TUGAS AKHIR - TI 091324

ANALISIS PROSES *SAFETY* DAN PENERAPAN SISTEM MANAJEMEN KESELAMATAN DAN KESEHATAN KERJA DI PT. INTERNATIONAL CHEMICAL INDUSTRY

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Surabaya 2016

FINAL PROJECT - TI 091324

ANALYSIS SAFETY PROCESS AND IMPLEMENTATION OF OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM IN PT. INTERNATIONAL CHEMICAL INDUSTRY

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Abstrak

PT. International Chemical Industry adalah salah satu perusahaan yang memproduksi baterai. PT. International Chemical Industry telah menerapkan SMK3, tetapi masih belum optimal. Dalam penelitian ini, perhitungan resiko kecelakaan yang mungkin terjadi dalam proses produksi menggunakan metode *Failure Mode Effect Analysis* (FMEA). Kemudian menggunakan metode *Nordic body map* (NBM) dan juga *Quick Exposure Checklist* (QEC) untuk menentukan bagaimana postur tubuh saat kondisi kerja dan nyeri atau sakit yang dirasakan. Setelah itu dilakukan *root cause analysis* untuk menentukan penyebab kecelakaan secara keseluruhan.

Berdasarkan hasil FMEA diperoleh 6 kategori risiko tinggi, 3 risiko menengah dan 26 kategori risiko rendah. Sementara kondisi pekerja dalam hal postur kerja perlu diselidiki lebih lanjut untuk operator dan perbaikan segera untuk non-operator (pekerja transportasi). Hasil rekomendasi adalah untuk mengembangkan sistem manajemen keselamatan dan kesehatan dan menciptakan sebuah program yang terjadwal, mengendalikan risiko yang terkait dengan alat pelindung diri, kelengkapan peralatan pertolongan pertama (P3K), dan memasang tanda-tanda keselamatan kerja dan kesehatan.

Kata Kunci: Keselamatan dan Kesehatan Kerja (K3), Sistem Manajemen K3 (SMK3), kecelakaan kerja, FMEA, *Process Mapping*, NBM, QEC, RCA

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Abstract

PT. International Chemical Industry is one of the companies producing batteries. PT. International Chemical Industry has implemented SMK3, but still not optimal. In this research, the calculation of the risk of accidents that may occur in the production process is using the method of Failure Mode Effect Analysis (FMEA). Then use Nordic body map (NBM) and also Quick Exposure Checklist (QEC) to determine how the body posture when working conditions and labor pains are felt. After the root cause analysis was conducted to determine the cause of the accident as a whole.

Based on the results of FMEA obtained 6 high-risk category, 3 medium risk and 26 low risk category. While the conditions of workers in terms of working posture needs to be investigated further for operators and repair immediately to non-carriers (transport workers). The results of the recommendations is to develop system management of occupational safety and health is to create a scheduled program, to control the risks associated with personal protective equipment, the completeness of first-aid equipment (P3K), and put up signs of occupational safety and health.

Keywords: Occupational Health and Safety (K3), Occupational Safety and Health Management System (SMK3), work accidents, FMEA, Hospital Occupational, Process Mapping, NBM, QEC, RCA

ANALYSIS SAFETY PROCESS AND IMPLEMENTATION OF OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM IN PT. INTERNATIONAL CHEMICAL INDUSTRY

FINAL PROJECT

This research was being submitted to accomplish the bachelor degree of:

Department of Industrial Engineering

Faculty of Industrial Technology

Institut Teknologi Sepuluh Nopember

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SURABAYA, JANUARY 2014

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PREFACE

Praise prayed to God for any overflow of grace, and guidance so authors can complete the bachelor thesis with the title "Analysis Safety Process and Implementation of Occupational Health and Safety Management System in PT. International Chemical Industry". This research was conducted as a requirement for completed undergraduate studies (S-1) and earned Bachelor of Industrial Engineering, Institut Teknologi Sepuluh Nopember. During the implementation and execution of the bachelor thesis, the author received a lot of guidance, direction, assistance, and motivations from various parties. Therefore, the authors would like express appreciation and gratitude deeply to the parties as follows:

1. The best Mom ever, Rosmimik, M.Si. Thank you for everything, for your patient, support, and your trust if I can graduate. You're the best mom, everything I do, I do it for you. And also to my father, Papa Ando, Marindo Palar for your support and pray.
2. My beloved sister and brother, Natasha Amor and Amor Ghozi. Finally, your brother graduate. Thanks cyinn.
3. Prof. Dr. Budi Santosa as head of the Department of ITS Industrial Engineering.
4. Mr. Ir. Sritomo Wignjosoebroto, M.Sc., as supervisor. Big thanks for the guidance, direction, and feedback in complete the research
5. Mr. Yudha Andrian as Co-Supervisor and Cordinator of Thesis for his information and kindness.
6. My big bro Sony Bagus Wibisono for your help, motivation, input, and prayer was given until today. You always available at any time if needed. Thank you so much. You're the best bro.

7. Isma Nur Sabrina, Nadia Aulia, Chariza Dinda, Wahyu Rosita, Syamsina Addani, Itqan Archia, Syahidan Hidaya, Arga Zanuar Sang Putra, Dhina Yuskartika, Maria Ulfa who always gave support, love, sorrow, joy until today. Forever friends.
8. Companion in arms, Rizqi Mardhi Farisi, finally we can finish this thesis. Thanks for help and team work.
9. All friends in Ergonomic and Work System Design Laboratory for all advice and help.
10. The whole class of Industrial Engineering, 2008. The best family, thanks for all passion 08IE ups and downs, experiences, stories, memories, and ideals that have been given. We are the best.
11. The entire faculty and department staff of Industrial Engineering ITS and the lessons learned during the author studied at Industrial Engineering ITS.
12. Everyone who has helped me during the process of writing this research.

Twenty years ago, Ronald Reagan said that admitting a mistake is not a weakness, but it is strength. Therefore, I ask for an apology if this research is still imperfect. In the end, I can only hope that this research can be useful in the future.

Surabaya, January 2014

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CHAPTER I
INTRODUCTION

1.1 Background

Workplace accidents especially in industrial sector is still high at an average of 17 people die each day of work based on the data from the Board of Occupational Safety and Health Agency (DK3N). The human factor plays an important role of workplace accidents.

Workplace accidents are accidents that occur in the workplace, especially in industrial environments. According to the International Labour Organization (ILO) each year 1.1 million are deaths caused by illnesses or accidents due to the employment relationship. Approximately 300,000 deaths happen from accidents and the rest 250 million are dying from diseases that related with work. Industrial accidents are generally caused by two main things that are dangerous work behaviors (unsafe human act) and hazardous conditions (unsafe conditions).

Table 1.1 Data Statistics of Workplace Accidents in Indonesia

Periode Tahun	Jumlah Kecelakaan Kerja (Kasus)	Klaim Jaminan Kecelakaan Kerja (Rp.)
2011	99.491	504 miliar
2010	98.711	401,2 miliar
2009	96.314	328,5 miliar
2008	94.736	297,9 miliar
2007	83.714	219,7 miliar

Resource: Jamsostek, (2012)

The application of occupational health and safety implemented for the benefit of the government, entrepreneurs and the the workforce. For a government that has the responsibility of protecting the rights of workers. The

good and right application of occupational safety and health can suppress or reduce the number of accidents. One of the workers rights is to work under safe conditions. Accordance with the law issued by the government that is, UU No. 1 of 1970 on Work Safety. Whereas for entrepreneurs and the workforce, implementation of occupational health and safety plays an important role in improving labor productivity that will determine the success of a production in an industry. If there any accidents happen in an industrial production process, it can disturb the other processes that can lead to decrease productivity. In chapter 2 of Permennaker no.05/men/1996, goals and objectives SMK3 application is to create a system of occupational safety and health (K3) in the workplace by involving elements of management, labor, and working conditions are integrated in order to prevent and reduce accidents and occupational diseases and the creation of a safe, efficient, and productive.

Activities in providing protection to eliminate or reduce the occurrence of occupational accidents is essentially composed of two aspects, that is the cost factor and the habits of the workforce itself (Hammer, 1981). In the prevention of work accidents in the work environment needs to be done several feasibility studies first, then supplies personal protective equipment (PPE) for the worker and others. This is related to the cost problem.

Effort to cope the accident only with considers the unsafe actions of workers will not give out the root of the problem that caused the accident (Reason, 1990). Because it needs to be investigated to determine root causes, not only can be seen from one part only. So that, today there is a shift in workplace safety and security measures, from measurements only look toward the accident rate measurements which focus on safety culture (Cooper, 2000). Culture of safety and job security plays a very important in shaping employees' attitudes about safety and job security, in particular by identifying and analyzing the factors that influence the occupational safety and health culture.

PT. International Chemical Industry (INTERCALLIN) is a company that produces batteries with the trademark "ABC". Began as a family company, PT. International Chemical Industry was transformed into an international company with 3 modern factories. The first factory established in Medan with

the name of PT. Everbright in 1959, then in 1968 also established factories in Jakarta under the name. International Chemical Industry. With the increasing demand for the products, PT. International Chemical Industry set up a factory in Surabaya in 1982.

Battery products of PT. International Chemical Industry not only sold in the local market, but also exported to overseas, such as: Europe (Russia), Asia (China, Japan), America (Canada) and Australia. In addition, PT. International Chemical Industry is also believed by national security institutions through a series of very stringent quality tests to supply Alkaline battery in the military since 2001. The sale of battery products of PT International Chemical Industry every year can reach up to about 100 million units per year.

Batteries is still widely used by humans. Raw materials of dry batteries contain harmful elements, such as: Lead (Pb), Cadmium (Cd), manganese (MnO2), carbon powder and NH4Cl. The materials are hazardous material that can cause negative effects, that is can damage the environment and is also dangerous to humans, especially the workers in the company itself. In addition to the production process also uses machines or heavy equipment. Good handling process safety can prevent accidents.

PT. International Chemical Industry (INTERCALLIN) implements the management system of occupational safety and health (SMK3) by forming P2K3L (Committee for Occupational Safety, Health and the Environment). Several things that are companies do such as: provide personal protective equipment (PPE) such as helmets, masks, boots, gloves, and goggles. However, in practice there are still many workers are not maximizing PPE facilities that provided by the company. This causes many accidents, such as stumbling, eye conceded grams, scratched and hit / fall device / objects. The causes of the highest accident due to negligence are itself. During this 2-year, accident rate increased by 30% and approximately 75% of workers in production department have had minor accidents

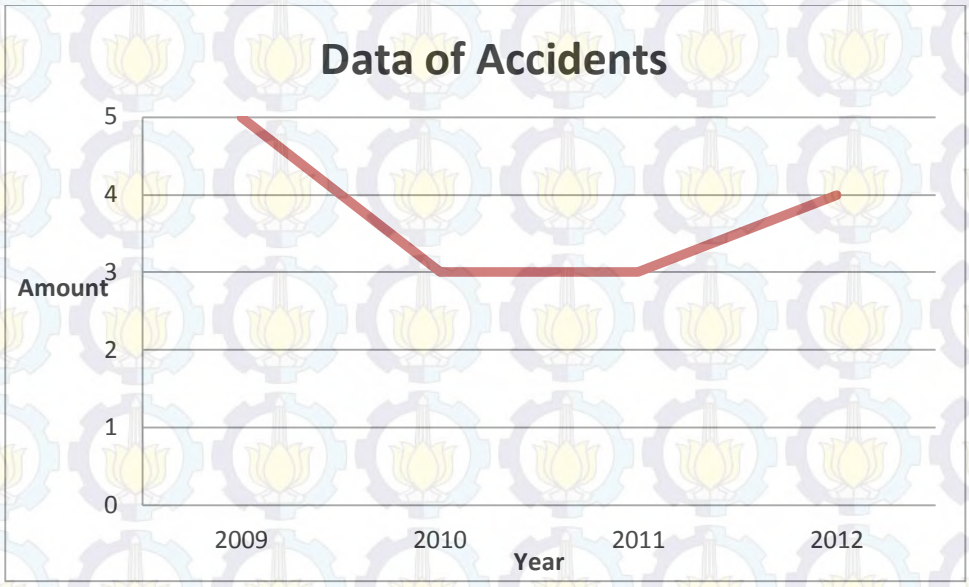


Figure 1.1 Data Recap of Work Accidents

This research was conducted to see the potential hazards or accidents that may occur in the company and what are the factors that can lead to accidents to workers and how to prevent it.

1.2 Research Question

Problems that will be solved by this research is "How to identify and determine whether the process on the PT International Chemical Industry can be the potential occurrence of a hazard by using Failure Mode and Effect Analysis (FMEA). Then identify the pain experienced by workers with the method of Nordic Body Map (NBM) and Quick Exposure Checklist (QEC), then the factors that can lead to accidents in the production process by using the method of Root Cause Analysis in order to formulate solutions for precautions.

1.3 Research Objectives

Related with background and problem formulation above, the study aims to:

1. To determine the potential occurrence of a hazard on the company.
2. To make analysis and evaluation of the factors that can be cause accidents in the production process.

3. To provide solutions precautions to control work accident based on the results of the study.

1.4 Scope of Research

The scope of this research include limitations and assumptions of the research.

1.4.1 Limitation

These are the limitations of the research,

1. Research is only done on the production department.
2. The research was conducted only on work accidents caused by human error in the workplace.

1.4.2 Assumption

These are the assumption of the research:

1. Workplace accidents referred in this research include work accidents itself and the pain of working.
2. No change in the organizational structure at the time of the research.

1.5 Benefit of Research

Benefits that can be gained through this the research, among others:

• Benefits for student:

1. To get better understanding in the application of Failure Mode and Effect Analysis method (FMEA), Nordic Body Map (NBM), Quick Exposure Checklist (QEC) and Root Cause Analysis (RCA) on the real problems in the company.
2. To provide improvement solutions in accordance with the conditions of the company.

• Benefits for company:

1. Company will know the real conditions of occupational safety and health and problems that faced by the company and control problems.

2. Getting a recommendation to achieve system management of ocuppational health and safety implementation in accordance with the company.

1.6 Systematics of Writing

The research writing system is divided into 6 chapters that consist of:

1. Chapter I contains the basic concept that the preparation of the final project consisted of background the research, the formulation of the problem, the purpose of writing, the benefits of writing and the scope of research.
2. Chapter II contains a literature review that is used as a reference in the literature akhir.Tinjauan assignments consist of a literature review of work safety, occupational accidents, risk, Failure Mode and Effect Analysis (FMEA), Nordic Body Map (NBM), Quick Exposure Checklist (QEC) and Root Cause Analysis (RCA).
3. Chapter III contains the steps to conduct research so as to find solutions for existing problems to get a conclusion.
4. Chapter IV contains the collection and processing of data about health and safety at the plant, the accident occurred as well as the manufacture of root cause analysis.
5. Chapter V contains the analysis of the results obtained from the previous chapter (Chapter IV).
6. Chapter VI contains the conclusions and suggestions of a cover research results

CHAPTER II
LITERATURE REVIEW

This chapter contains the literature used in writing a research report. Spoken literature includes books, journals and previous research.

2.1 Occupational Health and Safety

In improved productivity, health and safety factors have an important role to increase production due to ensuring the welfare of human resources. Health and safety can not be separated from each other, where health will not be performing well when the action and safety activities did not take place. Otherwise safety activities are not going well, when human resources are not healthy mentally and physically, for example, affected by stress and job dissatisfaction, and chronic health disorders or incidental (Gani 1992).

Health and safety are interrelated one another. A broader term and more camouflaged is the term health which refers on physical condition, mental, and stability of emotions in general. Individuals who healthy is the that is free from disease, injury as well as the problem mental and emotion which could disturb human activity normal in general. Health and safety not only for the workers who deal directly with the the machine.

Occupational safety and health will create a good realization of the maintenance employees. Realizing the importance of workplace safety will prevent and reduce the level of accidents, fires, and violations of safety regulations. The number of accidents is also a result of lack of supervision from superiors. If monitoring is done poorly it can increase the level of work accidents. The result is the employee's performance will also decrease. To avoid work accidents, needed an integrated effort by all components continuously at all levels of management.

Participation of all managers in the organization in the implementation of accident prevention is needed (Hammer, 1981).

2.2 Occupational Safety

Occupational safety is safety that aimed at machines, working tools, materials and processing process, foundation of work and environment as well as ways do the job (Suma'mur, 1981).

Occupational safety is one of the main factors that is often touted by those industries in recent years. Awareness of the importance of safety based on the circumstances in which an investment that has been made, which are generally of great value in a factory / plant, can be lost or damaged due to negligence in the operation or negligence in the existing safety procedures that can also harm the workers.

2.2.1 Hazard Risk in Workplace

Safety relates to the acute effects of a hazard that occurred, while health is the effect of a chronic hazard (Ashfal, 1999). Hazard is defined as a condition of working that could potentially cause injury to personnel, damage to equipment or building structures, loss of material, or a reduced ability to perform specified functions. Hazards in the workplace can be categorized as follows:

- Physical hazards

  Includes noise, lighting, temperature, radiation
- Chemical hazards

  Includes hazardous materials and toxic
- Biological Hazards

  Includes bacteria, viruses, fungi, etc.
- Mechanical hazards

  Includes machinery and equipment
- Ergonomic hazards

Includes harm caused due to certain positions (lifting, pushing, sitting, etc.), narrow space, poor lighting, etc.

- Psychosocial Hazards

  Includes shift work, long hours, job sharing

- Danger of behavior

  Include lack of expertise, poor adherence to SOPs, etc.

- Environmental hazards

  Covering a dark environment, not flat surfaces, moist, wet, etc.

2.2.2 Risk Analysis

According to the Standards Australia New Zealand (A / NZS) 4360: 2004, the risk is the chance occurrence of an uncertain event that can be affect the achievement of objectives. Meanwhile, according to Bowden et. Al. (2001) risk is the probability of an event that resulted in losses when the incident occurred during a certain period. According Laksmiwati (2008), the process of risk analysis carried out in several stages that can be described as below:

- Save system of work

  Identify the occupational safety and health systems in the company.

- Hazard identification

  Identify the situation or condition of any possible danger the risk of harm.

- Potential Consequences / severity of harm

The determination of how much a consequence of the dangers that exist on the object, made in the form of as below:

Table 2.1 Potential Consequences/Severity of Harm

Fatal	May cause one or more deaths
Major	Injury or serious damage to health, requiring medical attention and treatment, does not lead to death
Moderate	Reversible damage to health, requiring medical treatment, causing the loss of working days
Minor	Requiring first aid or did not cause the loss of working days

- Likelihood/chance of events actually occuring

  Identify the likelihood of an event that are at risk due to hazards that exist, described in the table below :

Table 2.2 Likelihood/chance of events actually occurring

Very Likely	Occurs in most situations, ≥ 16 times / month or almost every day
Likely	Often occurs at a given time, 5 ≤ x ≤ 15 times / month
Unlikely	Rarely, 2 ≤ x ≤ 4 times / month
Highly Unlikely	Very rare, ≤ 1 time / month

- Estimation and presentation

  After the identification process, then plotting consequences, likelihood, and hazard maps in order to get the value of a risk assessment code (RAC) as below:

Table 2.3 Estimation and Presentation

Consequences / ***Likelyhood***	***Fatal***	***Major***	***Moderate***	***Minor***
Very Likely	*Extreme*	*High*	*High*	*Medium*
Likely	*High*	*High*	*Medium*	*Medium*
Unlikely	*High*	*Medium*	*Medium*	*Low*
Highly Unlikely	*Medium*	*Medium*	*Low*	*Very Low*

Table 2.4 Hazard Map

Hazard Type	***Hazzard Source***	***Potential Hazard***	***Probability***	***Hazard Effects***	***Severity***	***Likelihood***	***RAC***

Score RAC:

1 : Extreme/Imminent danger

2 : High/serious danger

3 : Medium/moderate danger

4 : Low/minor danger

5 : Very low/negligible

Table 2.5 Hazard Risk Category

No	Category		
1		*Extreme/imminet danger*	Threaten
2		*High/serious danger*	Threaten
3		*Medium/moderate danger*	Moderate
4		*Low/minor danger*	Moderate
5		*Very low/negligible*	No need to be considered

2.3 Occupational Health

According to the WHO / ILO (1995), Occupational health aims to improve and maintain the health of the physical, mental and social as high for workers in all types of jobs, prevention of health problems workers caused by working conditions, protection for workers in the work of risk due to factors that are detrimental to health, and the placement and maintenance workers in a working environment adapted to the physiological and psychological conditions. In summary an adjustment to the work of human beings and every human being to a job or position.

Occupational health is defined as a specialization in health sciences / medicine and its practice, so that the community health workers obtain the highest degree, whether physical or mental or social efforts towards preventive and curative diseases or health problems caused by factors employment and working conditions as well as against common diseases (Sumakmur, 1981).

Occupational health requirements in terms of work environment include water, air, waste, lighting, noise, vibration, radiation, disease vectors, health requirements location, space and buildings, toilets and installation (Minister of Health of Indonesia Number 1405/MENKES/SK/XI/2002) .

2.4 Occupational Accidents

Occupational Accidents is an undesirable event that are harmful to humans, damaging property or loss to process. Understanding near miss, in terms of safety referred to the incident, "near-miss" or "near-accident" is an occurrence or unwanted event where the circumstances are a little different will cause harm to humans, damaging property or losses to the process (Direktorat Sarana Prasarana ITB 2009).

According to Suma'mur (1989) the term occupational accidents include all accidents that cause by work and all occupational diseases. An accident caused by an external event that suddenly and unexpectedly, while an occupational disease is caused by the bad influence of time such as by vibration or noise.

Based on the ILO (1998) work accidents arising from or during work can resulted fatal work accidents and accidents that are not fatal. According Rahardjo and Sunarsiah (2008), work accidents can be categorized as: (1) Accidents in the workplace, where the workforce perform the work according to the daily duties. (2) outside the workplace accident, which happened on the way to go or from home to work and vice versa. (3) Occupational diseases, arising from an employment relationship and is seen as a work accidents.

According Safitri (1998) work accidents occurred because of the technological factors, management, and humane. Technology factor is technology and management that used to do production activities within the company. Human factors that is behaviors or poor work habits, and management factors such as procedures related to K3 and poor oversight, including allowing the state less safe.

