Elixir International Journal

Available online at www.elixirpublishers.com (Elixir International Journal)

Thesis Publications – Production Management

Elixir Thesis Production Management 147TP (2020) 1-86

ISSN: 2229-712X

EVALUATION OF DETERMINANTS OF EFFECTIVE CONTROL OF MAJOR ACCIDENTS IN THE PORT OF MOMBASA

Author Name

NAHASHON MANYARA KIOGORA

Co-authors

Dr. Margaret Gichuhi
Prof. Robert Kinyua
Institute of Energy & Environmental Technology, Jomo Kenyatta University of Agriculture and Technology

A FINAL THESIS SUBMITTED TO THE INSTITUTE OF ENERGY AND ENVIRONMENT TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN OCCUPATIONAL SAFETY AND HEALTH OF JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY.

ARTICLE INFO
Article history:
Received: 7 September 2020;
Published: 22 October 2020;

Tele:
E-mail address: nmanyara@kemri-wellcome.org

DEDICATION

I dedicate this work to my family for their encouragement and support throughout the research period.

ACKNOWLEDGEMENT

Sincere gratitude to the Lord Almighty God for enabling me to complete this work successfully. Very special regards go to my supervisor's Dr Margaret Gichuhi and Professor Robert Kinyua for their guidance throughout every step of completing this work. More thanks go to IEET department and BPS staff for their guidance and support. My heartfelt gratitude goes to the management of Kenya Ports Authority for allowing me to carry out my research within their organization and assigning someone to accompany me throughout the period of my data collection. Special thanks go to Mr Kombo and Mr Barnabas who facilitated the issuance of questionnaire and the interview sessions of my data collection. My special appreciations go to all the workers at KPA of both morning and afternoon shift who took time to fill the questionnaires.

TABLE OF CONTENTS

CHAPTERS	PAGE.NO
DEDICATION	2
ACKNOWLEDGEMENT	3
INTRODUCTION	12
1.0 Background information	12
1.1 Statement of the problem	13
1.2 Justification	14
1.3 Objectives of the study	14
1.3.1 Main objective	15
1.3.2 Specific objectives	15
1.3.3 Null Hypothesis	15
1.4 Research questions	15
1.5 Scope	16
1.6 Study Limitations	16
LITERATURE REVIEW	17
2.0 Introduction	17
2.1 Theoretical review	17
2.1.1 Theories relevant to the study	17
2.2 Major accidents	19
2.2.1 Controls for major accident hazards	20
2.2.2 Hazard sources at ports	20
2.3 Training	20
2.3.1 Training and Education Needs Analysis	21
2.3.2 Training of personnel at all levels of the organization	21
2.3.3 Training of Contractors	22
2.3.4 Training for Emergencies	23
2.4 Risk assessment	23
2.4.1 Port operations and common good practices	23
2.4.2 Why risk assessment in the port	24
2.4.3 Port risk assessment approaches and the	25

"ALARP" principle
2.4.4 Risk assessment communication 25
2.5 Safe systems of work 26
2.5.1 Port safety management system 26
2.5.2 Operation procedures 27
2.5.3 Permit to Work (PTW) systems of work 27
2.5.4 Contractor management system 28
2.5.5 Emergency response systems 28
2.6 Cargo handling equipment 29
2.6.1 Care, repair and maintenance 29
2.6.2 Equipment preventive maintenance and "cannibalization" 30
2.6.3 Substandard equipment, maintenance facilities and environment 31
2.6.4 Equipment replacement policy and standardization 31
2.6.5 Port equipment maintenance funding 32
2.7 Conceptual framework 32
2.8 Gaps identified from the literature 33
RESEARCH METHODOLOGY 35
3.0 Research design 35
3.1 Target population 36
3.2 Sample strategy 36
3.3 Sample size and sampling procedures 36
3.4 Data collection instruments 37
3.4.1 Questionnaire 37
3.4.2 Interview questions 37
3.4.3 Hazard observation checklist 37
3.4.4 Pilot study 37
3.5 Data collection procedures 38
3.6 Data processing and analysis 38
3.6.1 Analysis and presentation Methods 38
3.6.2 Study area and location 39

RESULTS AND DISCUSSIONS	40
4.1 Introduction	40
4.2 Results and discussion	40
4.2.1 Demographics	40
4.2.2 Safe systems of work	42
4.2.3 Cargo handling equipment	46
4.2.4 Training gaps	52
4.2.5 Risk assessment Process	57
CONCLUSIONS AND RECOMMENDATIONS	62
5.1 General conclusion	62
5.1.1 Effectiveness of safe work systems implemented towards control of major accidents	62
5.1.2 Cargo handling equipment maintenance and repair system in place towards ensuring effective control of major accidents	62
5.1.3 Identify training need gaps towards enhancing effective control of major accidents	63
5.1.4 Current risk management process in place towards effective control of major accidents	63
5.2 Recommendations	64
5.2.1 Recommendations for future research	64
APPENDICES	65
REFERENCES	65
APPENDIX 1: QUESTIONNAIRE	72
SECTION I: Demographic information	72
APPENDIX II: INTERVIEW GUIDELINES	79
APPENDIX III: DATA ANALYSIS TABLES	80

LIST OF TABLES

TABLES	PAGE.NO.
Table 1: Causes of major accidents in Kaohsiung Port in Taiwan	12
Table 2: Port industry accident statistics in the UK	13
Table 3: distribution of respondents by department	42
Table 4: ANOVA for responses of different safe systems versus control of accidents	44
Table 5: ANOVA for responses on equipment related accidents versus the nature of accidents	48
Table 6:Inadequate equipment maintenance can lead to occurrence of major accidents	49
Table 7: Inadequate equipment maintenance can lead to occurrence of major accidents	49
Table 8: Inadequate equipment maintenance can lead to occurrence of major accidents	50
Table 9:Inadequate equipment maintenance can lead to occurrence of major accidents	50
Table 10: Chi-Square analysis between training and improvement on major accidents prevention at KPA	53
Table 11: Chi-Square analysis between experience of respondents and improvement on awareness on major accidents prevention at KPA	55
Table 12: ANOVA for responses on various training aspects versus the respondent’s job cadre	57

LIST OF FIGURES

FIGURES	PAGE.NO.
Figure 1: Top five locations for occurrence of major accident in the ports	13
Figure 2: Domino accident causation theory factors. Source: (Berman, 2013)	18
Figure 3: Major accident hazards escalation continuum. Source: (Burn & David, 2006)	18
Figure 4: Conceptual framework of determinants to effective control of major accidents	33
Figure 5: Research design flow	35
Figure 6: Sampling strategy	36
Figure 7: study area map; Source: KPA annual report 2019	39
Figure 8: Study location demographics showing distribution by gender	40
Figure 9: Showing age distribution of the respondents	41
Figure 10: Showing education levels of the respondents	41
Figure 11: Showing years of work experience of the respondents	42
Figure 12: Response on importance of safe systems of work	43
Figure 13: Response on emergency evacuation need at KPA	45
Figure 14: Response on emergency response testing frequency at KPA	45
Figure 15: Responses on equipment as causes of accidents at KPA	46
Figure 16: Responses on equipment related accidents at KPA	47
Figure 17: Responses on equipment maintenance related safety aspects at KPA	49
Figure 18: Responses on equipment management policy at KPA	51
Figure 19: Responses on number of respondents trained on accidents at KPA	52
Figure 20: Responses on improvement of major accident awareness after training at KPA	53
Figure 21: Responses on accident response preparedness after training at KPA	54
Figure 22: Showing respondents view on importance of training to both staff and contractors at KPA	54

Figure 23: Responses on training on accident prevention duration at KPA 56
Figure 24: Responses on training facilitation at KPA 56
Figure 25: Responses on participation in risk assessment at KPA 58
Figure 26: Responses on importance of risk assessment in control of accidents at KPA 58
Figure 27: Responses on need for risk assessment in authorizing contractors at KPA 59
Figure 28: Showing respondents view on usefulness of risk assessment at KPA 60

LIST OF ABBREVIATIONS

ALARP	As Low as Reasonably Practicable
COMAH	Control of Major Accident Hazards
HSE	Health and Safety Executive
ILO	International Labor Organization
IMO	International Maritime Organization
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KPA	Kenya Ports Authority
LDC	Least Developed Countries
NIOSH	National Institute of Occupational Safety and Health
OH&S	Occupational Health and Safety
OSHA	Occupational Safety and Health Authority
PTW	Permit to Work
QRA	Quantitative Risk Assessment
SMS	Safety Management System
SWL	Safe Working Load
ANOVA	Analysis of Variance

DEFINITION OF TERMS

As Low As Reasonably Practicable – This is a principle in hazard control which means that the risks are tolerable, on the basis that they are acceptably low, and cannot be cost effectively further reduced (**Kilvington**, 2004).

Cargo handling equipment – It is part of infrastructure which in its widest context refers not simply to the number of container berths, terminal area, cranes and tugs but also to the quality of cranes and other lifting equipment provided for the operations in the port. Container handling is by the jib cranes, multipurpose cranes, gantry cranes and even mobile cranes. Quay transfer may be by tractor-trailers, by straddle carriers or by heavy duty lift trucks. Stacking and de-stuffing may be carried out by straddle carriers, yard gantry cranes or a variety of lift trucks/reach stackers (**Choughule**, 2000).

Major accident hazard – Means a hazard that has the potential to cause a major accident e.g. hazardous substances that are explosive, flammable, toxic, reactive etc., i.e. accidents that could seriously harm people, property or the environment, (Deane, 2004).

Risk assessment - It is a systematic approach that involves identification of hazards, analysis and rating of the risks they pose to the people, business and environment, and determining control measures to mitigate them (**Liwång**, 2012).

Safe systems of work - Include structures and systems put in place to ensure operations in the port are carried out with minimal risk exposure, and includes port safety management system elements e.g. policies, procedures, Permit To Work, emergency response and evacuation etc. (**Corson** et. al, 2008; **Rujillo**, 1999)

SEVESO directive - Directive on the control of major accident involving dangerous substances in the European commission countries. It has been repealed three times and currently at SEVESO III (HSE, 2011)

CHAPTER ONE

INTRODUCTION

1.0 Background information

The port of Mombasa plays a pivotal role in the socio-economic development of East and Central African countries where goods of varying hazards transit the port. Operations in port entails the risk of serious accidents, to which shores and especially port areas and their vicinities are highly exposed to huge quantity of hazardous substances. Crane incidents are happening with increasing frequencies in the ports around the world. Besides adverse and unpredictable weather, other causes of crane accidents in ports include poor standards of safety in crane operation and terminal operations and failing to keep up standards of crane maintenance (Larry & Peter, 2007). The importance of ports as a potential source of accidents of diverse types (spills, explosions, fires, toxic clouds) is closely linked to the function of the port itself and to the installations and activities associated to it, which feature transfer from water to land (and vice versa) of large amounts of waterborne cargo with a wide diversity hazardous materials capable of causing major accidents (Tsenga & Nick, 2015).

According to a study carried out in Taiwan's Kaohsiung Port on causes of accidents in ports, fire, explosion and equipment (crane) failure accounted for close to 30 % of the total major accidents analyzed from the year 2010 to 2014.

Table 1: Causes of major accidents in Kaohsiung Port in Taiwan.

Year	Total	Collision/ Contact	Stranding/ grounding	Fire	Explosion	Loss of containment	Capsized/ list	Machinery failure	Others
2010	80	39	9	3	0	0	0	25	4
2011	104	28	8	7	3	0	2	39	17
2012	70	25	5	1	1	2	2	7	27
2013	30	18	2	1	0	0	0	2	7
2014	21	19	0	0	0	2	0	1	1
Total	305	129	24	12	4	4	4	74	56
%		42.2	7.8	3.9	1.3	1.3	1.3	24.2	18.3

Causes of major accidents in Kaohsiung Port in Taiwan.

Source: (Tsenga & Nick, 2015)

A study carried out by researchers in the United Kingdom (Southampton Solent University) to review shipping accidents as shown in the table below, showed statistics of occurrence of major accidents in the ports despite efforts to control them (Butt et al, 2014). This gives a strong view that there is need to continuously develop effective control measures on occurrence of this hazards in the ports.

Table 2: Port industry accident statistics in the UK

Using Over-7-Days (New Criteria)	2010 Full year	2011 Full year	2012 Full year	2013 Full year	2014 Jan to Jun only
Total no of employees covered	19508	18066	17526	16270	16338
Total no of fatal accidents	1	1	2	1	0
Total no of major accidents	37	33	17	30	13
Total no of Over-7-Day accidents	236 (1)	198 (1)	160 (1)	185	65
Total reportable accidents	274	232	179	216	78
Incidence rate	1.4	1.3	1.0	1.3	0.5
Total no of dangerous occurrences	73	51	30	24	5
Total no of industrial diseases	7	6	3	2	0

Source: Butt et, al., 2014

And, a similar study in Barcelona, Spain, showing locations of major accidents in the ports indicated that majority of major accident hazards had occurred during unloading/offloading from the ship or through use of handling equipment /cranes as showed below (Ronza et al, 2003).

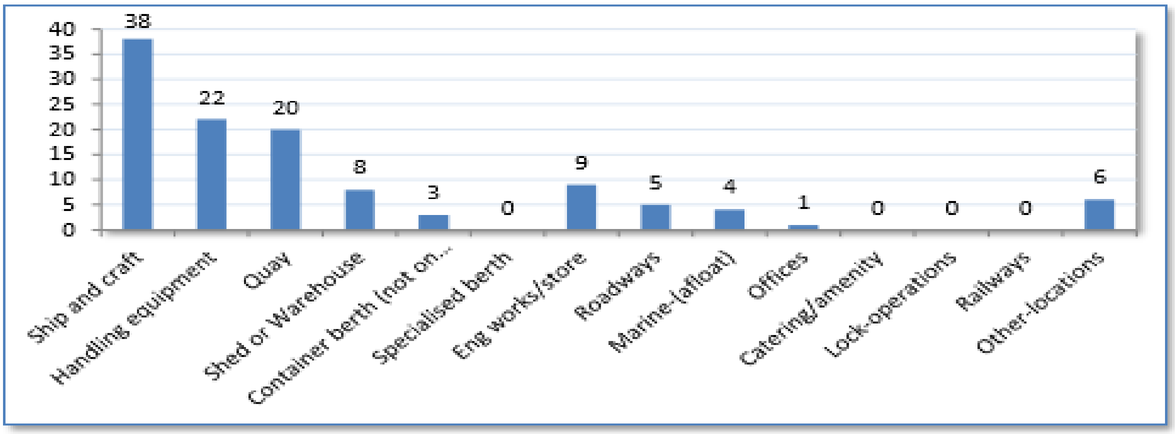


Figure 1: Top five locations for occurrence of major accident in the ports.

Source: Ronza et al., 2003

Control of major accidents requires intact effective hazard control measures and robust safe systems of work.

1.1 Statement of the problem

The relatively low frequency of reported major accidents resulting from port operations can lead to inadequate attention being paid to systems and controls to reduce the risk of major accident hazards in the ports. The potential for major accidents to happen in ports and harbours has increased in the recent past due to increase in trade volumes. Approximately

50% of goods carried by sea and handled in the ports can be classified as hazardous and if wrongly handled, could cause death of people, environmental disaster or destruction of property. Thus, the potential for major accidents in the port is high.

The port of Mombasa has experienced major accidents ranging from fire, explosion, chemical spillage and lifting equipment failure in the past. According to International Maritime Organization statistics, most maritime accidents happen in ports and harbors (IMO, 1998). A review of the quarterly accident report for KPA for the year 2017 showed that a total of 139 accidents had been reported and over 50% of them were from the container terminal. A major accident of fire, equipment failure, chemical spill etc. would lead to temporary shutdown or interruption of operations leading to huge direct and indirect losses. Therefore, adequate measures must be put in place to counter any emergency. For instance, fire kills, destroys buildings and other property leading to massive losses when it happens. An equipment failure such as crane collapse could lead to multiple fatalities or huge downtime losses in lifting of goods from or into a ship. The impact of this would cause huge losses to in-land manufacturing, transport and service industries which translate into massive financial losses besides possible loss of lives and property.

Since the port of Mombasa is a landlord port serving several landlocked neighbors, every other business opportunity places a demand on port operations and increased probability of a major accident occurring in the port. The port of Mombasa contributes towards employment, revenue collection by government and the export and import of products into the countries in East Africa region. It also has industrial linkages with other sectors such as transportation, manufacturing etc. making it such a critical facility not only in Kenya but in the region and therefore cannot afford any disruption of operations due to occurrence of a major accident.

1.2 Justification

Ports are often challenging places to work. Workers deal with a whole range of cargoes and work alongside a wide variety of people and equipment. In addition, work at ports takes place throughout the day and night and in all types of weather and often involves several different employers and contractors who could all affect each other’s activities.

All accidents come with attached costs, both direct and indirect. Examples of recent major accidents that have been recorded at study location included: A fertilizer silo falling on a testing operator and fatally injuring two people, seriously injuring 7 others. A signaler fatally crushed by a crane and seriously injured three other staff. A trailer hitting a container reach stacker thereby injuring seven staff and a cargo fall from a ship winch crane damaging the mobile crane and extensively damaging the cargo, among others.

Implementation of the recommendations derived from the findings would help in improvement of the safety culture across the organization through training of contractors and involvement all stakeholders in risk assessment. Training of staff and contractors on major accidents will help to reduce the number of accidents happening in the port through increased awareness on controls and adherence to safety procedures to ensure safe operations are done. A reduction in costs (direct and indirect) associated with the occurrence of accidents in the workplace e.g. compensation, legal costs etc will be achieved from the study and make the workplace safer thereby end up increasing the profitability and the morale of employees and hence the overall productivity of the organization.

1.3 Objectives of the study

1.3.1 Main objective

To evaluate the determinants of effective control of major accidents at the port of Mombasa

1.3.2 Specific objectives

- To assess the effectiveness of safe work systems implemented towards control of major accidents.
- To examine cargo handling equipment maintenance and repair system in place towards ensuring effective control of major accidents
- To identify training need gaps towards enhancing effective control of major accidents
- To assess the current risk management process in place towards effective control of major accidents

1.3.3 Null Hypothesis:

There are no determinants of effective control of major accidents at the port of Mombasa

1.4 Research questions

- Which are the contributions of safe systems of work in effective control of major accidents in the port of Mombasa?
- How has lack of adherence to machines and equipment repair and maintenance schedule affected effective control of major accident in the port of Mombasa?
- What has been the contribution of training in effective control of major accidents in the port of Mombasa?
- How has risk assessment helped in effective control of major accidents in the port of Mombasa?

1.5 Scope

The study was carried out at the port of Mombasa. The staff included the harbor executive consisting of general managers, the harbor managers who are mostly head of departments and supervisors, the dock workers who are the majority doing ground operations and contractor staff who make up a third of the total population at the port. This study sampled from a total population of 650 workers spread across various sections of the container terminal. The research involved perusal of available records related to training, risk assessment, contractor control, equipment maintenance and accidents occurrence within the organization as well as interviews with the Safety and Health representatives, machine and equipment operators, maintenance and repair technicians among other dock workers, so as to obtain information related to control of major accidents in the port. The study considered the opinions of both permanent and contractual employees who were working in the organization at the time of collecting data. The results were analyzed to arrive at the conclusions and recommendations.

1.6 Study Limitations

Although the objectives of this research were achieved, some challenges were encountered. One, the unwillingness of some participants to provide the required information of the study until confidentiality was guaranteed. Two, some of the questionnaires were never returned and others were returned late leading to delays in data analysis. Three, taking of photos was not allowed.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

Despite the fact that a general consensus exists on the fact that potential for major accidents to happen in ports has increased in the recent past due to increase in trade volumes, only few studies have tackled the critical issue of determinants to their effective control (Mejia et al., 2010). Ports are often challenging places to work in terms of hazards present in various undertakings, especially transport and handling of harmful cargoes which can be called the second most dangerous industry after the nuclear power industry (Tarmo, 2000). According to statistics most maritime accidents related to dangerous cargo happen in ports and harbors (IMO, 1998). The question here is not if a major accident can happen in our ports because the potential is very high, but how to effectively control before they happen or when they happen.

2.1 Theoretical review

There seems to be a resignation that 'accidents will happen' where so much human activity is being conducted. It has also been recognised for many years that certain commercial activities involving handling of dangerous substances with sophisticated equipment have the potential to cause accidents (Mejia et al., 2010). The effective control of major accidents risk requires an understanding of the theory of how accidents happen and energy transformations, if any, involved in potential major accident events. Without understanding how major accidents have occurred and how a combination of events and operations would lead to major accidents is deluding ourselves and the question becomes "when will our smoking gun explode?". The various theories relevant to this study were studied to gain more understanding on occurrence and control of major accidents.

2.1.1 Theories relevant to the study

2.1.1.1 Domino theory of accident causation

Pioneered by Heinrich, this theory describes the accident causation relationship in regard to; man and machine, unsafe acts and management controls. According to Heinrich (Berman, 2013), domino theory is comprised of five standing dominos (as per the figure below) which will fall one after the other if the first domino falls. Heinrich suggested that removal of one of the factors would prevent the accident and resultant injury. The accident can be prevented only if the chain of sequence is disturbed, e.g. the unsafe act/condition can be eliminated in order to prevent the accidents and associated injuries.

