average than the similar industrial sector. A similar picture exists for fatal and major injuries (OSHA, 2009). The main occupational health and hazards exposures occurs during the operational phase of glass manufacturing projects (ILO, 2010). The major OSH hazards exposed in the operation phase include excessive Noise, Heat, exposure to chemicals physical hazards including ergonomics hazards such as posture and movement related (ILO, 2010). Apart of that the psychosocial and physical environmental impact as well for the employees in the glass manufacturing environment (Patel *et. al,* 2006).

The glass manufacturing process can be subdivided in to the several sectional operations such as batch house, Furnace Section, Hot End Section and the Cold End section, including other sections such as Mould manufacturing, Utilities and engineering, FG stores, Electrical and electronic department. Among all these section in the glass manufacturing operation taken place in the Hot End department in container glass manufacturing companies. Comparatively Hot end workers in the Hot

End section expose for numerous hazardous conditions compared to the other sectional workers (ILO, 2010).

The glass industry having issues in OSH and ESH as well, which occurring during the glass manufacturing phase in certain ESH concerns will directly impact over the OSH concerns as well (Patel *et. al*, 2006)

The most significant Occupational and safety hazards conditions exists during operation stages of the manufacturing process. In most of the cases, they are considered as hazardous to the employees working in the manufacturing environment.

2.7.1 Exposure to High Heat

The heat stress had been neglected in the most of the industries specially in tropical and subtropical countries as an occupational safety and health issue Extreme hot environments are common in industries like iron, steel, glass and ceramics, rubber, coke ovens, mines (OSHA, 2009).

Types of heat related illnesses and conditions in work environments.

- Heat Stroke
- Heat Exhaustion
- Heat Cramps
- Heat Syncope
- Heat Rash
- Rhabdomyolysis

The workers who work near the furnaces and hot machine and hot surfaces are commonly face Heat stress, which naturally occurring due to the hot climate is augmented for the workers (Rathod, Bhajia, Pandy, Katajade, Parikh, Chattarjee, 1989). Glass manufacturing having the same hot climate in working condition in work environment, some employees are subjected constantly to high hot environment during working hours (Rathod *et al*, 1989). Srivastava *et al*, 2000 stated that the most common issue in the glass industry human body can lead to heat disorders due to subject the employee to Convective of radiant heat gains from various sources. Burns, heat exhaustion, heat stroke and heat cramps are effect of direst exposure to high heat in working environment. The heat stress will reduce the efficiency, enhance fatigue, and thus increase the level of accident due to that (Srivastava *et.al* 2000).

The pervasiveness of consequence of heat stress in the present study is

- Heat exhaustion (28.1%),
- Heat cramps (22.0%),
- Heat hyperpyrexia (2.6%) (Patel, *et al* (2006).

There are similar to that reported by Patel, *et al* (2006). This shows out happening of heat stress among glass factory workers. Workers in Iron industry similarly subjected 15.9% of and workers in Ceramic industry 20.3% experienced heat cramps (Patel, *et al* (2006).

Bazroy, Roy, Sahai (2003) evaluate the amount of injuries in glass bottle manufacturing plant. They found burns 7.1%. In the study done by Patel, *et al*, (2012) found burns 27.7% as a direct effect of heat exposure. Most causative factor for the heat stress of elderly population is reduced capacity to acclimatize to altering temperatures conditions and chance of getting pre-existing chronic health conditions. The elders, even the person is comparatively healthy having low capacity or often do not function optimally of Thermoregulatory mechanisms. Rathod *et al*, (1989) studied physiological strain & thermal stress in the flat glass industry in Malaysia and noted that workers exposed to severe condition of heat stress during various stages of production. In addition, Rathod *et al*, (2010), evaluated the glass bangle industry in that the total 40.1% of workers in manufacturing section were affected with severe heat stress conditions. Also carried out a study in eight glass bangle plants in India and Pakistan to make quantitative estimations of heat stress on exposed employee in summer period they noted employees are exposed to severe heat stress during numerous operations in the manufacturing process. In that study, they have found 40.1% workers affected with heat stress condition (Rathod *et al 1989)*. They found furnace as a dominant source heat in the environment is from the of radiant heat comes out from the heating sources. The experiential WBGT (^{0}C) peaked 400 ^{0}C against the American Conference of Governmental Industrial Hygienists (ACGH), Threshold

Limits Values (TLVs) of 26.70C in front of I/S machine (Individually sectioned). At all parts in the manufacturing area WBGT surpass the TLV limits. Under this scenario it had concluded that high ambient temperatures prevalent in tropical and sub-tropical countries, thus the The American Conference of Government Industrial Hygienists (ACGIH) standards will not suit local situation driving to high WBGT index in terms of same work performed in cooler climates.

Table 2.6 - Screening Criteria for TLV® and Action Limit for Heat Stress Exposure

% Work	**TLV***				**Action Limits**			
	Light	**Moderate**	**Heavy***	**Very Heavy***	**Light**	**Moderate**	**Heavy***	**Very Heavy***
75 to 100% (Continuous)	31.0°C	28.0°C	N/A	N/A	28	25		
50 to 75%	31.0°C	29.0°C	27.5°C	N/A	28.5	26	24	
25 to 50%	32.0°C	30.0°C	29.0°C	28.0°C	29.5	27	25.5	24.5
0 to 25%	32.5°C	31.5°C	30.5°C	30.0°C	30	29	28	27

Source - ACGIH "2017 TLVs and BEIs" TABLE 2

Heat exposure occurs during the operation of melting process of the furnace and Hot End production operation and maintenance of furnaces or other hot equipment. Heat exposure is unavoidable OSH concern in the glass manufacturing process (Patel, *et al*, 2006). During furnace repairing, Melting inspection and emergency attendance time. The workplace, adequate ventilation and cooling air not available in adequate levels. Non-Shielded surfaces where worker proximity and close contact with hot equipment are the most common incident that would leading the employees subjected to high heat conditions lading to heat stress (Patel, *et al*, 2012).

In many industries using the heat as an energy source in their manufacturing process, in most of the cases the exposure level study had not been conducted in order to prevent the workers form the high heat exposure level in the working environments (The American Conference of Government Industrial Hygienists (ACGIH), 2001). In many of the glass manufacturing facilities are not having adequate facilities to get the heated air out from the working floor and poorly ventilated as a result of that the internal working environment accumulates with exhausted air with all dust and fumes with ionized air (NIOSH, 2009). This condition purely leads to the accumulation of intolerable heal levels in the production floors thus creating the employees heat related OSH issues and heat stress (Ramsey, Chan, Yi, 1983)

The American Conference of Government Industrial Hygienists (ACGIH, 2001), states heat stress as "The net heat load, to which an employee may be exposed" Heat strain is defined as "the complete physiological reaction resultant due to heat stress." Heat illness is mainly causing due to exposure for longer durations excessive strain on the body and is a highly variable human response to heat stress (Ramsey *et al*, 1983). As stated by Ramsey *et al*, (1983) "Always the environments having high heat conditions negatively effect on the workplace safety".

It has recognized the thresholds for illness in terms of core body temperature of a human body (ACGIH 2001). While these thresholds may be exceeded by some persons without ill effect, the application of these guidelines will ensure protection of workers and teams, as a single illness affects the safety of the entire rescue crew. The threshold limits of temperature leading to loss of judgment and reaction time is 38 °C (100.4 °F). At a core temperature of 38.6 °C (101.5 °F) and above, physical heat strain has begun and, if not treated, will progress to acute heat illness and eventually the life-threatening condition of heat stroke (ACGIH, 2001). Deep body temperature (Core temperature) increased up to 39°C in controlled conditions (NIOSH, 2009), unless it is not controlled the subsequent resultant effect will be a heat stress even when their core temperature reached 38°C - 39 °C. In the core temperature reached 40 °C - 41 °C the heat stroke may occur (NIOSH, 2009).

2.7.1.1 Importance in metabolic rate

The body core temperatures are more closely related to metabolic rates of humans since the heat is produced in proportion to the work rate. But external temperature absorption exclude of work originated will subsequently cause heat stress as the body is unable to control the situation exceeding the threshold limits (Nielsen, 1967) The metabolic work rates defined by ACGIH directly impacts to the body core temperatures to be increased as the heat produced internally as the exertion increases (ACGIH "2017). Selection of work category in the table 2.7, that showing the workload using the examples as a guide. If heavy workloads planned in a day using the heaviest workload activity to determine the estimated metabolic rate (MRt). The workers exposure will exceed the TLV or AL without controls (ACGIH 2017).

Table 2.7 - Metabolic Work Rates

Category	Metabolic Rate (Watts)	Examples
Rest	115	Sitting
Light	180	Sitting, standing, light arm/hand work and occasional walking
Moderate	300	Normal walking, moderate lifting
Heavy	415	Heavy material handling, walking at a fast pace
Very Heavy	520	Pick and shovel work

Source - ACGIH "2017 TLVs and BEIs" TABLE 3

2.7.1.2 Effect on Cardiac output

Work under the severe heat conditions cause in a competition for cardiac output. As less blood is returned to the heart due to vasodilatation of the blood vessels in the skin (NIOSH, 2009). The blood, not only taking oxygen to the muscles but it is also working as a cooling fluid. As a result, heart rate increases to sustain the same cardiac output and at a sub-maximum work rate, thermoregulatory necessities override the working muscle’s oxygen demands. Accordingly, heart rate rises during heat stress compared to the same work rate in neutral conditions. This difference drops as VO2 nears maximum (Shepherd and Webb-Peploe (1970) cite work by Rowell (1974). The condition of this heat-induced increase in heart rate is taken as cardiac beats or thermal drift.

As stated by Meyer and Rapp (1995) below mentioned industry workers are at risk of heat stress NIOSH (2009) and Rodhal and Guthe (1988) stated that WHO also included a review of their own work: ·

- Glass manufacturing plants;
- Drying process of glass-wool
- Potash, Coal, gold mines,
- Steam and compressed air tunnels.

- Conventional and Nuclear power plants –
- Iron, steel, aluminium and other non-ferrous foundries and smelting operations.
- Brick-firing and ceramics processes- Plants producing rubber and rubber products.
- Utilities including Electrical generation (particularly boiler rooms)

2.7.2 Exposure to Noise

Noise during glass manufacturing process is one of the major OSH concern in this industry. NIHL (Noise induces Hearing Loss) is a characteristic occupational illness in this industry, particularly for glass-container manufacturing. In the glass-container forming process, in the Mould cooling process it creates a huge noise in the processing areas, this may create significant noise emissions. The noise level from glass-pressing machines can be as high as 100 decibels or more, possibly causing hearing impairment. Recommendations for preventing and controlling exposure to noise, including the use of hearing protection and other PPE, were discussed in the EHS Guidelines (NIOSH, 2009).

2.7.2.1 Occupational Exposure to high indoor noise levels

Excessive noise is commonly encountered as great variety of OSH hazard (Burroughs, Dennis, Ladran, Ismail, Balla, Ashoor, (1981). In the most manufacturing environments, more than 70% of the high noise exposure occurs (Saleha, Laura, 2011). Long-term exposure to noise at work places causes hearing loss called NIHL (Noise Induced Hearing loss). In addition remedies have successfully reduced noise levels in many work environments, noise is still a common OSH hazard, and noise induced hearing loss is one of the major occupational diseases worldwide (NIOSH, 2001).

Hearing loss is the 10 leading occupational diseases in both Canada and the United States. In United States, approximately 11 million workers are exposed to hazardous noise levels in the work environments. In Sweden about 9% of the total work force is exposed continuously to a hazardous noise level (NIOSH, 2001). According to the Burroughs *et.al* (1981) “Even though an effective practice of occupational health and hygiene has yet to be fully accepted and developed in Saudi Arabia as in the other developed countries only few studies have been conducted to investigate the occupational hazards, such as noise, and its health effects on the working population". In Malaysia, Hearing Conservation Programme (HCP) was introduced under Noise regulation 1989. However, after more than four years of noise regulation enforcement, the industries' compliance towards HCP is still unknown (Saleha *et al*. 2011). Cost of occupational accidents is enormous. The Canadian compensation board estimated the average cost per hearing loss claim to be C$ 14,000 and in the United States, compensation for hearing is estimated at US$ 200 million for the calendar year 1990 (Burroughs, *et al*. 1981). There values are likely to be somewhat higher in less developed nations, where engineering controls are not use as widely (Cameron, *et.al* 1983). This is because occupational health in the developing world is largely a neglected concept where there very limited resources to enforce and enhance existing work place safety regulations (Mulanovich, Lescano, Gonzaga & Balazes, 2007).Occupational exposure to excessive noise level is still ignorance industries in developing and third world countries study as India (*Patel et. al*, 2006). Industrial noise in Pakistan.

Table 2.8:- Allowable daily exposure to varying noise levels

Noise Level in dB (A)	**Allowable Daily Exposure (Hours/Day-5 days/week)**
90	8
93	4
96	2
99	1
102	0.5

(Source:-Amarasingha, 1998)

2.7.2.2 Noise Exposure health Effects

The basic disability due to noise is damage in the auditory system (Burroughs, *et al*. 1981) in addition the noise creates the stress condition in the mind and the physiological wellbeing of an individual thus the noise effects on the other type of body functions as well (Laura, 2011).

2.7.2.3 Noise induces hearing loss (NIHL)

The NIHL effect on the physiological damage on exposure to industrial noise is sensor neural hearing loss caused by prolonged exposure to noise (Saleha *et al*. 2011,). This OSH issue is commonly known as Noise Induced Hearing Loss/ NIHL (Herath, 1990) which is commonly bilateral (Palmer K, Coggon D, Griffin MJ, et al, 1998)). The NIHL will cause inner ear damages due to oxidative stress as well as mechanical trauma in the organ of corti depending on noise (Mulanovich, Lescano, Gonzaga & Balazes, 2007).

According to the Burroughs, *et al*. (1981) “occupational settings there are two basic types of NIHL which are caused by as 'acoustic trauma' or gradually developing NIHL”

Since in the ancient times relationship between excessive noise exposure and hearing loss has been recognized (Amarasinghe, 2009). Collectively results of such studies have been derived that occupational hearing loss resulting from exposure to high noise levels depends not only on exposure time but also on the Frequency, intensity, the type or noise (continuous, or impact) (Burroughs *et al*. 1981). The noise induce hearing loss impact on the auditory mechanism in the ear having a considerable impact with the age levels of the employees (Laura, 2011). In addition to occupational noise and aging, other factors may also induce the NIHL like gender, non-occupational noise exposure, exposure to ototoxic drugs or chemicals and genetic disorders contributes susceptibility and progression of NIHL (Laura, 2011). As stated by McBride & Williams (2001), “Exposure to broad band steady noise or noise with an impulsive component, the first sign was a dip or notch in the audiogram maximal at 4 kHz with recovery at 6 and 8 kHz. Although 4 kHz is the classic frequency affected, the notch may be noted elsewhere because where the cochlear damage occurs”.

NIHL affect on all ages and demographics. Not only NIHL primarily affects adult working population but also NIHL can be identified in the adolescent and young adult population as well. According to the Walkmans and I-pods the incidence of NIHL in young adults can be happened due to exposure to noisy music night clubs and conserts.

As stated by Cameron *et.al* (1983) “Unfortunately, there is no medical treatment for NIHL; there is only prevention”

2.7.2.4 Tinnitus

This disorder is known as both temporary and permanent hearing loss from noise, as well as other types of sensoneural hearing loss. (Cameron *et.al*, 1983). This often referred to as a ringing in the ears (Herath, 1990) and is a sign that the sensory cells in the inner ear have been irritated and is often a precursor to NIHL and therefore an important warning signal (Suter, 1998).

2.7.3 Exposure to respiratory hazards

The respiratory hazards are known to be the most frequent hazard in the glass industry due to the environmental factors like the silica dust, air born respirable silica dust, hydrocarbon fumes (ILO, 2010).

2.7.3.1 RCS - Respirable Crystalline Silica

The exposure to the extreme dust levels will definitely casing occupational respiratory diseases as well associated health problems. Occupational lung disease are basically resultant side effects of inhalation of dusts gases vapours (Amarasinghe, 2009). The dust are generated while the solid matters are broken in to pieces and it gives fine particles, which float in air called as Air borne (Herath, 2002). Dust is a resultant of grinding, drilling, blasting, milling, and crushing. All these kinds of dust can be either organic or inorganic in nature. Coal dust, Silica, Graphite, Asbestos are examples for inorganic dust, animal originated dusts, and Vegetative dusts are known as Organic dust. Most hazardous thing is the inorganic dust.

Exposure to respirable crystalline silica (RCS) fine airborne dust affects workers in handling, mixing and transporting raw materials to the glass furnaces. According to Glass Alliance Europe (2014), around 10% of the glass industry workforce is exposed to RCS, or a maximum of 100,000 employees in the European Union. Over the last ten years, some cases of workers with the disease of silicosis have been reported in the glass industry in Europe (ILO, 2010). Glass Alliance Europe considers that these cases reflect working conditions and exposure in the past, which are no longer prevalent. Control of Substances Hazardous to Health Regulations 2002 (COSHH). There were 95 cases of silicosis in 2007 and 85 in 2008 reported from the UK Industrial Injury (ILO, 2010).

OSH risks in glass process operations related to the presence of fine airborne dust particles due to the sand processing silica dust, feldspar, Calcite grinding and Dolomite. The mixing operations in the batch. The certain glass industries use of Quartz for special purpose. Final product get in high glazed perfumery packaging bottles create a high risk of quartz air borne dust particle, which are similarly hazardous like asbestos. In addition, the some toxic compounds like lead oxide sulphur dioxide nitrous oxide, Carbon monoxide and carbon dioxides are resultants of fossil fuel burning in the furnace combustion operation (Patel *et. al,* 2006). The smoke rising in the mould lubrication compounds are prominent, the most of the mould lubricants contains the high amount of sulphur level to get the more releasing properties where the lubricant combust in the mould blowing operation and the emitted high sulphur dioxide levels to the environment (IFC, 2012). Particulates originating of lead crystal during process can reach a lead content of 20% - 60%. Some special glass-manufacture processes may generate high levels of HCL, HF, arsenic, antimony, and selenium in the workplace (Arthur, 2009).

2.7.3.2 Silica Sand related OSH diseases

Sri Lanka is a country rich with all industrial minerals and deposits, the glass industry requires silica sand as its preliminary ingredient, the silica sand deposits are well spread in Marawila- Naththandia and Madampe areas in the north western province of Sri Lanka (Fernando, 1991). The total area covered by Silica sand is approximately 1000 Hectares (Fernando, 1991).

Silica dust created by cutting grinding drilling crushing or disturbing siliceous material. These dust particle can easily spared through the wind and can be long time suspended in the air, which will finally settled in a surface after taking considerable time. These air born dust particles, responsible for the health hazards in the industries where they use Silica sand as raw material like Glass industry (SHE, 1988).

2.7.3.3 Silicosis induced by Respirable Crystalline silica dust

According to Martin (2005) “this lung disease caused by inhalation of line silica dust; the dust causes inflammation and then scarring of lungs. It is one type of pneumoconiosis and it can occur from inhaled Silica, asbestos, coal beryllium and other respirable dusts”. This caused by inhalation or crystalline silicon dioxide and is one of the top occupational disease recorded since history. (Greenburg, 1998)

History of Silicosis is believed to be the oldest form of pneumoconiosis. The term was first used by Visconti in 1870, but this had already in ancient Egyptian and Greek mummies. Hippocrates also described observing breathing difficulties in metal miners and the condition was also seen in the sixteenth century in miners in Bohemia and in eighteenth century stonecutters. (Greenburg, 1998) Then in early 18th century Mr. Bernardino Ramazzini (1633-1714) has mentioned, "When the bodies of such workers are dissected, they have been found to be stuffed with small stones." (Diseases of Workers, De Morbis, Artificum, Diatriba, 1713) and it might be the first written document of silicosis.

The current world scenario the Silicosis is responsible for death of 28 employees in 1993 & 10 in 2008 in UK (Health & Safety Executive, 2011). even currently three million people are exposed to silica sand in Europe and 600,000 employees in UK itself UK (Health & Safety Executive, 2011), in eh USA more than 121,000 employees in industries had exposed to high concentration of crystalline dust of respirable silica of 0.05 mg/m^3 or more in 1993, (Linch *et al*, 1995). Any way the Silicosis result in death of young adults of age 15 – 45 years, due to intense exposure levels.in china more than 500,000 cases reporting and out of those 24,000 deaths are reported (WHO Silicosis, 2000). In Brazil, the gold miners more than 4500 workers are reported with acute condition of Silicosis and between 1978 to1998 (Murray, Coetzee, Back, Banyini, Ross. 2002). In South Africa high intensity of Silicosis identified in 1975 – 2007 it is increment of 5% to 29% (Murray, *et.al*. 2002).

2.7.3.4 Types of Silicosis

2.7.3.4.1 Acute Silicosis

Acute silicosis, onsets within months to 5 years of heavy exposure to free silica, particularly in sandblasting workers. Development is normally rapid, with cough, rapidly developing breathlessness, weight loss, respiratory failure and early death (survival is around 10 years) (Robelo, 2009).

2.7.3.4.2 Accelerated Silicosis

Accelerated silicosis is clinically apparent 5-10 years following first exposure to heavy concentrations of silica. It shown the conditions of chronic silicosis in clinical, histological and imaging terms, differentiated only by a rapid development. Inflammation, scarring and symptoms progress faster in accelerated silicosis than in simple silicosis. Major symptom is shortness of breathing (Robelo, 2009).

2.7.3.4.3 Chronic Silicosis

Chronic silicosis is the more common form of presentation (Filho, 2006) and clinically apparent around 15 years following exposure to free silica with low particle doses. It onsets insidiously and is initially asymptomatic with mean patient survival of 40 years (Brown, 2009).

2.7.3.4.4 Chronic Simple Silicosis

Chronic simple silicosis usually has progressive breathlessness on exertion and chronic cough, which begins as a dry cough that later becomes productive. Chronic complicated (Robalo, 2009).

2.7.4 Occupational Exposure to Refractory (Ceramic) Fibre (Glass Wool)

In the glass industry it widely using refractory fibres (Glass wool) for insulation purposes the Exposure of rats to ceramic fibres by inhalation caused benign or malignant lung tumours in rats of unspecified sex (IARC 1988). The induction of benign and malignant lung tumours following inhalation of ceramic fibres was confirmed in rats (adenoma, carcinoma, and histiocytoma). It observed in hamsters (adenoma and carcinoma) too. The routes of potential human exposure to ceramic fibres include ingestion and dermal contact; however, the primary route of exposure is inhalation during their usage in processing area without having proper safety applications, manufactured mineral-fibre products release airborne respirable fibres during their production and use. The upper-diameter limit for respirable fibres is considered to be 3 or 3.5 µm. In three refractory ceramic fibre manufacturing facilities, about 90% of airborne fibres are determined to be respirable (< 3 µm in diameter), and about 95% are less than 50 µm long (NIOSH 2009). It projected that 31,500 workers potentially are exposed to refractory ceramic fibres during their manufacture, processing, and end using glass industry, of whom only about 800 are involved in the manufacturing process (Brown T, (2009).

2.7.5 Respiratory hazards due to Emissions

Glass industry is one of the industries, which using high load of hydrocarbon fuels and coal as they primary sources of energy in melting glass (EIA, 2000). In recent technological advancements, the glass furnaces using electrical energy for boosting and smoothening the melting process and capacity increase in low capacity furnaces (Crova, 2014). Employees are subjected to a wide range of dusts, gases, vapours, smoke or fumes that each can possibly give growth to one or more respiratory diseases. Chronic obstructive pulmonary disease (COPD) is one of the critical causes of death worldwide (Meldrum, 2005) (Rabe. 2007). Approximately 15% of asthma and between 15% and 20% of COPD cases are thought to be due to occupational exposures (Balmes *et al*. 2003; Driscoll *et al*, 2005). However, the estimate for COPD may understate the risk for non-smokers, with a recent Swedish study attributing 50% of COPD cases in non-smokers to occupational exposures (Bergdahl *et al*. 2004).

3.7.6 Abrasive blasting (sand blasting)

The major source of exposure to particulate matter in abrasive blasting. A forcing stream of abrasive material with high speed towards a surface using compressed air in order to clean surface. The glass industry uses “Glass Beads” as abrasive agent for cleaning the glass molds and machinery parts. The emission of particulate matter to free environment is possible in the absence of dust filtration system. One of the main hazard in abrasive blasting are dust particles less than 5 microns. The most glass mould manufacturers using lead and lead based alloys in glass mould manufacturing due to ease of handling (Patel *et. al*, 2006). The free metal particles contain lead can emit as form of dust during sand blasting.

The inhalation of dust contain toxic compounds, eating food items contaminated with toxic compounds, ingestion/ absorption through the mouth is possible in this context.

2.7.7 Emissions & fumes

Some toxic gases are emission through the combustion of propane and oxygen with mono-nitrogen oxides (NO_x), Carbon Monoxide (CO), and Carbon Dioxide (CO2). NO_x gases can cause flu-like symptoms at low levels, and death can occur at extremely high levels (Schoor, et al, 1976). The common symptom of high exposure to too many mono-nitrogen oxides can be experienced with metallic taste in mouth followed by a headache and respiratory disorders. Under the sever conditions, the Mono-nitrogen oxide exposure can lead to death. Carbon monoxide is not noticeable or detectable to humans at dangerous levels (Schoor, et al, 1976). It is formed in reducing-flames &. Carbon monoxide detector with a digital read out needed as the gas is colourless and odourless. Among the key symptoms of carbon monoxide poisoning are headache that gets progressing to worse with excessive exposure. Under the sever conditions the headache will evolve into drowsiness, fatigue, nausea, vomiting, and eventually death (Schoor, et al, 1976).

