

# A Shipyard Accidents Analysis in Egypt

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**Abstract:** Shipyards works are traditionally hazardous, with an injury-accident rate more than twice that of construction and general industry. The losses of accidents could reach to death or financial losses. Losses can be reduced if proper corrective actions be taken after analyzing. For this reason, this paper has been obtained to analyze these occupational accidents in Shipyard P in Egypt.

**Duration of Study:** Research data have been collected between 2012-2015 statistics of occupational accidents with Shipyard in Egypt, within this study, occupational accidents that occurred in the shipyard between those years are investigated for defining important data for every accident case. The statistical method has been followed during the study depends on collecting data of victim's and accident nature.

The study results Accident Frequency Rate (AFR) of 1.9, 2.6, 1.7, and 0.7 which show improved performance during the last two years due to applied additional control measures has been taken. The lost time injury cases LTI present 50% of accidents cause of road and traffic accident and most of this accident due to using motorcycles as a transportation facility. All fatalities happened due to a traffic accident on the road between the employees home and work place, and it was no fatality happened in the workplace. Workers in age group less than 20 years old had the highest number of days-away-from-work cases for all year. 48% of accident happened to illiterate workers, which has low knowledge and training. Workers in experiential group less than 5 years' experience had the highest number of days-away-from-work cases for all study year.

The study showing lots of actions taking which decrease the accident frequency rate also the study recommends additional control measures for improving results according with international safety standard.

**Keywords:** Shipyard Accidents.

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## 1. INTRODUCTION

There are several numbers of activities to be done in a shipyard to reach the final product which may be a ship or offshore platform. These activities include (welding, grinding, cutting, lifting operations, hydro test, blasting, painting, etc..)[1]

The manufacturing operations in shipyards are always lined with hazards which may cause accidents, the accidents are often the reason for not reaching the planned target, profits and huge losses. Accident abls to shut down the shipyard, it could cause the losses of the skilled and experienced workers which lead to stop Production.

Major reasons of these accidents are due to bad behaviors, inadequacy of trainings and improper use of personal protection equipment.

It has been agreed that records of all major and minor occupational accidents have-not been saved or recorded, reasons of these accidents have-not been analyzed, risk assessments haven't been done or not implemented, Precautions have-not been managed within a management system and accidents occurred due to these reasons. [2, 3, 4]

Reporting accidents and ill health at work is a legal requirement. The information enables the Health and Safety Executive (HSE) and local authorities (referred to as ‘the enforcing authorities’) to identify where and how risks arise and to investigate serious accidents. [5]

The purpose of this study is to analyze the data collected from a shipyard P in Egypt as a case study. The data have been collected between the years of 2012-2015. According to the study, the data of victim's includes information about education level, ages, experiences, injured parts of the body, severity of injuries and causes. Also a comparison to define the highest rate of accident, is given in the study. Statistical analysis is used to identify the frequency and severity of risks at work place. Statistical analyses will determine the decisions to be taken to avoid accidents recurrence in the future. The study explains the corrective actions taken in the shipyard P to improve records.

## 2. ACCIDENT ANALYSIS PROCEDURE

The analysis generally includes a number of steps or stages. Depending on the approach and purpose of the analysis, there might be some variations in the procedure. Figure 1 presents a general model of safety analysis procedure sequence, with six basic steps; the sequence starts with the planning stage of the analysis and ends with the reporting of results. [6]

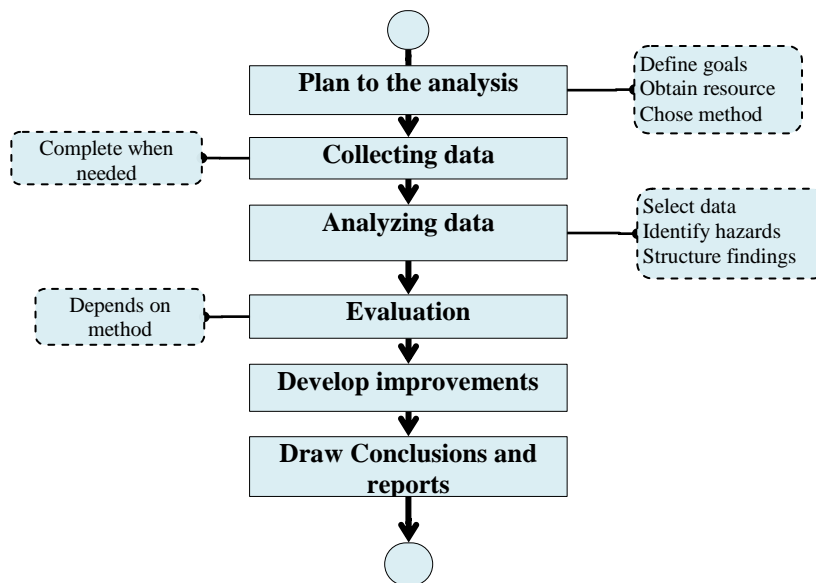


Figure 1 Basic steps in a safety analysis procedure

### 2.1. Plan for the analysis

**The first basic step is to plan the analysis.** The planning of an analysis involves defining the goals and scope of the analysis, choosing methodologies, the analysis allows to see what is currently happening and shows the present situation, benchmark or compare the result of the changes measures, planning to record the improvement due to this changes.