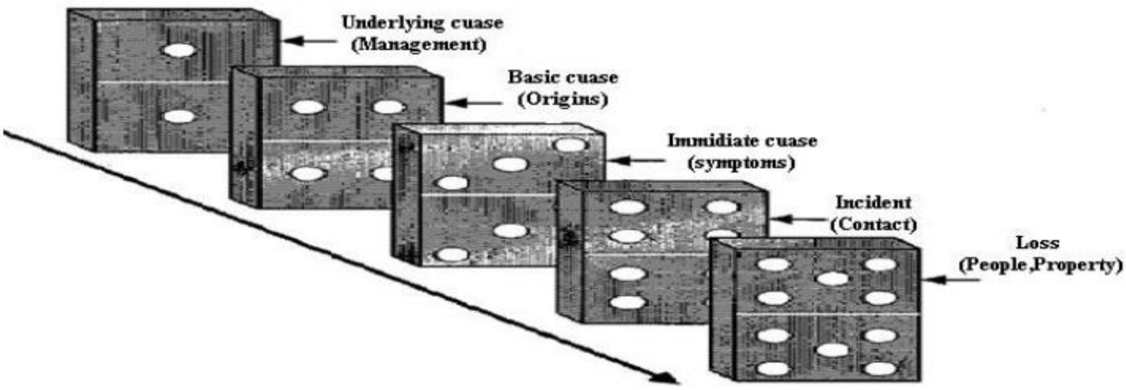


Figure 2: Domino accident causation theory factors. Source: (Berman, 2013).

This theory became the basis for many other studies on accident causation model with emphasis on management role in accident prevention. Management models believe that lack of management system (e.g. port safety management system) is responsible for occurrence of major accidents (Burn & David, 2006).

2.1.1.2 Multiple causation theory

It is an outgrowth of the domino theory, but it postulates that for a single accident there may be many contributory factors, causes and sub-causes, and that certain combinations of these give rise to accidents (Burn & David, 2006). According to this theory, the contributory factors can be grouped into the following two categories: Behavioral category which includes factors pertaining to the worker, such as improper attitude, lack of knowledge, lack of skills and inadequate physical and mental condition. Environmental category which includes improper guarding of other hazardous work elements and degradation of equipment through use and unsafe procedures. The major contribution of this theory is to bring out the fact that rarely, if ever, is an accident the result of a single cause or act.

Figure 3: Major accident hazards escalation continuum. Source: (Burn & David, 2006)

For instance, uncontrolled escalation of safety incidents can be the cause of major accident events although this factor is often overlooked or underestimated (Brandsæter, 2002).

2.1.1.3 The energy transfer theory

It postulates that a worker incurs injury or equipment suffers damage through a change of energy, and that for every change of energy there is a source, a path and a receiver (Dekleva, 2013). Kinetic energy is contained in an object that is moving. For example, a wrench falling from an overhead crane or the collapse of the crane structure. Chemical energy can occur in the form of chemicals reacting strongly with various parts of a human being as well as machines, equipment, and the environment. Thermal energy can manifest itself in the form of fire or explosion, which can destroy people, property and the environment. Mechanical energy can also manifest in form of cargo handling equipment failure while pressurized energy in the forms of pressurized gases and liquids in bulk which are offloaded from ships (Dekleva, 2013). Major accident hazards have high potential to act as uncontrolled release of energy and should be well mapped. Terrorist energy should not be underestimated as it can be expended by employees and non-employees to steal or destroy company resources or as an act of sabotage

2.2 Major accidents

Most developed nations have legislations dealing specifically with control of major accident hazards. In them, they are required to develop an adequate and documented performance-based approach framework, under which operator of a hazardous facility (e.g. Kenya Ports Authority) establishes, implements and maintains appropriate systems, procedures and processes intended to prevent major accidents and near misses, and to minimize the effects of major accidents at the facility on people, property and the environment.

For example, in 1999 the “Control of Major Accident Hazards Regulations” (COMAH) were introduced in Great Britain, replacing earlier legislation, with the aim of preventing major accidents involving dangerous substances and to limit the consequences to people and the environment of any which do occur (Chan, 2011). Some of the criteria for classifying major accidents were: On basis of fatalities, serious injuries that could be life threatening, involvement of many people and causing extensive damage to property, loss of income as well as spillage of hazardous substances to the environment causing pollution.

2.2.1 Controls for major accident hazards

Major accidents are usually characterized by coincidental breakdowns of multiple barriers rather than as a sequential progression of precursor events. The initiating event may be minor, but as the successive barriers fail the resulting accident continues to grow in significance and consequence (Roberson, 2004). Barriers can be thought of as the controls and defenses installed e.g. engineering controls, administrative controls and safe systems of work.

One cannot assume that the various barriers are completely independent of each other. For example, a company facing financial challenges is probably postponing preventive maintenance of key cargo handling equipment and machines or foregoing key training of its staff who may be taking shortcuts on operating procedures and using suspect material and riskier technology (Roberson, 2004).

2.2.2 Hazard sources at ports

According to (Deane, 2004), any facility where hazardous substances that are explosive, flammable, toxic, reactive etc. such as ports, have a potential to cause major accidents (i.e. accidents that could seriously harm people, property or the environment) should be carefully managed. This potential is a result of the storage, handling (loading or off-loading), transport or processing of significant quantities of dangerous chemicals. The relatively low frequency of major accidents resulting from such operations can lead to inadequate attention being paid to systems and controls to reduce the risk of probable large-scale damaging events (Cătălin et al., 2012).

2.3 Training

It is the responsibility of operators of major hazard facilities to ensure that a comprehensive and effective training and education program is developed, implemented, maintained and improved at the facility. The main objective of a training and education program is to ensure that employees at a major hazard facility contribute to the minimization of risk of major accidents by working safely (Radojkovic, 2011). The importance of a training and education program is based on the recognition that the day-to-day operation dealing with major hazards is dependent on the skills, knowledge and attitude of the employees of that facility. The cases of major accidents causing serious damage to people, property and the environment where the cause of the accident is attributable, in part, to inadequate training, are well documented.

2.3.1 Training and Education Needs Analysis

The first step in the development of the training and education program in the port would be systematic identification of training needs. The analysis should identify the learning objectives required for the different working groups and individuals within an organization. According to (Deane, 2004), one of the approaches used to identify training needs is to categorize the needs in accordance with the desired learning objectives. such as: General improvement of safety awareness, knowledge development for safe operation and influencing safety attitudes to encourage safe behavior.

The tasks or actions can be: Skill-based actions; Rule-based actions and Knowledge-based actions where different types of training are required for these different actions and behaviors (OSHA 2254, 1998). Rule-based training usually reinforces the behavior requiring employees to follow instructions and procedures. While this approach may be appropriate in certain circumstances, effective safe operations may require a training program to go beyond reminding the employees to follow rules.

Development of such a program should be based on consultation with employees in the organization to comprehensively cover all levels of employees as well as contractors and visitors, and all scope of their work. It should provide the merit of identifying the personal attributes, skills and qualifications when selecting the right person for a key position such as a crane operator (Deane, 2004). According to (Cătălin et al., 2012), port authorities should aim to develop structured and comprehensive mechanism to establish a training program that is appropriately resourced, with competency standards for key positions that will effectively impart the knowledge and information to enable them to control occurrence of major accidents.

2.3.2 Training of personnel at all levels of the organization

Induction training for new employees should provide, as a minimum, an initial level of understanding of the basic minimum requirements for working at the site (HSE, HSG 48). These may include elements such as: a site familiarization tour; an overview of site activities and processes; location of amenities, including the first aid rooms; an organizational structure, reporting mechanisms; General rules and procedures while on site; for reporting of unsafe conditions and general procedures during emergencies, including location of alarms; site security arrangements and rules for access to the site (Radojkovic, 2011).

There is an international legislation that deals specifically with training of employees working in the port. ILO considers the convention Occupational Safety and Health (Dock Work) Convention (No. 152), 1979 highly relevant to port performance. This Convention includes several mandatory requirements regarding training. For example, Article 4, paragraph 1. (c) states the following: “National laws or regulations shall prescribe that measures complying with Part III of this Convention be taken as regards dock work with a view to providing the information, training and supervision necessary to ensure the protection of workers against risks of accident or injury to health arising out of or in the course of their employment” Article 4, paragraph 2. (r) states “the measures to be taken in pursuance of this Convention shall cover training of workers”. Also, Article 38, paragraph 1 states “no worker shall be employed in dock work unless he has been given adequate instruction or training as to the potential risks attaching to his work and the main precautions to be taken”, ILO Code of Practice on Safety and Health in Ports (2005)

Dock Work Recommendation (No. 145), 1973: Convention concerning the Social Repercussions of New Methods of Cargo Handling in Docks. This Recommendation calls for training and retraining to enable dockworkers to carry out several tasks as the nature of work changes. Occupational Safety and Health (Dock Work) Recommendation (No. 160), 1979. This Recommendation includes a provision that states the following: “With a view to preventing occupational accidents and diseases, workers should be given adequate instruction or training in safe working procedures, occupational hygiene and, where necessary, first-aid procedures and the safe operation of cargo-handling appliances.” ILO Code of Practice on Safety and Health in Ports (2005). The provisions in this Code cover all aspects of port work where goods are loaded or unloaded to or from ships and includes work incidental to such loading or unloading activities in the port area.

A 1998 NIOSH study concluded that the role of training in developing and maintaining effective hazard control activities is a proven and successful method of accident intervention. Therefore, appropriate training relevant to the specific job should be provided to employees at all levels. Training that is not regularly enforced is often forgotten. These employees should be trained not only on how to perform their job safely but also on how to operate within a hazardous environment or how to respond during an emergency in their work areas (Townsend, 2007).

2.3.3 Training of Contractors

Contractors need to be subject to all safety controls, including training requirements, which apply to site employees to ensure their practices do not jeopardize themselves, others and the facility (Deane, 2004). Training for this group of stakeholders must include a detailed analysis of the identified hazards, the risks involved in the operation and the effective use of control measures. Certain job assignments should be limited to contractors who are "certified," "competent," or "qualified"— meaning that they have had special previous technical training, in or out of the workplace. Thus, specialized training such as safe operation of port equipment and machinery, chemical and hazardous materials safety and accident prevention and safety promotion should be offered to employees who operate specialized equipment both at the container terminals, quay side and stevedores.

2.3.4 Training for Emergencies

Crew preparedness is an important element of safety at sea and ports and should therefore be a key focus of attention for all ports in managing major accident hazards. Proficiency in responding to emergency situations by the personnel should include ability to operate essential emergency equipment and general familiarization with the emergency situations (Ilchenko, 2012, Mejia et al., 2010). The crew also must demonstrate proficiency in assigned emergency duties and the equipment connected to these. The same should also apply to the ground crew in the fire safety department to ensure they are ready for any fire or explosion that may occur during ground operations. This should be demonstrated through scheduled drills.

2.4 Risk assessment

In the world of international trade, nearly every business opportunity places a demand on port operations. In fact, the trends in international trade in strategic minerals and energy commodities, such as crude oil, have also been emphasizing marine transportation (IMO, 1998). The entry and presence of dangerous cargoes in port areas and any consequential handling should be controlled to ensure the general safety and security of the area, the containment of the cargoes, the safety of all persons in or near the port area, and the protection of the environment as well as the provision of emergency equipment appropriate to the hazards of the dangerous cargoes to be handled. Among the cargo being moved are strategic energy commodities and infrastructure, such as crude oil, liquefied petroleum gas (LPG), heavy machinery and hazardous chemical substances in loose or bulk essential to the global economy. In this regard the complex, fast-paced and high-volume global trade requires an effective risk profiling capability for ports and waterways for the safe and secure movement of these goods in the global supply chain (Stenek et al., 2011).

2.4.1 Port operations and common good practices

The concept of risk and risk assessment has been around since when it was first used primarily in the safety analysis of nuclear reactors after World War Two (WWII) (Altiok, 2009). Traditionally, risk assessments were based solely on expert opinion. Experts were asked to rate several incident scenarios, with instigators and consequences, using scales of some numbers. The numbers were then crunched, and risk was calculated. Expert opinion must be an integral part of risk assessment but should not comprise all of it (Altiok, 2009).

However, a good practice in most ports in developed nations is to use a mathematical risk model to calculate risks for each scenario as they develop in the simulation model. For instance, in the case of handling explosive materials in the port, the operator (Port) should consider two broad categories of accidental initiation of explosives material: Initiation caused by accidents imparting high levels of energetic stimuli to explosives, e.g. crane failures, vehicle collisions and fires, ship fires etc. and initiation brought about by the presence of unsafe items in explosives load and where an initiation may occur without there being any precursor accident of the types mentioned above (Stenek et al., 2011, Merrifield et al., 1992).

According to (International Chamber of Shipping, 2013), there is a great risk of a major hazard accident arising in the port operations as a result of the transport and handling in the ports of a hazardous substance in bulk. Most accidents can be avoided if the risks from the work are suitably and sufficiently assessed and appropriate control methods are adopted (SIP016, 2014).

According to (Stenek et al., 2011), in practice the application of a risk-based approach to port licensing may lead to real safety improvements against occurrence of major accidents through greater operator awareness of risk generating activities. For example, a full assessment of the risks from the handling of explosive substances in ports must take account of possible "domino effects" arising from potential interaction between explosives and other types of dangerous commodities.

2.4.2 Why risk assessment in the port

According to (Brandsæter, 2002), many port management systems have been developed partly as a result of lessons learned from incidents and accidents. The risk assessment is applied to add value to the existing system, informing it for development into a coordinated system managing risk.

The likelihood of a hazardous incident and its potential consequences can also often be determined with reference to historical data (Merrifield et al., 1992). However, (Liwång, 2012), cautions that historical data alone will not provide a true assessment of the risk of the current port operations, nor will it necessarily reveal an extremely remote event. There must be focus on accidents with multiple fatalities because society is more concerned about single events with many fatalities and societal risk, than it is about several incidents with few fatalities per incident (Kilvington, 2004).

Consultation with regular users and organizations having interest in the port is important while undertaking risk assessment and ports are such types with multiple stakeholders and users. This approach recognizes that the people best placed to identify hazards are often personnel working within the port, but that a "new pair of eyes" also notices items of significance that are accepted as normal in the system. According to (Liwång, 2012), risk assessment should be a consultative process that involves all stakeholders and creates synergy that ends up with a harmonized comprehensive risk assessment.

2.4.3 Port risk assessment approaches and the "ALARP" principle

According to (Abd el-al & Shaheen, 2009) a safe port is an efficient port, and this has become a buzzword in competition for shipping ports in the context of an intertwined world governed by global economies. It is critically important to be able to quantify risks in ports so that sound risk-mitigation policies can be developed to minimize major accident and damage to infrastructure that can, in turn, cause disruptions to the port's supply chain. (Altiok, 2009).

Quantitative Risk Assessment (QRA) requires vast amounts of incident data and significant resources to establish a numerical evaluation of the level of risk. For instance, to increase the amount of explosives that can be shipped through a port in the UK, risk assessment to justify this quantity is required (Merrifield et al., 1992). QRA can show whether the risks have been made ALARP (As Low As Reasonably Practicable). The qualitative approach uses risk in a comparative way to identify if one activity carries higher risk than another and is the most appropriate for a port risk assessment (Liwång, 2012). A useful way to compare risk levels is to base the risk assessment on a matrix approach where the product of frequency and consequence are used as guide for decision. Where frequency is extremely remote (rare) and consequence insignificant then the risk is termed acceptable, where hazards are defined as frequent and the consequence catastrophic, then risk is termed intolerable

At some point in the matrix there is a reasonable balance between the cost of further investment in risk management in relation to the consequence of outcome and the additional risk reduction achieved by the further investment. This area is termed ALARP (As Low As Reasonably Practicable) (Kilvington, 2004).

2.4.4 Risk assessment communication

When assessing risks, particularly risks associated with major accidents, it is unlikely that an operator will be able to demonstrate that risk has been eliminated or reduced to negligible levels. Instead, the operator will have to demonstrate that the risks are tolerable, on the basis that they are acceptably low, and cannot be cost effectively further reduced. (Stenek et al., 2011). All key findings should be disseminated throughout the workforce, to ensure that all employees understand the hazards and risks associated with the facility, the control measures in place to manage these risks, and their roles in the event of an accident (Elliott et al., 2008).

The workforce could affect the effectiveness of the control measures and through understanding the potential for accidents to occur if the control measures are degraded, an appropriate focus on maintaining the control measures can be held. The level of understanding of the technical issues that may exist at the port will vary enormously and will require various levels of information and therefore communication that addresses these issues may require expertise from public relations experts (Elliott et al., 2008).

2.5 Safe systems of work

According to (Merrifield et al., 1992), it is no longer enough to demonstrate that a lack of incidents indicates effective hazard control. Rather, a proactive and positive approach to safety management must be developed, implemented, audited and reviewed. The port safety management system should be developed with significant input from persons working in the Port, as well as users of the port, and be supported by a series of risk assessments. Ports and terminals should have procedures ready for immediate implementation in case of emergency. These procedures should cover all type of emergencies that can be expected for example; a major oil spill or cargo leaks that result in a fire or explosion or a crane failure with multiple accident implications (Schwed, 2010).

2.5.1 Port safety management system

Any safety management system inherently needs an assessment of risk to inform it of safety priorities and the performance of risk management systems managing those priorities. Since any system will be overlaid on existing risk management measures within the port, the true effectiveness of these needs to be considered at the assessment stage of the cycle.

There is a close relationship between risk assessment and the Safety Management System. A risk assessment defines the risks and the safety management system manages the risks (ABS, 2012). According to American Bureau of Shipping, (ABS, 2012) in all hazardous operations, it is now accepted good practice to have in place a Safety Management System (SMS) and to institutionalize safe working practices and attitudes through the development of a positive safety culture. The risk assessment will have identified the types of safety management systems that are needed with respect to those that are already in place (Kilvington, 2004).

No safety management system is complete without a process of audit and regular review (Helal, 2009). The system review is fundamental for the feedback and it is feedback that provides the safety management system with its intelligence (International Chamber of Shipping, 2013). With the review comes the opportunity to review procedures considering inherent major hazards in the port (Kilvington, 2004). According to (Galhena, 2003) a successful safety management system will evolve and be modified with the changing trade profile in the port and it will be a remit of the audit function to establish that this is happening.

2.5.2 Operation procedures

According to a survey carried out by the World Bank on Least Developed Country (LDC) ports (World bank technical paper,1990), many LDC ports have poorly educated and ill-trained equipment operators, who lack well-conceived and clearly understood operating procedures backed up by careful recruitment, selection and training. Lack of such procedures often encourage and subsequently legitimize routine violations and short-cuts. Such violations are often quoted as one of the most common root causes of major accident within and outside of the ports, cites the report.

For example, a detailed procedure would be required to guide how explosive and flammable chemicals should be handled in the port areas with clear description of the procedures by which the operator would move explosives through the port (Merrifield et al., 1992). The procedures to be followed in an emergency, including the procedures to be followed in the event of an explosives load being suspected of being in an unsafe condition. According to (Kilvington, 2004) where written procedures are not in regular use, as is the case for the bulk of the work carried out within the port, there is an implicit assumption that the skills and knowledge embedded in the procedure have been provided in initial training, and are regularly maintained via appropriate refresher training. There is a significant body of evidence that compliance with procedures is influenced by a wide range of factors and much of this evidence has come from detailed investigations which have followed major accidents (Merrifield et al., 1992; Frittelli, 2005)

2.5.3 Permit to Work (PTW) systems of work

A general rule should be all high-risk jobs should be approved through a permit to work system supported by a job safety analysis (Froese, 2006). The purpose of Permit To Work System is to ensure that hazardous work and operations in the ports are carried out in a way which minimizes any danger and meets appropriate safety standards and performance criteria.

Some of high-risk jobs requiring a permit include: Hot works like welding or grinding, working at height, excavation or drilling and all electrical works on light or heavy current etc.

Where appropriate, contractors are required to work within or to procedures, which are at least equivalent to those of the Port Authority's Permit to Work procedures (James et al., 2000). Performing hot work in a port and terminal is a high-risk activity and must be controlled through a hot work permit system. The permit system also ensures that hot works are not carried out during loading and discharging without permission, so that additional safety measures can be implemented (Froese, 2006).

2.5.4 Contractor management system

At any given time in a port there are several different employers and third parties who can all affect each other's activities. These may include port authorities, dock operators, stevedoring firms, government agencies, haulers, ships' masters and crew (HSE, 2011), who may be less familiar with the port environment than permanent employees. It's the employer's duty to protect the health, safety and welfare of workers whether they are full-time, part-time, permanent, non-permanent or temporary. This includes workers who are on short-term contracts or rolling contracts.

Contractor activities which may impinge on port operations should be subject to either risk assessment or procedural review and a method statement produced prior to the start of work of identifying hazards, risk controls and communication procedures required. Violations should result in cessation of activities until appropriate steps have been taken to rectify. A working plan should be developed covering areas like the responsibilities of each party, how each party will do its part, how the different parties will interface, common issues and arrangements, e.g. for emergencies as well as how the work will be coordinated and controlled (Merrifield et al., 1992).

2.5.5 Emergency response systems

Emergency planning is the process by which an organization prepares to respond to a natural or man-made event that significantly impacts its operations. Unfortunately, as major accidents do not routinely occur and are rare events, many operations fail to review, improve and maintain their Emergency Operations Plan (EOP), an oversight that increases risk – moving what might have been a controllable incident into a disaster or catastrophic situation (Corson et. al, 2008; Rujillo, 1999).

An emergency response can be triggered by occurrence of one of the major accidents discussed earlier on, such as crane failure, explosion, fire, environmental spill of a hazardous chemical or even a terrorist attack. The emergency plan must be properly incorporated within the overall facility safety management system as a control measure subject to the same regime as all other control measures (Abd el-al & Shaheen, 2009). Port authorities must always have emergency plans in case of accidents, and port workers must be trained on evacuation procedures. The development of the emergency response plan needs to include processes for testing, review, training and informing. This should ensure that it is understood by the workforce and other potentially affected people; and that it is subject to review, testing and update (Rujillo, 1996).

According to International Labour Organization, code of practice on security in ports, (ILO, 2003), ports should have plans for dealing with emergencies that could have a wider impact. There should be a written emergency plan if a major incident at the port could involve risks to the public, rescuing employees or co-coordinating emergency services. Ports must develop plans for emergencies that are based on risk assessments (Corson et. al, 2008). Where a workplace is shared with another employer the emergency plans and procedures should be coordinated.