Table **2.9** showing the industrial standards and benchmark levels of the emissions and effluents (WBG, 2007) these are developed as guidelines values in industrial benchmark levels to be controlled in industrial standards well-maintained appropriately designed production facilities. In case of under normal condition or in troublesome conditions the glass production facilities surpass limits (WBG, 2007)

Table 2.9. Air emission levels for glass manufacturing

Pollutant	Units	Guideline values
Particulates natural gas and other fuels	mg/Nm^3	100a 50a
SO_2	mg/Nm^3	700–1,500b
NOX	mg/Nm^3	1000
HCL	mg/Nm^3	30
Fluorides	mg/Nm^3	5
Lead	mg/Nm^3	5
Cadmium	mg/Nm^3	0.2
Arsenic	mg/Nm^3	1
Other heavy metals	mg/Nm^3	5c

Good operating conditions of the furnace and adoption of primary measures can achieve emission levels of 100 mg/Nm 3700 mg/Nm 3 for natural gas firing. 1500 mg/Nm 3 for oil firing 1 mg/Nm3 for selenium.

Monitoring and measurement of emissions of hazardous emission in the glass manufacturing industry should follow against the internationally published guidelines (WBG, 2007) and threshold levels include the threshold limits (TLV) occupational guidelines on exposure limits need to be taken as benchmark levels for setting the industrial norms (ILO 2010).

2.7.8 Physical Hazards

The glass working-environment is considered as high-risk physical hazardous area where the process it generates broken glass pieces known as cullet on floor cut injuries of legs and the hand are at high rate (Arthur, 2009). The slippery floor cause falling and the working in height, sharp pointed surfaces.in addition the eye injuries caused by the glass particles, in contact with mould lubricants, and hot end coating fluids are at top rated accidents and physical injuries happening in the glass industry (ILO, 2010).

- Potential eye injuries due to inclusions of glass particles accidently in to the eye
- Severe cutting injuries by the sharp edged glass pieces.

2.7.8.1 Cut injuries in glass industry

A comprehensive study was carried out in the glass manufacturing facility in Pondicherry in India in order to study the trend on accidents of container glass manufacturing facility (Rastogi, Gupta, Hussain 1992). It had observed that the trend of accidents are quite high and severity is considerably high at night (Bazroy *et al,* 2003). The study carried out in the Jan to Dec in 1998, a total of 3377 accidents had been reported during this time, whereas that amount is quite high as of the balance part of the year (Srivastava *et.al* 2000). The main reason for this is the incremental trend in production capacities and during this period the work refresh rate is considerably high, thus the operations.

The results of the analysis showed as a higher number of injuries was recorded in the first half of the night shifts and the second half of the other three shifts. Injuries are higher in the second half of the week and throughout the first half of the year. The widespread type of injury was cuts and lacerations (50.1%); injuries to the eye (due to foreign bodies, chemicals and welding sparks) claimed for 30%, sprains 8% and burns 7.1% of the injuries. Most regular sites of injury (40.6%) are the Hands and wrists, whereas the eye 30%,, foot 14.6%,, ankles 10.6% and other body parts 4.2% had injuries (Bazroy *et al,* 2003).

2.7.9 Ergonomics hazards

The term of ergonomics is derived from the Greek two words ‘‘Ergon’’ means (work) and ‘‘Nomos’’ means (laws). Otherwise ergonomics accurately giving the meaning of “the laws of work” (Murrell, (1971) Sluchak, (1992). Defined the ergonomics as factors of humans, determine human behavior, limitation during the working, capacities, abilities, and other uniqueness to the plan of machines , systems, tools, ,work patterns, targets, surroundings, and place of work for safety comfortable, productive, , and effective involvement of the employees (Chapanis, 1985; Sanders and McCormick, 1987).
Ergonomics are three main areas (Karwowski and Rodrick 2001),

- Physical Ergonomics – deals with physiologic and anthropometric aspects
- Cognitive Ergonomics – metal and physiological status (Vicente, 1999).

- Macro Ergonomics - organizational ergonomics (Karwowski, 2005).

Excessive number of literature is available for OSH with respect to workers suffering from disorders/ NCDs (Piedrahita, Oksa, Malm, Sormunen, Rintamaki (2007). Solomonow (2004) studied about the ligaments as a causative factor as a neuro-musculoskeletal disorders resultant trough the subjecting to activities related to occupations.

Creep, tension-relaxation, hysteresis, sensitivity to strain rate and strain/load incidences are revealed to result not only in mechanical functional degradation further in the progress of sensory-motor disorders with short term- and long-term implication on function and disability.

Foglemana and Lewisb (2002) recognized dangerous features in relation with the self-reported musculoskeletal discomfort in a population of video display terminal (VDT) operators. A cross-sectional epidemiologic study was carried out by Piedrahita *et al*. (2007) to find out the connection between musculoskeletal symptoms and cold exposure in a large-scale glass processing company in Colombia.

The glass manufacturing industry is considered as heavy industry which having high impact to humans and environment. The working environment creates many of ergonomic issue to employees in the glass environment specially in hot end (Patel, *et al*, 2006).

- heavy weight lifting & Back Pains

heavy tools and equipment handling in the glass industry is a common factor. In most of the cases the I/S machineries having huge metal parts to be lifted to certain heights (Patel *et al*, 2006). Wrong postures and continuous working in heated environments caused mussel tearing and exhausting Akerstedt, & Landstrom, (1998). The core site of the body affected in most of the time is backside. Thus the back pain and long-term numbness in the back areas common types of disorders that can be found in the glass industry (Patel *et al*, 2006).

- Sprains of legs / Sprains of arms

This is mostly seen the slipping and tripping falls on floor the floor is dammed with oil as the glass industry is using the oils and hydrocarbons excessively and in most of the time the spillage on floor is obvious, under this condition the accidental falling and subjecting to Sprains of legs / Sprains of arms (Srivastava *et al*, 2000).

- Any of Numbness of body part after working
- Cramping / Stiffness/ of legs, arms
- Swelling of any body part during working
- Hospitalizations due to Ergonomic issues

The numbness and Cramping due to mussel exhausting, stuffiness swelling during working is common disorders in the glass manufacturing industry (Srivastava *et al*, 2000).

2.7.10 Electrical Hazards

The electrical hazards also a neglected hazard that can be exist in the hot end environment. the IS (Individually Sectioned) machines are fully controlled and run through the high voltage power lies and panel boards, distribution boards are abundant in hot-end working environment. The hot glass pieces can get in to a power lines, wire harness and can electricity leakage due to that (Patel, *et al*, 2006).

2.8 Control & prevention measures to reduce of Hazard in the industry

The glass industry is known as an industry comparable to other industries the generation of hazards are high. The glass melting volumes getting day-by-day increasing regardless of its hazardous conditions, in most glass manufacturing organization have taken control measures in protecting all known OSH concerns by the OSH professionals. Among the popular controlling approached PPE application are widely recognized (Srivastava *et al,* 2000). According to the International Labour Organization adopted a new mechanism in controlling and prevention of the industrial major hazards through a national and international framework all those need to be mitigate the consequences and proceed to formulation implementation, monitoring and controlling. In prevention of hazards in any of industrial environment is basically in 5 methods,

- Elimination
- Substitution

- Engineering controls
- Administrative controls
- PPE

These mechanisms also widely applied in the glass industry for minimization of hazards (Srivastava *et al*, 2000).

2.8.1 Types of preventive methods

2.8.1.1 Application of personal protective equipment

The wearing of protective clothing's and use of PPE (protective equipment) are critical in reduction in hazards reduction and reduction of impact of the hazard to the worker in any industry (Joel, 2007). In addition the management commitment in also playing a vital role in achieving this task (Joel, 2007). In the broader analysis of the incidents and accidents happen in many of the industries are due to the non usage of relevant personal protective equipment, non suitability for the purpose or non-providing the PPE to workforce as it incurred cost (Srivastava *et.al* 2000). As per the risk management, Code of practice (2007), The PPE shall use with other control measures in combinations for more effectiveness. As the PPE is not strong enough to control the source of the hazards (Cooper, *et al*, 2004).

The employee PPE in glass industry include,

- Hearing protection devises (Ear mufflers, plugs)
- Respirators face masks, air supported head covers.
- Protective eyewear goggles, glasses, face shields.
- Electrical non-conductive, hard sole safety shoes with toe guards
- Safety helmets.
- Heat resistant clothing's, Cotton uniforms, fire resistant clothes.
- Cut resistant heat protective gloves
- Heat protective arm guards

2.8.1.2 Fire protection

The fire protection system is essential safety component on the glass industry. It is categories in to mainly two parts

- Fire hydrant system
- Fire extinguishers
- Fire alarm system
- Sprinkling system

According to the Perera (2010), the main purpose of the main root causes of fire and reduction of loo of properties and human lives. In this case there are activate fire alarm system, call security and report location on a fire, shut the doors to prevent the spreading. The trained fire-fighters can use of fire extinguishers to extinguish the fire with many sources such as carbon dioxide extinguishers, water fire extinguishers, powder fire extinguishers. Foam fire extinguishers (Perera, 2010).

2.8.1.3 OSH programs

Health and safety programs are more effective as a mechanism of preventive methods (Joel, 2007). In the environment when the employees are more aware of hazardous conditions and preventive/ mitigation measures they are willing to practice the implied safety measures (Joel, 2007)). Further, the regular meetings held in the organizations are a good preventive mechanism in acknowledging the employees. Thus, help in preventing the OSH issues due to non-adherence to control measures (Hinze, 1988 cites Lin & Mill 2001, p.499). Safety training plays a part in OSH standards (Hinze, 1988 cites Joel, (2007), p.135). According the risk management code, introduced (2007) workers training programs and instructions effectiveness will improve the control of measures and applications of any safe work procedure.

2.8.1.4 Risk assessment and management

Concept of risk is to measure the potential losses can happen due to human activities (Lind *et al*, 2008). The risk is three categories.

- Likelihood
- Harmfulness
- Sources

The risk sources are potential factors that can cause a risk / hazards to the human life. The risk sources are examined through the Reason's (1997, cited Lind *et al*, 2008) categories of organizational accidents. These combinations shown in the figure 2.5 (Risk sources).

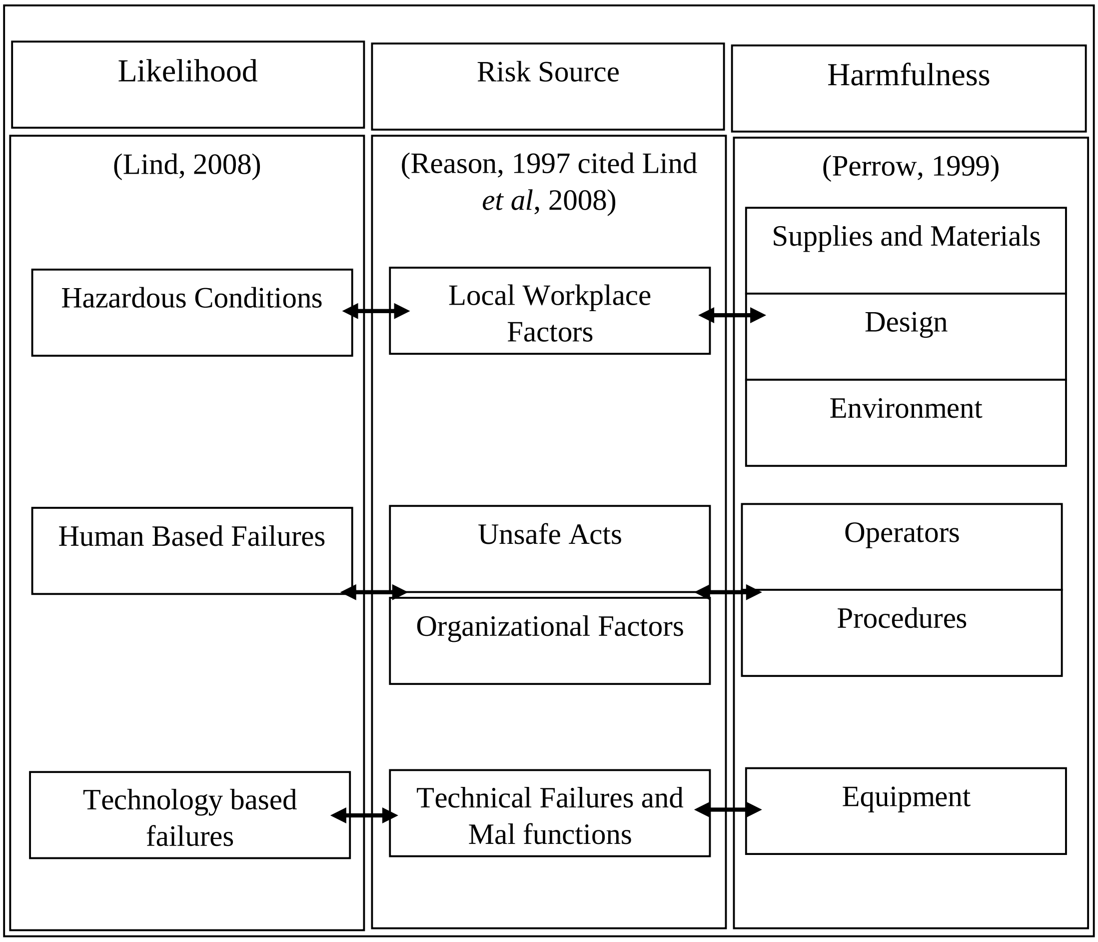


Figure 2.5 – Risk Sources

Management of risk is the final control measures and their implementations to eliminate or mitigate the risk in a system. Risk management system is very important in successful health and safety management (Cooper, *et.al* 2004)

The ideology of risk assessment is defined in the standards such as ISO 31010. ISO 45001-2018, ISO 14121 (1999), within three part process, which consist of hazard identification, risk analysis, and finally the risk management. This is shown in the figure 2.6.

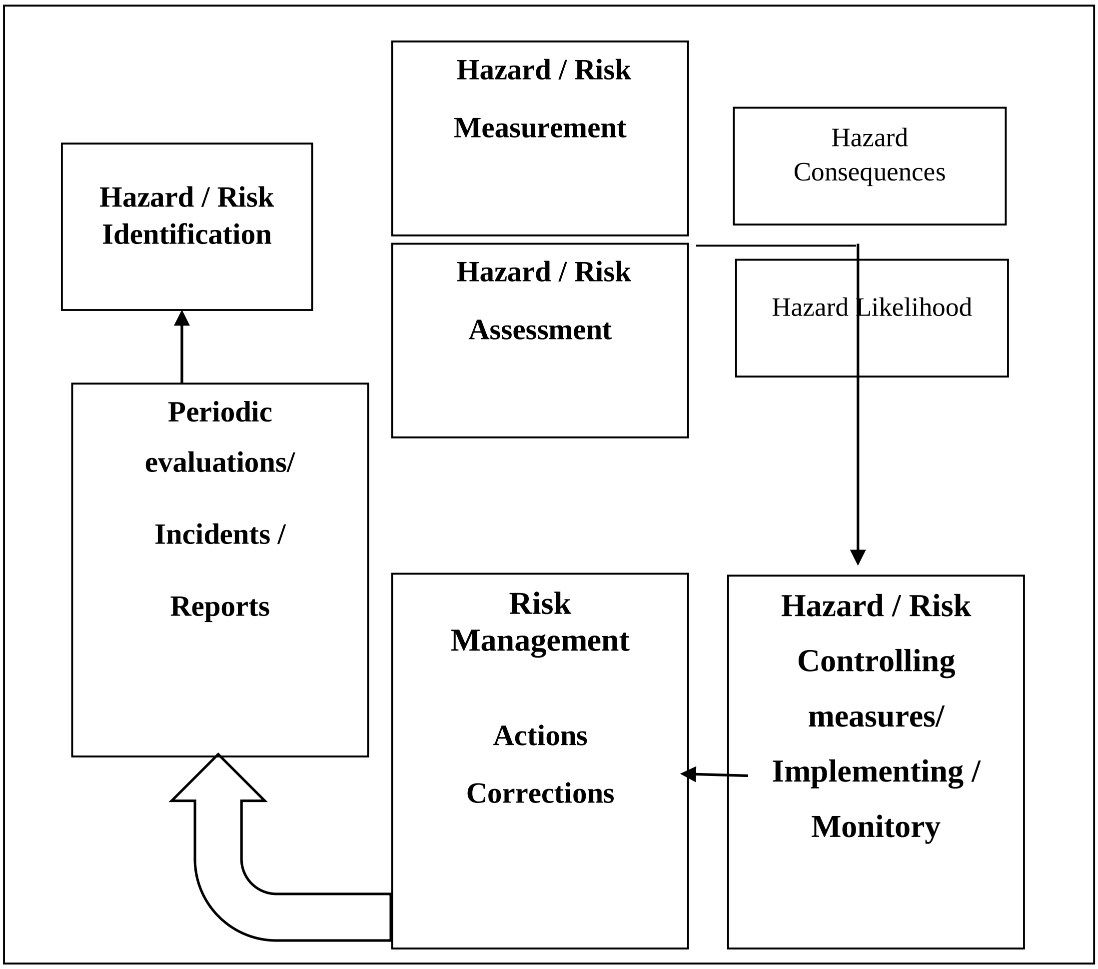


Figure 2.6: Risk Management process

CHAPTER THREE

3.0 Research Methodology

3.1 Introduction

Research is a collection of various focused approaches and dimensions (Naaranoja, Kahkonen, & Keinanen 2014) According to the Bogopane (2013), research methodology consist of population, information and sample pertaining to the study. A comprehensive literature survey was conducted in understanding the occupational safety and health hazards exist in the container glass manufacturing industry in globally. The study revealed out the depth of the issues that are possibly emerged as the health risk to the work force of the industry. Through this chapter, it mainly focuses on the research methodology followed by the study and its significance. Research design, data collection, data analysis and final evaluation & discussion planned under this section. Under this section, it will illustrate two sections called the methodology and research design. The theories that are used as a framework in relation with the hazards. In the glass industry in more boarder way for developing a safety framework in achieving the objectives. Chapters' main aim for developing a research methodology for best fit for the study. The chapter consists of the, population and sample data collection methods, data analysing techniques, Data presenting and validation.

3.2 Research design & Methodology

In the book of "when study research methodology, not only study of research methods" Kotler had well defined the term research methodology. According to Sachdeva, (2009) explained the research methodology as it is a reflection of rational behaviour of the research mechanism used in the study in analysing the current condition. It is a systematic process of that allows continuing of research. Kottler defined the research methodology as "when study about research methodology, not only study of research methods it is a broader study of rationality behind the research methods used in the background. Under this study the research methodology, initiate with identifying the research problem, literature survey, data collection, data analysis and conclusion according to the results. The depicting is shown in figure 3.1.

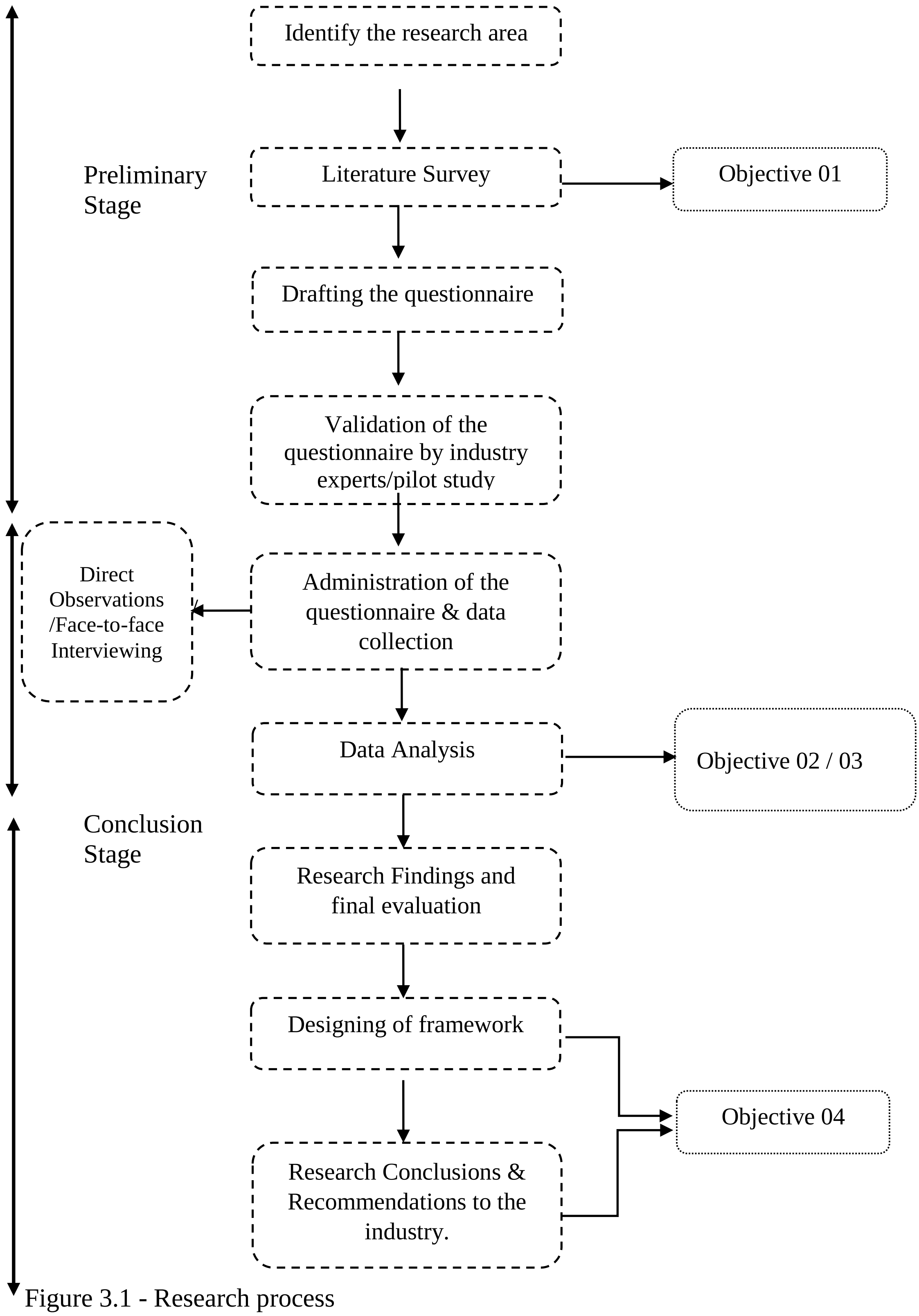


Figure 3.1 - Research process

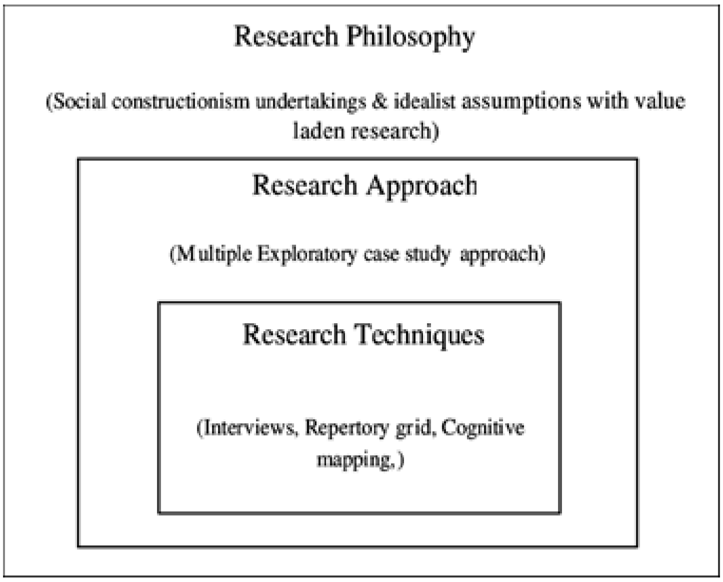


Figure 3.2: Nested research methodology (sources – Research design Qualitative, Quantitative. And Mixed Methods Approaches -SAGE)

Research design or any of research methodology was consist of following three key factors.

- First - Identify the research philosophy, in which it consist of belief on the ways in which data about a phenomenon need be collected, evaluated and used.
- Then identify appropriate research approach on theory building and evaluation.
- At last, identify the research techniques for data collection and analysis.

  In most of the cases, the results of the research will depend upon the research design.

Research design Qualitative, Quantitative. And Mixed Methods Approaches -SAGE)

3.3 Research design/ philosophy

A research philosophy was a confidence regarding the method in which data about a phenomenon need be gathered, evaluated and used. The terminology of epistemology (what is known to be true) that as opposite to the doxology (what is believed to be true) includes the numerous philosophies of research approach. Two key research philosophies had been recognized in science, namely positivist (sometimes called scientific) and the other one is interpretivist (also known as antipositivist) (Galliers, 1991).

The Research had planned a mix method of qualitative and quantitative, which based on positivistic model (Kraemer, 2002). The positivistic model adheres to the solely "factual" data gained through observation (the senses), as well as measure, is trustworthy. The part of the researcher was limited to data collection and interpretation in an objective way in the under positivism studies. Borrett, Sampson and Cavoukian, (2016) as stated, that the survey mechanism processes in primarily instrument in exploiting to examine the related evidence would collect in an organized and planned method and try to gather factual data to study the relationships between the facts and the relationship between the theories (Kraemer, 2002). The conclusion was based on the appropriate data evaluation and analysing. Research design protects the main parts, purpose of the study, research strategy and research approach.

As it very critical, the human involvement in the production process of the container glass industry. The study was mainly focusing on quantitative and qualitative mixed research designs in understanding how safety concepts are fit for the job role and will the practical safety initiative are in place or not. Through the quantitative approach, the data converted to measureable data. It could be used to get the comparison of factors of the research based on. It measured how the each individual would assist for the whole process in safety and health follow-ups and to what extent. The research targeted the worker level people those, who were having direct involvement with the critical production process in hot end. As the research, primary targ*et al*so was them.