2.4.1 Classification of Occupational Accidents

According to the ILO in 1962 in the book of Occupational Accidents and Accident Prevention (Suma'mur, 1981) classifies accidents into 4 classifications as below:

1. Classification by type of accident, for example, fell, hit by falling objects, pinched by items, the influence of high temperature, electric shock and contact with hazardous materials or radiation
2. Classification by cause
    a. Engine: power generation, with the exception of electric motors, the machine dealers, machines for working metal
    b. Conveyance or lifting equipment: lifting the machine and equipment, transportation equipment on rails, other wheeled conveyances, except railroad
    c. Other equipment: refrigeration installation electrical installations, including electric motors, except electric hand tools, ladders, etc..
    d. The materials, substances and radiation: explosives, dust, gases, liquids and chemicals, with the exception of explosives, radiation, etc..
    e. Work environment: outside the building, inside the building, below ground
    f. Other causes that do not include these groups: animals, etc.
3. Classification according to the nature of the injury or disorder, for example broken bones, bruises, amputations, burns and suffocation
4. Classification according to the location of abnormalities or lesions in the body, such as head, neck, materials, members of the top, bottom members, and general disorders

Based on this classification, essentially an accident caused by two groups (Suma'mur, 1981) that is:

1. Based on unsafe human acts
2. Based on unsafe condition

In addition to these classifications, Jamsostek also classifies work accidents into several types as below:

Table 2.6 Type of Accident according to Jamsostek

C	Tipe Kecelakaan
C1	Hit (generally indicate contact or contact with these sharp objects or hard objects resulting in scratched, cut, punctured, etc.)
C2	Beaten (usually due to a fall, glide, float, move, etc.)
C3	Caught in, under, and between objects (pinched, bitten, buried, sinks, etc.)
C4	Fall from the same height
C5	Fall from the different height
C6	Slip
C7	Exposure (generally related to temperature, air pressure, vibration, radiation, noise, light, etc.)
C8	Inhalation, absorption (showing the entry of hazardous materials or substances into the body, either through breathing or skin and generally cause asphyxiation, poisoning, suffocation, etc.)
C9	Touched electricity
C10	etcetera (etc.)

2.4.2 Occupational Accidents Statistics

Many factors that cause occupational accidents. Classification of work accidents is very useful in the investigation of working accidents. In addition it is also a lot of work accidents statistics useful to conduct analysis on the prevention or avoidance so that accidents do not happen again.

The frequency of work accidents is frequency rate of accidents is that often occur or will occur (Permatasari, 2011). To determine the amount or frequency of accidents for every million man-hours using this formula below:

$$F = \frac{\text{many accidents} \times 1.000.000}{\text{number of man} - \text{hours}}$$

Meanwhile, to measure the severity of an accident can be calculated using the formula:

$$S = \frac{\text{number of days lost} \times 1.000}{\text{number of man} - \text{hours}}$$

2.5 The Occupational Health and Safety Management

Management Systems Occupational Health and Safety is part of the organization's management system used to develop and implement occupational safety and health policy and manage risks (OHSAS 18001, 2007).

Management Systems Occupational Health and Safety is part of the overall management system which includes organizational structure, planning, responsibility, implementation, procedures, processes and resources needed for application development, achievement, assessment, and maintenance of occupational safety and health policies in order to control the risks associated with work activities in order to create a workplace that is safe, efficient, and productive this all associated with the business organization (Permatasari, 2011). The application of management systems occupational health and safety in the work environment is set in the Regulation of the Minister of Manpower No.PER.05/MEN/1996. The application of management systems occupational health and safety carried out by the board, entrepreneurs, and the entire workforce in one unit. The application of management systems occupational health and safety the company's also reiterated in Pasal 87 UU. NO 13 of 2003 on Employment, which reads: every company should implement safety and health management system shall be integrated into the company's management system. In the Minister of Labour was also mentioned that the company's employees, who has more than 100 employees are required to implement management systems occupational health and safety. The purpose of that is management systems occupational health and safety (Suardi, 2007):

1. As a tool to achieve the health workforce as much as possible, both laborers, farmers, fishermen, or free workers
2. In an effort to prevent, eradicate diseases and occupational accidents, maintain and improve the health of workers, increase the efficiency and productivity of human labor

Accordance with annex-1 Permenaker No.05/MEN/1996 there are 5 principles in applying management systems occupational health and safety is as follows:

- Principle 1: Commitment and Policy

  Companies should define occupational safety and health policies and ensure commitment to SMK3
- Principle 2: Planning

  Companies should plan to achieve policies, aims and objectives occupational safety and health
- Principle 3: Application of

  So that the effective implementation of management systems occupational health and safety then companies need to develop the capabilities and support mechanisms necessary to achieve the policies, goals, and objectives occupational safety and health
- Principle 4: Measurement and Evaluation

  Companies must measure, monitor, and evaluate the performance of the company as well as the occupational safety and health in preventive and corrective actions
- Principle 5: A review by The Management and Improvement

  Companies need to routinely review and continuously improve management systems occupational health and safety, with the goal of improving the performance of occupational safety and health

Successes in the Permenaker 50/MEN/1996 in a company can be measured as below (Suardi, 2007):

a. For the application of 0-59% and the rate of application of regulation violation (nonconformance) subject to legal action
b. For the application of 60-84% level of achievement awarded a certificate and silver flags

c. For the application of 85-100% level of achievement awarded gold flag certificate

2.6 FMEA (Failure Mode and Effect Analysis)

FMEA (failure mode and effect analysis) adalah a structured procedure to identify and prevent as much as possible modes of failure (failure mode). FMEA is used to identify the sources and root causes of quality problems. A failure mode is what is included in a design defect or failure, a condition beyond the limits established specifications, or changes in the the product that causes the disruption of the function of the the product.

There are two the use of FMEA that are in the design (Design FMEA) and the process (Process FMEA). Design FMEA will help eliminate the failures associated with the design, such as power failure improper, incompatible materials, and others. FMEA process will eliminate failures caused by changes in process variables, such conditions beyond the limits specified as improper size, texture and color that does not match, the thickness of which is not right, and others. This research using the method of Process FMEA.

According to Roger D. Leitch, the definition of failure modes and effect analysis is an analysis technique that when done right and the right time will give you a great value in helping the process of decision-making for engineer during the design and development. The analysis called analysis of "bottom up", as examined at the beginning of the production process and considering the failure rate of the system is the result of a whole different kind of failure.

2.6.1 Purposes of Failure Modes and Effect Analysis

There are several purposes of this method, among others:

1. Recognize and predict potential failures from the product or process that can occur.

2. Predict and evaluate the impact from failures on the functionality of existing systems.
3. Indicate priorities for improving a process or sub-system through the list of improved processes or sub-systems that must be repaired.
4. Identify and establish corrective actions can be taken to prevent or reduce the chances of failure or potential impact on the system.
5. Documenting the process as a whole

2.6.2 The Basic Step of FMEA

There is a fundamental step in the process FMEA is carried out by a team of design for six sigma (DFSS) is:

1. Building a process limits that the process is limited by the structure.
2. Build processes that describe the mapping from FMEA complete production process and the interface level in the hierarchical structure of the process and scope.
3. Looking at the structure of the process at all levels of hierarchy in which each design parameter is defined.
4. Identification of potential failure in each process.
5. Learn the cause of the failure from its influence.

2.6.3 Determine Severity, Occurrence,Detection and RPN

To determine the priority from a failure of the FMEA form should define in advance of Severity, Occurrence, Detection, and the end result is a Risk Priority Number.

- **Severity**

Severity is the first step to analyze the risk, that is calculates how much impact / intensity that can influence the output process. The impact is ranked starting scale of 1 to 10, where 10 is the worst impact.

Table 2.7 Range of Severity

Rating	Criteria
1	*Negligible severity* (bad influences can be ignored). We do not need to think that this result will have an impact on product performance. End users probably will not fix this defect.
2-3	*Mild severity* (minor bad influences). The impact caused only mild. End users will not feel any changes in performance. Repairs can be done during regular maintenance.
4-6	*Moderate severity* (moderate bad effect). End users will experience a decrease in performance, but still within tolerable limits. Recovery was not expensive and can be completed in a short time.
7-8	*High severity* (the high bad influence). End users will feel the negative consequences will not be accepted, is outside the tolerance limits. Repairs are carried out very expensive.
9-10	*Potential safety problem* (potential safety problems). Very dangerous consequences and affect the safety of the user. Contrary to the the law

(Source: Gaspersz, 2002)

- **Occurrence**

Occurrence is the possibility that the cause will occur and result in the form of failures during the product usage. By estimating the occurrence probability on a scale of 1 to 10.

Table 2.8 Range of Occurrence

Rating	Criteria
1	The probability of single disorder mode < 0,001 from the overall probability of interference during operation
2-3	The probability of single disorder mode> 0,001 tetapi < 0,01 from the overall probability of interference during operation
4-6	The probability of single disorder mode > 0,01 tetapi < 0,10 dari probabilitas keseluruhan terjadinya gangguan selama masa pengoperasian
7-9	The probability of single disorder mode > 0,10 tetapi < 0,20 from the overall probability of interference during operation
10	The probability of single disorder model > 0,20 from the overall probability of interference during operation

(Source: Vincentz, 1992)

- **Detection**

Detection value associated with the current control. Detection is a measurement of the ability to control / control failures that can be occur.

Table 2.9 Range of Detection

Rating	Criteria
1	The method of prevention is very effective . There is no chance that the cause may appear.
2	The possible causes occur is very low.
3	
4	Possible causes occur is moderate. Prevention methods allow cause it occur sometimes.
5	
6	
7	Possible causes occur is still high. Prevention methods are less effective, cause still repeated.
8	
9	Possible causes occur very high. Prevention methods are not effective, the cause is always recurs back.
10	

(Source: Gaspersz, 2002)

- **Risk Priority Number**

RPN is a mathematical the product from the seriousness of the effects (Severity), the possibility of a cause will lead to failure-related effects (Occurrence), and the ability to detect failures before they occur on the customer (Detection). RPN can be shown by the following equation:

$$\mathbf{RPN = S * O * D}$$

This number is used to identify a serious risk, as clues to the corrective action.

2.7 Process Mapping

To identify the stakeholders who nvolved in the work accidents is needed a tool that can be describe the whole process of handling the accident. In this research by utilizing flowchart for drawing process of working. Flowchart is a tool used to understand the performance and relationships in the business process (Harrington, 1991), the following is a type of flowchart according to Harrington:

1. Block diagram
2. The American National Standart Insitute (ANSI) stadart flowcharting
3. Functional flowchart
4. Geographic flowchart

Process mapping is a flowchart that illustrates the work flow of such activities, information, and materials in a process. Process mapping in the research using functional flowchart. Functional flowchart identifies how the functions from the department affecting vertical horizontal process flow within an organization (Harrington, 1991). Excellence using mapping process is as below (The CPS Incorporate RCPO):

1. Describes the flow of materials, information and documents
2. Show that there is a role in a variety of tasks based process
3. Shows the decisions made throughout the process chain
4. Shows the relationship between the interests of actors in the process and dependencies between processes

Process mapping is divided into three types of relationship maps, cross funtional maps, and process flowchart. Relationships maps serve to indicate the department from an organization and how to interact with customers and suppliers. While cross funtional function maps to show the actors in each process and how each of these actors are interconnected. The third type is a process flowchart describing a single stream that serves a cross functional diagram. This type is the same function as the flowchart in general. Here are the symbols on the mapping process:

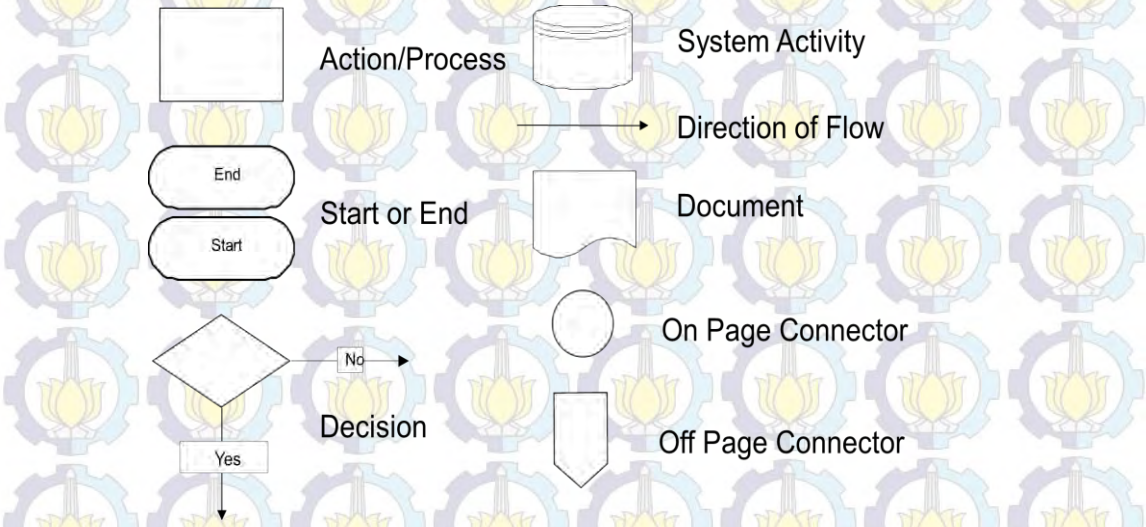


Figure 2.1 Process Mapping Symbols

Description:

Process : denotes an action performed by a computer

Start or end : declare the beginning or ending of a process

Decision : indicate a certain condition that would result in two possible answers yes or no

Arrow : stated course of a process flow

Document : print the output in the form of documents

System activity : declare a particular activity

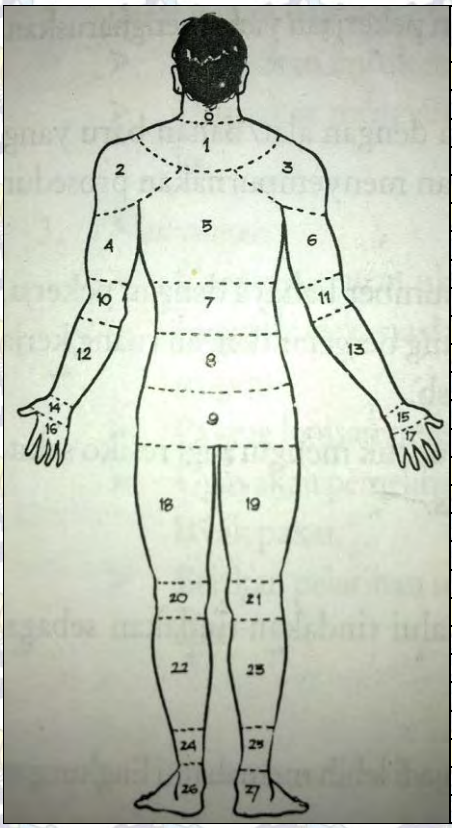
On-page Connector : declare the connection from the process to the same page

Off-page Connector : declare the connection from the process to the different pages

In this research process mapping is cross functional maps. Cross functional process maps will illustrate more clearly the the information about the the perpetrator is in the system. This diagram shows the relationship between business processes and functional units such as the department responsible for the process.

2.8 Nordic Body Map (NBM)

By using Nordic body map (NBM), it can be estimated the type and level of skeletal muscle complaints perceived by workers (Tarwaka; Bakri. S; Sudiajeng. L, 2004). There are 27 body segments representing the whole body will be selected by the respondent on which parts have complaints.



No.	Lokasi
1	Sakit pada leher
2	Sakit pada bahu kiri
3	Sakit pada bahu kanan
4	Sakit pada lengan atas kiri
5	Sakit pada punggung
6	Sakit pada lengan atas kanan
7	Sakit pada pinggang
8	Sakit pada pinggul
9	Sakit pada pantat
10	Sakit pada siku kiri
11	Sakit pada siku kanan
12	Sakit pada lengan bawah kiri
13	Sakit pada lengan bawah kanan
14	Sakit pada pergelangan tangan kiri
15	Sakit pada pergelangan tangan kanan
16	Sakit pada tangan kiri
17	Sakit pada tangan kanan
18	Sakit pada paha kiri
19	Sakit pada paha kanan
20	Sakit pada lutut kiri
21	Sakit pada lutut kanan
22	Sakit pada betis kiri
23	Sakit pada betis kanan
24	Sakit pada pergelangan kaki kiri
25	Sakit pada pergelangan kaki kanan
26	Sakit pada kaki kiri
27	Sakit pada kaki kanan

Figure 2.2 Nordic Body Map

(Source: Tirtayasa et al, 2003 in Devi, 2011 and Corlett, 1992 in Tarwaka et al, 2004)

To know the pains, suffered a long illness, the consequences of illness, and the amount of time lost can be determined by using the Standardize nordic questionnaire (Kaewbooncho et al, 1998 in Devi, 2011) such as in the table below::

Table 2.10 Level of exhaustion

No.	Location	Level of Fatigue				
		1	2	3	4	5
1	Pain in the neck					
2	Pain in the left shoulder					
3	Pain in the right shoulder					
…	…					
27	Pain in the right feet					

Description:

1 : Not very pain
2 : No pain
3 : A little pain
4 : Pain
5 : Very pain

Table 2.11 Pain Complaints time

No.	Location	Pain Complaints time				
		1	2	3	4	5
1	Pain in the neck					
2	Pain in the left shoulder					
3	Pain in the right shoulder					
…	…					
27	Pain in the right feet					

Description:

1 : 1-5 days
2 : 6-10 days
3 : 11-15 days
4 : 16-30 days
5 : > 30 days

Table 2.12 Consequences of Occupational

No.	Location	Consequences of Illness				
		1	2	3	4	5
1	Pain in the neck					
2	Pain in the left shoulder					
3	Pain in the right shoulder					
…	…					
27	Pain in the right feet					

Description:

1 : not Influential
2 : There was reduction in work activities comfort
3 : Reduce the types of work activities
4 : Got medical care

5 : Must replace workers

Table 2.13 Total Lost Work Time Due to Pain

No.	Location	Total Lost Work Time Due to Pain				
		1	2	3	4	5
1	Pain in the neck					
2	Pain in the left shoulder					
3	Pain in the right shoulder					
…	…					
27	Pain in the right feet					

Description:

1 : 0 days
2 : 1-5 days
3 : 6-10 days
4 : 11-15 days
5 : > 15 days

2.9 Quick Exposure Checklist (QEC)

Quick Exposure Checklist (QEC) is a method used to evaluate body postures and movements that include the back, shoulders, arms, and neck. QEC method provides a four-level to evaluate body posture (David et al, 2007 in Devi, 2011). Advantages of QEC method compared with other methods that is (Guangyan Li and Buckle, 2005 at the Devi, 2011):

1. Includes several major risk factors of work related musculoskeletal disorders (WMSDs)
2. Consider the needs of the user and can be used by people who have not experienced
3. Consider the interaction of a combination of multiple risk factors of workplace
4. Has good sensitivity and usability
5. Easy to learn and easy to use

In doing QEC there are three stages: (Purwaningsih 2007 in Devi, 2011):

1. **Stage 1: Development of methods for recording work postures**

   Parts of the body will be divided into segments which form seven groups A-G. This is done to ensure that all posture is recorded, so that any restriction by back or neck posture which may affect the posture of the upper body can be included in the assessment.

   Group A: assessment for back posture (A1-A3)

   Assessment for back posture should be made when the backs suffered heavy loads, such as bowing.

   - A1 : back is considered normal or almost neutral when the movement of people working with the angle of flexion / extension, turning your back or bowing is less than 200, as shown in Figure A1.

Figure 2.3 A1 (Normal Back/Almost Neutral)

   - A2 : Backs are considered moderate or moderately flexed or twisted when the movement of people working with the angle of flexion / extension, twist or bowing your back more than 200 but less than 600, as shown in Figure A2.

Figure 2.4 A2 (Moderate Back/Moderately Flexed or twisted)

- A3 : backs are considered too bowing or flexed or twisted excessively when the movement of people working with the angle of flexion / extension, twist or bowing your back more than 600 but close to 900, as shown in Figure A3.

Figure 2.5 A3 (back too bent/Exessively flexed or Twisted)

Group B: Assessment for the movement back (B1-B5)

- B1 if non-static body position
- B2 if a static body position
- B3 if the movement of the spine are rare (<3 minutes)
- B4 if the movement back to normal (3-8 minutes)
- B5 if the movement back too frequently (> 12 minutes)

Group C: Assessment foshoulder / arm posture (C1-C3)

Assessment should be done when the shoulder / arm experiencing a heavy load during the work, but not so urgent when the backs are being assessed.

- C1 if the position of the shoulder / arm below waist height
- C2 if the position of the shoulder / arm around the chest
- C3 if the position of the shoulder / arm around shoulder height or above

Group D: Assessment for the movement of the shoulder / arm (D1-D3)

- D1: rarely if no regular movement patterns
- D2: often when there is regular movement patterns with a few short breaks

- D3: very often when there is continuous movement patterns during working

Group E: Assessment for hand / wrist posture (E1-E2)

Assessment carried out during a bad job positions including flexion / extension, ulnar deviation / radial, and rotation of the forearm through the wrist.

- E1 : The wrist is considered too straight / almost straight when the limited movement of less than 150 normal posture as in the Figure E1.

Figure 2.6 E1 (Wrist always straight/Almost Straight)

- E2 : Considered wrist bends / deviant or deviated / bent when the movement of more than 150 normal posture as in picture E2.

Figure 2.7 E2 (Wrists bent / Deviant atau Deviated/bent)

Group F: Assessment for the movement of the hand / wrist (F1-F2)

A hand movement of the hand / wrist and arm, including the movement of the finger. Every movement is calculated each time the same pattern and repeated over a period such as one minute.

- F1 if the movement of the hand <10 minutes
- F2 if the movement of the hand between 11-20 times per minute
- F3 if the movement of the hands> 20 times per minute

Group G: Assessment for neck posture (G1-G3)

- G1 if the position of the neck is not bent
- G2 if sometimes down the neck position
- G3 if the position of the neck is often looked down

Assessment of workers in the same job

After the assessment, workers were asked to answer further questions as indicated on the second page of the tool QEC and accompanied by explanations when needed.

Calculation of the total assessment score

Of the total assessment score can be obtained with a combination of ratings from observers (A-G) and workers (a-e). Make sure that the combination of scores had been determined before summing.

2. **Stage 2: Development of a scoring system for grouping parts of the body**

   From the grouping determined posture A-G group scores for each posture. Then the scores are included in the assessment scores (exposure score) to obtain a total score

3. **Stage 3: Development of a scale that measures the level of risk levels and provides guidance needs action**

   Total score of stage 2 and then categorized according to the table below. From these results will be obtained to guide the risk of injury while doing

the activity so immediate repair method / job movement in the body segments that are harmful to reduce the occurrence of accidents or injuries.

Table 2.14 Preliminary Action Level QEC

Back		
QEC	***Action***	***Scale***
≤ 19.2	*Acceptable*	2-3
19.3-24	*Investigate further*	4-5
24.1-33.6	*Investigate further and change soon*	6-7
≥ 33.6	*Investigate and change immediately*	7+

Shoulder/Arm		
QEC	***Action***	***Scale***
≤ 20	*Acceptable*	2-3
20.1-25	*Investigate further*	4-5
25.1-35	*Investigate further and change soon*	6-7
≥ 35	*Investigate and change immediately*	7+

Hand/Wrist		
QEC	***Action***	***Scale***
≤ 18.4	*Acceptable*	2-3
18.5-23	*Investigate further*	4-5
23.1-32.2	*Investigate further and change soon*	6-7
≥ 35	*Investigate and change immediately*	7+

Neck		
QEC	***Action***	***Scale***
≤ 7.2	*Acceptable*	2-3
7.3-9	*Investigate further*	4-5
9.18-12.6	*Investigate further and change soon*	6-7
≥ 12.6	*Investigate and change immediately*	7+

Total		
QEC	***Action***	***Scale***
≤ 64.8	*Acceptable*	2-3
64.9-81	*Investigate further*	4-5
81.1-113.6	*Investigate further and change soon*	6-7
≥ 113.4	*Investigate and change immediately*	7+

(Source : Guangyan Li dan Bukle, 2005)

2.10 Root Cause Analysis (RCA)

To prevent the occurrence of accidents is not enough to just pay attention to unsafe occurrence that could lead to accidents (Reason, 1990), but also should do a search for the cause of the accident. So by knowing the factors that can lead to accidents, to minimize the occurrence of accidents. The method can be used to determine the causes and consequences of these accidents is the Root Cause Analysis (RCA).