### 2.2. Collecting data

**The second step is to collect data** and Information about the shipyard to be analyzed is essential and performed at the beginning. The need for information is governed by the aim of the investigation. If an employee involved with an accident at a workplace. the cases recorded as an Injury or fatality according to.

- 1) Record more than 3 days of sick leave by a registered medical practitioner due to the injury.
- 2) Stay in a hospital more than 24 hours under observation or treatment; if the employee subsequently dies as a result of the injury, the employer of that employee should, notify the Commissioner of the death. [7]

The shipyard should establish, a written procedure in its health and safety management to identify, record, investigate and analyses all incidents, as well as the specific corrective actions to be taken to prevent recurrence. The procedures include the data which help to analyze every accident.

**2.3. Analyses**

The third step is to analyze the collected data, which usually contains several elements (ages, education level, experiences, injured parts of the body, severity of injuries and causes). It can concern the selection of data to meet the needs of a specific method. In most methods, there is an element called Identify hazards, for the finding of hazards and different kinds of problems. An analysis often involves a lot of information, and there is a need to organize and structure the findings.

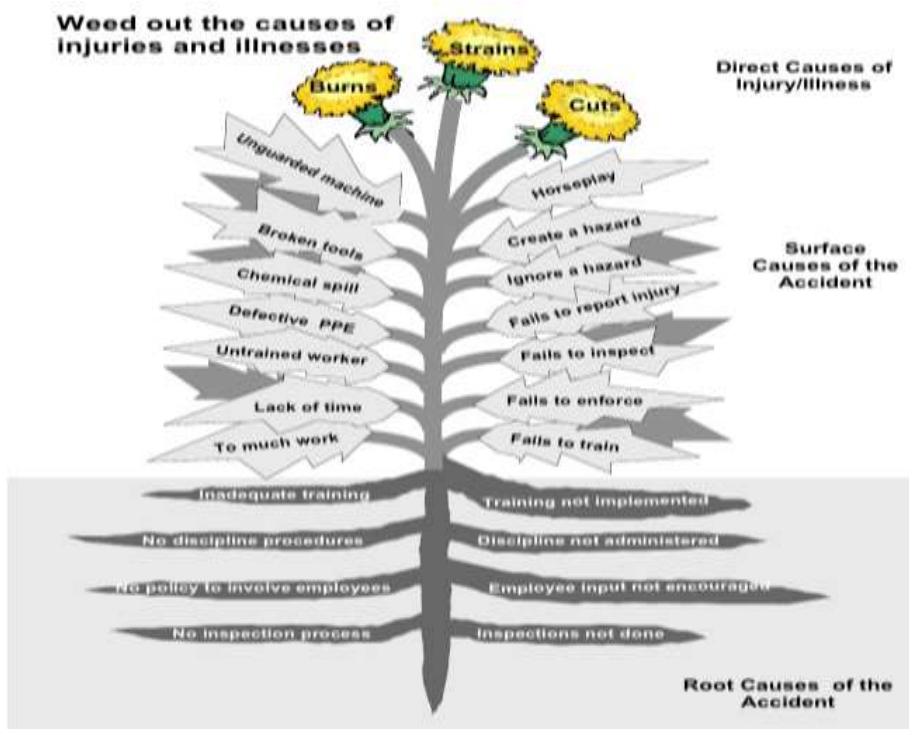
**2.3.1. Incidents investigation procedure**

The investigation procedure provides reports system to help identify and control the underlying or root causes of all incidents in order to prevent recurrence. The shipyard should establish good procedures for the investigation of incidents. The investigations of incidents, identify the unsafe conditions and unsafe acts, The investigation procedure must be approved through a safety management system.

Incident investigation procedures include the following information:

- Types of incidents to be investigated.
- Accurate reporting of incidents from responsible persons.
- Assign competent persons for the investigation.
- Establishment investigation procedures with form include certain information about every incident.
- Define direct causes, surface causes and root causes (figure 2) weed out the causes of injury and illness.
- Line managers, supervisors, safety personnel and safety committee members should be included in the incident investigation team.
- Implementation of recommendations and corrective action with follow up and target date.

Root Causes are the important result identifies underlying reasons why unsafe conditions exist or if a procedure or safe working instruction workplace was not implemented. Root causes generally reflect management, design, and planning, organizational or operational failings (e.g., a safety guard has not been installed; safety device of the equipment has been neglected by supervisors to ensure the speed of production). [8]



**Figure 2 Weed out the causes of injury and illness.**

### 2.3.2. Implementation and Review of Corrective Actions

- 1) The shipyard establishes a system to ensure that recommendations arising from the investigations and corrective actions are followed.
- 2) The shipyard prescribes short-term preventive actions by implementing corrective measures immediately to prevent recurrence of incidents.
- 3) The shipyard seeks to improve the overall safety management system with long term corrective actions.
- 4) The shipyard review corrective actions implement and their effectiveness in enhancing safety at the worksite.
- 5) The procedures established to ensure lessons learned from the incidents are communicated to all personnel in the shipyard.