The research data collection had done by primary data collection method of well-structured questionnaire. After determination of the sample size, the each person was given a well-structured questionnaire to be answered. The questionnaire consist of Likert Scale type of questionnaire, which enable the answering person to scaled down his/ her choice in a graduated scale with his or her preference. In analysing it, convenience to get it summarized. Further conversion in to statistical summary was more convenience than any other type. Then the all answers were tabulated by using excel sheet and summarized and get the average figures. Then all the summarized data collected using the questionnaires were edited for clarity and then frequency tables were drawn to show the results were analyse. The questionnaire used for gathering data is attached in **Appendix A.**

3.4 Scope of the study

The purpose of this research was to exploratory of the OSH background in the container glass industry, the study was further sought in development in the sound safety framework to the glass industry in the mode of safety framework.

The scope was limited to the Sir Lankan region mainly data gathering was done from local glass manufacturing facility. The study area covering only the Production department of the company, where it assess that the highest exposure to occupation health and safety issues by the employees. The cold end section employees also had part impact of the hot end condition but the extent of the severity was comparatively less in compared to hot end.

3.5 Research approach & Strategy

Research approach was how the research had been designed. The organized way to collect the data in achieving the research aim. As described in the earlier section the research was following the design of mix approach of qualitative and quantitative. In collection of data of the questionnaire is mostly utilized the quantitative approach and the during the interview the researcher followed the more qualitative discussion. The qualitative approach also adopted in focusing on its connectivity comparison between empirical observation and mathematical expression of quantitative relationships.

This research methodology was identified as the most appropriate approach in collection of data from a large group of peoples and collection of their responds, characteristics, actions or opinions in to a measureable and quantitative approach, which helped to achieve the research objectives finally. Further, the survey was a systematic way of collection of primary data of a population based on a sample selected. Thus it was mainly focused in capturing the characteristic of the total population but in case it was not an in depth evaluation of the total population characteristics. It was only a quick and efficient method of data collection (Tan, 2002).

Survey the research problem was continued through the methodology named research strategy. According to Dagnino (2014), "replying research questions in a methodical way views sustained through research strategy". Strategy used in this study was achieved by the fundamentally with a questionnaire (Mitchell and Jolley, 2013). As Maxwell (2013) stated "Questionnaire was to continue spread between to each and every single who continued selected on the study". The main advantage of a research like this was the capability of colleting huge number of respond from a population in a cost effective way. The research data will be precisely assisted by this mechanism (Borrett, Sampson and Cavoukian, 2016).

3.6 Population & Sample selection procedure

In general, the sample sizes used in qualitative research are not justified all the time (Marshall *et al*, 2013) even though researchers are concerned regarding applying & using the right sample size (Dworkin, 2012). Qualitative studies in general never target to approximation the magnitudes and generalize to a larger population, rather to assess pattern in a data set. The surveys can be either census or sample, whereas the census in considering the entire population and sample only a representation of it. However, the selection of sample for the survey will be a difficult task (Tan, 2002). In such cases, survey methodology of sample selection shall be done in a methodical and in this survey the sample selection and accuracy of the questionnaire was done through a pilot study.

The research was mainly focused on the occupational safety and health of the hot end workers of the container Glass industry. The container glass manufacturing facility in Sir Lanka, in which it consists of mainly two departments Production (Hot End) and the quality control (Cold End). In this study the population represent the direct production related employees those who directly subjected to manufacturing environment of the glass factory. The sample was designed to take only from hot-end department. As the Hot End employees' exposure to hazardous condition was comparatively high in the company. The study consisted of two categories of employees namely Hot End (Production Department) Senior Line In-charges (Line Forman), Hot End (Production Department) Junior Machine operators (JMO). The sample selection procedure was followed in selecting the employees and the questionnaire was distributed among them randomly. The total population of the hot end was 35, who directly in contact with the Hot End working environment and in this research the total sample population size selected was 32 according to the small sample selection formula given in the topic 3.7. This consist of 09 line in-charges and 23 JMOs. The qualitative analysis required only a smaller sample size when compared to quantitative analysis.

The distribution of questionnaires among the hot end staff was done randomly and questionnaire was administrated in full by the researcher, in a structured interview with face-to-face discussion.

3.7 Sample size determination

The sample size determination was done in accordance with the following equation the. The table for determination of sample size had been attached in **Appendix B.**

$$\mathbf{S = X^2 NP(1-P) \div d^2 (N-1) + X^2 P(1-P).}$$

S = required sample size.

$\mathbf{X^2}$ = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size.

P = the population proportion (assumed to be .50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05).

Table 3.1 - Population & sample selection table

No	Critical Path – sections	Operational total population	Total population	Total Sample size	% From total population	Proportionate Sample size
1	Hot End senior Line In-Charges	10	35	32	25.7%	09
2	Hot End Junior machine operators	25			65.7%	23

(Source - Small-Sample Techniques. The NEA Research Bulletin, Vol. 38)

3.8 Sampling limitations and controls

- In the literature survey in broadly discussing the OSH hazards in the glass manufacturing industry, the availability of literature are limited in Sri Lankan context. No empirical study had been conducted under this industry. Only one glass manufacturing factory exist in Sri Lanka, thus the questionnaire distribution & data collection will be limited.
- This study covers only Hot End department, Cold End and Quality Control, departments are excluded.
- The Study applicable only to the permanent employee carder of the company thus the impact of the OSH related conditions to the contractual cadre was not recorded and no empirical study will cover the hazardous conditions.
- The study excludes of the employee those who are with immediate recruitments (service < 6 months).

3.9 Data collection techniques and research analysis

Data compilation systems are to collect data to understand the scenarios and make the relationships in between the theories & actuals (Weller and Romney, 1998). Quinlan *et al*. (2015) designate that questionnaires, Interviews, document surveys, observatons, participation and studies continue two data collection techniques as examples (Tan, 2002). Borrett, Sampson and Cavoukian (2016) utter that “primary study was centered on scientific methods, philosophies, approaches and methods”. More on them stated that the questionnaires and surveys are the basic method of collecting of data, since in the studies the researchers are using open ended and closed-ended questionnaires and interviewed by preliminary data collection techniques.

This research used research techniues including Literatue survey, pilot study, Questionaire survey, structured interviews.

3.10 Literature survey

The literature survey basically derived from the research papers, Thesis, articals, journals available under common data platform. The research problem was derived through the literature findings under the contecxt of glass manufaturing industry and was used to get the basic answers to the follwing points.

I. Identify the occupation safety & health hazards in the container glass manufacturing inductry globally.

II. Identify the sources and causes of the health hazard in the glass manufacturing inductry.

III. Identify the preventive measures and recent devlopent in preventive mechanism in relaion with the glass manufca glass manufacturing inductry turing industry

The review furthermore extended for the reserch methodology and research problem was primerily based on the literature findings.

3.11 Pilot Study

A pilot study was kind of a mini-version of a full-scale study or a trial run done in groundwork of the comprehensive study. including questionnaires or interview schedules. (Compare Polit, *et al*. & Baker in Nursing Standard, 2002:33-44; Van Teijlingen & Hundley, 2001:1.) A pilot study was conducted in order to get the questionaire varification and identify the most frequent hazards identified in the literature survey prior to the questionnaire designing and distribution. As it should be evaluated with technical support, the pilot study was done among the hot end manager and most senior level managers who are having more than 10 years of experience in hot end conatiner glass manufacturing industry. Two pilot studies were done with the vise president and medical room incharge, who got participated voluntarily once at request. A questionaire critique sheet was distributed among the participants and collected the feedback in general,. All requested people got participated and according to the critique sheet feedback pattern of question with same meaning and language used was changed to get it more simplified , in order to understand the target set of employees to avoid any possible difficulties while answering the questionaire in addition further intervention of being independent answering rather than getting out side help during filling the sheet. The questioniaure critique sheet attached as **Appendix C**.

3.12 Questionaire survey

Detailed qustionare survey was a key part in any survey work, in terms of data collection close to real scenario. Since the questionaires are playing a vital role in any survey.This study finds data form the questionnaire based. The questionnaire consisted of 4 sections questions, all were following the Linkert scaled answeres which enable statistical process to be more easy. All the collected data was tabulized using MS Exel to get the numarical analysis such as summerization , sum, Averge. Within tabulize data It was used for the construction of Pie charts , Bar charts any other data representation methos.

The questionaire was basically constructed using likert scale mehod as described in Collis and Hussey (2003:184) where 01 is totally disaree and 05 where totally agree. The questions were turned into statements and the respondents were asked to indicate their level of agreement by checking the chosen box with an “X”. All the marked values were then be summarized in tabular form to the required analytical data.

Table 3.2 - Likert Scale

Subject Response	Scale
Strongly Disagree	1
Disagree	2
Neither Agree nor Dis-agree	3
Agree	4
Strongly Agree	5

3.13 Structured interviews

Structured interviews were conducted during filling the questionnaire and pilot study further identification of health and safety hazards in the hot end. The focus was to collect more data on the OSH condition and management support, which was not displayed

3.14 Distribution of questionnaire

The questionaire was distributed among the target population as printed sheet and face-to-face interview was done with rsearcher and questionnaire was administrated in full by the researcher, A translated questionnaire in to local language was used while filling the questionaire with the JMOs and line in-charges in order to get bettter understanding of the question in giving answer. The questionnaire was well explained before asking for the answers and mark the responcce with the agreement of the employee. After filling up the main questionnaire body the the replies given was explained again to the employee and get his signature to the quationnnaire.

3.15 Questionnaire structure

The questionaire consisted of 04 parts & 146 questions. **Section A** with demogrphic data compilation with 10 questions. **Section B** most frequent hazzards in identification awareness, commitment and adherence, of empoyee and company. Additionallly according to the evel of severity of eeach hazard consist of 36 questions. It was based on the Likert scale where all responds are converted to a quantifiable data, which allows data analysis to be more factual. **Section C** consist of general safety background of company consist of 06 questions. **Section D** was for the identification of causes & their significance to the hazards consist of 100 points to answer.

3.16 Data analysing techniques

Observations and recordings in the form of of data collection in a research activity was called as measurements (Base, 2002). The main objective of the data analysis was to find out the evidents of relationship and unerstanding the objectives.under this research it consisting of both quantitative and qualitative data. In this research qualitative anlysis was deployed for objective 01 and 02, whereas the objective 04 was focused on ranking the hazards with data analysis.

As described earlier the self structured questionaire distributed amoung the target sample population and all data was summerised in tabuler format using MS Excel software.

3.16.1 Relative Importance Index (RII)

The objective 03 was maily focused on ranking the OSH hazards in the hot end environment. In ranking and evaluation of the Likert scaled data can be done as shown in the table 3.2. The Relative Importance Index (RII) used in this reearch to rank the responds of the employees given in the form of Likert scale as of table no 3.3.
In this study the RII was used in ranking the most critical OSH hazards and rank the most critical causes of hazards.

$$\textit{Relative Importance Index (RII)} = \frac{\sum W}{A * N}$$

W – weighting of each cause by the respondent.

A – Highest weight (In this scale 05)

N - No of samples (In this study 32)

Table 3.3 - How to Evaluate –Likert Scale

0	1	2	3	4
Very Rarely	Rarely	Occasionally	Frequently	Very Frequently
Never	Seldom	Sometimes	Often	Almost always

3.16.2 Determination of level of significance

This research identified high critical hazards which were marked by the most of the employees. They were most critical to health and safety condition of the hot end employees of the contains glass manufacturing industry. In this result the RII values are coming in the range of **zero (0)** to **one (1)** the median value is **0.5**. The level significant was measured against the median values of the RII Whenever any range of values greater than the median value (>0.5) was considered as critical factor having high impact or high significance. The value less than the median RII value (<0.5) was considered as low impact or low in significance.

There are numerous types of data analyzing techniques for the likert scale data. In evaluating the central tendency in most of the cases the mean, median and modes were used as shown in the table no 3.4.

Table 3.4 - Suggested Data Analysis Procedures for Likert-Type and Likert Scale Data

	Likert-Type Data	**Liker Scale Data**
Central tendency	Mean/ Median / Mode	Mean/ Median
Variability	Frequencies	Standard deviation
Association	Kendall tau B or C	Person's r
Other statistics	Chi - Square	ANOVA. t-test, Regression

Source – Small scale research data analysis techniques

3.16.3 Percentage analysis

Most of the past researchers had used the percentage calculation for the analysis of the data of OSH hazards (Calvin and Joseph, Kong, 2009, Maclean, 1999, Phornthip, 2004 and Palihawadana, 2009). The main objective of the percentile calcualtion to obtain a evidence of relationship to help in understanding the objective of the study.

$$\text{Percentage of preventive methods} = \frac{\text{No of relevant "Yes" answers of Respondents}}{\text{Total \# of respondents}} \times 100$$

3.17 Validity & Reliability

The extent of validity of any research is more important as a reason of the outcome of aresearch results, conclusions and recomendations are based on the methodology of the research. Since the research without validity of the methodology was taken as imcomplete research. In evaluation the validity of the research it anlyze the validity of the operational measure in testing the theoritical concepts in this research. The validity was built on multiple data collection through questionaire, which was validated through a pilot study. A casual releationship built in estabilizing the internal validity, whereby certain conditions are linked with to another condition with analytical data and conclusions darwn within the context of the study.

In quantitative researches the external validity concepts is very important as the conclusions made by the research drived through the research findings can be generalized. It can be generalized to a wider population.

CHAPTER 04

4.0 Findings and Analysis

4.1 Introduction

This chapter discussed the findings of the study and analyse the findings comprehensively. The questionnaire, which utilised in gathering the primary data had been attached in the **Appendix A**. Health and safety hazards of the sample population, main causes for those and the preventive and remedial measures will be discussed in detail under this chapter. Local container glass manufacturing company will be the key study area in OSH related data collection. Sample population were selected and data collection done within this study area. In collecting the data from the industry a comprehensive questionnaire was used, where it validate with the pilot study before being used in the research. The questionnaire consisted mainly four parts. The elaboration of questionnaire structure had been given in the methodology chapter.

4.2 Pilot Study

Prior to the questionnaire delivered to the target group of employees the pilot study was conducted in validating the questionnaire and identifying the additional safety and health hazards in the hot end section in relation to the selected sample population. The pilot study questionnaire was given to senior 05 persons, who are having intensive knowledge in the business and the manufacturing operation.

The pilot study the key objective was to ranks the most frequent hazards occurring with high criticality and to more applicability of the questionnaire to the industry, readability and comprehensiveness was measured with the response given. Based on the pilot study 10 hazards were identified as most applicable and among them the 06 hazards areas were selected as they were most frequent to conduct the data collection in the study. All the hazards were taken in the section **D** of the questionnaire in cause's analysis. In objective achievement, three objectives aim to achieve through the data collection in questionnaire. Objective 01 was principally answered through the literature survey and the Objective **02** and 03 are based on the data analysis as findings through the structured questionnaire. Finally, the objective **04** was the outcome of the study, which based on all the data findings, analysis and the Literature survey. The questionnaire aimed to collect the OSH hazardous conditions of the hot end with their criticality and impact level. Finding the critical causes for each hazard was done through the RII (Relative Importance Index), percentage calculation tools. Further, it recommend the methods to improve the efficiency of the prevailing preventing methods using the percentage methods.

The primary data gathered from the questionnaire have been analysed through RII Relative Importance Index method and basic statistical methods. The total population of the hot end was 35. Out of 35 total population 09 was Line in-charges and 23 are of JMOs (Junior Machine Operators). The questionnaire was distributed among all target sample population. The target population was selected using small sample size determination table and formula as given in the Methodology Chapter under the section 3.7. All the responds from the sample population to the questionnaire was used in this data analysis. The questionnaire was administered by the researcher personally with face-to-face discussion & interviewing. In order to avoid the variation of questionnaire answering by the employee and to preserve the uniformity.

4.3 Data Collection

Data collection in this survey was basically in two methods. One was literature synthesis and other way was through a questionnaire give to the target population. The table no 4.1 showing the sample population selection in conducting the survey. Total sample population selected in this study was **32**, out of which the **23** was JOMs and **09** were Line In charges. The researcher administrated all questionnaires during the face-to-face discussion with each of survey participant. This allowed researcher to get the full view of the OSH status of the hot end and avoid the biasness of responses and extreme responding.

Table 4.1 – Sample population & the Responses to Questionnaire.

Area	Total Number Of population	Total Responded	As a percentage
JMO	25	23	92%
Line In-charges	10	9	90%
	35	32	91.43%

4.4.0 Questionnaire survey analysis

4.4.1 Introduction

The questionnaire consisted of questions on health and safety hazards commonly find in the glass manufacturing industry and adherence for the safety practices by the work environments. The questionnaire answering based on the "LIKERT" scale method. The likers scale status the issue or opinion and allowed respondent to mark his/her degree of agreement of disagreement to the statement or question. The degree of respondent value his reply. The Likert scale is very popular in the research questionnaires as it is very simple to make understand and to be understood. Another advantage is of the LIKERT scale is to get the qualitative data in to a quantifiable value and in the form of summed figure, which will help in evaluating the feedbacks in statistical approach. In the questionnaire. Four sections can be identified in the questionnaire. **Section A** was to collect demographic data of the sample population. **Section B** was to evaluate the most frequent & critical hazards, which had been validated through the pilot study existing in the hot end work environment and their adherence to the preventive methods by the employees and the company. **Section C** was for general safety background including systems and practices of the company. **Section D** was to evaluate affects and causes of most common hazards in the work environment as identified and ranked in the pilot study.

All data gather were entered to the excel workbooks and data analysis were done in fulfilment of objectives stated in the chapter no 01. To accomplish these aims several tools were used in this study. The "Relative Importance Index" (RII) method & Likert scale percentage method used. It derived most critical and serious hazards through the RII method and by RII ranking method it can it can be used to identify the significance of each cause and to reduce the level of impact.

4.4.2 Demographic data

4.4.2.1 Gender Distribution

In the glass industry worldwide employment of females significantly low in number. In the study, all the sample population consist only males.

4.4.2.2 Age Groups

In the sample population, the majority of the workforce consisted of middle age group from 28 to 48 years. the glass industry need to have an experience in working most of the case the majority of the line in-charges (66.6%) are over 48 years. The attrition level of JMO were comparatively higher than the line in-charge grade since the most of the JMOs were within the 18 to 37 age range. The middle age group contribute for highest respond rate and higher age groups were selected in this study group, as their exposure hazards and experience was comparatively higher than the JMOs. Since the validity of the responds will be comparatively high. The table no 4.2 showing the distribution of age groups of the sample population.

Table 4.2 - Age distribution of the sample population

Age ranges	Number	Percentage
18 – 27 years	4	12.50%
28– 37 years	7	21.88%
38 – 47 years	11	34.38%
48 – 58 years	10	31.25%

The Age distribution was shown in the figure 4.2. The most frequent age group was 38 to 47 years. Trend of attrition of the hot end JMOs and Line In-charges were minimum and recorded less than 1% for the last three consecutive years (Company Annual report 2017).

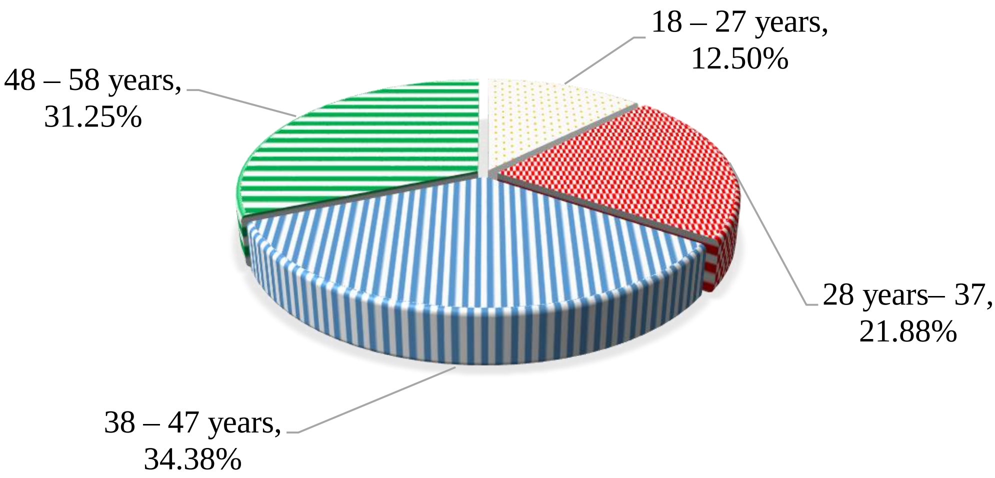


Figure 4.1 - Age categories

4.4.2.3 Work Area in the population

The population consisted of employees in the of main production area, JMO work on shift basis work in machines. Line in-charge had the ownership of the machine. 71.4% out of the total sample population were JMOs and 28.5% out of the total population were Line in-charges. The sample population, according to the work category shown in the table number 4.3.

Table 4.3 - Work categories in the research

Area of Work	Number	Percentage
Junior Machine Operators (JMO)	23	72%
Line In-Charges	09	28%

The figure 4.2 showing the classification of work categories participated for the research.

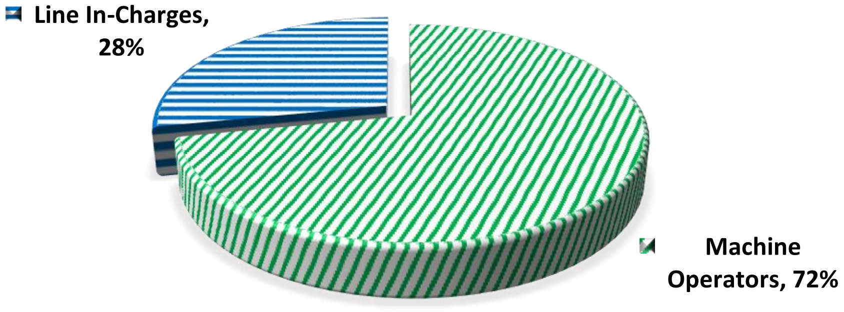


Figure 4.2 - Work area classifications and number of responses

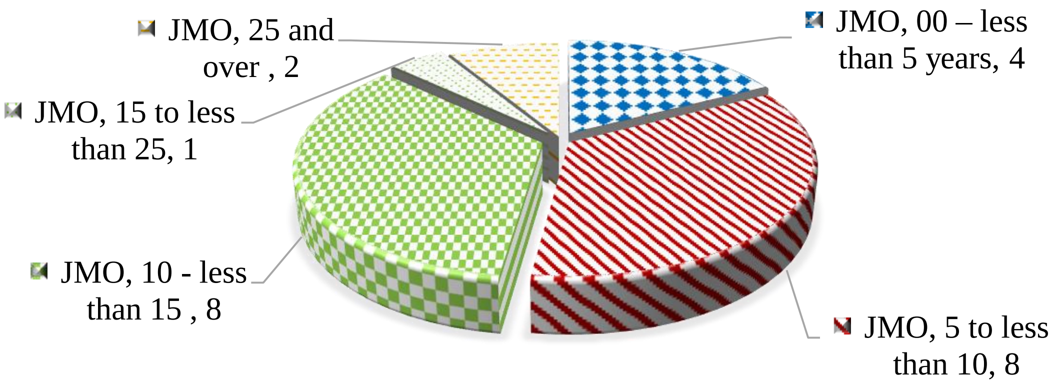
4.4.2.4 Work experience of employee in hot end

The sample selected randomly. It consist of 23 of JMOs and 09 Line in-charges. In the table 4.4 showing the service and work experience of the sample population. The work experience was very critical for the study.

Table 4.4 – Work Experience at the Hot End

Years	JMO	Line In-charge	Total
00 – less than 5 years	4	0	4
5 to less than 10	8	3	11
10 to less than 15	8	0	8
15 to less than 25	1	4	5
25 and over	2	2	4
Total	23	9	

The work experience of JMOs in work experience category years wise is shown in figure 4.4. The work experience of Line In-charge in work experience category years wise is shown in figure 4.3**.** The highest no of employees were recorded in 05 - less than 10 years of experience category'. Within this group, 08 JMOs and 03 Line In-charges had grouped. The second highest work experience category were recorded in 10 - less than 15 years of experience category'. 08 JMOs were recorded but no line In-charges under that category were recorded.



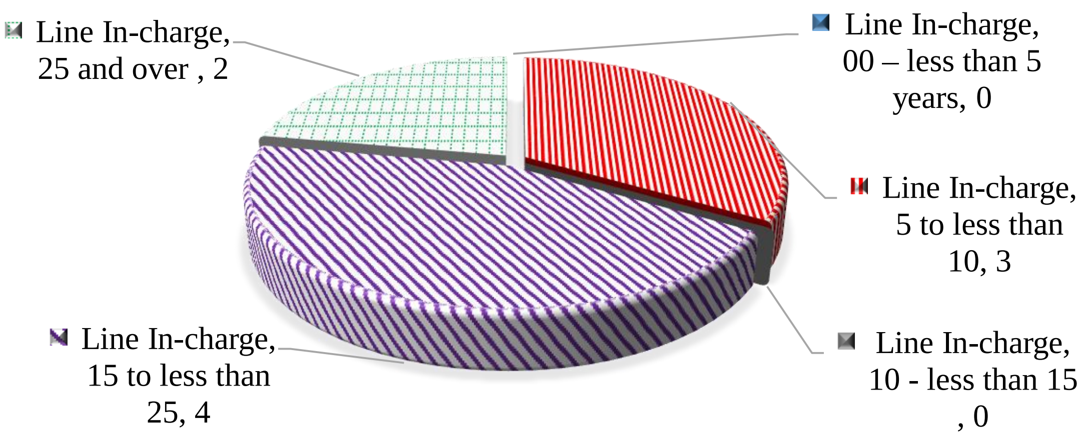


Figure 4.3 – work experience of JMOs & Line In-charge (L/I)

The table number 4.5 showing the combined tabulation of work experience vs. age categories (JMOs and Line In-charge). This will easy to identify the numbers distribution.

