ANALYSIS OF ACCIDENTS IN SHIFT WORK IN CONTAINER TERMINALS IN SRI LANKA

Hemantha Pushpakumara Dodangoda

(149377T)

Degree of Master of Science in Occupational Safety and Health Management

Department of Building Economics

University of Moratuwa

Sri Lanka

May 2019

ANALYSIS OF ACCIDENTS IN SHIFT WORK IN CONTAINER TERMINALS IN SRI LANKA

Hemantha Pushpakumara Dodangoda

(149377T)

Dissertation was submitted in partial fulfilment of the requirements for the degree Master of Science in Occupational Safety and Health Management

Department of Building Economics

University of Moratuwa
Sri Lanka

May 2019

DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and 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.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

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

Signature of the supervisor: Date:

Dr. Sachie Gunatilake
Senior Lecturer
Department of Building Economics
University of Moratuwa

ABSTRACT

Being one of the most competitive industries in globally, the port industry requires high efficiency rate at all levels of operation. In such circumstances, container terminals play a leading role. The competition among container terminals demands a high productivity and mainly it is achieved by increasing the efficiency of labor force. As a result, shift work has been functioning in container terminals at all levels of operation.

However, it has been founded that shift work has a negative impact on health and safety of employees. It affects the accident frequency in work places. Therefore this study focuses on finding the impact of shift work on accidents in container terminals in Sri Lanka.

At first, a comprehensive literature review was carried out to investigate the knowledge on the research area. Consequently, occupational health and safety management at work places, container terminal operation, prevailing hazards in terminals, shift work and effects of shift work for the accident frequency in different work places were reviewed.

A mixed approach was adopted to capture quantitative and qualitative data for this study. Therefore, quantitative data was collected from AIR (Accident Investigation Report) data base of ABC container terminal for a period of five years from 2012 to 2016 and expert interview survey was carried out in order to capture the qualitative data. Finally, the quantitative data was analyzed using statistical techniques while qualitative data was analyzed via logical reasoning to identify relationships between accidents, activities relevant to accidents, impacts, severity, causes of accidents and work groups and further to investigate the relationship between shift work and accident frequency.

Research findings asserted that, there is an effect of shift work on accidents in container terminals. But it was unable to quantify the effect using available data. However, there is a potential to do a further study on workers, who have been identified to be responsible for high accident frequency.

Key Words: *Accident Frequency, Port Industry, Sri Lanka, Container Terminals, Impact of Shift Work*

ACKNOWLEDGEMENT

I would like to express my deep gratitude to my research supervisor, Dr. Sachie Gunatilake, for her guidance, support and enthusiastic encouragement to complete this research work successfully.

I would also like to thank Dr. Nayanthara De Silva, MSc Course Coordinator for her advice and assistance in keeping my progress on schedule.

I would also like to extend my thanks to the management of ABC Container Terminals, especially for the support given for the data collection.

Thanks to all my colleagues and others who have helped in various situations to make this research study a reality.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
AIR	Accident Investigation Report
ILO	International Labour Organisation
WHO	World Health Organisation
HSE	Health Safety Executive
IOHA	International Occupational Health Association
OHS	Occupational Health and Safety
IARC	International Agency for Research on Cancer
TEU	Twenty Foot Equivalent Unit

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Shiftwork has been functioning in selected industries from decades ago. At present, it is most common in healthcare, manufacturing / industrial, transport, communications and the hospitality sectors. Manufacturers realized decades ago that stopping a production line at night and starting it up again every morning is not efficient and also not cost effective. Therefore, employers could relieve critical tasks in a production line by running the critical task with shift workers twenty four hours a day. They found that it was more cost effective than investing on expensive capital equipment, (Shiftwork Solutions LLC, 2003). Therefore in the past shiftwork was mainly for economic reasons.

Nowadays shiftwork is so prevalent due to various reasons such as economic reasons, demographic and social changes, technological changes etc. Research has shown that nearly 20% of the working population in Europe and North America is engaged in shiftwork (Unite the Union, 2013). In Norway, for example, the number of employees who are involved in shift work systems has increased gradually and was 23.4% in 2008 (Norwegian National bureau of Statistics). Also in Sri Lanka there is a considerable number of labors working in shiftwork in different industrial sectors.

However, Dawson (2001) discovered that, “there is growing evidence to suggest that shiftwork, particularly night shift is bad for workers’ health and safety. Tired workers are more likely to make mistakes which may have serious consequences not just for them but for others”. During the late night hours concentration is difficult. Therefore, it results a higher incidence of on-the-job and off-the-job accidents. Many research studies have shown that shiftwork and work at night can have adverse health effects such as gastrointestinal disorders, heart diseases and cancers (Unite the Union, 2013).

In the overview given by Costa (2016) on ‘introduction to problems of shift work’ stated that the combination of circadian disruption and sleep deprivation can be responsible for high levels of sleepiness and fatigue during the work periods. Consequently, there is a higher proneness for damages, promoting errors and accidents.

Moreover, the author highlights that there are many other considerations which can affect shift workers. It can have serious effects on the health of new and expectant mothers and on breastfeeding. Further, he points out that family and social life also can have negative effects due to extended working hours.

Wagstraff & Lie (2011) have done a systematic review of safety implications on shift and night work and long working hours based on some empirical research. Their review has revealed few main findings: “ (1) both long hours and shift and night work affect accident risk, this is of importance to all organizations and workers, but of particular importance to safety- critical activities such as transport and health sectors; (2) periods >8 hours carry an increased risk of accidents. So that the increased risk of accidents at around 12 hours is twice the risk at 8 hours; (3) shiftwork including nights carries a substantial increased risk of accidents than ‘pure’ night work”.

According to the above studies it implies that shift work has a direct impact on human behavior, which enhances the accident risk.

The port industry is one of the main industries where shiftwork is operated due to the complexity of operations. After the containerization, port can be defined as “the interface among different transportation modes” (Pastorino, Vairo, and Fabino, 2014) in which container terminals play a leading role. Griffin & Murphy (2006) have defined the port terminal function as “nodal points with in a global system of ocean and land side modes of transportation”. Further, they show that due to the fact that increased demand for international trade and logistic services, huge investments and improvements in both physical and operational efficiencies are necessary to increase terminal productivity

However, Alcade (2014) shows that pure physical expansion is restricted by limited supply of available land, especially in ports which are centered in urban areas. It is because of high environmental concerns. Therefore improving the productivity of terminal facilities will be the only feasible solution. Hence, the efficiency of terminal operators can be gained by having extended hours of operation, while improvement of operational efficiency can be done by introducing technological improvements through automation of handling equipment.

In a port, there are many hazards produced from complex activities. For example, Lu and Kuo (2016) found that container terminal operations are hazardous since stevedores have to be involved in various risky workplace activities that include "operating cranes, lashing, electrical repairs, tally operating, and truck driving". The complex and various activities of the port have led the port to be considered as "a place of risk", where hazards can cause damages to persons, the environment, and/or property (Constantinos, Chlomoudis, Pallis, 2016). Furthermore, with regard to hazards in port, Chlomoudis, Kostagiolas, Pallis (2012) showed five risk categories based on accident causes, which were "human, machinery, environment, security, and natural". Therefore, careful identification and assessment of these causal factors are extremely important in order to minimize or to prevent accidents.

1.2 Research Problem

Darbra & Casal (2004) showed a clear increase in the frequency of occurring accidents in seaports in 95 countries. The impact of certain accidents on the environment, including people can be very serious. They concluded that this tendency is due to the increase in port activity and the growth in sea transport of hazardous substances. Releases, fires, explosions and gas clouds were the most frequent accidents. More than half of the accidents have occurred during transport. This analysis has been done using the information contained in the Major Hazard Incident Data Service (MHIDAS, 2002). It was developed and managed by the Safety and Reliability Directorate (SRD) in UK.

Fabiano, Curro, Reverberi & Pastorino (2010) have revealed that "although new technological advances and work schedules can improve the productivity, it has not improved safety conditions in port activities. There is an increase of accidents due to movement of huge volumes of containers in Genoa Port (Italy), one of the largest of the Mediterranean Sea". Further, they discovered an increase of accidents due to transport vehicles (+8.3%) and a reduction of accidents due to substance or materials (- 4.3%) in the above port.

Based on data obtained from the Maritime Department of Hong Kong, the incidence of accidents related to cargo handling/loading and unloading containers in Hong Kong is quite high (Rachman & Djunaidi, 2018). In 2006, there were 302 cases of work accidents related to loading and unloading of containers. In 2007, there were 240 cases and following years, 2008 to 2010, 220 cases, 176 cases and 157 cases were recorded for each year, respectively.

When consider the causes of accidents, Renato, Vairo & Bevenuto (2014) have emphasized that socio-economic factors, technologies used, environmental conditions and labor force typology are the main factors that can be identified for the occurrences of accidents in port activities.

Most published research on container terminal safety has focused on technical and engineering design issues or mathematical modelling of techniques of risk analysis [Example: Mabrouki, Bentaleb & Mousrij, (2014)]. Other researchers have focused on issues of safety culture and leadership [Example: Shang & Tseng, (2010)].

Although extended working hours or shift work is a contributory factor for occurrences of accidents (Dawson, 2001), studies on effect of shift work on accidents in ports, specifically in container terminals were not founded. Hence this study aims to fill that gap through an analysis of safety related incidents in shift work in container terminals.

The Port of Colombo, located in the South-West corner of Sri Lanka is one of the top container ports in South Asia. The ABC container terminal is one of three operators in the Port of Colombo with a potential handling capacity of 2 million TEUs (Twenty Foot Equivalent Unit). The terminal holds a 30% market share in the port of Colombo's three container terminal operation.

The employees of ABC container terminal, about 650, work on two types of shifts, called roster basis shift and general shift. There are three groups that work on roaster basis and they are rotated among two twelve hour time schedules. Employees in the general shift, work on fixed standard 8 hrs.

The ABC Container Terminal is committed to providing a safe and a healthy work place to protect all those affected by its activities and to avoid or minimize any adverse environmental impact of its businesses. However, when the safety performance of this terminal is considered, considerable number of incidents is reported from all four working groups which are functioned in two types of shifts. Based on accident investigation reports of the organization, on average there are about 13-15 incidents reported monthly and about 150 annually. These accidents cause people injuries and equipment property damages affecting the productivity of the terminal. At the same time, the social and economic cost to the workplace as well as to individuals is considerable. However, occupational injuries and accidents are all caused by preventable factors which could be eliminated by implementing measures and methods that already exist (Alli, 2008). Therefore, to minimize or to avoid the accidents, it is essential to identify and eliminate the possible causes of accidents.

As of today in Sri Lanka, health and safety related incidents in shift work in container terminals have not been explored in scientific literature. Therefore this study aims at analyzing of all the incidents in shift work and to understand the effect of shift work on incidents in container terminals in Sri Lanka.

1.3 Aim

It is the aim of this research to investigate the effect of shift work on container terminal safety.

1.4 Objectives

1. To review the container terminal operation, accident risk and impacts of shift work on the work place incidents within different types of work places.
2. To identify the incidents occurring during shift work in Container Terminals.
3. To investigate the type of activities related to accidents, their causes and impacts
4. To investigate the relationship between incidents and shift work in Container Terminals

1.5 Research Methodology

Initially, a comprehensive literature survey was carried out by studying and referring journals, articles, books, safety and health institution's magazines and sources of electronic media. The main purpose of the literature review was to acquire an in-depth knowledge on accident risks due to container terminal operation and the impact of shift work on accident risk within different types of work places.

The research was done via mixed approach. Case study and interview survey were used to collect data for the study. Data collected from those methods were analyzed using statistical methods and through logical reasoning analysis in order to arrive at conclusions and recommendations.

1.6 Scope And Limitation

This study was limited to one container terminal in the Port of Colombo due to time and accessibility constraints. On the other hand, different container terminals have different regulations in terms of hours of operation (shift and roster schedules).Therefore, the schedules of shift work of one terminal may differ from the other and it would be a problem when analyzing the data. Further, in this analysis only the impact of shift work on accidents were studied, the impact on health problems were not considered.

1.7 Chapter Breakdown

Chapter 1: Introduction

- Introduction to the research work the background, aim and objectives
- The research methodology in brief with the scope of analyzing accidents in shiftwork in container terminals in Sri Lanka and limitations of the research.
- The structure of the report

Chapter 2: Literature Review

- Literature review on the concept of Occupational Safety and Health, safety hazards, classification of incidents and causes of incidents.
- Literature review on port activities, possible safety and health risks and hazards associated with the port industry, accidents in sea ports.
- Literature review on shiftwork, the effect of shiftwork on safety and health of workers and accidents due to shiftwork in different types of work places.

Chapter 3: Research Methodology

- The methods of data collection and analysis together with the justifications for using the particular research approach.

Chapter 4 & 5: Research findings and Analysis

- Analysis and discussion of the research findings which will lead in achieving the research objectives.

Chapter 6: Conclusions and Recommendations

- Conclusions, recommendations and suggestions for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 2 contains all the information gathered during the literature review of this study. The text provides an overview of the prevailing knowledge on the research topic. Therefore this chapter aims at analyzing the extent to which the outcomes of previous research work have addressed the research question of the study.

At first, the chapter gives an overview on the concept of occupational health and safety, safety hazards and classification of incidents and their causal factors. Then it provides an overview of past and present operation of container terminals, prevailing hazards and accident risk in container terminals. Next, focuses on shift work and its effects. Finally, impacts of shift work on industrial accidents at different types of work places have been identified.

2.2 The Concept Of Occupational Health And Safety

Occupational health and safety is one of the most important aspects of human concern and it has been defined in various ways by different scholars. According to World Health Organization (WHO, 1995), occupational safety and health has been defined as "a multidisciplinary activity aiming at: protection and promotion of the health of workers by eliminating occupational factors and conditions hazardous to health and safety at work".

The International Occupational Hygiene Association (IOHA) generally defines occupational health and safety (OHS) as "the science of anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment" (International Labor Organization [ILO], 2009).Therefore, occupational health and safety can be seen to

concern the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations (ILO/WHO, 1995).

According to Dejoy & Southern (1993), occupational health and safety is "the concern of human wellbeing". Heath (1982) proposed Health and Safety as "conditions and factors that affect, or could affect the health and safety of employees or other workers (including temporary, and contract workers), visitors, or any other person in the workplace". Further, Dorland (2001) asserted 'health' as a state of optimal physical, mental and social well-being. It is not merely the absence of disease and infirmity. Occupational health and safety as contained in Encyclopedia (1998) made it clear that 'job safety' as the interrelationship between people and work, material, equipment and machinery, environmental and economic consideration such as productivity. Moreover, Garcie-Herrero (2012) is of the view that health and safety at work is therefore aimed at creating conditions, capabilities and habits that enable the worker and his/her organization to carry out their work efficiently and in a way that avoids events which could cause them harm.

2.2.1 Managing Health And Safety At Work Places

Nowadays, development of industries and service organizations has resulted acceleration of work place health and safety problems. Health and safety hazards in the workplace are the main cause for these problems (Dejoy and Southern, 1993). Different hazards and risks in the workplace have different levels of risk and consequences. Various injuries closely related to workplace accidents have been found to be associated with numerous workplace hazards such as physical hazards, chemical and dust hazards, safety hazards and health hazards (Kadir, Mohammad, Othman, Chelliapan, Amrin, 2017). These hazards are considered as a driving force, when finding solutions how to prevent health and safety problems in industries. Thus, hazard identification and management are significant in implementing risk assessments, occupational safety and health management and accident prevention.

2.2.2 Classification Of Work Place Accidents And Causes Of Accidents

According to the Occupational Safety and Health Assessment Series 18001, the workplace incidents are "occurrences arising out of, or in the course of, work that

could or does result in injury and ill health. An incident where injury and ill health occurs is sometimes referred to as an ‘accident’. An incident where no injury and ill health occurs, but has the potential to do so, may be referred to as a ‘near-miss’, ‘near-hit’ or ‘close call’ ”. Hence, based on the above definition we can categorize workplace incidents as “Accidents” and “Near Misses”.

In an industry or workplace, accidents may happen at any time at any place under any circumstances that has exposure to hazards. Accidents often occur due to the existence of risk in every task or job. According to Heinrich Theory accidents can be defined as “unplanned and uncontrolled events in which the action or reaction of an object, substance, person, or radiation results in personal injury or the probability thereof” (Hosseinnian, Torghabeh, 2012).

The theory stressed on the causal analysis theory which analyses the major variable that causes an accident. An accident may involve human, machine, or infrastructure. In this theory, it suggests that an accident can be prevented if one of the barriers of the variables was eliminated.

Hola, Sawicki, and Szostak, (2018) have developed a methodology for classifying and evaluating the causes of accidents in construction industry , using accident data involved in construction scaffolding. In that methodology the causes of accidents are identified and classified as Technical, Organizational and human ones, based on the various unsafe acts and unsafe conditions occurred.

Further, Vogel and Bester (2005) have studied the relationship between road accident types and causes by analyzing 404 road accident reports. Based on analysis they show that most of road accidents occur due to one or more than of factors; human, vehicle and environment.

Carril and Oneiva, (2012) have also discovered a clear relationship between the mechanisms of accidents and organizational and managements causes in manufacturing sector. In addition Cintron (2005) argues that human errors are one of the main factors which lead to errors and accidents in similar industries.

In recent years, many countries have been more concerned and stringent on health and safety requirements than ever before. Some research findings show that pressures from communities play a major role for the enactment of various safety legislations and safety standards in different countries and regions for different industries. Ahonen (2002), argue that "different international and national safety standards provide guidance to help organizations develop their safety management systems (SMS) with respect to varied business needs and requirements".

2.3 Historical Overview Of Container Terminals

Few decades ago, port industry underwent some fundamental changes. These changes occurred after the introduction of the standard size intermodal shipping containers. Mainly the changes took place in shipping, cargo-handling, technology and working culture (Beresford, Gardener, Pettit, Naniopoulos & Wooldridge, 2002).

Containers can be seen as relatively uniform boxes. Their specific feature is contents do not have to be unpacked at each point of transfer. In last four decades the container, as an essential part of a unit-load concept (a unit load combines individual item or items in shipping containers into single "units", that can be moved easily by a pallet jack or forklift) has gained great importance in international sea freight transportation (Steenken & Stahlbock, 2004). Therefore the container has captured the market of transport in between continents very rapidly.

Today over 60% of world deep sea cargo is transported in containers. Big sea vessels transport containers having a capacity of up to 15,000 TEU (a TEU is a Twenty Foot Equivalent Unit) (Steenken & Stahlbock, 2004). Muller (1999) has identified that the countries which are economically strong and stable are 100% containerized. With the increase of containerization the number of sea port container terminals has also increased.

Fabiano, Curro, Reverberi, & Pastorino, (2010) shows that container transport was revolutionary with economic viewpoint as cost of freight went down by about 25%.

2.4 Structure And Operation Of A Container Terminal

According to Steenken & Stahlbock (2004), the structure of a container terminal can be described as “an open system of material flow with two external interfaces. These interfaces are the quay side with loading and unloading of ships and the land side where containers are loaded and unloaded on/off trucks. Containers are stored in stacks thus facilitating the decoupling the quay side and land side operation”.

