RISK MANAGEMENT ANALYSIS AT DISTRIBUTION DEPARTMENT USING HOUSE OF RISK METHOD
(STUDY CASE : PT. PLN (PERSERO) ULP KENDAL)

UNDERGRADUATE THESIS

Submitted to the International Undergraduate Program in Industrial Engineering in Partial Fulfilment of Requirement for the Degree of Sarjana Teknik at the Faculty of Industrial Technology
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Arranged by:

Name : Abdurrahman Sidiq
Student Number : 19522164

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AUTHENTICITY STATEMENT

For the sake of Allah Subhanahu Wata'alaa, I admit this work is the result of my own work except for the excerpts and summaries from which I have explained the source. If in the future, it turns out that my confession is proven to be untrue and violates the legal regulations in the paper and intellectual property rights, then I am willing to get a diploma that I have received to be withdrawn by the Islamic University of Indonesia.

Yogyakarta, January 01, 2023

(Abdurrahman Sidiq)

UNDERGRADUATE THESIS APPROVAL OF SUPERVISOR

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By

Name : Abdurrahman Sidiq

Student Number : 19522164

Yogyakarta, February 28, 2023

Supervisor,

(Dr. Drs. Imam Djati Widodo, M.Eng, Sc.)

UNDERGRADUATE THESIS APPROVAL OF EXAMINATION COMMITTEE

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Name : Abdurrahman Sidiq
Student Number : 19522164

Has been defended in front of Examination Committee in Partial Fulfilment of the Requirement for Bachelor Degree of Industrial Engineering Department Universitas Islam Indonesia

Examination Committee

Dr. Drs. Imam Djati Widodo, M.Eng, Sc.
Examination Committee Chair

Dr. Taufiq Immawan, S.T., M.M.
Member I

Dr. Agus Mansur, S.T., M.Eng, Sc.
Member II

Acknowledge by,
Head of Industrial Engineering
Faculty of Industrial Technology
Universitas Islam Indonesia

(Ir. Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D., IPM.)

DEDICATION PAGE

This undergraduate thesis that spent a lot of time and resources is dedicated to my family, especially Bapak, Ibu, Budhe Suwanti, Mas Dido, Mbak Ewil, and Mbak Endah that always support me in any kind of condition and situation.

To all my best friends who always share happiness and kindness to each other, we are a family.

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Dr. Drs. Imam Djati Widodo, M.Eng, Sc.

MOTTO

"Whoever goes out in search of knowledge, he will be in the way of Allah until he returns."

– H.R. Tirmidzi

PREFACE

Assalamu'alaikum Warahmatullahi Wabarakatuh.

Bismillah, Alhamdulillah, and the gratitude is presented to Allah Subhanahu Wata'alaa that has always granted His grace, strength, and also His blessing. Therefore, the author could complete the undergraduate research at PT. PLN ULP Kendal.

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Abdurrahman Sidiq

ABSTRACT

Risk management, which is essential to completing a project and business activities inside a company includes inside risk assessment. This research will be focused on risk assessment and preventive action in PT. PLN ULP Kendal, which is a distribution department that distribute electricity to the customers based on their specifications, amounts, and their needs. PT. PLN ULP Kendal include in a large scale of company that involved huge amount of process occurred in the distribution process of electricity to the customer. Therefore, there must be several risks that might be occurred because every process will face risks that could present threats to its success. For this undergraduate thesis, House of Risk method was chosen because this method combined two integrated model between Failure Mode Effect Analysis with House of Quality. Therefore, this method not only analysed the risk by categorized the risk into the events and agents, but also prioritized the risk to be further solved by the proposed preventive mitigation action with specific and comprehensive analysis with two phases. From those method that has been applied and calculated, the results reveal 13 risk events and agents and 7 preventive mitigation action to solve the priority risk agents based on the result of House of Risk phase 2.