2.6 Cargo handling equipment

The growing moves towards heavier lifting operations in ports is one trend that seems universally tipped to continue. Whether a port is large or small, it has a large investment in mechanical equipment and infrastructure that obviously needs to be maintained and protected. Amongst factors such as high efficiency, adequate infrastructure, good location and low port charges is reputation for cargo safety which is tied to maintenance of cargo handling equipment. Port efficiency is directly related to cargo handling equipment and is the most important factor in port selection and it is, therefore, essential that port operators and policy makers give top priority to improving equipment maintenance.

2.6.1 Care, repair and maintenance

Cargo handling equipment is part of infrastructure which in its widest context refers not simply to the number of container berths, terminal area, cranes and tugs but also to the quality of cranes and other lifting equipment provided for the operations in the port. According to (Ilchenko, 2012), equipment and machinery failure is the third most common reason for major accidents in the ports, after contact damage and collisions. If not reported in due time and not addressed immediately, defective equipment will result in major accidents and property damage.

The management of port equipment maintenance is probably the most serious operational problem facing port managers in developing countries (World Bank technical paper, 1990). According to a survey conducted by the World Bank, many Less Developed Countries (LDCs) are experiencing serious port cargo handling equipment maintenance problems and, worse, that these problems are steadily increasing as their ports struggle to acquire and manage the more complex cargo-handling equipment needed to respond to the port stakeholder's demands. The port's equipment maintenance alone accounts for 15 to 25 percent of total port operating expenditures and is frequently a port's largest single expenditure item.

The subject of cargo-handling equipment and facilities raises the important question of mechanization. It is estimated that 40% of a port's capital budget is spent on the procurement and maintenance of cargo handling equipment. So, it is most important for port management to put the required emphasis on maintaining a proper inventory and maintenance of the equipment (Shahjahan, 2000; Corson et al., 2008).

For the port areas, all mechanical equipment used specifically for the transfer of dangerous goods should be taken into consideration. Cranes are used on the terminal premises to handle cargo transfer equipment. The main hazards associated with the operation of cranes in port areas and terminals includes exceeding the Safe Working Load (SWL) where SWL indicates the load a crane can safely lift, suspend or lower and should be clearly marked on the crane. (James et al., 2000).While many port authorities and investors have been busy prioritizing container terminals, heavy lift facilities have been largely neglected and instead there is continual use of old mechanical lifting equipment which are subject to failure and lead to major accidents in port areas (Shahjahan, 2000). Reduction of major accident hazards in the ports could be achieved through co-operation of multiple stakeholders that includes Shipping Lines, Vessel operators, individual container terminals, Freight Forwarders, Importers, Exporters, Share Holders and Investors of Terminals (Wickrama, 2012).

2.6.2 Equipment preventive maintenance and "cannibalization"

Maintenance is related to fixing, repairing and service of devices and equipment and should be performed on planned schedules. It is important in all heavy industries particularly ports and terminals that are handling large quantities of dangerous goods because the failure to maintain port and terminal equipment regularly increases the risk of equipment breaking down, major accidents and compromising the safety of personnel (James et al., 2000).

In the absence of clear maintenance objectives, the complement of cargo- handling equipment seldom matches the workload imposed by the actual cargo traffic and equipment is frequently kept in service well beyond its economic life (Choughule, 2000). Many ports tend to perform most of the preventive maintenance (PM) and corrective work in-house, and rely on outside contractors for only the most specialized tasks, even though the in-house staff and equipment might not be able to perform the work reliably or cost effectively. This leads to equipment failure and could be the cause of serious accident.

One maintenance practice that is common in Least Developed Country (LDC) ports concerns "cannibalization," which refers to the use of parts from one "down" unit of equipment to repair another. This approach has become widespread in LDC countries because of the extensive delays in the procurement of vital spare parts and materials. Usually, the cannibalization is self-defeating because it continues indefinitely, and the equipment unit is never restored until such a time that a serious failure accompanied by a major accident leading to injuries or damage to property and infrastructure happens (World Bank technical paper, 1990).

2.6.3 Substandard equipment, maintenance facilities and environment

Even in cases where some effort had been made to establish a maintenance program, the facilities used for maintenance purposes are usually substandard. The maintenance department is often relegated to whatever building that happens to be available, and space and lifting facilities fall far short of being adequate (Shahjahan, 2000).

A port's equipment and infrastructure must be kept in a good condition so that it is readily available when needed by the operations staff. Effective maintenance can only be carried out under the right conditions. The quality of the port's workshops, servicing areas, stores and staff facilities must not only be appropriate for the tasks but also create a feeling of pride and responsiveness. If the lifting slings are not the approved type or are used beyond their capacity or the cranes are not inspected or tested at regular intervals, and the safety and warning devices are not working properly, there are grave concerns. If during loading and discharging the crane, slings or equipment fails, packaged dangerous goods could fall, leading to the release of toxic gases, flammable vapors, pollution and commercial losses. Cranes failing can also cause fatalities and severe injuries for personnel and damage to property and equipment (James et al., 2000).

2.6.4 Equipment replacement policy and standardization

According to the (World Bank technical report, 1990), there are too many different makes of similar kinds of equipment in ports. The ports find it difficult to concentrate on a few manufacturers - largely because of the sources of funding, but this becomes a major problem in the long-term. Thus, the maintenance task is made more difficult because of the need for increased training, more manuals and stocks of spare parts.

The lack of a systematic and consistent equipment replacement policy also causes enormous problems for maintenance. Thus, you will find many fleets consist of a variety of makes and models of equipment. Consequently, their operating, maintenance, and financial problems tend to be more serious than in fleets with more standardized equipment. In such instances few operators are trained and qualified to handle all the different types of equipment, productivity tends to be lower in these ports, more accidents occur, and there is more equipment damage. Ports need to avoid outdated safety practices at the equipment and machine operational level and embrace safety technology practices that focus more on anticipation of hazards than on reaction to their occurrence (Ludwig et al., 2010).

2.6.5 Port equipment maintenance funding

If maintenance is not funded at an adequate level, port equipment will deteriorate and probably lead to major accident, cargo handling rates will decline, and the revenue earned by the port will be reduced (Frittelli, 2005). However, port maintenance can be a costly activity. Unavoidably, even the smaller ports have a large investment in port mechanical equipment and an even larger investment in infrastructure; all of which requires proper funding.

Unfortunately, as ports struggle to meet the demands of the ship operators, they must acquire more complex cargo handling equipment and thus the funding is steadily becoming more difficult. Very often, too much effort is expended on attempting to keep time expired equipment operational without regard for the costs involved - sometimes on the misguided principle that this will save scarce foreign exchange (Choughule, 2000). Many ports have outmoded legislation that makes it difficult to dispose of old equipment and hence there is a tendency to try to keep them going disregarding the consequences of failure which can be major accident in form of damage to property, spillage and injury to people in operational areas (SIP007, 2010).

2.7 Conceptual framework

Despite high probability of occurrence and high potential for large-scale damage, major accident occurrence in Kenyan ports have not been sufficiently studied. The theoretical framework of this research aimed to: Provide recommendations that could help in ensuring effective control of major accident in ports and other hazardous installations in the country, identify some of the factors that could help determine how major accident could be managed proactively in the ports and highlight the gaps that may abound so as to recommend further studies in the thematic areas in the ports.

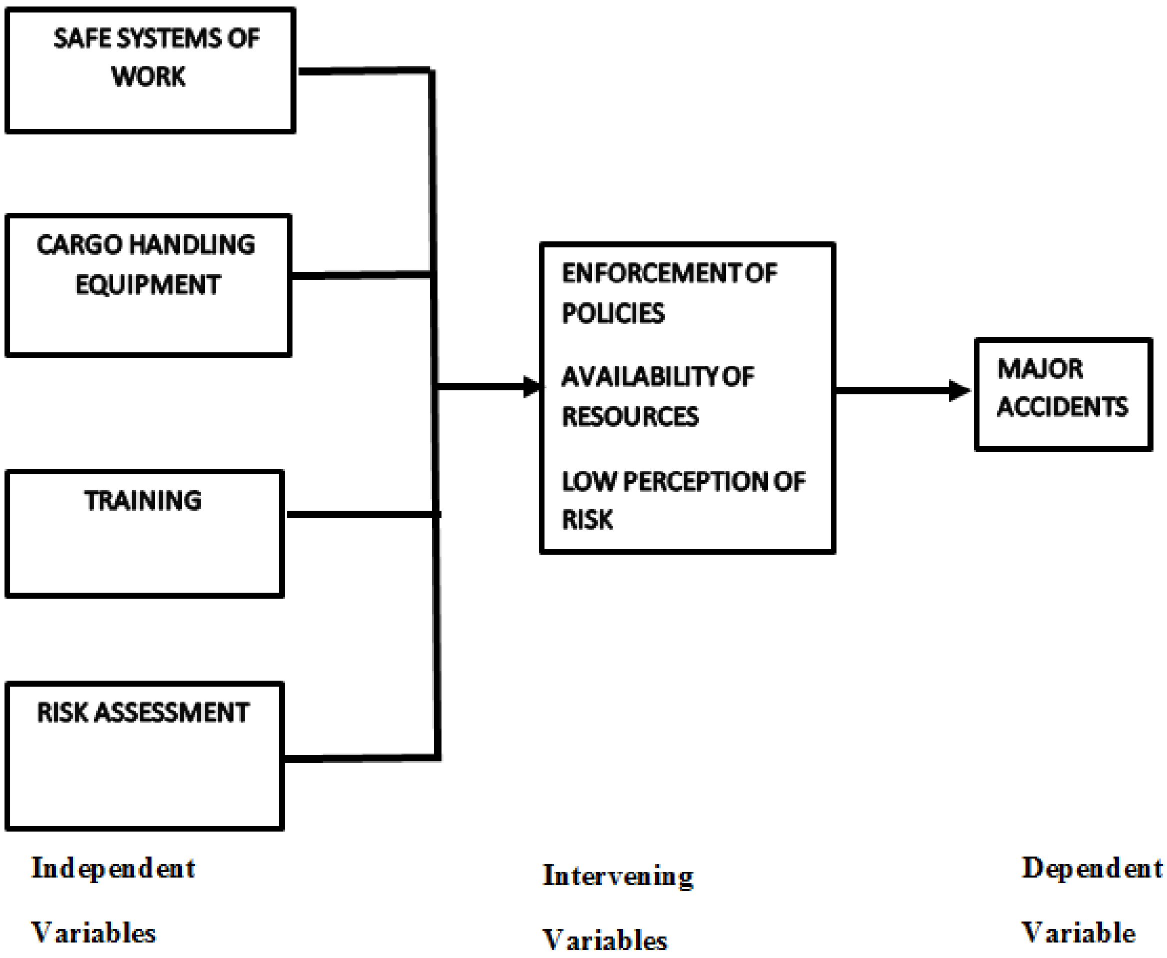


Figure 4: Conceptual framework of determinants to effective control of major accidents

Source: Author 2020.

2.8 Gaps identified from the literature

Port state control regimes which were established more than 30 years ago to help prevent accidents in shipping are obviously not enough to correct or prevent all major accidents, according to (James et al., 2010). Delivering effective major accident management has never been easy, and the penalties for failure, in terms of impact on people, environment, reputation and finances are becoming more extreme (Atubi, 2006). Major accident happens in different ports across the world but how the response to the accident is handled is the concern.

The review showed that there was not a specific legislation in Kenya dealing conclusively with handling of occurrence of major accident hazards in the ports or hazardous installation sites like in some other countries. There have been attempts by researchers to discuss occurrence of disasters in the country but none had narrowed down to occurrence of major accidents in the port, perhaps because there had not been reported occurrence of major accidents in the port in the recent past. However, the potential for occurrence of major accidents in our ports is enormous and the question is how to alleviate the impacts when our smoking gun explodes.

The theoretical review also showed that many countries have tried to put in place measures aimed at reducing major accident as they have always had serious negative impacts to the economy of a country and its surrounding neighbors. Many of the countries especially in developed nations have come up with legislative frameworks aimed at controlling major accident hazards so as to prevent loss of life and damage to property and the environment but despite of this, history shows that five of ten biggest man- made explosions happened in port areas (Tarmo, 2000) and that according to statistics most maritime accidents related to dangerous cargo handling happened in ports and harbours (IMO, 1998).

Furthermore, effects of major accident hazards and factors that can help to determine how effectively the hazards can be controlled are not thoroughly researched and reported in Kenya. This may have been because of unavailable relevant data in this area since most data associated with major accidents lean towards petroleum tankers and collapse of buildings in construction sites. It was also noted that, although there had been an attempt to quantify risk in other busy ports across the world, most ports had only analyzed their major accident risk qualitatively.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Research design

According to Mugenda (1999), research design is a plan according to which research participants are selected in order to collect information. It's the strategy, the plan and the structure of conducting a research project. It's the blueprint for collection, measurement and analysis of data. The function is to ensure that evidence obtained helps to answer the research question as unambiguously as possible.

The study was of a case study nature and involved describing characteristics of variables of interest in the study. The study adopted a descriptive survey research design where collection of data was done by interviewing and administering questionnaire to a sample from the population and using observation checklist. The use of a survey research design helped to describe the specific characteristic of a large group of persons, objects or institutions. It also allowed for extensive collection of data to describe characteristics of the variables of interest in the situation. Both qualitative and quantitative data was used to give exploratory analysis. The research participants were drawn from all levels of management including also the dock workers' union employees and the contractor staff working in the port.

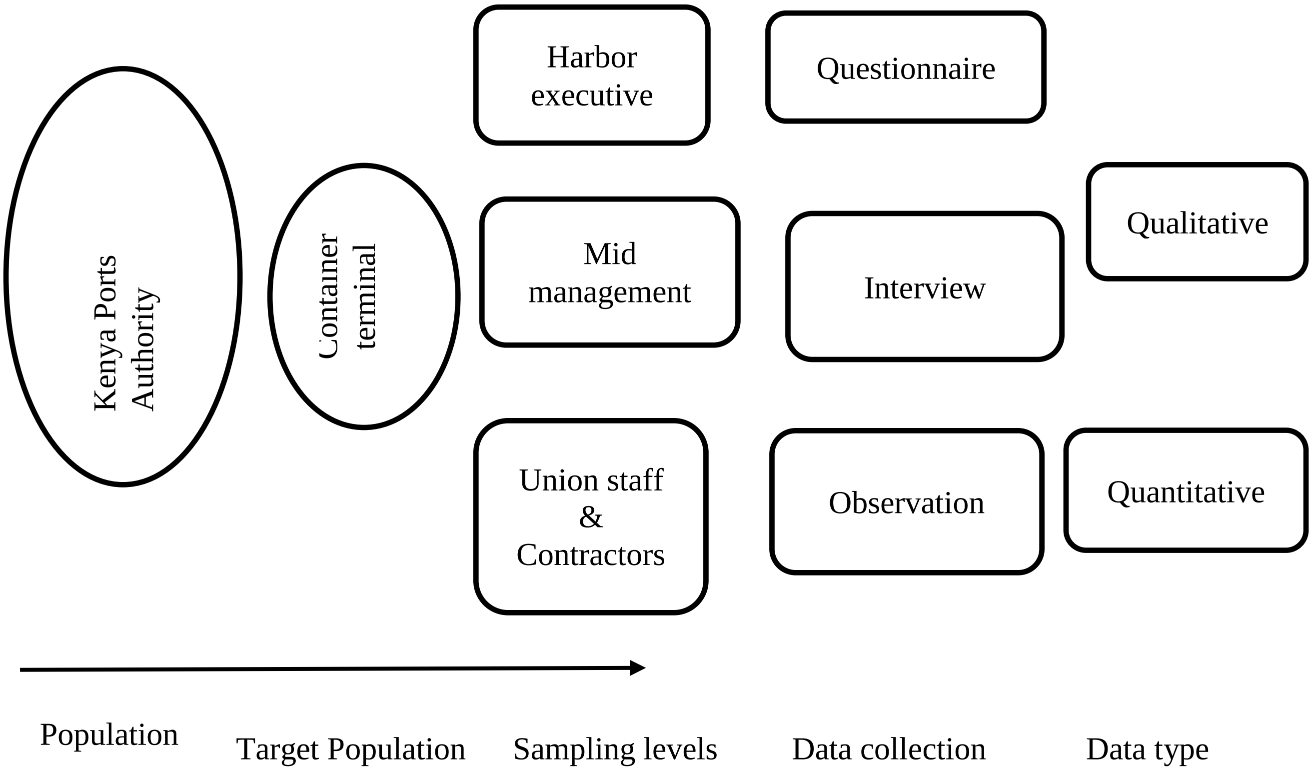


Figure 5: Research design flow

The descriptive design helped the researcher to acquire information from different respondents using self-administered questionnaires, interview and from observation. The design was used for this study because it was expected to be the best approach for obtaining suitable responses to questions concerning the status of the variables under this study.

3.1 Target population

The target population for this study was 650 drawn from various departments. The study also included contractor employees working on various projects in the port.

3.2 Sample strategy

A sample strategy is a plan for obtaining a sample from a given population and refers to the technique or the procedure the researcher would adopt in selecting items from the sample. Sample framework may as well lay down the number of items to be included in the sample and it should be determined before the data is collected (Kothari, 2004). A good sampling design would result in a truly representative sample, and in a small sampling error whose study results can be applied in general, for the whole population with some reasonable level of confidence. For the purpose of this study Stratified Random Sampling technique was used.

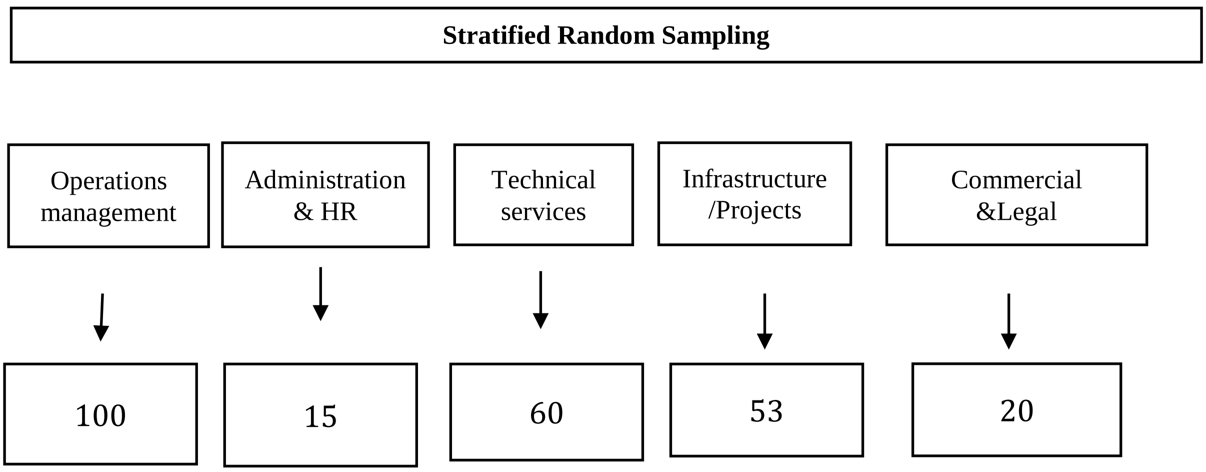


Figure 6: Sampling strategy

3.3 Sample size and sampling procedures

Slovin's formula was used to estimate sample size as follows;

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = Number of samples

N = Total population

e = Error tolerance/margin of error

$$247.6 = \frac{650}{(1+650\,(0.05)^2}$$

The sample size as determined above was 248.

The study was based on a 95% confidence interval and an estimated sampling error (e) of 5%. The sampling technique used while issuing questionnaires in this research was stratified random sampling. According to Kothari (2004) the main advantage of random sampling is that each item in the population has an equal chance of inclusion in the sample and each of the possible sample has the same probability of being selected. The procedure was that the researcher issued the questionnaires to study participants selected randomly within the departments in the target population. Regarding the conducting of interviews the researcher randomly selected respondents from the targeted departments for the interview process and conducted observation using a hazard checklist during the process of data collection.

3.4 Data collection instruments

Data collection instruments that were used are questionnaires, interview and observation checklist.

3.4.1 Questionnaire

Primary data was collected using questionnaires. The questionnaires were randomly administered to employees in the selected areas. They were based on the objectives of the study and contained both open and closed-ended questions. Closed-ended questions had responses from which respondents could pick an answer that described the situation. However open-ended questions gave the respondents an opportunity to give their own opinion on an issue.

3.4.2 Interview questions

These were directed to the respondents sampled for the interview and helped to collect additional information that was not possible to collect through the questionnaire.

3.4.3 Hazard observation checklist

The checklist helped the researcher to gather additional information on maintenance and use of the equipment and machines and information regarding other hazards like fire and chemicals.

3.4.4 Pilot study

Validation of the data collection instrument was done at Mombasa Container Terminal depot where four sample questionnaires were piloted, and necessary adjustments made depending on the responses got and to ensure that the language used was simple and clear before distribution of the main study questionnaires.

3.5 Data collection procedures

Data was collected from primary and secondary data sources. The primary source of information was by administration of questionnaires, interviewing of the respondents sampled and observation through checklist. The questionnaires were distributed to the respondents with the help of supervisors working at KPA. Secondary data was gathered from the library and internet to provide additional information on research in the thematic area. Additional information was also be collected through hazard observation checklist.

3.6 Data processing and analysis

The returned questionnaires were checked for any errors, accuracy and consistency. Thematic analysis was used where questions that addressed same or similar theme were analyzed. Data was then transferred to a computer in order to perform analysis.

The study used both qualitative and quantitative methods of data analysis where the qualitative procedure of analysis was used to analyze qualitatively the views of different respondents by grouping together those views that converged and came up with uniform themes. On the other hand, quantitative method was used to analyze quantifiable responses from the questionnaire. Tables were used to show various categories of data and their respective frequencies and percentages of occurrences. From these tabulations emerging patterns and trends were identified to make it possible to establish relationship between variables and to draw conclusions. The study data was presented in form of graphs and tables for ease of analysis and interpretation.