RCA is a method used to solve a problem which aims to identify the root cause of a problem or an event can occur. Elements on RCA consists of a variety of reasons. In the final task Permatasari (2011) argued that the elements in the RCA are as follows:

a. Materials, ie raw material defects, wrong type of workers and the lack of raw materials
b. Machinery or equipment, for example, the wrong tool, lack of maintenance, lack of equipment or tool placement, and equipment damaged
c. Environment, for example workplace untidy, poorly maintained workplace, and layout
d. Management, for example, the lack of management involvement, lack of attention to the task, and the task is dangerous not maintained properly
e. Methods, for example the lack of a procedure, lack of communication, and practice in the field is not in accordance with the procedures
f. Management system, for example, lack of training, lack of employee involvement, and lack of education on the dangers

In the final project, Ikasari (2012) states that in conducting the RCA there are 4 steps that must be done. Here are the steps in conducting RCA:

1. Data collection

At this stage, a complete data collection so that can know the causes and the root cause of the problem

2. Causal factors charting

   This diagram is intended to describe a structure for investigators in organizing and analyzing information gathered.

3. Identify the root causes of

   At this step will be to identify the cause of all causes (causal factors) so that it can be seen why the causal factors may occur. Diagrams used in conducting the identification using the Root Cause Map.

4. Recommendation and implementation

   The final step is to make recommendations from each root cause.

2.11 Review of Previous Research

This research was supported by several previous research. Reviews conducted relating to safety and accident using Root Cause Analysis method and other methods.

1. Hanum, L (2007), Measurement Level Implementation and Risk Analysis Occupational Safety and Health in PT.DOK Shipping.
   This research will measure how high the level of implementation of occupational safety and health in PT.Dok and analyzing occupational hazards that may occur and then hazard ranking carried by using a risk assessment. Subsequently determined how preventive and corrective actions to reduce the risk of hazard to workplace accidents.
2. Pramod, S (2009), Repair Systems Working with Workload Approach and Human Reliability Assessment (Case Study: PT.Djitoe Indonesian Tobacco Company).

In this research work system improvements with two approaches, namely workload and human error. Calculation of physical workload with QEC method.

3. Permatasari (2011) Identification of Causes Occupational Accidents Using Root Cause Analysis on Construction Project Mall Ciputra Surabaya ".
   In this research to identify the causes of accidents on construction projects. The research was conducted based on the company's risk assessment. Researchers using Root Cause Analysis with Event Tree approach used to identify risks and provide risk prevention measures.
4. This research evaluated occupational safety and health with failure mode effect analysis and identify the causes of accidents using Root Cause Analysis. Whereas to know occupational pains experienced by workers used Nordic Body Map and Quick Exposure Checklist.

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CHAPTER III

RESEARCH METHODOLOGY

Scientific research requires a framework or methodology of the research study before implementation. This research method provides systematic research steps used in conducting the research. These stages are used as a frame of reference for the research process running in a systematic, structured and purposeful, and guiding research to achieve predetermined objectives.

3.1 Preliminary Phase

At the preliminary phase will be divided into several phases in conducting research. Preliminary phase consists of identifying the problem, goal setting research, literature studies, and field studies.

3.1.1 Problems Identification

At this phase the identification of the problems that occurred in the research place as an object of observation. An observed object that is under investigation in this case was on PT. International Chemical Industry. The issues rise regarding the ergonomic assessment and identify the causes of workplace accidents.

3.1.2 Research Objective Setting

The purpose of the research, which refers to the background that is identify the potential hazards that may occur in the company and what are the factors that can cause accidents on workers. Identify potential hazards at the company performed using Failure Mode and Effect Analysis (FMEA) to identify the cause of the occupational accident using Root Cause Analysis. From the results of data processing are expected to get recommendations for improvements that will prevent the occurrence of danger to the company and minimize the occurrence of accidents.

3.1.3 Literature Study

Literature studies used to support the research on occupational safety and health (K3), Failure Mode and Effect Analysis (FMEA), Nordic Body Map (NBM), Quick Exposure Checklist (QEC), Root Cause Analysis, and process mapping. Literatures used are taken from text books, journals, the internet and the final project.

3.1.4 Field Study

The field study was conducted to determine the existing condition related to the research company. Field of study will obtain information about the employment situation in enterprises and data necessary to carry out the research. Field studies had conducted by interview, observation of observed objects, and through questionnaires.

3.2 Data Collection Phase

At this phase of data collection will be done relating to problems under study. The data retrieved are divided into two parameters, namely primary data and secondary data. Primary data obtained by conducting interviews and questionnaires to employees, parts management, and stakeholders associated with the incidence of work accidents. Interview foremost to the safety engineering as a person who knows how to apply health and safety measures and what to do when accidents happen. While the secondary data obtained from historical data. Secondary data needed include risks that occur in the work environment.

3.3 Data Processing phase

At this stage of the data processing will be carried out interviews, questionnaires and history data. Information obtained will be processed in accordance with the approach used. The first tools used in evaluation workplace safety hazard in this study are the identification and Failure Mode and Effect Analysis (FMEA). Then identify the pain experienced by workers from workplace accidents using Nordic Body Map (NBM) and Quick Exposure Checklist (QEC).

3.4 Data Analysis and Interpretation Phase

At this phase about the analysis and data processing problems has been done. From this analysis are expected to know the things that need to be fixed and given special attention by the company so that recommendations for improvements that can be implemented given appropriate.

3.5 Conclusions and Recommendations Phase

At this phase contains the conclusion of research conducted as well as helpful suggestions for further research. Flowchart

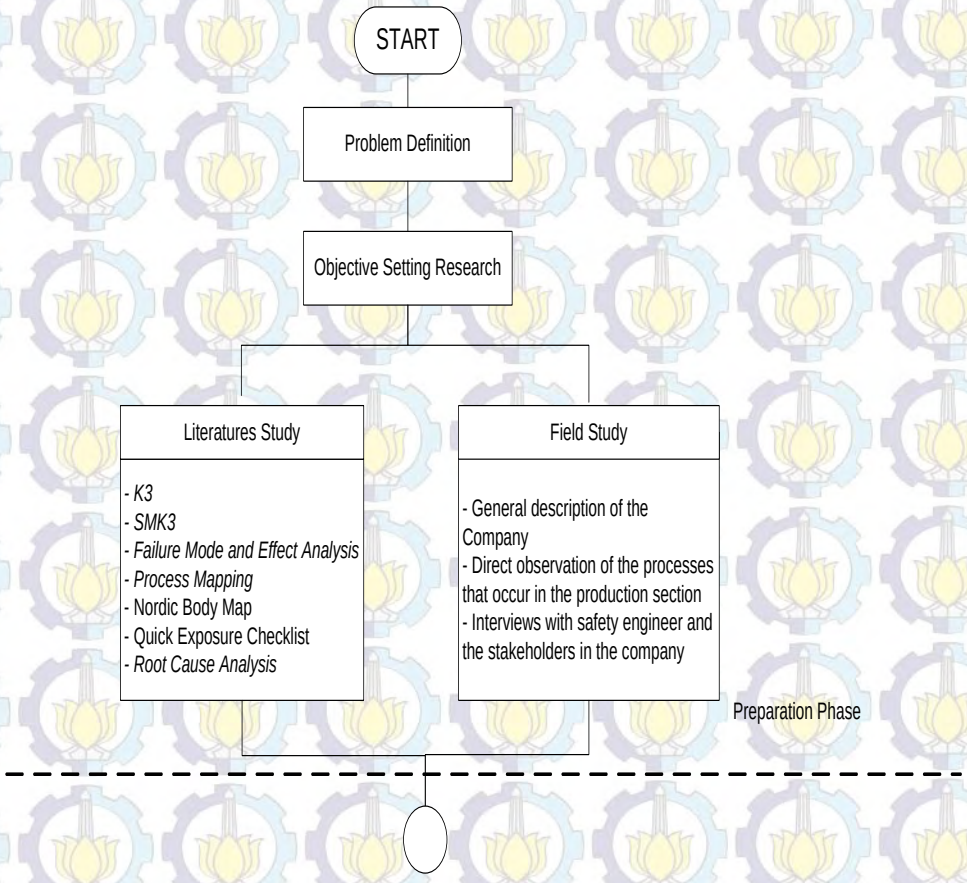

Figure 3.1 Research Methodology Flowchart

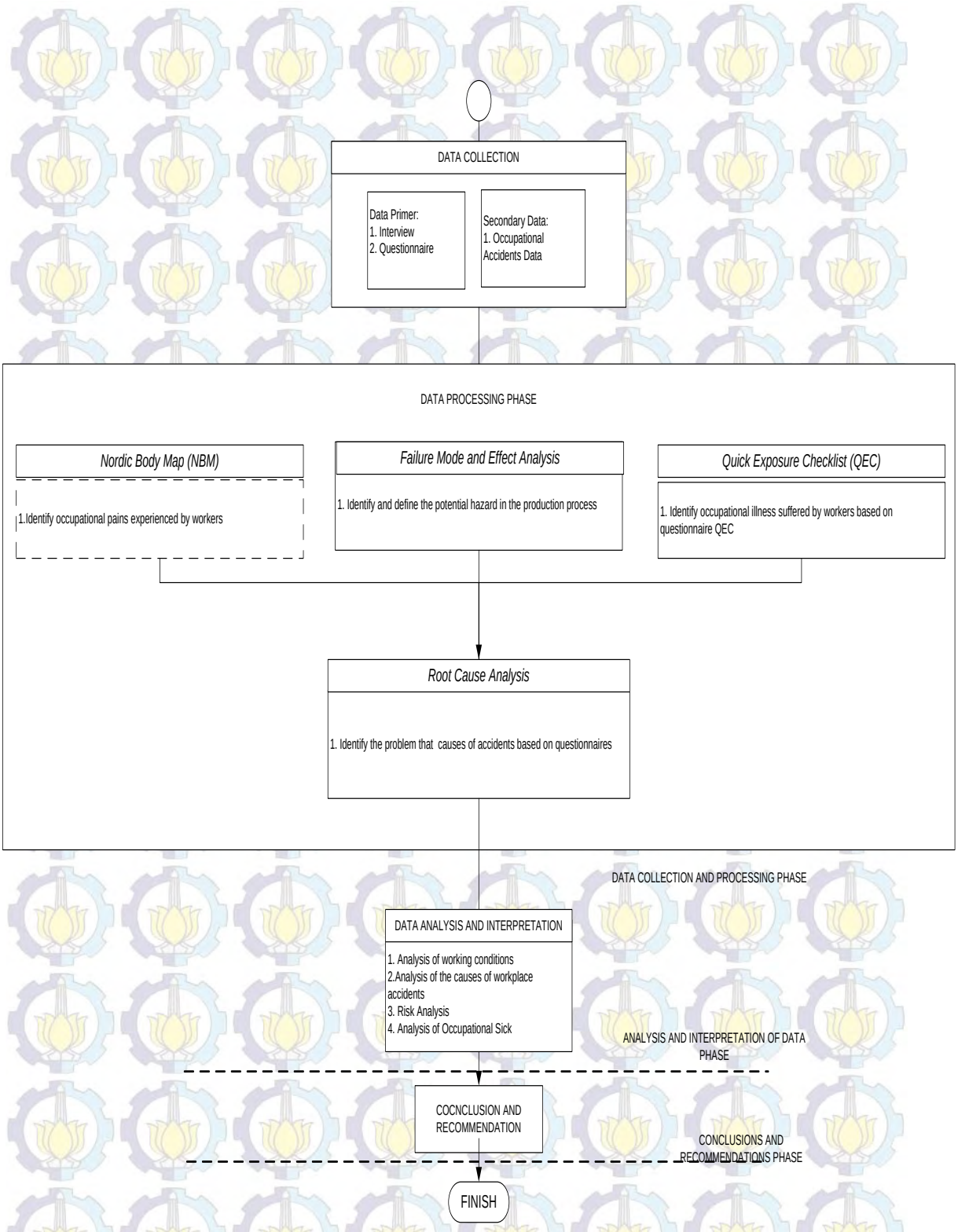

Figure 3.2 Research Methodology Flowchart (continue)

CHAPTER IV
DATA COLLECTING AND PROCESSING

In this chapter IV, will be collecting data and also data processing from PT. International Chemical Industry.

4.1 Data Collecting

On data collection, there are two types of data: primary data and secondary data. Primary data obtained directly using questionnaires or interviews, and secondary data was obtained from the data supporting historical data from company.

4.2 Company Profile

PT. Hari Terang Industry is manufacturing companies in the country which produce dry battery brands ABC with international quality standards, located at Jln. Industry Rungkut II/12 Surabaya. The company is a development from previous two battery factories, which are in Medan and Jakarta.

It is starting from the construction of the first ABC battery plant in Medan in 1959 by Chandra Djojonegoro and Chu Sok Sam with the name of PT. Everbright Battery Factory. In 1968, it under the name PT. International Chemical Industrial. To fulfill the needs of ABC battery products domestic market and abroad which is increasing, then built a factory in Surabaya with the name of PT. Hari Terang Industry (d / h PT. Hari Terang Industrial Co.., Ltd.) which has been operating since 1982.

Surabaya city elected based on consideration to improve the effectiveness and efficiency of distribution region of Eastern Indonesia market. Battery products are produced by PT. Hari Terang Industry include Zinc Carbon types of quality: Quality Standard and Economy. While the size of produced is: R20/UM-1 and R6/UM-3. All the products have high quality and produced based on: IEC

Standard 86-1/86-2 (1993), C.181-1986 ANSI, JIS C.8501-1993, SNI 04-2051-1990.77.

Since the 1980s ABC batteries have mastered 70% of the domestic market. One of the strengths of this battery is a powerful distribution as held by PT. Artha Boga Shining (ABC) and had 72 points in the distribution network throughout Indonesia. ABC battery is also exported to more than 50 countries using 70 different brands, except for Australia and some African nations that use ABC brand and Alkaline. Exports are able to contribute up to 40% from total revenue.

PT. International Chemical Industry Plant 1 produces carbon-zinc batteries and battery alakaline. The products of PT. International Chemical Industry Plant 1 ABC branded or customer orders. PT. International Chemical Industry Plant 2 produces 3 types of carbon-zinc batteries, the green battery type R20 ABC, ABC Blue Batteries and ABC blue Battery R6. The products are marketed under ABC brands including such as:

- ABC Rechargeable Battery
- ABC Alkaline
- ABC heavy Duty 9 Volt (battery box)
- ABC Super Power / Super Extra Heavy Duty (Black)
- ABC New Special / Extra Heavy Duty (Red)
- ABC Super Electric / Heavy Duty (Gold) for export market
- ABC Standard (blue)
- ABC Standard (green)
- ABC Standard (yellow)

Figure 4.1 ABC Battery

4.2.1 Visions and Company Policy

Company Visions is: 'Being a manufacturer of dry batteries with the international quality standard with environmentally friendly process that is managed effectively and efficiently so as to increase the competitiveness of local and global market.

While the Quality Policy and the Environment: PT International Chemical Industry and PT. Hari Terang Industry is a national private company that manufactures dry battery ABC brand of high quality and famous brands in accordance with customer demand, committed:

1. Implement the Quality Management System according to Standard ISO 9001:2000 and Environmental Management System according to ISO 14001:2004 standards effectively and efficiently;
2. Perform continuous improvement through quality objectives and measurable environmental programs in every department;
3. Give satisfaction to customers and other stakeholders both in terms of quality, price, delivery, and service;
4. Comply with legislation and other requirements relevant to aspects of the company's activities;
5. Preventing environmental pollution from the aspect of its activities, products or services related to the company;
6. Make savings of resources that include labor efficiency, electricity, water, and fuel oil.

Visions and policies are documented, communicated to all personnel and other related parties, and open to the public (Managing Director, October 2005).

4.2.2 Mission and Objectives of the Company

Mission PT. Hari Terang Industry in general is directing the actions to achieve the delivery of services and benefits to the community. The objectives are:

a. Active participation from the employees. Encourages all employees to play an active role in all aspects of the employment process,

combining personal responsibility with a willingness to play a role that has been determined by the job title.

b. Create value for the consumer lifestyle and for consumers. Today in PT Light Industry where everything begins and ends with the consumer, which is based on four key words, namely: health, hygiene, beauty and comfort that will consistently offering something of value for people around the world.

c. The increase in the three focus areas, (lifestyle, business partners, and brand). The most fundamental purpose is for serving and makes the community better through the products and services we provide. To achieve these objectives, the company continues to deepen the understanding of consumer lifestyles and changing needs of stakeholders, as well as carefully monitor trends products, services, information and technology available.

4.3 Product Identification observations

In this section will explain the observation products, namely Battery R6.

PT. International Chemical Industry has some kind of product in the production process, namely: R6, R20, and others. At R6 type batteries are the main points in manufacture which the components from the battery, namely:

* Carbon Zinc Battery R6-AA (BLUE)
* Size: R6/AA/UM3
* Jacket: METAL
* No mercury and Cadmium Added
* Designation : ANSI-, IEC-JIS
* Nominal Voltage: 1,5 V
* Certification: ISO 9001 and ISO 140001

4.3.1 Physical Flow Battery Production Process R6

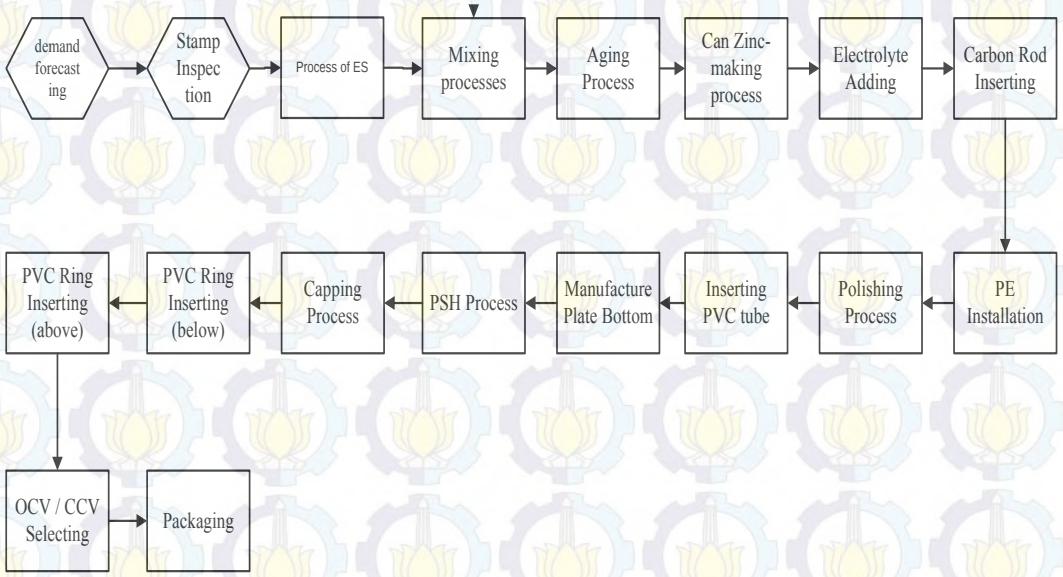

Figure 4.2 Physical Flow Battery Production Process R6

1. Starting with demand forecasting (3 headdress) and subsequently request to the supplier material carried
2. First Stamp sent by the supplier, then inspected first, and then does the processing.
3. The production process begins with the manufacture of ES using the pH and specific gravity
4. Mixing processes, where do manufacture of Black Mix done by measuring the moisture Aging, tapping value
5. In the aging process is obtained bobbin. To measure is used weight, absorbs, diameter, height, and density.
6. Can Zinc-making process carries out measurements on the diameter, height, and thickness. Furthermore, it will be combined with the separator in which to be measured is the result from the wide pieces and bobbin inserting separator and done.
7. In the next process is Electrolyte Adding in which the measurement is used as a weight.

8. Next will be built with Carbon Rod Inserting height and diameter as a measure.
9. Seal with high PE installation to a size where done by merging with compound seal.
10. Polishing process in which the process of polishing and cleaning performed.
11. Inserting PVC tube.
12. Manufacture Plate Bottom
13. PSH process, namely PVS Heater with a diameter of PVC Shrink tube to measure
14. Where the capping process will be carried out at height and diameter measurements of the capping.
15. PVC Ring Inserting (below) and Inserting Metal Jacket
16. PVC Ring Inserting (above) and crimping, then performed the aging process.
17. OCV / CCV Selecting, where detection on voltage of the battery if it is appropriate or not.
18. Packaging is done by packing a battery for the first four packs were included in the bus containing 24/96 dozen.

4.3.2 Production Process R6 Batteries

1. Begins with forecasting demand and next request to the supplier performed material. Material that has been delivered and inspected and then performed the processing.

2. The production process is performed using the machine assembling process. Here is the process:

* Mixing

Manufacture of black mix by analyzing the raw materials. After making Black Mix done, then Aging with moisture measurement, tapping value.

* Separator Inserting

Can elections in good condition and then set the can that has elected for conducted by coating the bottom of the bottom washer.

* Bobbin Inserting

Bobbin insert into a can that has been coated by a separator.

* Electrolyte Adding

Addition of electrolyte into the bobbin and weight measurements on the size

* Carbon Cod Inserting

Installation of Carbon Chad in the middle of bobbins, then make the curved section at the top of can.

* Washer Inserting

Do top Washer installation after the installation of carbon cod.

* Pressing

Compaction on top washer that has been installed in the previous.

* Zinc Can Curlin

Bending process on zinc can and diameter measurements will be the primary measure

* Polybuthene Sealing

Closing and giving adhesive to zinc can in order to not remove solids.

* Installation PE Seal (Finishing)

With high as main measure, where is the merger with compound seal.

*Polishing (Finishing)

Conducted the top of the carbon coating process cod with asphalt and bitumen coating the lips can and conducted polishing and cleaning the battery body

*PVC Tube Shrinking (Finishing)

Installation of paper ring and continued with PVC plastic shrinkage and then carried entry to the battery spring jacket

* Capping (Finishing)

Battery can coating with PVC plastic which is then carried out the installation of metal top, and also conducted measurements on height and diameter dimensions of the capping.

* PVC Ring Inserting (Packaging)

Installed PVC ring jacket and bending in the upper, and the installation of metal jacket

* OCV/CCV Selecting (packaging)

Where the detection on maximum and minimum battery voltage do, if it is appropriate or not.