Table 4.5 - Age Vs. work experience

		Age				
Work category	**Work Experience**	**18-27**	**28-37**	**38-47**	**47-58**	**Total**
JMO	**00 – less than 5 years**	4	0	0	0	**4**
Line In-charge		0	0	0	0	**0**
JMO	**5 to less than 10**	0	2	5	1	**8**
Line In-charge		0	1	2	0	**3**
JMO	**10 to less than 15**	0	4	4	0	**8**
Line In-charge		0	0	0	0	**0**
JMO	**15 to less than 25**	0	0	0	1	**1**
Line In-charge		0	0	0	4	**4**
JMO	**25 and over**	0	0	0	2	**2**
Line In-charge		0	0	0	2	**2**
	Total	4	7	11	10	**32**

The Line in-charge employees were the most senior work category of the Hot End in this study. Out of the 09 line in-charges. In the figure no 4.20 showing the combined bar chart of work experience, the work categories and the age groups.

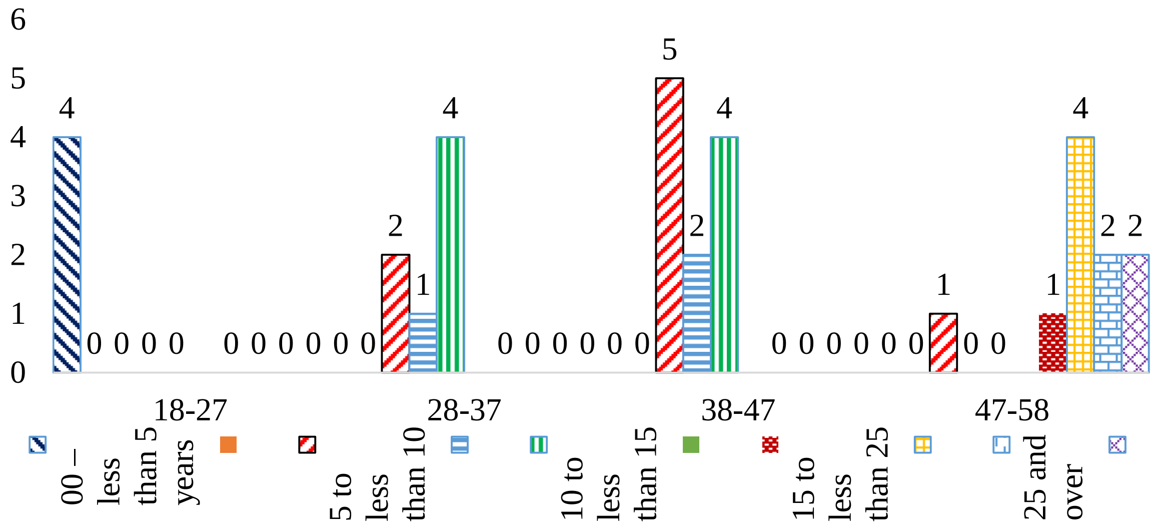


Figure 4.4 - Age groups and service experience

4.4.2.5 Maximum of sample population Education

The table number 4.6 showing the maximum education qualifications of the sample population. The majority was from GCE Advance Level and Ordinary Level educational qualifications, rest of the sample population diploma and degree level.

Table 4.6 – Maximum Education Level of the sample population

Maximum Education	JMO	Line In-charge
Grade 08	0	0
O/L, A/L	21	2
Diploma/ NDT Level	0	4
Degree	0	3

The same set of data had been depicted in figure number 4.5 according to the JMO and Line In-charge maximum educational levels.

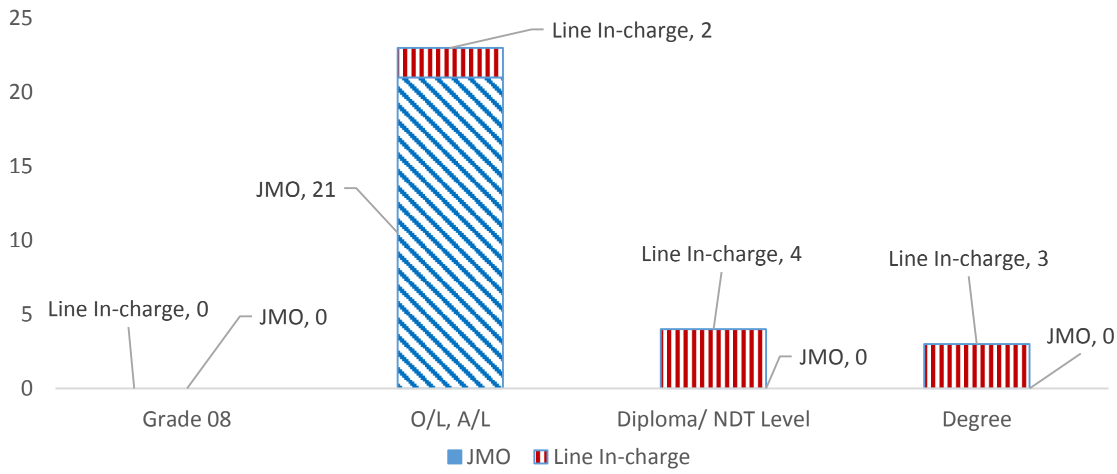


Figure 4.5- Maximum Education Level of the sample population

4.5. Occupation safety and health status of the sample selected

4.5.1 Hospitalization during working due to an accident

In this questionnaire, 03 peoples were hospitalized and shown in Table number 4.7. In this case, 02 hospitalizations were done as a result of cut and burn during the working time. third incident as a result of slipping and tripping on the staircase due to oily condition fourth incident due to moving machine part (Invert) hit against the right arm of a JMO. The data captured for 06 months (June 2018 to December 2018). The work category of the hospitalizations 03 were JMOs and 01 was Line- in-charge.

Table 4.7 - Hospitalization during working in last 06 months (June 2018 to December 2018)

	Status	JMO	Line- In-charge
Hospitalized for accident during working	Yes	3	1
	No	20	8

Out of the sample, population four incidents were recorded for hospitalization during working hours. Two incidents on Cut and burn injury. One incident on Slip and fall on floor and other one is due to machine part (Invert) hit against the left arm of an employee during swabbing the blank side. Figure 4.6 showing the details of hospitalizations.

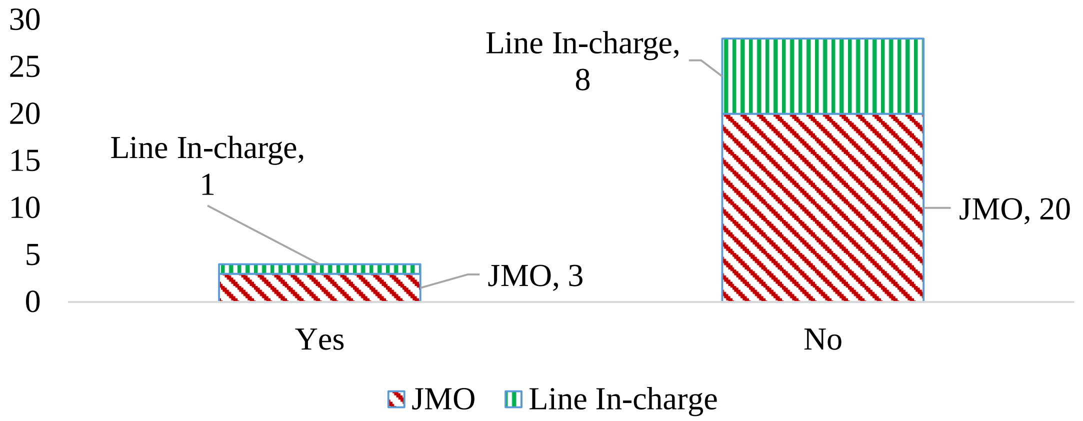


Figure 4.6 - Hospitalization during working

4.5.2 Suffering from Chronic Diseases

This question mainly aimed to distinguish the chronic diseases from, which the JMOs and Line In-charge suffering and to get the history. The Table 4.8 showing the data.

Table 4.8 – Chronic diseases suffering

		JMO	Line-In-charge
Suffering with any chronic health issue	Yes	3	0
	No	20	9

Out of 32 total sample population, 03 JMOs were suffering from chronic Asthmatic condition. As per the comment of the 02 JMOs, condition had started after joining with the company. The data is showing in the table number 4.9 They were currently using medical treatment to control the condition as per claim, the condition is getting worse when they exposed to hot end fumes of mould lubricating. The other JMO had the severe asthmatic condition (CPOD) even before join with the company.

Table 4.9 - Chronic Disease history

		JMO	Line In-Charge
if yes for Q 06	Before join with company	1	0
	After join with company	2	0

4.6 Evaluation of responses in relation to OSH condition of the factory

This section consist of critical health and safety hazards, which were commonly identified in the literature survey in the container glass manufacturing industry and validated through the pilot study. All the responses received and collected in using the questionnaire was tabulated and summarized by the researcher. The key focus was to find a relationship in supporting fulfilment of 02nd and 3rd objectives of the study. The following charts and table depicted the variables and the data relevance.

4.6.1 Responses in relation to the Noise & related hazards

The 1.1 to 1.6 questions was given in the questionnaire is focusing the noise and noise related hazards. The employee responses were cumulated to the response table no 4.10 with percentage analysis method.

Table 4.10 - Tabulated data on Noise Hazards (question number Q1.1 to 1.6)

	Q 1.1- Exposure to hazard		**Q 1.2 Medical treatment**		**Q 1. 3 Hospitalization**		**Q 1.4 Awareness**		**Q 1.5 PPE given**		**Q 1.6 PPE usage**	
Total	76	Total	56	Total	32	Total	81	Total	114	Total	120	
Mean	2.38	Mean	1.75	Mean	1.00	Mean	2.53	Mean	3.56	Mean	3.75	
S/D	0.75	S/D	0.72	S/D	0.00	S/D	1.05	S/D	0.91	S/D	0.67	
S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	
1	4	12.5%	13	40.6%	32	100.0%	4	12.5%	0	0.0%	0	0.0%
2	13	40.6%	14	43.8%	0	0.0%	14	43.8%	3	9.4%	0	0.0%
3	14	43.8%	5	15.6%	0	0.0%	9	28.1%	14	43.8%	12	37.5%
4	1	3.1%	0	0.0%	0	0.0%	3	9.4%	9	28.1%	16	50.0%
5	0	0.0%	0	0.0%	0	0.0%	2	6.3%	6	18.8%	4	12.5%
RII	0.475		0.350		0.200		0.506		0.713		0.750	

4.6.1.1 Level of exposure & severity - noise hazards

The Question Q 1.1 in the table number 4.10 raise on “I face difficulties with hearing after working”. The highest percentage of responses recorded were 43.6% that is occasionally and the second highest response is 40.6% is for rarely. 12.5% is confirming that there is no impact or very rarely, they feel the difficulty of hearing after working. One employee respond for the frequent category. The average of the all responds were 2.38, from which they confirmed their negative comment to the statement.

The Question Q 1.2 in the table number 4.10 aimed to evaluate the level of impact to the employee of the noise hazards. the question asked was “*I take medical treatment for my hearing loss (Mild hearing loss)”*. The highest response of 43.6% was responded as rarely and second highest response is 40.6% confirming they take medical treatment for the hearing losses very rarely or never. The average of all responds to Q 1.2 is 1.75, it is more closure to very negative feedback and confirming that no medical treatments for hearing related issue..

The Question Q 1.3 in the table number 4.10 is explaining more severe condition of noise related hazards, the question ask for the incidents of “*hospitalization on the hearing related issues during working time*”. As per the responds received, it is highly negative, 100% of employees confirming that there is no hospitalization for noise related issue.

There were some evident of existence of noise related hazards in the hot end working environment. However, it does not show a high severity condition like hospitalization.

4.6.1.2 Responses of Knowledge, adherence & prevention - noise hazards

The question Q1.4 in the table number 4.10 is raising the question of “*awareness of the noise related hazards*”. The highest responds recoded is 43.8% for rarely and second highest is 28.1% as occasionally. Under this question researcher taken this summed percentile of 71.9% as a negative response. The line in-charge category employee, who were having a higher education up to degree level, gave that feedback of 9.4% and 6.3% for frequently and very frequently respectively. The mean value is 2.53 where it will take as negative response.

The question Q1.5 in the table number 4.10 aimed to measure the commitment of the company on "*providing the Personal Protective Equipment (hereinafter known as PPE)*". The highest response received is 43.8% for occasionally and 28.1% was received for frequently as second highest number. 18.8% is agree to very frequent ranking and mean of all responds is 3.56, which will take as positive comment.

The question Q1.6 in the table number 4.10 "*I follow 100% safety practices on ear protection*" aimed purely on measuring the level of adherence to the safety practices in use. Highest level reported is 50.0% on frequently & 12.5% for very frequently respectively. Average of total response is 3.75, where is consider as a positive response. It seems more than 62.5% is fully complied on this. As per the responses give, the awareness level of noise related hazards were low among the employees. Company issues the PPE to the employees the level of adherence to the safety practices were minimum according to the certain responses.

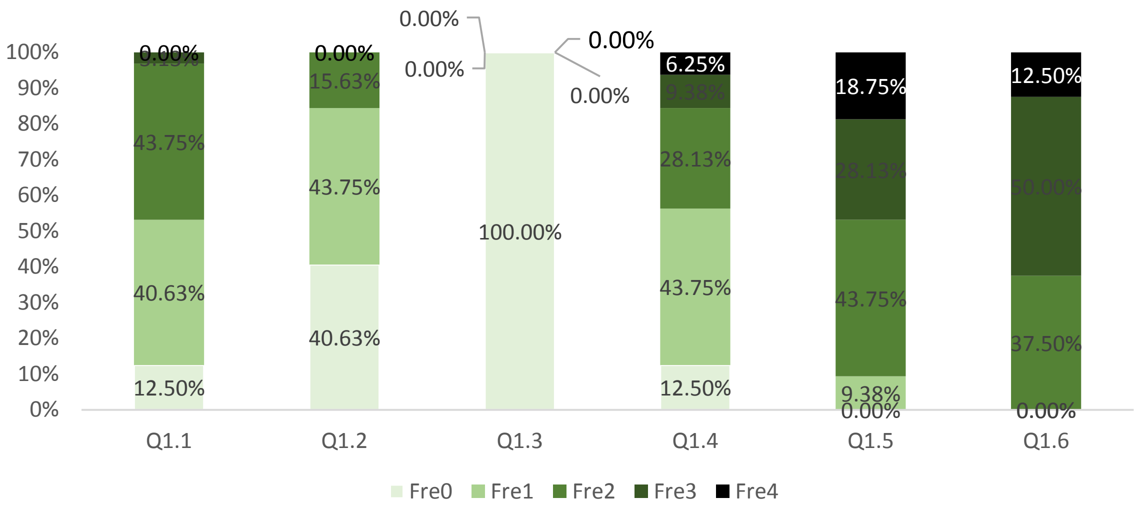


Figure 4.7 – Responses for noise hazards

4.6.2 Responses in relation to the - Burn injury Hazards

The 2.1 to 2.6 questions was given in the questionnaire is aiming burn injuries & related hazards. The employee responses were cumulated to the relative response table with percentage analysis method in below table number 4.11.

Table 4.11 - Tabulated data on Burn Injuries (question number Q2.1 to 2.6)

	Q 2.1- Exposure to hazard		**Q 2.2 Medical treatment**		**Q 2. 3 Hospitalization**		**Q 2.4 Awareness**		**Q 2.5 PPE given**		**Q 2.6 PPE usage**	
Total	124	Total	27	Total	6	Total	79	Total	125	Total	125	
Mean	3.88	Mean	0.84	Mean	0.19	Mean	2.47	Mean	3.91	Mean	3.91	
S/D	0.34	S/D	0.68	S/D	0.40	S/D	0.92	S/D	0.39	S/D	0.39	
S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	
1	0	0.0%	10	31.3%	26	81.3%	0	0.0%	0	0.0%	0	0.0%
2	0	0.0%	17	53.1%	6	18.8%	5	15.6%	0	0.0%	0	0.0%
3	0	0.0%	5	15.6%	0	0.0%	11	34.4%	1	3.1%	1	3.1%
4	4	12.5%	0	0.0%	0	0.0%	12	37.5%	1	3.1%	1	3.1%
5	28	87.5%	0	0.0%	0	0.0%	4	12.5%	30	93.8%	30	93.8%
RII	0.97		0.21		0.05		0.62		0.98		0.98	

4.6.2.1 Level of exposure & severity – Burn Injuries

The question Q 2.1 in the table number 4.11, raise on "*Minor Burnt injuries - superficial-first degree burning*. The highest percentage of responses recorded were 87.5% that is for very frequently and the second highest response is 12.5% is for frequently. Mean value is 3.88 & almost all (100%) is confirming that minor burn injuries are there.

The question Q 2.2 in the table number 4.11 raised on *"Burn injuries- Partial thickness burn"*. The highest response of 53.1% was responded as rarely and second highest response is 31.3% confirming for very rarely or never. The average of all responds to Q 2.2 is 0.84; it is more closure to very negative feedback and confirming that partial thickness burns are rare in nature.

The question Q 2.3 in the table number 4.11 is for "*deep partial thickness burn"*. As per the responds received, 81.3% confirming that it is very rarely and 18.8% saying that it is rare, mean value is 0.19 and it is very negative figure.

It is evident that minor burnt injuries are very frequent, whereas hospitalizations are minimum. In last year 02 JMOs were hospitalized for cut and burn injuries while working. Since the burn injuries can be considered as a very frequent hazard in hot end environment.

4.6.2.2 Responses of Knowledge, adherence & prevention on burn hazards

The question Q 2.4 in the table number 4.11 raised on "*awareness of the burn related hazards*". The highest responds recoded is 37.5% for frequently and second highest is 34.4% as occasionally. The mean value is 2.47 where it will take as negative response. The employees are not much aware of burn related hazards.

The question Q 2.5 in the table number 4.11 raised on "*providing PPE in prevention burn injuries*". The highest response received is 93.8% for very frequently and 3.1% for both frequently and occasionally. The mean value is responds is 3.91, which will take as very positive comment. The commitment of the company shows very good in providing PPEs to employees,

The question Q 2.6 in the table number 4.11 raised on "*I follow 100% safety practices on burn protection*" aimed purely on measuring the level of adherence to the safety practices among the workers. Q 2.6 get the same response as Q 2.5. Even though the protective equipment are given satisfactorily. The minor burn injuries are seems not controllable in working environment.

Burn injuries are also among the top hazards in the hot end working environment. Since the workers exposure level for the hot surfaces are with high probability. The prevention mechanism are not strong enough to control the hazard. Since the burn injuries are much more prominent in the hot end environment.

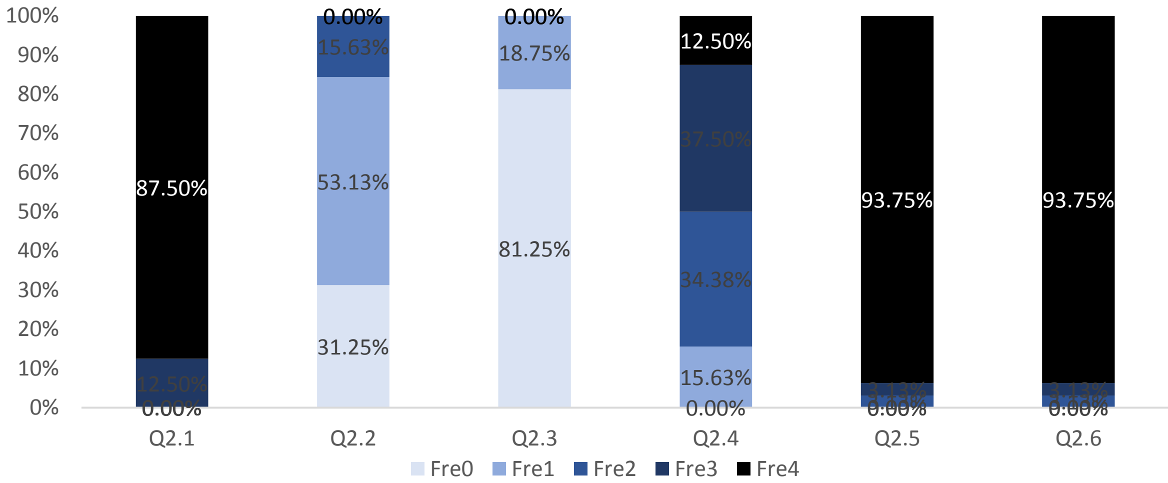


Figure 4.8 - Responses for Burn Injuries

4.6.3 Responses in relation to the - Heat Stress & Related Hazards

The 3.1 to 3.6 questions was given in the questionnaire is aiming Heat stress & related hazards. The employee responses were cumulated to the relative response table with percentage analysis method in below table number 4.12.

Table 4.12 - Tabulated data on heat stress (question number Q3.1 to 3.6)

	Q 3.1- Exposure to hazard		Q 3.2 Medical treatment		Q 3. 3 Hospitalization		Q 3.4 Awareness		Q 3.5 PPE given		Q 3.6 PPE usage	
Total	148	Total	94	Total	41	Total	101	Total	142	Total	151	
Mean	4.63	Mean	2.94	Mean	1.28	Mean	3.16	Mean	4.44	Mean	4.72	
S/D	0.49	S/D	0.62	S/D	0.68	S/D	1.02	S/D	0.56	S/D	0.46	
S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	
1	0	0.0%	0	0.0%	27	84.4%	1	3.1%	0	0.0%	0	0.0%
2	0	0.0%	7	21.9%	1	3.1%	7	21.9%	0	0.0%	0	0.0%
3	0	0.0%	20	62.5%	4	12.5%	14	43.8%	1	3.1%	0	0.0%
4	12	37.5%	5	15.6%	0	0.0%	6	18.8%	16	50.0%	9	28.1%
5	20	62.5%	0	0.0%	0	0.0%	4	12.50%	15	46.9%	23	71.9%
RII	0.97	100%	0.21	100%	0.05	100%	0.62	100%	0.98	100%	0.98	100%

4.6.3.1 Level of exposure & severity – Heat stress

The question Q 3.1 in the table number 4.12 raised on "*Heat stress conditions during working*". The highest percentage of responses recorded were 62.5%% that is for very frequently and the second highest response is 37.5% is for frequently. Mean value is 4.63 & almost all (100%) is confirming that heat stress condition are very frequent issue during working.

The question Q 3.2 in the table number 4.12 raised on *"Medical treatments due to Heat exhaustion*". The highest response of 62.5% was responded as occasionally and second highest response is 21.9% confirming for rarely or never. The average of all responds to Q 3.2 is 2.94; it is more closure to occasional condition and confirming that heat stress conditions are exist in the work place.

The question Q 3.3 The question aimed for identifying the hospitalization incidents due to heat stress in table 4.12. As per the responds received, 84.4% confirming that it is very rarely and 12.5% saying that it is occasionally, mean value is 1.28 and it consider as negative figure.

4.6.3.2 Responses of Knowledge, adherence & prevention on heat hazards

The question Q3.4 is to measure the "*awareness of the heat related hazards"* in table number 4.12. The highest responds recoded is 43.8% for occasionally and second highest is 18.8% as frequently. The mean value is 3.16 where it will take as positive response.

The question Q 3.5 in the table number 4.12 raised on PPE provide to employees in preventing heat stress. The highest response received is 50.0% for frequently and 46.9% for very frequently. The mean value is responds is 4.44, which will take as very positive comment.

The question Q 3.6 in the table number 4.12 aimed to measure the level of "adherence to the safety practices in preventing heat stress and related hazards. Highest response for 71.9% for very frequently and 28.1% for frequently. All find positive answers.

Heat stress seem the most frequent and highest RII scored hazard in the hot end. The heat related hazards in the working environment is more prominent in the glass this is mainly due to the high exposure to the hazard.

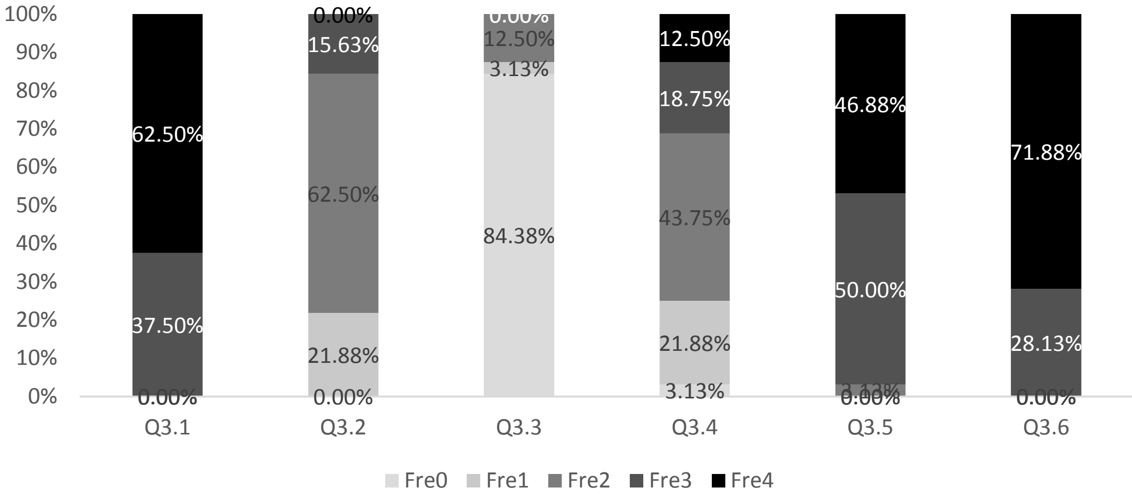


Figure 4.9 - Responses for Heat stress Hazards

4.6.4 Responses in relation to the – physical cut injuries

The 4.1 to 4.6 questions was given in the questionnaire is aiming the physical cut injuries and related hazards. The employee responses were cumulated to the relative response table with percentage analysis method in below table number 4.13.