3.6.1 Analysis and presentation Methods

The study data collected from questionnaires was classified into categories. It was then analyzed using Statistical Package for Social Science (SPSS) version 20. Using SPSS, the researcher was able to obtain the mean, frequency and percentages applicable to each variable. Data was edited, entered, coded and summarized based on objectives. Where necessary, some data was analyzed qualitatively using content analysis. The study used descriptive statistics to show distribution, relationships between variables under study and proportions in terms of percentages interpretation. This helped to provide an insight on the determinants to effective control of major accidents in the port of Mombasa.

3.6.2 Study area and location

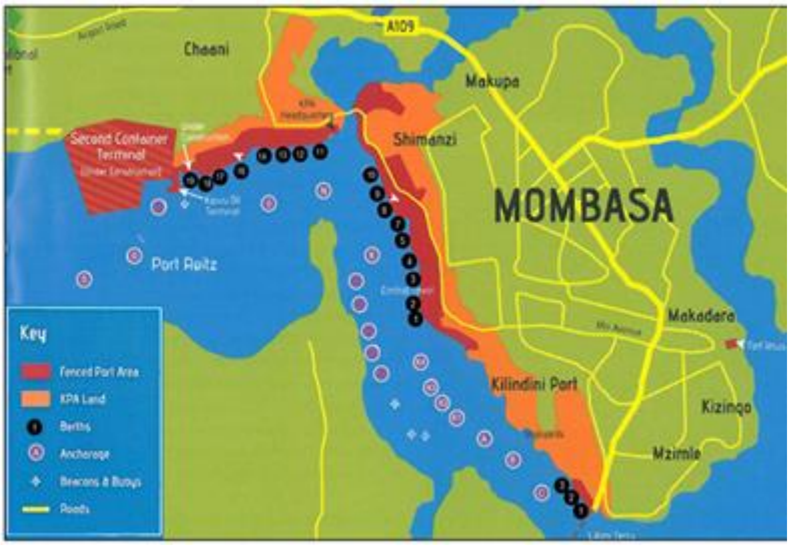


Figure 7: study area map; Source: KPA annual report 2019

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and findings, discussions and interpretations of the study carried out on the determinants of effective control of major accidents in the port of Mombasa. The target sample size was 248 out of which 206 took part in the study equivalent to 83% response rate. Mugenda and Mugenda (1999) argue that a rate of 50 percent or higher is adequate for data analysis. This implies that the returned questionnaires which were properly filled and hence had completeness on data correctness were adequate to do data analysis.

4.2 Results and discussion

4.2.1 Demographics

Results showed that there were more male respondents (77.2%) compared to female respondents (22.8%) as shown in the chart below.

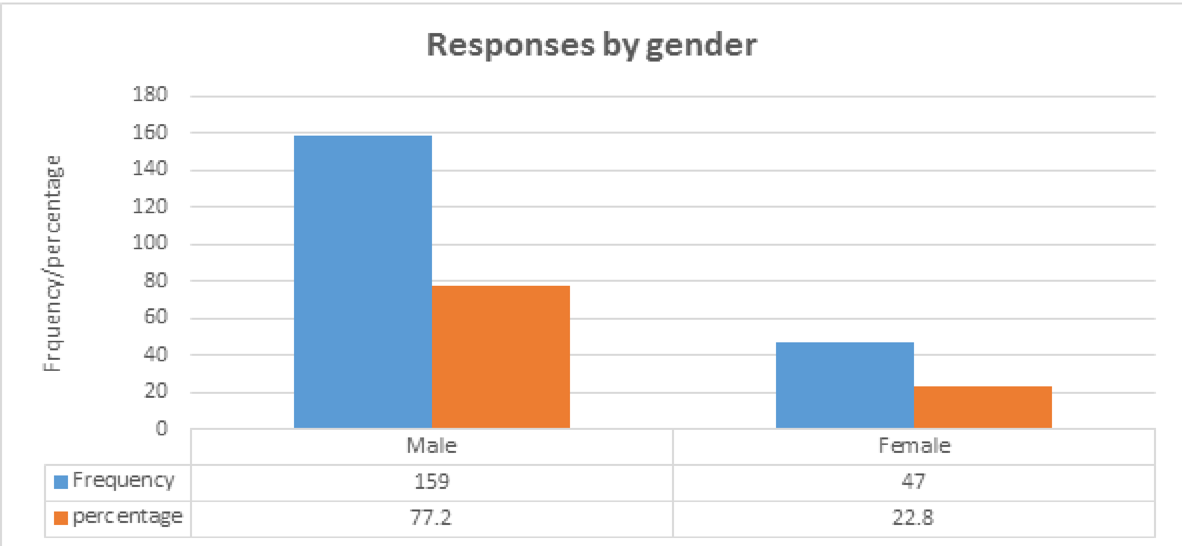


Figure 8: Study location demographics showing distribution by gender

Majority of respondents were above thirty years of age and had studied up to the level of diploma in their education as shown in the charts below.

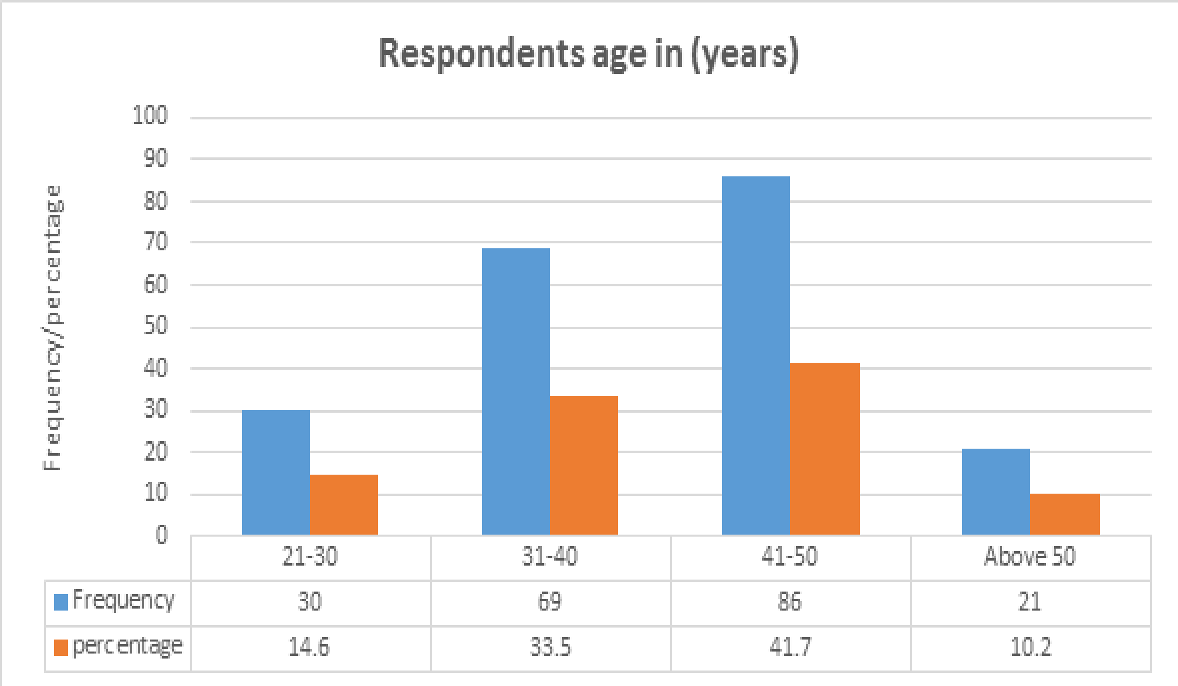


Figure 9: Showing age distribution of the respondents

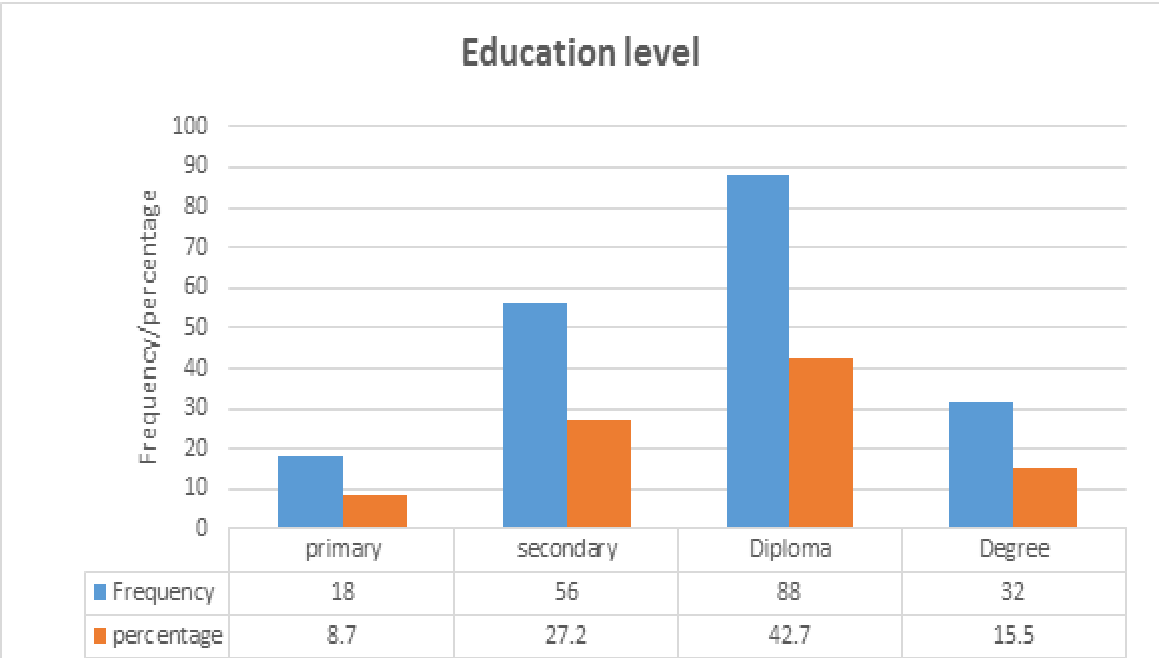


Figure 10: Showing education levels of the respondents

In terms of experience majority of the respondents had worked for the organization for more than ten years as shown in the chart below.

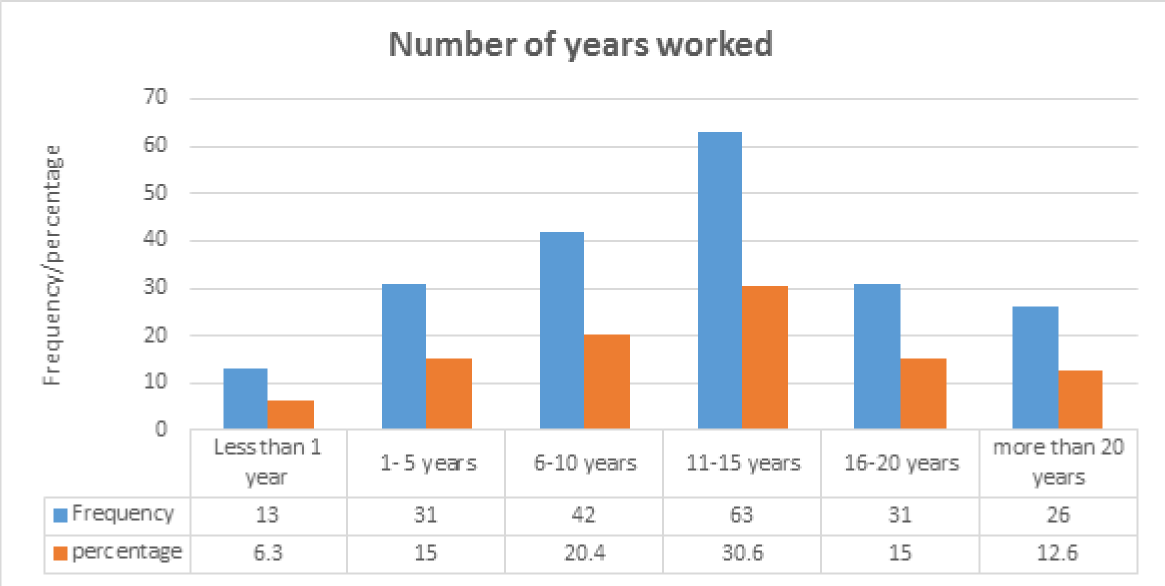


Figure 11: Showing years of work experience of the respondents

A great number of respondents, 48.5% were from the operations department majority of whom were dock workers spread across the container terminal, as well as the contractor staff.

Table 3: distribution of respondents by department

	Department	N	Percent		
	Operations	100	48.5		
	HR and Administration	13	6.3		
	Technical services	29	14.1		
	Infrastructure/projects	48	23.3		
	legal services	16	7.8		
	Total	**206**	**100.0**		

The ratio of contractors on site to KPA staff was confirmed by personnel department to be 1:4

4.2.2 Safe systems of work

Some of the safe systems of work in use were Permit to Work, checklist, operational procedures, shift handover notes etc. The port was found to be a multi-stakeholder operations site with 20% of employees being contractors. The two safe systems that were used to control contractors were permit to work system and contractor management system (access control). However, these two systems were lowly rated by respondents where they held the view that contractor management system and permit to work would have less effect compared to use of operation procedure and emergency response system in control of major accidents in the port as shown in the chart below. This agreed with an observation made under the training objective, where some respondents held the view that training of contractors was not as important as that of KPA employees. The number of respondents who were not sure or thought that the safe systems in place were not important showed that more awareness creation and training was required for all staff in the company.

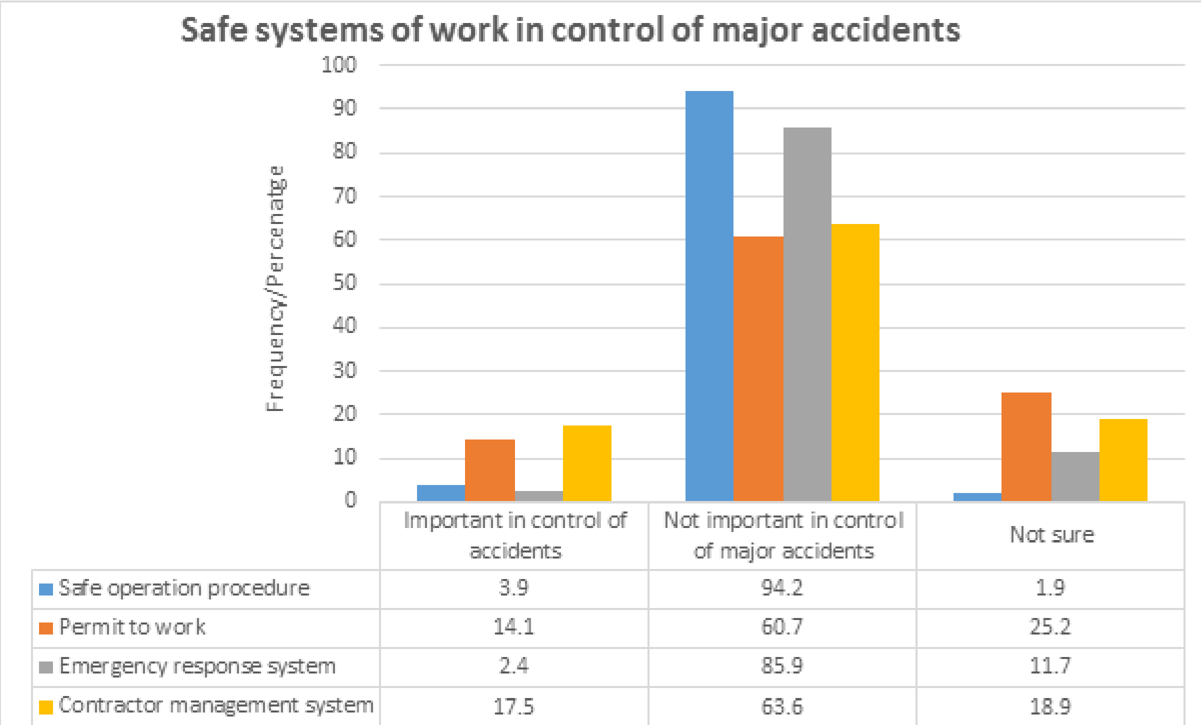


Figure 12: Response on importance of safe systems of work

A high number of 94.2% of respondents as shown in chart 5 above held a view that safe operations procedures would not help in control of major accidents in the port. This could mean that there are deep seated poor safety culture behavior and that sometimes the procedures would be disregarded to get the job done.

An Analysis of Variance (ANOVA) on the responses to the question on the importance of the safe systems in control of major accident at the port as shown in the table below was done. Results showed that only the permit to work system responses had significant variation from the mean since Sig=0.074>p=0.05, DF=3 at 95% confidence interval. There was no significant variation from mean of the other three safe systems since for safe operation procedures Sig=0.0302<P=0.05, DF=3, emergency response system Sig=0.013<P=0.05 DF=3 and contractor management system Sig=0.034<P=0.05 DF=3 as shown below. This meant that the permit to work safe system would not be very effective in control of major accidents.

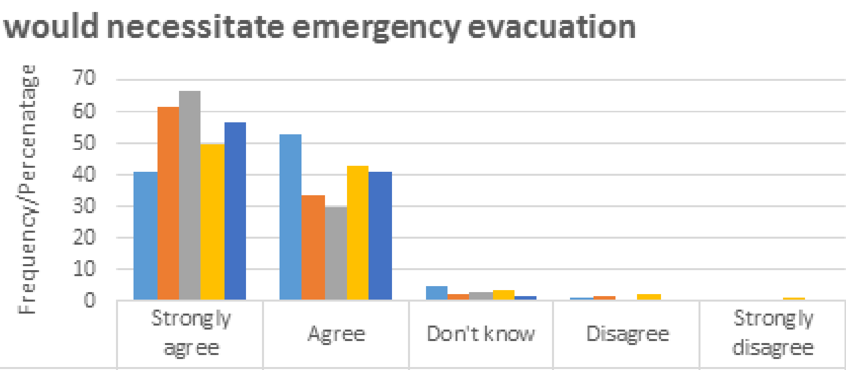
Table 4: ANOVA for responses of different safe systems versus control of accidents

Safe systems critical in control of major accident	DF	Mean squares	F	Sig
Safe operation procedures	3	0.334	1.204	0.032
Permit to work system	3	0.226	0.291	**0.074**
Emergency response system	3	1.149	2.016	0.013
Contractor management system	3	0.98	2.640	0.034

This was confirmed also during the interview where some staff said that procedures tend to waste time when the employees are under pressure to finish the job. This could be interpreted to mean that short cuts would be taken to meet the target and emergency alarms would be ignored but, in the process, major accidents would be incurred.

There emerged, during the interview and from analysis of results a general feeling of low perception towards the contractors working in the port areas. They felt that that their training on prevention of accidents was not as important as that of KPA employees. Secondly, that risk assessment should be used to license their operations to reduce accidents caused by them in the port. Thirdly, that use of permit system would be useful in control of accidents caused by contractors. Such low perception of contractors, if held by the top management, would mean that they would be disregarded in committing resources to improve contractor safety standards and implementation of major accident control measures such as training.

The risk perception of occurrences that would necessitate emergency response in the port was tested among the respondents. The five common potential major accidents in the ports: Equipment failure, Fire, explosion, chemical spillage or terrorist attack, were tested and each received over 90% approvals as occurrences that respondents felt could cause major accidents and necessitate emergency response as shown in the chart below. This meant that staff were aware of what had the potential to cause a major accident leading to an emergency evacuation.



	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
Equipment failure necessitates emergency response	40.8	52.9	4.9	1	0.5
Explosion necessitates emergency response	61.7	33.5	2.4	1.9	0.5
Fire necessitates emergency response	66.5	30.1	2.9	0	0.5
Chemical spillage necessitates emergency response	49.5	43.2	3.9	2.4	1
Terrorist attack and emergency response	56.8	41.3	1.9	0	0

Figure 13: Response on emergency evacuation need at KPA

However, when respondents were asked to state the frequency of testing emergency response procedure for the period they worked at the port, there were mixed responses with 75.2% saying it was done annually as shown in the chart below. This could mean that the procedure is not well entrenched in the company. Through interviews, some staff confirmed that the testing was done only in selected areas of the port by the fire department.

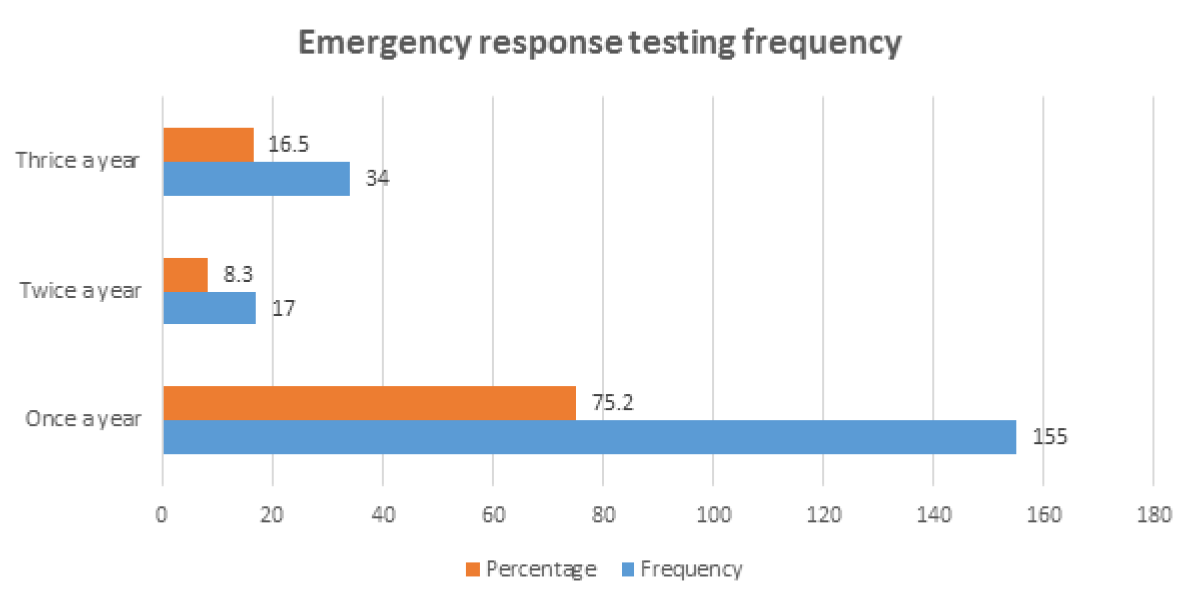


Figure 14: Response on emergency response testing frequency at KPA

From data analyzed, it emerged that the respondents did not appreciate that safe systems of work would be critical in control of major accidents in KPA. The issue of contractor management and associated safe systems like safe port operation procedures were not well entrenched in the port as some of the respondents disapproved them as being not effective in control of major accidents. This disapproval also would point to entrenched negative perceptions levelled against contractors. The disapproval of safety procedures by 94.2% of respondents as not important towards control of major accidents could mean unsafe behavior such as shortcutting are rampant.