* Packaging

Conducted with packing batteries using PVC plastic and proceed with the installation barcode where packaging is made into four pieces in 1 battery packs in put in a box containing 24/96 dozen.

4.4 Work Environment Conditions

The work environment is one factor that must be considered in the occupational health and safety. In the work environment the production process occurs. In it there was an interaction between man and man and man and machine. In the work environment there are many potential hazards that may arise as a result of unsafe behavior or unsafe environmental conditions.

Production at PT. International Chemical Industry is using heavy machinery operated by several operators. Here is an outline R6 battery production process based from the work stations:

Figure 4.3 Production Process PT. International Chemical Industry

1. **Black Mix and Electrolytes Station**

Black station mix and an electrolyte solution from the initial station R6 battery production process. The process of making Black Mix and electrolyte solution is a mixture of chemicals that can produce an electric current is used as a power source. Prose manufacture of Black Mix through some mixing chemicals, such as: Natural Manganese Dioxide (NMD), Electrolyctical Manganese Dioxide, and Acetylene Black. The three materials are mixed and then stirred by using a tool such as a capsule that can stir the three ingredients in bulk

Black mix station and electrolyte solution is the beginning station of production process R6 batteries. The process of making Black Mix and electrolyte solution is a mixture of chemicals that can produce an electric current is used as a power source. The process of making Black Mix through some mixing chemicals, such as: Natural Manganese Dioxide (NMD), Electrolyctical Manganese Dioxide, and Acetylene Black. The three materials are mixed and then stirred by using a tool such as a capsule that can stir the three ingredients in large quantities.

Space in this area is quite flexible, non-operator workers can move freely, as in the process of taking raw materials, and others. The condition of the floor in this area is quite good, but in some places there are cables that are not neat. This could potentially cause an accident to workers, such as falls. In this area there are also a lot of dust fluxes that can interfere with workers, especially the workers who not use personal protective equipment (PPE) complete, because the flux of dust can interfere with breathing. Then, it needed the appropriate type of mask. Normal lighting in the station and in the station area is quite hot.

Figure 4.4 Raw Material Storage Place

2. Assembling Station

At the assembling station various processes occur in it, as mentioned in the previous section. Assembling process is the process of making battery from the beginning to be a semi battery, where the battery can be used but it is still not safe because it is still in an open state. In the assembling station there are a lot of heavy machinery, process carried out at this station.

The space in this station is quite flexible for its workers. There still many cables from several machines that have not neat. There are also dust fluxes in some process in assembling the station and there is also a wet floor. That is acutely felt in this assembling station is the noise of heavy machinery which is quite noisy. It is required specific headphones that fit in this condition not just ordinary headphones.

Figure 4.5 Wet Floors

3. Finishing Station

The finishing process is a process of making a semi battery to be the battery. At this station, the condition of the floor there are some floors are cracked and there is even a hole, as well as wet. Space in this area is quite

flexible. Air condition at this station is better than both the previous station. The air temperature is not too hot and there is a slight vibration due to the engine operates.

4. Packaging Station

Packaging station is the last station in the R6 battery production process. After going through the finishing station, the battery will be packed into boxes to be marketed to distributors, before that, the battery will be selected in advance by testing the voltage of each battery is already ready to use.

Space in this area is quite free. While the condition of the air at the station quite clean. The air temperature is not too hot because some of the existing machines and there is little vibration due to the engine operating.

4.5 Committee Occupational Safety and Health (P2K3)

At PT. International Chemical Industry, there is a special section that focuses on the occupational safety, health and environmental, namely: Committee Occupational Safety, Health and Environmental (P2K3L) is a committee formed to handle the company in occupational safety, health and environment. The purpose of this is P2K3L formed to control the occupational safety and health and the environment in PT. International Chemical Industry in order to create safety and zero accident. P2K3L is tasked to identify risks in the work environment, create reports, do procurement of PPE, and also do counseling related information to workers K3. Organizational structure P2K3L PT. International Chemical Industry can be seen in Figure 4.6.

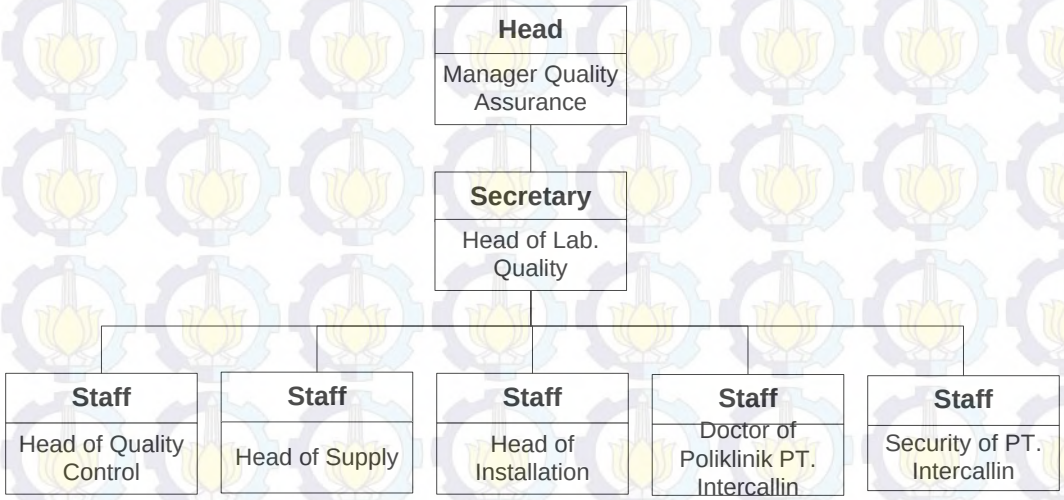

Figure 4.6 Organization Structure of P2K3L

Based on the above organizational structure, Head of the Laboratory as one of the executors in P2K3L and assisted by members.

Based on the picture above is known that P2K3L in PT. International Chemical Industry has been structured as an organization, but in practice this role is still not optimal. Based on the interviews conducted, it is caused by the lack of action and monitoring the implementation of occupational safety and health at the factory. Like a real example there are still some workers who not using PPE and no clear action for workers who not use PPE, such as punishment.

4.6 Personal Protective Equipment (PPE)

One way to prevent workplace accidents in a plant is by using PPE that has been provided by the factory and follow the existing procedures at the plant. PT. International Chemical Industry. Company provides PPE to be worn by the workers. Personal protective equipment (PPE) is the final step which is used to protect them in the work area.

In the production area, should all those who entered in the production area must use the PPE standards. This is in accordance with existing procedures. But it is not applied properly, there are some workers who not using the PPE standards set by the company. The workers only use PPE in certain areas are perceived by

workers is an area that is not safe. There is no reward and punishment on the use of PPE. So that workers tend to be free to wear PPE or not as you wish.

The following are some of PPE that has been provided by PT. International Chemical Industry:

Table 4.1 Personal Protective Equipment

No.	Types of PPE	Function
1	Plastic Googles	Plastic glasses used to protect the eyes from dust
2	Welding Googles	These glasses are used by workers when performing welding on machine parts that were damaged
3	Gloves	These gloves are used to protect hands from sharp objects, heat and fluid
5	Mask	Used to protect the nose and mouth from dust and chemical gases
6	Ear	Used to protect the ears from the noise
7	Safety Shoes	Used to protect the foot from sharp objects and heat

Figure 4.7 Worker condition in production area

4.7 Risks Identification

Risk identification is done based on the translation of the company's activities. Translation of activities used in the identification of risks is contained in the area of production activity of PT. International Chemical Industry. Each of these activities in the production area will be identified that have the potential occurrence of the risk. Risks that have been identified will be assessed to determine which risks are the most influential and need to be repaired. Identification and risk assessment process using FMEA (Failure Modes and Effects Analysis). The following are potential risks in activities that exist in the company in Table 4.2

Table 4.2 Potential Failure and Potential Accident

Station	Process	Risk Code	Potential Failure	Potential Accident
Black Mix dan Larutan Elektrolit	P.1.1 The producton of Black Mix and Aging	BR 1	Error in the taking of raw material Black Mix	Falls, chemical liquids, respirable dust flux interfere with breathing,
		BR 2	Error in moisture and tapping value measurement	
		BR 3	Raw material not mix homogenly	
		BR 4	Errors in entering the raw material, splattered all	
		BR 5	Machine cables are not neat	
Assembling	P.1.2 Seperator Inserting, Can elections and coating the bottom of with bottom washer	AR 1	Errors in the amount selection of the Can that needed	Wedged
		AR 2	Bottom of the Can that is not coated well	
	P.1.3 Bobbin Inserting inside the can that already covered by seperator	AR 3	Bobbin are spilled and it's wasted	Wedged, respirable dust flux interfere with breathing
		AR 4	Error in the taking of Bobbin	
	P.1.4 Electrolyte Adding into Can where bobbin already inside	AR 5	Error in electrolyte measurement	Struck by chemicals
		AR 6	Splattered all the electrolyte	
	P.1.5 Carbon Cod Inserting	AR 7	Carbon Cod not exactly locate in the middle	Part of the body, especially the hands pinched
		AR 8	Unperfect part in the can	
	P.1.6 Washer Inserting, pemasangan Top Washer	AR 9	Unperfect in the Top part	Wedged, cracked and holes floor
	P.1.7 Pressing	AR 10	cavity in the part of Top washer	Fall, wedged, hot temperatures
		AR 11	Machine cables are not neat	
		AR 12	Pressing machine too hot because without resting	
	P.1.8 Zinc Can Curlin	AR 13	Unperfect in bending of zinc can	Wedged
		AR 14	Error in diameter measurement	
	P.1.9 Polybuthene Sealing	AR 15	Adhesive does not come out	Fall, exposed to adhesive liquid
		AR 16	Machine cables are not neat	

Table 4.2 Potential Failure and Potential Accident (Continue)

Finishing	P.1.10 Installation PE Seal	FR 1	a cavity in installation of PE Seal	
	P.1.11 Polishing	FR 2	Coating is not perfect	Fall, exposed to polish liquid
		FR 3	Polish liquid is not out	
		FR 4	Machine cables not neat	
	P.1.12 PVC Tube Shrinking	FR 5	Error in diameter measurement	
	P.1.13 Capping	FR 6	Coating is not perfect	
		FR 7	Cavity in the installation of metal top	
Packaging	P.1.14 PVC Ring Inserting	PR 1	Installation loose ring	Wedged
		PR 2	Error in bending the tip jacket	
	P.1.15 OCV/CCV Selecting	PR 3	Cables not neat	Fall, electrocute
		PR 4	Error in voltage detection	
		PR 5	Error in labelling the coding	Wedged, fall
		PR 6	Product is not full	
		PR 7	Damage in product packaging dimension	

Based on Table 4.2 above, the identification of potential failure was made on every process in the company. Identification of potential failure based on analysis of company's conditions, historical data, and brainstorming.

After the identification of potential risks occurs in every process, next each of the risk identification is to identify the effect / impact of those risks. Effects of risks that occur can be seen in Table 4.3.

Table 4.3 Potential Effect of Failure

Risk Code	Potential Failure	Potential Effect(s) of Failure
BR 1	Error in the taking of raw material Black Mix	Production delay, unreach target, production time increase
BR 2	Error in moisture and tapping value measurement	
BR 3	Raw material not mix homogenly	Poor quality, defect product, financial loss
BR 4	Errors in entering the raw material, splattered all	Dust flux respirable by workers, worker get struck by chemicals
BR 5	Machine cables are not neat	Stumble workers, production delay

Table 4.3 Potential Effect of Failure (Continue)

Risk Code	Potential Failure	Potential Effect(s) of Failure
AR 1	Errors in the amount selection of the Can that needed	Production delays, production time
AR 2	Bottom of the Can that is not coated well	Poor quality, defect product, financial loss
AR 3	Bobbin are spilled and it's wasted	Dust flux respirable by workers, Production delays, production time increases
AR 4	Error in the taking of Bobbin	
AR 5	Error in electrolyte measurement	Production delays, production time increases, worker get struck by chemicals
AR 6	Splattered all the electrolyte	
AR 7	Carbon Cod not exactly locate in the middle	Poor quality, defect product, financial loss
AR 8	Unperfect part in the can	
AR 9	Unperfect in the Top part	Poor quality, defect product, financial loss
AR 10	cavity in the part of Top washer	Defect Product
AR 11	Machine cables are not neat	Stumble workers, production delay
AR 12	Pressing machine too hot because without resting	Defect Product, injury worker
AR 13	Unperfect in bending of zinc can	Defect Product
AR 14	Error in diameter measurement	Production delays, production time
AR 15	Adhesive does not come out	Stumble workers, production delay, production time increase
AR 16	Machine cables are not neat	
FR 1	a cavity in installation of PE Seal	Defect Product
FR 2	Coating is not perfect	Production delays, production time
FR 3	Polish liquid is not out	
FR 4	Machine cables not neat	Stumble workers, production delay

Table 4.3 Potential Effect of Failure (Continue)

Risk Code	Potential Failure	Potential Effect(s) of Failure
FR 5	Error in diameter measurement	Production delays, production time
FR 6	Coating is not perfect	Production delays, production time
FR 7	Cavity in the installation of metal top	Defect Product
PR 1	Installation loose ring	Defect Product
PR 2	Error in bending the tip jacket	Production delays, production time
PR 3	Cables not neat	Stumble workers, production delay
PR 4	Error in voltage detection	Production delays, production time
PR 5	Error in labelling the coding	producton time increases, high defect product
PR 6	Product is not full	Delivery delay, unreach target
PR 7	Damage in product packaging dimension	Lack of raw material, poor quality, production delay

The next stage is to identify the causes of risk. Here is an event that causes the risk in Table 4.4.

Table 4.4 Potential Cause of Failure

Risk Code	Potential Failure	Potential Cause (s) of Failure
BR 1	Error in the taking of raw material Black Mix	Human Error
BR 2	Error in moisture and tapping value measurement	Human Error
BR 3	Raw material not mix homogenly	Interference with the machine, stirring imperfect
BR 4	Errors in entering the raw material, splattered all	Human Error
BR 5	Machine cables are not neat	Poor maintenance
AR 1	Errors in the amount selection of the Can that needed	Human Error

Table 4.4 Potential Cause of Failure (continue)

Risk Code	Potential Failure	Potential Cause (s) of Failure
AR 1	Errors in the amount selection of the Can that needed	Human Error
AR 2	Bottom of the Can that is not coated well	Interference with the machine poor maintenance
AR 3	Bobbin are spilled and it's wasted	Human Error
AR 4	Error in the taking of Bobbin	Human Error
AR 5	Error in electrolyte measurement	Interference with the machine poor maintenance
AR 6	Splattered all the electrolyte	
AR 7	Carbon Cod not exactly locate in the middle	Interference with the machine poor maintenance
AR 8	Unperfect part in the can	
AR 9	Unperfect in the Top part	Interference with the machine poor maintenance
AR 10	cavity in the part of Top washer	Human Error, interference in the machine
AR 11	Machine cables are not neat	Human Error, Poor maintenance
AR 12	Pressing machine too hot because without resting	
AR 13	Unperfect in bending of zinc can	Human Error, Interference with the machine
AR 14	Error in diameter measurement	Human Error
AR 15	Adhesive does not come out	Human Error, Interference with the machine
AR 16	Machine cables are not neat	
FR 1	a cavity in installation of PE Seal	Human Error, Interference with the machine
FR 2	Coating is not perfect	Human Error, Interference with the machine
FR 3	Polish liquid is not out	
FR 4	Machine cables not neat	Poor maintenance
FR 5	Error in diameter measurement	Human Error
FR 6	Coating is not perfect	Human Error
FR 7	Cavity in the installation of metal top	Human Error, Interference with the machine

Table 4.4 Potential Cause of Failure (continue)

Risk Code	Potential Failure	Potential Cause (s) of Failure
PR 1	Installation loose ring	Human Error, Interference with the machine
PR 2	Error in bending the tip jacket	Human Error
PR 3	Cables not neat	Poor maintenance
PR 4	Error in voltage detection	Poor maintenance
PR 5	Error in labelling the coding	Human error
PR 6	Product is not full	Production capacity does not fulfill
PR 7	Damage in product packaging dimension	Human error

Next is to identify the control or prevention is made at this time by PT. International Chemical Industry so that the risk of potentially will not occur. Precautions taken by the company can be seen in Table 4.5.

Table 4.5 Current Control

Risk Code	Potential Failure	Detection/ Current Controls
BR 1	Error in the taking of raw material Black Mix	Checking back raw materials and monitoring
BR 2	Error in moisture and tapping value measurement	Checking back the data input
BR 3	Raw material not mix homogenly	SOP, Stirring appropriate time and manner prescribed and
BR 4	Errors in entering the raw material, splattered all	Cleaning area
BR 5	Machine cables are not neat	Inspection and cleaning area
AR 1	Errors in the amount selection of the Can that needed	Re-check the Can and monitoring
AR 2	Bottom of the Can that is not coated well	Product inspection and maintenance for machine
AR 3	Bobbin are spilled and it's wasted	inspection and cleaning area

Table 4.5 Current Control (continue)

Risk Code	Potential Failure	Detection/ Current Controls
AR 4	Error in the taking of Bobbin	Checking Bobbin and monitoring
AR 5	Error in electrolyte measurement	Checking back
AR 6	Splattered all the electrolyte	
AR 7	Carbon Cod not exactly locate in the middle	Product inspection and maintenance for machine
AR 8	Unperfect part in the can	
AR 9	Unperfect in the Top part	Product inspection and maintenance for
AR 10	cavity in the part of Top washer	Checking and also do routine in machine
AR 11	Machine cables are not neat	inspection and cleaning area. Worker use PPE
AR 12	Pressing machine too hot because without resting	
AR 13	Unperfect in bending of zinc can	Checking and also do routine in machine
AR 14	Error in diameter measurement	Checking the data and monitoring
AR 15	Adhesive does not come out	Checking and also do routine in machine maintenance
AR 16	Machine cables are not neat	
FR 1	a cavity in installation of PE Seal	Checking and also do routine in machine
FR 2	Coating is not perfect	Checking and also do routine in machine
FR 3	Polish liquid is not out	
FR 4	Machine cables not neat	inspection and cleaning area
FR 5	Error in diameter measurement	Checking the data and monitoring
FR 6	Coating is not perfect	Checking and also do routine in machine maintenance
FR 7	Cavity in the installation of metal top	
PR 1	Installation loose ring	Checking and also do routine in machine maintenance
PR 2	Error in bending the tip jacket	Checking the data and monitoring

Table 4.5 Current Control (continue)

Risk Code	Potential Failure	Detection/ Current Controls
PR 3	Cables not neat	inspection and cleaning area
PR 4	Error in voltage detection	Checking the data and monitoring
PR 5	Error in labelling the coding	Monitoring and checking the process of coding
PR 6	Product is not full	Any inspections during the production process , recycle product into the next Lot
PR 7	Damage in product packaging dimension	Any inspections during the production process to the finished product

4.8 Nordic Body Map (NBM)

Questionnaires Nordic Body Map (NBM) is used to determine the level of pain complaints that perceived by workers in 27 parts of the body. It is all based on the results of a questionnaire. The recap can be seen in Table 4.6.

Table 4.6 Recap Questionnaire of Nordic Body Map

No.	Location	Workers																													Average	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
1	Pain in the neck	1	4	4	3	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	4	1	1	1	3	1	1	1	1	1	2	45
2	Pain in the left shoulder	3	1	3	3	1	3	1	1	1	1	1	1	3	4	1	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	2	49
3	Pain in the right shoulder	1	1	3	3	1	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	2	1	2	1	2	1	1	4	4	1	2	46
4	Pain in the left upper arm	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	4	1	1	1	1	36
5	Pain in the back	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	34
6	Pain in the right upper arm	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30
7	Pain in the waist	1	3	3	3	1	1	1	1	1	2	1	1	1	1	1	1	1	3	1	1	4	1	1	1	4	1	1	1	1	1	2	45
8	Pain in the hips	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30
9	Pain in the buttocks	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30
10	Pain in the left elbow	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
11	Pain in the right elbow	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
12	Pain in the left forearm	1	1	2	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	34
13	Pain in the right forearm	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	34
14	Pain in the left wrist hand	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	33
15	Pain in the right wrist hand	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	33
16	Pain in the left hand	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30
17	Pain in the right hand	1	1	4	3	3	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	4	1	2	1	4	1	1	1	1	1	2	45
18	Pain in the left thigh	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30
19	Pain in the right thigh	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30
20	Pain in the left knee	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	32
21	Pain in the right knee	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
22	Pain in the left calf	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	3	1	1	1	4	1	1	1	1	1	2	40
23	Pain in the right calf	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	4	1	4	1	2	1	4	1	1	1	1	1	2	46
24	Pain in the left ankle	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	33
25	Pain in the right ankle	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	4	1	1	1	4	1	1	1	1	1	2	41
26	Pain in the left foot	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
27	Pain in the right foot	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31

Description:

1: Do not get sick 3: Pain

2: A little pain 4: Very sick

4.9 Standardize Nordic Questionnaire

From NBM questionnaire known parts of the body which is most pain was felt by workers. The most pain parts of the body will be in the recap which will record the length of pain complaints, consequences occur, and the length of time lost due to work-related pain. Here is a recap of questionnaires that have been taken:

Table 4.7 Time of Complains Pain

No.	Location	Workers																												Average
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	Pain in the neck	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Pain in the left shoulder	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	Pain in the right shoulder	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	Pain in the waist	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	Pain in the right hand	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	Pain in the left calf	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	Pain in the right calf	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	Pain in the right ankle	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Average	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Description:

1: 1-5 days 4: 16-30 days

2: 6-10 days 5:> 30 days

3: 11-15 days

Table 4.8 Consequences Due to Pain

No.	Location	Workers																													Average
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	Pain at the neck	1	1	1	3	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
2	Pain at the left shoulder	1	1	1	2	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
3	Pain at the right shoulder	1	1	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	2	1	1
4	Pain at the waist	1	1	1	2	1	1	1	1	1	2	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
5	Pain at the right hand	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	Pain at the left calf	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	Pain at the right calf	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1
8	Pain at the right ankle	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
	Average	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Description:

1: No effect

2: There was a reduction activities comfort

3: Reduce the types of work activities

4: Got medical care

5: Need to change jobs

Table 4.9 Work Time Lost

No.	Location	Workers																													Average
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	Pain at the neck	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Pain at the left shoulder	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	Pain at the right shoulder	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	Pain at the waist	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	Pain at the right hand	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	Pain at the left calf	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	Pain at the right calf	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	Pain at the right ankle	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Average	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Description:

1: 0 day

2: 1-5 days

3: 6-10 days

4: 11-15 days

5:> 15 days

4.10 Occupational Accidents

There are occupational accident recap in PT. International Chemical Industry. This data based on historical data from the company. All of this accident occurs where workers were working.