Table 4.13 - Tabulated data on cut injuries (question number Q4.1 to 4.6)

	Q 4.1- Exposure to hazard		**Q 4.2 Medical treatment**		**Q 4. 3 Hospitalizatio n**		**Q 4.4 Awareness**		**Q 4.5 PPE given**		**Q 4.6 PPE usage**	
Total	106	Total	48	Total	50	Total	147	Total	148	Total	155	
Mean	3.31	Mean	1.50	Mean	1.56	Mean	4.59	Mean	4.63	Mean	4.84	
S/D	0.54	S/D	0.57	S/D	0.88	S/D	0.50	S/D	0.49	S/D	0.37	
S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	
1	0	0.0%	17	53.1%	21	65.6 %	0	0.0%	0	0.0%	0	0.0%
2	0	0.0%	14	43.8%	5	15.6 %	0	0.0%	0	0.0%	0	0.0%
3	23	71.9 %	1	3.1%	5	15.6 %	0	0.0%	0	0.0%	0	0.0%
4	8	25.0 %	0	0.0%	1	3.1%	13	40.6%	12	37.5 %	5	15.6 %
5	1	3.1%	0	0.0%	0	0.0%	19	59.4%	20	62.5 %	27	84.4 %
RII	0.97	100%	0.21	100%	0.05	100%	0.62	100%	0.98	100%	0.98	100%

4.6.4.1 Level of exposure & severity – Physical cut injuries

The question Q 4.1 in the table number 4.13, raise on “minor cut injuries during working”. The highest percentage of responses recorded were 71.9%% that is occasionally and the second highest response is 25% is for frequently. Mean value is 3.31 a positive number.

The question Q 4.2 in the table number 4.13, raised on “Moderate cut injuries”. The highest response of 51.3% was responded as very rarely and second highest response is 43.8% confirming for rarely. The mean value of all responds to Q 4.2 is 1.5; it is negative.

The question Q 4.3 in the table number 4.13, raised on identifying the incidents of hospitalization due to cut injuries. As per the responds received, 65.6% confirming that it is very rarely.

4.6.4.2 Responses of Knowledge, adherence & prevention on cut injury hazards

The question Q 4.4 in the table number 4.13, raised on awareness of the physical cut injuries & related hazards. The highest responds recoded is 59.4% for very frequently and second highest is 40.6% as frequently. The mean value is 4.59 where it will take as very positive response.

The question Q 4.5 in the table number 4.13, raised to measure the commitment of the company on providing PPE in prevention cut injuries. The highest response received is 62.5% for very frequently and 37.5% for frequently. The mean value is responds is 4.63, which will take as very positive comment.

The question Q 4.6 in the table number 4.13, raised on measuring “the level of adherence to the safety practices in use to prevent cut injuries. Highest response for 84.4% for very frequently and 15.6% for frequently. All find very positive.

Minor level cut injuries are ranked as high where as medical treatment level and hospitalizations are not prominent. However, in 2018 02 employees had been hospitalized due to cut and burn incident. Since cut injuries are also taken as prevailing hazard in the hot end environment.

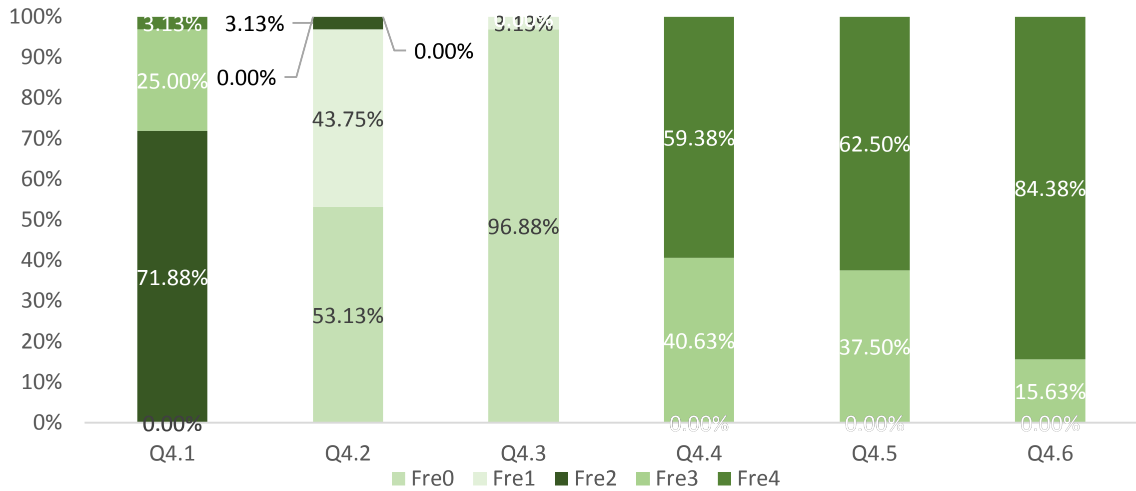


Figure 4.10 - Responses for Physical cut injury hazards

4.6.5 Responses in relation to the – Respiratory hazards

The 5.1 to 5.6 questions was given in the questionnaire is aiming the respiratory issues and related hazards. The employee responses were cumulated to the relative response table with percentage analysis method in below table number 4.14.

Table 4.14 - Tabulated data on respiratory hazards (question number Q5.1 to 5.6)

	Q 5.1- Exposure to hazard		**Q 5.2 Medical treatment**		**Q 5. 3 Hospitaliza tion**		**Q 5.4 Awareness**		**Q 5.5 PPE given**		**Q 5.6 PPE usage**	
Total	113	Total	54	Total	41	Total	113	Total	122	Total	128	
Mean	3.53	Mean	1.69	Mean	1.28	Mean	3.53	Mean	3.81	Mean	4.00	
S/D	0.84	S/D	1.18	S/D	0.63	S/D	0.72	S/D	0.78	S/D	0.62	
S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	
1	0	0.0%	22	68.8 %	26	81.3 %	0	0.0%	0	0.0%	0	0.0%
2	4	12.5 %	3	9.4%	3	9.4%	2	6.3%	0	0.0%	0	0.0%
3	10	31.3 %	3	9.4%	3	9.4%	13	40.6 %	13	40.6 %	6	18.8 %
4	15	46.9 %	3	9.4%	0	0.0%	15	46.9 %	12	37.5 %	20	62.5 %
5	3	9.4%	1	3.1%	0	0.0%	2	6.3%	7	21.9 %	6	18.8 %
RII	0.97	100%	0.21	100%	0.05	100%	0.62	100%	0.98	100%	0.98	100%

4.6.5.1 Level of exposure & severity – Respiratory hazards

The question Q 5.1 in the table number 4.14, raised on "*breathing difficulties during working"*. The highest percentage of responses recorded were 46.9%% that is frequently and the second highest response is 31.3% is for occasionally. Mean value is 3.53 a positive number.

The question Q 5.2 in the table number 4.14, raised on "*Medical treatments for respiratory issue"*. The highest response of 68.8% was responded as very rarely. The mean value of all responds to Q 5.2 is 1.69; it is negative.

The question Q 5.3 in the table number 4.14, raised on identifying the "*hospitalization incidents due to respiratory issues"*. As per the responds received, 81.3% confirming that it is very rarely.

4.6.5.2 Responses of Knowledge, adherence & prevention on Respiratory Hazards

The question Q 5.4 in the table number 4.14, raised on measuring the *"awareness of the respiratory hazards"*. The highest responds recoded is 46.9% for frequently and second highest is 40.6% as occasionally. The mean value is 3.53 where it will take as positive response.

The question Q 5.5 in the table number 4.14, raised on measuring the *"commitment of the company on providing PPE in prevention respiratory issues"* to employees. The highest response received is 40.6% for occasionally and 37.5% for frequently. The mean value is responds is 3.81, which will take as positive comment.

The question Q 5.6 in the table number 4.14, raised on measuring the *"preventing respiratory hazards"* aimed purely on measuring the level of adherence to the safety practices in use in table 4.14. Highest response for 62.5% for very frequently and 18.8% for very frequently as well occasionally.

The hazard condition the ergonomics are very critical and awareness and adherence to the right practices seen minimum among the workers. The factory-working environment is not supporting to ergonomics

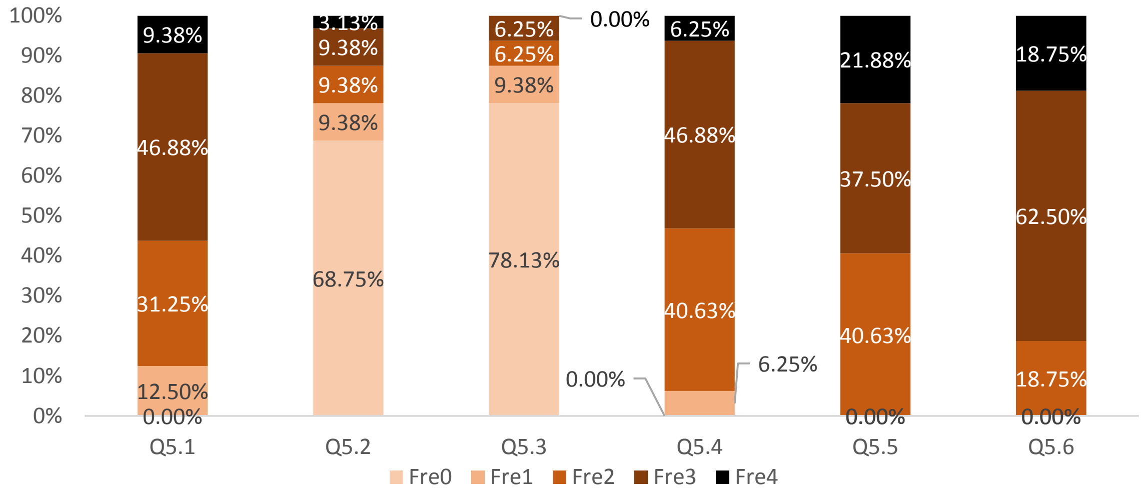


Figure 4.11 - Responses for Respiratory Hazards

4.6.6 Responses in relation to the – Ergonomics hazards

The 6.1 to 6.6 questions was given in the questionnaire is aiming the Ergonomics and related hazards. The employee responses were cumulated to the relative response table with percentage analysis method in below table number 4.15.

Table 4.15 - Tabulated data on Ergonomics Hazards (question number Q 6.1 to 6.6)

	Q 6.1- Exposure to hazard		**Q 6.2 Medical treatment**		**Q 6. 3 Hospitalization**		**Q 6.4 Awareness**		**Q 6.5 PPE given**		**Q 6.6 PPE usage**	
Total	139	Total	69	Total	33	Total	51	Total	71	Total	70	
Mean	4.34	Mean	2.16	Mean	1.03	Mean	1.59	Mean	2.22	Mean	2.19	
S/D	0.60	S/D	0.88	S/D	0.18	S/D	0.67	S/D	0.87	S/D	0.78	
S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	S/N	32	
1	0	0.0%	8	25.0%	31	96.9%	16	50.0%	7	21.9%	6	18.8%
2	0	0.0%	13	40.6%	1	3.1%	13	40.6%	13	40.6%	15	46.9%
3	2	6.3%	9	28.1%	0	0.0%	3	9.4%	10	31.3%	10	31.3 %
4	17	53.1%	2	6.3%	0	0.0%	0	0.0%	2	6.3%	1	3.1%
5	13	40.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
RII	0.97	100%	0.21	100%	0.05	100%	0.62	100%	0.98	100%	0.98	100%

4.6.6.1 Level of exposure & severity – Ergonomics hazards

The question Q 6.1 in the table number 4.15, raised on measuring the level of existence of "*Ergonomic issues*". The highest percentage of responses recorded were 53.1%% that is frequently and the second highest response is 40.6% is for very frequently. Mean value is 4.34 a very positive number.

The question Q 6.2 in the table number 4.15, raised on "*Medical treatments for Ergonomic issues*". The highest response of 40.6% was responded as rarely. The mean value of all responds to Q 6.2 is 2.16; it is negative feedback.

The question Q 6.3 in the table number 4.15, raised on identifying *"the hospitalization incidents due to ergonomics issues"*. As per the responds received, 96.9% confirming that it is very rarely.

4.6.6.2 Responses of Knowledge, adherence & prevention on Ergonomic Hazards

The question Q 6.4 in the table number 4.15, raised on *"awareness of the ergonomics issues"*. The highest responds recoded is 50% for very rarely and second highest is 40.6% as rarely. The mean value is 1.59 where it will take as very negative response.

The question Q 6.5 in the table number 4.15 raised on "*the commitment of the company on providing PPE in prevention ergonomics issues*".to employees. The highest response received is 40.6% for rarely. The mean value is responds is 2.22, which will take as negative comment.

The question Q 6.6 in the table number 4.15 raised on *"I follow 100% safety practices in preventing ergonomics issues*" aimed purely on measuring the level of adherence to the safety practices in use. Highest response for 46.9% for rarely and 31.3% for occasionally. It is to be consider as negative comment.

During the discussion with the hot end workers specially the JMOs, the awareness of the ergonomics issues were significantly low. This will be the most causative factor to get the ergonomics hazards to get the third place in ranking the most critical hazards in the hot end.

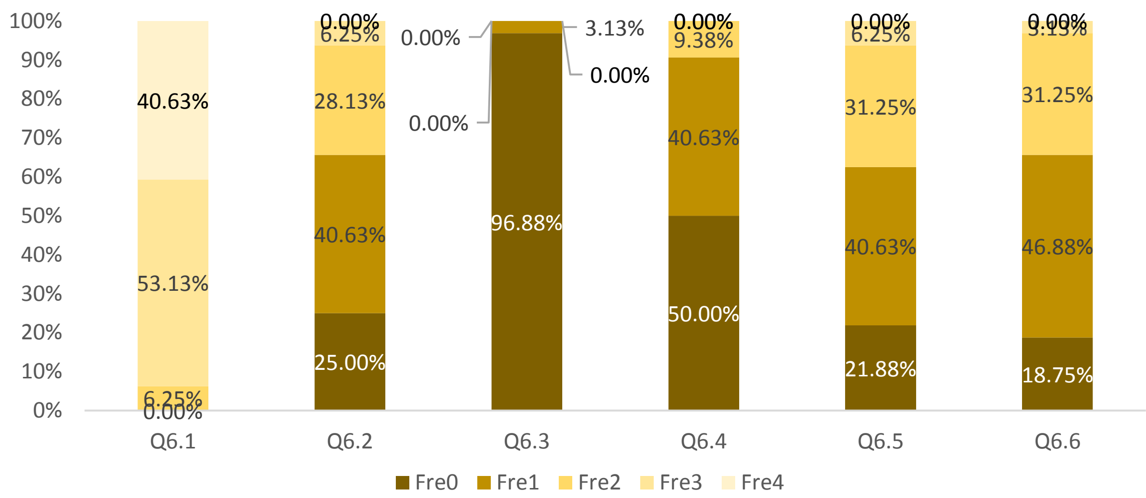


Figure 4.12 - Responses for Ergonomics hazards

4.7 Ranking of hazards with Relative Importance Index (RII)

The section is ranking the Occupational health and safety hazards identified during the study according to the response given by the employees to the questionnaire. According to the RII index, the hazards have been ranked according to the level of frequency and criticality. The employee responses were tabulated. The employees scaled the question according to the Likert scale. These values were summed to a table to get the final score value of the question. To calculate the criticality and probability of the hazards existing, the given values were transformed to Relative Importance Index value based on the formula. The formula explained in the chapter three.

4.7.1 Ranking the hazards according to severity

4.7.1.1 Severity level I – Exposure to hazard

This analysis represent the minor level of the hazard. It will, be a just exposure but with low impact to the employee. These incidents are taken as **none recordable incident (NRI) or None Loss time incident (NLTI).** In most of the cases these types of incidents are not recorded as incident, near miss or accident in the medical records of the company. Since the hazard will be categorized as criticality level 01. The As described in the chapter three, the each hazard category carries 06 different questions, out of which the first three will measure the level of criticality or the impact level to the employee. The table number 4.16 showing the Hazards of Hot End ranked according to the RII index.

Table 4.16: Hazards of Hot End ranked according to the RII index – severity level I

Ranking According To The Hazard Criticality Level I - Minor	**RII**	**Rank**
I had Burnt injuries (superficial-first degree) during working	0.975	1.0
I face Heat Stress during work (Mild heat stress condition)	0.925	2.0
I had Ergonomic Issus During Working	0.869	3.0
I had Breathing difficulties during working/ area is full of smoke.	0.706	4.0
I had Minor cut injury (FAI) (minor cut injuries)	0.663	5.0
I feel Difficulties of hearing after working (Mild hearing loss)	0.475	6.0

According to the data analysis given in the table 4.16, the burnt injuries ranked as highest as it is having RII value of 0.975. Under this, it considered and minor types of burn injuries. Second highest RII value of 0.925 is for heat stress condition during work specially during job change time or during accidental glass tuck during machine operation. Most of the JMOs are suffered under this condition. The criticality level 01 condition requires a rest under normal atmospheric condition for some time to recover from the condition (Srivastava *et.al* 2000). The third highest RII values of 0.869 is for ergonomics hazards during working. In most of the cases, the lifting of heavy objects like metal molds and machine parts during job change time and reaching the remote machine parts and awkward postures in and repetitive motions in machine running cause ergonomic issues. The most serious case is unawareness on right ergonomics by the employees that will be discussed in the topic of awareness and adherence. The fourth highest RII value 0.706 is with breathing issues during working in the hot end. In mould lubrication hydrocarbon based materials with high content of Sulphur, compounds are used. Each of machine section should be lubricated in 20 – 30 min gap where a machine is having 32 - 60 lubrication points, that will emit huge volume of flue gases rich with Sulphur dioxide (SO_2) and CO and CO_2, and NO_x concentrations will be much higher than normal. Long exposure will cause breathing difficulties (Abbasi, Fleming, 1988). The next RII 0.663 and 0.475 respective for minor level cut injuries and hearing short term hearing loss due to high noise.

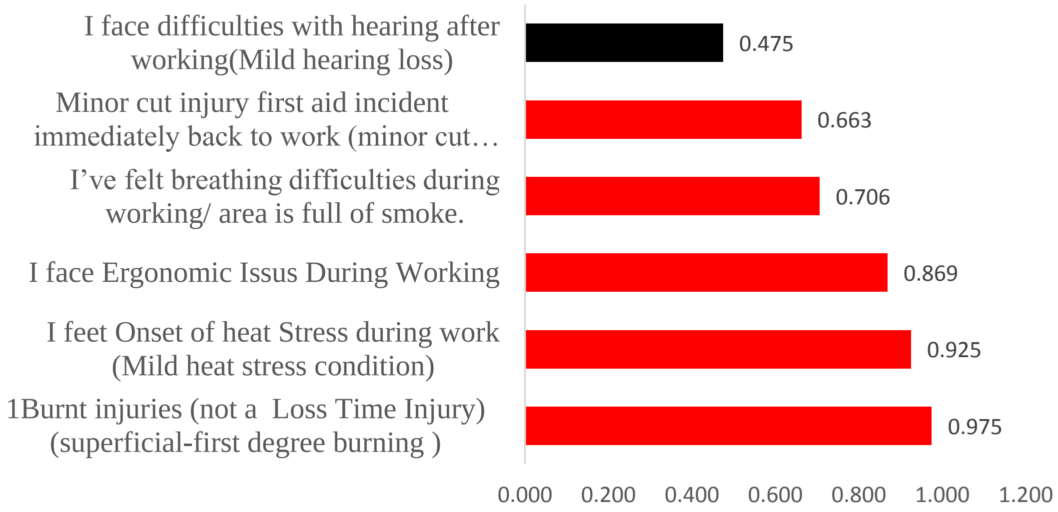


Figure 4.13: Hazards of Hot End ranked according to the RII index – minor incidents

4.7.1.2 Severity level II – Medical treatment

The second level is medical treatment incident but with incremental impact in comparison to the level 01 category. This cause Mid-level impact to the employee. These incidents are taken as Recordable incident (RI) or Loss time incident (LTI). In certain cases the medical treatment for 2-3 weeks under. Probably LTI incident. These kinds of medical incidents are most of the time recorded in the medical records and will be taken in calculation of Total recordable incident Rate (TRIR) or Total Loss Time Incident Rate (LTIR). This will be one of a KPI in the safety department.

Table 4.17: Hazards of Hot End ranked according to the RII index – severity level II

Ranking According To The Hazard Criticality Level II – Moderate	RII	Rank
I had medical treatments due to Heat exhaustion. (moderate heat stress condition)	0.588	1.0
I had medical treatment for ergonomic issue recently	0.431	2.0
Burnt injury Medical treatment 00 – 04 week medical leave (partial thickness burn)	0.369	3.0
I had Mild hearing loss medical treatment for my hearing loss	0.350	4.0
I had medical treatment for respiratory issue	0.338	5.0
I had Cut injuries (Moderate cut)	0.300	6.0

Under this the hazards ad been ranked according to the Mid-severity level in the table number 4.17. Which may need medical treatment or special attention in curing. In most of the cases the incident will be lost time injury (LTI) The RII value of 0.588 is recorded for moderate heat stress condition where it cannot be immediate recover by rest only. According to this research, the hot end employees' faces moderate heat exhaustion condition more frequently than other hazards. The second highest is ergonomic issues having RII value of 0.431. Burnt injuries where is need maximum 4 weeks to recover recorded as third ranked hazard in the hot end. RII values of 0.359, 0.350 and 0.300 are respectively on hearing loss need medical treatment, respiratory issues with medical treatment and cut injuries with medical treatment with max 2 weeks medical leaves. In comparison other than heat exhaustion other condition are less significant as RII values fall below the middle value of RII 0.500.

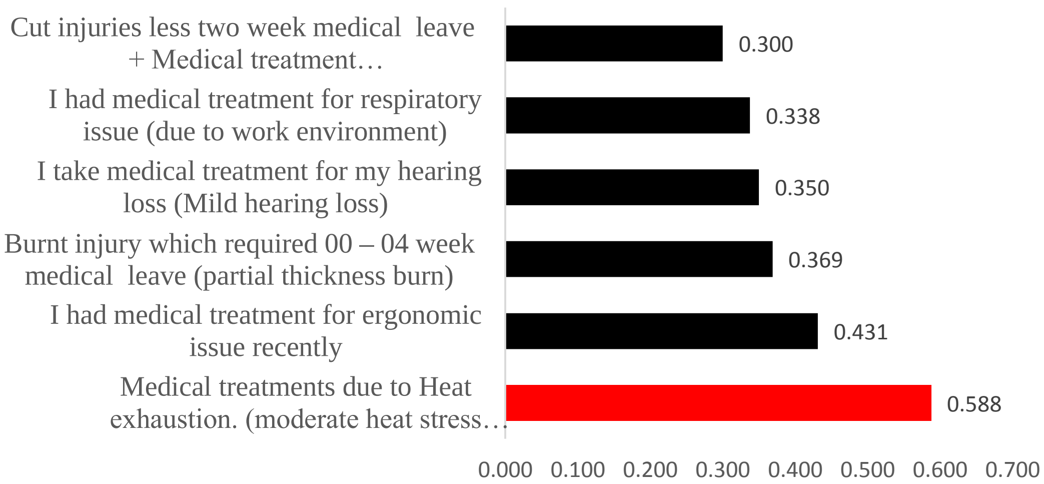


Figure 4.14: Hazards of Hot End ranked according to the RII index – Moderately critical incidents

4.7.1.3 Severity level III – Hospitalization

These incidents are taken as **Recordable incident (RI) or Loss time incident (LTI)** with elevated level criticality in compared to criticality level II. 100% these incidents are recorded in the medical records in the company. In certain cases the victim can undergo temporary disability condition, transfer to another department or light work employment after being recovered from the incident. The summary of tabulated data are shown in the table number 4.18.

Table 4.18: Hazards ranked according to the RII index – severity level III

Ranking According To The Hazard Criticality Level III - Critical	RII	Rank
I have been hospitalized for deep partial Burn injury / 04 weeks leave	0.325	1.0
I have been hospitalized for Severe cut injury/ 2 weeks medical Leave	0.313	2.0
I have been hospitalized for Heat Stroke condition (high heat stress)	0.256	3.0
I have been hospitalized for respiratory issues/ breathing difficulty.	0.256	3.0
I've been hospitalized for ergonomic issue / during working	0.206	5.0
I have been hospitalized for hearing loss (Moderate Hearing loss)	0.200	6.0

Almost all the RII values are lying below the middle value of 0.500 and this condition is less frequent and less significant according to this results interpretation. 04 incidents had been recorded in this research for hospitalizations. Two incidents on cut and burn, 01 incident on slip-and-fall and other for hand injury due to moving machine part.

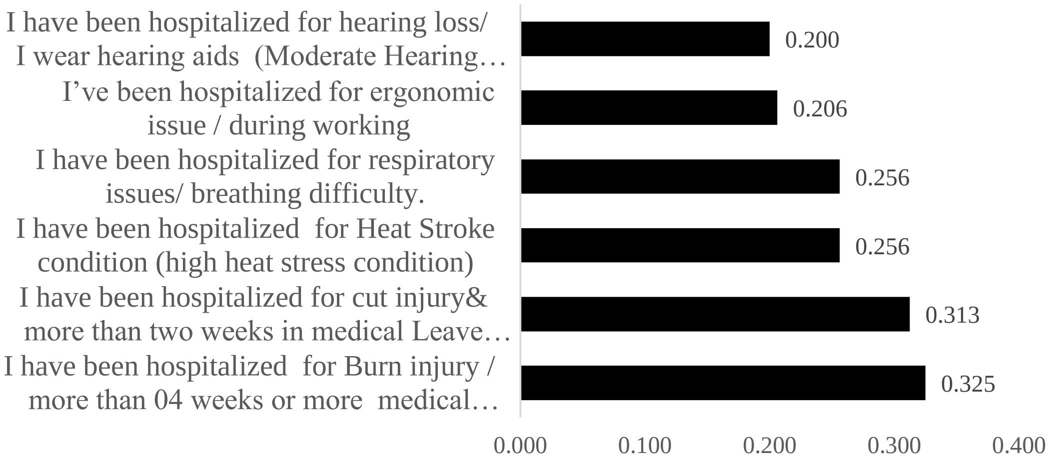


Figure 4.15: Hazards ranked according to the RII index – Hospitalizations/ high criticality

4.7.2 Overall Ranking Hazards – Severity

Table 4.19: Overall Ranking of hazards in hot end

Ranking Hazards According To Level Of Criticality & Impact	∑ RII / n	Rank
Heat Stress & Related hazards	0.590	1
Burning Injuries & Related hazards	0.556	2
Ergonomics Issues & Related hazards	0.502	3
Respiratory Issue & Related hazards	0.433	4
Physical Cut Injuries & Related hazards	0.425	5
Noise issue & Related hazards	0.342	6

The overall results of the study on ranking the OSH hazards in the working environment of the hot end section of glass manufacturing industry can be given as table number 4.19. According to the table number 4.19, the values showing that the heat stress with RII value 0.590 are the most frequent hazard in the section. This had been ranked as 01. The second highest RII value is 0.556 for burn injuries ranked level 02, as shown in the table 4.16 showing the value of 0.975 for minor burn injuries. The third rank RII 0.502 is on the ergonomic issues. The respiratory issues physical cut injuries and noise hazards showing the RII values respectively 0.433, 0.425 and 0.342 was given the rank 04, 05 and 06. In the final conclusion the heat stress and the burn n injuries are the most frequent hazards in the hot end working environments as per the response of the employees of the hot end.