The fire department was fully resourced and aware of all the facilities and areas. However, respondents interviewed and information from the hazard checklist used showed that they were not fully conversant with the process of emergency response and evacuation procedure in place during a major accident. It was expected that in such a busy workplace with many employees and several operations, emergency response personnel were fully knowledgeable of emergency procedure. However, there were those who said that they had not witnessed testing of fire alarm or participated in any emergency drill during their employment.

4.2.3 Cargo handling equipment

Several port cargo handling equipment were observed being used to facilitate movement of the cargo to and from the ship's side, transit shed, warehouse, barge, railway wagon or road vehicle. Cargo handling equipment seen at the port included: Cranes (rubber-tired gantry or rail mounted gantry), container handlers (top picks and side picks), forklifts (mostly by contractors), bulk handling equipment (tractors, loaders) etc.

When respondents were asked whether use of equipment would cause a major accident, a great number of respondents, 89.8%, held the view that cargo handling equipment had potential to lead to occurrence of major accidents.

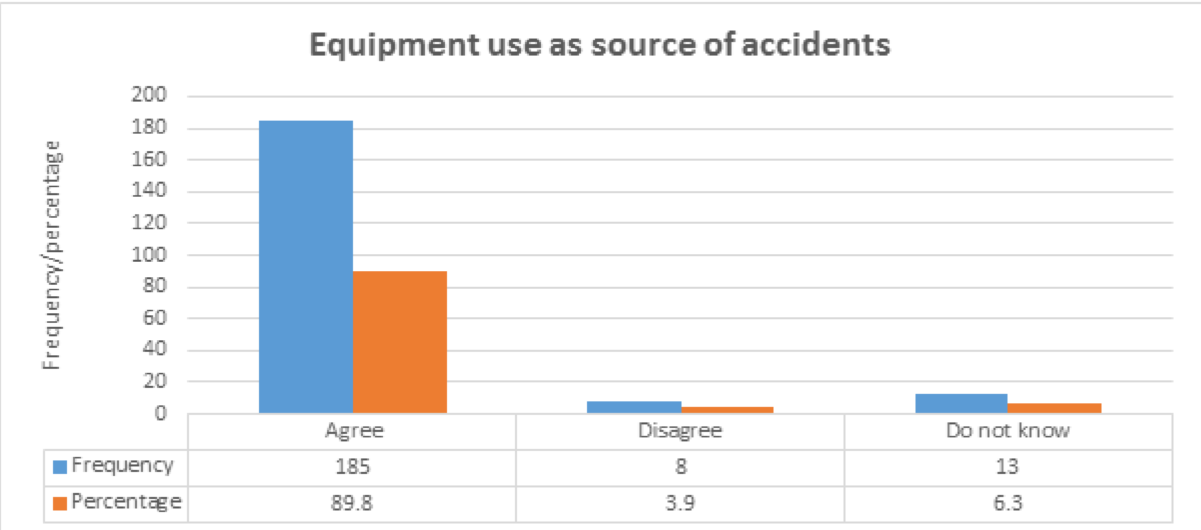


Figure 15: Responses on equipment as causes of accidents at KPA

When asked whether they had witnessed occurrence of a major accident for the period they had been employed at KPA, respondents said they had witnessed various major accident occurrences such as fire and spillage that were related to cargo handling equipment as shown in chart below. Through the interview, some respondents confirmed that there had been recent and past fatality incidents related to use of equipment. However, the most common occurrence was property damage and spillage of hazardous chemicals.

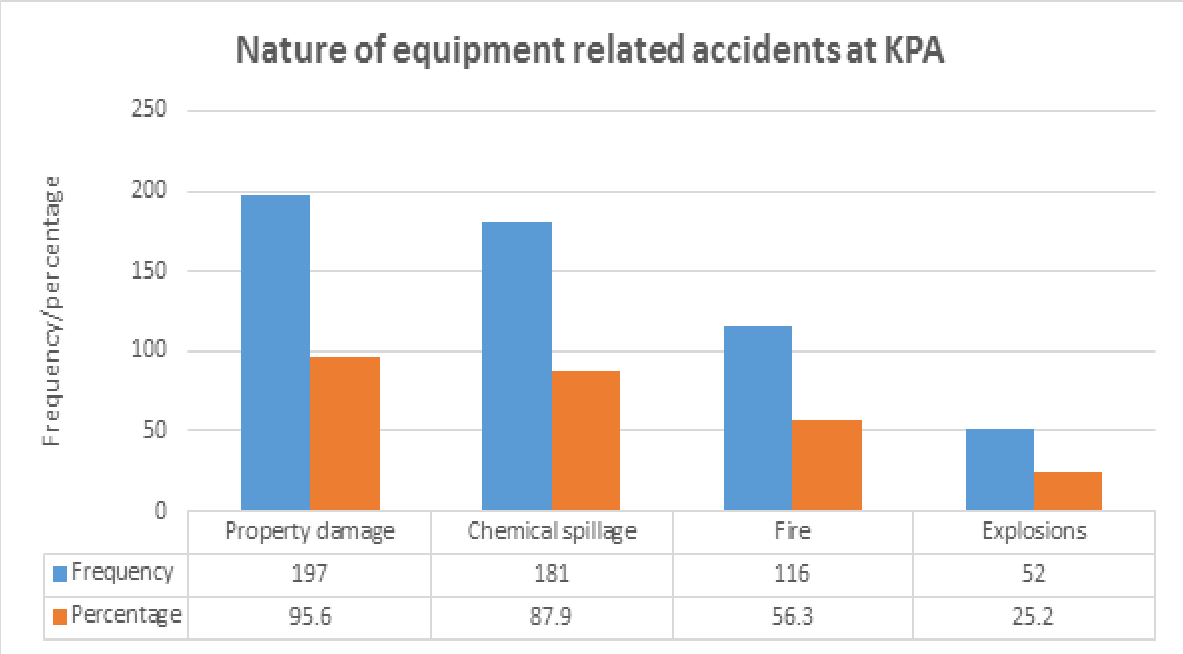


Figure 16: Responses on equipment related accidents at KPA

An analysis of variance (ANOVA) was applied to the responses received regarding the nature of the accidents related to equipment witnessed by the respondents in the port as shown below. Equipment related accidents that led to fire at Sig=0.029<P=0.05 DF=3, equipment related accidents that led to explosion at Sig=0.015<P=0.05 DF=3, equipment related accident that led to environmental spillage at Sig=0.024<P=0.05 DF=3 and equipment related accidents that led to property damage at Sig=0.0232<P=0.05DF=3 showed that there was no significant variation from the mean and therefore statistical evidence that major accidents would result from the equipment.

Table 5: ANOVA for responses on equipment related accidents versus the nature of accidents

Equipment related accident		Sum of Squares	df	Mean Square	F	Sig.
Accident due to fire	Between Groups	.922	3	.307	1.248	**.029**
	Within Groups	49.757	202	.246		
	Total	50.680	205			
Accident due to Explosion	Between Groups	.395	3	.132	.691	**.015**
	Within Groups	38.479	202	.190		
	Total	38.874	205			
Accident due environmental spillage	Between Groups	.445	3	.148	1.393	**.024**
	Within Groups	21.521	202	.107		
	Total	21.966	205			
Accident due to property Damage	Between Groups	.056	3	.019	.874	**.023**
	Within Groups	16.356	202	.081		
	Total	16.413	205			

The four equipment maintenance safety aspects: Old and obsolete, exceeding Safe Working Load, operation by non-qualified staff and poor policies, were posed to the respondents who agreed for each aspect, by over 86%, that this would have a bearing on occurrence of major accidents as shown in chart above. Interview with third party operators and observation of maintenance stickers of some equipment in operation revealed that some equipment was overdue for maintenance and servicing while others were not enrolled into any repair and maintenance program.

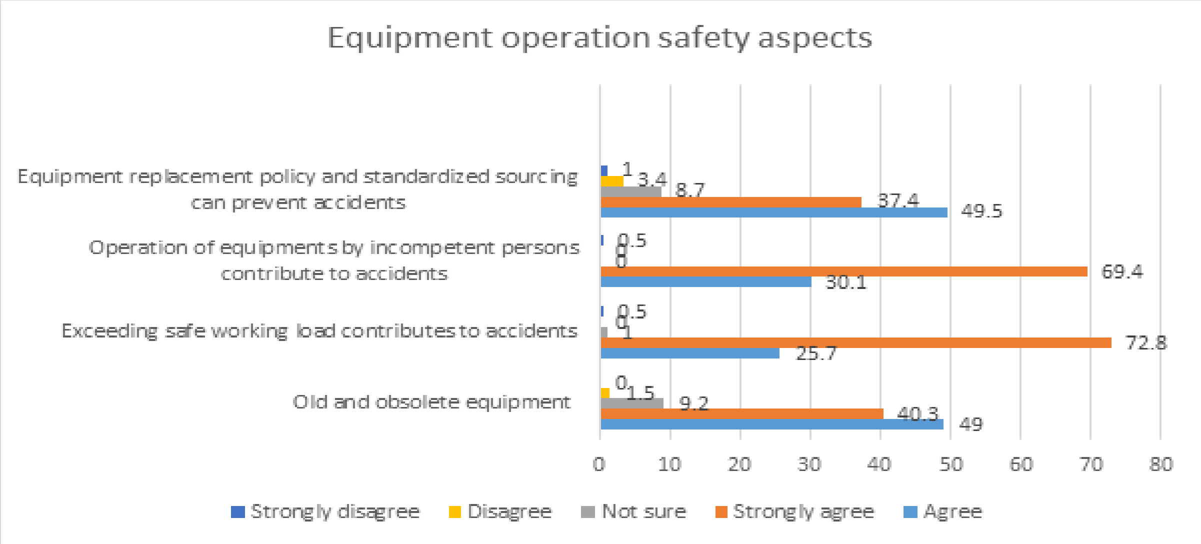


Figure 17: Responses on equipment maintenance related safety aspects at KPA

A Pearson's Chi-Square test of association was done at P-value=0.05**,** to establish whether there was any significant association between inadequate/poor equipment maintenance with the various equipment-related nature of accidents: Fire, explosion, chemical spillage and property damage, cited by respondents at KPA as shown below. Since P= 0.031, P=0.039, P=0.027 & P=0.016 ≤ α=0.05 at 95% confidence interval, it means that there is a statistically significant association between poor maintenance of equipment and likelihood to lead to major accident of either fire, explosion, chemical spillage or crane failure and property damage a shown below.

Table 6: Inadequate equipment maintenance can lead to occurrence of major accidents

	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	3.865[a]	4	.042
Likelihood Ratio	3.537	4	.044
Linear-by-Linear Association	1.027	1	**.031**
N of Valid Cases	206		

* Accident due to fire

Table 7: Inadequate equipment maintenance can lead to occurrence of major accidents

	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	6.518[a]	4	.016
Likelihood Ratio	6.702	4	.015
Linear-by-Linear Association	.717	1	**.039**
N of Valid Cases	206		

* Accident due to explosion

Table 8: Inadequate equipment maintenance can lead to occurrence of major accidents

	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	6.610[a]	4	.015
Likelihood Ratio	5.067	4	.028
Linear-by-Linear Association	.124	1	**.027**
N of Valid Cases	206		

* Accident due to chemical spillage

Table 9:Inadequate equipment maintenance can lead to occurrence of major accidents

	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	2.220[a]	8	.019
Likelihood Ratio	3.463	8	.029
Linear-by-Linear Association	.210	1	**.016**
N of Valid Cases	206		

*accident due to crane failure

Further interview revealed that there had been near misses and accidents arising from overdue maintenance. There was no established preventive maintenance schedule for the equipment used by contractors mostly the forklift trucks and reach stackers as was established through the hazard checklist and interview. Some cranes had no clearly visibly marked safe working load and there was observed employees moving under the operating cranes loaded with containers in the yard completely oblivious of the danger involved.

Interview with respondents revealed that employees were unaware of the existence of the Factories (Dock) rules of 1962 despite majority of them belonging to the Dock workers union. This regulation, Factories (Docks) Rules, was a Legal Notice of 1962 (L.N.306/1962) of the former Factories and other places of work Act, which was repealed to the current OSH Act 2007, and has not been reviewed since then. It has largely dealt with ship, equipment and machinery inspection but provides no guidelines for dealing with control of major accident hazards occurrence in the port. There is currently no regulation in Kenya or a policy in KPA that comprehensively addresses the control of major accident hazards in the ports and related industries despite the increased port services demand and rapid expansion of the port facilities and associated inland dry ports and major hazard installations e.g. Chemical industries in Kenya and the region.

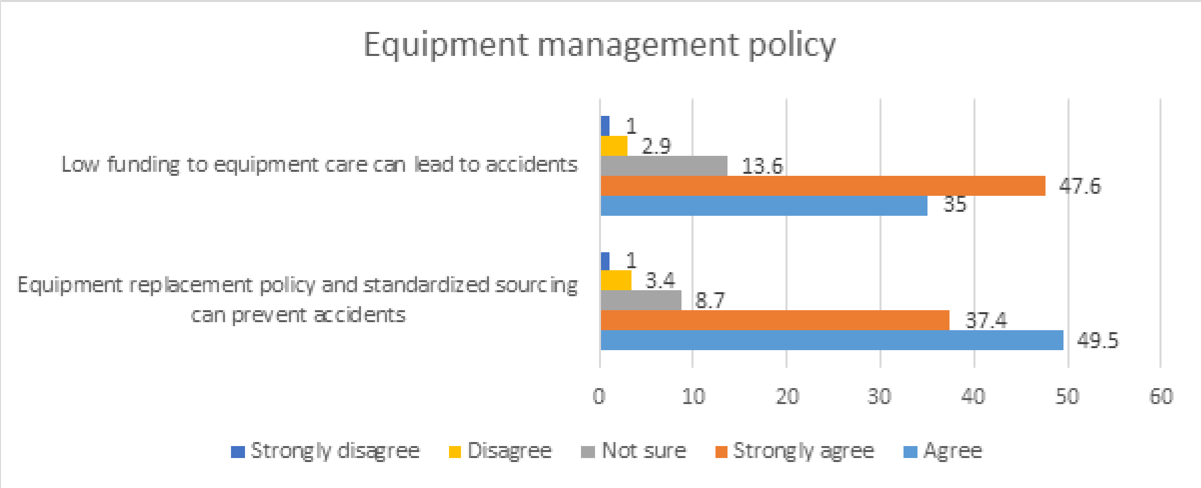


Figure 18: Responses on equipment management policy at KPA

The aspects of equipment replacement and standardized sourcing was also approved of by the respondents where 86.9% held the view that it would help in controlling occurrence of major accidents. The operator respondents interviewed said that some equipment were easier to operate than others and that there were some operators who had not received training in safe operation of some equipment on assumption that all equipment operation was the same, and therefore, high chances of causing accident when they operate equipment that they were not familiar with. This was because of having various models of equipment sourced from different manufacturers but doing the same job. The issue of funding for equipment replacement was also tested on respondents whereby 82.6% agreed that low funding would result to accidents. Through interview the researcher found out that low funding had led to delayed procurement of some critical spare parts and therefore continued use of some equipment requiring replacement of parts and in some cases cannibalizing of other equipment so as to provide spare parts for another due to lack of funds to buy new spare parts. Through check on service stickers and observation the researcher witnessed some equipment overdue for service being used by the contractors on site to handle cargo.

It was found out that there had been accidents at the port attributable to cargo handling equipment and that the accidents had been in the forms of fatality, fire, explosion, spillage and property damage. Further through interview, there had been accidents attributable to each of the equipment safe maintenance and operation aspects assessed i.e. poor maintenance, old and obsolete equipment, exceeding SWL and incompetent operation. Majority of respondents and those interviewed agreed that a regulation dealing with prevention of major accident in port areas would help to control occurrence of major accidents in the ports. A review of the accident occurrence from the quarterly report of Oct to Dec 2017 had a total of 139 accidents.

Container terminal had the highest number of accidents at 88 compared to conventional terminal which had 51. Less accidents at the conventional terminal would probably be because of less equipment used and less traffic compared to the container terminal. Most of the accidents were related to equipment failure and private trucks operated by contractors colliding with packed container.

4.2.4 Training gaps

According to (Deane, 2004), one of the approaches used to identify training needs is to categorize the needs in accordance with the desired learning objectives such as: General improvement of safety awareness, knowledge development for safe operation and influencing safety attitudes to encourage safe behavior. Ports should be "socio-technical" systems because, in practice, operations in port terminals are carried out by a partnership between human beings and technology. This partnership can only be successful if appropriate emphasis is given to training of employees.

It was found out that the number of those who had not been trained on major accident was high compared to those who had been trained as shown in chart below. It was evident from the responses given that training gaps existed and in various contexts where 53.1% of respondents said they had not undergone any training or awareness on prevention of accidents or hazards despite operating in a potentially risky environment. A review of the training curriculum also showed that there were no topics covering major accidents awareness or prevention.

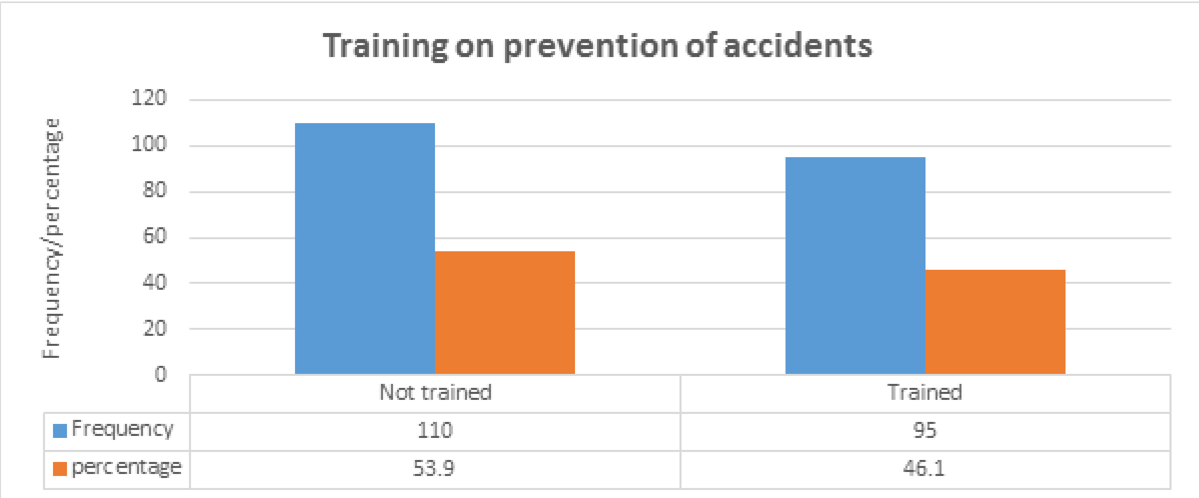


Figure 19: Responses on number of respondents trained on accidents at KPA

Furthermore, majority of respondents either did not know or disagreed with the expectation that the training topics offered improved their knowledge on major accidents.

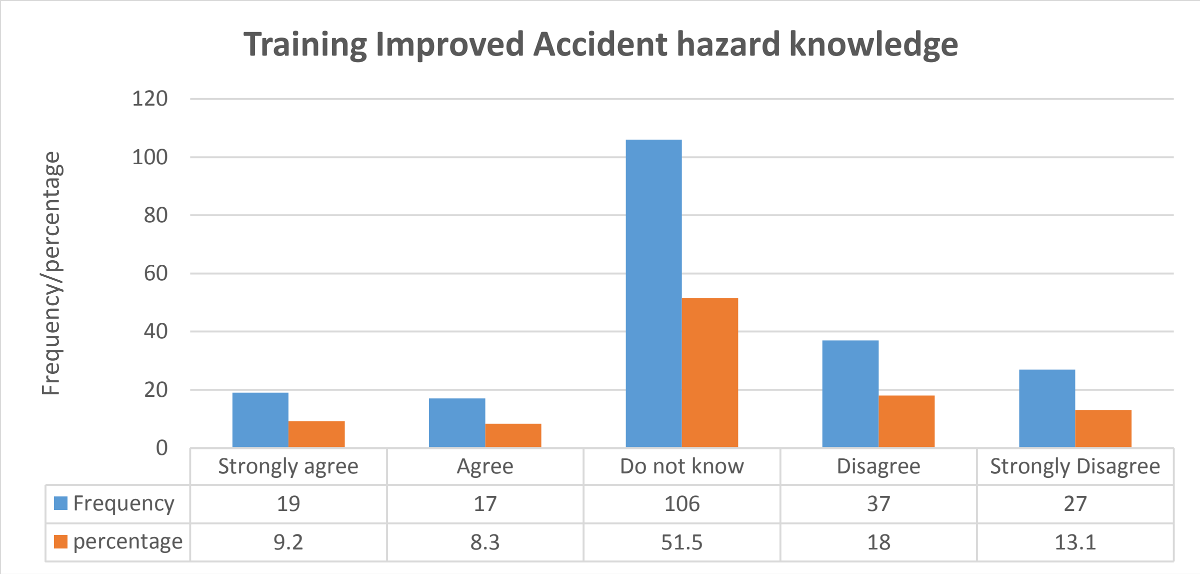


Figure 20: Responses on improvement of major accident awareness after training at KPA

A Chi-Square analysis test for association was done where there was a significant association between training on major accident hazards and improvement on understanding of major accident prevention as shown below $X^2 = 0.029$ P=0.05 DF=1

Table 10: Chi-Square analysis between training and improvement on major accidents prevention at KPA

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	135.851[a]	8	.000
Likelihood Ratio	163.649	8	.000
Linear-by-Linear Association	4.791	1	**.029**
N of Valid Cases	206		

This could mean that training on major accident would help in increasing employees understanding and response to major accident events which was found to be lacking at the time of the research.