Table 4.10 Occupational Accident Year 2009-2012

No.	Incident			Gender	Effect		Location of Injury	Lost work days (days)	Causes of Accidents	Type of Accidents
	Date and Month	Time	Year		Unable to work	Minor Injuries				
1	17 February	09.30 WIB	2009	M		√	Fingers and palms	not recorded	Wedged in round rubber	C3
2	23 March	02.30 WIB	2009	M	√		Body	not recorded	Slipped on the stairs	C5
3	19 May	14.00 WIB	2009	M		√	Right litlle finger	1	Wedged by crane	C3
4	10 September	04.00 WIB	2009	M	√	√	Right hand	2	Wedged by crane	C3
5	23 November	09.00 WIB	2009	M		√	Right hand	2	Wedged by crane	C3
6	17 March	10.30 WIB	2010	M		√	Left hand	2	Splashed by liquid electrolyte	C8
7	23 June	04.00 WIB	2010	M		√	Right hand	3	Hit by plat	C1
8	21 October	14.30 WIB	2010	M		√	Right hand	2	Wedged by crane	C3
9	18 February	09.00 WIB	2011	M		√	Right litlle finger	1	Wedged by crane	C3
10	13 September	09.30 WIB	2011	M		√	Jari-jari, telapak tangan	not recorded	Wedged in round rubber	C3
11	16 November	07.30 WIB	2011	M		√	Right foot, knee	not recorded	Fall	C5
12	29 March	02.30 WIB	2012	M	√		Right foot,	4	Slipped on the stairs	C5
13	15 May	07.30 WIB	2012	M	√		Right hand	10	wedged in conveyor machine	C3
14	4 June	06.30 WIB	2012	M		√	Fingers and palms	3	wedged in door receiver	C3
15	26 September	02.00 WIB	2012	M	√		Right foot,	4	Slipped on the stairs	C5
Total Missing Working Day								34		

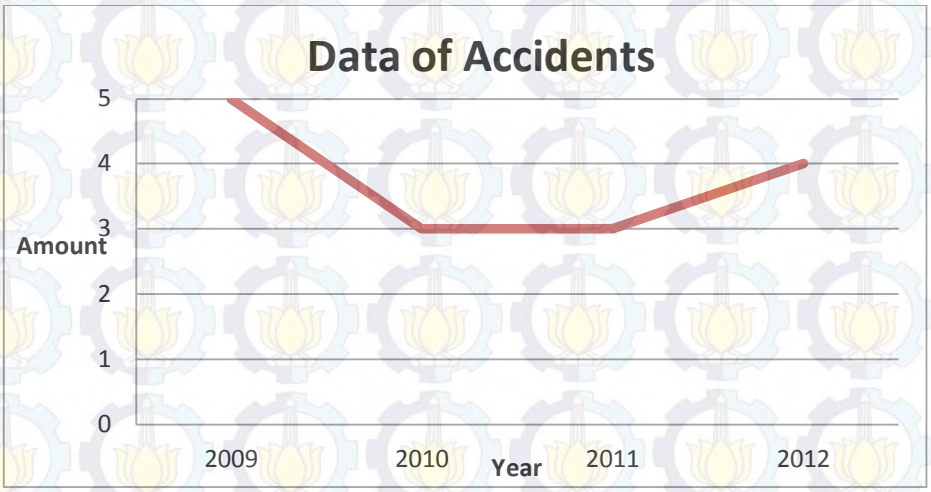

Figure 04.8 Graphs Occupational Accidents Year 2009-2012

4.11 Handling of occupational accidents

At PT. International Chemical Industry, there are several treatment used in case of occupational accidents according to the type of accident that occurred. In the picture 4.8 below is the handling of occupational accidents scenarios based on the severity of the case.

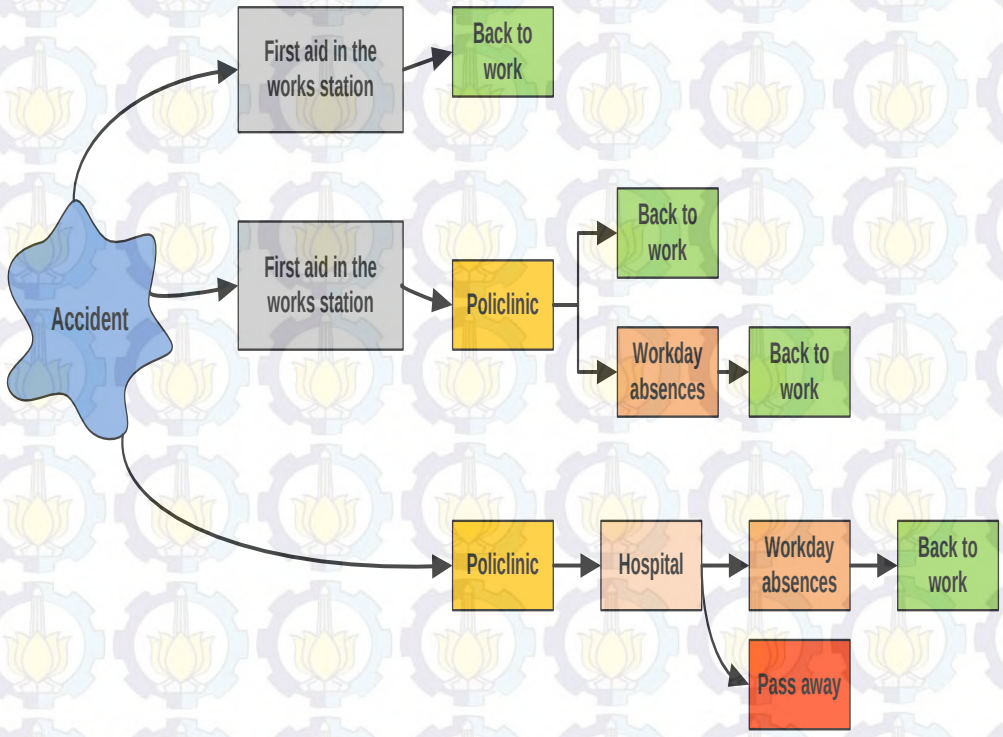

Figure 4.9 Occupational Accidents Handling of Process

In the area at each work station is equipped with P3K box and extension workers have been given basic first aid. If severe accidents and the clinic cannot handle, it will be referred to the Hospital.

- **Data Processing**

Based on the data was obtained in the previous section. In this section the data will made. First data processing is done to do a risk assessment using FMEA, then calculate the work using NBM complaints, while working posture identification using QEC software based on the observation sheet that has been given to the workers at PT. International Chemical Industry, then made RCA that will be used as a basis for recommendation for PT. International Chemical Industry.

4.12 Risk Assessment (Failure Mode Effect Analysis)

Risk management is an assessment of the risks that have been identified. Risks that have been identified will be assessed to determine which risks have the most high and the most critical case. Critical risk indicated by the high value of the RPN. FMEA risk assessment method is where the risk assessed by severity, occurrence, and detection. Value of severity, occurrence, and detection results obtained from the distribution of questionnaires expert judgment. Assessment questionnaire made by the quality assurance manager PT. International Chemical Industry who has the authority, competence and understand the conditions of production, K3 and corporate environments. Here is the result of a risk assessment questionnaire that has been identified:

Table 4.11 Risk assessment

Risk Code	Potential Failure	S	O	D
BR 1	Error in the taking of raw material Black Mix	10	4	2
BR 2	Error in moisture and tapping value measurement	5	4	2
BR 3	Raw material not mix homogenly	9	2	1
BR 4	Errors in entering the raw material, splattered all	9	6	3
BR 5	Machine cables are not neat	3	4	3
AR 1	Errors in the amount selection of the Can that needed	2	3	1
AR 2	Bottom of the Can that is not coated well	4	3	2
AR 3	Bobbin are spilled and it's wasted	8	6	4
AR 4	Error in the taking of Bobbin	8	2	2
AR 5	Error in electrolyte measurement	9	3	2
AR 6	Splattered all the electrolyte	8	6	4
AR 7	Carbon Cod not exactly locate in the middle	8	3	1
AR 8	Unperfect part in the can	4	3	1
AR 9	Unperfect in the Top part	4	3	2
AR 10	cavity in the part of Top washer	7	2	2
AR 11	Machine cables are not neat	3	4	3
AR 12	Pressing machine too hot because without resting	7	4	4
AR 13	Unperfect in bending of zinc can	4	3	2
AR 14	Error in diameter measurement	2	2	1

Table 4.11 Risk assessment (continue)

Risk Code	Potential Failure	S	O	D
AR 15	Adhesive does not come out	4	2	2
AR 16	Machine cables are not neat	3	4	4
FR 1	a cavity in installation of PE Seal	7	2	1
FR 2	Coating is not perfect	4	3	1
FR 3	Polish liquid is not out	4	3	2
FR 4	Machine cables not neat	3	3	3
FR 5	Error in diameter measurement	2	2	2
FR 6	Coating is not perfect	2	3	2
FR 7	Cavity in the installation of metal top	7	2	2
PR 1	Installation loose ring	7	2	1
PR 2	Error in bending the tip jacket	3	3	2
PR 3	Cables not neat	3	3	2
PR 4	Error in voltage detection	8	3	1
PR 5	Error in labelling the coding	10	8	1
PR 6	Product is not full	4	4	2
PR 7	Damage in product packaging dimension	4	4	2

From Table 4.11 above, the value of S indicates severity, O shows occurrence, and D showed detection. Each one is worth one to ten. Having obtained the value of severity, occurrence, and detection calculated value of the RPN (Risk Priority Number) which is a ranking of the risks that have been identified. RPN values obtained using the formula. From the value of the RPN knowable risks that have the highest impact (critical) system which can interfere with the company. Here is the calculation of RPN values for each risk.

Table 4.12 RPN Scoring

Risk Code	Potential Failure	Risk Priority Number
BR 1	Error in the taking of raw material Black Mix	80
BR 2	Error in moisture and tapping value measurement	40
BR 3	Raw material not mix homogenly	18
BR 4	Errors in entering the raw material, splattered all	162
BR 5	Machine cables are not neat	36
AR 1	Errors in the amount selection of the Can that needed	6
AR 2	Bottom of the Can that is not coated well	24
AR 3	Bobbin are spilled and it's wasted	192
AR 4	Error in the taking of Bobbin	32
AR 5	Error in electrolyte measurement	54
AR 6	Splattered all the electrolyte	192
AR 7	Carbon Cod not exactly locate in the middle	24
AR 8	Unperfect part in the can	12
AR 9	Unperfect in the Top part	24
AR 10	cavity in the part of Top washer	28
AR 11	Machine cables are not neat	36
AR 12	Pressing machine too hot because without resting	112
AR 13	Unperfect in bending of zinc can	24
AR 14	Error in diameter measurement	4
AR 15	Adhesive does not come out	16
AR 16	Machine cables are not neat	48

Table 4.12 RPN Scoring (continue)

Risk Code	Potential Failure	Risk Priority Number
FR 1	a cavity in installation of PE Seal	14
FR 2	Coating is not perfect	12
FR 3	Polish liquid is not out	24
FR 4	Machine cables not neat	27
FR 5	Error in diameter measurement	8
FR 6	Coating is not perfect	12
FR 7	Cavity in the installation of metal top	28
PR 1	Installation loose ring	14
PR 2	Error in bending the tip jacket	18
PR 3	Cables not neat	18
PR 4	Error in voltage detection	24
PR 5	Error in labelling the coding	80
PR 6	Product is not full	32
PR 7	Damage in product packaging dimension	32

Value of the RPN is used to determine level of risk. Risks are categorized into three levels, namely:

- High Risk : RPN value ≥ 80
- Medium risk : RPN Value 40-79
- Low Risk : RPN value <40

At the end, we obtained several categories of risk from the calculation of the RPN.

4.13 Nordic Body Map

From the NBM questionnaire, it will be known any part of the body of the workers that sick during work. The greatest value of recap NBM questionnaires will be processed by Standardize Nordic questionnaire to determine the length of time a complaint, the consequences of pain, and length of time lost due to lost work. Here is a recap of the results of the questionnaire NBM.

Table 4.13 Recap NBM questionnaire

No.	Location	Rata-rata	Total
1	Pain in the neck	2	45
2	Pain in the left shoulder	2	49
3	Pain in the right shoulder	2	46
4	Pain in the left upper arm	1	36
5	Pain in the back	1	34
6	Pain in the right upper arm	1	30
7	Pain in the waist	2	45
8	Pain in the hips	1	30
9	Pain in the buttocks	1	30
10	Pain in the left elbow	1	31
11	Pain in the right elbow	1	31
12	Pain in the left forearm	1	34
13	Pain in the right forearm	1	34
14	Pain in the left wrist hand	1	33
15	Pain in the right wrist hand	1	33
16	Pain in the left hand	1	30
17	Pain in the right hand	2	45
18	Pain in the left thigh	1	30
19	Pain in the right thigh	1	30
20	Pain in the left knee	1	32
21	Pain in the right knee	1	31
22	Pain in the left calf	2	40
23	Pain in the right calf	2	46
24	Pain in the left ankle	1	33
25	Pain in the right ankle	2	41
26	Pain in the left foot	1	31
27	Pain in the right foot	1	31

Based on the results of NBM recap showed that there are eight locations most complained pain by the workers of the neck, left shoulder, right shoulder, waist, right hand, left calf, right calf and right ankle. Each one of these locations has a value of 2 points.

Next, perform data processing using Standardize nordic questionnaire. Standardize the purpose of using the Nordic questionnaire is to determine the length of time a complaint, the consequences of pain, and length of time lost due to lost work. Recap Standardize Nordic questionnaire can be seen in Table 4.14

Table 4.14 Recap Standardize Nordic Questionnaire

Worker	Average		
	Pain Complaints time	Consequence	Lost Work Time
1	1	1	1
2	1	1	1
3	1	1	1
4	1	1	1
5	1	1	1
6	1	1	1
7	1	1	1
8	1	1	1
9	1	1	1
10	2	1	1
11	1	1	1
12	1	1	1
13	1	1	1
14	2	1	1
15	1	1	1
16	2	1	1
17	1	1	1
18	1	1	1
19	1	1	1
20	1	1	1
21	1	1	1
22	1	1	1
23	1	1	1
24	1	1	1
25	1	1	1
26	1	1	1
27	1	1	1
28	1	1	1
29	1	1	1
30	1	1	1

4.14 Quick Exposure Checklist

Next method is used to process the data that has been obtained is QEC method or Quick Exposure Checklist. QEC is the method used to determine the parts of the body that need special attention and improvement. This method uses software QEC 2003 in the process. Body parts to be observed are the back, shoulders, wrists, and neck. Data obtained by giving questionnaires such as questions on software QEC. Display of software used QEC 2003 can be seen in Figure 4.10 and Figure 4.11.

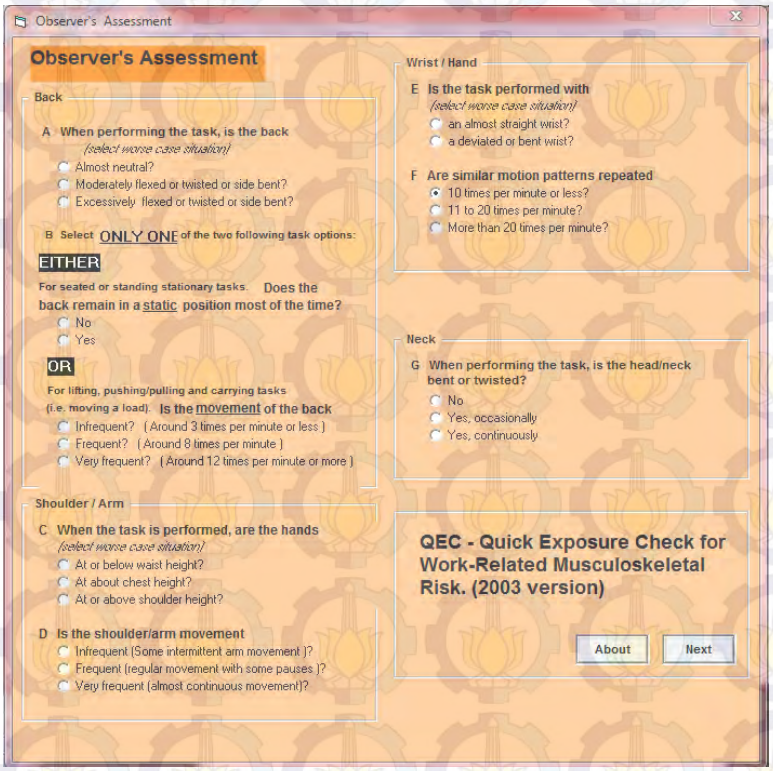

Figure 4.10 Software QEC Display for observer

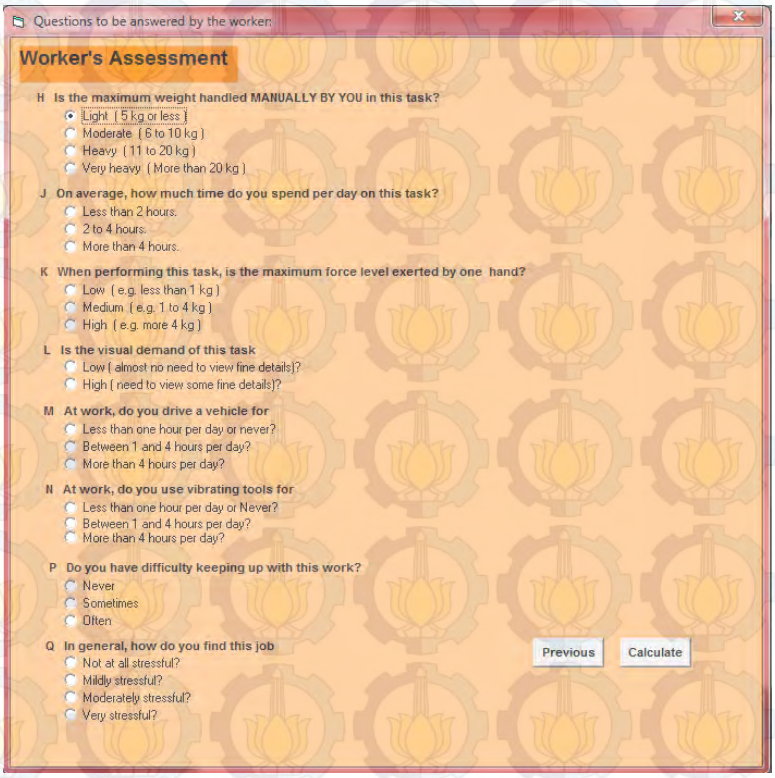

Figure 4.11 Software QEC Display for worker

Figure 4.12 Display of QEC Result

In this method, measurements are divided into two types of workers, the operator and non-operator (transport workers or laborers). So it will be easier to analyze for improvement, because the two jobs have different job. Based on the results of the calculation software QEC, QEC scores obtained for both types of workers following:

Table 4.15 QEC Total Score for Operator

No.	Bagian	Pekerja - Operator																			Total	QEC Score
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	*Back*	8	8	8	14	8	8	16	8	8	16	24	24	24	24	24	22	22	30	22	30	348	17.4
2	*Shoulder/arm*	14	14	14	22	22	14	14	14	14	22	30	34	34	30	34	30	30	34	30	34	484	24.2
3	*Wrist/hand*	10	10	14	10	32	14	10	10	34	18	24	26	26	24	26	34	34	30	28	30	444	22.2
4	*Neck*	8	8	8	6	16	16	14	16	14	14	8	12	8	8	8	12	12	10	12	10	220	11
5	*Driving*	4	4	4	4	4	1	1	4	1	1	1	1	1	1	1	4	4	4	1	4	50	2.5
6	*Vibration*	4	1	4	1	1	4	1	4	1	4	1	4	1	1	1	1	4	1	1	1	41	2.05
7	*Workplace*	4	4	1	4	1	4	1	1	1	1	4	4	4	4	4	4	4	4	1	4	59	2.95
8	*Stress*	1	1	4	1	1	1	1	4	4	4	1	4	1	4	4	4	4	4	1	4	53	2.65

Table 4.16 QEC Total Score for Non Operator

No.	Bagian	Pekerja - Non Operator										Total	QEC Score
		1	2	3	4	5	6	7	8	9	10		
1	*Back*	14	14	14	26	26	24	24	34	34	34	244	24.4
2	*Shoulder/arm*	22	22	22	36	32	34	34	34	34	34	304	30.4
3	*Wrist/hand*	14	14	14	26	14	26	30	30	28	26	222	22.2
4	*Neck*	10	8	8	14	12	8	16	12	10	14	112	11.2
5	*Driving*	4	9	9	4	4	4	4	4	4	4	50	5
6	*Vibration*	1	4	1	4	4	4	1	4	4	4	31	3.1
7	*Workplace*	4	4	4	1	4	4	4	1	1	1	28	2.8
8	*Stress*	4	4	4	4	9	4	4	4	4	4	45	4.5

After the results obtained from using the software QEC 2013, the next total score will be calculated to determine the total value of QEC score by summing the scores back, shoulder, wrist, and neck. Here is the calculation of a total score of QEC:

Total score for operator = back score + shoulder score + wrist score + neck score

= 17,4+ 24.2 + 22.2+11

= 74,8

Total score for non operator = back score + shoulder score + wrist score + neck score

= 24,4 + 30.4 + 22,2 + 11,2

= 88,2

Based on the above calculation, showed that the operator belongs to the category further investigate and for non-operator jobs classified in the category investigate further and Change Soon. In addition to calculating the total score of

QEC for categories of workers also performed calculations QEC score for each body part. Recap QEC scores can be seen in Table 4:17 and Table 4.18.

Table 4.17 QEC Score for Operator

No.	Part	Scale	QEC Score	Action
1	*Back*	2-3	17.4	Acceptable
2	*Shoulder/arm*	4-5	24.2	Investigate Further
3	*Wrist/hand*	4-5	22.2	Investigate Further
4	*Neck*	6-7	11	Investigate Further and Change Soon

Table 4.18 QEC Score for Non Operator

No.	Part	Scale	QEC Score	Action
1	*Back*	6-7	24.4	Investigate Further and Change Soon
2	*Shoulder/arm*	6-7	30.4	Investigate Further and Change Soon
3	*Wrist/hand*	4-5	22.2	Investigate Further
4	*Neck*	6-7	11.2	Investigate Further and Change Soon

4.15 Occupational Accidents

Accident data that have been obtained will be grouped into types based clustering crash accident of Jamsostek. Recap types of accidents that occur at PT. International Chemical Industry can be seen in Table 4.19.