Container terminals have facilities with special equipment to carry out three main activities as follows:

1) Waterside activities: Loading and discharging of containers from deep sea vessels, feeder vessels and barges.
2) Yard activities: Temporal storage of the boxes awaiting shipment by either water or land based modalities.
3) Land side activities: The onward modality of the containers to land transportation modes (train & truck) vice versa.

2.5 Handling Equipment

Equipment and stacking facilities are the two major components which are taken into account when container terminals are described very specifically. According to logistics, terminals are consisted of two components as ‘stock’ and ‘transport vehicles’. The yard stacks, ships, trains and trucks belong to the category ‘stock’. They are also considered as storage entities. Equipment that is used for horizontal transport such as cranes and vehicles belong to the category of ‘transport vehicles’ (Steenken & Stahlbock, 2004).

Container terminals use different types of cranes (Noell, 2003) .The quay (or gantry) cranes play a major role in loading and unloading ships. There are two types of quay cranes. They are known as ‘single- trolley’ and ‘dual- trolley’ cranes. The trolleys travel along the arm of a crane and special devices called ‘spreaders’ are attached to them in order to pick up containers.

A variety of vehicles such as trucks with trailers, multi trailer and automatic guided vehicles (Ioannou et al., 2001) are used for the horizontal transport both for the water side and land side operation. These vehicles are known as first class vehicles. However, they don't have the ability to lift containers by themselves.

The second class transport vehicles do have the ability to lift containers by themselves. Straddle carriers, fork lifts and reach-stacker belong to this class. Containers and also stack containers in the yard are transported using these straddle carriers.

2.6 Health And Safety Conditions Of Workers In Container Terminals

Ports are often challenging places to work due to various reasons. Ports are functioning around the clock without any breaks in all types of weather conditions, dealing with wide variety of people. Though it looks exciting to work in ports it is potentially a high risk industry due to these challenges. There are often work pressures on employees. Port work often involves a number of different employers and/or contractors who can all affect each other's activities. Hence the operation of loading and unloading of containers has a significant impact on health and safety of workers due to hazards and risks associated with it.

Darbra and Casal (2004) have concluded from their study that "a significant increase in the frequency of accidents in seaports over time, starting from 471 accidents occurring in seaports in the years 1941- 2002. 83% of the accidents occurred in the last 20 years and 59% in the past decade".

Shang, Yang, and Lu (2011) have given some important statistics about accidents during cargo handling. According to the report of Health and Safety Executive (HSE, 2009), in the UK between April 2003 and March 2008, a work related injury occurring during cargo handling has resulted death of five people. There were 287 suffered and 1,909 were off work for more than three days. The Kaohsiung Port Authority indicated occurrences of 35 accidents in container terminals in Taiwan between 2004 and 2008.

2.7 Common Hazards And Risks That Exist In Container Terminals

Poor management and control of risks and hazards can also be a cause of accidents. Organizations that are unable to manage risk and hazards in the workplace tend to fail in managing accidents. Thus, the ideal solution for the reduction of accidents and the implementation of effective occupational safety and health management is to manage and control the risk of occurrence of the hazards.

Shang, Yang, and Lu (2011) highlighted " the potential risks in container stevedoring operations include structural failure during loading/unloading, falling from container tops, falling from the container lashing station, injury during unsafe handling of containers, being hit by a moving vehicle at the quayside, being crushed, getting struck by container doors, and exposure to harmful chemicals (HSE, 2009)".

The report submitted to the Institution of Occupational Safety and Health (IOSH) research committee by Walters (2016) shows the perception of terminal workers regarding the risks of activities within terminals. According to the workers loading and unloading ships and the storage and transportation of containers are the main high risk activities. Also there were risks due to coming into contact with moving machinery, vehicles, falling objects and falls from height. Risk of accidents was also raised as a result of work pressure when high productivity levels are maintained. Further, workers believed that poor ergonomic design and long shift patterns increase the experiences of health problems such as stress, fatigue and musculoskeletal disorders.

Detailed descriptions of common hazards that exist in container terminals are described as follows.

2.7.1 Falls From Height

The activities such as 'carrying out trimming', 'sheeting and container lashing', 'securing loads', 'accessing ships', 'working on board a ship or working on heavy machinery' are often associated the risk of falls from height.

In the port industry significant numbers of heavy vehicles are being utilized day to day transportation activities of containers within and outside the port premises therefore risk of falling, slips, trips from heavy vehicles are high.

It is reported that 60 employees were killed and 5000 seriously injured during the last 5 years in the UK in Haulage and distribution industries due to falling from vehicles (HSE, 2003).

Another 23000 workers suffered serious injuries which they were kept away from work more than three working days (HSE, 2003).

The two most common types of traffic accidents occurred that causing major injuries are being struck by moving vehicles and people falling from vehicles. (E.g. broken bones) (HSE, 2003).

"Over the period 1998/99 to 2002/03, the percentage share major injuries caused people falling from vehicles has increased 39% in 1998/99 to 47% in 2002/03" (HSE, 2003).

2.7.2 Falling Objects

There is a risk of falling objects when carrying out loading and unloading operation and stacking and stowing goods. Loose and incorrectly or poorly slung or stacked items are the main causes for this hazard. Also there are possibilities of dropping fittings and fixtures used during lashing operations. Further, poor loading of objects may collapse or fall having become unstable during transport.

2.7.3 Fire/Electrocution

There can be fire/electrocution dangers due to poor designing, construction, installation and maintenance of electrical equipment and installations.

2.7.4 Lifting Equipment

A wide range of lifting equipment such as gantry cranes, slewing cranes, forklift trucks or other similar machinery are used in loading and unloading operations in

container terminals. Poorly planned lifting operations involve high risks to people working in the area. Accidents may occur due to ‘failure of lifting equipment’, ‘falling loads’ and ‘workers being crushed by a moving load or lifting equipment’.

Shang and Lu (2009) found it is a serious problem in container terminals to systemize the management of risk in loading and unloading operations. Hence, controlling of accident risk effectively has become crucial. In addition Lu, Tzeng,Yang and Shiu (2001) have indicated that, operators who suffer container loading and unloading accidents mostly depend on insurance without having sound risk management strategies.

Further, a study of Shang and Tseng (2010) shows that the top three factors associated with severity of accident risk in loading and unloading operations are “moving the crane without raising the lifting arm of the gantry crane, resulting in damage to the pilot’s compartment”, “transferring containers direct to the trailers” and “as a result of climatic factors (typhoon), the facility takes no action to prevent collisions”.

2.7.5 Hazardous Or Asphyxiate Substances

During the operation of loading and unloading solid bulk cargoes often generate dust or respiratory sensitive fine particles that can cause asthma. Cargoes can be hazardous if they are flammable, toxic, poisonous or corrosive. Some cargoes, for example, grain may have been fumigated. Some cargoes in the hold may become hazardous or poisonous as a result of gases produced due to decomposition of bacterial action, for example fish meal. The vehicles in the ship's hold may also cause generating hazardous fumes due to exhaust emissions.

Sea transportation of chemicals has undergone significant changes over last 30 years. At present shipping of chemicals in containers is very popular due to the demand of chemicals in process industries. However, different hazards are created due to discrete storage of hazardous chemicals in containers (Fabino et al., 2010).

Christou (1999) has identified the hazards connected with handling and storage of hazardous materials in port areas. They are mainly due to hardware failures in equipment that are used for loading /unloading operations, bad weather conditions or fire/explosion in a close by ship.

2.7.6 Moving Vehicles And Equipment

After containerization, a port can be defined as the interface among different transportation modes; rail, road, inland navigation. With the increase of traffic movements, traffic incidents have become a serious problem in container terminals. Also with the demand of higher efficiency, fast-paced operations and large heavy equipment are the main causes for these incidents. Many work related injuries and fatalities that occur in container terminals are due to traffic incidents (Fabino et al., 2010).

The Bureau of Labor Statistics has reported 88 fatalities on the marine cargo handling industry from 2005 to 2012 (HSE, 2013). Incidents relevant to transportation have caused 52 of those fatalities. Some of factors that contribute to traffic incidents are 'unsafe equipment', 'inadequate traffic controls', 'condition of

terminal driving surfaces', 'weather', 'driving obstacles', 'improper parking', ' fatigue and unsafe vehicle operation'.

2.7.7 Slips And Trips

The highest number of port accidents reported to Health and Safety Authority are due to slips, trips and falls on the same level. Poor housekeeping has been identified as the main factor for those accidents. (Hazards in port and doc operations, information sheet, 2015, February).

2.7.8 Environmental Hazards

The weather has a large impact on port operations. Bad weather can reduce visibility. Adverse cold and wet weather conditions can reduce concentration and make manual work more difficult. 'Heat exhaustion', 'sunburn or sunstroke' may result due to hot weather. Wind, rain and fog can all increase the risk of slips, trips and falls. Tidal movements also can affect the loading and unloading operations in the sea side resulting collisions between dockside equipment and ships.

Alises, Molina, Gomez, Pery and Castillo (2014) pointed out "Overtopping events due to storms may cause different failure modes and affect both management and exploitation of port activities and the design of seawall structures".

2.7.9 Night/Shift Work

The growth and development of port industry have created an increased demand of productivity levels in port areas, which resulting a requirement of high productivity at each and every operational level. Consequently, this situation has created an increased competition between container terminals.

Shaghaghi, Corkhill and Salhi (2010) revealed that this increasing competition arising in container terminals requires efficient delivery of operation at all levels and it can be achieved mainly by efficient use of labor resources. Thus, it is required a flexible labor schedule to match the service demand. As a result, shift and roster

work schedules have been started functioning in container terminals in order to maximize efficiency and reduce associated labor costs.

However, National Secretary of the Maritime Union of New Zealand says “Fatigue and stress come from the pressure for fast turnaround, long shifts, consecutive shifts and irregular work hours and these contribute to fatigue and stress related issues, which increase the risk of health and safety incidents.” J. Fleetwood (Personal communication, April 2015)

2.8 Understanding Shiftwork

As per the health and safety guidance (managing shift work) there is no specific definition of shiftwork in law (HSE, 2006), but it usually means;

“A work activity schedule outside standard daytime hours, where there may be a handover of duty from one individual or work group to another; A pattern of work where one employee replaces another on the same job within a 24-hour period”.

Standard daytime hours are considered as a work schedule involving an activity during the day. It is commonly for a period of eight hours between 7.00 am to 7.00pm. There are usually two periods of work, one in the morning, and the other in the afternoon, separated by a lunch-time break.

In the guidance following all systems of work other than standard daytime hours are considered as shiftwork.

- Work during the afternoon, night or weekend, typically with periods of the work schedule outside standard daytime hours;
- Extended work periods of 12 hours of more , often associated with compressing the working week;
- Rotating hours of week;
- Split shifts, where work periods are divided into two distinct parts with several hours break in between;
- Overtime;
- Standby/on-call duties.

2.9 Effects Of Shiftwork

Many researchers have identified many undesirable consequences for both men and women who work according to shifts and non-standard working hours. Mainly, they are during the night or with early morning starts.

Costa (1996) discovered the following:

> "Shift work, in particular night work, can have a negative impact on health and well-being of workers as it can cause: (a) disturbances of the normal circadian rhythms of the psychophysiological functions, beginning with the sleep/wake cycle; (b) interferences with work performance and efficiency over 24 hour span, with consequent errors and accidents; (c) difficulties in maintaining the usual relationships both at family and social level, with consequent negative influences on marital relations, care of children and social contacts; (d) deterioration of health that can be manifested in disturbances of sleeping and eating habits and, in the long run, in more severe disorders that deal prevalently with the gastrointestinal (colitis, gastroduodenitis and peptic ulcer), neuro-psychic (chronic fatigue, anxiety, depression) and, probably, cardiovascular (hypertension, ischemic heart diseases) functions. Besides, shift and night work may have more specific adverse effects on women's health both in relation to their particular hormonal and reproductive function, and their family roles".

2.9.1 Health Effects

Mirtorabi (2006) stresses that "the human body does not function well during night time hours. Daytime activity and nighttime rest is not a mere social preference but an entrenched biological demand". However, impact of abnormal working patterns on health in not very much clear. But the disturbance of biological rhythms over many years may have negative long-term effects (unite guide for members, 2013).

2.9.1.1 Biological Effects

(i) Cardiovascular Disorders

Most of research recognizes a relationship between shiftwork and cardiovascular diseases (Knutsson & Boggild, 2000). According to Knutsson et al., (1986) this link causes generating higher levels of cholesterol and triglycerides that can cause cardiovascular illness.

Smith et al., (2003) has also confirmed that point by saying "Shiftwork may also exacerbate the body's stress response and result in increased heart rate and cholesterol, elevated blood pressure and altered glucose metabolism. Also shift worker tend to exhibit more risk behaviors such as smoking that increases cardiovascular diseases"

Further, Boggild & Knutsson (1986) have found that on balance, "shift workers have a 40% greater risk for cardiovascular mortality or morbidity than their day worker counterparts".

(ii) Gastrointestinal Disorders

Gastrointestinal dysfunction is a common complaint made by shift workers. Costa (1996) has found "20-25% of night workers reported incidents of heart burn, gas, irregular bowel movement, and constipation and appetite irregularities. For day shift workers it was 10-25%". Also night workers show higher proneness to suffer from digestive tract disorders.

(iii) Reproductive Disorders

As per Smith et al., (2003) shift work may also have impact on women's reproductive health. There is a higher number of female shift workers who have reported irregular menstrual cycle length and pattern. In addition, it has also been found that there is a relationship between shiftwork and higher risk of spontaneous abortion.

(iv) Diabetes

Canadian Diabetes Association (2006) has proved that "shift work disrupts the bodily rhythms necessary for optimal diabetes control. Insulin secretion and glucose tolerance follow a circadian rhythm. By disrupting these rhythms shiftwork can have negative impact on controlling glucose level resulting diabetes". For diabetics, regular timing of meals plays a major role in controlling diabetes. But shiftwork may be a barrier for those factors difficulties in managing diabetes.

(v) Asthma

The individuals with chronic asthma may usually report greater symptoms at night due to the fact that bronchial reactivity occurs mainly during the early morning hours. Therefore shiftwork may exacerbate the conditions of Asthma (Green-McKenzie & Behrman, 2005).

(vi) Development of Cancer

Research has found that there is a link between shiftwork and development of cancers. The Health and Safety Executive (HSE) has done a review in 2003 and has evidenced that a possible relationship between non-standard working hours and breast cancer in women.

The international Agency for Research on Cancer (IARC) has announced in late 2007 that "shiftwork involving circadian disruption is probably carcinogenic to humans". Further IARC said "Epidemiological studies have found that long term night workers (mainly nurses and flight attendants) have a higher risk of breast cancer risk than women who do not work at night (unite guide for members, 2013)

2.9.1.2 Psychosocial Effects

Many research works have stated that shift workers often show symptoms related to mental issues namely fatigue, irritability, apathy, and poor appetite and psychosomatic complaints.

Smith et al., (2003) has discovered that "sleep disruption and loss are the most obvious effects on a shift worker. The longer the shift lasts, the more serious the effects. Bodily processes such as temperature, heart rate and blood pressure are lowest at night, so employees who work at night cannot perform well"

Amreja, Satia and Singh, (2016) have recently found that rotating shift employees have higher State-Trait anxiety scores and stress levels than other employees. They also show there are variations in the level of work life balance among the employees based upon the shifts they are working in.

2.9.2 Individual Effects (Degradation of Family Life)

Many research works have shown shiftwork affects the family and social life.

Skipper, Jang and Brink, (1990) says "shiftwork interferes with family relations". Jekeilek (2003) has also proved that shiftwork increases degradation of family life creating marital stress and promoting work-family conflicts.

Shift worker also find it difficult to fulfil their responsibilities as parents. Shiftwork weakens the relationships between parent and child. Because the contact time with children is reduced and children are required to remain quiet when the shift worker sleeps during daytime. Isolation from friends and family, difficulties to participate in social events are some other negative effects which are faced by shift workers.

Harrington (2001), one of Britain's leading experts in occupational health concluded that shift work and in particular night working could cause "considerable disruption of family and social activities as many of these rhythms of the general population oriented around the day". He said "child care, house work shopping and leaving a partner alone at night can all lead to marital strain and family dysfunction".

2.9.3 Accidents

Recent studies of Folkard & Tucker, (2003) have shown that shift work has an effect on the risk of injury. They have found that "working night shifts has about a 25-30% higher risk of injury than working day shifts". They also show that "working on 12 hour shifts rather than on 8 hour shifts increases the risk of injury, again by 25-30%".

Lyzincki (1998) shows that shiftwork related fatigue has an impact on drivers who have become responsible for both motor vehicle and passenger train accidents.

In addition, Perter & Raggatt (1992) have also identified that truckers, working long shifts report a very high risk between the seventh and tenth hour of the driving shift. Moreover, it doubles the risk after the twelfth hour.

Smith & Colligan (1982) performed a study addressing health and safety consequences of shift work among food processing workers from 8 American plants. They found that the rotating shift workers showed that 44% of these workers need ≥ 1 week to adjust their sleep pattern. A significant higher frequency of work injury was found among male rotators than day workers. The actual injuries included sprains, superficial injuries and open wounds, contusions and fractions.

Hanecke, Tiedemann, Nachreiner and Grzech-Sukalo (1998) used data from the Confederation of Workers' Compensation Board to investigate whether accident risk could be a function of hour at work and time of day in the German working population. The results showed a higher number of accidents for people starting their job at 06:00, 07:00 and 08:00. A small peak of work accidents was found among people starting their work at 14:00 and an even lower peak among people starting their work at 22:00-24:00.

Another study of Gold (1992) has found that nurses working rotating shifts were twice as likely to meet off the job accidents. Also the likelihood of reporting an on the job accident or mistakes related to sleepiness is twice.

Reason (1995) has discovered that “most accidents or adverse events are due to human rather than technical failures”. Further, he says that “it is a well-known fact in the transport sector, while it is becoming a well-established fact in the health sector. It is probably the case for all complex and potentially hazardous systems where humans interact”

.

Fadda (2015) has also revealed that the number of accidents in intermodal terminals depends on a wide range of human errors due to fatigue despite the automation level. Recent studies suggest that operator fatigue could be a major contributor to incidents in container terminal.

2.10 Summary

Chapter two, literature review chapter was aimed at synthesizing the literature available on shift work and container terminals. At first, understanding of the structure and operation of container terminal was achieved. Then the health and safety conditions of employees in container terminals and their exposures to hazards were identified. Secondly, knowledge on the shift/night work and long working hours, its effects related to health and safety of employees with in different work places was gained.

Literature confirmed the fact that port industry, especially container terminals has a very high competition among each other due to increase of container shipments. Therefore shift and roster work schedules are operated in container terminals in order to maximize the efficient use of labor resource at each operating level. Also it was identified that container terminals have very complex working environments due to the nature of its operation. As a result workers are always exposed to various hazards including shift work. The accident frequency rate in container terminals is governed by various factors, such as economic factors, technologies used (low automation, discontinuous operating) job design, organization of work/environmental conditions and human factors.

It is also confirmed the fact that the shift/night work has adverse effects on health and safety of employees, particularly in industries where safety critical activities are involved, especially health and transport sectors.