It was found out that 82.5% of respondents in the below chart felt that the training they had received had not given them the confidence required in terms of responding to or handling major accidents if they did occur in their workplaces. This would be interpreted to mean that the training did not achieve the desired impact, or the content covered was irrelevant to accident prevention. The fact that 82.5% of respondents in chart below said they had no confidence in dealing with major accident after the training shows that the topics covered did not address the major accident hazards and this is an area that the organization could improve on when conducting safety training.

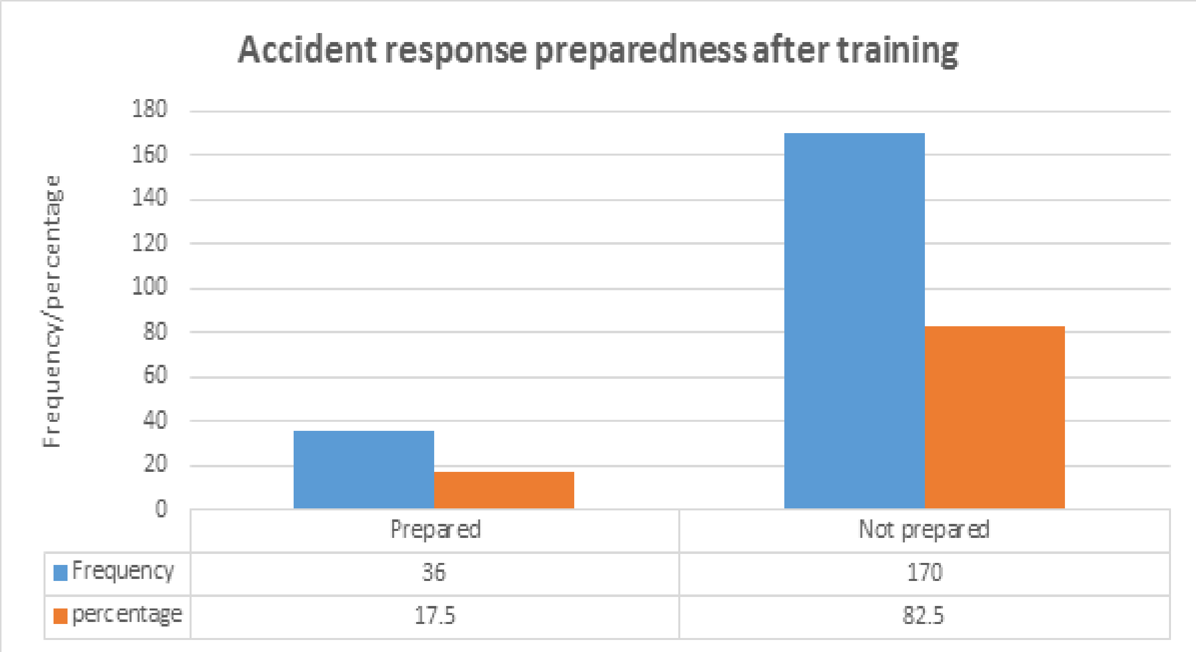


Figure 21: Responses on accident response preparedness after training at KPA

It was noted that 96.6% of respondents agreed training of all staff on accidents was important but only 81.1% agreed that training of all contractors was important. This showed a negative perception about contractors which could affect the attention that they are given regarding training on awareness of preventing accidents.

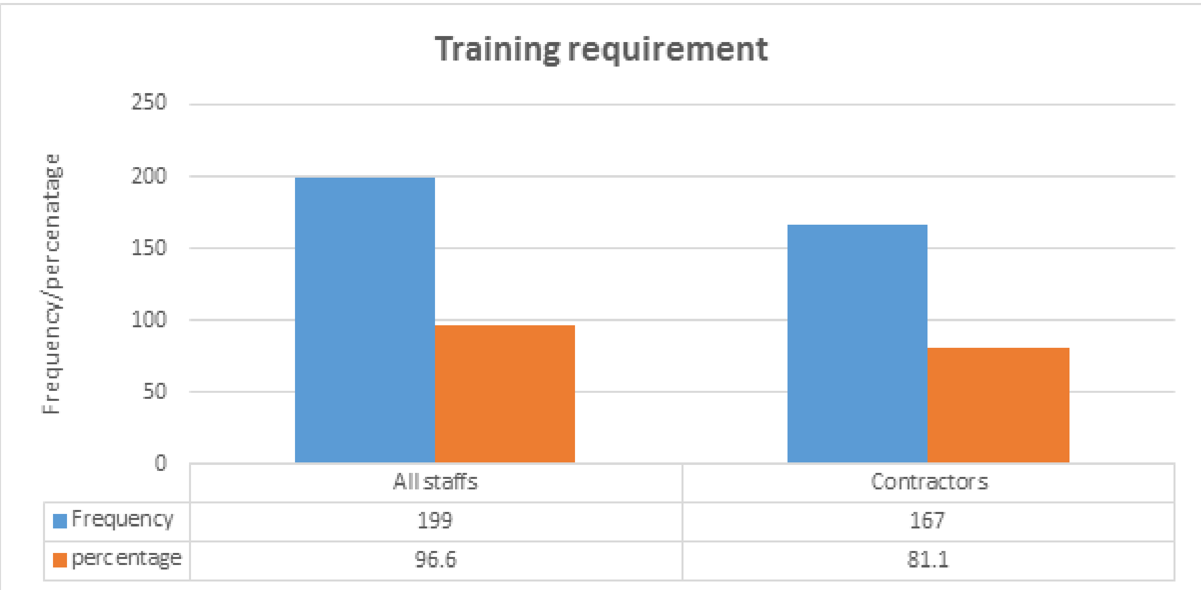


Figure 22: Showing respondents view on importance of training to both staff and contractors at KPA

In addition, a Chi-Square analysis test of the period worked (experience) also had significant influence on awareness on major accidents occurrence since it was found to improve awareness on major accident occurrence as shown below $X^2= 0.013$ $P=0.05$ $DF=1$ as shown in table 4b below.

Table 11: Chi-Square analysis between experience of respondents and improvement on awareness on major accidents prevention at KPA

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	86.293[a]	20	.000
Likelihood Ratio	63.297	20	.000
Linear-by-Linear Association	6.167	1	**.013**
N of Valid Cases	206		

An aspect of training gap identified was to do with contractors on site. This included contractor staff who were doing housekeeping, construction jobs and those working in leased berths e.g. the grain bulk terminal. The ratio of these contractors to the KPA staff on site was found to be 1:4 and they were spread out in all areas including container and conventional terminals hence need to have them trained.

Contractor staff interviewed on site confirmed that they had neither received any form of training on accident prevention in the ports from their employers nor from the KPA, contrary to requirement by OSH Act 2007 section 17(1- 4), that requires provision of information and training for non-employees of the occupier. The contractor employees interviewed said that there was no training program to instruct them on safety on site including safe operation of equipment as was also revealed by the hazard checklist information. Lack of tight control on contractors might lead to operation of machines by incompetent people increasing chances of occurrence of a major accident. In the current global era of privatization of berths there is need to dispel the notion that training of contractors on control of major accident hazards is not as important as that of employees of Kenya port yet they worked in the same environment and exposed to the same hazards. Training was not standardized and offered to both employees and contractors to raise the risk perception levels regarding major accident occurrence in the ports.

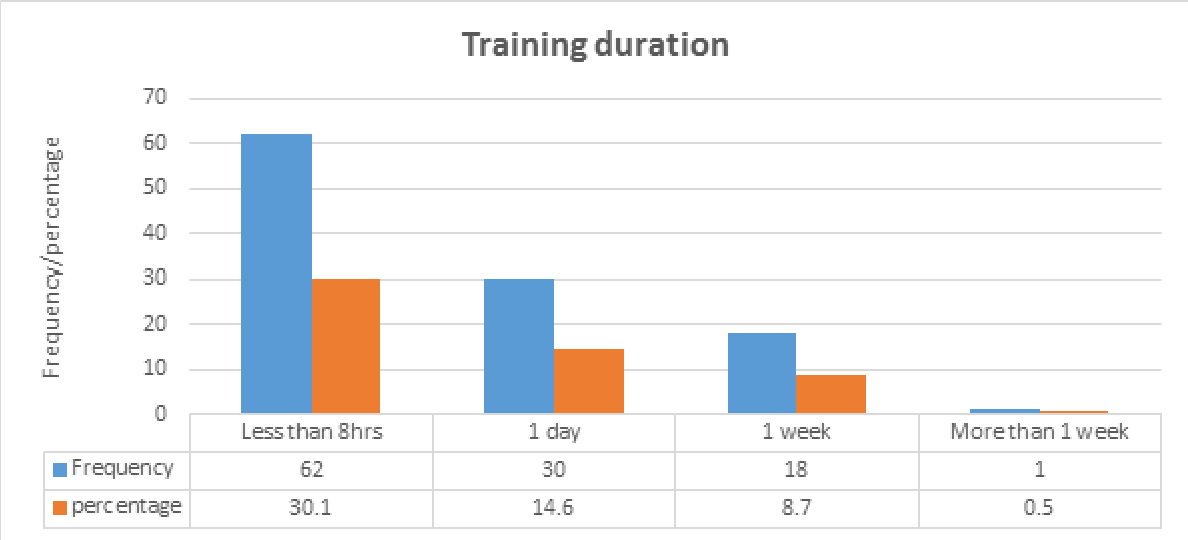


Figure 23: Responses on training on accident prevention duration at KPA

Most of the trainings lasted for less than a working day and were mostly facilitated internally as shown in chart above. This would be interpreted to mean that the duration of training was not enough to achieve the required impact, to impart knowledge and skills on major accident prevention since the respondents said the training did not improve their major accident awareness. It would also mean that internal facilitators may have not delivered the training in a manner likely to increase awareness of major accident prevention by the trainees.

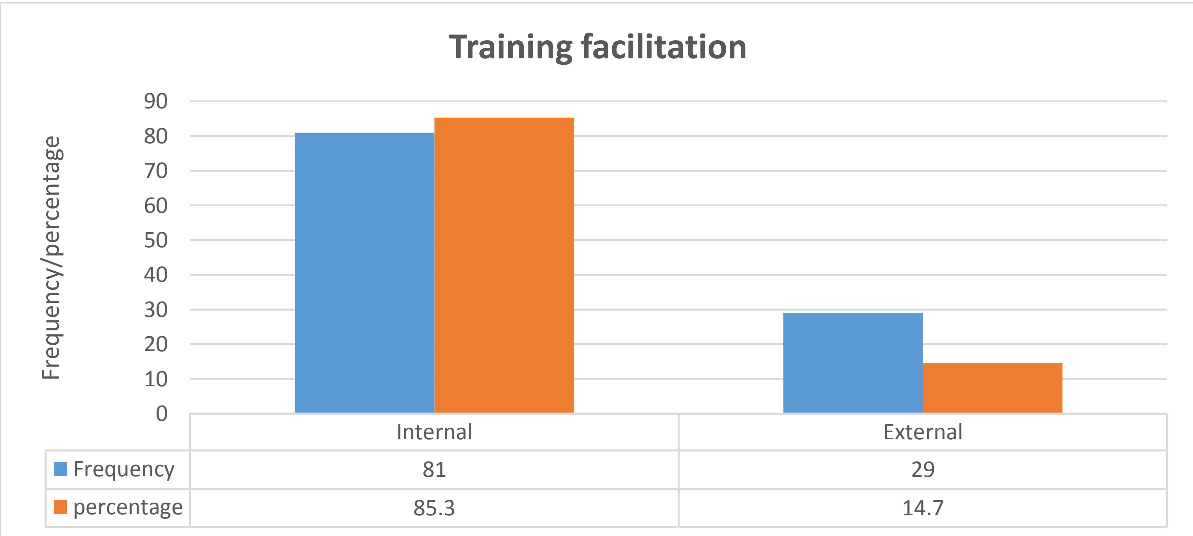


Figure 24: Responses on training facilitation at KPA

It was found out that most of the trainings, 85.3%, have been done by internal trainers. Training is supposed to give knowledge and instill confidence, perhaps the internal facilitators had not been able to train the staff to the levels that would give them confidence to handle major accident scenarios, or probably the duration of training had not been enough or possibly irrelevant content was covered. These were some of the training gaps aspect that needed to be scrutinized and addressed. There should be made available training programmes to cover all employees to ensure they have basic awareness on major accident hazards in the port areas.

An ANOVA on the responses received regarding various training aspects: Whether training improved knowledge on major accidents, topics covered improved understanding of major accident occurrence or whether they would be able to respond appropriately during accidents after training compared to their job cadre was done as shown below. Major accident knowledge improved after training on major accident versus job cadre Sig=0.041<P=0.05 DF=2, topics covered improved understanding of accident occurrence versus job cadre Sig=0.038<P=0.05 DF=2 and respondents felt confident to respond appropriately to a major accident versus job cadre Sig=0.035<P=0.05 DF=2, showed that there was no significant variation from the mean and therefore the trainings offered did not improve the knowledge on major accident or understanding of their occurrences. In addition, the staff trained did not feel confident to handle any emergence response arising from an accident.

Table 12: ANOVA for responses on various training aspects versus the respondent's job cadre

Variable	DF	Mean squares	F	Sig
Major accident knowledge improved after training * job cadre	2	.881	2.439	**.041**
Topics covered improved understanding of accident occurrence * job cadre	2	1.144	1.043	**.038**
Feel confident to respond appropriately to a major accident * job cadre	2	.332	2.247	**.035**

4.2.5 Risk assessment Process

The risk of a major accident arising in the port operations as a result of the transport and handling in the ports of a hazardous substance in bulk was found to be high. Good safety management practice requires a proactive approach toward safety that aims to identify risks early and control them, instead of waiting for occurrence of an accident to trigger risk assessment. The risk assessment framework was found to be one where risk assessment was carried out by the safety department or line managers without involving or consulting other employees especially the operators, who do the job.

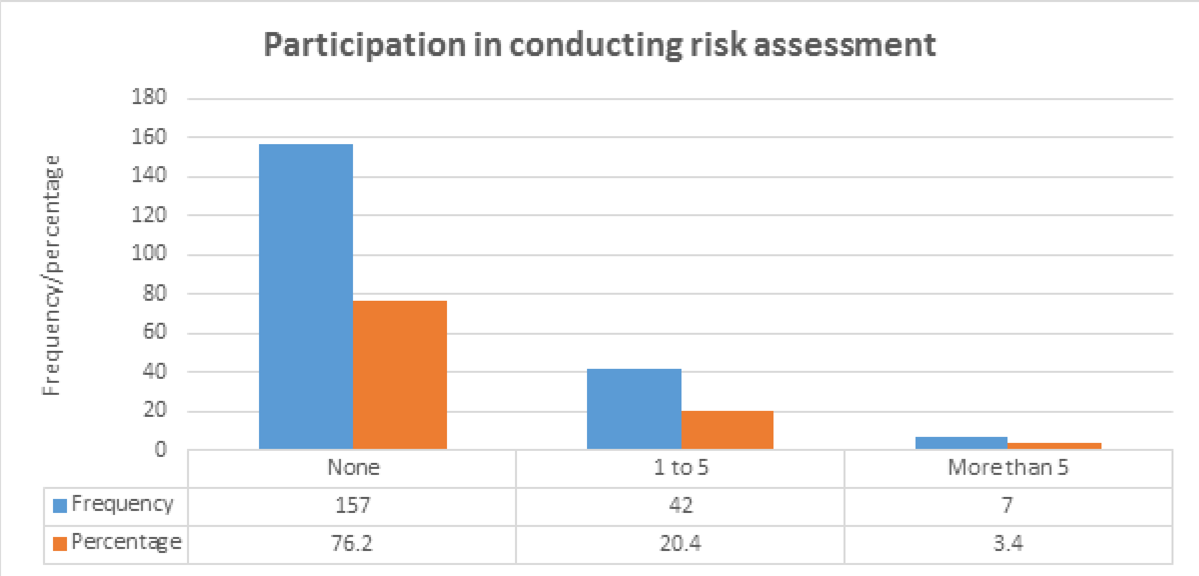


Figure 25: Responses on participation in risk assessment at KPA

Only 23.8 % of respondents as shown on chart above had taken part in conducting risk assessment. The rest had not participated either individually or in a team in any form of risk assessment. The reason given was that this was done by the safety department and the supervisors or line managers meaning this was not a consultative process involving all employees who actually do the job.

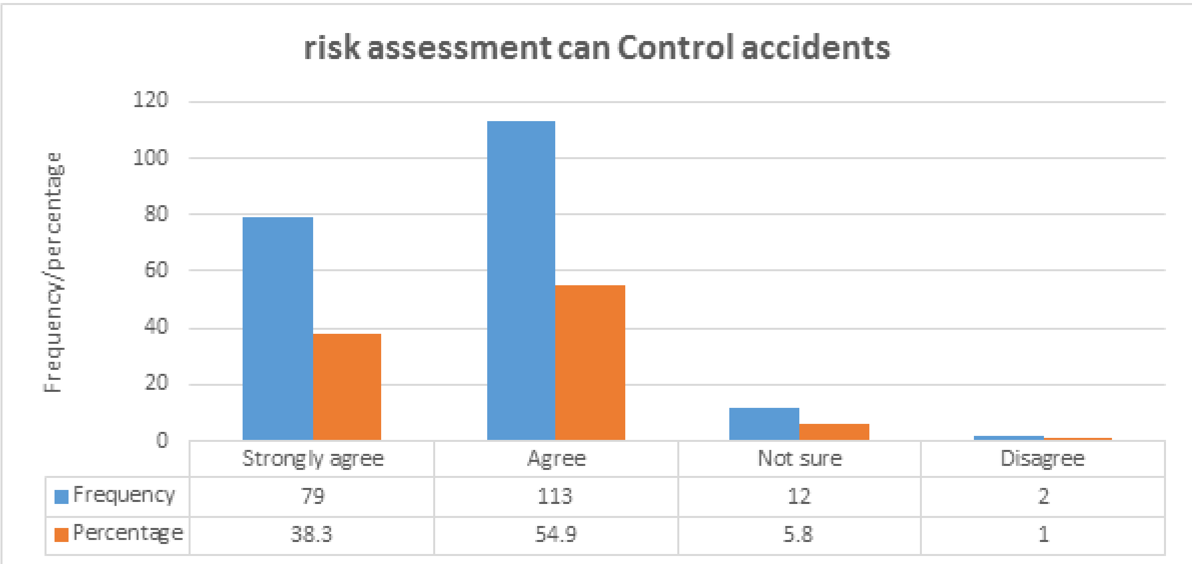


Figure 26: Responses on importance of risk assessment in control of accidents at KPA

The finding that majority of 93.2% were of the view that risk assessment of hazardous installations would help in prevention of major accident hazards showed that respondents held the view that risk assessment, if done thoroughly and extensively for all the port operations and the recommendations implemented as required, would help in effective control of major accidents in the operations. But they would need to be involved to appreciate the importance of risk assessment in control of major accident.

There was a mix up of responses, during the interview, regarding risk assessment framework in terms of how it should be conducted, who should conduct and how often it should be conducted. Which showed that this process was not well entrenched in the organization. This was contrary to OSH Act 2007, part II, General duties of the occupier, where one of the duties of the occupier is to ensure Safety & Health of all persons working in the workplace. The Act (OSH Act 2007 part II 6(3)) has instructed carrying out of risk assessment in respect to chemicals, machinery, equipment, tools and processes under the control of the occupier to ensure no risk to safety and health of employees. A good practice would be to involve all employees when conducting the risk assessment. It was found out that majority of the employees did not know much about risk assessment and had no practical working knowledge of conducting any risk assessment in their daily work including the technical departments.

