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OCCUPATIONAL HEALTH AND SAFETY PRACTICES_ A CASE STUDY OF A CHEMICAL INDUSTRY

Muhammad Abubakar[1], Shazeen Irwa[2], Hafiz Muhammad Ali Hassan[3], Muhammad Waqas Dilawar[4], Muhammad Umair Chand[5]

[1]Ph.D. Scholar, College of Earth and Environmental Science, University of the Punjab, Lahore
[2]College of Earth and Environmental Science, University of the Punjab, Lahore, Pakistan
[3]HSE Training Manager at TUV Rheinland, Kingdom of Saudi Arabia
[4]Ali Safety Certifications International, Lahore, Pakistan
[5]Institute of Administrative Sciences, University of the Punjab, Lahore, Pakistan

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Corresponding Author:
Muhammad Abubakar,
Ph.D Scholar, College of Earth and Environmental Science, University of the Punjab, Lahore
muhammadabubakar704@gmail.com

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ABSTRACT

Background and Objective: The research critically examines XYZ chemical industry's OHS management, emphasizing EHRA challenges and non-compliance factors. Objectives include evaluating health and safety systems, identifying/mitigating risk factors, and suggesting measures. The aim is to assess working conditions, ensure compliance, and recommend steps for eliminating health hazards.

Methodology: The methods used to carry out the study at XYZ chemical industry, Lahore are: 1) Interview/questionnaires, 2) Meetings, 3) Gap analysis, 4) Desk study, 5) Self-observation / walk through surveys, 6) Hazard identification / risk assessment.

Result:

Conclusion: Area in-charges provided input on identified risks' severity and probability, followed by assigning ratings. High-risk areas (Production, Storage, Maintenance, Drum House, Quality Assurance labs) with ratings beyond 6 are deemed unacceptable, prompting proposed control actions for severity reduction

1. INTRODUCTION

Occupational health and safety (OHS) management system can be a systematic approach towards the health and safety system of any organization for the identification and management of risks. Occupational health and safety are a science of evaluation, recognition, anticipation and control of hazards that arises from the working environment and can have impacts on staff and workers working in that environment. Occupational health basic aim is the assurance, promotion and maintenance of the highest degree of physical, mental and safety conditions of the workers. Occupational health and safety are a basic concern for all businesses [3]. It provides a safe healthy environment and can have many benefits e.g. decrease of illness and injury; provides a greater public awareness; decrease of absenteeism; reduced costs; increased productivity. Health and safety are the basic responsibility of everybody from top management to workers on the factory floor. OHS provides protection and safety from workplace hazards like fumes, noise, heat, dust, stress etc. In other words, OHS emphasizes on the social, physical and mental well-being of the worker [1].

Modern world foundation is based upon the global chemical industry. 70,000 products can be produced from the raw materials and can be used not only for industry but people also get benefit from these chemicals in their daily life. Besides this, chemical sector also plays an important role in pharmaceuticals, agriculture, detergents, textile, environment, power, transport, housing, paper & leather etc. In modern and dynamic world, chemical sector plays a central role. On the basis of its importance, chemical industry is ranked ninth (murmann,2002) out of seventy-seven in industrial sector. In 2002, statistics shows that global chemical industry stood around 1.78 trillion U.S dollars worldwide while, in 2016, it is 5.2 trillion dollars [2]. The United Nations organizations proclaimed 2011 as 'the international year of chemistry' to show the importance of chemicals. Safe handling of chemicals is risky and cumbersome at any stage. Industries are now emphasizing on safety of chemicals to avoid any accidents and also focusing on misuse of chemicals deliberately.

In Pakistan, chemical sector is a major part of large-scale manufacturing (LSM). In Pakistan, industry basically is classified into two sectors and it is classified on the basis of HS code categorized by the state bank of Pakistan (SBP).

- Primary sector chemical industry
- Secondary sector chemical industry

Primary sector industries are capital intensive industries and are at large scale and are highly sophisticated and comprises of refineries, TX, natural gas, petrochemicals, metallurgy, agriculture, petroleum refinery and mineral based industries. The conversion of natural resources into primary products is included in primary sector chemical industry. They also serve as supplier feed stocks to the secondary chemical industry. Secondary chemical industry use products which are derived from primary sector and is based on high, medium or less advanced technologies. With the emerging trends in technology and progress in the field of chemical

manufacturing, besides the benefits and uses we get from chemicals, there is also a risk of hazards that damages and have strong impact on the society. It is essential to analyze the impacts of risks associated with the manufacturing of chemicals [4].

A case study was therefore, conducted at XYZ industry to access the risks identified in a chemical industry. This study was conducted to identify and evaluate the occupational health and safety issues of a chemical industry. Attempts have been made to identify and evaluate work related hazards and risks, which originate from production processes and techniques. XYZ industry is a major industry that is involved in the manufacturing and marketing of the chemicals nationwide. It has been operating since October,1994. As the proposed case study was carried out in a leading chemical industry of Pakistan who are producer for the chemical and leather article industry. They are not in business just to supply, manufacture or even to devise new chemicals. They are in business to create advantages for their customers. Their goal is to create competitive advantage for customers' business by providing new and better solutions, products and services. Company holds IMS certifications (ISO 9001:2015, ISO 14001:2015, OHSAS 18001:2007) as well. XYZ industry has its own Health, Safety and Environmental (HSE)policy. It is a shared and control document and is endorsed by the manager of HSE department. Policy is based on the commitment that "safety, health and environment protection is our first priority". Their Aim is to manage all the OH&S hazards and environmental issues associated with their operations, activities and services and to minimize their impact on work place safety and natural environment. The motto of policy is "no accident, no harm to people and no damage to environment".