Table 4.19 Grouping of Accidents and Total Working Days Lost

No.	Incident			Gender	Effect		Location of Injury	Lost work days (days)	Causes of Accidents	Type of Accidents
	Date and Month	Time	Year		Unable to work	Minor Injuries				
1	17 Februari	09.30 WIB	2009	M		√	Fingers and palms	not recorded	Wedged in round rubber	C3
2	23 Maret	02.30 WIB	2009	M	√		Body	not recorded	Slipped on the stairs	C5
3	19 Mei	14.00 WIB	2009	M		√	Right litlle finger	1	Wedged by crane	C3
4	10 Septemberr	04.00 WIB	2009	M	√	√	Right hand	2	Wedged by crane	C3
5	23 November	09.00 WIB	2009	M		√	Right hand	2	Wedged by crane	C3
6	17 Maret	10.30 WIB	2010	M		√	Left hand	2	Splashed by liquid electrolyte	C8
7	23 Juni	04.00 WIB	2010	M		√	Right hand	3	Hit by plat	C1
8	21 Oktober	14.30 WIB	2010	M		√	Right hand	2	Wedged by crane	C3
9	18 Februari	09.00 WIB	2011	M		√	Right litlle finger	1	Wedged by crane	C3
10	13 Septemberr	09.30 WIB	2011	M		√	Jari-jari, telapak tangan	not recorded	Wedged in round rubber	C3
11	16 November	07.30 WIB	2011	M		√	Right foot, knee	not recorded	Fall	C5
12	29 Maret	02.30 WIB	2012	M	√		Right foot,	4	Slipped on the stairs	C5
13	15 Mei	07.30 WIB	2012	M	√		Right hand	10	wedged in conveyor machine	C3
14	4 Juni	06.30 WIB	2012	M		√	Fingers and palms	3	wedged in door receiver	C3
15	26 September	02.00 WIB	2012	M	√		Right foot,	4	Slipped on the stairs	C5
Total Missing Working Day								34		

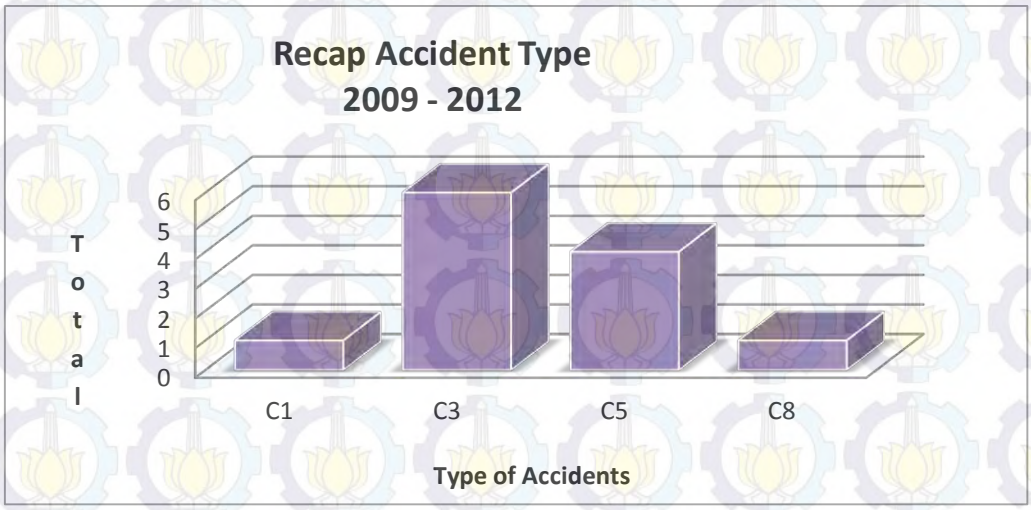

Figure 4.13 Based on Types of Accidents

Based on historical data on accidents PT. International Chemical Industry found that accidents that often happen that the type of C3 and C5.

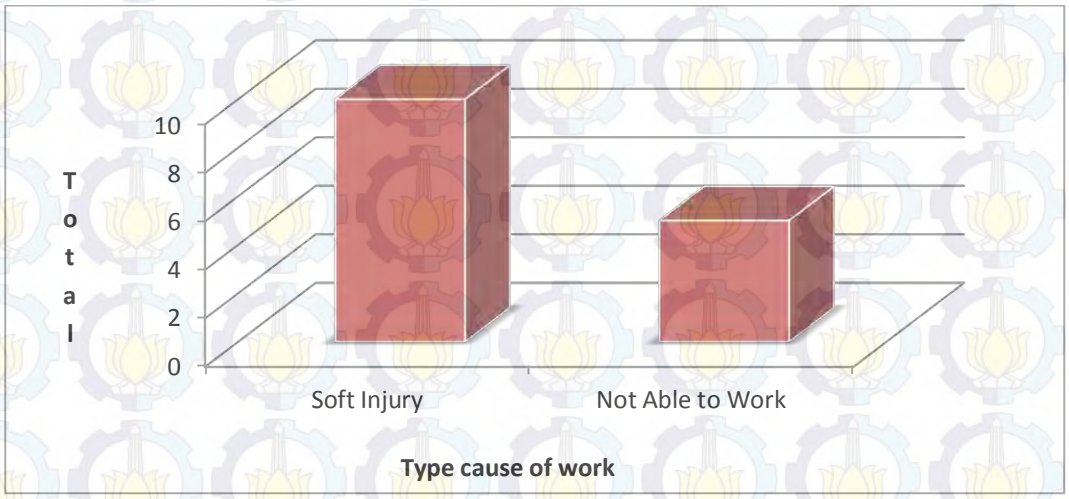

Figure 4.14 Based on cause of accidents

4.16 Occupational Accidents Statistics

To determine the size of the risk will be calculated with the occupational accidents statistics to find out the level of frequency and level of occupational accidents consequences. From data that has been obtained it will be made and the results obtained frequency calculations of the accident which occurred 2009-2012 as follows:

Year 2010

Accidents = 3

Number of work hour = 6 months x 30 days x 24 hours x 330 workers

= 1.425.600 work hours

Then obtained,

$$F = \frac{\text{many accidents} \times 1.000.000}{\text{number of man} - \text{hours}}$$

$$F = \frac{3 \times 1000000}{1425600} = 2.10$$

So the frequency of accidents that occurred within one year 3 accidents occurs every one million hours of human.

Table 4.20 Recap Level of frequency

Year	Work Hors	Number of Accidents	Frequency of Accident (F)	Average
2009	1425600	5	3.51	2.63
2010		3	2.10	
2011		3	2.10	
2012		4	2.81	

Based on the calculation of the frequency rate for the year 2009-2012, it found the average frequency of occurrence of accidents in a year that is about 4 accidents per 1,000,000 man-hours. After the calculation of the severity of the accidents that occur each year. Here is the calculation of severity that occurred in 2009-2012:

Year 2009

Number of lost workday = 5 days

Number of Work Hours = 6 month x 30 days x 24 hours x 326 worker

= 1.425.600 work hours

Then obtained,

$$S = \frac{\text{number of days lost} \times 1.000}{\text{number of man} - \text{hours}}$$

$$S = \frac{5 \times 1.000}{1.425.600} = 0.0105$$

So each year approximately 0.00105 day or a day lost at every 1,000 man hours.

Table 4.21 Recap Level of Consequences

Year	Work Hors	Work days Lost	Level f Severity	Average
2009	1425600	5	0.0035	0.0910
2010		7	0.0049	
2011		1	0.0007	
2012		21	0.0147	

Based on the calculation of severity obtained during the years 2009-2012 the annual average of 0091 or as much as a day lost per 1,000 man-hours.

4.17 Standard Procedure of Handling Accident Mapping

Handling existing accident at PT. International Chemical Industry will be illustrated in the diagram to determine if the process of handling an accident at work and the company's stakeholders are also involved in the event of an accident. Figure 4.15 is the mapping process when an accident.

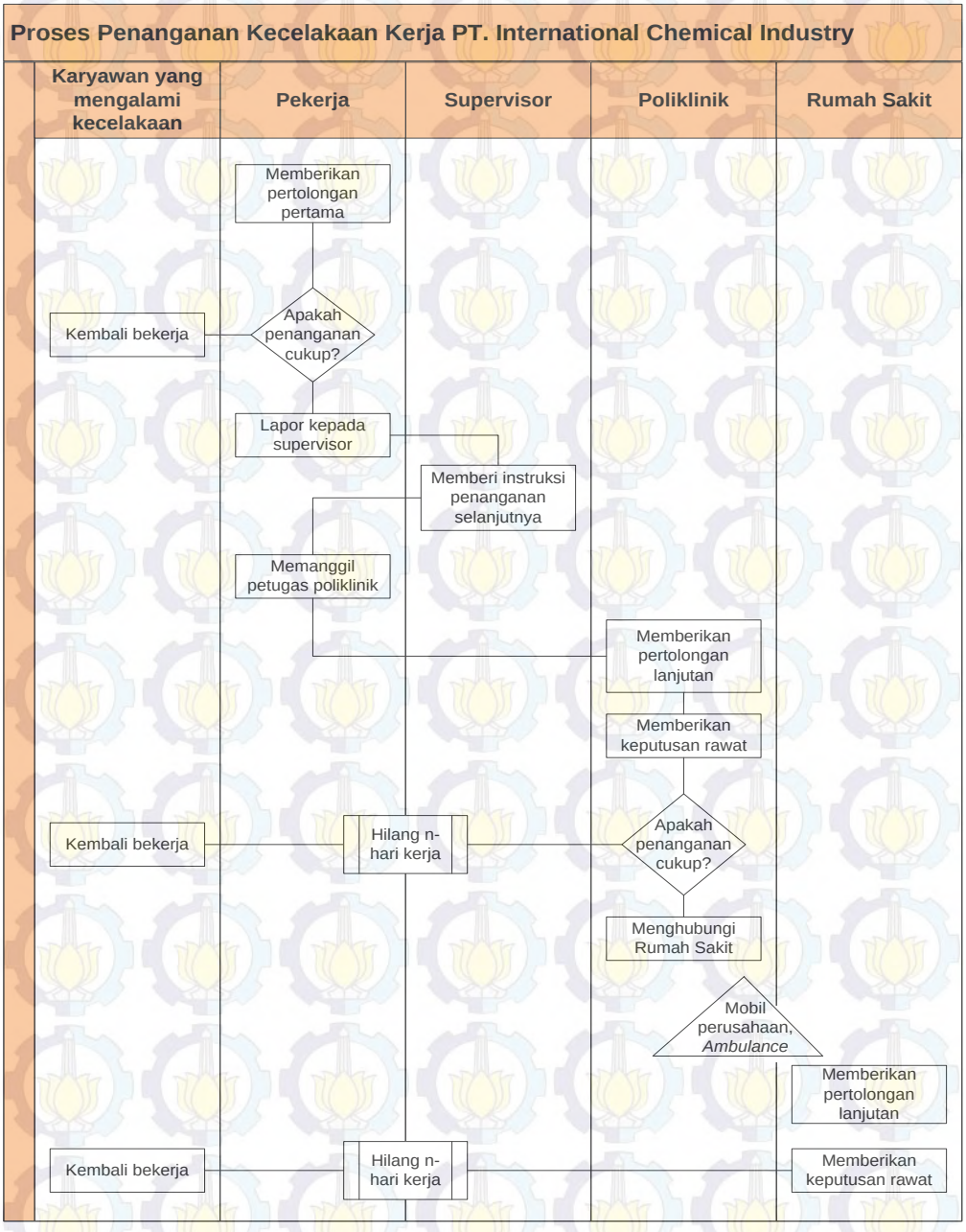

Figure 4.15 Stakeholders Involved to Handling of Accident

Stakeholders involved when accidents by Picture 4.14 are a worker and supervisor. When there is an accident, the worker and supervisor will indirectly having advantage and losses when helping victims. Gains and losses are shown in Table 4.22.

Table 4.22 Advantages and Disadvantages

Worker	
Advantages	**Disadvantages**
Victims get help immediately	Workers had to stop his work to help victim
Avoid more severe consequences from the accident	

Supervisor	
Advantages	**Disadvantages**
Victims get further help immediately	For a while supervisor concentration so focused on the victim's, so lack of supervision in the production process
Avoid more severe consequences from the accident	Temporarily leave monitoring the work station
organized conditions	

4.18 Root Cause Analysis

Next method used is the root cause analysis. This method aims to identify the causes of accidents and then provide recommendations for improvements based on the analysis that had been made.

Analysis of the cause of the accident made the type of accident with the most frequency. The most common accidents there are C3 and C5. Table 4.23 is an analysis of the factors that lead to occupational accidents on each type of accident.

Table 4.23 Root Cause Analysis Accidents

Type of Accidents	Kind of Accidents	Why-1	Why-2	Why-3	Why-4	Why-5
C3	Caught in, under and between objects (wedged, bitten, buried, drowned, etc.).	Environmental conditions are less safe, clean and tidy	Not maintain the security and cleanliness of the environment	Less safety motivation	Poor Monitoring	Company Policy
					No signs / posters K3	
			imperfections equipment	Poor maintenance	Poor maintenance scheduling, less intense	
		Perform unsafe actions	Not wearing PPE	The existing PPE less convenient to use		
				PPE is available less		
				Lack of awareness of safety	There is no clear policy or sanctions regarding the use of PPE	Company Policy
				Lack of knowledge about K3	Never follow the K3 education	
				Less monitoring from supervisor	Company Policy	
				Lack of signs / posters K3		
		Workers Less Concentration	Not focused (distracted)			
			Conditions are not well	There is a physical problem (pain) / psychological (family)		

Table 4.23 Root Cause Analysis Accidents (continue)

Type of Accidents	Kind of Accidents	Why-1	Why-2	Why-3	Why-4	Why-5
C5	Falls from different heights	Environmental conditions are less safe and tidy	Not maintain the security and cleanliness of the environment	Less safety motivation	Poor Monitoring	Company Policy
					No signs / posters K3	
			Not focused (distracted)			
		Workers Less Concentration	Conditions are not well	There is a physical problem (pain) / psychological (family)		

Based on the Root Cause Analysis of the results above, it was found that most of the causes of accidents associated with the company policy and also the problems of individual workers, both physical and psychological.

4.19 Improvements recommendation

Based on the collection and processing of data obtained from the field, there are some important points that need to be run to maximize the implementation and achievement of objectives SMK3. These points are very important in supporting the achievement of objectives SMK3. Important points that need to be met by the company can be viewed as the following::

Recommendations proposed in PT. International Chemical Industry are as follows:

1. Make the program a regular meeting at least 1 month to discuss the conditions and the extension of the occupational safety and health.
2. Performing Control the risk of accidents

3. Conduct regular workplace inspections and scheduled and documented
4. Installing signs occupational safety and health
5. Completeness of first-aid equipment (P3K)

4.19.1 Risk Control

PPE is the last tool that is used to prevent hazards to workers. The use of PPE in reducing the risk of accidents should be used in conjunction with the use of other risk control. So the achievement would be more effective risk control. PPE standards suggested in the processing station can be seen in Table 4:24

Table 4.24 Standard PPE

No.	Type	Criteria	PPE	Picture
1	Helmet	Resistant to fire, electric shock and do not break if exposed to heavy load 3kg	Helm MSA Local MD	
2	Safety Shoes	Wearing Steel Toe Cap (Iron Finger Protector Foot) Sole wears a lightweight and strong PVC Memakai Sole PVC yang ringan & kuat	PX 209	
3	Gloves	Able to absorb sweat Not to grip when used	Gloves SAS Latex	
4	Masks	Able to withstand dust and other small particles and gas	Masker N95 3M	
5	Googles	no distortion effects Resistant to chemical splashes	Googles 3M	
6	Penutup telinga	reduce noise intensity by 20-30 dB	Ear Muff	

4.19.2 Safety Signs

Warning signs is one of the important factors in the K3. With the signs that labor will always be reminded of the rules that are required or specific prohibition in the work environment. Signs are divided into three, namely:

1. Command: ban, obligation
2. Alert: danger, warning, attention
3. information

Recommended guidelines for PT. International Chemical Industry can be seen in Table 4.25.

Table 4.25 Recommendation Safety Signs

Picture or Signs of K3	
	
	
	
	

Signs that have been recommended will be plotted according to the needs of each station.

CHAPTER V
ANALYSIS AND INTERPRETATION

In this section will made do the analysis and interpretation from the data processing was done in the previous chapter.

5.1 Analysis of Environmental Conditions Work

Based on the survey to the PT. International Chemical and also obtained data collection, working conditions, especially in the area of production of PT. International Chemical Industry has been good enough by seen from the level of noise, lighting and temperature in the production area. However, there are some areas which are considered quite high noise level and air temperature are also pretty hot. In terms of condition of the air that it perceived in the work environment there are dust flux at several stations. This dust comes from black mix raw material battery. While for the space is sufficient on all stations. On the environmental conditions required regular maintenance. Shift cleaning is important after work in production areas, such as the condition of the floor is a bit dirty and there is also a wet floor can cause workers to slip and fall. In addition, there are some holes in the floor of the production area.

At PT. International Chemical Industry, there are some occupational safety and health posters in gates installed in the factory area. However, the production area is still very minimal presence of signs or occupational safety and health posters. Signs and occupational safety and health posters is necessary so that the workers always remember that they are working in a dangerous area, so that they will act safely and maintain a work environment. Occupational safety and health signs can be installed in the production area at each station. In addition to the installation of signs and occupational safety and health posters, the use of PPE is still less orderly. Still there are some workers who are not using the PPE standards set by the company. Especially in the area of production, it though the production area is one of the areas that have the potential for accidents. Workers should know and understand the importance of using PPE. This is due to the lack of control of

the management and a lack of motivation owned safety workers. Some workers also claim that the use of PPE uncomfortable when working.

5.2 P2K3L Analysis

PT. International Chemical Industry already has a special section dealing with the occupational safety and health and also environmental issues, the Committee for Safety and Health and the Environment (P2K3L). P2K3L in PT. International Chemical Industry has been going pretty well. It can be seen from the organizational structure P2K3L the superbly formed and structured. No need to be a change in the structure P2K3L, because it has been going pretty well. But in the implementation SMK3 still need some remedial action to be done. Need for at least 1 month of regular meetings to discuss the condition of the plant and K3 also conduct outreach workers returning to the occupational safety and health.

5.3 Risk Analysis

The risks identified in this study are the risks associated mainly in production processes which can cause occupational accidents. Risk identification is done based on risks that have occurred within the company. Furthermore, the identified risk is also a risk that could potentially occur in the company.

There are 35 identified risk overall. At the Black mix and Electrolyte Liquid identified 5 risk, as many as 16 risks identified in assembling stations, finishing station 7 risks has been indentified and the last in packaging station there are 7 risk.

Risks that have been identified then seen to potential accident occurred. Here is is the identification and accident potential of each risk:

Table5.1 Potential Accident

Risk Code	Potential Failure	Potential Accident
BR 1	Error in the taking of raw material Black Mix	Falls, chemical liquids, respirable dust flux interfere with breathing,
BR 2	Error in moisture and tapping value measurement	
BR 3	Raw material not mix homogenly	
BR 4	Errors in entering the raw material, splattered all	
BR 5	Machine cables are not neat	
AR 1	Errors in the amount selection of the Can that needed	Wedged
AR 2	Bottom of the Can that is not coated well	
AR 3	Bobbin are spilled and it's wasted	Wedged, respirable dust flux interfere with breathing
AR 4	Error in the taking of Bobbin	
AR 5	Error in electrolyte measurement	Struck by chemicals
AR 6	Splattered all the electrolyte	
AR 7	Carbon Cod not exactly locate in the middle	Part of the body, especially the hands pinched
AR 8	Unperfect part in the can	
AR 9	Unperfect in the Top part	Wedged, cracked and
AR 10	cavity in the part of Top washer	Fall, wedged, hot temperatures
AR 11	Machine cables are not neat	
AR 12	Pressing machine too hot because without resting	
AR 13	Unperfect in bending of zinc can	Wedged
AR 14	Error in diameter measurement	
AR 15	Adhesive does not come out	Fall, exposed to adhesive liquid
AR 16	Machine cables are not neat	

Table 5.1 Potential Accident (Continue)

Risk Code	Potential Failure	Potential Accident
FR 1	a cavity in installation of PE Seal	
FR 2	Coating is not perfect	Fall, exposed to polish liquid
FR 3	Polish liquid is not out	
FR 4	Machine cables not neat	
FR 5	Error in diameter measurement	
FR 6	Coating is not perfect	
FR 7	Cavity in the installation of metal top	
PR 1	Installation loose ring	Wedged
PR 2	Error in bending the tip jacket	
PR 3	Cables not neat	Fall, electrocute
PR 4	Error in voltage detection	
PR 5	Error in labelling the coding	Wedged, fall
PR 6	Product is not full	
PR 7	Damage in product packaging dimension	

In the identification of risk, considering the objective goals based company. Identified risks are risks that can interfere / influence the strategic objectives of the company. One of the goals of the company is prioritizing product safety and customer satisfaction, and also prevents occupational accidents in order to achieve zero accident.

FMEA risk assessment method where is the risk assessed by severity, occurance, and detection. Value of severity, occurance, and detection based Gaspersz (2002). From value of severity, occurance, and detection can be known value of the RPN (Risk Priority Number) to determine the ranking of the risks identified. Here is the results recap RPN value at each station that has been identified risks. Recap RPN value at each station it is aims to demonstrate the highest risk category for each activity in the work station.

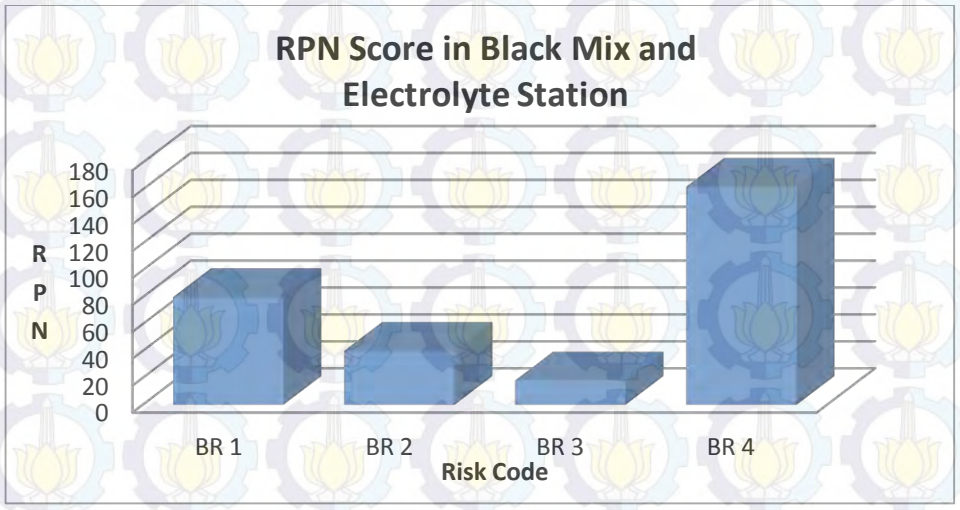

Figure 5.1 Histogram RPN Score in Black Mix and Electrolyte Liquid Station

Based on Figure 5.1 can be seen there is a risk who has highest RPN score, that is BR4 with score 162.