Keywords : Risk Management, House of Risk, Failure Mode Effect Analysis, House of Quality, Mitigation

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CHAPTER I

INTRODUCTION

1.1 Research Background

The world of industry is directly impacted by changes in the economic, social, political, and environmental environments. Due to their inability to adjust to the situation and thoroughly assess the risk, many once-large corporations either faced bankruptcy or went out of from their business. According to Chang & Cheng (2010), those factors will ensure that the product quality, pricing, and timeliness meet with market demand to preserve an enterprise competitive advantage. Therefore, it is important to monitor and manage the company's operations since a company's ability to operate profitably will have an impact on their industry or enterprise. The organization tried a variety of approaches in objectives to achieving operational or performance excellence. The supply chain plays a crucial part in the company's operations as one of the processes that handles the fulfillment of demands from the procurement of their service through the satisfaction of customer wants. The supply chain is essential for creating a competitive firm (Anasfasia, 2017).

Supply chain management is a method, tool or approach in managing supply chain which includes a network of companies such as suppliers, manufacturers, distributors, and shop or retail (Pujawan & Er, 2017). The implementation of supply chain management that carried out at PT. PLN ULP Kendal which distributes the electricity to the customers. Business process activities in the supply chain have the opportunity for risk to arise. Therefore, companies must carry out risk management. Risk management is needed in companies to minimize the level of impact from the risks and the opportunities for risks to arise (Hanafi, 2009).

The personnel in charge of the entire processes from company should be aware of the risks because the supply chain creates the possibility for the risk to be occur (Oliveira, 2019). To perform and implement risk reduction initiatives, risk assessment may be utilized to improve decision-making efficiency. To identify and analyse potential supply chain risks and to reduce such risks, it is required to undertake the research. A risk management is required in the future to make the companies are aware of issues ranging from minor to major ones that may impede the company's supply chain flow and their business activities.

Risk management, which is essential to completing a project and business activities inside a company includes inside risk assessment (Chaouch S, 2019). This research will be focused on risk assessment and preventive action in PT. PLN ULP Kendal, which is a distribution department that distribute electricity to the customers based on their specifications, amounts, and their needs. Therefore, risk management inside the organization is greatly improved by the performance measurement of the organization to bring the company to a better direction in the future (Gaspersz, 2005).

PT. PLN ULP Kendal include in a large scale of company that involved huge amount of process occurred in the distribution process of electricity to the customer. Therefore, there must be several risks that might be occurred because every process will face risks that could present threats to its success. Risk is defined as the probability of an event and its consequences. Types of risk can be divided into four categories, such as environment, reputation, asset, and worker. Risks can affect the achievement of objectives either positively or negatively. Risk includes both opportunities and threats, and both should be managed through the risk management process (Geraldin, P., 2007).

In carrying out business processes in a company to achieve its objectives, there are always risks that can occur and affect the company's success in achieving goals. PT. PLN ULP Kendal as an electricity supplier company requires speed and accuracy of work in order to distribute the electricity with certain specifications that needed by customers and could be maintain its quality. PT. PLN ULP Kendal is a State-Owned Enterprises that includes at the work area of PT. PLN Semarang Area which distributes the electricity sources in all 7 region in Semarang that includes Kendal, Weleri, South Semarang, Boja, Central Semarang, East Semarang, and West Semarang. At PT. PLN ULP Kendal, there is a distribution department that have the task to gain, manage, and control the electricity supply to the customers. The work carried out by the distribution department at PT. PLN ULP Kendal will face risks that may be affected in disruption of the final activities of the company with considering that the quality and supply control is the last task before the electricity is distributed. And all of these process has a threat that may occur to disrupt normal activities or stop something that has been planned. Therefore, it is necessary to overcome the risky activities that cause these risks.