Chemical industry of Pakistan is facing several challenges, main concerns are regarding safety and security. The basic legislations *(Supplementary Appendix 01; table 01)* dealing with the overall OHS related issues in Pakistan include factories Act 1934's chapter 3 some more regulations dealing with OHS are as follows:

- Hazardous occupations rules, 1963
- Punjab factories rules, 1978
- Mines Act, 1923
- Workmen compensation at, 1923
- Dock laborer's Act, 1934
- Provincial employee's social security ordinance, 1965
- Boilers and pressure vessels ordinance, 2002
- the fatal accidents Act, 1855
- International labor organization (ILO)

Aims and Objectives

The main purpose is to critically observe the OHS management system of the XYZ chemical industry. The main focus of this study was on assessing the current scenario of EHRA and challenges they faced, to know the main factors that are acting behind non-compliance of regulations and to give them mitigation measures.

Main objectives to conduct this study are:

- To evaluate health and safety system
- To identify and evaluate the risk factors that are affecting working conditions and suggested mitigated

measures for improving health, safety conditions.

- Based on their impact or criticality, prioritize the risks, threats and known vulnerabilities and then suggest suitable measures for them.

The main objective behind the research work and visit of workplace was to observe whether the conditions of the working environment of the XYZ industry is meeting different standards or not and also to recommend any possible steps to eliminate the health hazards and the risks associated with the environment.

2. METHODOLOGY

The methods used to carry out the study at XYZ chemical industry, Lahore are:

1. Interview/questionnaires
2. Meetings
3. Gap analysis
4. Desk study
5. Self-observation / walk through surveys
6. Hazard identification / risk assessment

2.1 Questionnaires/ interview

Health and safety conditions in the industry were confirmed by the interviews of the workers and operators. Questionnaire was designed for the workers for this purpose which was filled by different workers of different shifts. Interviews has been conducted to different area in charges and heads to take and analyze the data in this study group interview was conducted from production manager, maintenance manager, Ware house manager, Admin Manager to check out the ongoing major risks in their relevant areas as well as their approach towards latest methodology towards risk management. The worker's questionnaire is attached as *(Supplementary Appendix 01; Fig 2.1)*

2.2 Meetings

During the visit to XYZ chemical industry Lahore, meetings with HSE managers were conducted in order to check the current situation of HSE conditions at industry. Discussion was mainly on health & safety of the workers, fire safety systems, manual handling, fire control, accident reporting, investigation, solid waste management and environmental impacts.

2.3 Gap analysis

The present parts of the system were checked by Gap analysis i.e. current status of HSE was evaluated by checking the existing policies, processes, procedures, roles, record keeping and training processes. These evaluations are commonly referred as "gap analysis".

2.4 Desk study

It involves the review of the relevant literature and detail study of the present OSHE conditions of XYZ chemical industry.

2.5 Self-observations / walk through surveys

A survey was conducted to get through the norms, daily routine, processes that were carried out there. During the survey and self-observations, HSE inspections checklist were carried out for each section of the industry to check either working conditions

of industry are according to health and safety regulations.

2.6 Hazard identification/ risk assessment

The activity employed a descriptive study approach in scrutinizing Occupational Health and Safety management practices in XYZ industry Lahore. The study included OSH Risk Assessment survey and OSH program implementation survey. To achieve the ultimate goal, the study was divided into certain objectives i.e the study was divided into three components. The primary component was of Literature review of the study and the requirements and guidelines. The secondary part was of collecting the data related to the study. The tertiary component was analysis of the data obtained on the basis of standards and guidelines and then performing gap analysis and then giving recommendations as mitigation measures.

2.7 Location of the Study

The exercise was conducted at the XYZ chemical Industry Lahore. The industry has almost 13 sections laboring a high number of employees. The sampling sites are located in the production area of the industry. Sample contained 850 employees.

2.8 Study Population

The study was conducted on

- Workers (sweeper and helpers)
- Supervisors
- Visitors
- Staff Members
- Managers

2.9 Procedure:

The very first step of the procedure is hazard identification in which all of the potential risk and hazards should be identified and characterization should be done. Next step is to calculate the risk and this is done by multiplying frequency and severity and then the risk is categorized into severity levels. In the last step of procedure, the risk calculated from the risk matrix of all component sections is taken and an average is being calculated which is being employed in results.

2.9.1 Risk Matrix

Risk matrix provide a measurement standard to measure the risk. The relevant data tables including Table 2.9.1(b) , while constructing the matrix is provided in *(supplementary Appendix 02)*

Table 2.9.1 (a): Risk Matrix

3. DATA ANALYSIS AND FINDINGS

3.1 Units of the industry

There were several core departments from which analysis were done to identify the health and safety hazards as well as aspect impact environmental analysis. Following are those departments,

1. Maintenance
2. Storage House
3. Drum House
4. Production
5. QA Lab
6. Admin

3.2 Stage – 01 (Health & Safety Risk identification)

Following hazards were identified relating to health and safety of the employee during the relevant department visit. Severity and probability ratings were given after taking justifications and comments from the relevant departmental in charges.