The findings drawn from this chapter act as a base for the chapter three, which provides details of the research approach and techniques adopted for the study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter focuses on the research methodology framework adopted to accomplish the pre-defined objectives. Hence, the chapter explains the elements of research framework under, research process, approach, strategy and the techniques in terms of data collection and analysis that whereas undertaken in the study.

3.2 Research Process

The research process is a sequence of pre-determined activities that are used in order to ensure that the research is carried out effectively.

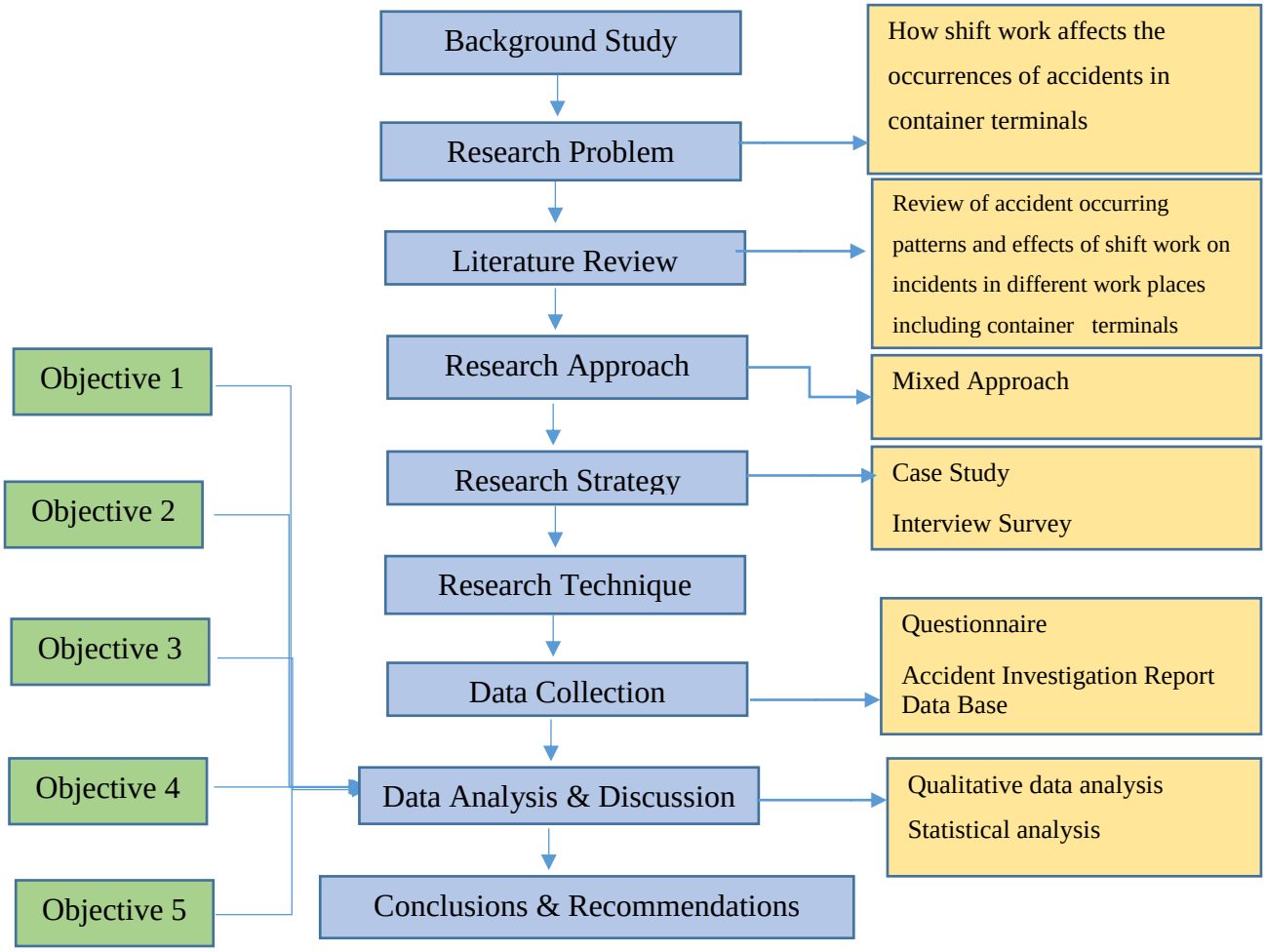


Figure 3.1 : Research Framework

3.3 Research Approach

Creswell (2003) has pointed out that there are three approaches to undertake a research, namely qualitative, quantitative and the mixed approach. According to Harwell (2011), the approaches identified cannot be viewed as rigid and discrete techniques even if each approach is established upon a set of assumptions, values and also concepts that are accepted by the researches. Further, Mack, Woodsong, MacQueen, Guest and Namey (2005) have stated that the distinction is due to the nature of objectives, the manner in which questions are designed, types of data collection techniques adopted and the degree of flexibility in the design.

After analyzing the qualitative and quantitative approaches, mixed approach was selected to carry out this research which comprised both quantitative and qualitative approaches. At first, with relevant to objective two and three, type of incidents occurred, type of activities related to accidents, their causes and impacts were identified and quantified using quantitative analysis. Further, those results were used to investigate the relationship between incidents and shift work. Secondly, the obtained results were validated using a qualitative approach that is conducting a questionnaire survey with health and safety experts in the same organization.

3.4 Research Strategy

Research strategy aims at guiding the researcher in the determination of the research methodology (Bryman, 2007). Hence, the research strategy has to be selected according to the data intended to be captured. Therefore survey strategy and case study strategy were selected for this research.

3.4.1. Case Study Strategy

Case studies are adopted in circumstances when in-depth evaluation is needed to address the research problem (Yin, 2014). Further, Case studies are the most appropriate method when the research focuses upon a program, event, activity or a process (Bhattacherjee, 2012).Therefore in this study, “case study strategy“ was adopted in order to capture the required data relevant to the incidents in container terminal operation.

3.4.1.1 Case Selection

When the container terminal operation is considered`, performing of the main activity of loading and unloading of containers is almost similar in each container terminal. However, there can be differences in worker competencies, equipment used, shift work schedules etc. Therefore a single case study was adopted in order to avoid ambiguities when analyzing data to accomplish the objective two and three of this research. Out of three terminals that are functioning in the port of Colombo, the ABC container terminal was selected as the sample case for this study due to the reasons of, easy accessibility, convenience in data collection and good terminal capacity [Handles about 2 million TEU s (Twenty Foot Equivalent Unit) per year].

3.4.1.2 Unit of Analysis

The unit of analysis is the entity which is being analyzed by the research. Through the case study of this research, the incidents occurred in shift work relevant to health and safety were analyzed. Thus, the unit of analysis was the "health and safety related incidents occurred in shift work ".

3.4.2 Survey Strategy

Survey strategy involves collecting data with regard to preferences, behaviors and perceptions in a systematic approach. Generally, survey strategy requires a sample based on which conclusions of the population are made (Bryman et al., 2011). Depending on the nature of data collected, survey strategy is classified as questionnaire survey and interview survey (Bhattacherjee, 2012). Interview survey is the technique by which data is captured from the verbal responses and in a questionnaire survey data is gathered from the written responses.

3.4.2.1 Interview Survey And Sample Selection

Interview survey paves the way for the researcher to gather data in a personalized manner in comparison to the questionnaire survey. As Walliman (2011) pointed out the types of interviews can be in three forms as 'structured interviews', 'unstructured interviews' and 'semi-structured interviews' depending on the nature of the questions asked.

In this research, semi-structured interviews, based on standard and open type questions were carried out in order to validate the results which obtained from quantitative analysis. The sample of experts was selected identifying three personnel in the terminal by designation, Health, Safety and Environment Manager, Engineering Manager and Safety Officer. Sample selection was made based on their industrial exposure.

3.5 Data collection

Once the research approach is set, techniques need to be identified to capture data which pave the way to answer to answer the research problem. Data is extracted either from primary sources or secondary sources. For this research, secondary data was drawn from the literature synthesis in chapter two and from the AIR (Accident Investigation Report) data base (Case study) which is maintained by the ABC terminal. Primary data was collected via the expert interview survey using semi-structured interviews.

3.5.1 Data Collection Of Case Study

3.5.1.1 Data Sources

The AIR database, an electronic database is maintained by the ABC terminal to record all the incidents happen inside the terminal premises according to the incident reporting procedure of the company. AIR database maintains data in two formats. A spread sheet format is being used to maintain identification of the incident, date of the reporting, person who reports the incident, working shift, area of work, vessel and voyage (if relevant), equipment get involved and estimated cost for the damage. Corresponding AIR report is maintained for each and every incident. This information is stored in text format providing information on the details of the incident, initial incident investigation and provisions are given to provide information on: engineering investigation findings and estimated repair cost by Engineering Department, recommendations from the reporting party how to recover the cost, medical treatment and loss time injury by the HR department and suggestions and comments by HSE (Health, Safety and Environment) department. Provision is given to the reporting party to attach relevant photographs. Incidents

which occurred and recorded within 5 year period from calendar year 2012 to 2016 were extracted from the AIR spread sheet database and corresponding AIR reports were taken for the analysis.

3.5.1.2 Quantitative Data

Quantitative data from the AIR spreadsheet database is used to analyze type of incidents occurred, type of activities related to accidents, their causes and impacts relevant to incidents in shift work in the ABC container terminal. Some variables were directly taken from the AIR spreadsheet database and few variables were computed using original data from the AIR database. Hence, the two variables, date of incident happened and the times were taken directly from the relevant AIR investigation reports. A composite variable with several levels has been built to identify the factors (personal, environment, equipment or any combination of these 3 factors) influenced to the incident. This task was completed by the researcher by considering each description of incident on how and why the incident happened as recorded in AIR reports (Refer Appendix A). The following table describes the direct variables and computed variables using both secondary data sources.

Table 3.1: Variables, data sources and method of extraction/ &computation

No	Variable description	Data Source	Method of extraction/computation
1	AIR identification number	AIR spreadsheet	Copy and paste
2	AIR reporting Year	-	From AIR identification number
3	AIR reporting Month	-	From AIR identification number
4	AIR reporting Day	-	From AIR identification number
5	Date of incident occurred	AIR Investigation reports	Transfer data by referring Investigation reports
6	Time of incident occurred	AIR Investigation reports	Transfer data by referring Investigation reports
7	Day of incident occurred	-	Convert from the “Date of incident occurred”
8	Status of reporting (whether report or not by the relevant party)	AIR spreadsheet	Copy and paste
9	Person who reported the incident	AIR spreadsheet	Original data maintain as name of initials of the person done the reporting. Replace the initial with designation.
10	Shift identification –	AIR spreadsheet	Copy and paste

	Work Group		
11	Name of the Vessel	AIR spreadsheet	Copy and paste
12	Voyage of the Vessel	AIR spreadsheet	Copy and paste
13	Estimated cost to recover the damage	AIR spreadsheet	Copy and paste
14	Nature of the incident	AIR spreadsheet	Identify by referring description of the incident
15	Severity of the incident (based on the company rating index)	AIR spreadsheet	Copy and paste
16	Factor influenced (human, environment, equipment or any combination of these 3 factors)	AIR Investigation reports	Transfer data into a quantitative form by referring Investigation reports

3.5.2 Analysis Of Quantitative Data

Data analysis was done according to the objectives that were to be achieved. Following statistical tools and methods were used in the data analysis.

The analysis was on single and bi-variant levels, comparison within working shifts. Analysis of incidents was carried out on day, month and yearly basis. Trends of incidents occurred with the time factor were also analyzed. Further, the influencing factors and the level of impact of the incidents were analyzed. Significant differences and trends were highlighted mostly through percentages and actual numbers.

3.5.2.1 Data Analysis Tools

Mainly two data analysis tools have been used to tabulate, analyze and present data in the study. Both the tools are computer soft-wares which support to do the tabulation and analysis accurately and present data efficiently.

(1) Microsoft Excel Spreadsheet program in personal computer environment has been used to recode, compute and tabulate quantitative data. The graphical presentations were produced through this tool.
(2) In order to further tabulate, analyze and statistical testing of quantitative data, a computer soft-ware SPSS Release 16.0 has been used. Single and bi-variate levels analysis were carried out through this statistical tool.

3.5.2.2 Limitations Of Data

It has been identified several limitations of data specially dealt with quantitative data. These limitations were identified while planning the study and analyzing the data. Identified limitations are described below:

(1) Quantitative data analysis had to restrict on data which is collected from AIR data bases. This limitation appears as AIR databases have been developed to fulfil company requirements not to reach the objective of this study.
(2) There is no checking mechanism to find reasons for incompleteness of data in some variables. A classic example is that financial data to estimate cost for the damage. Missing data in this variable can be either no damage to recover or missing in reporting. It seems that access to the AIR database is given to different departments and there is no checking mechanism for record completion procedure.
(3) Changing of the data collection format (AIR report format) by the organization in 2013 by introducing new variables resulted missing values for past records, in 2012. Therefore, categorization of Severity of the incident has been identified from year 2013. This categorization is not available for 2012 data records.

3.5.3 Data Collection Of Expert Survey: Semi Structured Interviews

3.5.3.1 Structure Of The Interview Guideline

The interview guideline was developed with the aim of validating the results obtained from quantitative analysis with regard to objective two. Semi-structured interviews were undertaken and thus, open ended questions were included (Refer Appendix B). The structure of the interview guideline is depicted in table 3.2.

Table 3.2: Structure of the Interview Guideline

Question No.	Objective
1 & 3	Status of reporting culture
2	Identification of categorization of incidents
4,5 &6	Identification of reasons for increasing trends in accident risk

3.5.3.2 General Information On Respondents

Interviewees were selected based on their experience and competency of the subject matter, hands on experience and managerial experience in the ABC container terminal. Three interviewees were selected to gather data due to the time constraints.

Safety Officer was identified for this sample as he worked as an operator of the terminal more than 10 years before he became the Safety Officer of the terminal. He understands the behaviors of the operative staff well and their thinking patterns difficulties that they are facing while operation is being carried out. It was expected that his networking and collaboration with the shop floor level employees would significantly help to validate the results. Other two officers, Engineering Manager and Health, Safety and Environment Manager were selected from the senior management level as they have more than 12 years experience in operation as well as managing safety and health in the terminal.

The interviews were conducted face to face and responses were recorded during the interview. Then the responses were transcribed. Profiles of the respondents are illustrated in table 3.3.

Table 3.3: Details of Interviewees of the Interview Survey

Interviewee	Designation	Experience
HS1	Safety Officer	+15 years
HS2	Engineering Manager	+15 years
HS3	Heath, Safety Environment Manager	+12 years

3.5.3.3 Analysis Of Interview Data

Interview data was analyzed by logical reasoning based on the responses given by interviewees.

3.6 Summary

Chapter three of the study, research methodology briefly discusses the research process, research approach and research strategy including the data collection and data analysis techniques. At the beginning, a literature review was conducted as the base for the study. Then the most appropriate research approach (mixed approach) was identified for the study. Once mixed approach was selected as the best approach for this research, case study and interview survey were selected as most suitable strategies to collect data. After capturing required data from the techniques adopted, analysis of quantitative data was carried out using different methods and tools of statistical techniques while analysis of qualitative data was done by logical reasoning.

CHAPTER 4

DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1 Introduction

This chapter has been drafted with the intention of presenting and explaining of all quantitative and qualitative data that were captured and analyzed in the study. Initially, the recorded quantitative data were tabulated with other relevant variables based on the type of analysis (single or bi-variate) intended to be done. Then each table was followed by a graphical presentation to see a clear relationship between variables. At first, a general analysis of significant relationships between incidents and other variables such as frequency, relevant activities, impact, severity, causes has been done and discussed. In addition, qualitative data that were captured from the expert interview survey was used to validate the results obtained from the quantitative data to accomplish the pre-defined objectives of this research.

4.2 Incidents In ABC Container Terminal

The incidents are "occurrences arising out of, or in the course of, work that could or does result in injury and ill health. An incident where injury and ill health occurs is sometimes referred to as an 'accident'. An incident where no injury and ill health occurs, but has the potential to do so, may be referred to as a 'near-miss', 'near-hit' or 'close call' ". Based on the above definitions (Occupational Safety and Health Assessment Series 18001), in this study we have categorized the incidents as "Accidents" and "Near Misses".

There were 787 recorded incidents in the AIR (Accident Investigation Report) database of the ABC Container Terminal. Out of 787, two (2) incidents had been recorded without the date of incident. Twelve (12) incidents had occurred during the latter part of the year 2011 and 773 incidents had occurred during 5 year period from 2012-2016. As our study period is 2012-2016, total of 773 incidents were taken for the initial analysis without considering the completeness of data records.

While analyzing each and every AIR report, it was found that fourteen (14) incidents had been recorded in the database without basic categorization of the incident, such that whether they were accidents or near misses. Categorization of these 14 cases was not possible because qualitative information on brief description of the incident and the type of damage incurred in AIR individual reports were missing. Hence, it was decided to exclude these 14 cases from the analysis. Finally, the analysis is based on 759 incidents which had occurred during the period of 5 years 2012-2016 at the ABC container terminal premises.

4.3 Types Of Incidents

Out of 759 recorded incidents 702 (92.5%) were accidents and the balance of 57 (7.5%) were near misses. Number and percentage of incidents by type are distributed among the year of incident in the Table 4.1.

Table 4.1: Distribution of incidents by type and year

Year of incident	Type of incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
2012	167	94.9%	9	5.1%	176	100.0%
2013	180	90.9%	18	9.1%	198	100.0%
2014	132	90.4%	14	9.6%	146	100.0%
2015	100	95.2%	5	4.8%	105	100.0%
2016	123	91.8%	11	8.2%	134	100.0%
Total	702	92.5%	57	7.5%	759	100.0%

Note: 759 incidents occurred in 2012-16 were used in the analysis.

The graphical presentation of data in Table 4.1 is shown in the Figure 4.1 below.

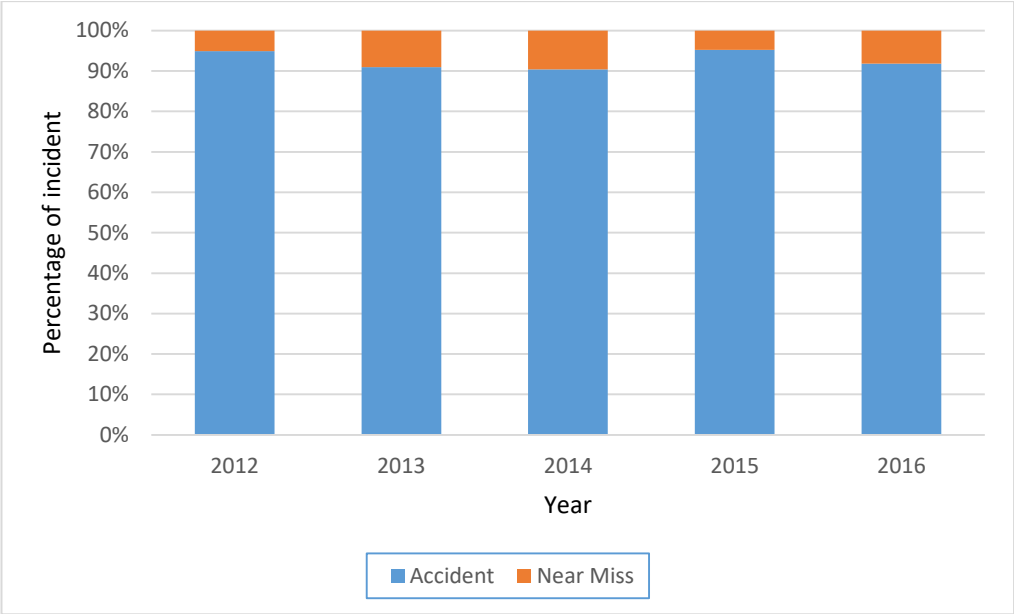


Figure 4.1 : Percentage distribution of type of incident by year

As a percentage, accidents have occurred more than 90% in all 5 years. Percentages of near misses to the total incidents are very less all over the study period. It has shown no clear upward or downward trend in occurring accidents from 2012 to 2016. But there is a drop in 2015 and again an increase in year 2016. It shows over 5% of near misses throughout the period except in the year 2015 (4.8%).