### 2.4. Evaluation

**The fourth step is the evaluation;** the evaluation is intended to support decision-making about the risks and the need for improvements, and also to aid selection of the problems that need further attention. Such evaluation can take different forms (numbers, charts, trends, bars, pie and several types). The evaluation showing simple diagram and rates for comparing data and defined the highest and most important result clearly.

Incident statistical analysis rates have been standardized, so that any regulatory agencies can compare statistically significant data rates like OSHA and other regulatory agencies. [13]

Incident statistical analysis rates include but not limited:

#### 2.4.1. Accident Frequency Rate (AFR)

The accident frequency rate, which describes the number of people injured over a year for each million1 hours worked by a group of employees or workers.

Accident Frequency Rate (AFR) =

No. of Workplace Accidents Reported over a year x 1,000,000

No. of Man-hours Worked over a year

#### 2.4.2. Accident Severity Rate (ASR)

Accident severity rates describes the number of Days away from Work due accidents during every study year for each million1 hours worked.

Accident Severity Rate (ASR) = No. of Days away from work due Accidents x 1,000,000

No. of Man-hours Worked

#### 2.4.3. Shipyard P Workplace Injury Rate

Workplace injury rate: which describe the number of Fatal and Nonfatal Injuries over a number of Employed Persons for each hundred thousand persons.

Workplace Injury Rate = No. of Fatal and NonFatal Injuries x 100,000

No. of Employed Persons per year

[9, 10, 11, 12]

#### 2.4.4. Incident Agent and Types of incidents;

Incident Agent refers to the object causes the incident or physical environment of the incident, which due to its hazardous nature/condition, leads to the occurrence of a particular type of incident. It is related to the incident, not injury. [14]

Types of incidents refer to the type of event which resulted in the injury of a victim. Like lost time injury (LTI) or Fatality case, the incident type should be the one that triggered the chain of other incidents. [14]

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Work-related is supposed for injuries and illnesses happened due to events or exposures occurring in the workplace, See 29 CFR Part 1904.5(b) 15]

### 2.4.5. Causes of incidents

People involved in accidents as they walk around the hazard in the workplace, or when they come into contact with machines. It is therefore useful to understand the common causes of accidents, and the control measures which can be implemented to avoid them.

Slips, trips and falls record highest number causes of accidents in the workplace. However, there are many other hazardous activities present risks to health and safety like working at heights or excavations.

**The immediate cause incident** is the most apparent reason why a negative event happens, eg wire not isolated; the employee fall, etc. There may be numerous immediate causes identified in any one incident. [17, 18]

### 2.4.6. Human factors and behavioral considerations;

Personal factors can affect health and safety includes physical stature, age, experience, health, hearing, intelligence, communication skills, level of educations and qualifications. [20]

### 2.5. Develop system improvements

This fifth step may be included in safety analysis stages and may be not

For example OHSAS 18001 including statement of contentious improving and (ISO, 2009C) does not include the improvements stages.

The improvements step is beneficial to be included in many situations of analytic procedure

Improvements step helps analysis to provide better understanding of the system problems and risks.

### 2.6. Conclusions and reports

**The final basic step is to draw conclusions** on the basis of the previous stages and to report the results of the safety analysis. [6]

#### 2.6.1. Corrective and Preventive Actions

Investigation, Inspection, audit and safety walk through which done for an incident / accident, arising non-conformances items help to define corrective and preventive actions should be taken.

Corrective actions are actions taken to eliminate the root causes of accidents or incidens in order to stop repeating and prevent recurrence. This may include:

- Short term and long term actions;
- Evaluation of hazard identification and review risk assessment results;
- Implement changes to work procedures;
- Implementing or modifying control measures and additional mitigations.
- Use of appropriate information raised safety observation, audit report, employees' feedback, expert advice, lesson learned from incident etc.;
- Recognize problems and preventive action required through inspection, safety walk through. Observation card program, etc.
- Apply hazard identification tools in risk assessment such as checklists, job hazard analysis etc.;
- Start reviewing actions to ensure control measures are effective.
- Correctives and preventive measures should be assigned with owners for responsibility to ensure completion, follow up target date for closure to be evaluated. For the implementation of such actions.[7]

**3. CASE STUDY (SHIPYARD P SITE OVERVIEW)**

The shipyard of the study located in Alexandria – Egypt. The fabrication Area of the yard is 209,000 m<sup>2</sup>, Harbor Area 100,000 m<sup>2</sup> with Water Depth 5.5 meters at Mediterranean Sea.

The maximum work force is about 2500 manpower distributed over different activities in the yard. The yard containing 7 workshops, 4 warehouses, a clinic, a lot of heavy equipment’s, large open work areas, two tug boat... etc..)