3.2.1 Maintenance

Table 3.2.1 (Maintenance HEALTH & SAFETY hazards)

3.2.2. Storage houses

Table 3.2.2 (Storage safety hazards)

3.2.3 Drum house

Table 3.2.3 (Drum house safety hazards)

Severity → Likelihood ↓	**Negligible 1**	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
Rarer	1	2	3	4	5
Unlikely	2	4	6	8	10
Possible	3s	6	9	12	15
Likely	4	8	12	16	20
Frequent	5	10	15	20	25

3.2.4 Production house

Table 3.2.4 (Production safety hazards)

3.2.5 Quality assurance lab

Table 3.2.5 (QA safety hazards)

3.2.6 Administration department Health & safety hazard identification

Table 3.2.6(Administration department)

Table 3.2.1 (Maintenance HEALTH & SAFETY hazards)

No.	Hazard Object	Hazard	Description	Severity	Probability
1	Generators	Noise hazard	Noise of more than 85db is being produced by the generators	3	3
		Electric Shock	In case of lose electrical wiring, electric shock can be produced	3	
		Fire hazard	Short circuit due to lose wiring may cause fire hazard	3	2
		Falling hazard	During repair work at generators, person may fall at a height of more than 10 ft.	2	1
2	Electric Panel	Fire Hazard	Due to short circuit in case of rise in temperature, fire hazard may originate	3	1
3	Welding Plant	Electric Shock	Electric shock may be taken by the employee due to loose wiring	3	2
		Eye hazard	Eye can be damaged during welding operation	3	1
5	Lath Machine	Moving Machinery	Loose cloths may get trapped in the machine during its operation	2	1
4	Grinder	Face and eye hazard	Face and eye can get damaged during grinder operation if not working safely	3	1

Table 3.2.2 (Storage safety hazards)

No.	Hazard Object	Hazard	Description	Severity	Probability
1	Chemical Bags and cans placed in racks of 20 ft. height	Fall hazard	Chemical bags may fall due to Improper placement	3	3
2		Physical hazard	Chemical contact with skin may cause skin burn and other physical injury	3	2
3		Fire hazard	Electric short circuits can cause fire hazard in WHs	3	1
4		Tripping hazard	Improper placement of pallets can cause tripping hazard	2	2
5		Heat & Temperature	With the increasing temperature of the WHs due to atmospheric temp can cause fire hazard in chemicals at certain temp	3	1

6		Slip Hazard	Leakages in the cans of liquid chemicals on the floor can cause slip hazard	2	3
7		Impact and acceleration	Due over speed of fork lifters	2	1

Table 3.2.3 (Drum house safety hazards)

No.	Hazard Object	Hazard	Description	Severity	Probability
1	Drum loading and stacking	Fall hazard	Manual loading of drums in the truck may result in fall hazard	3	2
2		Slip/trip	Inappropriate method of drum handling may leads to slip/trip hazard	3	2
3		Spillage	Residual liquid may be spilled from the drum if not washed properly	2	2

Table 3.2.4 (Production safety hazards)

No.	Hazard Object	Hazard	Description	Severity	Probability
Chrome Plant					
1	MT platform	Fall hazard	While working carelessly at platform of 10 ft. height, person may fall	3	1
2	Moving machinery	Physical hazard	Wearing loose cloths may entrap in moving parts of machinery	3	1
3	Loose wiring	Fire hazard	Due to loose wiring short circuit can happen, hence fire may initiate	3	1
4	Chemical Splashing	Physical damage	Chemical splashing during mixing operation may damage eye, skin etc.	3	2
5	Chemical spillage	Slip/Trip hazard	Chemical was spilled on the floor due to which slip/ trip hazard initiate	2	2
6	SO2 blower	Suffocation	In case of ineffective blower operation, suffocation hazard may initiate	3	1
7	Electric objects	Electric shock	Loose wiring of electric machinery can cause electric shock	3	1

8	HT Furnace	Skin burn	High temperature of the furnace can cause skin burn when someone gets in touch with its walls	2	1
9	Spray Dryer	Dust allergy	During spray drying, powder production can leads into dust allergy	2	2
Syntan Plant					
1	Moving machinery	Physical hazard	Wearing loose cloths may entrap in moving parts of machinery	3	1
2	Loose wiring	Fire hazard	Due to loose wiring short circuit can happen, hence fire may initiate	3	2
3	Electric objects	Electric shock	Loose wiring of electric machinery can cause electric shock	3	1
4	Confined space	Suffocation	During maintenance of reactor person may have some injury or suffocation	2	2
5	Chemical spillage	Slip/Trip hazard	Chemical was spilled on the floor due to which slip/ trip hazard initiate	2	2
6	Volatile chemicals	Pungent smell	During evaporation of volatile toxic chemicals, lungs and asthma hazard may arise in case of long exposure	3	2
Polymer, P1, P2, P3 Plants					
1	Moving machinery	Physical hazard	Wearing loose cloths may entrap in moving parts of machinery	3	1
2	Loose wiring	Fire hazard	Due to lose wiring short circuit can happen, hence fire may initiate	3	1
3	Electric objects	Electric shock	Loose wiring of electric machinery can cause electric shock	3	2
4	Confined space	Suffocation	During maintenance of reactor person may have some injury or suffocation	2	2
5	Chemical spillage	Slip/Trip hazard	Chemical was spilled on the floor due to which slip/ trip hazard initiate	2	2
6	Volatile chemicals	Pungent smell	During evaporation of volatile toxic chemicals, lungs and asthma hazard may arise in case of long exposure	3	2
7	Spray Dryer	Dust allergy	During spray drying, powder production can leads into dust allergy	2	2
Boiler Room					
1	Loose wiring	Fire hazard	Due to loose wiring short circuit can happen, hence fire may initiate	3	1
2	Pressure Vessel	Explosion	Uncontrollable high pressure may leads to boiler explosion	3	1