Categorization Of Incidents – Expert Interview Survey Result (Refer Appendix B, Question2)

All of the three interviewees said "…….*the incidents have been categorized into two specific categories including near misses and accidents in ABC container terminals, and they further consider near misses as close call accidents……."*

4.4 Incidents Occurring Patterns According To Month And Week

4.4.1 Incidents Occurred By Month

Incidents can happen at any time inside the premises other than in a period where the operation is stopped. As the terminal operates throughout the year continuously, it is also important to see the distribution of incidents occurred month wise.

To see the pattern of occurring “Accidents” and “Near Misses” in month wise, all 5 years data were accumulated into months and plotted in a bar chart (Figure 4.2).

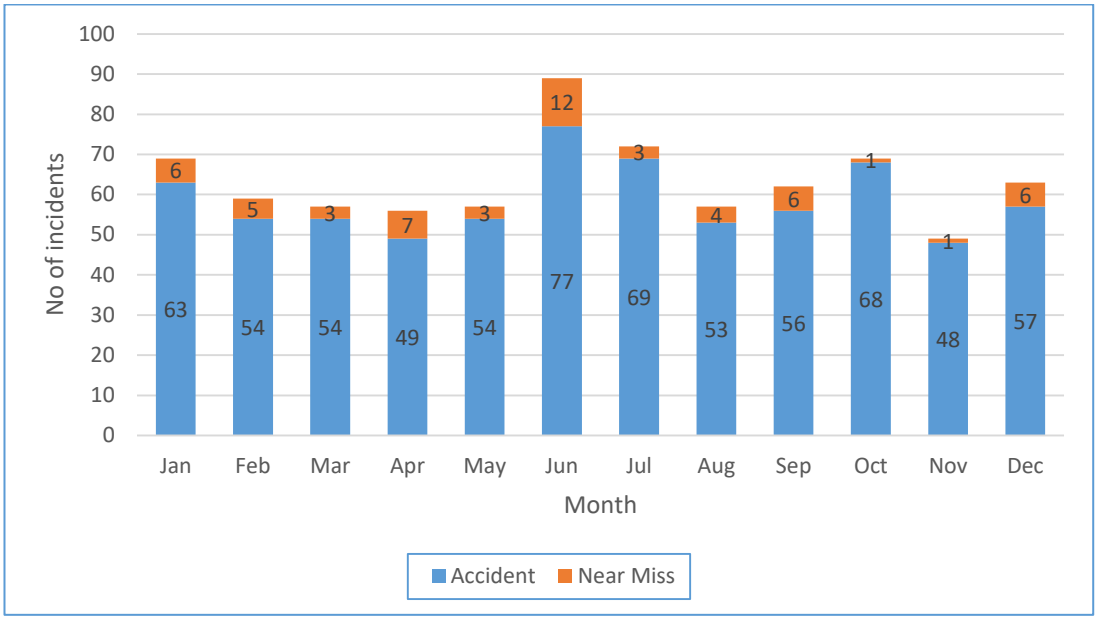


Figure 4.2 **:** Incidents occurred by type and month

It is clearly noticed that the highest number of incidents have occurred during the middle of the year that is during the months of June and July. The pattern takes a symmetric view around the middle months. Again an increase can be seen in the month of October.

The number of accidents which has occurred during calendar months is cross tabulated with the year in the Table 4.2 below.

Table 4.2: Distribution of accidents occurred by month and year

Month	Year											
	2012		2013		2014		2015		2016		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
January	23	13.8%	16	8.9%	12	9.1%	7	7.0%	5	4.1%	63	9.0%
February	15	9.0%	14	7.8%	10	7.6%	10	10.0%	5	4.1%	54	7.7%
March	21	12.6%	8	4.4%	14	10.6%	3	3.0%	8	6.5%	54	7.7%
April	8	4.8%	12	6.7%	10	7.6%	9	9.0%	10	8.1%	49	7.0%
May	10	6.0%	18	10.0%	11	8.3%	11	11.0%	4	3.3%	54	7.7%
June	14	8.4%	22	12.2%	11	8.3%	12	12.0%	18	14.6%	77	11.0%
July	13	7.8%	24	13.3%	12	9.1%	12	12.0%	8	6.5%	69	9.8%
August	12	7.2%	9	5.0%	12	9.1%	8	8.0%	12	9.8%	53	7.5%
September	6	3.6%	20	11.1%	11	8.3%	8	8.0%	11	8.9%	56	8.0%
October	12	7.2%	16	8.9%	12	9.1%	12	12.0%	16	13.0%	68	9.7%
November	14	8.4%	9	5.0%	8	6.1%	4	4.0%	13	10.6%	48	6.8%
December	19	11.4%	12	6.7%	9	6.8%	4	4.0%	13	10.6%	57	8.1%
Total	167	100.0%	180	100.0%	132	100.0%	100	100.0%	123	100.0%	702	100.0%

Note: 702 accidents occurred in 2012-16 were used in the analysis

Figure 4.3, an area chart graphically represents the yearly distribution of accidents by month.

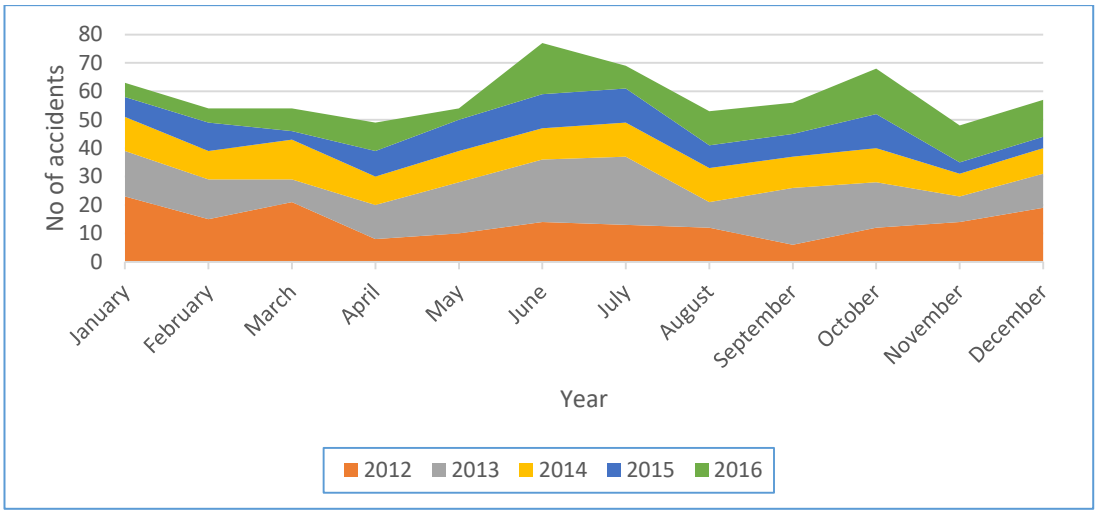


Figure 4.3 **:** Distribution of accidents occurred by month and year

The highest number of accidents has occurred during the month of June which is the middle month of the year. This highest statistic is shown in 3 out of 5 years; those are 2013, 2015 and 2016. The months of highest number of accidents have happened in year 2012 and 2014 are January and March respectively. However, the month in which the lowest number of accidents that have occurred varies from year to year. It is September for 2012 (3.6%), March for 2013 (4.4%), November for 2014 (6.1%), November and December equally for 2015 (4.0%) and May for 2016 (3.3%).

Reasons Of Increasing Trends In Incidents - Expert Interview Survey Result (Refer Appendix 2, Question 4)

During the interview HS1 stated "……*after new year bonus and 'Wesak' holidays they attempt to increase their productivity targeting for the following year bonuses.*

HS2 and HS3 *both expressed that inter terminal transport are high in respect to the number of container transport during June, July and December due to the fact that transshipment of containers is high during those months. As a result, increasing the probability to raise the number of incidents during those months……"*

4.4.2 Incidents Occurred By Week

Accidents and Near Misses which were occurred in the day of the week are given in the Table 4.3. Figure 4.4 demonstrates how accidents have occurred during days of a week.

Table 4.3: Distribution of incidents occurred by day of week

Day of week	Type of incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
Monday	124	17.7%	8	14.0%	132	17.4%
Tuesday	87	12.4%	8	14.0%	95	12.5%
Wednesday	112	16.0%	13	22.8%	125	16.5%
Thursday	110	15.7%	11	19.3%	121	15.9%
Friday	105	15.0%	6	10.5%	111	14.6%
Saturday	85	12.1%	4	7.0%	89	11.7%
Sunday	79	11.3%	7	12.3%	86	11.3%
Total	702	100.0%	57	100.0%	759	100.0%

Note: 759 incidents occurred in 2012-16 were used in the analysis

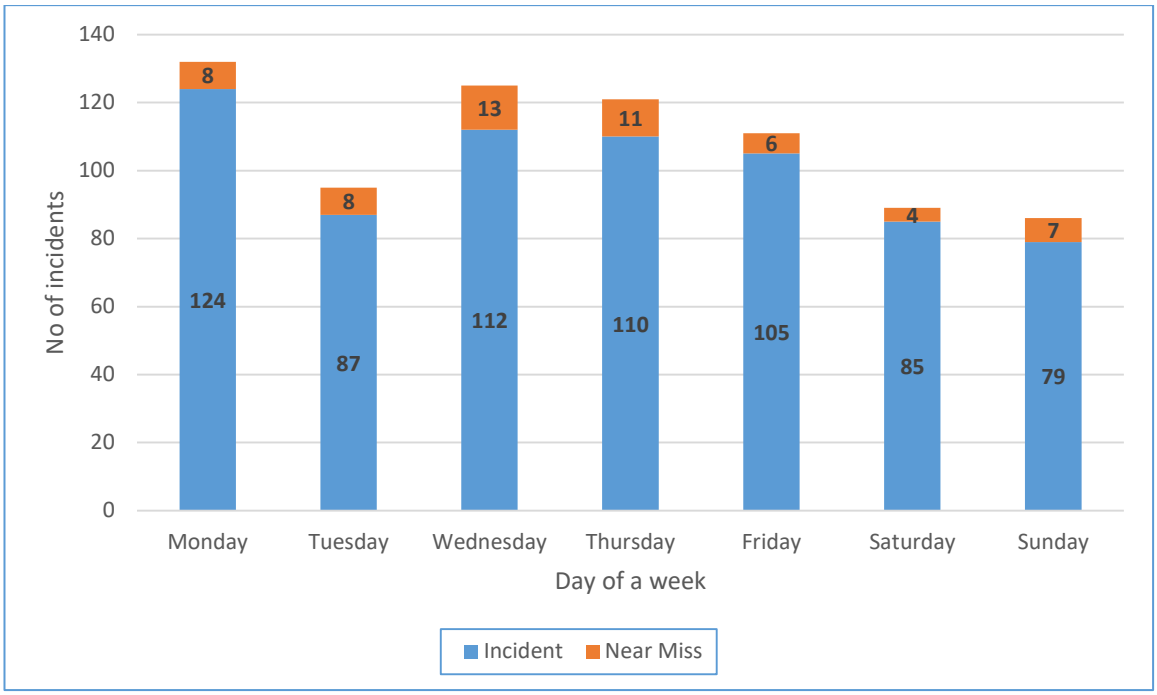


Figure 4.4 : Incidents occurred by days of week

The highest number of accidents has occurred on Mondays and the lowest was on Sundays. The second lowest number of accidents has happened on Saturdays. It is clear that lower number of accidents have happened during week-ends compared to week days.

Reasons For Having Highest Number Of Accident On Mondays And Lowest In Sundays - Expert Interview Survey Results (Refer Appendix B, Question 5)

At the interview, HS2 and HS3 revealed "……*as per their roaster, Monday is the beginning of the new shift after two days of weekend holidays. This can contribute the reduction of the individual concentration level towards their job generating more accidents on Mondays……."*

HS2 further confirmed "…….*Sunday being a holiday for ABC container terminal, there are no much activities relevant to the operations and therefore the risk of accidents occurring is less.*

HS3 cited *"…….there is no supervision during Sundays and the pressure for productivity is less which has an impact on accidents.*

HS1 *was not able to give a specific reason for increasing accidents on Mondays but his explanations were focusing on the insufficient supervision and the less tension during Sundays……."*

4.4.3 Discussion On Frequency And Type Of Incidents And Incidents Ocurring Patterns

According to the analysis, it was identified that above 90% are accidents and the rest of incidents are near misses (refer table 4 .1). In every year the number of accidents that have occurred is in between 120 and 200. The accident frequency fluctuates throughout the 5 year period except a clear drop in 2015.

As shown by many statistics (Maritime department of Hong Kong, 2011, Health and safety executive, 2009) the accident frequency in container terminals is quite high, since the activities at the container ports are always involved risk. The specific reasons for the above occurrences could not be identified. However, productivity level can be a possible cause which is determined by terminal statistics such as number of transshipments, number of vessels handled, number of container movements, number of cranes utilized etc.

When accident occurring patterns are considered the highest number of accidents has occurred in the middle of the year that is during months of June and July. But it was in January and March in two years. According to the expert interview survey this is due to the reasons of, targeting high productivity levels by the employees and handling large number of volumes during these periods.

Also the number of accidents occurred during weekdays is higher than during weekends and the highest is on Monday. The expert interview survey results have confirmed the reasons for high accident risk on Monday is because of lack of individual concentration on the job after weekend holidays and low accident risk during weekends is due to less tension, low productivity level and no supervision.

4.5 Relationship Between Incidents And Shift Work

4.5.1 Available Groups And Shifts In The Selected Terminal And Their Activities

All the activities in the ABC container terminal are done by 4 working groups in 3 different shifts schedules. The three shifts are operated from 07:00 am to 7.00pm, from 7.00 pm to 07:00 am and a general shift from 08:00 am to 5.00 pm. Except the workers in general shifts, workers in other three groups are rostered according to a roster schedule. Working groups and assigned shifts are described below:

- Group 1: Operational activities on roster basis (07:00 am to 7.00 pm or 07.00 pm 07:00 am)
- Group 2: Operational activities on roster basis (07:00 am to 7.00 pm or 07.00 pm 07:00 am)
- Group 3: Operational activities on roster basis (07:00 am to 7.00 pm or 07.00 pm 07:0 am)
- General: Support services (day shift 08:00 am to 05.00 pm)

Group 1, Group 2 and Group 3 consist of mixed operational and support staff namely crane operators, preventive and breakdown maintenance engineers, deck and wharf personnel, prime mover operators and vessel planners. Each group is headed by the duty manger. He is the in charge of the particular shift.

Crane operators are responsible for loading and unloading containers from ships to shore and shore to ships vice versa. Preventive and breakdown maintenance engineers are responsible to support smooth operation of the equipment of the container terminal. To support the crane operators and to ensure correct loading sequences are supported by deck and wharf personnel. Prime mover operators are responsible for transporting containers from one location to the other including loading and unloading containers from the vessels.

Vessel planners are assigned to plan and manage maximum use of vessel space and cargo movement, including arrangements that take into account the port’s loading facilities (the number of cranes, the availability of space in the terminal based on

shipper's manifests). The ship planner considers the physical condition of the ship and the effect on the ship's stability of the cargo that is being loaded.

General shift consists of human resources, administration and security, health, safety and environment and finance professions as support services to the terminal operation.

All the three groups, 1, 2 and 3 are in similar operations and they are assigned to a roaster on 2 days day shift and 2 days night shift and two days off basis.

4.5.2 Distribution Of Incidents By Work Group And Type

Groups 1-3 are assigned to work on roster basis on one group per shift. Table 4.4 cross tabulates work group and the type of incidents occurred for five year period.

Table 4.4 **:** Distribution of incidents by work group and type

Work Group	Type of incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
Shift work						
Group 1	204	29.1%	18	31.6%	222	29.2%
Group 2	187	26.6%	13	22.8%	200	26.4%
Group 3	254	36.2%	19	33.3%	273	36.0%
General shift						
General	53	7.5%	6	10.5%	59	7.8%
Unknown	4	.6%	1	1.8%	5	.7%
Total	702	100.0%	57	100.0%	759	100.0%

Note: 759 incidents occurred in 2012-16 were used in the analysis

The number of accidents and near misses that have occurred in shiftwork is higher than in general shift. The highest number of accidents (273) has reported from Group 3. Next highest (222) has reported from Group 1 and then (200) from Group

2. The number of incidents that have occurred in general shift is comparatively very low. As a percentage it is about 7.8% where as it is 91.6% in shift work.

4.5.3 Distribution Of Incidents Occurred By Time

The "time of the incident occurred" is also important since the operation is run for 24 hours. Thus, exact time of the incident occurred was grouped into 4 time slots in a day as follows;

i) Mid night 00:01 am - 06:00 am
ii) 06:01 am - 12:00 noon
iii) 12:01 pm - 06:00 pm
iv) 06:01 pm - 00:00 mid night

Total number of incidents were distributed among 4 time slots with the type of incident and given in the Table 4.5.

Table 4.5 : Distribution of incidents occurred by time of the day

Time window	Type of incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
00:01 am - 06:00 am	143	20.4%	7	12.3%	150	19.8%
06:01 am - 12:00 noon	194	27.6%	20	35.1%	214	28.2%
12:01 pm - 06:00 pm	171	24.4%	13	22.8%	184	24.2%
06:01 pm - 00:00 mid	143	20.4%	14	24.6%	157	20.7%
Not specified	51	7.3%	3	5.3%	54	7.1%
Total	702	100.0%	57	100.0%	759	100.0%

Note: 759 incidents occurred in 2012-16 were used in the analysis

The highest number of accidents (27.6%) and near misses (35.1%) has occurred during 6 am to 12 noon. Second highest number of accidents (24.4%) has happened during 12 noon to 6pm and the rest has occurred equally in other 2 time slots. One fourth of near misses have happened during night time (6 pm to mid night) 22.8% of

near misses have occurred in the afternoon 12 noon to 6 pm and the balance was during mid-night time (00.01 am to 06:00 am).

Table 4.6: Distribution of incidents occurred time by year

Time window	Year of incident											
	2012		2013		2014		2015		2016		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
00:01 am-06:00 am	34	22.2%	33	17.9%	29	20.4%	25	25.0%	29	23.0%	150	21.3%
06:01am-12:00 noon	47	30.7%	59	32.1%	39	27.5%	33	33.0%	36	28.6%	214	30.4%
12:01 pm- 6:00 pm	39	25.5%	50	27.2%	37	26.1%	19	19.0%	39	31.0%	184	26.1%
06:01 pm-00:00 mid	33	21.6%	42	22.8%	37	26.1%	23	23.0%	22	17.5%	157	22.3%
Total	153	100.0%	184	100.0%	142	100.0%	100	100.0%	126	100.0%	705	100.0%

Note: 705 incidents occurred in 2012-16 were used in the analysis

Records of time "Not specified" were excluded.