As early indicator, at October 2022, the cases of the electricity disruption at PT. PLN ULP Kendal area touching 58,7% of percentage in a month due to the bad weather that occurs at Kendal area. The bad weather also cause the Service Level Agreement that was determined at PT. PLN Kendal mostly did not achieved. At August until October 2022 period, the time of the electricity disruption respond are exceed more than the 30 minutes. This factors are involved the working field department to overcome the electricity disruption by fixing the electricity network, change the transformator, and cut the trees that disrupt the function of the electricity network. Therefore, the work activities from the distribution department of PT. PLN ULP Kendal faced high potential risk. From a record data that was taken at March until October 2022, there are 2 death case that was caused from the work accident. The first case occurs at May 2022 that caused by the worker that was electrocuted, and the second case occurs at September 2022 that caused by the worker that was fell from height with no supervision. Therefore, based on these initiative factors, the risk management analysis is needed using House of Risk method to overcome the risk by providing the preventive mitigation action as a result.

At risk management, there are a lot of methods that could be used to analyse the risk. There are Failure Mode Effect Analysis (FMEA), Quality Function Development (QFD), Fault Tree Analysis (FTA), HIRARC, and Job Hazard Analysis. For this undergraduate thesis, House of Risk method was chosen because this method combined two integrated model between Failure Mode Effect Analysis with House of Quality. Therefore, this method not only analysed the risk by categorized the risk into the events and agents, but also prioritized the risk to be further solved by the proposed preventive mitigation action with specific and comprehensive analysis. House of Risk could also separate acceptable minor risks from major risks and prepare data to aid in prioritizing and managing risks.

House of Risk method is divided into 2 phases, including the House of Risk Phase 1 which functions to determine the level of priority for risk agents or causes of risk, and the House of Risk 2 which functions to determine priority preventive mitigation strategies that are considered effective in decision making by providing a framework to proactively manage the risk in the distribution department of PT. PLN ULP Kendal. Therefore, in improving the performance of PT. PLN ULP Kendal, it is expected to have strategies and policies that are applied used the House of Risk method not only for analysed the risk but also provide preventive mitigation action based on company potential problem.

1.2 Problem Formulation

Based on the background that already explained and structured, the problem formulation for this undergraduate research are obtained as shown below:

1. What kind of the risk events that exist at distribution department of PT. PLN ULP Kendal?
2. What kind of the risk agents that might cause the risk at distribution department of PT. PLN ULP Kendal?
3. What kind of the appropriate action plan to mitigate and prevent the risk at distribution department of PT. PLN ULP Kendal?

1.3 Research Objective

Based on the problem formulation that already determined, the research objective that need to be achieved from this undergraduate research are described as shown below:

1. To find the risk events that exist at distribution department of PT. PLN ULP Kendal.
2. To find the risk agents that exist at distribution department of PT. PLN ULP Kendal.
3. To identify the appropriate action plan to mitigate and prevent the risk at distribution department of PT. PLN ULP Kendal.

1.4 Research Scope

There are several scope of limitations for this undergraduate research that should be determined as guidelines which will be described as shown below:

1. This undergraduate research was conducted at PT. PLN ULP Kendal started from October and finished on December 2022.
2. The method that was used for this undergraduate research is House of Risk method.
3. The data used in this undergraduate research were taken using the field observation and interviews with supervisor and staff of distribution department at PT. PLN ULP Kendal.

1.5 Research Benefit

The research benefits that are obtained and could be used by many parties will be described with the following details as shown below:

The benefit of this undergraduate research at PT. PLN ULP Kendal for student:

1. As the preparation of self and knowledge before the plunge to society especially in the industrial world.
2. As a comparative study of the theory and practice that student get in lectures with the actual reality in the work field.
3. Student is able to measure skills or creativity of student and gain new experiences or skills as well as a media for critical thinking and practice attitude skills, as well as acting patterns in industrial societies.
4. Student could optimize the knowledge to be a full-skilled student from experiences in the company.

The benefit of this undergraduate research at PT. PLN ULP Kendal for University:

1. As a testing media to understand the capability and ability of the student in applying theories in practical.
2. University could gain feedback to improve the quality of education to follow the development of the industrial world.
3. University is able to build a good relationship with the company where the students conduct the undergraduate research.