3	Hot Surface	Physical hazard	Hot surface may cause heat burn from steam header and etc.,	3	2
4	Spillage	Slip/Trip hazard	water was spilled on the floor due to which slip/ trip hazard initiate	2	2

Table 3.2.5 (QA safety hazards)

No.	Hazard Object	Hazard	Description	Severity	Probability
1	Loose wiring	Fire hazard	Due to loose wiring short circuit can happen, hence fire may initiate	3	1
2	Electric objects	Electric shock	Loose wiring of electric equipment can cause electric shock	3	1
3	Toxic chemical nature	Physical hazard	In case of body contact with these chemicals can cause physical damage to body	2	1
4	Glass equipment	Cuts and bruises	In case of improper handling of glass equipment, it can cause cut hazard to body	3	2
5	Spillage	Slip/trip hazard	In case of slippery surface due to chemicals spillage, slip hazard can arise	2	2
6	Dye Mixer	Noise pollution	Heavy sound is being produced during plant operation specially at chrome i.e. 90 dB	3	3

Table 3.2.6 (Admin safety hazards)

No.	Hazard Object	Hazard	Description	Severity	Probability
1	Kitchen wiring	Fire/ shock hazard	Due to loose wiring short circuit can happen, hence fire as well as electric shock may happen	3	1
2	Kitchen staff	Health hazard	Inappropriate health of kitchen staff can pose hygienic hazard in the foods	3	2
3	Ammunition	Life hazard	If non licensed ammunition is given to untrained security staff then it can be dangerous for the life of others	3	1

4. RESULT AND DISCUSSION

Stage # 02 (Risk Calculation)

After identifying the risks relating to health, safety and environment in several core departments of the company, intensity of the risk that is risk index was calculated after discussion and taking the reviews of the area in charges regarding those risks through interviews. Risk index was calculated by the standard formula of risk evaluation that is the multiplication of probability of occurrence and severity of the consequences of the identified risk.

Risk index = Probability * Severity

Assumption: Risk index that is greater than 6 would be considered as high risk. Following are the risk evaluation of core departments of the company.

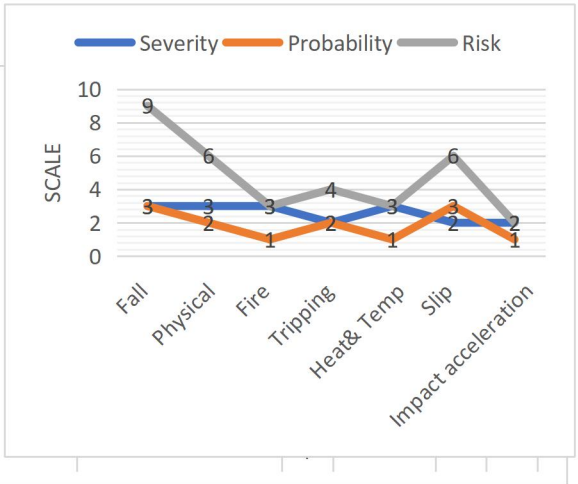
Based upon the hazards that were identified in the identification stage, risk index is calculated by using severity and probability of their occurrence by taking comments regarding those risks in interviews of their area in charges.

4.1 Maintenance H&S risk evaluation:

Interpretation of the risk:

After analyzing the risk in different areas of the maintenance department with respect to health and safety, following is the risk trend of the MNT department (Graph 4.1)

Graph 4.1 MNT safety risk



4.2 Storage houses H&S risk evaluation:

Graph 4.2 Storage safety risk

Significant high risk is falling hazard of the chemical bags placed at racks > 6

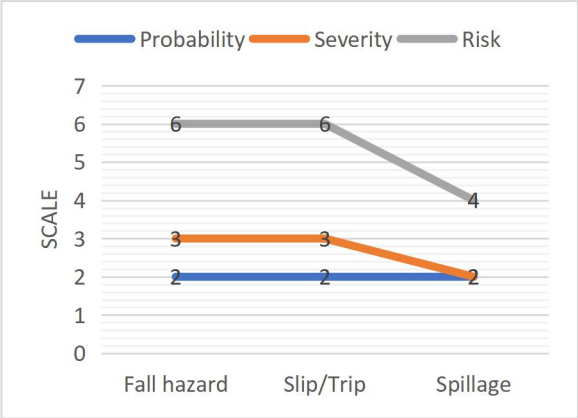
4.3 Drum house evaluation

Interpretation of the risk:

After analyzing the risk in different areas of the drum house department with respect to health and safety, following is the risk trend of the drum house department, as significant risks are those that are above risk index of 6.