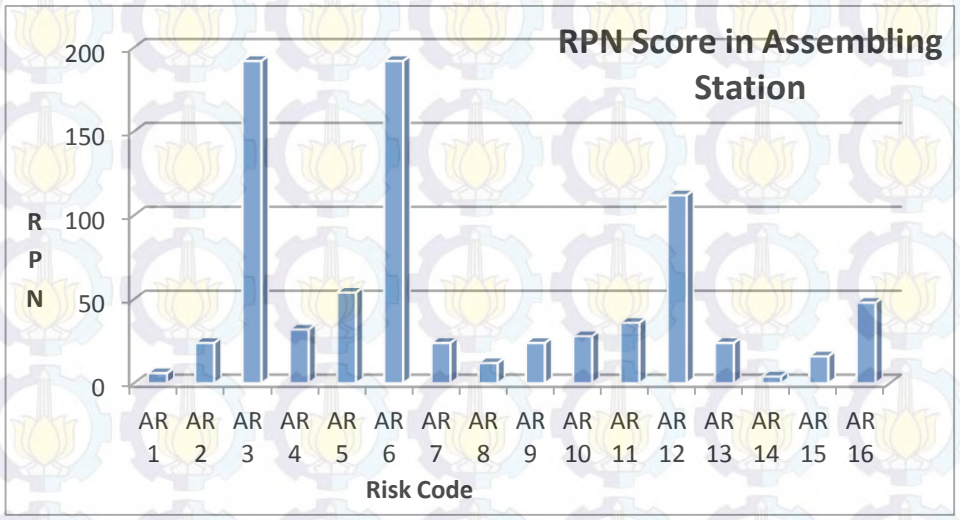

Figure 5.2 Histogram RPN Score in Assembling Station

Based on Figure 5.2 can be seen there are two risk who has highest RPN score that are AR 3 with 192 and AR 6 with 192.

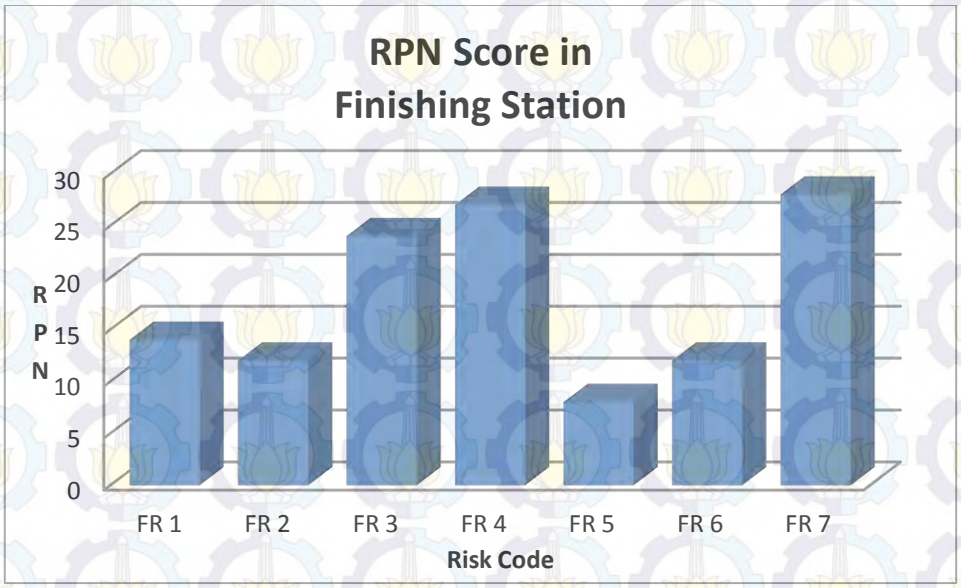

Figure 5.3 Histogram RPN Scre in Finishing Station

Based on Figure 5.3 can be seen there is a risk who has highest RPN score, that is FR 7 with score 28.

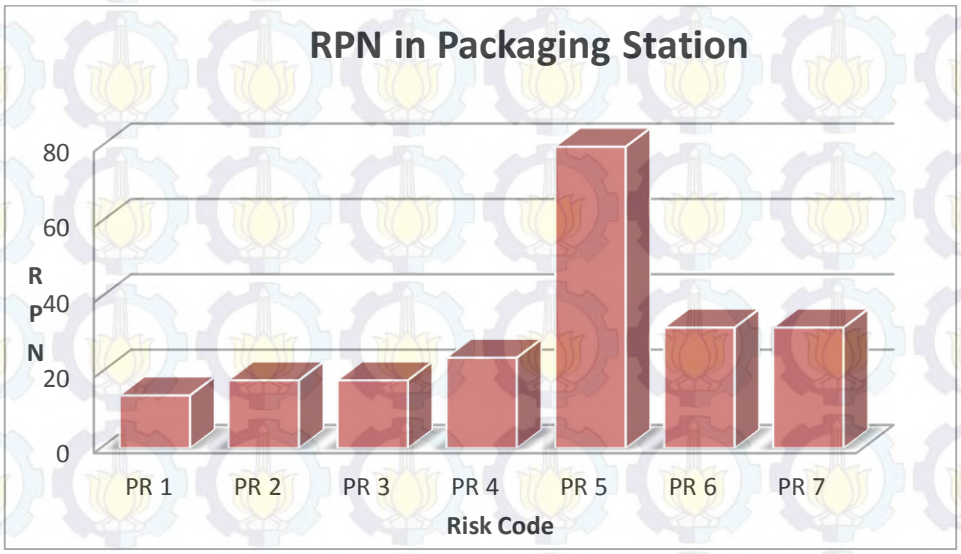

Figure 5.4 Histogram RPN Score in Packaging Station

Based on Figure 5.4 can be seen there is a risk who has highest RPN score, that is PR 5 with score 80.

From ranking RPN (Risk Priority Number), a risk assessment is divided into three categories: high risk, medium, and low. Distribution of risk categories as described in Chapter IV. The risk categories that have been identified as follows.

Table 5.2 Risk Category

Risk Code	Potential Failure	Risk Priority Number (RPN)	Category
AR 3	Bobbin are spilled and it's wasted	192	High
AR 6	Splattered all the electrolyte	192	
BR 4	Errors in entering the raw material, splattered all	162	
AR 12	Pressing machine too hot because without resting	112	
BR 1	Error in the taking of raw material Black Mix	80	
PR 5	Error in labelling the coding	80	
AR 5	Error in electrolyte measurement	54	Medium
AR 16	Machine cables are not neat	48	
BR 2	Error in moisture and tapping value measurement	40	
BR 5	Machine cables are not neat	36	Low
AR 11	Machine cables are not neat	36	
AR 4	Error in the taking of Bobbin	32	
PR 6	Product is not full	32	
PR 7	Damage in product packaging dimension	32	
AR 10	Cavity in the part of Top washer	28	
FR 7	Cavity in the installation of metal top	28	
FR 4	Machine cables are not neat	27	
AR 2	Bottom of the Can that is not coated well	24	
AR 7	Carbon Cod not exactly locate in the middle	24	
AR 9	Unperfect in the Top part	24	
AR 13	Unperfect in bending of zinc can	24	
FR 3	Polish liquid is not out	24	

Table 5.2 Risk Category (Continue)

Risk Code	Potential Failure	Risk Priority Number (RPN)	Category
PR 4	Error in voltage detection	24	
BR 3	Raw material not mix homogenly	18	
PR 2	Error in bending the tip of jacket	18	
PR 3	Machine cables are not neat	18	
AR 15	Adhesive does not come out	16	
FR 1	a cavity in installation of PE Seal	14	
PR 1	Installation loose ring	14	Low
AR 8	Unperfect part in the can	12	
FR 2	Coating is not perfect	12	
FR 6	Coating is not perfect	12	
FR 5	Error in diameter measurement	8	
AR 1	Errors in the amount selection of the Can that needed	6	
AR 14	Error in diameter measurement	4	

Based on Table 5.2, which is the risk rating value of the RPN (Risk Priority Number) indicates the critical value of each identified risk. So that, the risk can be seen which one has the most impact to be categorized. From the results of the risk categories, risk AR 3, AR 6, 4 BR, AR 12, 1 BR, and PR 5 were high. Risks AR 5, AR 16, and BR 2 are medium category. While the rest including in the low risk category. Mitigation made at a high risk category where the risk of a low has chance, but if the low risk occurs due to the influence, it caused a negative impact on the company.

5.3.1 High Risk Category

Risk that include in high risk category is the risk that the RPN score has a value equal to more than 80. High-risk category is a risk that has an impact or a very large influence for the company system. Which includes here are high risk categories, namely:

a. Risk AR 3: Risk of Bobbin are spilled

Bobbin is one important element in the manufacture of batteries, because the bobbin is one of the raw materials required for the product to be. Right composition of bobbin that makes good quality of battery products and it also can be used. If there is scattered bobbin, it allows the amount of bobbin that put into the battery composition is lacking or inappropriate. It can be fatal and potentially by the end of the process the product will fail and will not be sold to consumers. In addition, the bobbins are chemicals that are harmful if inhaled by humans. Dust flux can interfere with breathing humans, especially for workers who perform these activities. A risk that may occur for workers who will be affected directly is shortness of breath when workers do not wear masks. If the workers had been using masks, but the masks used does not fit then dust flux will still inhaled by workers, but the effect will not be immediate but later. This can result to a more severe illness such as acute respiratory disorders could even cause cancer.

.

b. Risk AR 6: Splattered all the electrolyte

Electrolyte is one of the components of this product manufacture R6 batteries. This electrolyte is one of the raw materials required for the product to be. If the process is much the spilled electrolyte, allows the amount of electrolyte in the battery is inserted into the composition lacking or inappropriate. It can be fatal and potentially by the end of the process the product will fail and will not be sold to consumers. Electrolyte is one of the chemicals. Each chemical raw material in this product is hazardous materials. Workers on the activity of this process are potentially affected by the dangers

of the liquid electrolyte. When directly exposed human skin, will cause irritation to the skin. Therefore workers must be careful in this process.

c. Risk BR 4: Errors in entering the raw material, splattered all

The raw material is one important element in making of a product. This main element affects the quality of a product at the time of use. In the event of an error in entering the raw material can make automated product fails and can not be marketed. Composition of each of these raw materials must also be considered, if there is excess or deficiency can lead to failure of the product so it can not be marketed because it can not be used. The raw material of the battery is a hazardous chemical, so if the raw material is exposed directly to humans (workers) can cause several effects both direct effects such as irritation, shortness of breath and other or indirect effects that would arise, such as: acute respiratory disorders can even cause cancer. Therefore, obey SOP procedures in the work process and also use PPE when in the area of production is one of the easiest ways to prevent accidents.

d. Risk AR 12 : Pressing machine too hot because without resting

Pressing machine is one of the machines that is used in this manufacture of batteries R6. This machine is very important in the process. Seen from the condition, these machines cables that have been damaged and only a kind of adhesive and then wrapped with a cloth. This is very dangerous, because it can lead to broken machine so that production can be stop. So tt can harm the plant. But the worst is likely to catch fire and explode machine, causing huge losses for companies, workers and the surrounding environment. Machine is one of the important points in a mass production. Regular engine maintenance and scheduled to avoid machine damage that can lead to things that are detrimental to the company. Especially for workers who come into direct contact with the machine.

e. Risk BR 1: Error in the taking of raw material Black Mix

The raw material is one of the important elements in making of a product. This main element affects the quality of a product at the time of use. In the event of an error in entering the raw material can make automated product fails and can not be marketed. Composition of each of this raw material must

also be considered, if there is excess or deficiency can lead to failure of the product so it can not be marketed because it can not be used. Where a decision errors in raw material it is fatal to the product. Therefore we need to concentrate on working time and also re-checker to avoid mistakes that can lead to loss.

f. Risk PR 5 : Error in labelling the coding

Coding and stickers giving important as related information and expiration date of production, production lot number, and the formula of the product, as well as for checking process control. If an error occurs in granting Coding, It will be fatal in misinformation regarding the expiration date. Product quality and safety standards must provide correct information about the product expiration date. Therefore, in accordance with the provisions granting Coding is important to consider.

5.3.2 Medium Risk Category

Medium risk category is a risk that has RPN values between 40 and 79. Medium risk is the risk that has a lesser impact on enterprise systems compared with high-risk category. Here is is an intermediate risk category, among others:

a. Risk AR 5: Error in electrolyte measurement

Impacts that can be occurring when the risk occurs are not perfect product. If related with the main raw material, it can cause the product to fail because the composition is not appropriate. Supervision and Checking back so need to be applied and made continuously to prevent the occurrence of errors that can cause harm in the end.

b. Risk AR 16: Machine cables are not neat

Neatness and cleanliness are sometimes forgotten, but both of these things if not maintained can lead to accidents. Later this occupational accident would be detrimental to the company and the workers. Untidy cables this machine can cause workers to fall stumble. If effects of physical stumble for workers alone can lead to the worker can not work for several time, so it will detriment of company because it is not optimal. The worse thing that can happen when workers are tripped by wires that eventually having serious

injuries and had to be rushed to a hospital or cable are detached from machine so that the production process stops and make delay production time.

c. **Risk BR 2: Error in moisture and tapping value measurement**

Measurement is one of the important things in the process of making the product. Precise measurements will produce a good product in terms of quality and function that can be marketed to consumers. Moisture measurements and tapping this value needed to fit the product so that they can be used. If measurements do not fit then product should be measured so that it takes over again. This may delay the production process so that production targets can not be achieved.

5.3.3 Low Risk Category

Low risk is the risk that the category has a RPN value below 40. Low risk category if there is a risk that does not have a significant adverse effect on company system. Activities of a company that has a low risk of likelihood are very small or rare. Detection or control of the company has been able to cope with the risk.

5.4 Analysis of Occupational Sick

Based on questionnaire that has been distributed to the workers in the production area, there are several complaints related to occupational pain. There are 8 points of the body that many complaints by workers. Eight points of the body that include: neck, left shoulder, right shoulder, waist, right hand, left calf, right calf and right ankle. Complaints for each body part are a bit of a pain that is felt is indicated by a value of 2. Standardize Nordic questionnaire obtained by long time complained of pain on average on a scale of 1 is longer felt pain about 1-5 days. But there is one worker who complained of pain on a scale of 2, namely a long illness with symptoms 6-10 days. On the consequences of the pain, the majority of workers where the pains scale of 1 member perceived no effect on employment. In addition there are two workers who complained of a reduction in comfort at work or on a scale of 2. Meanwhile, for all the lost time workers

choose a scale of 1 or never absent if there are complaints of occupational pain. Workers at PT. International Chemical Industry considers pain still felt they could cope without having to be absent from work. The workers are very rarely or never consult them to the hospital or to the doctor for a check up. Workers also never absent because of illness perceived. It is not considered severe disease and requires a working holiday.

5.5 Analysis of Working Posture

In the production area of PT. International Chemical Industry, working posture has been observed, shows that the non-operator working QEC has a total score of 88.2. So the conclusion is the act of analysis and require immediate repair. While the total score of QEC for operator workers is 74.8, which means this condition needs to be investigated further.

On the operator is part of the body, which backs the condition is still acceptable or acceptable with QEC score of 17.4. But there are also conditions that must be further analyzed and corrected immediately, ie on the neck with QEC score of 11. While for the other body parts, such as the shoulder and the hand condition required further analysis with each QEC score was 24.2 for the shoulder and 22.2 for the hand.

In the non-operator many parts of the body with the necessary conditions are further analyzed and corrected immediately, ie on the back, shoulders, and neck. QEC score for each section is 24.4 back, shoulder 30.4, 11.2 and neck. While for the hand with QEC score of 22.2 with the necessary conditions are needed further analysis.

On the part of workers of non-operator requires immediate repair analysis due to the work done is quite heavy. The average worker should always bend in transporting the product before it is moved using a forklift material handling like. In addition to the work performed are in need of frequent moves and several small breaks. While the operator, the average worker on duty to observe machine during the production process complaints that many felt was the most important part of the neck.

5.6 Analysis of Occupational Accidents

At PT. International Chemical Industry, based from historical data obtained from years 2009-2012, there are several types of accidents that have occurred. However, C3 and C5 types of accidents often occur in PT. International Chemical Industry, the accident type is classified as minor injuries in an accident and unable to work. From the data obtained are still a lot of important data in the event of an accident that was not recorded, such as the costs incurred and the number of days lost. It is very important for the company because it can be used to determine the accident statistics and can be used to control the conditions of the accident.

Based on the results from processing of historical data recap accidents PT. International Chemical Industry in 2009-2012, in one year there were at least 3 times occupational accidents. While for the working days lost, in one year by at least 1 day, lost work days. and processing From historical data in 2009-2012 that has been done on the PT. International Chemical Industry in 3 accidents occurred at least a year of work and working days lost on average in one year as much as a day. In the statistical processing of accidents can not be done optimally on all year. This is because a lot of important data that is used for the calculation of statistical work is not recorded. It can be used as a reference that P2K3L performance less than the maximum so it needs to be repaired. In 2012 accidents is still static, so it takes more monitoring and also the level of workers' awareness of the accidents that can not only harm the plant, but themselves, especially their physical.

5.7 Analysis of Occupational Accidents in Handling Process

There are several scenarios that exist when the occupational accidents occurred at PT. Internatonal Chemical Industry when the occupational accidents occurred. Workers who are having minor accidents will be given first aid provided by the company located in each work station department. If first aid is not enough then carried out one or more workers would bring the victim goto clinic to receive further treatment. While for the workers who are having serious injuries would be immediately referred to the hospital. Transport used to deliver workers to the

hospital using a transport company, if it is not possible, then it should call an ambulance from the hospital.

When occupational accidents happen, there are losses incurred. In the event of an accident at one station, the workers who are victims of the occupational accidents, he will stop working and workers in the surrounding areas will be participated to help the workers. Thereby it will be disrupting the production process. During that time, control of the production process was reduced, making it possible if there is a product defect or error in the production process.

5.8 Analysis of Root Cause Analysis (RCA)

Root cause analysis method used to find out the cause from accidents. Based on the data processing RCA showed that the problems experienced by workers (pain / other issues), distracting, lack of PPE availability, PPE provided less comfortable, and company policies. Findings from RCA processing will be used to make recommendations for improvement in order to determine further action to prevent accidents or even eliminate accidents.

5.9 Analysis of Improvements Recommendations

Recommendations for improvement made for development of system management of occupational safety and health poured on the points that need to be done fundamentally by the company. The most important thing in implementing system management of occupational safety and health, which are the company's commitment. Factor documentation, planning, and measurement and evaluation should also be carried out either by P2K3L PT. International Chemical Industry. Besides routine and scheduled meetings, are held at least once a month to discuss the condition of occupational safety and health in company. By developing this system management of occupational safety and health expected to increase the awareness and knowledge of the workforce occupational safety and health will also increase the productivity of company. It also can improve the brand image of a company that could ultimately improve the competitiveness of enterprises to achieve the required system management of occupational safety and health great implementation team. Implementation is not only the responsibility of

occupational safety and health company team, but all levels within the company have their respective roles and must have a good understanding about occupational safety and health. P2K3 as the team responsible for implementing system management of occupational safety and health must have a strong commitment and actions are clear and obvious.

The purpose of system management of occupational safety and health is one of which is to ensure the safety of workers. For it is necessary to control risk in the workplace. One of the easiest controls is to use PPE when working. The use of PPE is the way that I used to control risks in the work area. There are 6 types of PPE standards recommended in accordance with the needs of workers, such as gloves, masks, safety glasess, ear plugs, helmets, and safety boots. In addition to risk management in the form of provision of PPE, other recommendations that the installation of signs of occupational safety and health. With the signs are expected to familiarize workers will always act safely even without any supervision. Occupational safety and health procurement guidelines have been adapted to the needs of each station.

CHAPTER VI
CONCLUSION AND RECOMMENDATION

In this chapter will be a conclusion to answer the research that has been done. It also provided advice that can support the next research.

6.1 Conclusion

The conclusion that can be drawn from the research that has been done is as follows:

1. Overall there are 35 identified risks. There are 5 risks are identified in the Black mix and Electrolyte Liquid, 16 risks identified in assembling stations, finishing station 7 risks has been indentified and the last in packaging station there are 7 risk.

   From FMEA questionnaires, obtained score of RPN which is a critical level of risk. The evaluation of risk can be seen from RPN score. Risks in each business process is divided into three categories based on the value of RPN, which are: (1) six in high-risk category with RPN values ≥ 100, (2) 3 in medium risk category with RPN values between 40 and 79, (3) 26 risk is in low category with RPN values <40.

2. Accidents that occur in PT International Chemical Industry during the year 2009-2012 were an accident type C1 (hit, generally indicate contact such as: sharp, hard objects), C3 (caught in, under, and between objects such as: bitten, pinched, sink), C5 (Fall from different height), and C8 (Inhalation, absorption of hazardous materials). The causes of these accidents include PPE provided less convenient and there are some less appropriate PPE, otherwise there were no signs occupational safety and health, the problems experienced by workers (sore / other issues), distracting, and company policies.

3. Based on the processing of working posture for the operator PT. International Chemical Industry needs to be investigated further, while

for non-operator workers (transport workers) need to be analyzed and further investigation and repaired immediately.

Pains are felt by workers in 8 parts of the body, namely the neck, left shoulder, right shoulder, waist, right hand, left calf, right calf and right ankle with a little pain complaints.

4. Recommendations for improvement to maximize the implementation and achievement of the SMK3 by conducting meetings that are scheduled at least once a month, to control the risk of accidents, installing signs occupational health and safety, conduct regular workplace inspections and scheduled and documented, and complement P3K box.

6.2 Recommendation

Suggestions and feedback can be given in this research are as follows:

1. It is expected to have a more detailed study in discussing of occupational safety and working relating to insurance costs as well as workers. So the total cost is obtained due to accidents and other damages in case of accidents.
2. To get maximum results in achieving the goals SMK3, it will be better consult with an expert in occupational health and safety.

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Enclosure 1

KUISIONER PENELITIAN

Kuesioner penelitian ini dibuat sebagai bahan untuk menyelesaikan Tugas Akhir Teknik Industri ITS. Untuk kepentingan penelitian ini, identitas bapak/ibu/ saudari kami jamin kerahasiaannya. Atas dasar tersebut, maka kami mohon agar kuesioner ini dapat diisi dengan jujur dan sebenar-benarnya sesuai dengan kondisi bapak/ibu/ saudari. Atas bantuannya kami ucapkan terima kasih.

Judul Tugas Akhir :

"Analisis *Safety Process* dan Penerapan Sistem Manajemen Keselamatan dan Kesehatan Kerja (SMK3) di PT. International Chemical "

Tujuan Survey :

Survey ini dilakukan untuk mengetahui kecelakaan yang terjadi serta untuk mengetahui apa penyebab utama dari terjadinya kecelakaan.

Peneliti:

Amor Bayu Pratama
Mahasiswi Program Sarjana Teknik Industri
Institut Teknologi Sepuluh Nopember (ITS) Surabaya
Telp : 087852709446

Identitas Responden

Nama :
Jenis kelamin : L / P
Usia : a. < 19 tahun | b. 20-29 tahun | c. 30-39 tahun | d. >40 tahun
Pendidikan terakhir : a. SD | b. SMP | c. SMA | d. Diploma/Sarjana/Magister
Jabatan :
Status pekerja :

Kuisioner 1 (Kecelakaan Kerja)

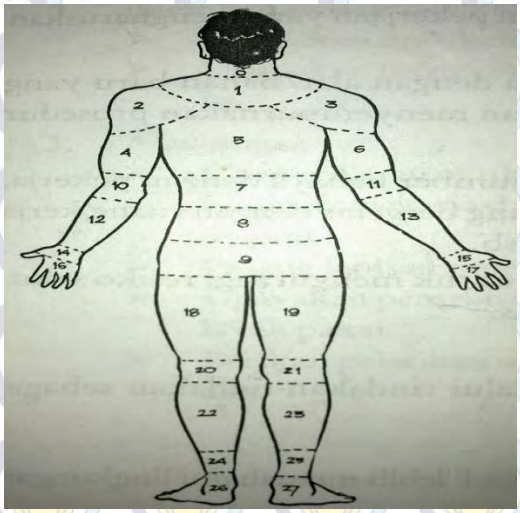
Di bawah ini merupakan pertanyaaan untuk mengetahui kecelakaan kerja yang pernah dialami oleh pekerja, penyebab kecelakaan, dan hari kerja yang hilang akibat kecelakaan kerja.