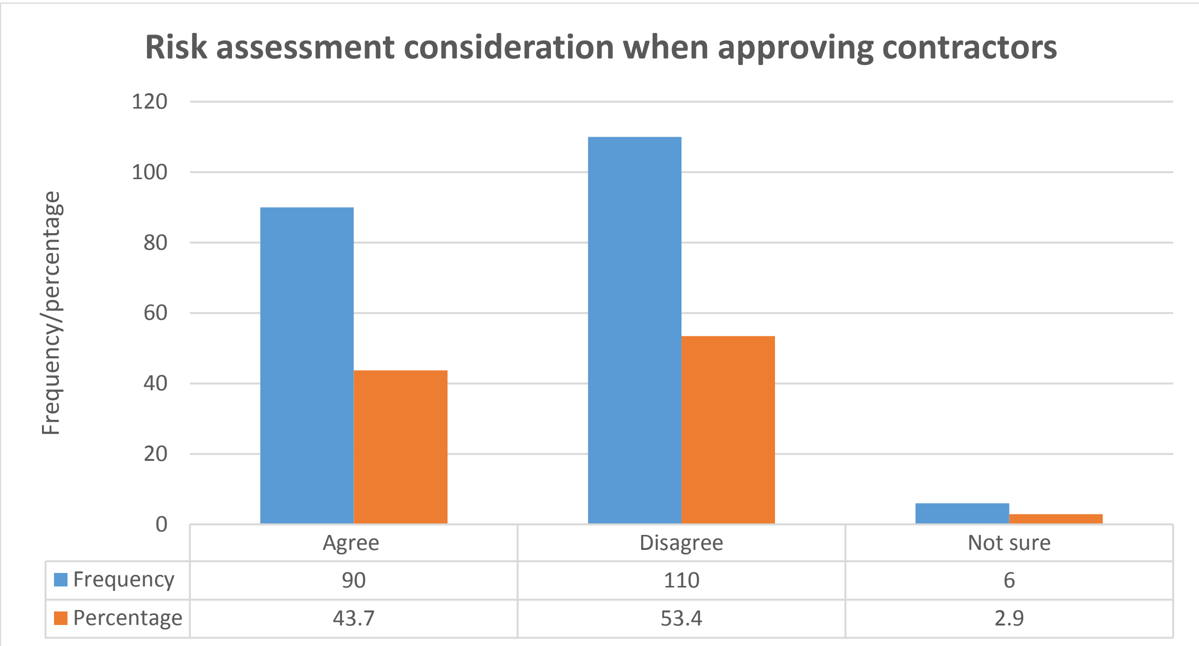


Figure 27: Responses on need for risk assessment in authorizing contractors at KPA

It was noted that 43.7% of respondents as shown in chart above believed that risk assessment should be used in determining which contractor to be allowed to operate in the port while only 53.4% of the respondents disagreed.

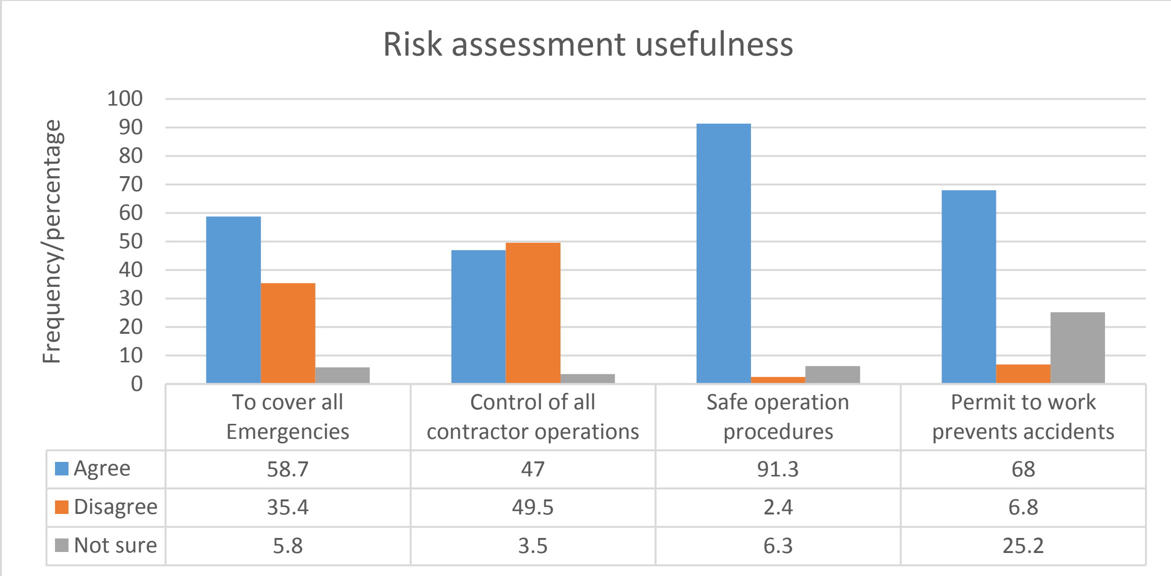


Figure 28: Showing respondents view on usefulness of risk assessment at KPA

The extent of implementing risk assessment came into focus during the interviews with most respondents saying they were not involved in any way, and where it was done the recommendations were ignored because some would require approval by many people which would take long time to implement due to bureaucratic processes. Interviewed respondents who were operators said they would want to conduct the assessment themselves because they were the ones who operated the plants and equipment. Therefore, the risk management framework was found to be one where the risk assessment was conducted by line managers and the safety department without involving or consulting other stakeholders, and the recommendations were delayed due to long processes of approval.

It was noted that the respondents held the view that use of risk assessment as a way of approving contractors operating in the port and approving hazardous installations in the port would help to control major accidents in the port if well implemented and sustained. This was a view also strongly supported by the respondents who were interviewed and therefore provides a huge opportunity to minimize occurrence of major accidents in the port. While respondents were not fully supportive of the training of the contractors on major accidents in the port as they were for the KPA employees, the same respondents, 97.1%, held the view that risk assessment, if used in approving port contractor operation license, would lead to prevention of major accidents. This showed that the respondents appreciated the value risk assessment would have on control of major accident although they may not have had practical knowledge of doing risk assessment as it was not a well-entrenched system in the port operations.

Results discussion

Effective safe systems such as contractor management system were found to be lacking in this organization. Requirements such as their training, their cargo handling equipment maintenance and their awareness of occurrence and control of major accidents was lacking. Such system would be very useful due to the emerging need of privatization of berths and terminals where contractors working for leaseholders within leased areas in the port would need to work in accordance with permit requirements issued for high risk jobs which are in accordance with leaseholder's contractual requirements.

Cargo handling equipment was confirmed to have caused accident in the organization with the common accidents being chemical spillage and property damage. The reviewed quarterly accident report showed majority of the accidents were attributable to equipment failure and truck collision. The main container terminal had recorded the highest number of accidents compared to the conventional terminal. There had also been cases of documented fatality which were confirmed through the interview session with the respondents. This showed that management of Cargo handling equipment aspect would be a factor that determines occurrence of major accidents in the port and should be well managed and closely monitored. There was no agreed standardized sourcing for the equipment and most of the technicians interviewed said this affected their maintenance and repair. It was confirmed that lack of standardized sourcing and proper funding for the equipment had contributed to operation of equipment past due date for maintenance or replacement due to unavailability of spare parts as well as some equipment being "cannibalized" to provide spare parts for others.

Training gaps were identified and there was need to ensure all employees were aware of the kind of risks that they were exposed to including handling of hazardous chemicals and operation of equipment with potential to lead to major accidents. The training on control of major accidents for all employees working in the port is important and there is need to dispel the perception that training of contractor employees is not as important as that of staff employed by KPA.

Operational employees were not involved in the conduction of risk assessment and even the risk assessments that had been done were not implemented to the extent recommended in the action plan because of the long delays and bureaucracy in getting approvals for resources to implement the control measures. In addition, all operations that were likely to lead to emergency in the port were not assessed and awareness created regarding the same. This left the staff exposed to the impact of potential occurrence of major accidents in the port.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 General conclusion

The overall objective of this research was to evaluate determinants of effective control of major accidents in the port of Mombasa. The study was guided by four specific objectives namely; to assess the effectiveness of safe work systems implemented towards control of major accidents; to examine cargo handling equipment maintenance and repair system in place towards ensuring effective control of major accidents; to identify training need gaps towards enhancing effective control of major accidents; and to assess the current risk management process in place towards effective control of major accidents. There was found to be ineffective safe systems of work that were poorly implemented and cargo handling equipment in use at the port that were not under any preventive maintenance plan. In addition, some gaps in training were identified and the risk management process in place was found to be isolated where operators were not involved in any way. No policy or regulation dealing specifically with control of major accident in the ports was implemented.

5.1.1 Effectiveness of safe work systems implemented towards control of major accidents

The safe systems found in use were access control, permit to work and shift handover notes. Control of entry of third parties in the port was mainly done by use of access control only as opposed to risk assessment of their jobs and permit to work. There was poor contractor management system in the port in that the control of contractor activities in the port as one of the safe systems of work was not well entrenched, to the extent that the contractor activities and operations were neither regulated nor closely monitored to avoid occurrence of major accidents. There was no system of ensuring contractor compliance once they were inside the port and working in different projects. The safe operation procedure as well as other safe systems of work like the PTW were not enhanced to the extent of improving compliance and minimizing major accident occurrence. The testing of emergency control system in this organization was not well implemented and employees were not consulted to ensure effectiveness in case of real accidents.

5.1.2 Cargo handling equipment maintenance and repair system in place towards ensuring effective control of major accidents

Cargo handling equipment were found to be the largest contributor to accidents occurring in the port by way of a fatality, spillages and property damages. There was no preventive maintenance schedule for equipment used by the contractors on site. In addition, some equipment in operation by the contractors and port staff were found to be overdue for service and maintenance. Others were not enrolled in any repair and maintenance schedule as discovered through the checklist and during the interview although they were under operation. Through observation and maintenance records reviewed, there was no clear documentation on equipment preventive maintenance or statutory inspection schedule for equipment used by contractors. This showed that cargo handling equipment maintenance and repair system was not well enforced. It was also found out that there was no enforced national regulation guiding control of major accident in the ports or a major accident prevention policy in place, that would help in enforcement of control of occurrence of major accident in the port.

5.1.3 Identify training need gaps towards enhancing effective control of major accidents

Training gaps existed and although majority of the respondents had worked for the company for more than ten years, some had not received any form of training on control of major accidents as only 46.1% of respondents had been trained on other areas like first aid awareness. For those who had been trained, they did not feel that the training offered them the required competency and confidence to respond to an emergency arising from occurrence of a major accident. This could mean that the training did not have required impact either because of the relevance of the content covered, the duration of training or competency of the facilitators in covering topics in major accident prevention. Furthermore, there emerged a general perception that the training of contractors was not as important as that of the Kenya Ports Authority employees even if they worked in the same environment and consequences of a major accident would not discriminate the two groups.

5.1.4 Current risk management process in place towards effective control of major accidents

It was found out that risk assessment was done by line managers and safety department without involving the operators who actually do the job meaning there was no empowerment of the operators to conduct sufficient and suitable risk assessment whenever they undertake any activity or operation in the port. There was also no standardized method known by all staff of reviewing or updating the risk assessment to ensure changes in risks have been mitigated. The recommendations and proposed actions from risk assessment were not implemented to the extent recommended because of bureaucratic approval process and low allocation of resources. This may lead to delays in conducting repairs and maintenance thereby creating an opportunity for occurrence of a major accident.

5.2 Recommendations

From the four objectives studied the following are the recommendations based on the results analyzed.

a) Develop and implement a robust safe system of control of contractors and other technical operations in the port and streamline it to align with the port safety management system to ensure close monitoring and control of all contractor activities. This could be in form of port safety handbook outlining requirements such as safe permit system, site supervision, hazard training and operation of tools and equipment.

b) Inclusion in the staff training curriculum the topic of prevention of occurrence of major accident to all employees in the port including contractors. This training should have the content and sessions that imparts practical skills to employees in order to give them confidence to respond to real major accident scenarios. It would be important to seek facilitation by an external consultant who may be more competent in offering such technical training on control of major accidents in the port.

c) It is recommended that a major accident control policy is developed and implemented. The researcher would be willing to offer technical support in developing such a policy in the area of control of major accidents and hazards.

d) Implement port overall emergency plan by bringing it to the attention of all staff and operators within the port. There should be regular practicing or testing of the plan, as far as reasonably practicable to ensure that it is effective and should cover the entire organization to create more awareness among staff on evacuation in case a major accident occurred.

e) The port management should implement an equipment replacement policy based on international best practice, and a standardized system of sourcing cargo handling equipment. The management should allocate enough funds for replacement of old or obsolete equipment as well as spare part inventory.

5.2.1 Recommendations for future research

Based on this research, the following are some of recommendations for future research in relation to evaluation of determinants to effective control of major accidents in the ports.

- In-depth analysis of the number of accidents attributable to the contractors at KPA and how a robust safe system to manage their operations could reduce those numbers.
- Whether there is a relationship between human error and port accidents at KPA
- Find out whether there is a relationship between occurrence of major accidents and a lack of legislation or policy on major accident prevention in the context of port operations.

APPENDICES

REFERENCES:

Abd el-al, H. M., & Shaheen, A. (2009). The risk assessment and effect on improving the productivity in Egyptian container terminal. Maritime College, Arab Academy for Science and Technology, Alexandria, Egypt.

Retrieved from: http://www.academia.edu/7130109/html

Altiok, T. (2009). Model-based risk: Consider how modelling can be used to conduct risk assessments for ports and waterways. Department of Industrial and Systems Engineering at Rutgers University in New Jersey.

Retrieved from: http://www.cait.rutgers.edu/system/files/u5/CSID9J10Tayfur.pdf

American Bureau of Shipping. (2012). Guidance notes on safety culture and leading indicators of safety. Northchase Drive Houston, TX77060, USA.

Retrieved from:

http://www.eagle.org/eagleExternalPortalWEB/ShowProperty/BEA%20Repository/Rules%26Guides/Current/188_Safety/Guide

Atubi, A.O. (2006). Determinants of road traffic accident occurrences in Lagos state: Some lessons for Nigeria. Abraka, Nigeria.

Retrieved from:

http://www.ijhssnet.com/journals/Vol_2_No_6_Special_Issue_March_2012/23.pdf

Berman, G. (2013). Changing how training sessions are delivered may make safety training programs more effective. Retrieved from: http://www.ocseriousinjury.com.

Brandsæter, A. (2002). Risk assessment in the offshore industry. DNV Consulting Support, GI 291, Det Norske Veitas AS, 1322 Hovik, Norway.

Retrieved from:

http://jadelltd.com/wa_files/HSE_20_20Risk_20assessment_20in_20the_20offshore_20industry.pdf

Burn, S.D. & David, D. (2006). Understanding major accident hazard management – The more you know the more you know you don't know. Symposium series no. 151, 2006.

Retrieved from:

https://www.icheme.org/communities/subject_groups/safety%20and%20loss%20prevention/resources/hazards%20archive/~/media/Documents/Subject%20Groups/Safety_Loss_Prevention/Hazards%20Archive/XIX/XIX-Paper-59.pdf

Butt, N., Johnson, D., Pike, K. Pryce-Roberts, N. & Vigar, N. (2014). Port Industry Accident Statistics of Shipping Accidents. Southampton Solent University,School of Maritime and Technology, East Park Terrace, Southampton SO14 0YN, UK.
Retrieved from:
http://awsassets.panda.org/downloads/15_years_of_shipping_accidents_a_review_for_wwf_.pdf

Cătălin, F.D., Valentin., Mirela, P., Alecsandri, V. (2012). The prevention of hazardous substances and major accidents. Journal of Engineering Studies and Research Volume18(3). University of Bacău, Bacău, România.
Retrieved from: www.pubs.ub.ro/dwnl.php?id=JESR201203V18S01A0009

Chan, K. H. (2011). Appraisal of Determinants in Property Maintenance. Hong Kong SAR, China.
Retrieved from:
https://www.fig.net/resources/proceedings/fig_proceedings/fig2011/papers/ts04f/ts04fkhchan_5014.pdf

Choughule, S. (2000). The Management of Port Equipment Maintenance. The world bank policy planning and external affairs infrastructure and Urban Development Department Report INU 57. University of Wales, College of Cardiff, UK.
Retrieved from:
http://documents.worldbank.org/curated/en/265791468740356815/pdf/multi-page.pdf

Corson, L.A. & Fisher, S. A. (2008). Manual of Best Management Practices for Port Operations and Model Environmental Management System. Ports Association West Lafayette, Indiana, Washington, D.C.
Retrieved from:
http://www.glmri.org/downloads/resources/manualBestManagementPorts.pdf

Deane, H. (2004). Major industrial accidents paper no. 6. Training and Education Department of Infrastructure, Planning and Natural Resources.
Retrieved from: http://docplayer.net/8404223-Prevention-of-the-risks-of-major-industrial-accidents-bekra-legislation-guidance-for-operators.html

Dekleva, E. (2013). Handling and operations with DG 's in the Port of Koper. Luka Koper d.d. SEEMariner International conference, Mantova, Canada.
Retrieved from: http://www.sbra.be/sites/default/files/port_of_koper_uka_koper.pdf

Elliott, M.R., Kleindorfer, P.R., DuBois, J.J. & Wang, Y. (2008). Major Industrial Hazards Advisory Paper No. 3: Hazard Identification, Risk Assessment and Risk Control Linking OII and RMP data: Does everyday safety prevent catastrophic loss. USA.
Retrieved from:
http://www.readbag.com/workcover-nsw-au-formspublications-publications-documents-major-industrial-hazards-advisory-paper-no3-hazard-identification-risk-assessment-risk-control

Frittelli, J.F. (2005). Port and Maritime Security. Specialist in Transportation Resources, Science and Industry Division, New York, USA.
Retrieved from: http://fas.org/sgp/crs/homesec/RL31733.pdf

Froese, J. (2006). Effective operations in ports. What can the port industry and its clients, the shipping companies, expect from this research and investigation. Hamburg Technical University, Hamburg, Germany.
Retrieved from:
http://www.transportresearch.info/sites/default/files/project/documents/20121003_124507_14753_EFFORTS-WPIV.--INF-20090211-Final-PT41-26_2%20Artikel%20EFFORTS.pdf

Galhena, R. (2003). UNCTAD monographs on port management. UNCTAD/SHIP/494, United Nations, New York and Geneva.
Retrieved from: http://unctad.org/en/Docs/poship494d16.en.pdf

Health and Safety Executive. (2011). A quick guide to health and safety in ports, INDG446.
Retrieved from: www.hse.gov.uk/pubns/indg446.pdf

Helal. H.M. (2009). Safety and Security around the Egyptian Coasts (Security and Safety in Short Sea Shipping Operations). College of Maritime Transport & Technology Arab Academy for Science, Technology and Maritime Transport, Egypt.
Retrieved from: www.aapa-ports.org

HSE, HSG 48. What we mean by human factors reducing error and influencing behavior.

Ilchenko, Y. (2012). Port State Control: Synopsis of frequent findings and detention items.
Retrieved from:
http://upcommons.upc.edu/bitstream/handle/2117/9656/PORT%20STATE%20CONTROL%20INSPECTIONS%20AND%20THEIR%20ROLE%20IN%20MARITIME%20SAFETY.pdf?sequence=1

IMO Resolution A.862(20). (1998). Code of practice for the safe loading and unloading of bulk carriers. Canberra City, Australia.
Retrieved from:

http://www.imo.org/en/OurWork/Safety/Regulations/Pages/BulkCarriers.aspx

International Chamber of Shipping. (2013). Implementing an effective safety culture: Basic advice for shipping companies and seafarers. International chamber of shipping IMO Symposium on the Future of Ship Safety. London.
Retrieved from: www.ics-shipping.org.

International Labour Organization. (2003). Code of practice on security in ports. Tripartite Meeting of Experts on Security, Safety and Health in Ports, Geneva, United Nations.
Retrieved from:
http://www.ilo.org/sector/Resources/codes-of-practice-and- guidelines/WCMS_162328/lang--en/index.htm

International Maritime Organization. (1998). Revised recommendations on the safe transport of dangerous cargoes and related activities in port areas. London. Retrieved from: https://www.amnautical.com/products/safe-transport-of-dangerous-cargoes-and-related-activities-in-port-areas-2007-edition#.WBHHZI9OLIU

Kilvington, R. (2004). Port & Harbour Risk Assessment and Safety Management. New Zealand.
Retrieved from:
https://www.maritimenz.govt.nz/commercial/ports-and-harbours/documents/Port-harbour-risk-assessment.pdf

Kothari, C. (2004). Research methodology: methods and techniques. U.S.A: New Age international.
Retrieved from:
http://www2.hcmuaf.edu.vn/data/quoctuan/Research%20Methodology%20-%20Methods%20and%20Techniques%202004.pdf

Larry, L., Tok, SC., Darley, P. (2007). "Crane Accidents and Emergencies – Causes, Repairs, and Prevention".
Retrieved from: http://www.portek.com/publications/Cranes_Accidents.pdf

Liwång, H. (2012). Maritime security, safety and regulations. Department of Shipping and Marine Technology Division of Marine Design Chalmers University of Technology. Report No 12:141, Gothenburg, Sweden.
Retrieved from:
http://www.vasco-da-gama.eu/medias/fichiers/Summer-School/Liwang_VDG_Aug15.pdf

Ludwig, S. & Thurman, M.J. (2010). Improving Your Machine Safety Program: Shift the focus from avoiding negative outcomes to achieving positive results.

Retrieved from:
https://ohsonline.com/articles/2010/12/15/improving-your-machine-safety-program.aspx

Mejia, M.Q. Jr., Cariou, P., Wol, F.C. (2010). Vessels at risk and the effectiveness of Port State Control inspections.
Retrieved from: https://hal.archives-ouvertes.fr/hal-00470635/document

Merrifield, R. & Moreton, P. A. (1992). An investigation into the feasibility of using risk assessment methodology for licensing explosives handling in ports. Volume I. Minutes of the Twenty-Fifth Explosives Safety Seminar Held in Anaheim.
Retrieved from: https://www.researchgate.net /publication/ 235091859_ An_ Investigation_ into_the_Feasibility_of_Using_Risk_Assessment_Methodology_for_Licensing_Explosives_ Handl ing_Ports

Mugenda, O.M. & Mugenda, A.G. (1999). Research methods: Quantitative and qualitative approaches. Nairobi: ACTS Press.
Retrieved from: http://www.pdfsdocuments.com/mugenda-mugenda-research-methods.pdf

OSH Act. (2007). Article 63 (2 & 9a)

Radojkovic, A. (2011). HSE Regulations & Enforcement Directorate (DG), Qatar Petroleum. Retrieved from
http://static.globalreporting.org/reportpdfs/2012/07229363870495a88837055c4eadff7b.pdf

Roberson, J.H. (2004). Using leading indicators to avoid major accidents. U.S. defense nuclear facilities safety board, USA.
Retrieved from: http://www.csb.gov/UserFiles/file/Roberson%20(DNFSB)%20 Testimony % 20-%20printed.pdf

Ronza, A., Fe ´lez, S., Darbra, R.M., Carol, S., Vı ´lchezm, J.A., Casal, J. (2003). Predicting the frequency of accidents in port areas by developing event trees from historical analysis. Journal of Loss Prevention in the Process Industries 16 (2003) 551–560. Barcelona, Catalonia, Spain.
Retrieved from:
https://www.researchgate.net/publication/222012589_Predicting_the_frequency_of_accidents_in_port_areas_by_developing_event_trees_from_historical_analysis

Rujillo, L.T & Nombela, G. (1996). Privatization and regulation of the seaport industry. Universidad de Las Palmas de Gran Canaria Dpto.AnlisisEconmicoAplicado35017Las Palmas de Gran Canaria, Spain.
Retrieved from: http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-2181

Rujillo, L.T & Nombela, G. (1999). Policy research working paper. Privatization and Regulation of Containerized shipping. World Bank Institute Governance Regulation, and Finance. New York.