The benefit of this undergraduate research at PT. PLN ULP Kendal for Company:

1. As a means of community service, especially education sector in order to educate the nation.
2. The company could obtain the objective that can be accounted for the improvement of productivity and recommendations as a reference in decision making and problem solving.
3. To bridge the cooperative relationship between the company and university in the future especially in terms of labour recruitment.

1.6 Systematic Writing

This undergraduate research will be organized into several chapters that will be explained as shown below:

CHAPTER I INTRODUCTION

Chapter I contains the background for the undergraduate thesis that followed by the problem formulation, research objective, research scope, and also the research benefit.

CHAPTER II LITERATURE REVIEW

Chapter II contains the summary of the findings that are compiled from the prior studies and research that are relevant and related with this research. After the prior studies and research are reviewed and summarized, it will become the reference for resolve the existing problem.

CHAPTER III METHODOLOGY

Chapter III describes the research framework and data collection method from this undergraduate research. Research methodology will make the research become structured and organized. The research flow will be also explained with a purpose to make the readers could understand the core point of the research.

CHAPTER IV DATA COLLECTION AND PROCESSING

Chapter IV describes the data collection with the visualization and overview from the company, risk events, and risk probabilities that will be further processed using House of Risk method to become a proposed improvement method for the company.

CHAPTER V RESULT AND DISCUSSION

Chapter V will describes the result that was obtained from this research that will be analysed subjectively using theoretical explanations that was supported with the research findings and studies that was related with the problem and also fulfil the research objectives that already determined.

The outcomes from the analysis will provide a recommendation for the company to improve their risk management at distribution department.

CHAPTER VI CONCLUSION AND SUGGESTION

Chapter VI contains a closing that are consists of conclusions and suggestions for this undergraduate research. The conclusion was construct based on the result and discussion that was obtained from the research that should solve the research objective.

CHAPTER II

LITERATURE REVIEW

2.1 Empirical Study

2.1.1 Risk Management

Risk is an integral part of every phase of the project, and risk management is an essential part of the decision-making process at every stage of the project. The success or failure of a project depends to a large extent on the potential risk approach in which the appearance of the risk could affect the productivity, quality, timeliness and cost of the project (Crmkovic, 2016). The fundamental risk management consists of 4 major processes namely : Risk identification (to identify all potential events that may have an adverse effect on the project) ; Risk Analysis (to assess the impact and the probability that the identified risk will lead to the undesirable outcomes) ; Risk planning (to develop strategic options, to determine actions, and to enhance opportunities and reduce threats to the project's objectives) ; Risk monitoring and control (to keep track of the registered risks according to the control and monitoring plans) (Kajko, Mattsson, 2008).

The International Organization for Standardization ISO 31000, 2009, identifies the following principles of Risk Management that should be contained and involved to create value ; be an integral part of the organizational processes ; be part of decision making that explicitly addresses uncertainty ; be systematic and structured ; be based on the best available information ; be tailored ; take into account human factors ; be transparent and inclusive ; be dynamic, iterative and responsive to change ; and be capable of continual improvement and enhancement. The adoption of risk management methodology could lead the company to reduce the uncertainty in enterprise management, to ensure continuity in production and trading in the market, to decrease the risk of failure, and to promote the enterprise's external and internal image. Therefore, risk management could create business value, and maximizing the business profits by minimizing the costs. Therefore, the risk management is a disciplined study that helps its users understand how to manage potential risk, either it is present or future risk.

Risk management focuses on identifying what could go wrong, evaluating which risks should be deal with and implementing strategies to deal with those risks. Risk management is the process that allows individual risk events and overall risk to be understood and managed proactively, optimizing success by minimizing threats and maximizing opportunities. Businesses that have identified the risks will be better prepared and have a more cost-effective way of dealing with them (Arnuphatrairong, 2014).