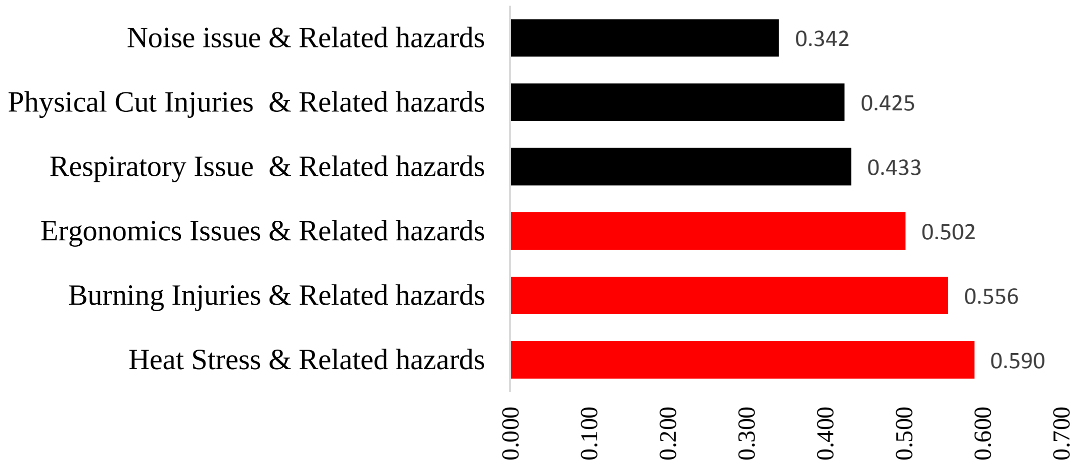


Figure 4.16 - Overall Ranking of hazards in hot end

4.8 Ranking of hazards according to the awareness, commitment and adherence

4.8.1 Knowledge (Level of awareness)

The prevention of the hazards is preliminary depend upon the level of awareness of the employees regarding the hazard, the level of commitment of the company management in taking preventive measure, investments, timely decision in reducing the hazard level and the adherence to the safety precautions. This is measured in the section B of the questionnaire and results are tabulated in table number 4.20, 4.21, 4.22.

Table 4.20: Rank the level of knowledge (Level of awareness) of hazards by employees

Ranking According To The Knowledge (Level of Awareness)	RII	Rank
I'm aware of physical hazards in working environment	0.919	1
I'm aware of respiratory hazards in working environment	0.706	2
I am aware of burn & related hazards.	0.694	3
I'm aware of heat related hazards	0.631	4
I am aware of noise related hazards	0.506	5
I'm aware of ergonomic hazards in working environment	0.319	6

The awareness of the hazards, commitment of the company and the level of adherence measured during the survey using the same method. In the table 4.20 showing the results after calculation of RII of each response from the hot end employee. Out of all, ergonomic issues with RII value of 0.319 having the lowest number recorded under knowledge (Level of awareness). The resultant can be seen in the table 4.16 (RII 0.869) and in overall hazard ranking in the table number 4.19 it recorded the third place due to (RII 0.502) which showed that the Ergonomic issues are significant hazard in the working environment.

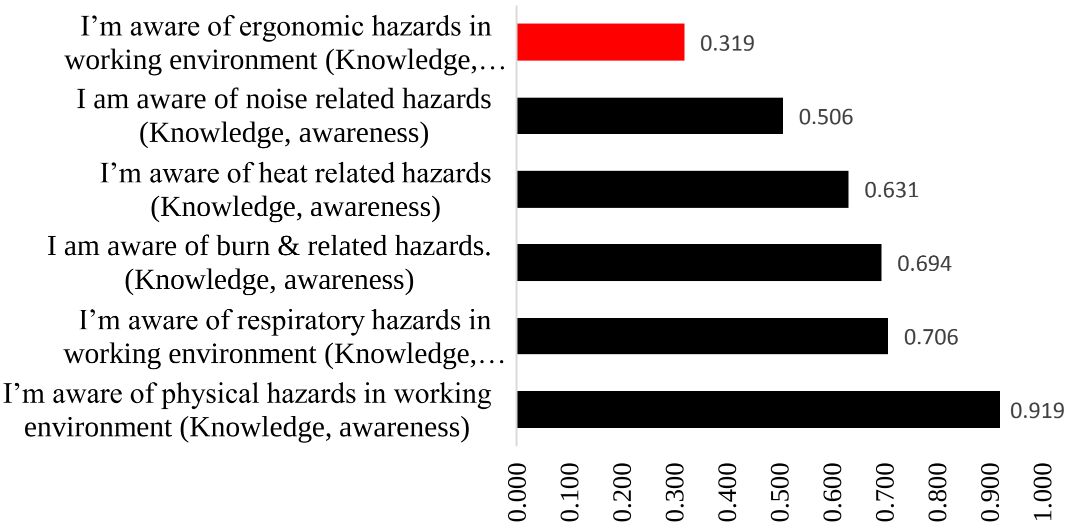


Figure 4.17 - Rank the level of knowledge (Level of awareness)of hazards by employees

4.8.2 Level of commitment in prevention

In the table number 4.21, the evaluations were taken on the commitment of the company management in preventing the hazards by investing on PPEs for the employees. Nevertheless the PPE controlling is the last rank of the hierarchy of hazard controlling, in the glass business PPEs play a vital role the hazard elimination, substitution and engineering controls are lacking.

Table 4.21: Rank the level of commitment in prevention the hazard by company

Ranking according to the commitment in prevention the hazard	RII	Rank
I've been given (& use) helmets, Arm guards during work	0.981	1
I've been given (& using) cut resistant glove & safety shoes	0.925	2
I have been given (& use) protective clothes to prevent heat	0.888	3
I've given & use safety dust masks & breathing apparatus	0.763	4
I've given & use ear guard/ear muffler during working (commit)	0.713	5
good factory environment prevention of ergonomic issues	0.444	6

The commitment of company was analysed by this study. The study focused on providing of right safety PPEs to employees and employee commit to wear them appropriately. In this study, it is showing that the least value of RII 0.444 recorded for providing of appropriate ergonomic environment in supporting preventing the level of hazards. The second lowest is ear protection against noise hazards RII 0.713. Company provides an ear muffler one time for year, which is not adequate and most of the JMOs using ear plugs. Earplug is not giving right protection and long hour wearing can cause headache and uncomfortable as pressure differences are occurring in mid ear. Same way dust marks RII 0.763 too having lowest rating for same reason.

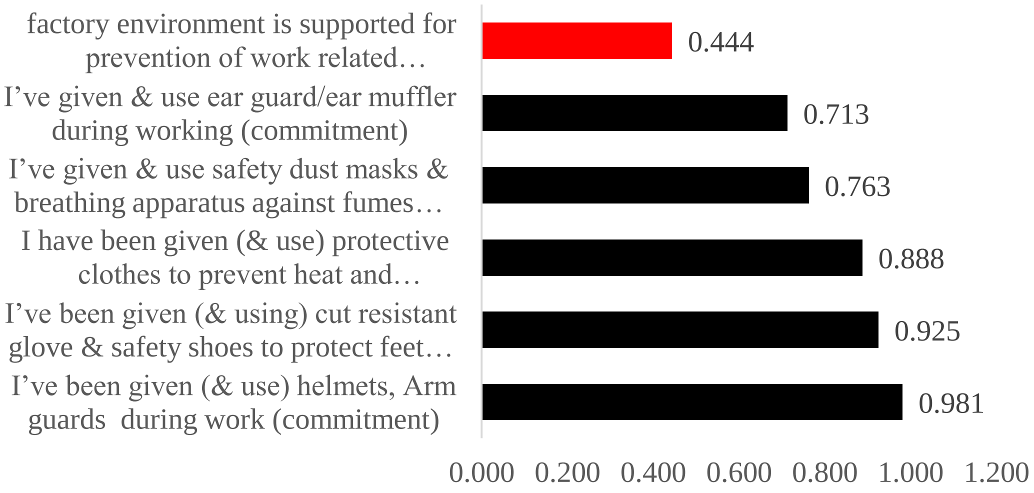


Figure 4.18 - Rank the level of commitment in prevention the hazard by company

4.8.3 Level of Adherence to the safety practices

In the table number 4.22 it is showing the level of adherence to the safety practices by the employees. The RII values mentioned in the table clearly showing that that the level of adherence to the safety practices by the employees are good.

Table 4.22: Rank the level of adherence of the safety practices

Ranking according to the adherence	RII	Rank
I follow 100% safety practices on burn protection (adherence)	0.981	1
I follow 100% safety practices on cut protection (adherence)	0.969	2
I follow 100% safety practices on heat protection (adherence)	0.944	3
I follow 100% safety on dust & smoke protection (adherence)	0.800	4
I follow 100% safety practices on ear protection (adherence)	0.750	5
I always follow appropriate ergonomics practices (adherence)	0.438	6

The level of adherence to OSH practices plays a key role in preventing hazardous conditions. According to the study, the responses showing that the employees adhered to the available safety practices well. The ergonomic is the only practice with **RII 0.483** that is not adequately following. This may be due to lack of awareness and knowledge of best practices. Ear protecting is the next lowest number with **RII 0.750**. The most probable cause was explained in earlier chapter.

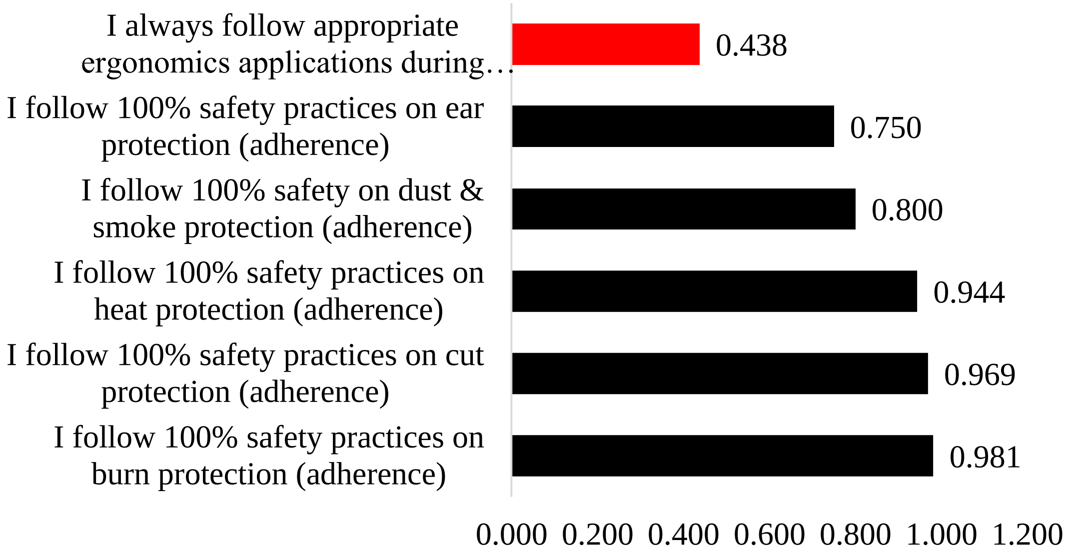


Figure 4.19- Rank the hazards according to level of adherence

4.9 Overall Ranking Hazards awareness, commitment and adherence

The awareness, commitment and the adherence were summed together and got the mean value was calculated in getting the overall ranking in the table number 4.23. In that calculation the cut injuries scored the highest as RII 0.938, the Burning hazards got the second rank by scoring RII 0.885 and third and fourth respectively heat stress and the respiratory hazards. The minimum RII score recorded for Ergonomics hazards. Even though RII values shown high value the probability of occurrence of hazards is not at low level. Thus, it could be the level of exposure to the hazard is not controlled as appropriate.

Table 4.23: Overall ranking according to the awareness, commitment and adherence

Ranking Hazards According To Level Of Awareness & Adherence	$\frac{\sum RII}{n}$	**Rank**
Physical Cut Injuries & Related hazards	0.938	1
Burning Injuries & Related hazards	0.885	2
Heat Stress & Related hazards	0.821	3
Respiratory Issue & Related hazards	0.756	4
Noise issue & Related hazards	0.656	5
Ergonomics Issues & Related hazards	0.400	6

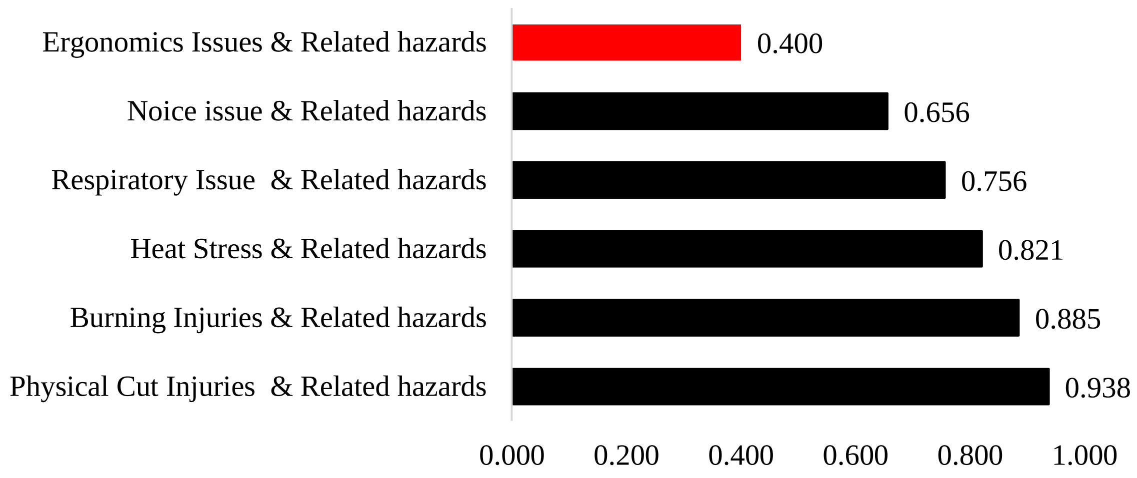


Figure - 4.20 Overall ranking according to the awareness, commitment and adherence

In this, study the overall ranking done for the awareness, Knowledge commitment and adherence with using the RII and shown in the table number 4.23. The least values recorded for ergonomics issues the recorded value is of RII 0.400. The second least value recorded for Noise and related hazards the recorded value is of RII 0.656. in the table no iii (the ranking of overall hazards) it is showing the heat hazard is the most frequent hazard existing in the hot end the RII value is 0.590. Even though the adherence and knowledge showed considerably high values, in the table the existence of heat hazards are proven. The second highest hazard is burn injuries and related hazards the RII value is RII 0.556 same way the burn hazards related knowledge adherence and commitment show high even though the burn injuries are ranked as second frequent hazards in manufacturing environment.

4.10 Identify critical causes for each critical health and safety Hazards

The most frequent and critical hazards were identified using the section **B** of the questionnaire. The section **D** of the questionnaire is mainly focused on identifying causes for the health hazards. As evaluated in the pilot study and safety data the 06 hazards types were identified as most frequent and with high criticality. The balance **04** hazards were identified in the pilot study and within safety records, then categorized as none critical hazards with low impact. In the section, **D** is mainly focused on identifying the causes of the hazards and to rank them. The main causes for each hazards were identified through the literature survey also. 10 causes were identified in this study as principally contributing to emerge a condition as a hazard. Meanwhile the causes were used to identify the level of impact to the main hazard. The Likert scale converted the employee comment to quantifiable figure.

4.10.1 Causes for Noise hazards

The table number 4.24 is showing the critical causes for the noise hazards. The container glass working noise level would be in between 85 dB to 95 dB (Srivastava *et.al* 2000). This is mainly because of the machine pneumatic operation. It is taken as one of the critical hazards in the glass facility.

Table 4.24 – Critical causes for Noise hazards

Noise hazards	Lack of machinery maintenance	Lack of Safety awareness, Training and competency….	Lack of supervision and monitoring	Lack of resources & infrastructure	Lack of following the instructions	Lack of Organizational environment and Management support	Lack of Safety communication	Lack of Risk judgments and management reaction	Lack of Following the Standards and adherence to systems	Lack of House keeping
	148	127	108	106	102	98	94	89	85	37
Mean	4.63	3.97	3.38	3.31	3.19	3.06	2.94	2.78	2.66	1.16
RII	0.925	0.794	0.675	0.663	0.638	0.613	0.588	0.556	0.531	0.231

The table 4.24 showing the prioritized order bar chart of causes for the noise hazards of the hot end working environment the highest RII values of 0.925 recorded for Lack of machinery maintenance.

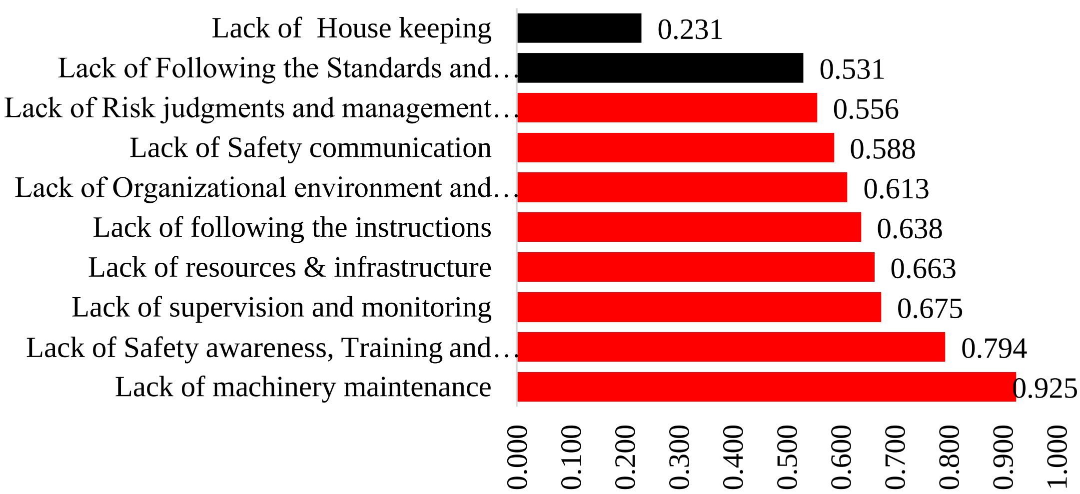


Figure 4.21 – Critical causes for Noise hazards

4.10.2 Causes for Burn injuries

The burn injuries are the most frequent hazard occurring in the hot end environment getting RII values of 0.556 in overall hazards ranking. In table number 4.25 ranking the critical causes for the burn injuries, the lack of resources with RII value 0.981 shows the highest value.

Table 4.25 – Critical causes for Burn injuries

Burn Injuries	Lack of resources & infrastructure	Lack of Safety awareness, Training and competency….	Lack of supervision and monitoring	Lack of following the instructions	Lack of Risk judgments and management reaction	Lack of Organizational environment and Management support	Lack of Safety communication	Lack of machinery maintenance	Lack of Following the Standards and adherence to systems	Lack of House keeping
	157	116	114	102	94	92	90	86	73	43
Mean	4.91	3.63	3.56	3.19	2.94	2.88	2.81	2.69	2.28	1.34
RII	0.981	0.725	0.713	0.638	0.588	0.575	0.563	0.538	0.456	0.269

The burn injuries are the most frequent hazard occurring in the hot end environment getting RII values of 0.556 in overall hazards ranking. In ranking the critical causes for the burn injuries, the lack of resources with RII value 0.981 shows the highest value. This may be because of none availability of burn protective equipment like arm guards, heat resistance hand gloves. In the safety-records showed 03 incidents of burn the back palm 02 lower arm due to hand glove made with cotton with less thickness.

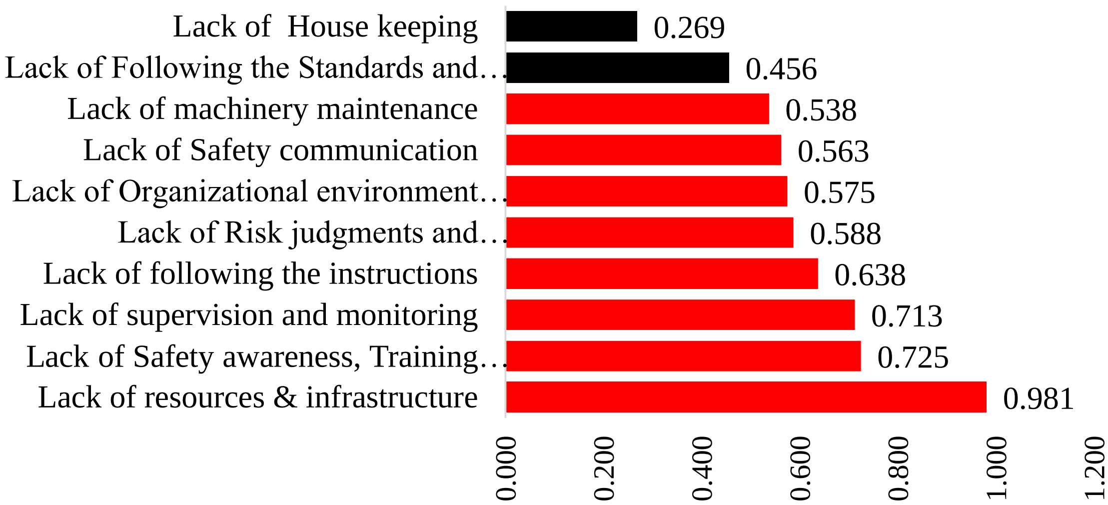


Figure 4.22 – Critical causes for Burn injuries

Most frequent minor burn injuries occurring during handling of pre-heated mould equipment installations. The second highest value recorded for lack of training and awareness. Furthermore, the third highest RII value recorded for Lack of supervision and monitoring. This may be the supervision of infrastructure and resourced by the management and superiors.

4.10.3 Causes for Heat Stress

According to the section A of the questionnaire, the highest rank of the hazards was recorded for the heat stress RII value **0.590**. In the container, glass industry the average temperature in front of the blow side of the machine is approximately 60^0C to 65 ^{0}C (*Patel et. al,* 2006) , in the table number 4.26 it is showing the highest RII values for the causes were recorded to lack of safety awareness & training RII of **0.888.**

In most of the time, the lack of understanding on extreme heat conditions and prevention mechanisms will be low. The next highest figures of RII **0.738** and **0.694** respectively for supervision and lack of infrastructure. Lack of heat retardant protective clothing's and frequent machine sudden breakdowns can also cause more exposure to high heat conditions.