Graph 4.3 drum house safety risks

Significant high risk are slip/trip and fall hazard during loading of drums on the track=6



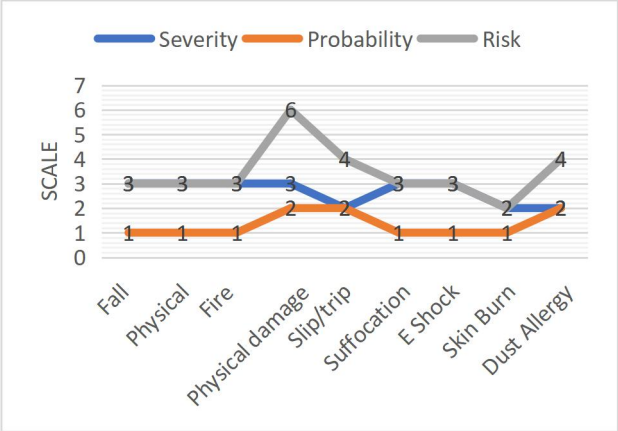
4.4 Production

4.4.1 Interpretation of the risk index

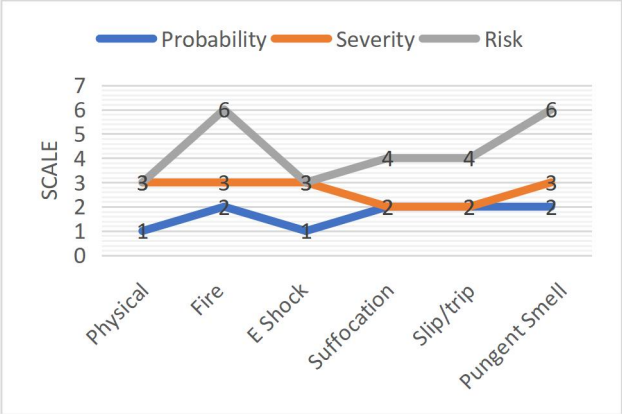
Chrome plant

Graph 4.4.1 Chrome safety risk

Significant high risk is physical damage due to splashing of chemicals during mixing operation=6



Syntan plant:



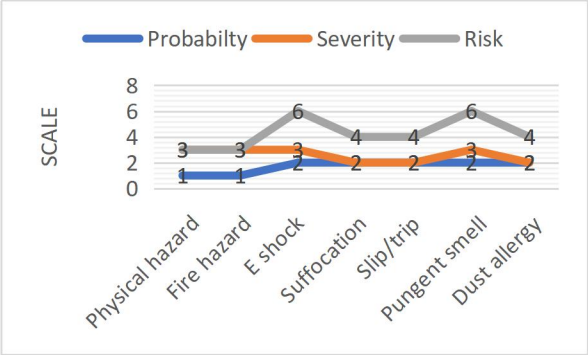
Graph 4.4.2 syntan safety risks

Significant high risk is fire risk due to loose wiring at the plant electric panel=6

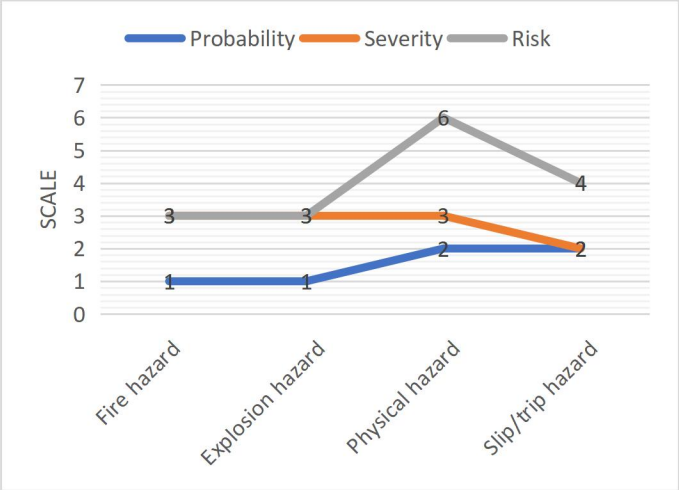
Polymer plant:

Graph 4.4.3 Polymer safety risk

Significant high risk is electric shock due to non-insulated wiring at the plant electric



panel=6



Boiler room:

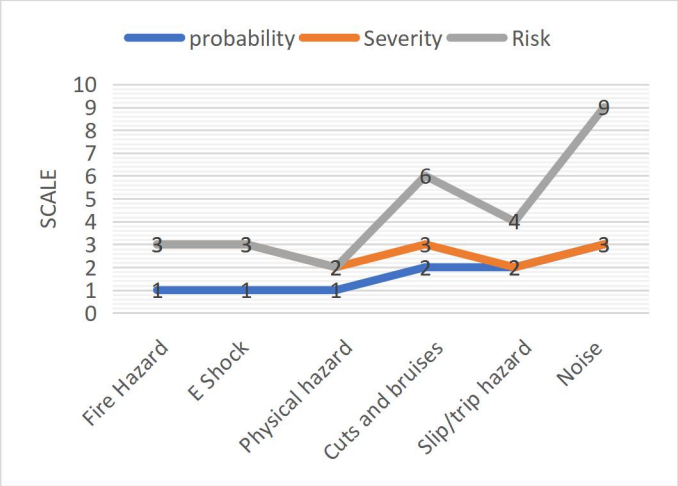
Graph 4.4.4 Boiler safety risk

Significant high risk is the chances of contact with hot surface of boiler=6

4.5 Quality assurance lab

Graph 4.5 QA safety risk

Significant high risks in usage of glass equipment=6



4.6 Administration department

4.6.1 Health & safety risk evaluation:

Based upon the hazards that were identified in the identification stage, risk index is calculated by using severity and probability of their occurrence by taking comments

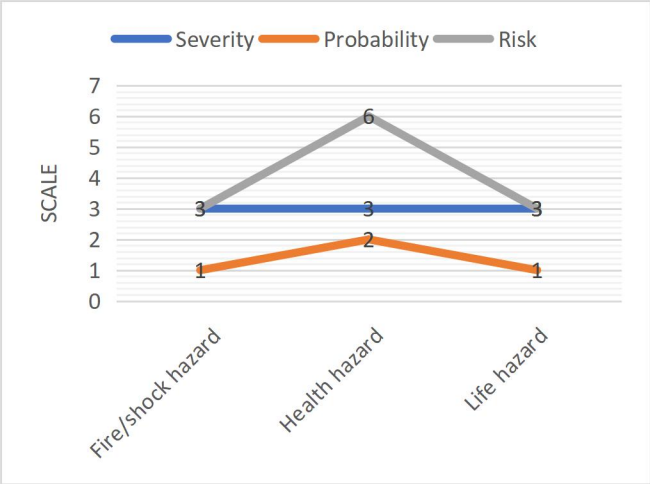
regarding those risks in interviews of their area in charges.