2.1.2 Risk Management Component

According to Oliveira (2019), the risk management component consists of three parts : risk assessment and analysis, risk evaluation, and risk treatment. The three components of risk management will be described and mentioned as shown below:

1. Risk Assessment & Analysis

   The first component of the risk management process is called the risk assessment and analysis. A risk assessment evaluates the company's exposure to uncertain events that could impact its day-to-day operations and estimates the damage those events could have on the company's revenue and reputation. Effectively assessing and analyzing the company's risks helps protect assets, improve decision making and optimize operational efficiency across the board to save money, time, and resources.

2. Risk Evaluation

   After the risk assessment or analysis has been completed, a risk evaluation should be taken. A risk evaluation compares estimated risks against risk criteria that the organization has already established. Risk criteria can include associated costs and benefits, socio-economic factors, legal requirements, and system malfunctions.

3. Risk Treatment & Response

   The last component in the risk management process is risk treatment and response. Risk treatment is the implementation of policies and procedures whether the risk will be avoided, mitigate, escalate, accepted, or transferred. Therefore, it is important that risk management is an ongoing process and the company's risk management policies should be revisited every year to ensure policies are up-to-date and relevant.

2.1.3 Purpose of Risk Management

The purpose of the risk management that implemented to the company will be described as shown below:

1. Identifies and evaluates risks.
2. Reduce and eliminate harmful threat.
3. Supports efficient use of resources.
4. Gain better communication of risk within the company.
5. Reassures stakeholders.
6. Support company's continuity.

2.1.4 Risk Management Benefit

The benefit of the risk management that implemented to the company will be described as shown below:

1. Increased the company's awareness of threats from early identification.
2. Improved the company's ability to respond the unexpected event.
3. Continuous improvement of company's products or services.
4. Enhanced the company's ability to gain profit from new opportunities.
5. Improved the company's management of decision-making.
6. Higher probability of achieving company's objectives.
7. Enhanced the company's stakeholder value.
8. Improved the company's effectiveness use of resources.

2.1.5 House of Risk

House of Risk is a framework that was developed by Geraldin (2007) and Pujawan (2005) using the development of FMEA (Failure Mode and Effect Analysis) method and QFD (Quality Function Deployment) method. In FMEA, risk assessment could be calculated through the calculation of the RPN (Risk Potential Number) obtained from the multiplication of three factors, namely the probability of risk occurrence, the impact of the resulting damage, and risk detection. However, in the approach, the house of risk calculation of the value from the RPN is obtained from the probability of the risk source and the impact of damage related to that risk. In this case to look for possible sources of risk and the severity of risk events.

If Oi is the probability of occurrence risk source j, Si is the severity of the effect if the risk event i, and Rj is a correlation between the sources of risk j and the risk event i (which indicates how likely sources of risk j incoming risk event i) then ARPj (Aggregate Risk Potential of risk agent j) can be calculated by the formula as follow:

$$ARPj = Oj \Sigma SiRij \qquad (1)$$

ARP = Aggregate Risk Potential

O = Possibility of occurrence of risk agent

S = Severity of influence of risk event

R = Correlation between risk agent and risk events

According to Pujawan (2007), the application of House of Risk consists of two stages, namely:

1. House of Risk Phase 1

   House of Risk phase 1 is used to identify risk events and potential risk agents so the output of House of Risk phase 1 results in grouping risk agents into priority risk agents to take preventive measures (mitigation) in accordance with the Aggregate Risk Potential (ARP) value. In the model House of Risk phase 1 connects a set of needs (what) and a set of responses (how) that indicate one or more needs. The degree of correlation is specifically classified as having absolutely no relationship with giving values (0), low (1), moderate (3) and high (9). Adopting the above procedure, House of Risk phase 1 is developed through the following stages:

   1. Identifying risk events that can occur in any business process. Risk events are placed in the left column and expressed as Ei .
   2. Estimating the impact of several risk events (if they occur). The severity of the risk event is placed in the right-hand column of the table and is expressed as Si.
   3. Identify the sources of risk and assess the likelihood of each risk source occurring. The source of risk (risk agent) is placed in the top row of the table and associated with the bottom row events with the notation Oj.
   4. Develop a matrix relationship.