To identify a specific trend, it is important to analyze the time of incident occurred throughout the study period. The table (Table 4.6) shows the patterns of incidents happening over the period of 5 years. The highest number of incidents has occurred during 6 am to 12 noon in each year, except in year 2016 and it is during 12 noon to 6 pm.

The below line graphs in Figure 4.5 presents the percentage of incidents that have happened during the period of 5 years 2012-2016 in each time slot.

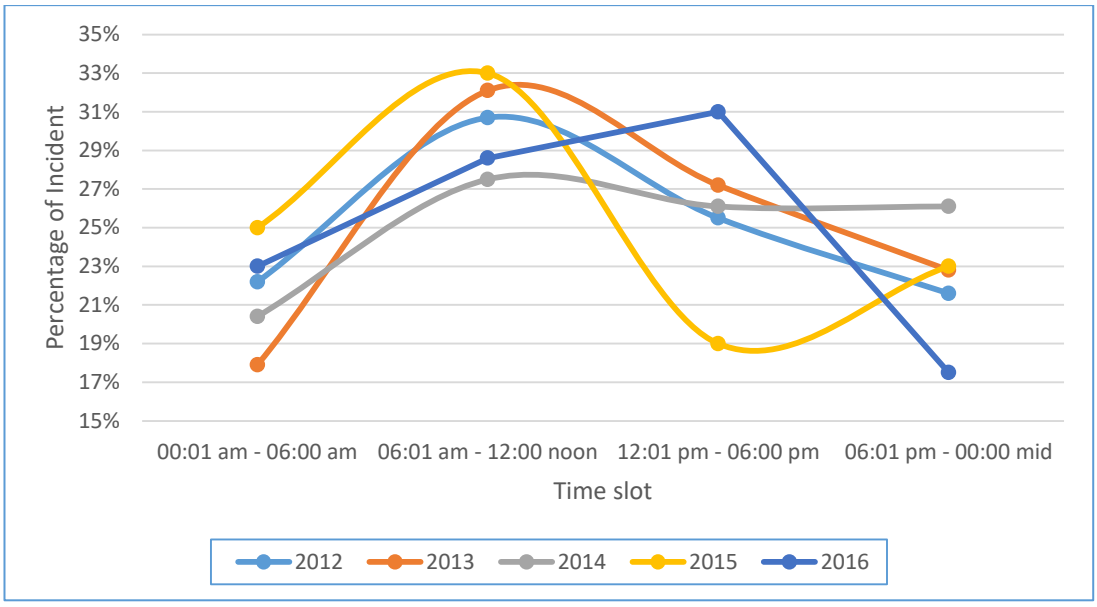


Figure 4.5 : Incidents occurring pattern in years by time slots

This graphical presentation clearly illustrates that the pattern of occurring incidents is more or less similar in first 3 years which is from 2012 to 2014. But After 2014 it shows a change in 2015 and 2016.

Next, how accidents have occurred with time throughout the 5 year study period has been analyzed. The distributions are given in the Table 4.7 and Figure 4.6. The highest number and percentage of accidents have happened during 6 am to 12 noon for all the years except in year 2016. In 2016, the highest number and percentage has shifted to afternoon time period (12 noon to 6 pm). However, more than 50% accidents have occurred during day time (6 am to 6pm) in each year and it is about 60% in years 2013 and 2016. Overall, 56.1% of accidents and incidents have occurred during day time.

Table 4.7: Distribution of accidents occurred time by year

Time window	Year of Incident											
	2012		2013		2014		2015		2016		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
00:01 am-06:00 am	32	22.2%	31	18.5%	28	21.9%	25	26.3%	27	23.3%	143	22.0%
06:01 am-12:00 noon	43	29.9%	53	31.5%	35	27.3%	32	33.7%	31	26.7%	194	29.8%
12:01 pm-06:00 pm	37	25.7%	45	26.8%	33	25.8%	18	18.9%	38	32.8%	171	26.3%
06:01 pm-00:00 mid	32	22.2%	39	23.2%	32	25.0%	20	21.1%	20	17.2%	143	22.0%
Total	144	100.0%	168	100.0%	128	100.0%	95	100.0%	116	100.0%	651	100.0%

Note: 651 accidents occurred in 2012-16 were used in the analysis

Records of time "Not specified" were excluded.

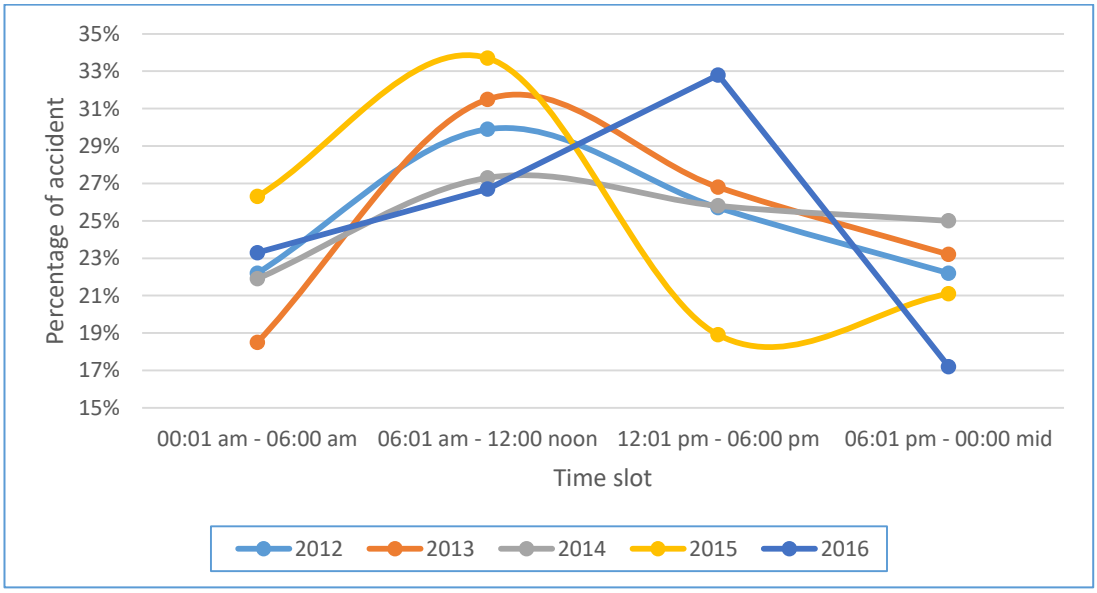


Figure 4.6 : Accidents occurring pattern in years by time slots

High Number Of Accidents Reported From 6 Am To 12 Noon– Expert Interview Survey Results (Refer Appendix B, Question 6)

HS3 cited "……*from 6 am to 12 noon, focus of the operators are much less for the operational activities compared to the evening time as most of the workforce in*

ABC terminals are travelling from long distances or remote areas. So that they have lack of sleep and fatigue could be created.

HS1 *indicated "Existed fatigue in the morning" as the reason for high number of accidents during the time period of 6am-12noon.*

However, HS2 *in his interview positively and confidently responded that ABC container terminals personnel are traveling from various locations and remote areas therefore fatigue could have significantly impacted for the accidents during morning hours……."*

4.5.4 Discussion On Relationship Between Type Of Incident And Work Group, Occurring Time Of Day

When the four working groups and their shifts are considered, highest number of accidents has reported from the three groups which work on roster basis and they involve in operational activities. It was the highest in Group 3 (refer table 4.4). More than 90% of accidents have reported from the roster basis shift. From the other work group which works on the general shift and involved in support services, the number of accidents reported is comparatively very less. It shows that the roster basis shift, having extended operational hours (12 hrs) has more accident risk. This point has been proved by Wagstraff & Lie (2011) in their systematic review on safety implications on shift and night work and long working hours.

According to the terminal performance report, Group 3 shows a higher performance rate than other two groups, as it has handled more volumes of containers per hour than Group 1 and Group 2. Therefore, work pressure can be the apparent cause for high accident risk. However, there can be other causes which are not directly visible.

Further, it shows that the highest number of accidents and near misses have occurred during 6am to 12 noon. This is in contrast to the opinions of Dawson, (2001) and Wagstraff & Lie (2011), as they emphasize that particularly night shift has high accident risk than day shift. Therefore that fact is not applicable to this particular container terminal as some other contributory factors may also have existed.

However, expert interview survey data with regard to this phenomenon shows that the high accident risk during 6am to 12 noon is due to the fatigue existed in the morning as a result of lack of sleep created by long distance travelling.

Further, the analysis show that, above 50% of accidents have occurred during the time period of 6am to 6pm (day time) in all five years. Apart from that, the vessel schedule also shows that number of cargos handled during day time is higher than during night time. Therefore, high productivity levels and fatigue in workers , both can be a possible causes for the high accident risk during day time.

4.6 Activities Related To Incidents And Their Impacts

Each and every incident has an impact. It can be on people, properties or environment. Mainly accidents create significant impacts on above three areas. Therefore in this study only the impacts which have been created by accidents are considered.

4.6.1 Type Of Impact Of Accidents

Impacts of the accidents were classified into 18 different types which are applicable to the ABC container terminal. This classification was done referring to reported brief descriptions on how the incident occurred in the AIR data base. The distribution of accidents by the type of impact is given in the below frequency table, Table 4.8.

Table 4.8: Impact type of accidents

Impact	No	%
Personal Injury	**89**	**12.7%**
Fire incident	**12**	**1.7%**
Terminal Transport Equipment damage	**324**	**46.2%**
Terminal Vehicle	42	6.0%
FL/RS/FS	11	1.6%
PM damage	105	15.0%
Tire Burst	2	.3%
RTG	109	15.5%
External Truck	55	7.8%
Systems/Process failure	**26**	**3.7%**
Portable Equipment damage	**41**	**5.8%**
Electrical	1	.1%
RTD	11	1.6%
Portable Equipment	29	4.1%
Terminal Property damage	**191**	**27.2%**
Vessel + Container	35	5.0%
Container Damage	29	4.1%
QC Damage or Vessel	125	17.8%
Cargo Damage + PM	1	.1%
Rigging	1	.1%
Other damages	**19**	**2.7%**
Total	702	100.0%

Note: 702 accidents occurred in 2012-16 were used in the analysis

Legend: FL/RS/FS – Fork Lift/Reach Stacker/Forklift Small
PM- Prime Mover, QC- Quay Crane,
RTG – Rubber Tire Grantry, RTD- Radio Transmitting Device

For further analysis, these 18 types were further categorized into seven (7) broad categories clubbing similar nature of incidents. “Personal Injury”, “Fire incident” and “Systems/Process failure” were kept unchanged as they cannot be clubbed with any other types.

“**Terminal Vehicle”, “FL/RS/FS”, “PM damage”, “Tire Burst”, “RTG” and “External Truck”** were clubbed into one category named “Terminal Transport Equipment damage”.

Impacts of **Electrical, RTD and Portable Equipment** were clubbed together as “Portable Equipment damage”.

“Vessel + Container”, “Container Damage”, “QC Damage or Vessel”, “Cargo Damage + PM and Rigging” were put together into “Terminal Property Damage”.

Impact of “Other damages” also remains unchanged. Impacts of accidents in broad categories are shown in the Table 4.9

Table 4.9: Impact of accidents in broader categories

Impact	No	%
Personal Injury	89	12.7%
Fire incident	12	1.7%
Terminal Transport Equipment damage	324	46.2%
System/Process failure	26	3.7%
Portable Equipment damage	41	5.8%
Terminal Property damage	191	27.2%
Other damages	19	2.7%
Total	702	100.0%

Note: 702 accidents occurred in 2012-16 were used in the analysis

Out of 702 total, 324 (or 46.2%) accidents have an impact on Terminal Transport Equipment damages. Second highest impact is Terminal Property Damages (27.2%)

and followed by Personal Injury (12.7%). About 13 of 100 incidents ended up with a personal injury. Fire due to accidents is very low (12 or 1.7%).

4.6.2 Type Of Activities Related To The Incidents

Studying and analyzing of activities which caused these incidents are very important in order to find out the relationships between incidents, impacts and causes.

The major activity of each incident was identified for each impact and then the level of severity was analyzed. The method used to identify the major activity was screening of all the descriptions of incidents. Although the multiple activities were applicable in some incidents, the major activity was chosen. The Table 4.10 shows the major activities by type of incident.

Table 4.10: Major activity by type of incident

Activity	Type of Incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
Building maintenance	2	.3%	0	.0%	2	.3%
Cargo loading	1	.1%	0	.0%	1	.1%
Climbing up & down	8	1.1%	0	.0%	8	1.1%
Container loading	80	11.5%	6	10.7%	86	11.4%
Container movement	63	9.1%	3	5.4%	66	8.8%
Container placing	4	.6%	0	.0%	4	.5%
Container unloading	68	9.8%	1	1.8%	69	9.2%
Document management	1	.1%	0	.0%	1	.1%
Door closing	4	.6%	0	.0%	4	.5%
Equipment handover/receiving	7	1.0%	1	1.8%	8	1.1%
Equipment maintenance	57	8.2%	16	28.6%	73	9.7%
Equipment movement	197	28.3%	18	32.1%	215	28.6%
Facility maintenance	1	.1%	0	.0%	1	.1%
Getting down from cab	1	.1%	0	.0%	1	.1%
Hatch cover placing	40	5.7%	0	.0%	40	5.3%
Hatch cover removing	11	1.6%	0	.0%	11	1.5%
Hot work	12	1.7%	2	3.6%	14	1.9%
Inspection	33	4.7%	0	.0%	33	4.4%
Lashing	2	.3%	0	.0%	2	.3%
Personal climbing	2	.3%	0	.0%	2	.3%

Personal walking	14	2.0%	1	1.8%	15	2.0%
Pulling a person	1	.1%	0	.0%	1	.1%
Pushing a person	1	.1%	0	.0%	1	.1%
Safety observation	14	2.0%	1	1.8%	15	2.0%
Ship berthing	3	.4%	0	.0%	3	.4%
Tools unloading	1	.1%	0	.0%	1	.1%
Unlashing	1	.1%	0	.0%	1	.1%
Vehicle maintenance	5	.7%	0	.0%	5	.7%
Vehicle movement	55	7.9%	6	10.7%	61	8.1%
Walking	2	.3%	1	1.8%	3	.4%
Walking near by dogs	5	.7%	0	.0%	5	.7%
Total	696	100.0%	56	100.0%	752	100.0%

Note: 752 incidents occurred in 2012-16 were used in the analysis

"Not reported" events were excluded

There were 31 activities which identified in related to 752 incidents. There were 7 incidents without proper descriptions, so that their relevant activities were unable to identify. The highest frequency of the activity was "Equipment movement" (215 & 28.6%) followed by "Container loading" (86 & 11.4%), "Equipment maintenance" (73 & 9.7%). All the other events have frequency of less than 9%. But "Container unloading", "container movement" and "vehicle movement" also show high occurring frequency.

4.6.3 Relationship Between Activities Related To The Accidents And Their Impacts

Out of two types of incidents (accidents and near misses) identified in Table 4.1 in chapter 4, only accidents can result injury or ill health. Hence, only accidents are considered with the relevant impact as personal injury, fire, terminal transport equipment damage, system/process failure, portable equipment damage, terminal property damages and other damages as these are the highest impacts caused by accidents.

Accident activities were cross-tabulated with the impact of the accident in the Table 4.11 below.

Table 4.11: Impact by activity of the accident

Activity	Impact of Accident							
	Personal Injury	Fire	Terminal Transport Equipment	System/Process	Portable Equipment	Terminal Property Damages	Other	Total
Building maintenance	.0%	.0%	.0%	.0%	2.6%	.0%	5.3%	.3%
Cargo loading	.0%	.0%	.0%	.0%	.0%	.5%	.0%	.1%
Climbing up & down	7.9%	.0%	.3%	.0%	.0%	.0%	.0%	1.1%
Container loading	7.9%	.0%	5.0%	19.2%	2.6%	26.2%	5.3%	11.5%
Container movement	4.5%	8.3%	9.1%	38.5%	2.6%	8.9%	5.3%	9.1%
Container placing	.0%	.0%	.0%	11.5%	.0%	.5%	.0%	.6%
Container unloading	7.9%	.0%	7.2%	11.5%	2.6%	17.3%	5.3%	9.8%
Document management	.0%	.0%	.0%	3.8%	.0%	.0%	.0%	.1%
Door closing	4.5%	.0%	.0%	.0%	.0%	.0%	.0%	.6%
Equipment handover/receiving	.0%	.0%	.0%	.0%	17.9%	.0%	.0%	1.0%
Equipment maintenance	15.7%	16.7%	8.1%	.0%	10.3%	4.2%	15.8%	8.2%
Equipment movement	9.0%	.0%	49.4%	.0%	15.4%	12.0%	10.5%	28.3%
Facility maintenance	1.1%	.0%	.0%	.0%	.0%	.0%	.0%	.1%
Getting down from cab	.0%	.0%	.0%	.0%	2.6%	.0%	.0%	.1%
Hatch cover placing	.0%	.0%	.0%	.0%	.0%	20.9%	.0%	5.7%
Hatch cover removing	.0%	.0%	.0%	.0%	.0%	5.8%	.0%	1.6%

Hot work	1.1%	75.0%	.3%	.0%	.0%	.0%	5.3%	1.7%
Inspection	2.2%	.0%	3.8%	3.8%	23.1%	2.1%	26.3%	4.7%
Lashing	2.2%	.0%	.0%	.0%	.0%	.0%	.0%	.3%
Personal climbing	1.1%	.0%	.3%	.0%	.0%	.0%	.0%	.3%
Personal walking	15.7%	.0%	.0%	.0%	.0%	.0%	.0%	2.0%
Pulling a person	1.1%	.0%	.0%	.0%	.0%	.0%	.0%	.1%
Pushing a person	1.1%	.0%	.0%	.0%	.0%	.0%	.0%	.1%
Safety observation	6.7%	.0%	.6%	3.8%	10.3%	.0%	5.3%	2.0%
Ship berthing	1.1%	.0%	.0%	3.8%	.0%	.5%	.0%	.4%
Tools unloading	.0%	.0%	.0%	.0%	.0%	.5%	.0%	.1%
Unlashing	1.1%	.0%	.0%	.0%	.0%	.0%	.0%	.1%
Vehicle maintenance	.0%	.0%	.6%	.0%	7.7%	.0%	.0%	.7%
Vehicle movement	1.1%	.0%	15.3%	3.8%	2.6%	.5%	10.5%	7.9%
Walking	1.1%	.0%	.0%	.0%	.0%	.0%	5.3%	.3%
Walking near by dogs	5.6%	.0%	.0%	.0%	.0%	.0%	.0%	.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
N	89	12	320	26	39	191	19	696

Note: 696 accidents occurred in 2012-16 were used in the analysis

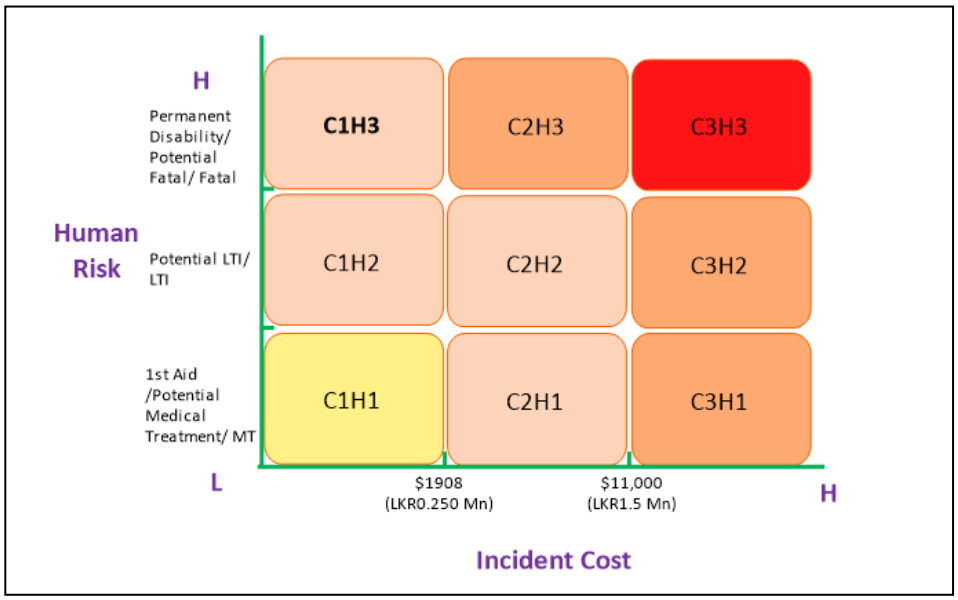
"Not reported" events were excluded

Equal percentage (15.7%) of personal injuries have occurred while personal walking and during equipment maintenance processes. 9% of personal injuries were due to movement of equipment. Seventy five percent of fires occurred due to hot work activity and 16.7% were during equipment maintenance. Half of terminal transport equipment was damaged mainly during equipment movement (49.4%) and 15.3% was due to vehicle movement. It was highlighted that a more than one third of system/ process failures were occurred during container movements and total of 80.7% such failures were related to container handling (loading, movement and unloading). About one fifth of portable equipment damages have occurred during equipment handling and the same portion was found while inspection. Terminal property damages were mainly due to container loading (26.2%), hatch cover placing

(20.9%) and container unloading (17.3%). 15.8% of other damages are due to equipment maintenance and the same portion was found while inspection.