Table 4.26 - Critical causes for heat stress

Heat Stress & hazards	Lack of Safety awareness, Training and competency….	Lack of supervision and monitoring	Lack of resources & infrastructure	Lack of Organizational environment and Management support	Lack of following the instructions	Lack of Safety communication	Lack of Risk judgments and management reaction	Lack of machinery maintenance	Lack of Following the Standards and adherence to systems	Lack of House keeping
	142	118	111	101	100	98	91	83	66	63
Mean	4.44	3.69	3.47	3.16	3.13	3.06	2.84	2.59	2.06	1.97
RII	0.888	0.738	0.694	0.631	0.625	0.613	0.569	0.519	0.413	0.394

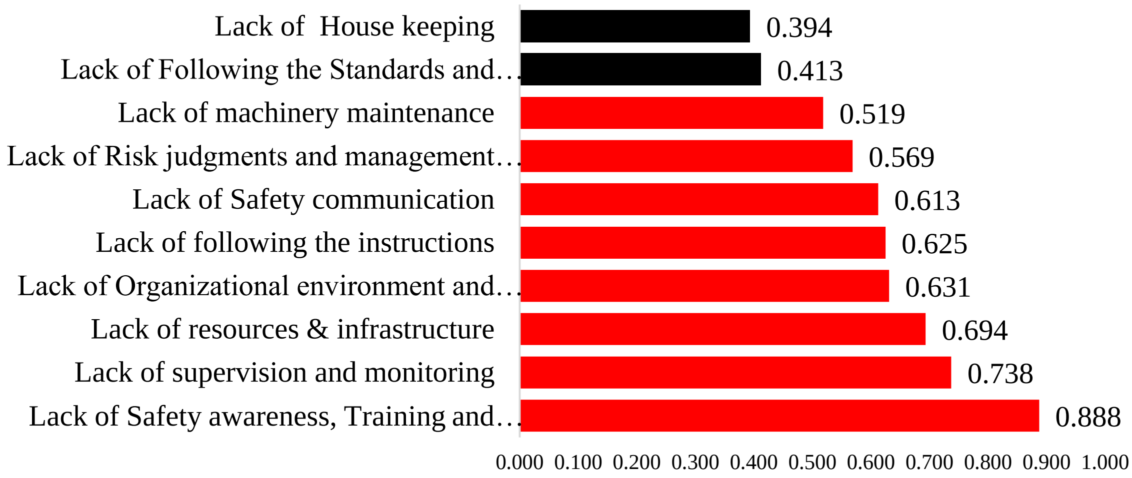


Figure 4.23 – Critical causes for heat stress

4.10.4 Causes for Physical Cut injuries

Table 4.27- Critical causes for Physical Cut injuries

Physical Cut injuries	Lack of House keeping	Lack of resources & infrastructure	Lack of supervision and monitoring	Lack of Organizational environment and Management support	Lack of Safety communication	Lack of following the instructions	Lack of Risk judgments and management reaction	Lack of machinery maintenance	Lack of Safety awareness, Training and competency….	Lack of Following the Standards and adherence to systems
	112	111	109	108	106	103	84	84	77	70
Mean	3.50	3.47	3.41	3.38	3.31	3.22	2.63	2.63	2.41	2.19
RII	0.700	0.694	0.681	0.675	0.663	0.644	0.525	0.525	0.481	0.438

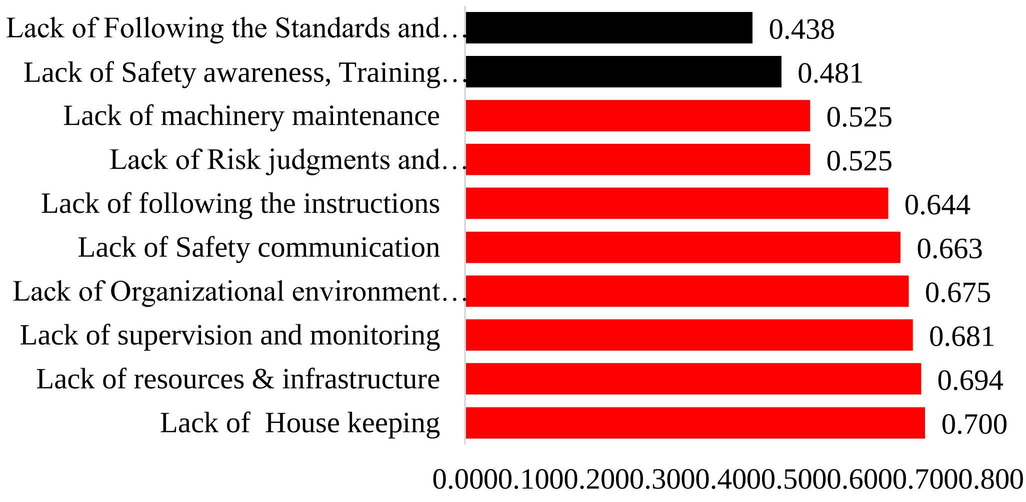


Figure 4.24- Critical causes for Physical Cut injuries

The cut injuries are mainly due to the broken glass pieces on floor and on the machineries. The highest RII value RII **0.700**, recorded for the lack of housekeeping. Removal of broken glass pieces on the floor should be a daily activity, nevertheless the house keeping condition of the got end in not up to the required level. The second highest RII value of **0.694** is for the lack of resources & infrastructure. RII **0.681** is for lack of supervision and monitoring. Mostly poor management of hot end housekeeping and none availability of tools and equipment in prevention of cut injuries.

4.10.5 Causes for Respiratory Issues

The glass manufacturing industry, there are various critical causes for the respiratory hazards among them the silica dust is prominent. In this study it had score the poor housekeeping can cause the hazard as respirable silica dust can cause the hazard.

Table 4.28- Critical causes for respiratory hazards

Respiratory issues	Lack of House keeping	Lack of Safety awareness, Training and competency…	Lack of resources & infrastructure	Lack of following the instructions	Lack of supervision and monitoring	Lack of Safety communication	Lack of Organizational environment and	Lack of machinery maintenance	Lack of Following the Standards and adherence to systems	Lack of Risk judgments and management reaction
	146	140	113	111	106	102	98	92	89	86
Mean	4.56	4.38	3.53	3.47	3.31	3.19	3.06	2.88	2.78	2.69
RII	0.913	0.875	0.706	0.694	0.663	0.638	0.613	0.575	0.556	0.538

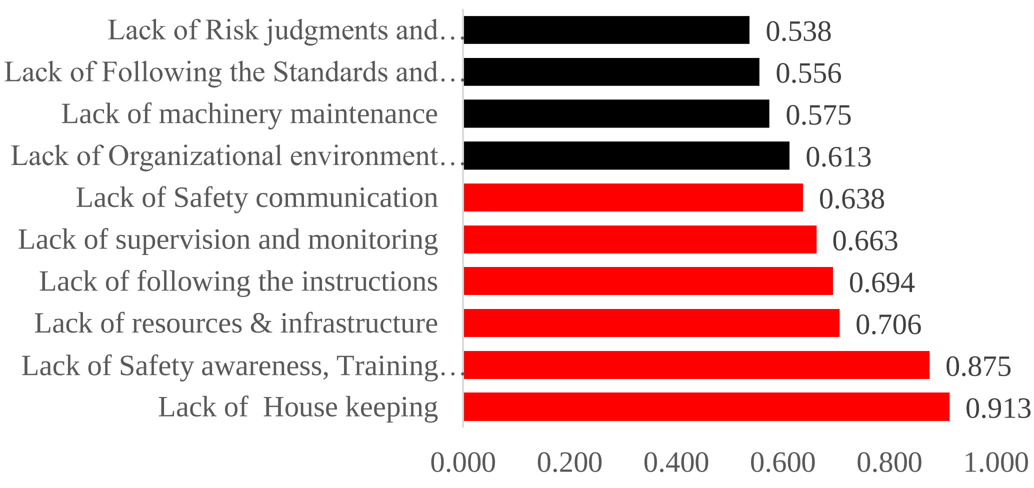


Figure 4.25 - Critical causes for respiratory hazards

The respiratory hazards falls on 4th place in overall hazard ranking while having the RII of 0.433. The main causes for the respiratory hazards are due to the less and poor housekeeping condition, usage of excessive mould lubricants in swabbing the blow and blank molds. Hot end coating (monobutyltintricloride MBTC) used for surface coating of container glass to get the surface more scratch resistance is considered as highly toxic compound known as highly corrosive compound extremely dangerous to inhale directly. Inhalation can cause sudden onset of asthmatic condition and lead to CPOD (de Jong, 1989). The free silica dust as respirable air born crystalline silica and high toxic gasses emissions due to partial combustion. The second & third highest values of the causes are Lack of training/ awareness and lack of resources respectively.

4.10.6 Causes for Ergonomics Issues

During the interviewing, it had noticed that the employees unaware of the term ergonomics and the right practices. In overall ranking the hazards, the ergonomics issues ranked as third having more impact with RII 0.502.

The main causes for the ergonomic issues to be significant are lack of training, awareness, Lack of resources and infrastructure and none following of instructions the RII values respectively RII 0.894, 0.706 and 0.675.

Table 4.29 - Critical causes for Ergonomics issues

Ergonomic issues	Lack of Safety awareness, Training and competency….	Lack of resources & infrastructure	Lack of following the instructions	Lack of Safety communication	Lack of supervision and monitoring	Lack of Following the Standards and adherence to systems	Lack of Organizational environment and Management support	Lack of machinery maintenance	Lack of Risk judgments and management reaction	Lack of House keeping
	143	113	108	104	104	94	91	91	84	52
Mean	4.47	3.53	3.38	3.25	3.25	2.94	2.84	2.84	2.63	1.63
RII	0.894	0.706	0.675	0.650	0.650	0.588	0.569	0.569	0.525	0.325

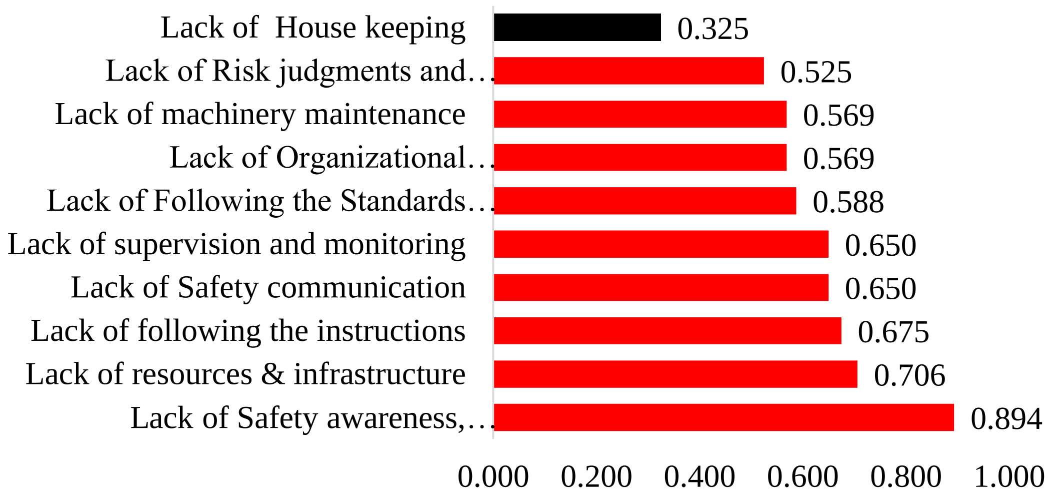


Figure 4.26 - Critical causes for Ergonomics issues

4.10.7 Causes for Slipping, Tripping and fall on floor

During the pilot study slipping and tripping had marked and ranked as less frequent safety hazard in the working environment given in the table number 4.30. The most possible root cause for the slipping and tripping hazards is due to the heavy oil layer on the floor and metallic platforms.

The glass industry using excessing amount of mould lubricants and spillages are happening on floor. Under poor housekeeping, conditions the oily surfaces can cause this safety issue. The Lack of housekeeping get the RII value of 0.863 is proving the condition. The second and third RII values are 0.713 and 0.638 respectively for the Lack of resources and lack of supervision and monitoring.

Table 4.30: Causes for Slipping, Tripping and fall on floor

Slipping, Tripping	Lack of House keeping	Lack of resources & infrastructure	Lack of supervision and monitoring	Lack of Risk judgments and management reaction	Lack of following the instructions	Lack of Organizational environment and Management support	Lack of Safety communication	Lack of machinery maintenance	Lack of Following the Standards and adherence to systems	Lack of Safety awareness, Training and competency….
	138	114	102	99	98	96	93	86	74	67
Mean	4.31	3.56	3.19	3.09	3.06	3.00	2.91	2.69	2.31	2.09
RII	0.863	0.713	0.638	0.619	0.613	0.600	0.581	0.538	0.463	0.419

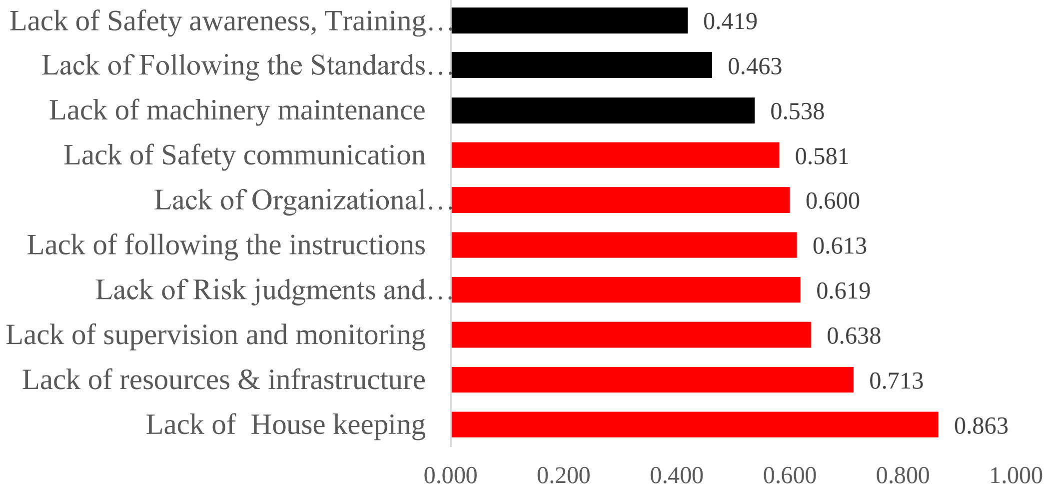


Figure 4.27: Causes for Slipping, Tripping and fall on floor

4.10. 8 Causes for accidents with using machinery

Table 4.31: Causes for Accidents by machinery

Accidents by machinery	Lack of resources & infrastructure	Lack of machinery maintenance	Lack of Safety awareness, Training and competency….	Lack of following the instructions	Lack of supervision and monitoring	Lack of Safety communication	Lack of Organizational environment and Management support	Lack of Risk judgments and management reaction	Lack of Following the Standards and adherence to systems	Lack of House keeping
	151	143	136	114	112	109	99	84	76	54
Mean	4.72	4.47	4.25	3.56	3.50	3.41	3.09	2.63	2.38	1.69
RII	0.944	0.894	0.850	0.713	0.700	0.681	0.619	0.525	0.475	0.338

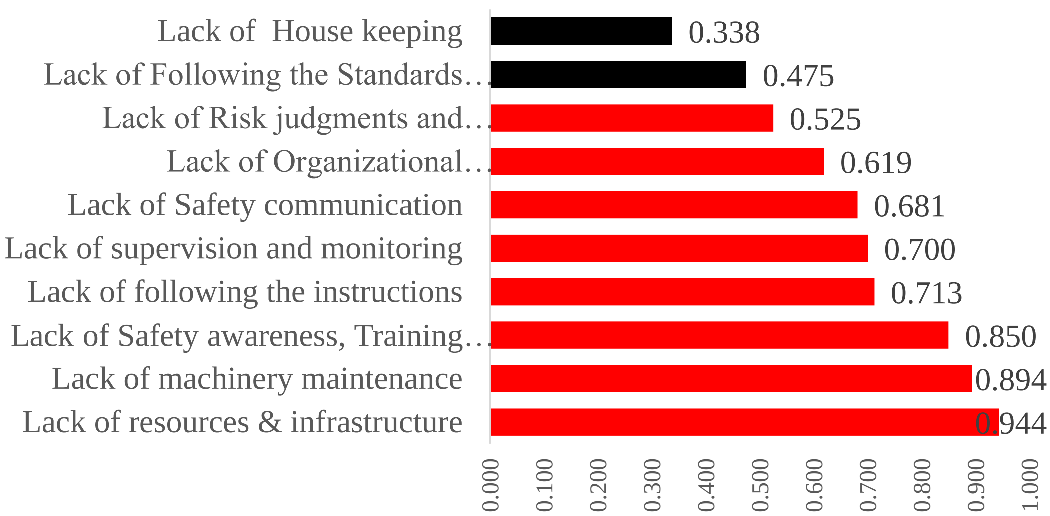


Figure 4.28: Causes for Accidents by machinery

The accidents by machinery is not taken in the main questionnaire body as it was ranked during the pilot study as less frequent. Since the hot end had recorded 02 hospitalizations due to accidents caused by the machine. The highest RII of **0.944** was recorded for the lack of resources and infrastructure. The main accidents caused by the machine is the hit against the revert mechanism during swabbing the blank mould. Main preventive action is to have a section guard, where it facilitate the operator to swab the section appropriate, this may reflect in the answer as the second highest RII of **0.894** also recorded on Lack of machinery maintenance. The third factor is lack of safety awareness and training level that with RII value of **0.850.**

4.10.9 Causes for Eye injuries.

During the pilot study slipping and tripping had marked and ranked as less frequent safety hazard in the working environment. The most possible root cause for the slipping and tripping hazards is due to the heavy oil layer on the floor and metallic platforms.

Table 4.32: Causes for Eye injuries

Eye injuries	Lack of following the instructions	Lack of Safety awareness, Training and competency….	Lack of resources & infrastructure	Lack of House keeping	Lack of supervision and monitoring	Lack of Safety communication	Lack of Organizational environment and Management support	Lack of Risk judgments and management reaction	Lack of machinery maintenance	Lack of Following the Standards and adherence to systems
	137	136	116	113	110	102	95	95	94	85
Mean	4.28	4.25	3.63	3.53	3.44	3.19	2.97	2.97	2.94	2.66
RII	0.856	0.850	0.725	0.706	0.688	0.638	0.594	0.594	0.588	0.531

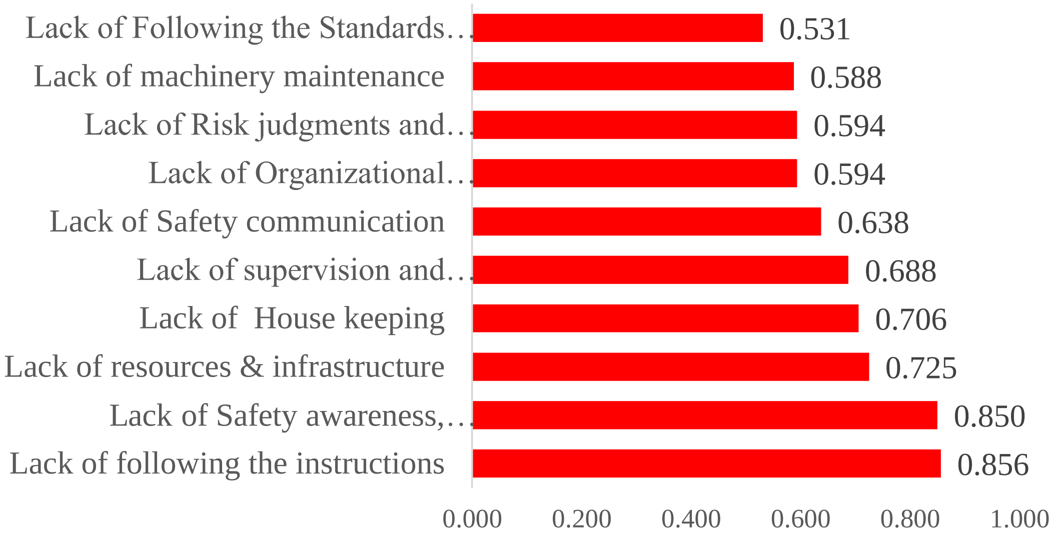


Figure 4.29: Causes for Eye injuries

The main causes for the eye injuries in the hot end is chemical contact specially the mould lubrication oil and the contact with glass pieces. The most advisable thing is to wear a eye goggle. The RII value 0.856 is mainly because of lack of following the instructions. The second main cause is lack of awareness and the training having RII of 0.850. In most of the cases, the hot end workers are reluctant to wear an eye goggle as visibility is obstruct a little. In 2016 and 2017 two hospitalization incidents were recorded on eye injuries, one with chemical contact and other one is glass piece hit directly with eye and eye get damaged. These two incidents could have been avoided if eye goggle used appropriately.

4.10.10 Causes for Sprains of body parts.

The sprain of the body parts is referred as ergonomic issues recorded in the hot end environment but directly cannot be consider as ergonomic as the cause in many ways given in the table number 4.33. The main cause for the sprains are identified as lack of safety awareness the RII value is 0.819. This may be due to heavy weight lifting in wrong postures.

Table 4.33 Causes for Sprains of body parts

Sprains of body parts	Lack of Safety awareness, Training and competency….	Lack of Safety communication	Lack of Organizational environment and Management support	Lack of Risk judgments and management reaction	Lack of supervision and monitoring	Lack of machinery maintenance	Lack of following the instructions	Lack of Following the Standards and adherence to systems	Lack of resources & infrastructure	Lack of House keeping
	131	111	99	90	102	86	103	83	112	108
Mean	4.09	3.47	3.09	2.81	3.19	2.69	3.22	2.59	3.50	3.38
RII	0.819	0.694	0.619	0.563	0.638	0.538	0.644	0.519	0.700	0.675

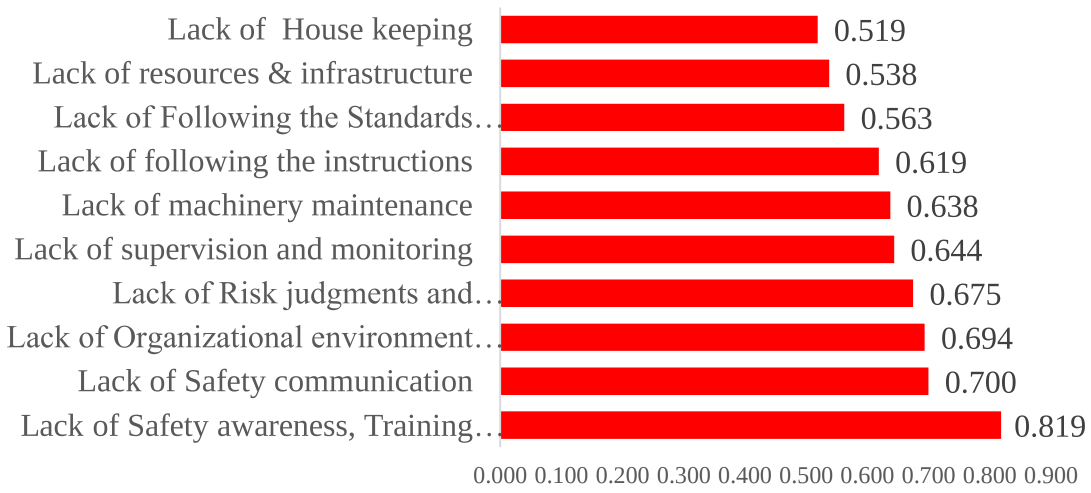


Figure 4.30: Causes for Sprains of body parts

Most of the cases sprains can be happened due to the slip and tripped falling and legs or hand touch the floor in awkward position. The second highest contributor is lack of safety communication having the RII value of 0.694.

4.11 Overall ranking the critical causes for overall safety and health hazards.

All the causes identified in the study were ranked according to the responses from the employees, which they ranked as contributory for hazard to be existed in the working environment. The results were shown in the figure 4.30.

Table 4.34 – Ranking the Critical causes for overall safety and health hazard

Overall ranking the causes	Lack of Safety awareness, Training and competency….	Lack of resources & infrastructure	Lack of supervision and monitoring	Lack of following the instructions	Lack of Safety communication	Lack of Organizational environment and Management support	f. Lack of machinery maintenance	Lack of Risk judgments and management reaction	Lack of House keeping	Lack of Following the Standards and adherence to systems
∑RII n	0.775	0.753	0.678	0.674	0.631	0.611	0.583	0.560	0.541	0.497

As shown in the table 4.34 the lack of safety awareness and training is the most critical cause with RII 0.775 for the existance and occurance of hazards in the hot end working environmen. Respecctively the Lack of resources & infrastructure and Management reaction againt elimination of hazardous conditions respectivley RII 0.753 and 0.678. as is seen the all the factors are having significan impact on occuence of said hazards in the hot end except lack of folowing standards and systems in the factory. The employees does'n believed in ysytems and stanards itself will give much results in eliminating hazards.

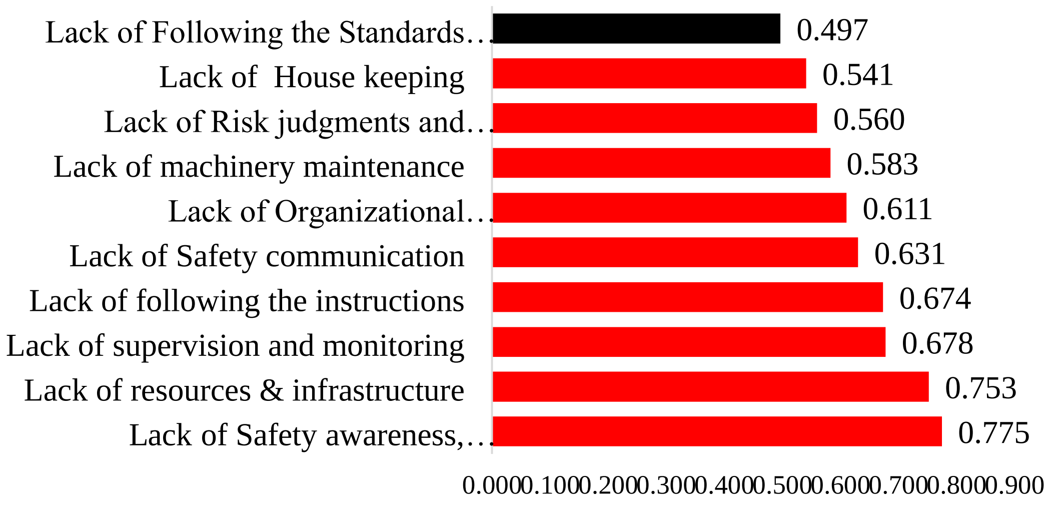


Figure 4.31 - Ranking the Critical causes for overall safety and health hazard

4.12 Company General OSH background

The company general OSH background also evaluated with the questionnaire in the section C, the general OSH background found to be unsatisfactory as many of the questions get negative comments from the employees. This also represented in the analysis of accidents prevailing trend of accidents.