5. Calculate the Aggregate Risk Potential of agent j = ARPj that is determined as a result of the likelihood of the occurrence of the risk source j and the set of causal impacts from each risk event caused by the risk source j as in the equation above.
6. Ranking risk sources based on a collection of potential risks in descending order (from highest value to lowest value).

2. House of Risk Phase 2

House of Risk phase 2 is used for the design of mitigation strategies undertaken to handle risk agents of priority categories by considering effective differences such as the involvement of sources and the level of difficulty in their implementation. The output from House of Risk phase 1 will be used as input for House of Risk phase 2. The steps that will be described for House of Risk phase 2 are as follows:

1. Select a number of risk sources with high priority ranking, state the second House of Risk. The results of the selection will be placed in what is to the left of House of Risk phase 2.
2. Identify consideration of actions that are relevant for the prevention of sources of risk. These actions are placed in the top row as how in House of Risk phase 2.
3. Determine the relationship between each preventive measure and each source of risk, Ejk. This relationship can be considered as the level of effectiveness in action k in reducing the likelihood of the occurrence of a risk source.
4. Calculation of the total effectiveness of each action is described as follows:

$$TEk = \Sigma j \; ARPi \; Ejk \qquad (2)$$

TE = Total Effectiveness of Action
ARP = Aggregate Risk Potentials
E = Relationship between each precautionary measure and each source of risk

5. Estimate the degree of difficulty in carrying out each action, Dk and put those values in a row at the bottom line of the effective total.

The level of difficulty is indicated by the scale and reflects the funds and other sources needed in carrying out the action. Calculate the effective total on the difficulty ratio by using the formula:

$$ETDk = TEk / Dk \quad (3)$$

ETD = Effectiveness to Difficulty Ratio

TE = Total Effectiveness

D = Difficulty

For the data that needed to obtain the results of House of Risk method will be described as follows:

1. Risk Event

   This data is obtained by making a list of risks that can occur in the company based on interviews expert.

2. Data on Causes of Risk

   This data can be obtained by conducting interviews with each section of the company. One cause of risk may cause several risks, so there may be more risk causing data than risk event data.

3. Severity

   Severity is the amount of disruption caused by the occurrence of risk to the company's business processes. This data can be obtained through the distribution of questionnaires in each part of the authorized company. This questionnaire contains the value of risk impact scoring for the company. The rating scale is 1 - 10, where a value of 10 is the one that has the greatest impact if it occurs.

4. Occurrence

   This data is a level of opportunity for the emergence of a risk cause that results in the emergence of one or several risk impacts. Data can be obtained by calculating the chance of an event on the company's record or according to experience in the authorized department.

5. Correlation

   Data Relationship data between a risk event and the cause of the risk. This data is identified by adjusting the conditions and activities of the company's supply chain and can be obtained through the calculation of statistical correlation values.

Correlation data can also use the judgment of the authorities by making a standard {0, 1, 3, 9} which means 0 = no correlation, 1 = low correlation, 3 = moderate correlation, and 9 = high correlation.

2.1.6 Pareto Principle

The Pareto principle, also known as the "80-20" rule states that for many events, around 80% of its effects are caused by 20% of the causes. This principle was advanced by business management thinker Joseph M. Juran, who named it based on Italian economist Vilfredo Pareto who in 1906 observed that 80% of income in Italy was owned by 20% of the population. In addition, Pareto revealed the fact that 80% of land in Italy is actually owned by only 20% of its citizens. Not only in terms of urban governance, even from local produce, 80% of the local products come from only 20% of the total bean crop in there.