4.6.4 Level Of Severity Of Incidents

Severity of the impact due to an incident can be evaluated in different ways. This particular organization uses a rating matrix to measure the severity on cost of the damage (C) and human risk (H) in two dimensions in three levels each (see Figure 4.7).



F
igure 4.7 : Severity Matrix

Cost and Human risk are categorized as follows:

Cost of damage:

C1 – Less than LKR 250,000

C2 - LKR 250,000 – LKR 1.5 Million

C3 – Above LKR 1.5 Million

Human risk:

H1 – First Aid/Potential medical treatment/Medical treatment

H2 – Potential lost time injury/Lost time injury

H3 – Permanent disability/Potential fatal/Fatal

The staff of health and safety department with the help of financial department of the company has evaluated the severity of incidents reported and the ratings were given according to the rating matrix with nine cells.

The potential risk was evaluated for the near misses as well. Severity and the type of incident are given in the Table 4.12. There were 176 incidents which have occurred in the year 2012. These incidents were not evaluated as this evaluation method was implemented in the year 2013. Around two third (64.2%) incidents were rated as C1H1 which could be categorized as "Low severity". The "Medium severity" contains 3 ratings C1H2, C2H2 and C2H1. The rest of 5 ratings were grouped into "High severity".

Table 4.12: Level of severity by type of incident

Level of severity	Type of incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
C1H1	452	64.4%	35	61.4%	487	64.2%
C1H2	46	6.6%	3	5.3%	49	6.5%
C1H3	1	.1%	4	7.0%	5	.7%
C2H1	19	2.7%	4	7.0%	23	3.0%
C2H2	9	1.3%	0	.0%	9	1.2%
C2H3	0	.0%	1	1.8%	1	.1%
C3H1	5	.7%	1	1.8%	6	.8%
C3H2	1	.1%	0	.0%	1	.1%
C3H3	2	.3%	0	.0%	2	.3%
Not Given	167	23.8%	9	15.8%	176	23.2%
Total	702	100.0%	57	100.0%	759	100.0%

Note: 759 incidents occurred in 2012-16 were used in the analysis

The level of severity of accidents was further analyzed with the activities related to. Such analysis is given in the Table 4.13 below.

Table 4.13: Level of severity of accidents by activity

Activity	Level of severity							
	Low		Medium		High		Total	
	No	%	No	%	No	%	No	%
Building maintenance	2	.4%	0	.0%	0	.0%	2	.4%
Cargo loading	0	.0%	1	1.4%	0	.0%	1	.2%
Climbing up & down	6	1.3%	1	1.4%	0	.0%	7	1.3%
Container loading	32	7.2%	7	9.5%	1	11.1%	40	7.5%
Container movement	35	7.8%	8	10.8%	2	22.2%	45	8.5%
Container placing	3	.7%	0	.0%	0	.0%	3	.6%
Container unloading	48	10.7%	8	10.8%	0	.0%	56	10.6%
Document management	1	.2%	0	.0%	0	.0%	1	.2%
Door closing	1	.2%	3	4.1%	0	.0%	4	.8%
Equipment handover/receiving	7	1.6%	0	.0%	0	.0%	7	1.3%
Equipment maintenance	42	9.4%	6	8.1%	1	11.1%	49	9.2%
Equipment movement	130	29.1%	15	20.3%	5	55.6%	150	28.3%
Facility maintenance	1	.2%	0	.0%	0	.0%	1	.2%
Hatch cover placing	31	6.9%	1	1.4%	0	.0%	32	6.0%
Hatch cover removing	7	1.6%	0	.0%	0	.0%	7	1.3%
Hot work	7	1.6%	4	5.4%	0	.0%	11	2.1%
Inspection	28	6.3%	1	1.4%	0	.0%	29	5.5%
Lashing	0	.0%	2	2.7%	0	.0%	2	.4%
Personal climbing	2	.4%	0	.0%	0	.0%	2	.4%
Personal walking	8	1.8%	5	6.8%	0	.0%	13	2.5%
Safety observation	10	2.2%	3	4.1%	0	.0%	13	2.5%

Ship berthing	1	.2%	1	1.4%	0	.0%	2	.4%
Tools unloading	1	.2%	0	.0%	0	.0%	1	.2%
Vehicle maintenance	2	.4%	0	.0%	0	.0%	2	.4%
Vehicle movement	37	8.3%	7	9.5%	0	.0%	44	8.3%
Walking	2	.4%	0	.0%	0	.0%	2	.4%
Walking near by dogs	3	.7%	1	1.4%	0	.0%	4	.8%
Total	447	100.0%	74	100.0%	9	100.0%	530	100.0%

Note: 530 accidents occurred in 2012-16 were used in the analysis
"Not reported" activities and "Not given" severity level are excluded

Equipment movement is the main cause for more than one fourth of low severe accidents. Other significant low severe activities are container unloading (10.7%), equipment maintenance (9.4%) and container loading (7.2%). One fifth (20.3%) of medium severe accidents have occurred during equipment movement. The activities, "Container movement" and "Container unloading" have equally contributed (10.8%) to medium severe accidents. Although, the number of high severe incidents are less (9), 5 incidents have occurred while equipment movement.

4.6.5 Discussion On Relationship Between Accidents, Impacts, Activities And Level Of Severity

According to the above analysis (table 4.9) accidents have caused high impacts on "terminal transport equipment damages", 'terminal property damages" and "personal injuries". High activity frequency has shown by "equipment movement', "container loading/ unloading", "container movement", "equipment maintenance " and "vehicle movement". A good co-relation was shown between these impacts and activities when they were cross tabulated (table 4.11). It is evident that all these activities are more or less responsible for the three impacts. Further, when accidents were categorized according to their severity, the same activities have been more or less responsible for all low, medium and high severe accidents. Therefore these six activities can be considered as the hazardous activities in the ABC container terminal which create high accident risk. Since "equipment movement "has caused the highest

frequency of all three types of severe accidents, it can be considered as the most hazardous activity in the terminal.

As per the report of Walters (2016), which was submitted to the IOSH research committee shows the perception of terminal workers regarding the risks arising from activities within container terminals. The risks were associated with the "operational activities involved in loading and unloading ships" , "the storage and transportation of containers", and " moving machinery and vehicles". These have been further proved by the above findings of this study.

In addition, a report of Health and Safety Executive (HSE, 2009) has highlighted the potential risks in container stevedoring operations as "structural failure during loading/unloading, injury during unsafe handling of containers, being hit by a moving vehicle at the quayside, being crushed, getting struck by container doors, and exposure to harmful chemicals". Fabiano et al., (2010) has also shown there is an increase of accidents due to vehicle transport in container terminals. Therefore it implies that the most of activities are similar, which create high accident risk in container terminals.

4.7 Causes Of Incidents

In this research, there are three main causes attributed to accidents as identified, personal, environment and equipment. The accidents due to personal causes are directly attributed to the operator or the personnel involved in accidents. In this study personal causes included violation of safety procedures, rules or engaging risky behaviors and unsafe behaviors and inattention while performing his job role.

Environmental causes were considered when accidents are directly attributed to the working environment. Environmental causes included either natural or built environment such as aspects of terminal design, poor visibility due to bad weather conditions (low-light situations, heavy rain, heavy wind and high temperature) and poor housekeeping.

Equipment causes were considered when accidents have occurred due to contributory causes of terminal equipment that were not directly attributed to human behavior or working environment. Equipment causes included sudden failures of equipment (completely or partially), falling equipment parts, corrosion due to preventive maintenance and use of wrong equipment.

The main cause of incidents, whether it is personal, environment, equipment or a combination of these 3 main causes were identified by referring descriptions of each incident report. Distribution of causes of incidents are shown in the below frequency Table 4.14 There were 94 incidents which main cause was not be able to identify based on the available information.

Table 4.14: Cause of incidents

Cause(s)	No	%
Personal	487	64.2%
Environmental	17	2.2%
Equipment	89	11.7%
Personal & Environmental	30	4.0%
Personal & Equipment	34	4.4%
Environmental & Equipment	3	.4%
Personal, Environmental & Equipment	5	.7%
Not specified	94	12.4%
Total	759	100.0%

Note: 759 accidents occurred in 2012-16 were used in the analysis

Out of 759 incidents, 487 (64.2%) incidents have occurred due to personal causes. Causes of equipment have been identified as the second highest (89 or 11.7%). Only 17 (2.2%) incidents have occurred due to direct causes of environment. There are combinations of these three causes which don't show a greater impact. There were

94 (or 12.4%) incidents of which causes were not be able to identify due to lack of information.

4.7.1 Cause Of Incidents By Type

Types of incidents (both incidents and near misses) are cross tabulated with related causes (Table 4.15).

Table 4.15: Cause of incidents by type

Cause(s)	Type of incident					
	Accident		Near Miss		Total	
	No	%	No	%	No	%
Personal	473	75.7%	14	35.0%	487	73.2%
Environmental	14	2.2%	3	7.5%	17	2.6%
Equipment	68	10.9%	21	52.5%	89	13.4%
Personal & Environmental	30	4.8%	0	.0%	30	4.5%
Personal & Equipment	32	5.1%	2	5.0%	34	5.1%
Environmental & Equipment	3	.5%	0	.0%	3	.5%
Personal, Environmental & Equipment	5	.8%	0	.0%	5	.7%
Total	625	100.0%	40	100.0%	665	100.0%

Note: 665 incidents occurred in 2012-16 were used in the analysis

"Not specified" causes in incidents are excluded

As per the above table it shows that personal causes (75.7%) are responsible for the highest accident risk, whereas equipment causes are for near-misses (52.5%). Other than personal causes, around one fourth of accidents were occurred due to all other causes. One third of near-misses have happened only due to personal causes. Environmental causes have contributed to least number of near-misses.

Causes of accidents were crossed checked with "Work Group" in Table 4.16.

Table 4.16: Distribution of accidents by cause and work group

Cause	Work Group									
	Group 1		Group 2		Group 3		General		Total	
	No	%	No	%	No	%	No	%	No	%
Personal	147	84.0%	127	72.2%	174	77.0%	25	54.3%	473	75.9%
Environmental	3	1.7%	4	2.3%	4	1.8%	3	6.5%	14	2.2%
Personal & Environmental	7	4.0%	6	3.4%	14	6.2%	3	6.5%	30	4.8%
Equipment	9	5.1%	29	16.5%	18	8.0%	10	21.7%	66	10.6%
Personal & Equipment	8	4.6%	7	4.0%	12	5.3%	5	10.9%	32	5.1%
Environmental & Equipment	0	.0%	2	1.1%	1	.4%	0	.0%	3	.5%
Personal, Environmental & Equipment	1	.6%	1	.6%	3	1.3%	0	.0%	5	.8%
Total	175	100.0%	176	100.0%	226	100.0%	46	100.0%	623	100.0%

Note: 623 accidents occurred in 2012-16 were used in the analysis
"Not specified" causes in accidents are excluded

According to the above analysis, it is clear that the highest contribution to all accidents in each work group was from personal causes. In total it is about 75% for all accidents occurred by all the 4 groups. Equipment causes have become second highest and it is 10.6%. Further, combined causes 'personal & environment' and 'personal and equipment' also have considerable impact on accidents.

Causes of accidents were cross-checked with the month of accidents have happened to see whether any seasonal effects on causes. The analysis shows in the Table 4.17

Table 4.17: Percentage distributions of accidents which influenced by causes

Cause	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Personal	78.0%	74.1%	59.5%	79.1%	70.2%	74.2%	81.8%	78.6%	82.7%	76.6%	72.1%	76.8%	75.7%
Environmental	2.0%	3.7%	9.5%	4.7%	4.3%	1.5%	.0%	.0%	1.9%	.0%	.0%	1.8%	2.2%
Personal & Environmental	6.0%	7.4%	4.8%	7.0%	12.8%	6.1%	1.5%	4.8%	1.9%	3.1%	2.3%	1.8%	4.8%
Equipment	10.0%	9.3%	19.0%	7.0%	10.6%	10.6%	6.1%	11.9%	5.8%	10.9%	18.6%	14.3%	10.9%
Personal & Equipment	4.0%	5.6%	7.1%	2.3%	2.1%	7.6%	7.6%	4.8%	3.8%	4.7%	4.7%	5.4%	5.1%
Environmental & Equipment	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%	3.1%	.0%	.0%	.5%
Personal, Environmental & Equipment	.0%	.0%	.0%	.0%	.0%	.0%	3.0%	.0%	1.9%	1.6%	2.3%	.0%	.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: 623 accidents occurred in 2012-16 were used in the analysis
"Not specified" causes in accidents are excluded

Graphical presentation of the data in Table 4.13 is given in the Figure 4.6. The graph illustrates that personal causes contribute to the highest percentage of accidents throughout 12 months of five year period. It can be clearly noticed that there is a drop in personal cause in the month of March, at the same time showing an increase in environmental and equipment causes. It is evident that the environmental cause shows a continuous decrease while equipment cause shows a slight increase in contribution for accident risk. Moreover, there is no significant variation in the contribution of personal cause between June-December (72%-82%).

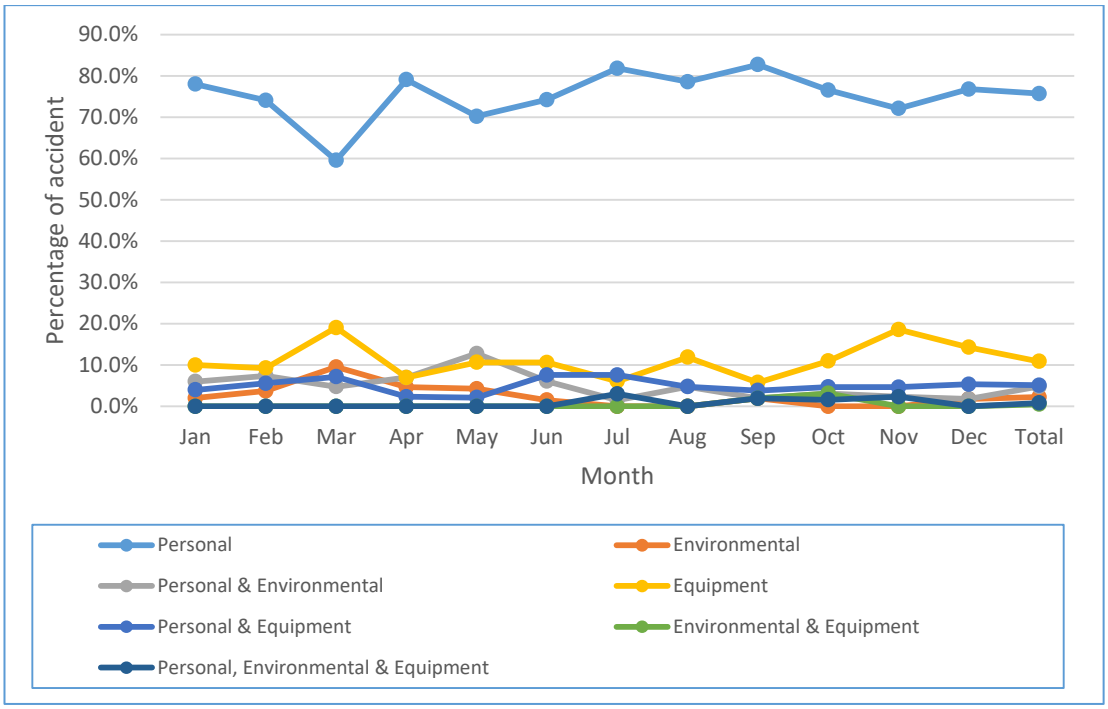


Figure 4.8: Patterns of causal factors during calendar month

4.7.2 Activity Of Incident By Cause Of Incident

Activity of an incident can be further investigated with the cause of the incident. Percentage distribution of incidents by activity and cause is shown in the Table 4.18.