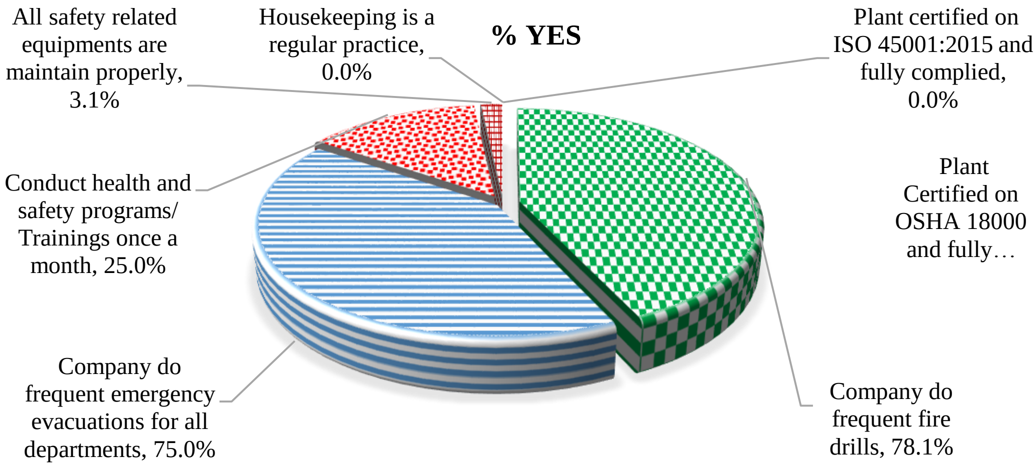


Figure 4.32 – OSH initiative of the company – answers with "YES"

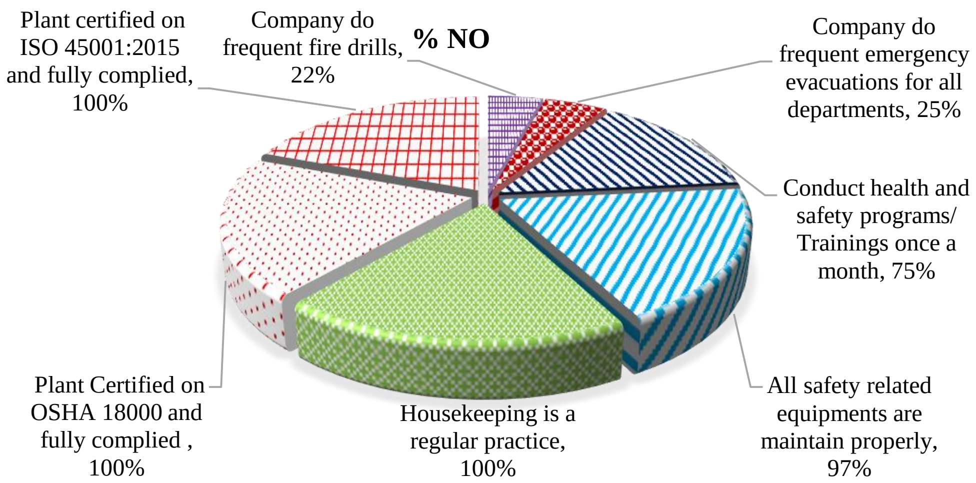


Figure 4.33 – OSH initiative of the company – answers with "YES"
(Based on the answers given to questionnaire by employees)

In comparison the questions get reply "No" for 48.21% than answer "Yes". This condition is considered unsatisfactory in maintaining the general OSH background in the working environment.

CHAPTER FIVE

5.0 Conclusions

The study had been conducted in finding the occupational health and safety hazards and preventive mechanisms the container glass industry. Mainly it was focussed on the safety and health hazards in the container glass industry. It also identified the causes for the health and safety hazards according to the view of the employees. The container glass industry worldwide is having a competitive market segment and considered as heavy industry. The glass industry in commonly known as hazard generation industry most of the cases in the batch house, furnace and Hot End.. The Health and safety issues in the glass industry is a world wise problem. The most critical factor is the hazards generate in the glass industry seems more chronicle and long term. Since the workers are subjecting to the more hazardous conditions frequently the glass industry frequently facing difficulties in terms of cost, time and management efforts.

In this study, the mainly focusing on four objectives the first objective was adopted by the literature survey, which had been used to identify the types of health and safety, causes of health and safety, importance of health and safety, proactive preventive methods of health and safety hazards in the container glass industry. The availability of the data on the container glass industry in relation to the container glass industry is limited and a rich pile of literature can be found in relation to the Asian region and EU region. The second and third objectives are planned to achieve through the data gathering through the structured interview and the questionnaire. The forth objective is the final recommendation giving by considering the conclusions arrived in considering the first, second and third objectives. The research methodology giving the mechanism adopted in achieving the objectives. Method of data collection and analysis and presenting already discussed in the chapter three.

The objective one fulfilled satisfactorily with the literature synthesis. Key hazards, that are widely seen in the glass industry were identified and critically evaluated within the literature survey and most of the hazards that are identified as significant seems widely spread in the industry, irrespective of the region.

The hazards widely existence in the Sri Lankan context was identified through the structured interview through a questionnaire. A pilot study was deployed in validating the questionnaire before implementing in the survey. In addition, the critical causes were too presented to the interviewee in fulfilling the objective three for identifying the critical causes for the hazards exist. The exploratory survey identified the hazards and the critical causes existing in the container glass industry already identified and validated through the literature survey. In data analysis, the RII tool and the percentage calculation and ranking were used for better representing the data in getting a better meaning and representation.

The focus of the research is on the hazards in the hot end section of the container glass manufacturing industry. In accordance to the questionnaire & data analysis, it give a clearer picture on the hazards existing currently in the hot-end working environment of the glass industry. The validity of the study is mainly through the industry expertized knowledge and the experience and the true condition of employee exposures to the hazardous conditions and the safety and health data available in the factory. The most critical hazards in the container glass industry were the heat stress and related hazards. The second level critical hazards was the burn injuries and related hazards. The ergonomics issues were taken under the third level critical hazards in the glass industry. Respectively cut injuries and noise hazards were placed in fifth and sixth place. The Heat stress conditions are the most frequent and significant hazard as shown in the study. The level of adherence and commitment recorded high RII value of 0.590, where is it taken as high significant level. This is evident that preventive actions are not adequate or not appropriate. The level of exposure to the heat condition of the hot end workers are significantly higher among the workers in the study group, who worked in a shorter distance to the machinery compared to the other workgroups of other sections of the industry tends to get more heat stress than others. Since the heat, stress conditions are much more significant in this industry, in most of the cases the heat stress can only be reduced by reducing the exposure level.

The burn injuries are the second highest hazards in the hot end section where the preventive measures are also implemented but due to the nature of the work and level of exposure to the hazard is throughout the working hours or shift elimination of burning hazard form the hot end environment is difficult. Since more preventive actions to be implemented in preventive

According to the results, the ergonomics are the most leas known hazard by the employees. The RII score 0.502 seems to have significant impact to the employee in long term. The working environment lease supported in preventing and minimizing the hazards related to ergonomics, there had not done an assessment on long-term effect of ergonomics to the hot end worker. The weight lifting, awkward body postures and repetitive work patterns mostly cause the hazard to be more dominant.

The noise issues and related hazards scored RII of 0.342 where is showed less significance when compared to other hazards in the hot end. The frequency of getting the Impairment on hearing was significantly higher in the employees in the study group who have worked for more than 20 -30 years in the hot end section. Among this group it had noticed that the most of the employees are working within shorter distance to the machine. Hearing impairment is increases with increasing the proximity to the machine. However, the use of hearing protective devises in both categories never users and sometime users significantly contributing to the increase the prevalence of hearing impairment.

The recorded noise level closer to the machine is about 85 – 90 dB, wherever subjecting to this noise level for continuously 08 hours would certainly cause a NIHL (Noise Induced hearing loss). The PPE given in ear protection is adequate and compliance to the PPE is observed to be satisfactory. Since the noise marked as low impact hazard in the hot end working environment of the container glass manufacturing industry.

The survey results showed that the high affected critical causes for each hazard and those were vary to hazard to hazard. The critical causes that were identified and ranked taken under the objective three. In overall ranking the Lack of safety awareness with RII value of 0.775, Lack of resources and infrastructure having the RII value of 0.753 and lack of safety supervision and monitoring 0.678, were the first key causes for having the more hazards in the working environment. Among others following instructions, communication, company commitment, machinery maintenance, housekeeping and following systems and standards were among the vitals. Since the data gathered and analysis satisfactorily fulfil the achievement of the stipulated objectives under this study and the fourth objective was given in detail under the topic of recommendation with the safety framework.

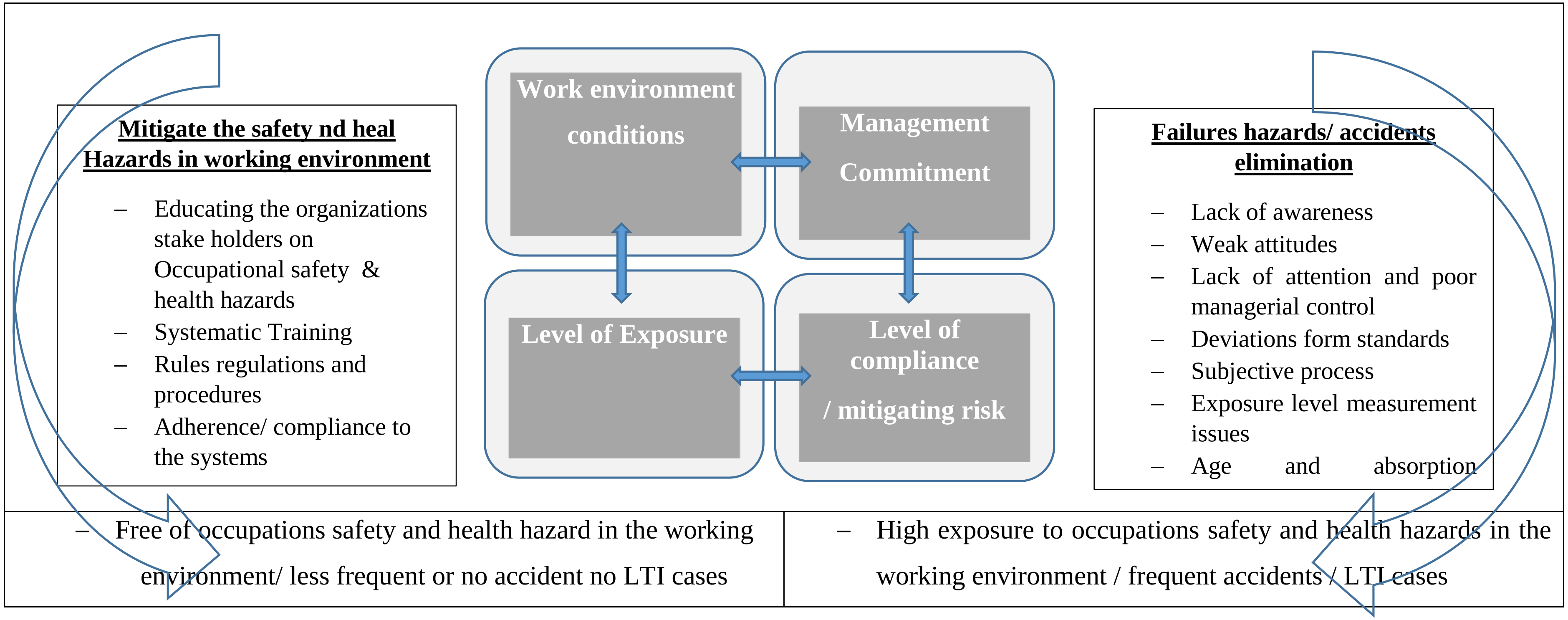


Figure - 5.1 the Map of hazard existence

5.1 Recommendations

The glass industry in nature total elimination of hazardous conditions from the working environment would not be possible, the hierarchy of safety controls system to be implement to the working environment. In most of the cases, the elimination and substitution will be challenging due to the nature of the business. Further the engineering controls, administrative controls and PPE would play a vital role in safeguarding the work force in exposing hot the hazards in the hot end environment.

Among the key findings, the level of existence of the hazard seems to be comparatively the same to the general status of any container glass production facility in the given context. Preliminary this conclusion arrived through the literature survey conducted and the hazardous conditions prevailed in the typical glass production facilities. The precautions for the existing hazards is not controlled as per the industry standards and the according to the local legislative guidelines. As shown in the figure 5.1 the map of hazard existence the risk and hazard mitigation actions had been found minimum in the study environment. The ranking the hazard elimination in prioritizing the point the elimination an substitution are not fully applicable to the glass making environment but engineering, administrative and PPE controls need to be improved. Further the safety based culture of the organization had not been developed as per the

requirement. The majority of the workers found to be the non-compliance to the requirements even though they have replied to the questionnaire for maximum compliance to the stated requirements. The training and development in terms of building the safety based work culture in this category industries are much more important than monitoring and supervising. Investment on the poke-yoke approach also applicable to this. The attitude of the employees plays a key role in this approach.

The management commitment in investing and implementing the fore mentioned implications are vital. The case study revealed out the required level of management support and commitment is not seen to build the true approach of proactive hazard elimination. This study revealed key failures of these point discussed since the working environment level of significance of hazardous conditions is comparatively high.

All the causes of the study identified as contributing to the hazards to be treated with appropriate measure in controlling the hazards to be reached to an adverse level. Specially the low technological initiatives like house-keeping, supervising and monitoring, training and development and management support and decision on time would rather develop favourable working conditions.

The workers in the section should pay more attention on adherence to the safety practices in terms of PPE compliance. The employees shall ware heat protective equipment in preventing the body and specially the eyes from heat. The management shall provide the workplace changes or the new employee employment to the hot end environment shall not done without having a proper training and exposure to work patterns & behaviours of the hot end. The technical skills, vocational qualifications to be enhance before the work started in the section & the throughout the life the training and required calibration to be made to the workforce. The hazards like heat stress can be minimize by providing the rest in between the work sessions epically the increasing the ventilation and installation of blower fans with cooled air can reduce the heat stress conditions. Further, the employment in excessive durations like 24 hours shall be minimized. Under unavoidable circumstance, the duration of working hours and support in maintaining the body fluid condition will be vital with mineral/ salt supplement. Further through these actions the earnings of the employees shall not be affected unless there will be unrest condition due to low earning.

The safety condition off any of working environment and employee behaviours cannot be changed or good practices cannot achieved through zero investments since the investing on engineering controls in preventing the hazard condition in freehand, increasing the exposure level to the workforce.

PPE compliance and reporting hazardous conditions and the near misses in the working environment. In most of the time the high exposure caused by the unexpected down time attendance and excessive number of job changes during a period of time. In managing the such conditions can avoid the workers OHH (Occupational Health Hazard) conditions favourably.

Further in general t regular medical assessment of the employee health condition and timely actions will prevent in getting the condition reached to an advance condition

The glass manufacturing industry one of highly technology based industry. The use of technology in constructing the more work friendly and reduced OHH conditions are in trend in nowadays. Most of the companies using automated swabbing machine, mould-lifting machines, less hazardous chemicals replacing old, low pneumatic HP/ LP consumption machines/ water cooled moulds than the vetiflow are recent trends in developments in the container glass manufacturing industry.

It is essential to ensure the process knowledge, safety in day to day operations, use of personal protective equipment, first aid, fire fighting & evacuations and hydrant system, emergency procedures and shutdown, adherence to the systems and standards appropriately will certainly minimize the hazards in the work environment.

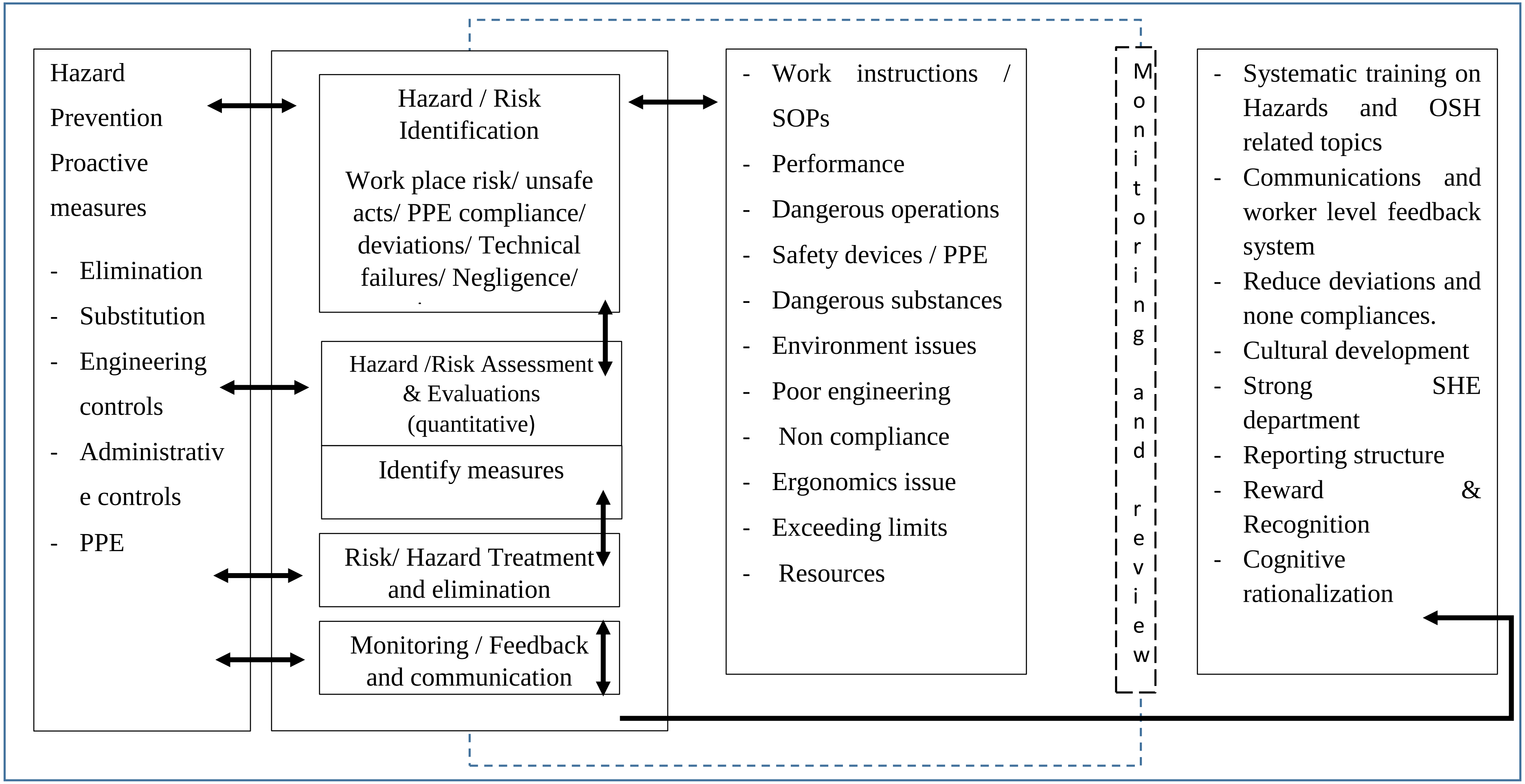


Figure 5.2 – Safety framework

5.2 Suggestions for future research

Container glass industry is worldwide business; the total glass melting tonnages in 2018 was recorded at 56.51 Million metric tons. Glass industry exposure of occupations safety and health hazards empirical data availability is limited, as the studies on these areas are not done broadly. Available studies are mostly from the developed countries, where the working environment, OSH conditions and OSH applications and practices would be considerably different than the developing or under developed countries. Nevertheless, the formal researches on the glass industry in long-term health effects of the employees are found less in developing countries. Further, the study on the employees who had long exposures with minimum PPE applications and retired from the industry should be the focus. For further research studies, the researcher recommend to use a bigger sample size in container glass industries covering batch house, furnace, and cold end, where other hazardous conditions prevail. Further researcher recommend to use minimum 05 container glass production facilities in different locations in the Asian region with novel style questionnaire.

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APPENDIX A

SURVEY QUESTIONNAIRE

Occupational Safety and health condition of Machine operators of Container glass industry

Purpose of the study is to evaluate the occupational safety and health status of the container glass industry. The study mainly focuses on the hot-end section machine operators.

PART A – Demographic/ employee status Data

1. Work category	Machine operator	☐		Supervisor	☐		
2. Gender	Male	☐		Female	☐		
3. Age	18 – 27 years	☐		28 years– 37	☐		
	38 – 47 years	☐		48 – 58 years	☐		
4. Work experience in Hot End	00 – less than 5 years	☐		More than 5 years to less than 10 year	☐		
	More than 10 years – less than 15 year	☐		More than 15 years to less than 25 year	☐		
	25 year and over	☐					
5. Hospitalized due to an accident during work	yes	☐		no	☐		
6. If yes, how many times		01	02	03	04	05	Or more
7. Are you suffering from any chronic health issue	yes	☐		no	☐		
8. if yes for Q 06 Please specify							
9. if yes for Q 06	were you suffering even before join with the company			It started after joining the company			
10. Maximum education level	☐	Grade 08	☐	O/L, A/L	☐	Diploma/ NDT	Other specify

achieved			Level	

How use the Evaluate –Likert Scale

Apply to all	1	2	3	4	5
#.1/2/3	Very Rarely	Rarely	Occasionally	Frequently	Very Frequently
#.4/5/6	Never	Seldom	Sometimes	Often	Almost always

Please rank the following hazards and questions based on your working experience in the hot end sections

Put a √ where appropriate / No answer expected for blacked out.
** = No of incidents in last 06 months - put the number 0 or 1,2,3……..N
= "Not Relevant" to me – **NR**
= I'm "Not Aware" – **NA**

PART B – hazard impact/ condition of employee and level of adherence.

01 Noise hazards	1	2	3	4	5	**
1.1 I face difficulties with hearing after working(Mild hearing loss)						
1.2 I take medical treatment for my hearing loss (Mild hearing loss)						
1.3 I have been hospitalized for hearing loss/ I wear hearing aids (Moderate Hearing loss)						
1.4 I am aware of noise related hazards (Knowledge/ awareness)						
1.5 I've given & use ear guard/ear muffler during working (commitment)						
1.6 I follow 100% safety practices on ear protection (adherence)						
02Burn Injuries –	1	2	3	4	5	**
2.1Burnt injuries (not a Loss Time Injury) (first degree burning)						
2.2Burnt injury which required 00 – 04 week medical leave (superficial second-degree burn)						
2.3 I have been hospitalized for Burn injury / more than 04 weeks or more medical leave (deep partial thickness burn)						
2.4 I am aware of burn & related hazards. (Knowledge/ awareness)						
2.5 I've been given (& use) helmets, Arm guards during work (commitment)						
2.6 I follow 100% safety practices on burn protection (adherence)						
03 Heat Stress conditions	1	2	3	4	5	**
3.1 I feet Onset of heat Stress during work (Mild heat stress condition)						
3.2 Medical treatments due to Heat exhaustion. (moderate heat stress condition)						
3.3 I have been hospitalized for Heat Stroke condition (high heat stress condition)						
3.4 I'm aware of heat related hazards (Knowledge/ awareness)						
3.5 I have been given (& use) protective clothes to prevent heat and ventilation is Good (commitment)						
3.6 I follow 100% safety practices on heat protection (adherence)						
04 Physical injuries - Cut injuries	1	2	3	4	5	**
4.1 Minor cut injury first aid incident immediately back to work (minor cut injuries)						

4.2 Cut injuries less two week medical leave + Medical treatment (Moderate cut)						
4.3 I have been hospitalized for cut injury& more than two weeks in medical Leave (Severe cut injury)						
4.4 I'm aware of physical hazards in working environment (Knowledge, awareness)						
4.5 I've been given (& using) cut resistant glove & safety shoes to protect feet from broken glasses (commitment)						
4.6 I follow 100% safety practices on cut protection (adherence)						
05 Respiratory issues	1	2	3	4	5	**
5.1 I've felt breathing difficulties during working/ area is full of smoke.						
5.2 I had medical treatment for respiratory issue (due to work environment)						
5.3 I have been hospitalized for respiratory issues/ breathing difficulty.						
5.4 I'm aware of respiratory hazards in working environment (Knowledge, awareness)						
5.5 I've given & use safety dust masks & breathing apparatus against fumes and smoke (commitment)						
5.6 I follow 100% safety on dust & smoke protection (adherence)						
6.0 Ergonomic issues "work-related injuries and illnesses"	1	2	3	4	5	**
6.1 I face Ergonomic Issus During Working						
6.2 I had medical treatment for ergonomic issue recently						
6.3 I've been hospitalized for ergonomic issue / during working						
6.4 I'm aware of ergonomic hazards in working environment (Knowledge, awareness)						
6.5 factory environment is supported for prevention of work related ergonomic issues (commitment)						
6.6 I always follow appropriate ergonomics applications during working (adherence)						
PART C – OSH General background Tick (√) the correct box	Yes			No		
Company do frequent fire drills						
Company do frequent emergency evacuations for all departments						
Conduct health and safety programs/ Trainings once a month						
All safety related equipment are maintain properly						
Housekeeping is a regular practice						
Plant Certified on OSHA 18000 and fully complied						
Plant certified on ISO 45001:2015 and fully complied						

Please mark your comment according to below scale 1– No effect / 2 – Low / 3 – Moderate / 4 – high / 5.- Severe

PART D – Identification of causes & their significance to the hazards.

Causes / Hazards	a/ Lack of Safety awareness, Training and competency	b/ Lack of Safety communication	c/ Lack of Organizational environment and Management support	d/ Lack of Risk judgments and management reaction	e/ Lack of supervision and monitoring	f. Lack of machinery maintenance	g/ Lack of following the instructions	h/ Lack of Following the Standards and adherence to systems	I / Lack of resources & infrastructure	j/ Lack of House keeping
Noise hazards										
Burn Injuries										
Heat Stress & hazards										
Physical Cut injuries										
Respiratory issues										
Ergonomic issues										
Slipping, Tripping and fall on floor										
Accidents by machinery										
Eye injuries										
Sprains of body parts										

APPENDIX B

TABLE 1

Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.

APPENDIX C

PILOT STUDY

SURVEY CRITIQUE SHEET.

Name -- department-------------------------------------

Employment category-----------------------------

Please fill in the blanks by putting √ marked where appropriate
This survey questions are well understood
Yes……… No……….
I filled the answers by myself alone
Yes……… No……….
I took more than ½ an hour to answer the questions
Yes……… No……….
All answers carrying my personal view
Yes……… No……….

	Question area	The question express the idea correctly		The Scale is understandable		Question strong enough to capture the data		I have another suggestion	
	Noise hazards–	Yes	No	Yes	No	Yes	No	Yes	No
	Burn Injuries								
	Heat Stress								
	Physical injuries								
	Respiratory issues								
	Ergonomic issues								
	Other hazards								

Remarks---

Date & Sign---