Table 4.6(Admin safety risk evaluation)

Interpretation of the risk:

After analyzing the risk in different areas of the admin department with respect to health and safety, following is the risk trend of the admin department, as significant risks are those that are above risk index of 6.

Graph 4.6 Admin safety risk



Stage # 03

Risk mitigation

This stage includes results of the risks identified in various core departments of the company as well as their impact on health, safety and environment of the company stakeholders by using traditional model of risk evaluation. Results of the high and low impact risks are elaborated here and control actions are also suggested here to reduce the severity of their bad impact.

Maintenance H&S risks

After assessing the severe impacts of the identified risks involved in the maintenance department following is the categorization of the risks,

High Risk > 6	Low Risk< 6
Generator	Generator
Noise Hazard	Electric Shock
Fire Hazard	Fall Hazard
Welding Operation	Electric Panel
Electric Shock	Fire Hazard
	Welding Operation
	Eye Hazard
	Grinder Operation
	Face and Eye damage
	Lath Machine
	Physical Hazard

Control Suggestions

After discussing and taking the reviews about the severity and then actions to be taken to avoid above mentioned risks, following suggestions were been given to control their severe impact

High risks

Generators are producing extensive high frequency sound (90db) when they are in operation, so the people working near generator room should use ear plugs of ear muffs to reduce its severe impact on their ears [5]. There is a risk of fire hazard when generators are in operation due to loose wiring as well as increase in temperature due to excessive run up. So to reduce the impact of this risk electrical; wiring should be made insulated as well as smoke detectors should be installed there for rapid indication of abnormality. Loose wiring of welding plant can give electric shock to the operators, so insulated wiring should be use as well as plant should be made earthed before start up as well as use of welding PPEs should be ensured [6].

Low risks

Loose wiring of generators can impart electric shock to the operators, so wiring should be made insulated for the generators. During maintenance operation for the generators, workers have to climb up on them at a height of more than 10 ft. so to avoid fall risk always ensure the provision of safety harness before climbing. Fire may get initiated at the electric panel due to increase in temperature during excessive usage as well as due to short circuit of the loose wirings, so to minimize the impact of this risk Ac should be installed in the panel room to maintain the temperature as well as should ensure proper insulated wirings. During welding operation flames of oxyacetylene can damage the eyes of the operator if he doesn't use face shield or welding shield for the protection, so always ensure the usage of required PPEs during welding operation [7]. During grinding operation workers make them open for some physical risks like eye and face injury, so always ensure the provision of required PPEs before and during operation of grinding. There are usually some moving parts of the lath machine working at a time which can be dangerous if operators wear loose cloths that can be struck in machine and can cause severe physical damage, so don't use loose clothing while working at lath machine [8].

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Storage houses H&S risks

After assessing the severe impacts of the identified risks involved in the storage houses, following is the categorization of the risks,

High Risk > 6	Low Risk< 6
Placement of chemical bags at racks	Placement of chemical bags at racks
Fall Hazard	Fire Hazard
Physical Damage	Tripping Hazard
Slip Hazard	Heat & Temperature
	Impact and acceleration

High risks

Improper placement of chemical bags at racks may fall on someone that is the major risk involved in warehouses. So to avoid this risk proper placement of pallets should be ensured. Due to volatility of the liquid chemicals as well as dust of the powder chemicals can damage the physical parts of the body [10], if it is not managed properly. Exhaust system should be effective as well as dust masks should be used during working. Due to the spillage of the liquid chemicals slip hazard will originate it is not controlled. Leakages should be controlled as preventive action. Some adsorbent material like sand or spill kit should be used immediately to avoid spill damage.

Low risks

Due to improper wiring in the warehouses short circuit can result in to fire hazard, as well as due to spillage of the flammable liquids fire may originate. Proper insulation of the electrical wiring should be ensured as well as control of spill and best spill management practices. Due to random placement of the pallets of the chemicals can originate tripping hazard, fork lifters can

struck with them resulting in tripping hazard. Pallets should be placed in a symmetrical way to avoid this hazard. Due to improper ventilation system temperature of the ware houses may get increased due to which fire may originate from the source of ignition like flammable chemicals. Proper exhaust system as well as cooling system for dangerous chemicals should be ensured to avoid fire hazard [11].

Drum house H&S risks

After assessing the severe impacts of the identified risks involved in the drum house, following is the categorization of the risks,

High Risk > 6	Low Risk< 6
Placement of drums in truck Fall Hazard Slip/trip Hazard	Placement of drums in truck Spillage

High risks

During loading of chemical drums in the truck may result in fall hazard due to slipping and tripping of the drums as well as due to height work if not managed properly.