Table 4.18: Activity of incident by type of cause

Activity	Type of cause							
	Personal	Environmental	Equipment	Personal & Environmental	Personal & Equipment	Environmental & Equipment	Personal, Environmental & Equipment	Total
Building maintenance	.0%	12.5%	.0%	.0%	.0%	.0%	.0%	.3%
Cargo loading	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Climbing up & down	.4%	.0%	1.1%	6.7%	8.8%	.0%	.0%	1.2%
Container loading	11.6%	.0%	6.9%	13.3%	23.5%	.0%	20.0%	11.4%
Container movement	10.4%	6.2%	4.6%	10.0%	5.9%	.0%	.0%	9.1%
Container placing	.8%	.0%	.0%	.0%	.0%	.0%	.0%	.6%
Container unloading	11.4%	.0%	5.7%	3.3%	5.9%	.0%	20.0%	9.7%
Document management	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Door closing	.6%	.0%	.0%	.0%	.0%	.0%	.0%	.5%
Equipment handover/receiving	1.2%	.0%	1.1%	.0%	.0%	.0%	.0%	1.1%
Equipment maintenance	3.9%	25.0%	27.6%	10.0%	20.6%	33.3%	20.0%	9.0%
Equipment movement	32.1%	12.5%	29.9%	20.0%	11.8%	33.3%	.0%	29.5%
Facility maintenance	.0%	.0%	1.1%	.0%	.0%	.0%	.0%	.2%
Getting down from cab	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Hatch cover placing	7.0%	.0%	.0%	3.3%	5.9%	33.3%	.0%	5.8%
Hatch cover removing	1.7%	.0%	1.1%	3.3%	2.9%	.0%	.0%	1.7%
Hot work	.6%	6.2%	2.3%	3.3%	.0%	.0%	.0%	1.1%

Inspection	1.4%	6.2%	6.9%	.0%	2.9%	.0%	.0%	2.3%
Lashing	.2%	.0%	.0%	.0%	2.9%	.0%	.0%	.3%
Personal climbing	.4%	.0%	.0%	.0%	.0%	.0%	.0%	.3%
Personal walking	1.4%	18.8%	1.1%	10.0%	2.9%	.0%	.0%	2.3%
Pulling a person	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Pushing a person	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Safety observation	2.3%	.0%	1.1%	6.7%	2.9%	.0%	.0%	2.3%
Ship berthing	.4%	.0%	1.1%	.0%	.0%	.0%	.0%	.5%
Tools unloading	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Unlashing	.2%	.0%	.0%	.0%	.0%	.0%	.0%	.2%
Vehicle maintenance	.6%	.0%	1.1%	.0%	.0%	.0%	.0%	.6%
Vehicle movement	9.7%	.0%	6.9%	3.3%	2.9%	.0%	40.0%	8.7%
Walking	.2%	6.2%	.0%	.0%	.0%	.0%	.0%	.3%
Walking near by dogs	.0%	6.2%	.0%	6.7%	.0%	.0%	.0%	.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
N	483	16	87	30	34	3	5	658

Note: 658 incidents occurred in 2012-16 were used in the analysis

"Not specified" causes in accidents are excluded

As presented in the above table around one third (32.1%) of incidents have occurred in the event of equipment movement due to personal causes. When consider the environmental causes, 25% of incidents have occurred while equipment maintenance and 18.8% is due to personal walking. It was highlighted that the events "equipment movement" and "equipment maintenance" have significant contribution with all contributory causes for the accident frequency.

4.7.3 Discussion On Causes Of Incidents

In this analysis, for about 94 incidents the relevant cause was not able to identify due to lack of information. Although '94 incidents' is a considerable amount, the analysis based on other data show a very clear relationship between incidents and relevant

causes. Therefore it is assumed that missing information has no impact on drawn conclusions.

According to the analysis, it is shown very clearly that people or human errors are the main cause for most of accidents, while equipment causes are for near misses. Even in the combined causes, there is a contribution from people.

As per the previous research studies, almost all researchers have discovered that human factor has a greater contribution for industrial accidents [Hosseinnian, Torghabeh, (2012), Hola, Sawicki, and Szostak, (2018), Vogel and Bester (2005), Carril and Oneiva, (2012)]. Reason (1995) has found that most accidents or adverse events are due to human rather than technical failures, especially in the transport sector. According to Fabiano, Curro, Reverberi, & Pastorino (2010) there can be several factors such as economic factors, technologies used, organization of work, environmental conditions and human factors which affect the frequency of accidents in container terminals.

In this study, personal errors were due to violation of safety procedures, rules or engaging in risky behaviors and unsafe behaviors and lack of concentration while performing his job role. As Wagstraff & Lie (2011) have revealed from their studies, they emphasize that shift work has a direct impact on human behavior. Lack of sleep, fatigue, less concentration which can be created by shift work may cause unsafe human behaviors leading to accidents. However, other than shift work the activities in container terminals are very complex and always associated with risks. Therefore responsible factors for these incidents may vary widely. Thus, the number of containerized shipments handled per hour, vessel schedules, type and number of equipment used, weather conditions, may also be the possible reasons for these incidents.

Further, the table 4.18 shows an important relationship between incidents, activities and causes. In our previous analysis we found that there are six hazardous activities in this terminal and “equipment movement” is the most hazardous. According to the above table, it shows that the highest personal factor contribution is for the most hazardous activity of “equipment movement “.

4.8 Further Analysis Of Incidents On Shift Work

Distribution of types of incidents in time window and work group is shown in the table

Table 4.19: Incidents occurred in time and work group by type

Time window	Work Group	Type of Incident					
		Accident		Near Miss		Total	
		No	%	No	%	No	%
00:01 am-06:00 am	Group 1	46	32.4%	1	14.3%	47	31.5%
	Group 2	31	21.8%	3	42.9%	34	22.8%
	Group 3	65	45.8%	3	42.9%	68	45.6%
	Total	142	100.0%	7	100.0%	149	100.0%
06:01 am-12:00 noon	Group 1	41	21.2%	5	25.0%	46	21.6%
	Group 2	58	30.1%	3	15.0%	61	28.6%
	Group 3	77	39.9%	7	35.0%	84	39.4%
	General	17	8.8%	5	25.0%	22	10.3%
	Total	193	100.0%	20	100.0%	213	100.0%
12:01 pm-06:00 pm	Group 1	59	34.5%	4	30.8%	63	34.2%
	Group 2	43	25.1%	4	30.8%	47	25.5%
	Group 3	50	29.2%	4	30.8%	54	29.3%
	General	19	11.1%	1	7.7%	20	10.9%
	Total	171	100.0%	13	100.0%	184	100.0%
06:01 pm-00:00 mid	Group 1	38	26.6%	6	46.2%	44	28.2%
	Group 2	49	34.3%	2	15.4%	51	32.7%
	Group 3	52	36.4%	5	38.5%	57	36.5%
	General	4	2.8%	0	.0%	4	2.6%
	Total	143	100.0%	13	100.0%	156	100.0%
Total	Group 1	184	28.4%	16	30.2%	200	28.5%
	Group 2	181	27.9%	12	22.6%	193	27.5%
	Group 3	244	37.6%	19	35.8%	263	37.5%
	General	40	6.2%	6	11.3%	46	6.6%
	Total	649	100.0%	53	100.0%	702	100.0%

Note: 702 incidents occurred in 2012-16 were used in the analysis, Unknown" types of incidents are excluded

According to the above table presentation, the highest number of incidents has occurred during the time window mid night to 6 am by Group 3 (45.6%). In addition, Group 3 is responsible for highest accident frequency in time windows of 6 am to 12 noon and 6 pm to mid nights which are 39.4% and 36.5% respectively. During 12 noon to 6 pm, highest accident frequency is shown by Group 1 (34.2%).

Also level of severity of accidents could be investigated with the time window and work group. Such 3-way analysis is given in the table 4.20. The number of high severe accidents was very low (8) and occurred by Group 2 in each roster. It was highlighted that highest medium severe accidents were related to Group 1. Although the highest accident frequencies have been reported from Group 3, most of them were low severe accidents.

When consider the causes of accidents, personal causes were the leading cause for high accident frequencies occurred in each shift work group. It was highlighted that during 6 am to 12 noon, more than one fourth of accidents have occurred by Group 2 due to cause of equipment. In the General shift, highest accident frequency (40%) was due to equipment. This analysis is given in the table 4.21 below.

Table 4.20: Accidents occurred in time and work group by severity

Time window	Work Group	Level of severity							
		Low		Medium		High		Total	
		No	%	No	%	No	%	No	%
00:01 am - 06:00 am	Group 1	24	27.9%	11	52.4%	0	.0%	35	32.1%
	Group 2	18	20.9%	4	19.0%	2	100.0%	24	22.0%
	Group 3	44	51.2%	6	28.6%	0	.0%	50	45.9%
	Total	86	100.0%	21	100.0%	2	100.0%	109	100.0%
06:01 am - 12:00 noon	Group 1	21	16.9%	10	43.5%	1	33.3%	32	21.3%
	Group 2	42	33.9%	6	26.1%	1	33.3%	49	32.7%
	Group 3	50	40.3%	3	13.0%	1	33.3%	54	36.0%
	General	11	8.9%	4	17.4%	0	.0%	15	10.0%
	Total	124	100.0%	23	100.0%	3	100.0%	150	100.0%
12:01 pm - 06:00 pm	Group 1	35	31.8%	10	43.5%	1	100.0%	46	34.3%
	Group 2	24	21.8%	4	17.4%	0	.0%	28	20.9%
	Group 3	37	33.6%	4	17.4%	0	.0%	41	30.6%
	General	14	12.7%	5	21.7%	0	.0%	19	14.2%
	Total	110	100.0%	23	100.0%	1	100.0%	134	100.0%
06:01 pm - 00:00 mid	Group 1	24	23.1%	3	50.0%	0	.0%	27	24.1%
	Group 2	40	38.5%	2	33.3%	1	50.0%	43	38.4%
	Group 3	37	35.6%	0	.0%	1	50.0%	38	33.9%
	General	3	2.9%	1	16.7%	0	.0%	4	3.6%
	Total	104	100.0%	6	100.0%	2	100.0%	112	100.0%
Total	Group 1	104	24.5%	34	46.6%	2	25.0%	140	27.7%
	Group 2	124	29.2%	16	21.9%	4	50.0%	144	28.5%
	Group 3	168	39.6%	13	17.8%	2	25.0%	183	36.2%
	General	28	6.6%	10	13.7%	0	.0%	38	7.5%
	Total	424	100.0%	73	100.0%	8	100.0%	505	100.0%

Note: 505 accidents occurred in 2012-16 were used in the analysis

"None" severity accidents are excluded

Table 4.21: Accidents occurred in time and work group by cause

Time window	Work Group	Causes							
		Personal	Environmental	Personal & Environmental	Equipment	Personal & Equipment	Environmental & Equipment	Personal, Environmental & Equipment	Total
00:01 am - 06:00 am	Group 1	83.3%	2.4%	4.8%	7.1%	.0%	.0%	2.4%	100.0%
	Group 2	80.6%	.0%	3.2%	9.7%	3.2%	3.2%	.0%	100.0%
	Group 3	79.0%	.0%	1.6%	9.7%	6.5%	1.6%	1.6%	100.0%
	Total	80.7%	.7%	3.0%	8.9%	3.7%	1.5%	1.5%	100.0%
06:01 am - 12:00 noon	Group 1	89.2%	.0%	.0%	8.1%	2.7%	.0%	.0%	100.0%
	Group 2	59.3%	3.7%	5.6%	25.9%	3.7%	1.9%	.0%	100.0%
	Group 3	80.6%	.0%	10.4%	6.0%	3.0%	.0%	.0%	100.0%
	General	46.7%	6.7%	.0%	40.0%	6.7%	.0%	.0%	100.0%
	Total	72.8%	1.7%	5.8%	15.6%	3.5%	.6%	.0%	100.0%
12:01 pm - 06:00 pm	Group 1	82.4%	.0%	3.9%	2.0%	11.8%	.0%	.0%	100.0%
	Group 2	80.5%	2.4%	.0%	9.8%	4.9%	.0%	2.4%	100.0%
	Group 3	71.7%	2.2%	8.7%	10.9%	6.5%	.0%	.0%	100.0%
	General	47.1%	5.9%	17.6%	11.8%	17.6%	.0%	.0%	100.0%
	Total	74.8%	1.9%	5.8%	7.7%	9.0%	.0%	.6%	100.0%
06:01 pm - 00:00 mid	Group 1	85.7%	5.7%	2.9%	2.9%	2.9%	.0%	.0%	100.0%
	Group 2	77.8%	.0%	4.4%	13.3%	4.4%	.0%	.0%	100.0%
	Group 3	73.3%	6.7%	4.4%	4.4%	6.7%	.0%	4.4%	100.0%
	General	75.0%	25.0%	.0%	.0%	.0%	.0%	.0%	100.0%
	Total	78.3%	4.7%	3.9%	7.0%	4.7%	.0%	1.6%	100.0%
Total	Group 1	84.8%	1.8%	3.0%	4.8%	4.8%	.0%	.6%	100.0%
	Group 2	73.1%	1.8%	3.5%	15.8%	4.1%	1.2%	.6%	100.0%
	Group 3	76.8%	1.8%	6.4%	7.7%	5.5%	.5%	1.4%	100.0%
	General	50.0%	8.3%	8.3%	22.2%	11.1%	.0%	.0%	100.0%
	Total	76.4%	2.2%	4.7%	10.1%	5.2%	.5%	.8%	100.0%
N		452	13	28	60	31	3	5	592

Note: 592 accidents occurred in 2012-16 were used in the analysis

"Not specified" causes of the accidents are excluded

4.8.1 Discussion On Further Analysis Of Incidents On Shift Work

From the previous analysis (refer 4.5.4) we could identify that roster basis shift workers show higher frequency of incidents than the general shift workers. Also the day shift shows a higher accident frequency than night shift. Therefore it implies that there is a relationship between accident frequency and roster basis shift workers.

According to further analysis of roster basis shift work, it was further proven that roster basis day shift has shown a higher accident frequency than night shift. In contrast, previous research work of Wagstraff & Lie (2011) has revealed that night work has high accident frequency. However, it was not proven from this study.

As per the terminal statistics, it shows that the number of cargos that are handled during day time is higher than night time. Also the number of equipment used in container handling is different. Therefore, other than the shift schedule, these factors may also have caused high frequency of accidents during day time.

Furthermore, it was identified that Group 3 shows higher accident frequency than other 2 groups during both night and day shifts. Apparently, the possible reasons could be shift schedule or high work pressure.

According to Fadda (2015), the number of accidents in container terminals depends on wide range of human errors due to fatigue. Joe Fleetwood points out that fatigue can be generated due to shift work and high work pressures. Therefore, both these factors may have caused for the Group 3 to show high accident frequency.

In addition, Costa (2016) argues that there are thousands of different shift schedules which may have a quite different impact on worker health, safety and social life, in particular with reference to amount of night work, timing and duration of shifts, length of shift cycle, speed and rotation of shifts and position of rest days. Hence, the above factors also have to be considered in order to reach at clear conclusions.

4.9 Incident Reporting Status

Reporting of incidents is a prime requirement when the health and safety of employees are concerned in an organization. Corrective measures or steps to avoid recurrence can be taken only if incidents are reported. Hiding of incidents may cause more incidents to occur and lead towards wrong decisions. Hence, it is important to study the incident reporting culture of this particular organization.

Out of total 759 incidents, 690 (90.9%) had been reported by relevant employees at the time of incident. The balance of 69 (9.1%) incidents had not been reported at the time of incident and had been reported later while attending corrective actions of those incidents. Almost all the near misses (98.2%) or 56 out of 57 have been reported at the time of incident. It was noted that 68 (9.7%) accidents have not been reported at the time of accident happened. The distribution of "Unreported" accidents over the years is given in the Table 4.22.

Table 4.22: Distribution of accidents by reporting status and year

Year of incident	Reporting status					
	Reported		Unreported		Total	
	No	%	No	%	No	%
2012	142	85.5%	24	14.5%	166	100.0%
2013	161	89.0%	20	11.0%	181	100.0%
2014	118	89.4%	14	10.6%	132	100.0%
2015	94	94.0%	6	6.0%	100	100.0%
2016	119	96.7%	4	3.3%	123	100.0%
Total	634	90.3%	68	9.7%	702	100.0%

Note: 702 accidents occurred in 2012-16 were used in the analysis

The percentage distribution of accidents based on reporting status over the 5 years is graphically presented in the Figure 4.9. It is clearly indicated that the number as well as the percentage of unreported accidents show a down ward trend over the 5 year period.

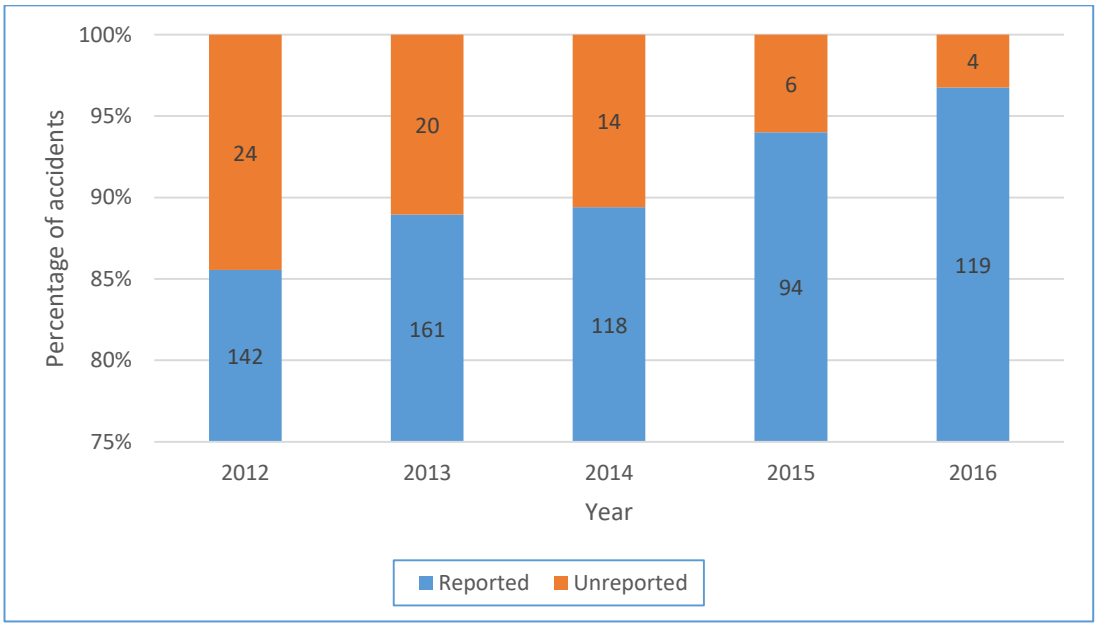


Figure 4.9 : Percentage distribution of accidents by reporting status and year

Incident reporting culture in group shift work is evaluated in this analysis. Table 4.23 below gives the distribution of accidents per work group and their reporting status.

Table 4.23: Distribution of accidents by work group and reporting status

Work Group	Reporting status					
	Reported		Unreported		Total	
	No	%	No	%	No	%
Shift work						
Group 1	181	88.7%	23	11.3%	204	100.0%
Group 2	174	93.0%	13	7.0%	187	100.0%
Group 3	230	90.6%	24	9.4%	254	100.0%
General shift						
General	46	86.8%	7	13.2%	53	100.0%
Total	631	90.4%	67	9.6%	698	100.0%

Note: 698 accidents occurred in 2012-16 were used in the analysis

Note: "Unknown" is excluded.

According to the above table, accidents have not been reported by all four groups. The Unreported accidents of roster basis shift work groups show the relevant percentages as Group 1 (11.3%), Group 2 (7.0%) and Group 3 (9.4%) respectively. Although the general shift group is responsible for less number of accidents, 13.2% of accidents were not reported by them.

To identify the incident reporting culture of the organization, it would be helpful analyzing the impact of the incidents with the reporting status. The Table 4.24 below shows the analysis of accidents by their impact and reporting status.

Out of 68 unreported accidents, more than half (51.5%) were Terminal Transport Equipment damages. Thirteen (19.1%) were Terminal Property damages. It was evident that all the personal injuries and fire occurrences have been reported at the time of the incident.