The yard has good facilities and manpower to work as ship building yard and offshore platform structures fabricator, Products cover the full range of offshore platforms like Decks, jackets, piles, top side facilities, Tripods, Monopods, ...etc. in addition to deep water completion structures like PLEMs, PLETs, Jumpers, Spools, Manifolds, SDUs. SDAs...etc.

The construction work includes different activities like (welding, cutting, lifting, painting, blasting, radiation activities... etc..)

**3.1. Data collected during the study**

Research data have been collected between 2012-2015 statistics of occupational accidents in “Shipyard P”, Occupational accidents that occurred in the shipyard between those years are investigated for defining important data for every accident case.

Accidents and fatalities happened in Shipyard P showing Situations in which there is a need for a safety analysis. For example, there are situations where:

- Severe accidents have happened. See Table 1
- The production was affected and delayed due to losses in manpower.
- A planned change in technical equipment lead to deterioration in performance.
- An organizational change is planned.
- A safety problem has been detected and improvements are needed.

**Table 1 Accidents and fatality happened in “shipyard P” per years 2012 to 2015**

Years	2012	2013	2014	2015
Average number of workers per year	2300	1950	1700	1950
Hours worked per year	6716000	5694000	5848770	7084000
Total Accident (Traffic +work related + other)	32	28	26	26
Number of fatalities	0	2	2	0

**3.2. Shipyard P accident Frequency Rate (AFR)**

Accident Frequency Rate chart (AFR) in Figure 3 showing the accident frequency rate AFR during period of years from 2012 to 2015.

Frequency Rate (AFR) of 1.9, 2.6, 1.7, and 0.7 which show improved performance during the last two years due to application of additional control measures taken.

These results of analysis showing the safety performance of the activities during every year of this period, the AFR chart trend the efficiency of safety precaution taken during the period.

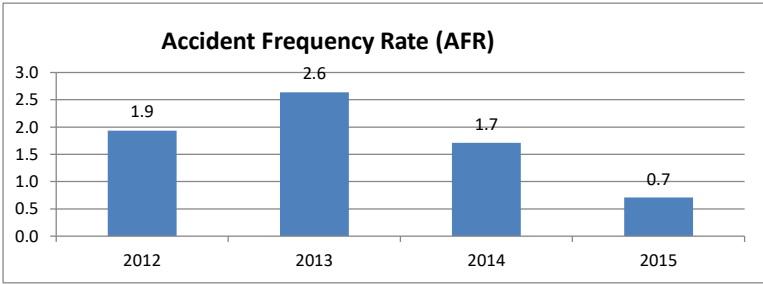


Figure 3 Accident Frequency Rate chart (AFR)

**3.3. Shipyard P Accident Severity Rate (ASR)**

Accident severity rates Figure 4 describes the number of Days away from Work due to accidents during every study years from 2012 to 2015 for each million hours worked.

Accident Severity Rate (ASR) of the study periods was 48.1, 116.4, 60.5, and 24.7

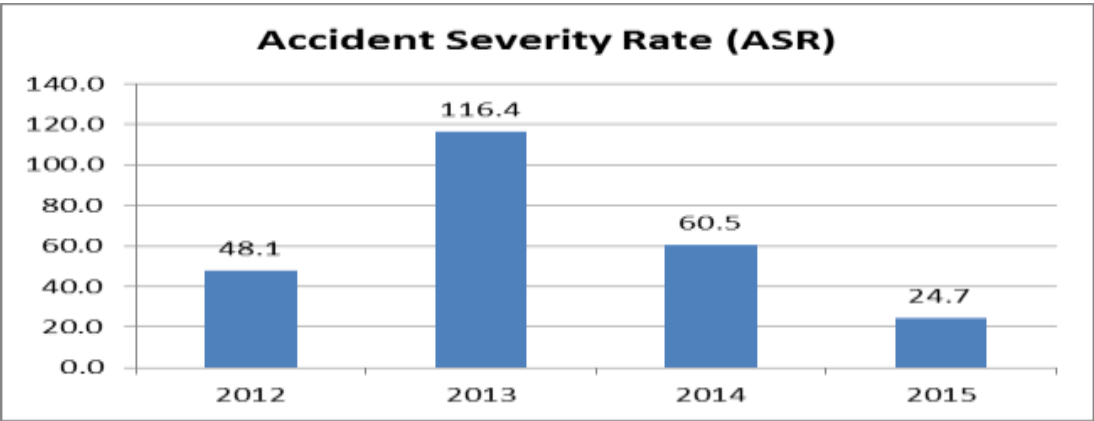


Figure 4 Accident severity rate chart (ASR)

**3.4. Shipyard P Workplace Injury Rate**

Workplace injury rate in Figure 5 describes the number of Fatal and Nonfatal Injuries over a number of Employed Persons for each hundred thousand persons during every study years from 2012 to 2015.