Low risk

Residual chemicals in the drums may get leaked from empty drums due to improper washing as well as spillage may also get happened from the filled drums due to drum damage, due to this spillage fire or electric shock hazard may originate as well. Proper inspection of the drums should be done before loading activity to avoid spillage hazard

Production units H&S risks

After assessing the severe impacts of the identified risks involved in various production units, following is the categorization of the risks,

Chrome plant

High Risk > 6	Low Risk< 6
Chemical Splashing Physical damage	MT platform Fall hazard Moving machinery Physical damage Loose Wiring Fire hazard Chemical spillage Slip/trip hazard SO2 blower Suffocation Electric objects Electric shock HT furnace Skin burn Spray dryer Dust allergy

High risk

During mixing operation of the chemicals, severe splashing of the chemical were observed due to high RPM of the mixer that can be highly dangerous for the physical parts of the body if that gets in contact with body [12].

Low risk

While climbing at the MT platform for cleaning and maintenance operation without safety harness can lead to fall hazard. Loose dress of the employee may struck in the moving parts of the machines if not working in a safe manner, that can result into a major physical hazard Some of the loose wiring of the electrical panel at chrome plant were observed that can lead to fire hazard if not

insulated properly. Spillage of the chemicals on the floor can cause slip and trip hazard resulting in major physical damage. In case of in effective operation of the SO2 blowers, dust particles may accumulate in the environment and thus resulting in suffocation for the workers there. Loose and insulated wirings can cause electric shock hazard for the employees [13].Non insulated body of the
high temperature furnace can cause skin burn when a person get in touch with it accidently.

High Risk > 6	Low Risk< 6
Loose wiring Fire hazard Volatile chemicals Pungent smell	Moving machinery Physical damage Chemical spillage Slip/trip hazard Electric objects Electric shock Confined space Suffocation

Syntan plant

High risks

Loose wiring of the electrical panels were observed at syntan plant which may result into fire hazard if not managed properly. Some of the time volatile chemicals are being processed at this plant which can cause hurdles in the breathing system or suffocation may also originate.

Low Risks

Loose dress of the employee may struck in the moving parts of the machines if not working in a safe manner, that can result into a major physical hazard. Spillage of the chemicals on the floor can cause slip and trip hazard resulting in major physical damage. Loose and insulated wirings can cause electric shock hazard for the employees. For maintenance or washing purpose of the reactors, workers used of going into the reactor which is a confined space oxygen level in that confined space is less than atmospheric oxygen which may result in suffocation problem for the employees entering inside it.

Polymer plant

High risks

Loose and insulated wirings can cause electric shock hazard for the employees. Some of the time volatile chemicals are being processed at this plant which can cause hurdles in the breathing system or suffocation may also originate.

Low risks

Loose dress of the employee may be struck in the moving parts of the machines if not working in a safe manner, that can result into a major physical hazard. Loose wiring of the electrical panels was observed at polymer plant which may result into fire hazard if not managed properly. Spillage of the chemicals on the floor can cause slip and trip hazard resulting in major physical damage. For maintenance or washing

High Risk > 6	Low Risk< 6
Electric objects Electric shock Volatile chemicals Pungent smell	Moving machinery Physical damage Loose Wiring Fire hazard Spray Dryers Dust allergy Chemical spillage Suffocation

purpose of the reactors, workers used of going into the reactor which is a confined space oxygen level in that confined space is less than atmospheric oxygen which may result in suffocation problem for the employees entering inside it.

Boiler room

High Risk > 6	Low Risk< 6
Hot surface Physical hazard	Loose Wiring Fire hazard Chemical & water spillage Slip/trip hazard Pressure Vessel Explosion

High risks

Hot surface of the reactors having exothermic reactions can cause skin burn when in contact with human body [14].

Low risk

Loose wiring of the electrical panels was observed at polymer plant which may result into fire hazard if not managed properly. Spillage of the chemicals & water on the floor can cause slip and trip hazard resulting in major physical damage. As boilers are high pressure vessels which may explode if pressure is not been under controlled limits.

QA lab H&S risks:

After assessing the severe impacts of the identified risks involved in the QA lab, following is the categorization of the risks,

High Risk > 6	Low Risk< 6
Glass equipment Cuts & bruises Dye mixer	Loose wiring Fire hazard Electrical Objects
Noise pollution	Electric Shock

High risks

During handling of glass equipment without proper safety PPEs, glass equipment can damage the body parts. Dye mixer produces an intense sound when in operation, so this sound can damage hearing ability of the persons if they are not using ear plugs.

Low risks

Loose wiring of the electrical panels was observed at polymer plant which may result into fire hazard if not managed properly. Loose and insulated wirings can cause electric shock hazard for the employees. There are several toxic chemicals in the lab that can damage the physical parts of the human body, if these are not handled with care. Spillage of chemicals on the floor of lab can cause slip/trip hazard if it is not controlled properly.

Administration H&S risks:

After assessing the severe impacts of the identified risks involved in the QA lab, following is the categorization of the risks,

High Risk > 6	Low Risk< 6
Kitchen staff health Health hazard	Kitchen wiring Fire/shock hazard Ammunition Life hazard

High risks

If physical health of kitchen staff is not up to the standard, then it can cause health hazard for other workers of the company. If regular

tests of their physical health are not being done then it can be dangerous for others.

Low risks

If wiring of the kitchen Is not insulated then it can cause short circuit as well as shock to the workers. If ammunition that is available to security staff is not licensed as well as staff is not trained then it can cause life security hazards for others.