1. Apakah Anda pernah mengalami kecelakaan kerja:
   a. Iya b. Tidak
2. Jika Anda menjawab IYA pada pertanyaan no.1 isilah tabel dibawah ini :

No.	Jenis Kecelakaan	Penyebab Kecelakaan	Total Waktu Hilang Akibat Kecelakaan Kerja (hari)				
			0	1-5	6-10	11-15	>15
1	Terjepit mesin						
2	Tertimpa benda berat						
3	Terpeleset tangga						
4	Terkena air panas						
5	…..						

Kuisioner 2 (Sakit Akibat Kerja)

Di bawah ini merupakan pertanyaaan guna mengetahui sakit akibat kerja yang dialami oleh pekerja.



Gambar Posisi Bagian Tubuh yang Sakit

No.	Lokasi	Tingkat Kelelahan				
		1	2	3	4	5
1	Sakit pada leher					
2	Sakit pada bahu kiri					
3	Sakit pada bahu kanan					
4	Sakit pada lengan atas kiri					
5	Sakit pada punggung					
6	Sakit pada lengan atas kanan					
7	Sakit pada pinggang					
8	Sakit pada pinggul					
9	Sakit pada pantat					
10	Sakit pada siku kiri					
11	Sakit pada siku kanan					
12	Sakit pada lengan bawah kiri					
13	Sakit pada lengan bawah kanan					
14	Sakit pada pergelangan tangan kiri					
15	Sakit pada pergelangan tangan kanan					
16	Sakit pada tangan kiri					
17	Sakit pada tangan kanan					
18	Sakit pada paha kiri					
19	Sakit pada paha kanan					
20	Sakit pada lutut kiri					
21	Sakit pada lutut kanan					
22	Sakit pada betis kiri					
23	Sakit pada betis kanan					
24	Sakit pada pergelangan kaki kiri					
25	Sakit pada pergelangan kaki kanan					
26	Sakit pada kaki kiri					
27	Sakit pada kaki kanan					

Keterangan:

1 : Tidak ada keluhan
2 : Sakit ringan (lelah/tegang)
3 : Agak sakit
4 : Sakit
5 : Sangat sakit

No.	Lokasi	Konsekuensi Akibat Sakit				
		1	2	3	4	5
1	Sakit pada leher					
2	Sakit pada bahu kiri					
3	Sakit pada bahu kanan					
4	Sakit pada lengan atas kiri					
5	Sakit pada punggung					
6	Sakit pada lengan atas kanan					
7	Sakit pada pinggang					
8	Sakit pada pinggul					
9	Sakit pada pantat					
10	Sakit pada siku kiri					
11	Sakit pada siku kanan					
12	Sakit pada lengan bawah kiri					
13	Sakit pada lengan bawah kanan					
14	Sakit pada pergelangan tangan kiri					
15	Sakit pada pergelangan tangan kanan					
16	Sakit pada tangan kiri					
17	Sakit pada tangan kanan					
18	Sakit pada paha kiri					
19	Sakit pada paha kanan					
20	Sakit pada lutut kiri					
21	Sakit pada lutut kanan					
22	Sakit pada betis kiri					
23	Sakit pada betis kanan					
24	Sakit pada pergelangan kaki kiri					
25	Sakit pada pergelangan kaki kanan					
26	Sakit pada kaki kiri					
27	Sakit pada kaki kanan					

Keterangan:
1 : Tidak Berpengaruh
2 : Terjadi pengurangan kenyamanan aktivitas kerja
3 : Mengurangi jenis aktivitas kerja
4 : Mendapat perawatan medis
5 : Harus mengganti pekerja

No.	Lokasi	Waktu Kerja yang Hilang				
		0	1-5	6-10	11-15	>15
1	Sakit pada leher					
2	Sakit pada bahu kiri					
3	Sakit pada bahu kanan					
4	Sakit pada lengan atas kiri					
5	Sakit pada punggung					
6	Sakit pada lengan atas kanan					
7	Sakit pada pinggang					
8	Sakit pada pinggul					
9	Sakit pada pantat					
10	Sakit pada siku kiri					
11	Sakit pada siku kanan					
12	Sakit pada lengan bawah kiri					
13	Sakit pada lengan bawah kanan					
14	Sakit pada pergelangan tangan kiri					
15	Sakit pada pergelangan tangan kanan					
16	Sakit pada tangan kiri					
17	Sakit pada tangan kanan					
18	Sakit pada paha kiri					
19	Sakit pada paha kanan					
20	Sakit pada lutut kiri					
21	Sakit pada lutut kanan					
22	Sakit pada betis kiri					
23	Sakit pada betis kanan					
24	Sakit pada pergelangan kaki kiri					
25	Sakit pada pergelangan kaki kanan					
26	Sakit pada kaki kiri					
27	Sakit pada kaki kanan					

Lembar Observasi

Di bawah ini merupakan pertanyaaan untuk mengetahui kondisi postur tubuh saat melakukan kerja.

Observer	
Punggung	
Ketika melakukan pekerjaan, bagaimanakah posisi punggung?	
A1	Normal
A2	Sedang
A3	Terlalu membungkuk
Bagaimana posisi tubuh saat melakukan pekerjaan?	
B1	Tubuh non-statis
B2	Tubuh statis
Seberapa sering pergerakan tubuh?	
B3	Jarang (< 3 menit)
B4	Normal (berkisar 8 menit)
B5	Terlalu sering (> 12 menit)
Postur Bahu dan Lengan	
Bagaimana posisi bahu dan lengan saat tugas dilakukan?	
C1	Di bawah ketinggian punggung
C2	Disekitar dada
C3	Di atas ketinggian bahu
Bagaimanakah perulangan pergerakan lengan?	
D1	Jarang : tidak ada pola pergerakan rutin
D2	Sering : terdapat pola pergerakan rutin dengan beberapa istirahat pendek
D3	Sangat sering : terdapat pola pergerakan kontinyu saat bekerja
Pergelangan Tangan	
Bagaimana posisi pergelangan tangan saat tugas dilakukan?	
E1	Selalu lurus
E2	Membengkok/menyimpang
Seberapa sering pergerakan tangan saat tugas dilakukan?	
F1	< 10 kali tiap menit
F2	11-20 kali tiap menit
F3	> 20 kali tiap menit
Leher	
Bagaimana posisi leher/kepala saat melakukan pekerjaan?	
G1	Tidak menunduk
G2	Terkadang menunduk
G3	Sering menunduk

Worker	
Berapa berat maksimum yang dipegang saat bekerja?	
a1	Ringan
a2	Sedang
a3	Berat
Berapa waktu yang dibutuhkan untuk melakukan tugas?	
b1	< 2 jam
b2	2-4 jam
b3	> 4 jam
Berapa tekanan maksimum yang dibutuhkan oleh 1 tangan saat bekerja?	
c1	Rendah
c2	Sedang
c3	Tinggi
Apakah Anda mengalami getaran saat bekerja?	
d1	Rendah/tidak
d2	Sedang
d3	Tinggi
Apakah pekerjaan membutuhkan kekuatan visual?	
e1	Rendah/hampir tidak membutuhkan melihat secara detail
e2	Tinggi/membutuhkan untuk melihat secara detail
Apakah Anda merasa kesulitan menjaga kondisi kerja?	
f1	Tidak pernah
f2	Kadang-kadang
f3	Sering
Apakah pekerjaan yang Anda laukan menimbulkan ketidaknyamanan?	
g1	Tidak sama sekali
g2	Rendah
g3	Sedang
g4	Tinggi

Enclosure 2

KUISIONER PENELITIAN

Kuesioner penelitian ini dibuat sebagai bahan untuk menyelesaikan Tugas Akhir Teknik Industri ITS. Untuk kepentingan penelitian ini, identitas bapak/ibu/ saudari kami jamin kerahasiaannya. Atas dasar tersebut, maka kami mohon agar kuesioner ini dapat diisi dengan jujur dan sebenar-benarnya sesuai dengan kondisi bapak/ibu/ saudari. Atas bantuannya kami ucapkan terima kasih.

Judul Tugas Akhir :

"Analisis *Safety Process* dan Penerapan Sistem Manajemen Keselamatan dan Kesehatan Kerja (SMK3) di PT. International Chemical "

Tujuan Survey :

Survey ini dilakukan untuk mengetahui pemahaman pekerja mengenai *basic* K3 di perusahaannya

Peneliti:

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Identitas Responden

Nama :
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Pendidikan terakhir : a. SD | b. SMP | c. SMA | d. Diploma/Sarjana/Magister
Jabatan :
Status pekerja :

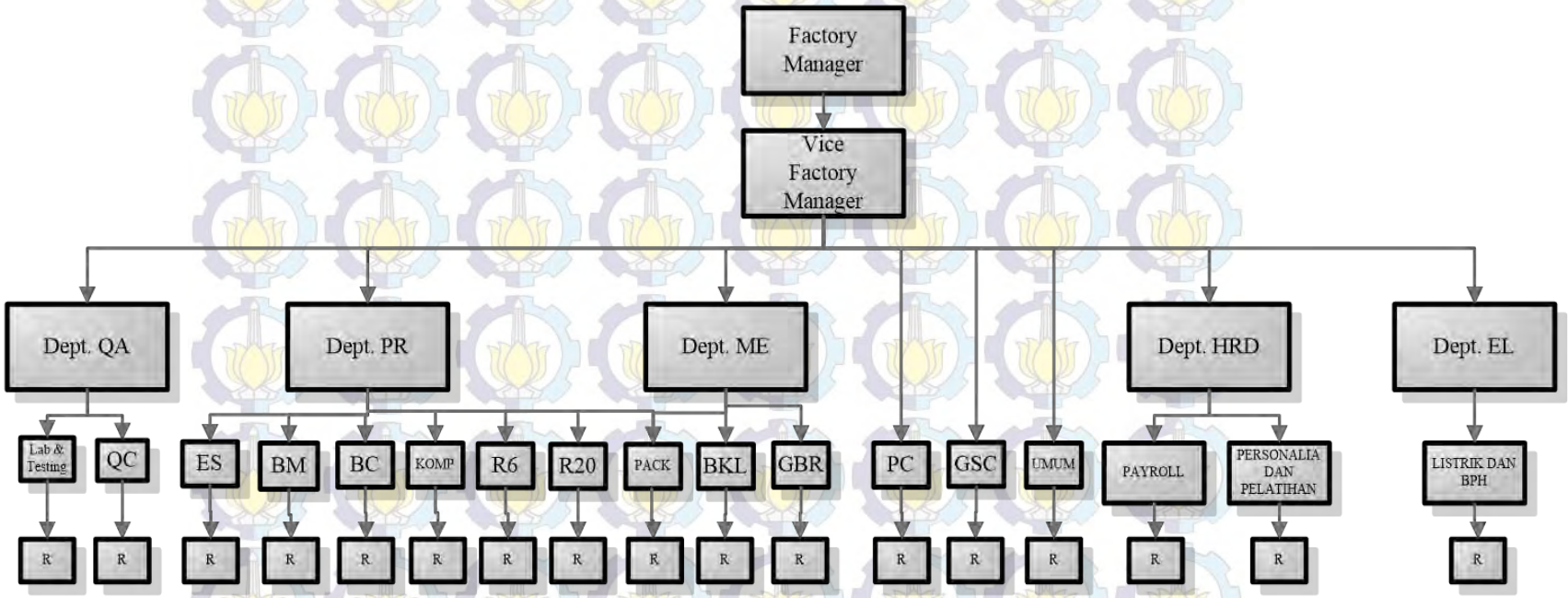
Kuisioner (Pemahaman Karyawan Mengenai K3)

Di bawah ini merupakan pertanyaaan untuk mengetahui bagaimana pemahaman pekerja mengenai keselamatan dan kesehatan kerja (K3) yang ada di perusahaan.

1. Apakah Anda tahu apa itu Sistem Manajemen Keselamatan dan Kesehatan (SMK3) ?
   a. Iya b. Tidak
2. Apakah perusahaan telah menerapkan sistem keselamatan dan kesehatan kerja (SMK3)?
   a. Iya b. Tidak
3. Apakah Anda sudah mentaati peraturan keselamatan saat bekerja (*safety behavior*)?
   a. Iya b. Tidak
4. Apakah perusahaan Anda pernah melakukan penyuluhan/training/pelatihan mengenai K3?
   a. Iya b. Tidak

5. Apakah Anda pernah mengikuti penyuluhan/training/pelatihan mengenai K3?
   a. Iya b. Tidak
6. Dimana Anda mengikuti penyuluhan/training/pelatihan mengenai K3?
   a. Perusahaan b. Di luar perusahaan
7. Apakah perusahaan telah menyediakan alat pelindung diri (APD) yang digunakan saat bekerja?
   a. Iya b. Tidak
   Sebutkan: 1. … 4. … 2. … 5. …
   3. … 6. …
8. Apakah Anda sudah menggunakan alat pelindung diri (APD) saat bekerja?
   a. Iya b. Tidak
9. Apakah jumlah APD yang tersedia sudah mencukupi yang dibutuhkan semua karyawan?
   a. Iya b. Tidak
10. Apakah APD yang ada nyaman digunakan?
    a. Iya b. Tidak
11. Apakah ada sanksi yang diberikan perusahaan jika Anda tidak menggunakan APD ?
    a. Iya b. Tidak

Enclosure 3



Picture Organization Structure PT. International Chemical Industry

Enclosure 4

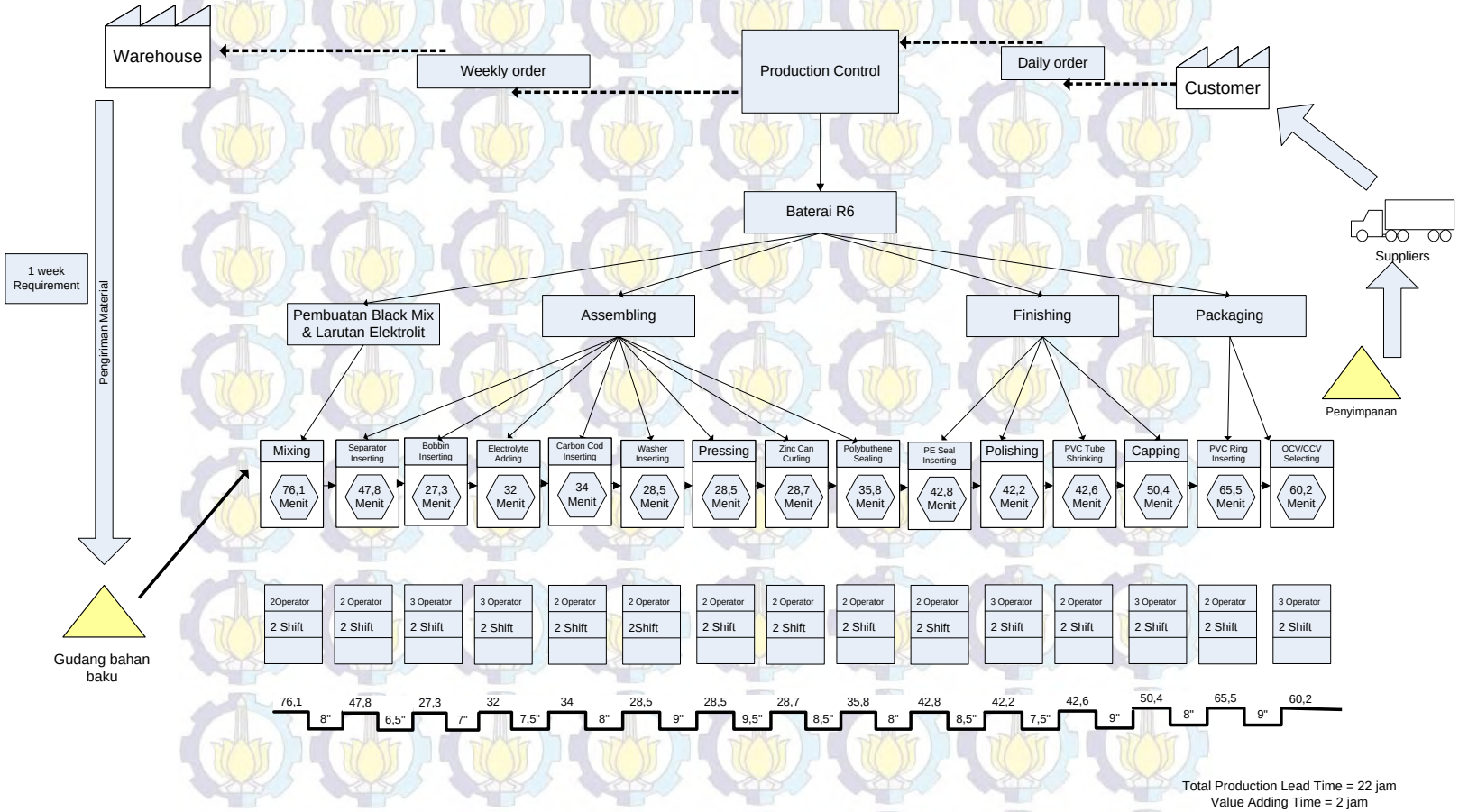


Figure of Production Process

Enclosure 5

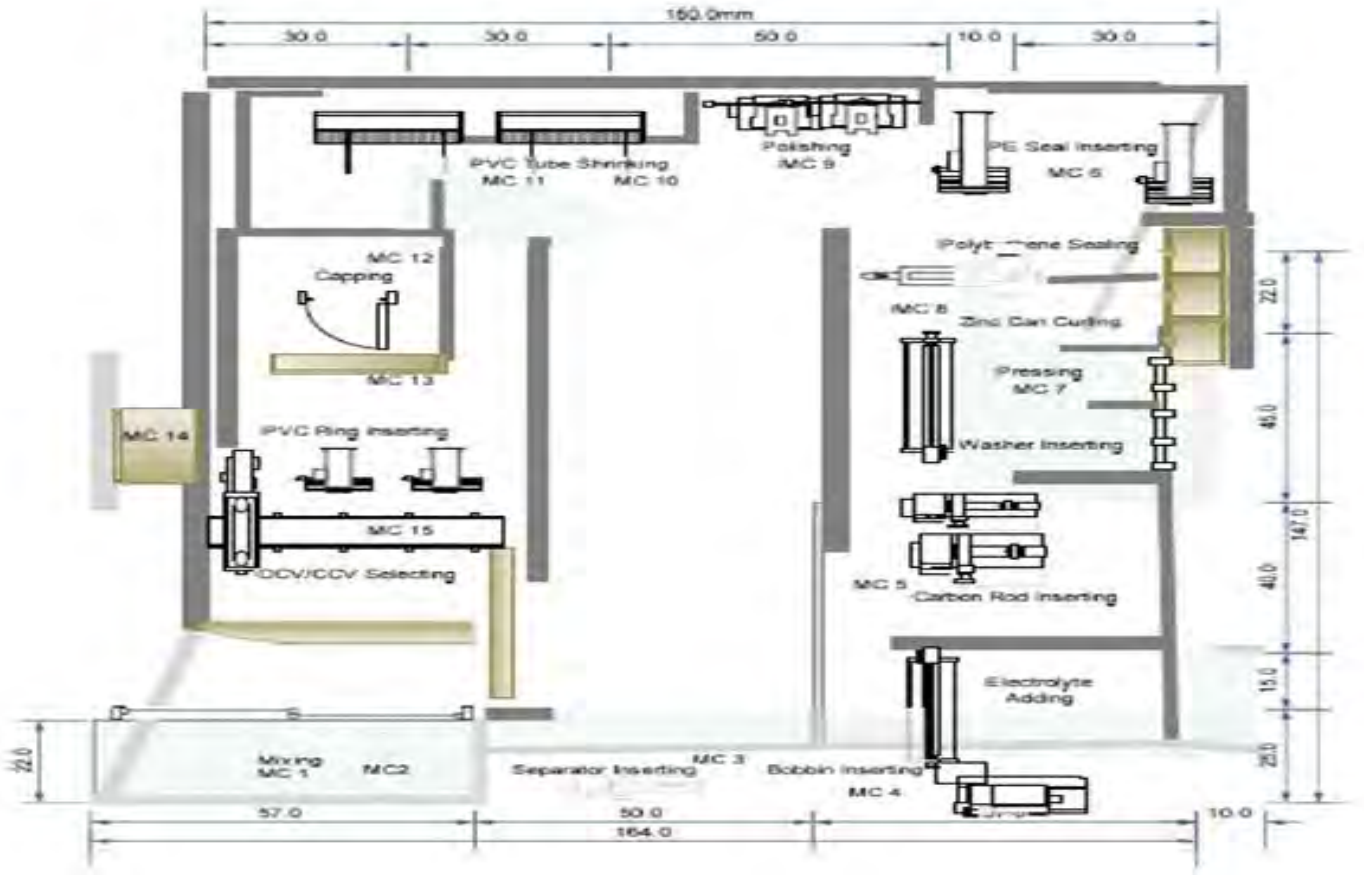


Figure of Production Floor

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BIOGRAPHY

Amor Bayu Pratama, born in Bogor on 23 April 1990. The author is the first child of three siblings. The author who often get called Amor's, start formal education in kindergarten Kartika III Bogor, Bogor SDN Polisi IV Bogor, SMPN 1 Bogor, SMAN 1 Bogor and achieve Bachelor of Industrial Engineering degree in Industrial Engineering at Institut Teknologi Sepuluh nopember (ITS) Surabaya. During college, authors have a wide range of experience. In the organization, the author is Indonesia Focal Point and Human Resource Manager in Committee for ASEAN Youth Cooperation Volunteers and Regional Consultant of of Indonesian Youth Parliament Council. Authors who are interested in human rights and social issues has had an international journal related to human rights, entitled Rights of PLWHA related Rights to get Health Service as well as Legal Protection in Indonesia and get an offer internships in Amensty International, Poland. Additionally, the author often represent as delegation of Indonesia in the International conferences and trainings, such as: Delegation of Indonesia for the Asian Youth Forum 2013, the Indonesian Ambassador for UNESCO Asia Pacific Youth Peace Ambassador in 2012 and others. Moreover, in the field of science applications author had done practical work in PT. Bayer MaterialScience Indonesia, PT. Lerindro International and PT. GlaxoSmithKline (GSK). Before graduating from ITS, the author has accepeted in the apprentice program in PT. HM SAMPOERNA.