Workplace Injury Rate of the study periods was 565.2, 769.2, 588.2, and 256.4

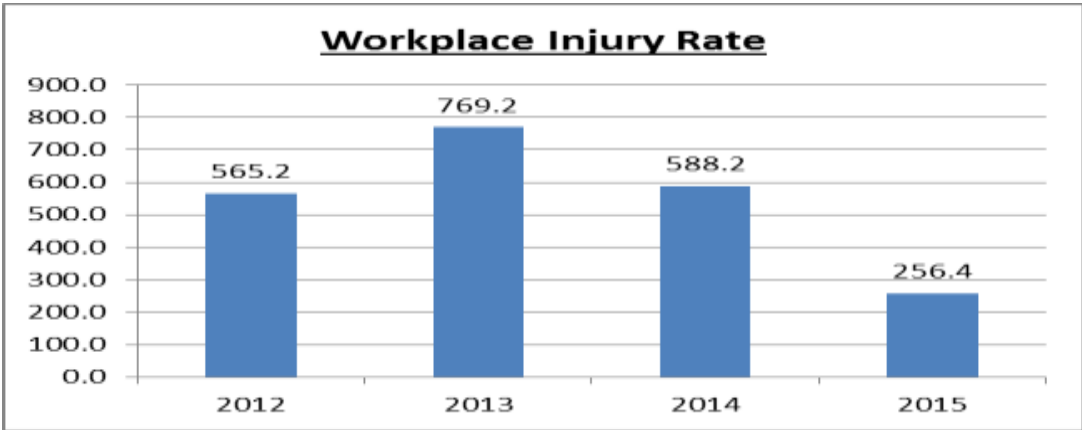
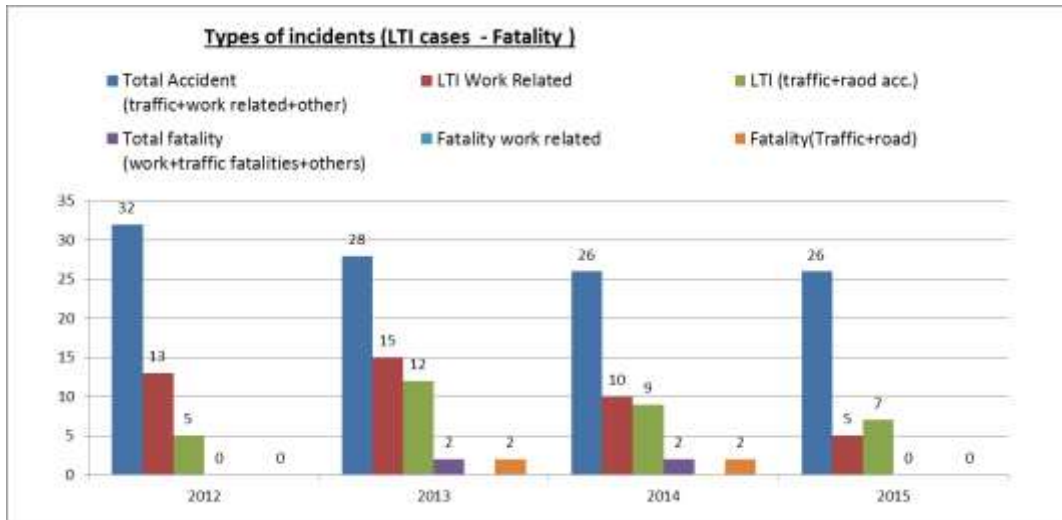


Figure 5 Workplace injury rate charts



**3.5. Incident Agent and Types of incidents**

Figure 6 showi Types of incidents (LTI cases - Fatality) how the total number of accidents during the study period, 2012 to 2015 including a total of fatality happened. the charts also showing lost time injury cases work related and non-work related cases.



**Figure 6 Type of incidents charts (LTI cases - Fatality)**

All fatalities have been recorded during this study case happened due to traffic accidents on the road between the employees home and work place, and it was no fatality happened in the workplace The investigation reports defined that fatality accidents happened by using the transportation facility specially personnel transportation facilities.

Analysis of the year 2013 as example record totally two fatal cases happened rezone of road accident not due to work related same as other years, 100% of fatal accidents were due to road accidents. The lost time injury cases LTI present 50% of accidents cause of road and traffic accident, most of this accident due to using motorcycles as a transportation facility.

**3.5.1. Corrective action for Incident Agent and Types of incidents**

The shipyard P starts to take positive action to prevent or decrease these accidents as follows:

1. Defensive driving training session for all drivers includes technical and theoretical skills by an approved trainer (at least 2000 training hours per month has been done).
2. Monthly safety stand down for all employee discussing accidents causes, corrective actions, precautions to prevent repeating and others.
3. Provide good quality transportation facilities.
4. Establish monthly vehicle inspection with expert auditors.
5. Prevent using of the motorcycle even for personal use.
6. Activate discipline action for traffic rules violation
7. Medical check for drivers, including drugs and alcohol medical tests to avoid driving under the influence of drugs or alcohol.
8. Rewarding scheme and bonus for best safety driver monthly.
9. Encourage employees and Passenger to take positive action against road violation using observation card and submit to the HSE department to take action.
10. Install GPS tracker device for monitoring and control vehicles.