In The Pareto Principle, we will be advised to choose one of the many tasks. Later, we will be invited to focus on fewer things but can provide optimal results. The Pareto Principle will be useful for determining which areas will be the focus of efforts and resources of a company to achieve optimal results. By utilizing the 80/20 rule, later we can prioritize tasks so that we can focus on 20% (effort) which will produce 80% (result).

In the most general sense, the advantage of Pareto analysis is this analysis could identify and determine the root causes of the risk or problems. At the company business processes, the most important resource is time and due to time, the goals usually are not to eliminate or maximize but rather to optimize. The Pareto rule helps with optimization. Therefore, the company could resolve the risk with the highest priority first.

2.2 Inductive Study & Research Gap

The inductive research study consists of previous literature that correlate with this current research that talks about risk management using House of Risk method. At this part, the research gap also will be provided. Research gap is a gap that can be entered by a researcher based on experience or previous research. Scientific research basically aims to get a new answer to something that is considered a problem. Therefore, the research gap can also be used as a comparison regarding our research and previous research that already conducted especially in a specific topic. The research gap that includes for this undergraduate research are consists in three indicators as differences from other previous literature research. There are specified big enterprise, service company, and high potential risk enterprise. The research method comparison also provided to compare the method that used on each research.

For specified big enterprise, this indicator defined the research is used specified and big enterprise that already known by the public such as multinational and start-up company. For service company indicators, the research that conduct regarding the risk management that analysed the service company. This indicator will be the differentiation between this research and another research that used manufacturing company for previous research. For high potential risk enterprise indicator is defined as the company that involved high risky activities that could measure from its employee risks, high risk process that could cause extreme fatality such as death, technology risks, and company's facility risks. Therefore, those three indicators could be the gap for this research to represent that this undergraduate research is unique and different from previous research that was used for the inductive study. In more detail, the inductive study and the research gap that used for this undergraduate research will be described in more detail inside table 2.1 as shown below.

Table 2.1 Research Inductive Study & Research Gap

No	Author	Year	Main Result	Research Gap			Research Method			
				Specified Big Enterprise	Service Company	High Potential Risk Enterprise	HOR	FMEA	Project Risk Management	Job Hazard Analysis
1	Zwikael, Ahn	2011	Risk management practices have moderate on the effect of project risk to its success in multiple project scenarios. The projects that are completed more successfully are achieved by the projects with low levels of perceived risk.	**V**					**V**	
2	Susanto, A., Meiryani	2018	Existing risk management needs to be evaluated for reliability. The control activities will be optimal using a risk approach. All components of the risk management process can be used in the activities of industries.		**V**				**V**	

No	Author	Year	Main Result	Research Gap			Research Method			
				Specified Big Enterprise	Service Company	High Potential Risk Enterprise	HOR	FMEA	Project Risk Management	Job Hazard Analysis
3	Rabechini, R., Monteiro	2013	The specific study of the project risk management area in the specific research with a sample of this magnitude, producing important insights for new studies and bases for cross industry comparison.	**V**					**V**	
4	Rizky, Evi W.	2019	The product design is validated by a team of experts. The results show that there are potential hazards scattered throughout the production process.	**V**		**V**		**V**		
5	Setiasih, Junadi	2017	FMEA has proven valuable in identifying and treating risks in the process of radiation therapy that is related validation of treatment planning process indicates success to anticipate many actual process errors (59%).		**V**	**V**		**V**		

No	Author	Year	Main Result	Research Gap			Research Method			
				Specified Big Enterprise	Service Company	High Potential Risk Enterprise	HOR	FMEA	Project Risk Management	Job Hazard Analysis
6	Wibowo, D., Ervina	2020	The variables are inputted for the House of Risk phase 1 model through the measurement of impact (severity) and the level of probability of occurrence obtained from the results of a questionnaire to get the correlation value of each risk event. The results of the House of Risk phase 1 model are processed using pareto diagram.	**V**		**V**	**V**			
7	Taufiq, Kusuma, D.	2018	After conducting calculation using the house of risk both phase 1 and 2, obtained priority strategy handling risk of the company is to building relationships closely and communication with supplier and do management safety stock raw materials.	**V**			**V**			