Conclusion

During visits to the chemical industry where the operations were carried out, observations were made about the industry's overall working environment as well as the current health and safety conditions in each area. The XYZ chemical business prioritizes safety, which is why every conceivable piece of equipment was offered to personnel. One aspect that was lacking was the adoption of the HSE department directives on the workers because there were issues with policy implementation. Everything was provided to the workers by the management and authorities, but the workers were hesitant to use them because their comfort zone had been violated, resulting in decreased work efficiency, which could lead to decreased productivity. However, some conditions like Firefighting conditions at the industry were quite satisfactory and they also had their main focus on the firefighting and their team in this regard was also well informed and trained. Overall, the sector was concerned about worker safety and had done some good. Toolbox discussions were also held, as well as many trainings on worker safety, to guide them towards a safe approach. One of the advantages of the aforementioned education was that the language for communication used in these trainings was easy to understand for the workers. After the trainings, assessments were also done by tests that were also written and oral. At the end, the practical application was also applied, and workers were put to the examination through developing a scenario and they were left to deal with it to develop their safety skills under controlled environments. The industry's risk assessment is up to date, and suggestions have been made to properly deal with these risks and hazards. Research was carried out to check and highlight the risks involved in a chemical industry regarding health and safety of the workers. Study was carried out by conducting the interviews of the area in charges where risks were involved by using purposive data collection strategy. After getting answers and views of the area in charges regarding the severity and probability of the identified risks, their ratings were given.

Following were the areas of high risks in the chemical industry

- Production
- Storage houses
- Maintenance
- Drum House
- Quality Assurance labs

Risk rating of beyond 6 is marked as non-acceptable or high risk and required control actions are proposed to reduce their severity. Most highlighted risks that are probably present in a chemical industry are spillage, fire risk, chemical waste disposal, operation of heavy machinery, evaporation of toxic fumes and dust etc.

Hazards that are associated majorly with the identified risks are mostly slip/trip hazard,

fire, water, air, noise pollution etc. that needs to be controlled.

Risk analysis was also been done in the study that describes and highlights the high and low risk areas and after analysis-controlled actions have also been suggested in the study.

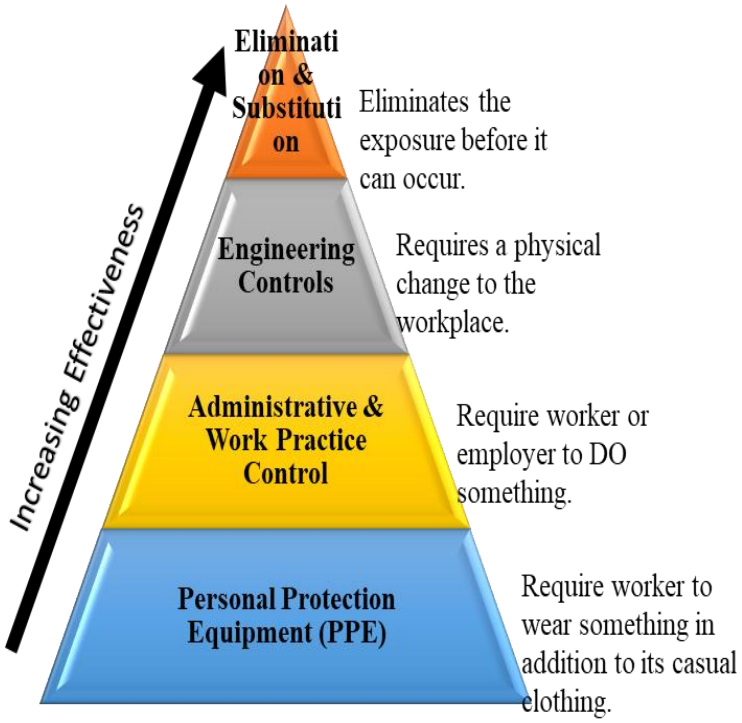
Some control actions are also been suggested in this study to reduce the impact of the identified risks. If on applying a certain control on the risk, the risk doesn't reduce to below the line then additional controls need to be applied until or unless the risk rating goes down below.

Recommendations:

Controls are the last step in the risk assessment in which all the controls are suggested for the significant hazards by applying these controls, hazards can be minimized in the organization. These controls are applied according to the hierarchy, depending upon the risk which we are controlling. As least significant hazards are control by PPEs while the most significant hazards are controlled by elimination/substitution.

Hierarchy of Controls

In this study possible chemical risks are identified and then analysis has been carried out to check out their probability and severity of hazards to be generated from those risks. After analyzing the risks, controlled actions have also recommended to reduce the severe impacts of those possible risks. Chemical industries can take following initiatives to avoid and mitigate the adverse effects of the risks as Carrying out comprehensive risk and gap analysis of the company. Identified gaps and risks should be discussed in management review meeting and controlled actions as well as resources required to mitigate the risks should also be addressed. Preventive maintenance of machines should be ensured regularly to avoid noise pollution and emission of environment unfriendly gases and fumes. Resource efficient management and disposal of chemicals should be ensured to avoid underneath water pollution and spillages which in results can cause slip/trip hazard. Responsible care management system should be adopted by company having the responsibility of chemical handling and its related risks in product life cycle perspective and ensure proper disposal of chemicals.



Limitation & future perspective

Further study can be carried out in the area of risk assessment for the chemical industry

as this study was carried on the practical basis having data from one chemical industry. So in future more studies can scale up this project to more than one chemical firm

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