The corrective actions were implemented by the end of 2014 and gave good results in 2015 and no fatality has been recorded also road accidents decrees as shown in figure 6



**3.6. Causes of incidents**

The immediate cause of accident analysis during the study period in shipyard P figure 7 shows that most of the accident distributed into 7 causes, the road and traffic accidents are the greatest percentage of accidents during all the studied years, most road accidents not related to the job title but it was the reason of bad behaviors in bad traffic condition while transportation to the shipyard.

The greatest percentage of accidents (44%) were happening during the year 2012, was due to violent cases at this period of the analysis only (Revolution in Egypt 25.1.2011) and did not repeat again in 2013, 2014 or 2015.

Trip, slip and fall record the second greatest accident, about 9% in 2012 – 18% in 2013 – 34%, 38% for 2014 and 2015, respectively.

**3.6.1. Prevent tripping, slip and fall incidents**

To prevent tripping, slip and fall incidents shipyard start to take preventive action in worksites by instructing the employee by the following: [18]

- Keep reporting of an accident or a near miss to HSE department with information to prevent accident reoccurrence.
- Take positive action to eliminate the hazard and remove immediately, like clean the spill or housekeeping.
- Observe and hazard at the ground and report it.
- Keep the workplace clean and tidy.
- Use proper Personal Protective Equipment, replace it if damaged or expired.
- Advice and tell colleges about any dangerous situations, or if someone doing something wrong effect his safety.

Fall object accident record values of 12%, 14%, 8% and 11% for the years of 2012, 2013, 2014 and 2015 , respectively, see figure 7

**3.6.2. Tips for Preventing Falling Object Injuries:**

1. Prevent tools falling by using tool lanyards.
2. Keep material and tools away from edges, and using working platform with toe board.
3. Avoid using unsealed pockets to keep things, like top shirt pockets to keep phones, pens, and tools.
4. Avoid handling objects over guardrails.
5. When working on an elevated surface secure the objects.
6. Ensure proper toe boards at work platform or scaffold.
7. Use personal protective equipment (PPE) especially helmet.
8. Use safety tape around fall or drop hazardous zone.
9. Use proper PPE and ensure validity and reliability (suitable for the job).
10. Manage and avoid Simultaneous Operations (SIMOPS) operations.[19]