Retrieved from: http://documents.worldbank.org/curated/en/973281468740398501/pdf/multi-page.pdf

Schwed, J.M. (2010). The Port Authority of NY& NJ Downtown Restoration Program. The World Trade Centre Site Construction, Health and Environmental Program New York.

Retrieved from: https://www.panynj.gov/wtcprogress/pdf/pa-wtc-shep.pdf

Shahjahan A.S.M. (2000). Cargo handling equipment productivity analysis of the Chittagong Port Authority in Bangladesh, World Maritime University.

Retrieved from:

http://commons.wmu.se/cgi/viewcontent.cgi?article=1319&context=all_dissertations

SIP007(2010). Health and safety imports. Guidance on loading and unloading of dry bulk cargo.

Retrieved from:

http://www.portskillsandsafety.co.uk/sites/default/files/documents/SIP007_-_GUIDANCE_ON_LOADING__UNLOADING_OF_DRY_BULK_CARGO_-_ISSUE_1_0.pdf

SIP016 (2014). Guidance on emergency planning in ports. Health and Safety in Ports.

Retrieved from:

http://www.portskillsandsafety.co.uk/sites/default/files/documents/sip016__guidance_on_emergency_planning_in_ports_-_issue_1_-_april_2014.pdf

Stenek, V., Amado, J.C., Connell, R., Palin, O., Wright, A.S, Pope, B., Hunter, J, McGregor, J, Morgan, W. Stanley, B., Parsons, W., Washington, R., Liverman, D., Sherwin, H., Kapelus, P., Andrade, S.C, Pabón, J.D. (2011). climate risk and business ports. International Finance Corporation. University of Oxford.

Retrieved from:

http://www.ifc.org/wps/wcm/connect/326115804aa7af0c9f04df9e0dc67fc6/ClimateRisk_Ports_Colombia_Appendices.pdf?MOD=AJPERES

Tarmo, O.T.S. (2000). Transport and handling of dangerous cargoes in port areas: Weaknesses of Existing International and Estonian Regulations.

Retrieved from:

http://commons.wmu.se/cgi/viewcontent.cgi?article=1242&context=all_dissertations

The world bank policy planning and external affairs. (1990). Technical Paper. Infrastructure and Urban Development. The Management of Port Equipment Maintenance. University of Wales, College of Cardiff. USA.
Retrieved from:
http://documents.worldbank.org/curated/en/265791468740356815/pdf/multi-page.pdf

Townsend, D. (2007). Increase Safety Awareness with Signs.
Retrieved from:
http://en.wikipedia.org/w/index.php?title=Effective_safety_training&oldid=60243235 6.

Tsenga, P. & Pilcherb, N. (2015). Exploring the Causes of Port Accidents: A Case Study of Kaohsiung Port, Taiwan. Retrieved from Exploring the Causes of Port Accidents: A Case Study of Kaohsiung Port, Taiwan.

US Department of Labor. (1998). Training Requirements in OSHA Standards and Training Guidelines. OSHA 2254 1998 (Revised).
http://www.osha.gov/Publications/osha2254.pdf. Accessed on 15/10/2015

Wickrama, P, B. (2012). Challenges faced by modern container terminals. Sea trade Middle East Maritime Conference, Dubai.
Retrieved from:
http://aapa.files.cmsplus.com/SeminarPresentations/2013Seminars/13TerminalTraining/Jacob%2C%20Ashebir.pdf

APPENDIX 1

QUESTIONNAIRE

Evaluation of determinants of effective control of major accidents at Kenya Port Authority

Serial no: ....

Date: ....

Organization: .... Section: ....

Position: ....

INSTRUCTIONS

The questionnaire has 3 sections. Section I will be on demographic information, section II will be on hazard awareness and section III will include the various variables concerned in this research. Kindly tick (√) the appropriate answer(s) or write brief notes where appropriate.

The questionnaire will take approximately 40 minutes. You are assured that your answers will be treated confidentially. Hence, do not provide your name. All the data collected will be kept secure and no other person, besides the researcher and the supervisor will have access to the completed questionnaire. There is no correct or wrong answer and you are encouraged to answer the questions to the best of your knowledge.

SECTION I: Demographic information

1. What is your sex?

Male ( ) Female ( )

2. What is your age? ....years

3. What is your level of education?

Primary education ( ) Secondary education form ( )

Mid-level College education ( ) University education ( )

SECTION II: Hazard awareness

4. How long have you worked at KPA? ………………. years

5. During this time have you witnessed any kind of major accident in your workplace?

Yes ( ) No ( )

6. Which one below describes the way the accident happened?

Fire ( )

Explosion ( )

Chemical spillage ( )

Container crane failure ( )

Any other **(Please describe):**
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………….……

7. What is your opinion on the statement: Handling of explosives and flammable chemicals at the port **CAN** lead to occurrence of a major accident?

Agree ( ) Disagree ( ) Not sure ( )

SECTION III: Determinants of effective control of major accidents

8. How many trainings on major accident hazard awareness have you attended in the last one year? …………………………..

9. How long did the training take?

a) More than one hour ( )
b) Less than one day ( )
c) One week ( )
d) More than one week ( )
e) Other ………………….

10. Were the trainings by an internal or external facilitator

Internal ( ) External ( )

11. Would you say that the topics covered increased your understanding of major accident hazards occurrence in the port?

a. Strongly disagree ( )
b. Disagree ( )
c. Neither agree nor disagree ( )
d. Strongly agree ( )
e. Agree ( )

12. How would you describe your knowledge of the major accident hazards after the training?

Poor ( ) Average ( ) above average ( )

13. Has the training offered prepared you to respond appropriately in case of occurrence of a major accident hazard in the port?

Yes ( ) No ( )

14. Would you say the following is important or not important?

a) Training of all staff on major accident hazards management

Important (   )   Not important (   )

b) Training of contractor/port stakeholder's employees on major accident hazards control

Important (   )   Not important (   )

15. How many times have you conducted risk assessment either individually or as a team in the last five years?

None (   )   1 – 5 (   )   5 – 10 (   )

16. What is your opinion on the following statements:

a) Risk assessment of critical and hazardous port operations can be useful in control of occurrence of major accident hazards

a. Strongly disagree (   )
b. Disagree (   )
c. Neither agree nor disagree (   )
d. Strongly agree (   )
e. Agree (   )

b) If port operations risk assessments are conducted suitably and sufficiently and recommendations implemented adequately, occurrence of major accident hazards would be effectively controlled

a. Strongly disagree (   )
b. Disagree (   )
c. Neither agree nor disagree (   )
d. Strongly agree (   )
e. Agree (   )

17. How often are new risk assessment done or existing risk assessments updated

Monthly (   )
Every six months (   )
Annually (   )

Who conducts risk assessment in your organization?

Line manager (   )
Technical/engineering team (   )
Team appointed by CEO (   )
External consultants (   )

18. Give your opinion on the following statement by ticking where appropriate:

	Strongly disagree	Disagree	Neither agree nor disagree	Strongly agree	Agree
Risk assessment should be considered in licensing and renewing license for all contractors operating in the port					
Risk assessment in the ports should cover all types of emergencies that should be expected from hazards due to all operations in the port					

18. Control of the operations of the contractors in the ports is critical in controlling occurrence of major accidents in the port

Agree ( ) Disagree ( ) Not sure ( )

19. What is your opinion on the following statements:

a) Port safe operations procedures CANNOT help in effective control of major accident hazards

Agree ( ) Disagree ( ) Not sure ( )

b) Permit To Work System is very useful in controlling works of contractor jobs and by extension controlling occurrence of major accident hazards.

Agree ( ) Disagree ( ) Not sure ( )

20. How often is the emergency response system plan tested

Once per year ( ) Twice per year ( ) Others ( )

21. The following statements test your perception towards occurrence of major accident hazards that may call for emergency response. For each statement please give a single response by circling any of the five options in a scale of 1 to 5.

1-Strongly disagree

2-Disagree

3-Neither agree nor disagree

4- Strongly agree

5- Agree

Emergency response would be necessitated by the following

Critical equipment failure e.g. Container crane failure	1	2	3	4	5
Explosion	1	2	3	4	5
Fire	1	2	3	4	5
Environmental spill of a hazardous chemical	1	2	3	4	5
terrorist attack	1	2	3	4	5

23. Risk assessment and port safety management system complement each other in control of major accident hazard at KPA

Agree ( ) Disagree ( ) Not sure ( )

24. Rate by ticking the following safe systems of work according to your opinion on their ability to help in effective control of major accident hazards at KPA

The following safe systems of work are very critical in control of major accident hazards at KPA	Important	Not important	Not sure
Safe operation procedures			
Permit To Work System			
Emergency Response system			
Contractor management system			

25. Equipment contribute to smooth operations and efficiency in the port but can also lead to occurrence of major accident hazards in the port

Agree ( ) Disagree ( ) Not sure ( )

26. How many major accidents attributable to cargo handling equipment have you witnessed in your workplace in the recent past? ………………. incidents

27. What was the nature of the accident?

Fire ( ) Explosion ( ) Environmental spillage ( ) property damage ( )

28. Poor port equipment care, repair and maintenance would predispose occurrence of major accidents in the ports.

Agree ( ) Disagree ( ) Not sure ( )

29. The following statements help you to rate the cargo handling equipment aspects in relation to control of major accident hazard. For each statement you will circle a single response on a scale of 1 to 5 below.

1-Strongly disagree

2-Disagree

3-Neither agree nor disagree

4- Strongly agree

5- Agree

The following cargo handling equipment aspects would contribute to occurrence of major accident in the port

Old and obsolete port equipment	1	2	3	4	5
Poorly repaired and maintained port equipment	1	2	3	4	5
Exceeding the Safe Working Load (SWL)	1	2	3	4	5
Operation by incompetent operators	1	2	3	4	5

30. On a scale of 1- 5 below tick your opinion on the following statements:

	Strongly disagree	Disagree	Neither agree nor disagree	Strongly agree	Agree
Adherence to cargo handling equipment replacement policy and establishing a standardized sourcing could have a bearing on controlling accidents attributable to equipment failure in the ports.					
Low cargo handling equipment maintenance funding can ultimately lead to occurrence of a major accident hazard					

31. Which of the following statements would fit your opinion on the need for legislation dealing with control of major accident hazards in the ports

A Legislation dealing with issues of control of major accident hazards in the ports would help control major accident hazards

B Legislation dealing with issues of control of major accident hazards in the ports would **NOT** help control major accident hazards

32. In your opinion what should be done to effectively control the major accident hazards in the ports?

....

....

....

....

....

THANK YOU.

APPENDIX II

INTERVIEW GUIDELINES

Department……………………………..

Job Title ………………..

Date………………………

Interview subjects guide.

Training

1. Levels of training provided.
2. Training needs gap analysis and identification
3. Specialised training for machine operators and major hazards

Risk assessment

4. Extent to which risk assessments are conducted and actions implemented
5. Use of external risk assessment consultants

Safe systems of work

6. Testing of emergency response systems; Internally or externally
7. Control of risky contractor activities in the ports
8. Current port safety management system in place and interaction with other systems

Cargo handling equipment maintenance

9. Equipment preventive maintenance schedule
10. Testing and inspection of lifting equipment in the ports
11. Old equipment replacement
12. Past accidents or incidents attributable to any of the above variable

APPENDIX III
DATA ANALYSIS TABLES

DEMOGRAPHICS

Variable	Trait	Frequency (N)	Percentage (%)	Mean	SE
Gender	Male	159	77.2	1.23	0.029
	Female	47	22.8	1.77	0.029
	Total	**206**	**100**		
Age (years)	21-30	30	14.6	1.85	0.25
	31-40	69	33.5	1.67	0.33
	41-50	86	41.7	1.58	0.34
	Above 50	21	10.2	1.90	0.21
	Total	**206**	**100.0**		
Education level	primary	18	8.7	1.10	0.10
	secondary	56	27.2	1.60	0.15
	Diploma	88	42.7	2.73	0.13
	Degree	32	15.5	3.69	0.24
	Total	**206**	**100.0**		
Number of years worked	Less than 1 year	13	6.3	1.73	0.21
	1- 5 years	31	15.0	1.65	0.24
	6-10 years	42	20.4	1.93	0.31
	11-15 ears	63	30.6	1.52	0.14
	16-20 years	31	15.0	1.23	0.12
	more than 20 years	26	12.6	1.22	0.26
	Total	**206**	**100**		
Department					
Department		N	Percent	Mean	S.E
	Operations	100	48.5	3.05	0.81
	HR and Administration	13	6.3	4.15	0.22

	Technical services	29	14.1	4.0	0.08
	Infrastructure/projects	48	23.3	4.0	0.09
	legal services	16	7.8	4.73	0.15
	Total	206	100.0		

Accident type	**Frequency (N)**	**Percentage (%)**	**Mean**
Crane failure	200	97.1	1.71
Chemical spillage	189	91.7	1.17
Fire	158	76.7	1.65
Explosions	103	50	1.26

SAFE WORK SYSTEMS

Variable	**Aspect**	**N**	**Percentage**	**Mean**	**S.E**
Emergency Response testing frequency	Once a year	155	75.2	1.21	0.048
	Twice a year	17	8.3	112	0.08
	Thrice a year	34	16.5	1.38	0.127
Equipment failure necessitates emergency response	Agree	109	52.9	1.25	0.059
	Strongly agree	84	40.8	1.15	0.57
	Don't know	10	4.9	1.60	0.30
	Disagree	2	1	2	00
	Strongly disagree	1	0.5	1	
Explosion necessitates emergency response	Agree	69	33.5	1.28	0.08
	Strongly agree	127	61.7	1.17	0.46
	Don't know	5	2.4	1.8	0.49
	Disagree	4	1.9	2	0.57
Fire necessitates emergency response	Agree	62	30.1	1.24	0.082
	Strongly agree	13	66.5	1.18	0.045
	Don't know	6	2.9	2.3	0.422
	Disagree	0	0	0	0
	Strongly disagree	1	0.5	1	0
Chemical spillage necessitates	Agree	89	43.2	1.21	0.065

emergency response	Strongly agree Don't know Disagree Strongly disagree	102 8 5 2	49.5 3.9 2.4 1	1.11 2.25 2.2 2	0.42 0.366 0.2 1
Terrorist attack and emergency response	Agree Strongly agree Don't know Disagree Strongly disagree	**85** **117** **4** **0** **0**	41.3 56.8 1.9 0 0	1.21 1.22 2 0 0	0.65 0.054 0.57
Risk assessment and safety management system are key accident control	Agree Disagree Not sure	178 8 20	**86.4** **3.9** **9.7**	1.21 2 1	**0.41** **0.032** **0.00**

Variable	**Aspect**	**N**	**Percentage**	**Mean**	**S.E**
Safe operation procedure	Not important Important Not sure	194 8 4	94.2 3.9 1.9	1.21 2 1	0.42 0.327 0.0
Permit to work	Not important Important Not sure	125 29 52	60.7 14.1 25.2	1.09 1.45 1.47	0.32 0.145 0.118
Emergency response system	Not important Important Not sure	177 5 24	85.9 2.4 11.7	1.16 1 1.83	0.037 0.101 0.200
Contractor management system	Not important Important Not sure	131 30 39	63.6 17.5 18.9	1.07 1.42 1.62	0.29 0.128 0.146

CARGO HANDLING EQUIPMENT

Variable	**Aspect**	**N**	**Percentage**	**Mean**	**S.E**
Equipment use a source of accidents	Agree Disagree Do not know	185 8 13	89.8 3.9 6.3	1.52 2 1.77	0.058 0.0327 0.20
Nature of equipment related accidents	Fire Explosions Spillage Property damage	116 52 181 197	56.3 25.2 87.9 95.6		0.073 0.116 0.055 0.052
Poor maintenance causes accidents	Agree Disagree Do not know	200 5 1	97.1 2.4 0.5	1.17 1.2 1	0.0037 0.020 0
Old and obsolete equipment contributes	Agree	101	49	1.18	0.055
Exceeding safe working load contributes to accidents	Agree Strongly agree Not sure Disagree Strongly disagree	53 150 2 0 1	25.7 72.8 1 0 0.5	1.15 1.17 1 0 1	0.73 0.42 0 0 0
Operation of equipment by incompetent persons contribute to accidents	Agree Strongly agree Not sure Disagree Strongly disagree	62 143 0 0 1	30.1 69.4 0 0 0.5	1.19 1.15 0 0 1	0.72 0.041 0 0 0
Proper legislation can curb accident occurrence	Agree Disagree	178 28	86.4 13.6	1.11 1.5	0.33 0.15

Equipment replacement policy and standardized sourcing can prevent accidents	Agree Strongly agree Not sure Disagree Strongly disagree	102 77 18 7 2	49.5 37.4 8.7 3.4 1	1.13 1.16 1.22 1.71 1	0.048 0.059 0.152 0.184 0
Low funding to equipment care can lead to accidents	Agree Strongly agree Not sure Disagree Strongly disagree	72 98 28 6 2	35 47.6 13.6 2.9 1	1.07 1.19 1.21 1.67 1	0.041 0.057 0.107 0.33 0

Proper legislation can curb accident occurrence	Agree Disagree	178 28	86.4 13.6	1.11 1.5	0.33 0.15
Equipment replacement policy and standardized sourcing can prevent accidents	Agree Strongly agree Not sure Disagree Strongly disagree	102 77 18 7 2	49.5 37.4 8.7 3.4 1	1.13 1.16 1.22 1.71 1	0.048 0.059 0.152 0.184 0
Low funding to equipment care can lead to accidents	Agree Strongly agree Not sure Disagree Strongly disagree	72 98 28 6 2	35 47.6 13.6 2.9 1	1.07 1.19 1.21 1.67 1	0.041 0.057 0.107 0.33 0

TRAINING GAPS

Variable	Trait	Frequency (N)	Percentage (%)	Mean	SE
Accident occurrence	Fire Explosions Chemical spillage Container crane	158 103 189 200	76.7 50 91.7 97.1	1.65 1.26 1.17 1.71	0.067 0.032 0.13 0.26
Explosives and Flammable chemical NOT a risk	Agree Disagree Not sure	22 168 16	10.7 81.6 7.8	1.92 1.21 1.43	0.02 0.24 0.13
Training on accidents hazards	**Not trained** **Trained**	**110** 95	**53.9** 46.1	**1.27** 1.23	**0.29** 0.14
Duration	Less than 8hrs 1 day 1 week More than 1	62 30 18 1	30.1 14.6 8.7 0.5	1.20 1.24 1.32 1.91	.081 0.12 0.028 0.09
Facilitators	Internal External	81 29	85.3 14.7	1.67 1.09	0.12 0.09
Training Improved Accident hazard knowledge	Agree Strongly agree Do not know Disagree Strongly Disagree	**17** **19** **106** **37** **27**	8.3 9.2 51.5 18 13.1	1.32 1.45 1.48 1.39 1.09	0.12 0.09 0.98 0.08 0.12
knowledge gained on major accident hazards	Above average Average Poor	13 60 133	13.6 29.1 64.6	1.58 1.17 1.21	0.11 0.07 012
Ability to respond to hazard after training	**Prepared** **Not prepared**	36 170	17.5 82.5	1.15 1.22	0.29 0.33
Important to train the following	All staffs Contractors	199 167	96.6 81.1	1.19 1.52	0.23 0.12

RISK ASSESSMENT FRAMEWORK

Variable: Risk assessment	**Aspect**	**N**	**Percentage**	**Mean**	**S.E**
Frequency of conducting	None	157	76.2	1.57	0.54
	1-5	42	20.4	1.31	0.72
	More than 5	7	3.4	2	0.21
Control of accidents	Agree	113	54.9	3.33	0.66
Updating risk assessment	Monthly	89	42.2	3.01	0.91
	Every 6	84	40.8	3.27	0.0195
	months	27	13.1	3.42	0.35
Consideration when licensing contractors	Agree	110	53.4	1.53	0.62
	Strongly agree	90	43.7	1.56	0.07
	Not sure	6	2.9	1.33	0.21
To cover all Emergencies	Agree	121	58.7	1.45	0.59
	Strongly agree	73	35.4	1.52	0.65
	Not sure	12	5.8	2.33	0.22
Control of all contractor operations	Agree	**97**	47	3.17	0.18
	Disagree	**102**	49.5	3.15	0.176
	Not sure	**7**	3.5	3.67	0.577
Safe operation procedures	Agree	188	**91.3**	**1.47**	**0.42**
	Disagree	5	**2.4**	**1.20**	**0.20**
	Not sure	13	**6.3**	**2.54**	**0.243**
Permit to work prevents accidents	**Agree**	140	68	1.50	0.049
	Disagrees	14	6.8	1.29	0.125
	Not sure	52	25.2	1.67	0.116