Table 4.24**:** Distribution of accidents by impact and reporting status

Impact	Reporting status					
	Reported		Unreported		Total	
	No	%	No	%	No	%
Personal Injury	89	14.0%	0	.0%	89	12.7%
Fire incident	12	1.9%	0	.0%	12	1.7%
Terminal Transport Equipment damage	289	45.6%	35	51.5%	324	46.2%
System/Process failure	19	3.0%	7	10.3%	26	3.7%
Portable Equipment damage	32	5.0%	9	13.2%	41	5.8%
Terminal Property damage	178	28.1%	13	19.1%	191	27.2%
Other damages	15	2.4%	4	5.9%	19	2.7%
Total	634	100.0%	68	100.0%	702	100.0%

Note: 702 accidents occurred in 2012-16 were used in the analysis

Reporting of incidents at ABC container terminals – Expert interview survey results (Refer Appendix B, Question 5)

As per the interview results, HS1 stated "……*all incidents are reported as per the company procedure.*

However, during the interview with HS2*, he pointed out that though all incidents must be reported, during night time some incidents were not reported especially by group 3. It is due to the exceptional reasons as declared by him and the specific reasons were not mentioned……."*

In addition, HS3 pointed out "……..*they are focusing to improve the reporting culture of incidents at ABC container terminal. Currently, all incidents are not reported, the reason may be there is no consequences management process established for those who disregard the process of reporting incidents. He also*

stated that all employees have been requested to report incidents as part of the condition of employment at ABC container terminals....."

Reporting of near misses – Expert interview survey result (Refer Appendix B, Question 3)

All employees have been informed that they should report near misses that occur at the terminal. It is routinely reminded to all the employees during their monthly meetings as stated by all 3 interviewees. Nevertheless, all of them further stated that "……..*reporting culture of near misses needs to be further enhanced. Since there are no injuries or damages, employees sometimes believe that it is not necessary to report them. It was highlighted that all near misses might not have been reported……."*

4.9.1 Discussion On Reporting Culture Of The Organization

According to the analysis of reporting status of incidents, it shows a positive trend in reporting of incidents. Over the period of five years there was an increase in reported incidents, at the same time a reduction in unreported incidents (refer table 4.22). The reason could be the increased awareness made among workers on the importance of reporting incidents. This has been further confirmed by the expert interview results, that the management of ABC container terminal is routinely reminding the process of reporting incidents to their employees.

However, it shows that there is considerable number of unreported incidents in roster basis shift (refer table 4.23). More than 50% of unreported accidents are' terminal transport equipment damages' and the second highest is "Equipment property damages'. These are the high impacts caused by accidents which were found during analysis.

As per the expert interview survey analysis, they agreed that some incidents are not reported due to the reason of not functioning consequence management process for who disregard the process of reporting incidents. Further, they pointed out that all near misses are not reported, because of workers' belief that it is not necessary to report near misses, as they do not result any injury or ill health.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on establishing the findings derived from the previous chapter pertaining to the analysis of the captured data. The conclusions summarize the accomplishment of each objective along with the findings under each objective. In addition, recommendations were made based on the research findings for the management of ABC container terminal to minimize the accident frequency in shift work. Finally, new research directions emerged from this study are indicated.

5.2 Conclusions

Nowadays shift work is so prevalent in many industries due to various reasons. It is inevitable in the port industry and especially in container terminals mainly due to economic reasons. When consider the pros and cons of shift work, its effects on health and safety conditions come under cons and management attention regarding this is highly required. In order to find the impacts cause due to shift work, it is essential to carry out a systematic analysis between shift work and safety performance of the organization. In such circumstances, after conducting a similar study in a container terminal following conclusions could be drawn.

Objective 1: To review the impacts of shift work on the work place incidents within different types of work places.

The first objective of the study was achieved through the literature review. Substantial amount of literature has emphasized the frequency of accidents and the impact of shift work on the work place accidents. Shift work causes high impact for work place incidents especially in transport and health sectors. Also it creates adverse effects on both health and safety conditions of employees.

Objective 2: To identify the incidents occurring during shift work in Container Terminals.

It is concluded that out of reported incidents above 90% are accidents and the rest are near misses in all five years. Percentages of near misses to the total incidents are very less all over the study period. It has shown no clear upward or downward trend in occurring accidents from 2012 to 2016. . A good incident reporting status is shown as there is a downward trend in the unreported accident frequency over the period of 5 years.

Objective 3: To investigate the type of activities related to accidents, their causes and impacts

There are six activities which show high frequency of incidence relevant to accidents namely, "equipment movement", "Container loading", "Container unloading", "Container movement", "Equipment maintenance" and "Vehicle movement". The "equipment movement" is the most hazardous activity.

There are three highest impacts caused by the accidents namely, "Terminal transport equipment damage", "Terminal property damage" and "Personal injuries".

There are about 84% low severe accidents. There are only nine high severe accidents have occurred and out of them five accidents are due to equipment movement.

Objective 4: To investigate the relationship between incidents and shift work in Container Terminals

The effects of shift work in ABC container terminal could be concluded as follows.

The roster basis shift workers who carry out operational works are responsible for more than 80% of accidents. The Group 3 is responsible for more than 50%. Therefore, it can be concluded that there is a relationship between accidents and roster basis shift workers.

However, it was identified that day shift causes high accident frequency and there is no significant impact on accidents from the night shift. The highest accident frequency occurs during day time between 6.00am to 12 noon. According to terminal

statistics there is a work pressure during day time due to the requirement of high productivity levels. Furthermore, the main cause of the accidents was identified as personal factors, based on the unsafe acts and behaviors identified related to workers with relevant accidents. In addition, employee fatigue was also identified as a contributory factor for accidents. Based on these findings shift work schedules and work pressure could be concluded as possible causes which have contributed to high accident risk. However, further studies are necessary to carry out in order to find the exact impact from the shift work to reach at a clear conclusion.

5.3 Recommendations

Overall, the current study reveals information on the specific accident patterns in the Container Terminal operations and the impact of shift work on the reported accidents providing additional support for the relevant workplace to identify the specific patterns in order to investigate and eliminate the contributory factors that may cause such pattern. By considering the outcomes of the study, the author confirms that personal factors have a great impact on occurrences of accidents and further highlights the importance of introducing adequate systems and programs to improve the safety behavior of the employees in the relevant workplace. As a result, following tasks are recommended in order to minimize the occurrences of accidents.

As it was identified, some accident occurring patterns are due to the morning fatigue exist in employees. Therefore, it is suggested that to analyze the fatigue level of the operatives before they are assigned for critical activities in order avoid the errors due to fatigue that may occur by them.

During the study it was discovered that there are six activities to be most hazardous as they have caused high accident frequency. So that, it is important to eliminate the risks involve in these activities in order to minimize accidents. For that, author suggests at first, to develop risk profiles for those hazardous activities, the documents which contain the risks involve in those particular tasks. Then these risk profiles must be communicated to employees who engage in those activities. Finally, activity based training and awareness must be provided in order to make them understand the severity of these risks and how to minimize them.

Further, it was identified that shift work schedules and work pressure have a link with occurrences of accidents. To balance the work pressure, the author suggests conducting an analysis of work load capacity of employees to identify how much they are loaded by operational work. Consequently, if the employee is loaded more than 70% additional man power must be provided or introduce flexible working hours, which provide short breaks in between working hours. (Eg: 10 minutes break every two hours).

To minimize the impact of shift work schedules, revision of shift work schedules is recommended with reference to amount of night work, timing and duration of shifts, length of shift cycle, speed and rotation of shifts and position of rest days. Prior to that, assessment of life style is needed in order to identify their off the job activities.

Furthermore, it is extremely important to improve the incident reporting culture, as it helps the management to avoid recurrences of accidents. For that, it is suggested implementing a consequence management process which should be linked to disciplinary procedure of the organization for those who disregard the process of reporting incidents.

5.4 Further Research And Future Directions

The Following are the further research perspectives that were identified during this study.

- To quantify the effect of shift work by studying workers psychological factors
- To identify the organizational factors that caused accidents.
- To study the health effects and psychosocial issues due to shift work

REFERENCE LIST

Ajmera, P., Satia, H. K., & Singh, M. (2016). Impact of shift work schedules on levels of stress, anxiety and work life balance in BPO employees. *International Journal of Recent Advances in Multidisciplinary Research*.

Alises, A., Molina, R., Gómez, R., Pery, P., & Castillo, C. (2014). Overtopping hazards to port activities: Application of a new methodology to risk management (Port risk management tool). *Reliability Engineering & System Safety*, *123*, 8-20.

Alli, B. O. (2008). Fundamental principles of occupational health and safety Second edition. *International Labour Office, Geneva*.

Beresford, A. K. C., Gardner, B. M., Pettit, S. J., Naniopoulos, A., & Wooldridge, C. F. (2004). The UNCTAD and WORKPORT models of port development: evolution or revolution?. *Maritime Policy & Management*, *31*(2), 93-107.

Bhattacherjee, A. (2012). Social science research: Principles, methods, and practices.

Bird, R.C., Mirtorabi, N. (2006). Shiftwork and the law. *Journal of Employment and Labour Law, 27*, 389.

Bøggild, H., & Knutsson, A. (2000). Shift work and heart disease: Meta analysis of the epidemiological literature. *Shiftwork in the 21st Century. Challenges for Research and Practices*, 189-94.

Bryman, A. (2007). Barriers to integrating quantitative and qualitative research. *Journal of mixed methods research*, *1*(1), 8-22.

Canadian Diabetes Association. (2006). *Diabetes and shift work: Maintaining healthy diabetes control*. Retrieved from http://www.diabetes.ca/Section-About/shiftwork.asp.

Carrillo, J. A., & Onieva, L. (2012, July). Organizational causes of accidents in manufacturing sector. In *6th International Conference on Industrial Engineering and Industrial Management* (pp. 587-594).

Chlomoudis, C. I., & Tzannatos, E. S. (2016). Port Risk Assessment Methodology for Human Accidents in Container Terminals: Evidence from the Port of Piraeus–Greece. *International Journal for Traffic and Transport Engineering*, *6*(4).

Chlomoudis, C. I., Kostagiolas, P. A., & Pallis, P. L. (2012). An Analysis of Formal Risk Assessments for Safety and Security in Ports: Empirical Evidence from Container Terminals in Greece. *Journal of Shipping and Ocean Engineering*, *2*(1).

Christou, M. D. (1999). Analysis and control of major accidents from the intermediate temporary storage of dangerous substances in marshalling yards and port areas. *Journal of Loss Prevention in the Process Industries*, *12*(1), 109-119.

Cintron, R. (2015). Human Factors Analysis and Classification System Interrater Reliability for Biopharmaceutical Manufacturing Investigations.

Costa, G. (1996). The impact of shift and night work on health. *Applied ergonomics*, *27*(1), 9-16.

Costa, G. (2016). Introduction to problems of shift work. *In Social and Family Issues in Shift Work and Non Standard Working Hours* (pp. 19-35). Springer, Cham.

Creswell,J. W. (2003). Research design: Qualitative, quantitative and mixed method approaches (2nd ed.). Thousand Oaks, California: Sage Publications, Inc.

Darbra, R.M., Casal, J. (2004). Historical analysis of accidents in seaports. *Safety Science, 42,* 85-98.

Dawson, D. (2001). *Dept of Indus relations, Govt of Queensland, extended working hours in Australia: Counting the costs.* Retrieved from http://www.qld.gov.au/pdf/ir/extended hours.pdf.

DeJoy, D. M., & Southern, D. J. (1993). An integrative perspective on work-site health promotion. *Journal of occupational medicine.: official publication of the Industrial Medical Association*, *35*(12), 1221-1230.

Fabiano, B., Currò, F., Reverberi, A. P., & Pastorino, R. (2010). Port safety and the container revolution: A statistical study on human factor and occupational accidents over the long period. *Safety Science*, *48*(8), 980-990.

Folkard, S., Tucker, P. (2003). Shift work, safety and productivity. *Occupational Medicine, 53*(2), 95-101.

García-Herrero, S., Mariscal, M. A., García-Rodríguez, J., & Ritzel, D. O. (2012). Working conditions, psychological/physical symptoms and occupational accidents. Bayesian network models. *Safety science*, *50*(9), 1760-1774.

Gold, D. R., Rogacz, S., Bock, N., Tosteson, T. D., Baum, T. M., Speizer, F. E., & Czeisler, C. A. (1992). Rotating shift work, sleep, and accidents related to sleepiness in hospital nurses. *American journal of public health*, *82*(7), 1011-1014.

Green-McKenzie, J., & Behrman, A. (2005). Shiftwork in the practice of emergency medicine. *Emedicine Journal*, *6*.

Hänecke, K., Tiedemann, S., Nachreiner, F., & Grzech-Šukalo, H. (1998). Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population. *Scandinavian journal of work, environment & health*, 43-48.

Harrington, J. M. (2001). Health effects of shift work and extended hours of work. *Occupational and Environmental medicine*, *58*(1), 68-72.

Harwell, M. R. (2011). Research design: Qualitative, quantitative, and mixed methods: Pursuing ideas as the keystone of exemplary inquir. In *The Sage handbook for research in education: Pursuing ideas as the keystone of exemplary inquir*. Sage.

Hazards in port and doc operations, information sheet (2015, February).
Health and Safety Executive. (2006). *Managing shift work*. Retrieved from http://www.hse.gov.uk

Health and Safety Executive. (2013). Statistics report for the ports industry 2012/2013(provisional).http://www.hse.gov.uk/statistics/souces.htm/enforcement.

Heath, E. D. (1982). Worker training and education in occupational safety and health: A report on practice in six industrialized western nations: Part two of a four-part series. *Journal of Safety Research*, *13*(2), 73-87.

Hoła, A., Sawicki, M., & Szóstak, M. (2018). Methodology of classifying the causes of occupational accidents involving construction scaffolding using pareto-lorenz analysis. *Applied Sciences*, *8*(1), 48.

Hosseinian, S. S., & Torghabeh, Z. J. (2012). Major theories of construction accident causation models: A literature review. *International Journal of Advances in Engineering & Technology*, *4*(2), 53.

Ioannou, P. A., Jula, H., Liu, C. I., Vukadinovic, K., Pourmohammadi, H., & Dougherty, E. (2000). Advanced material handling: Automated guided vehicles in agile ports. *Center for Advanced Transportation Technologies, Univ. Southern California, Los Angeles*.

Jekielek,S.M. (2003), *Do nonstandard work hours harm relationship quality?*. Retrieved from http://paa2004.princeton.edu/download.asp.

Kadir, Z. A.,Mohammad, R., Othman, N., Chelliapann, S., Amrin, A. (2017). Risk assessment of human risk factors in port accidents. *International Journal of Mechanical Engineering and Technology*. 8(11), 535-551

Le-Griffin, H. D., & Murphy, M. (2006, February). Container terminal productivity: Experiences at the ports of Los Angeles and Long Beach. In *NUF Conference* (pp. 1-21).

Linnemann, C. C., Cannon, C., DeRonde, M., & Lanphear, B. (1991). Effect of educational programs, rigid sharps containers, and universal precautions on reported needlestick injuries in healthcare workers. *Infection Control & Hospital Epidemiology*, *12*(4), 214-219.

Lu, C. S., & Kuo, S. Y. (2016). The effect of job stress on self-reported safety behaviour in container terminal operations: The moderating role of emotional intelligence. *Transportation research part F: traffic psychology and behaviour*, *37*, 10-26.

Lu, C. S., Tzeng, W. R., Yang, Y. L., & Shiu, W. H. (2001). The study of container terminal in (Un) loading risk management. In *Annual Conference Proceedings of the Chinese Institute of Transportation Safety* (No. 8, pp. 126-135).

Lyznicki, J. M., Doege, T. C., Davis, R. M., & Williams, M. A. (1998). Sleepiness, driving, and motor vehicle crashes. *Journal of the American Medical Association*, *279*(23), 1908-1913.

Mack, N., Woodsong, C., MacQueen, K. M., & Guest, G. i Namey, E.(2005). *Qualitative research methods: A data collector's field guide*.

McCluskey, L. (2013). Shift work and night work. *Unite the Union*, p.4.

Muller, G. (1999*). Intermodal freight transportation,* (4th ed.), Westport, Eno Transportation Foundation.

Noell, N.M.K. (2003). *Special cranes, crane construction.* Retrieved from http://www.nmknoel.com.

Pastorino, R., & Vairo, T. (2014). Area Risk Analysis in an Urban Port: Personnel and Major Accident Risk Issues. *Chemical Engineering*, *36*, 343-348.

Peter, T., Raggatt, F. (1991). Work stress among long distance coach drivers: A survey and correlation study. *Journal of Organizational Behavior, 12*, 565-566.

Rachman, A. Zulkifli, D. (2018). Risk assessment of work accidents accidents among loading and unloading workers at terminal III (ocean - going) of the port of Tanjung Priok. International Conference of Occupational Health and Safety, (ICOHS 2017).

Rachman, A., & Djunaidi, Z. (2018). Risk Assessment of Work Accidents Among Loading and Unloading Workers at Terminal III (Ocean-going) of the Port of Tanjung Priok. *KnE Life Sciences*, *4*(5), 98-107.

Reason, J. (1995). Understanding adverse events: Human factors. *BMJ Quality & Safety*, *4*(2), 80-89.Retrieved from https://www.hsa.ie/eng/

Shang, K. C., & Lu, C. S. (2009). Effects of safety climate on perceptions of safety performance in container terminal operations. *Transport reviews*, 29(1), 1-19.

Shang, K. C., & Tseng, W. J. (2010). A risk analysis of stevedoring operations in seaport container terminals. *Journal of Marine Science and Technology*, *18*(2), 201-210.

Shang, K. C., Yang, C. S., & Lu, C. S. (2011). The effect of safety management on perceived safety performance in container stevedoring operations. *International Journal of Shipping and Transport Logistics*, *3*(3), 323-341.

Shift work solutions LLC. (2003). *Using shift work to improve your lean manufacturing operation.* Retrieved from http://www.shiftwork.com/pdf/Lean%20Manufacturing.pdf.

Smith, C.S., Quick, J.C., & Tetrick, L.E. (2003). Shift work and working hours. (Eds.), *Hand book of Occupational Health Psychology*, pp.160-180.

Smith, M. J., Colligan, M. J., & Tasto, D. L. (1982). Health and safety consequences of shift work in the food processing industry. *Ergonomics*, *25*(2), 133-144.

Steenken, D., Voß, S., & Stahlbock, R. (2004). Container terminal operation and operations research-a classification and literature review. *OR spectrum*, *26*(1), 3-49.

Vogel, L., & Bester, C. J. (2005, July). A relationship between accident types and causes. In *Proceedings of the 24th Southern African Transport Conference (SATC 2005)* (Vol. 11, p. 13).

Wagstaff, A. S., & Lie, J. A. S. (2011). Shift and night work and long working hours-a systematic review of safety implications. *Scandinavian journal of work, environment & health*, 173-185.

Walliman, N. (2017). *Research methods: The basics*. Routledge.
World Health Organization (1995), Forty eight world health assembly. Retrieved from http://apps.who.int

Yin, R. K. (2014). Case study research: design and methods 5th ed. *Thousand Oaks*.