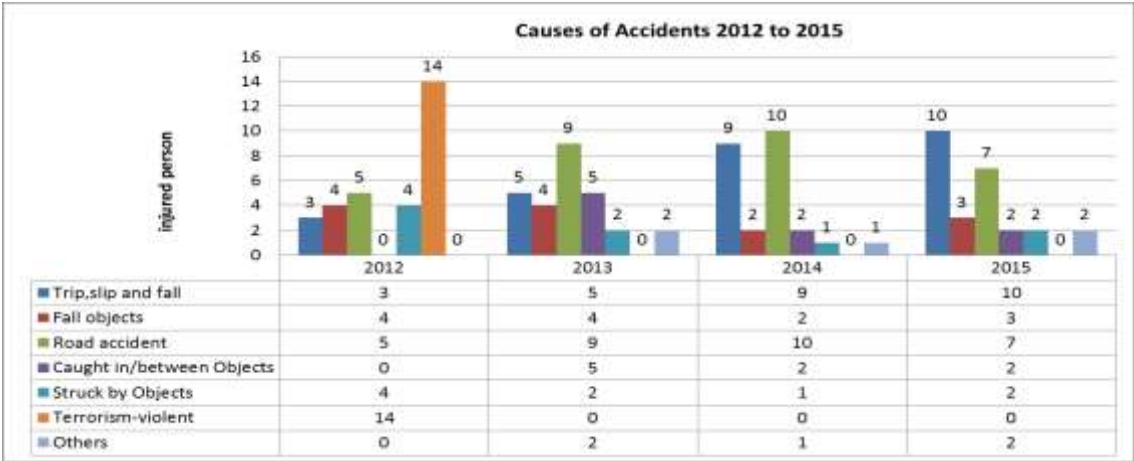


Figure 7 Immediate causes of accidents

**3.7. Human factors and behavioral considerations**

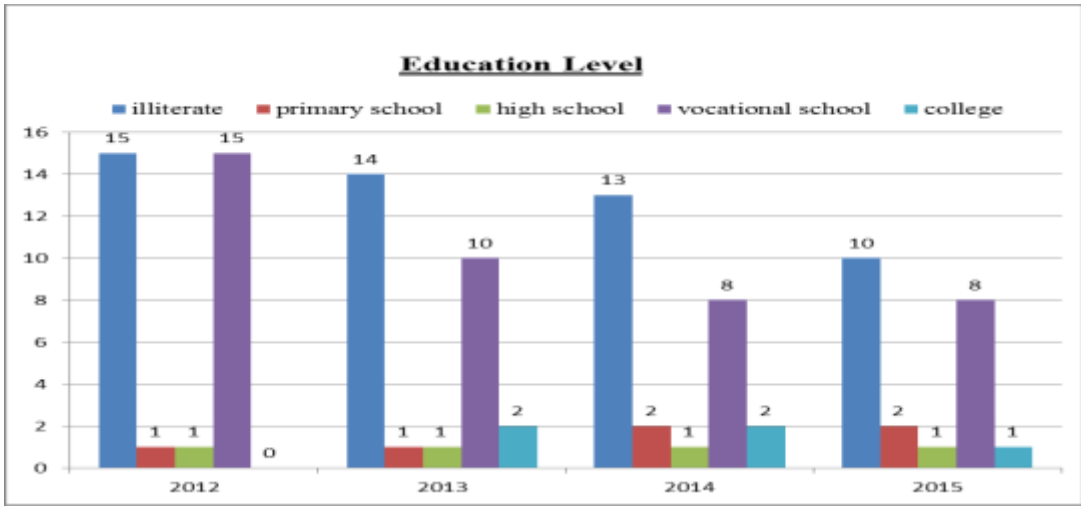
In shipyard P, workers differentiated into several titles. About 5% are engineers, 75% technical labors, 20% Supporting Functions. 50% of these resources are permanent employees, remaining labor divided between subcontractors, clients and third party companies in shipyard P. High amount of subcontractors reduces the possibility to implement health and safety issues at the workplace. Big amount of subcontractor acting as barriers of health and safety precautions to be applied.

The analysis below, Figure 8 Education level accident factor, showing the numbers of accident happened during the study period, 2012 to 2015, about 48% of accident happened to illiterate workers, which has low knowledge and training, even if they had a good experience (low educated level).

The second of the highest percentage education level was for vocational school education level this result due to involving this group with hazardous technical works, also due to big numbers of employments (multitude of this level)

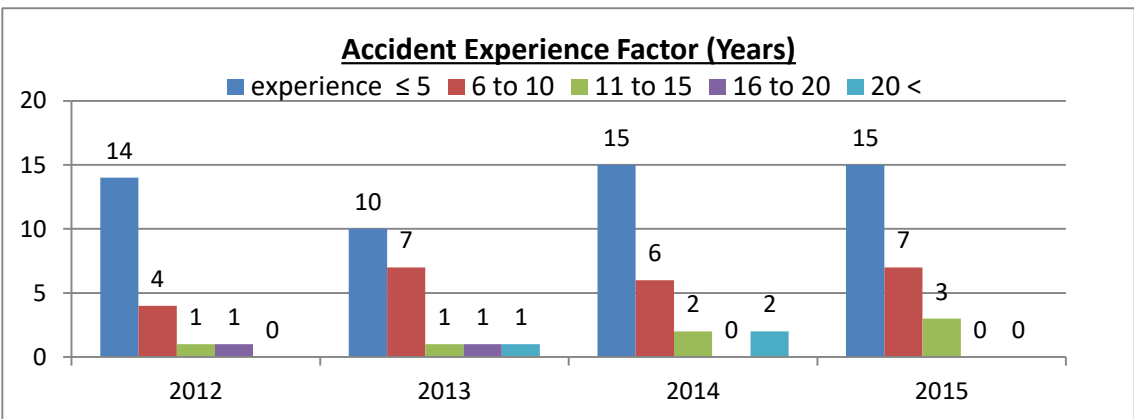
The lowest percentages in the chart for high school level and college educated level, this reflecting that good level of education always support knowledge, good perception of risk, good attitude to work.

To ensure training effectiveness, it needs to be provided in a manner that employees are able to understand. This means that the employer, in developing and providing training, needs to consider the educational levels, and language barriers of the employees. Training should also provide the opportunity to ask questions and receive answers about safety issues. [16]



**Figure 8 Education level accident cases factor**

Accident experience factor Figure 9 showing that workers in experiential group less than 5 years of experience had the highest number of days-away-from-work cases for all year 2012, 2013, 2014 and 2015.



**Figure 9 Accident experience factor**

During the years of 2002 /2003 in the UK, 21 fatalities recorded at workplace of young workers. Young workers mostly have a lack of experience and knowledge of risks in the worksite, willingness of young workers to work hard and peer group pressure increase the level of risk.

The age of anybody under 18 years old defined as a young person as noted in Management of Health and Safety at Work Regulations 1999. Which stipulates that a special risk assessment must be completed with specific key elements before the young person starts work.

More detailed guidance is available from HSE Books HSG165 concern young people at work .also detailed information in HSG 199 Managing health and safety on work experience. [20]

It is mandatory to ensure that young workers have understood the instruction and training provided to them. The training topics should include

- Hazards and risks in the workplace.
- Safety precautions to be followed.[21]

In shipyard P the study of Accident age factor has been analyzed, Figure 10 showing that workers in age group less than 20 years old had the highest number of days-away-from-work cases for all year 2012, 2013, 2014 and 2015.

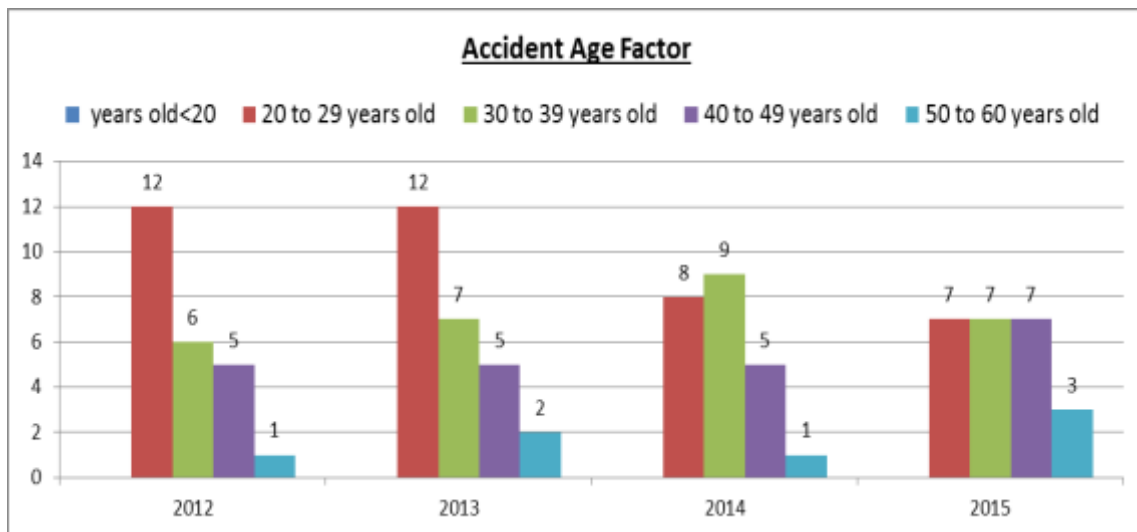


Figure 10 Accident Age factor

#### 4. CONCLUSION

1. Social & cultural characters (Language, level of education, health & safety culture and religious beliefs) can affect health and safety.

Personal factors can affect health and safety includes physical stature, age, experience, health, hearing, intelligence, communication skills, level of educations and qualifications. [20]

2. During the study periods 2012, 2013, 2014 and 2015 the result of analysis showing Accident Frequency Rate (AFR) of 1.9, 2.6, 1.7, and 0.7 which show improved performance during the last two years due to applied additional control measures taken.

Accident Severity Rate (ASR) of the study periods was 48.1, 116.4, 60.5, and 24.7

Workplace Injury Rate of the study periods was 565.2, 769.2, 588.2, and 256.4

Some of corrective action was taken to improve these results and succeeded

3. All fatalities happened due to a traffic accident on the road between the employees home and work place, and it was no fatality happened in the workplace

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4. The investigation defined that fatality accidents happened by using the personal transportation facility specially personnel transportation facilities.

Analysis of the year 2013 as example record totally two fatal cases happened cause of road accident not due to work related same as other years, 100% of fatal accidents were due to road accidents.

5. The lost time injury cases LTI present 50% of accidents cause of road and traffic accident and most of this accident due to using motorcycles as a transportation facility.

The shipyard starts to take positive action to prevent or decrease this potential accident.

6. The immediate cause of accidents figure 7 shows that most of accidents due to 7 causes, road and traffic accident are the greatest percentage of accidents during all the years, most road accidents was not related to the job title but it was the reason of bad traffic condition and behaves while transportation to the workplace using personnel facilities.
7. 44% of the accident was happened during 2012 due to violent cases at this period of the analysis only (Revolution in Egypt 25.1.2011) and did not repeat again in 2013, 2014 or 2015.
8. Trip, slip and fall record the second greatest accident, about 9% in 2012 – 18% in 2013 – 34%, 38% for 2014 and 2015
9. Accident age factor Figure 10 showing that workers in age group less than 20 years old had the highest number of days-away-from-work cases for all year 2012, 2013, 2014 and 2015.
10. Fall object accident record values of 12%, 14%, 8% and 11% for the years of 2012, 2013, 2014 and 2015 see figure 7
11. About 48% of accident happened to illiterate workers, which has low knowledge and training even better experience (low education level).

The second biggest percentage education level was for vocational school education level due to involving them with hazardous technical works and their big numbers of employments (multitude of this level)

The lowest percentages in the chart for high school level and college education level, this reflecting that good level of education always support knowledge, good perception of risk, good attitude to work.

12. Accident experience factor Figure 9 showing that workers in experiential group less than 5 years' experience had the highest number of days-away-from-work cases for all year 2012, 2013, 2014 and 2015.
13. Workers in age group less than 20 years old had the highest number of days-away-from-work cases during study year's period
14. Corrective actions have been taken to eliminate the root causes of accidents or incident in order to prevent recurrence improve the statistics and decrease the accidents..

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