No	Author	Year	Main Result	Research Gap			Research Method			
				Specified Big Enterprise	Service Company	High Potential Risk Enterprise	HOR	FMEA	Project Risk Management	Job Hazard Analysis
8	Ridha, N., Arief, I.	2021	Checking the completeness of the material periodically also proposed to overcome the risk of information about product details changing during planning.	**V**		**V**				**V**
9	Pujawan, Geraldine, H.	2009	Increasingly, companies need to be vigilant with the risks that can harm the short-term operations as well as the long-term sustainability of their supply chain. The framework will enable the company to select a set of risk agents to be treated and then to prioritize the proactive actions, to reduce the aggregate impacts of the risk events induced by those risk agents.	**V**			**V**			

No	Author	Year	Main Result	Research Gap			Research Method			
				Specified Big Enterprise	Service Company	High Potential Risk Enterprise	HOR	FMEA	Project Risk Management	Job Hazard Analysis
10	Herry, B., Ridha, G.	2021	Identify the activities of the ground coffee supply chain in Kahyangan Jember and its risks to determine the level of risk and resulting development of a risk management strategy.				**V**			
11	Proposed Research	2022	Identify the risk events and agents that occurs at PT. PLN ULP Kendal which include the high potential risk enterprise in electricity sectors to be proceeded to looking for priority risk and find the preventive mitigation action to overcome the risk potential.	**V**	**V**	**V**	**V**			

CHAPTER III

RESEARCH METHOD

3.1 Research Object

The research object is to improve the performance of the risk management process at distribution department of PT. PLN ULP Kendal using House of Risk method. The data that used in this undergraduate research is obtained from field observation and interview from the supervisor and staff at PT. PLN ULP Kendal. Therefore, this undergraduate research aims to improve the risk management process by provide the action to mitigate and prevent the risk to be occurs at PT. PLN ULP Kendal.

3.2 Risk Owner

Risk owner is the parties or person that responsible for the risk mitigation. The risk owner is found in each work function, work unit, and business process that occurs at PT. PLN ULP Kendal. For this undergraduate research, the risk owners are the ULP Manager, Occupational Safety and Health Official, and the supervisor of the distribution department, including the customer service and administration supervisor, energy transaction supervisor, and technical supervisor.

3.3 Research Instrument

The research instrument that will be used in this research is a questionnaire. The questionnaire will be used to interview the supervisor and staff at distribution department of PT. PLN ULP Kendal. The questionnaire will be an instrument to obtain the data that will be needed that include the risk events, risk probabilities, and risk severity.

3.4 Data Collection Method

There are two types of data that used to support this research, namely primary and secondary data. Those two types of data have different data collection method. The explanation regarding the data collection method will be described as shown below.

3.4.1 Primary Data

Primary data is a compilation of information that was gathered by the researcher in order to solve the problem formulation that was structured for the research (Ajayi, 2017). In primary data, there are key data sources that are very useful to support the research. Key data sources could be survey, field observation, test, questionnaire, and personal interview. The researcher will conduct an interview with the supervisor and staff of PT. PLN ULP Kendal in order to obtain important information and data that needed for this research include risk events, risk probabilities, and risk severity as the interview scope.

3.4.2 Secondary Data

In definition, secondary data refers to information that already gathered, produced, and accessed by the other researchers (Martin, Serra, 2018). Secondary data could be in a form of a literature, such as books, journals, articles, and other publications that used to support this research especially in risk management and House of Risk method.

3.5 Data Processing Method

Data processing for this undergraduate research is carried out after obtaining the results of interviews from the supervisor and staff at PT. PLN ULP Kendal which are contains of risk events, the causes of risk events, the frequency of occurrence of risk causes, the resulting impact or severity if the risk occurs, as well as the correlation between risk causes and risk events. After the data is gathered completely, the data could be processed using the House of Risk method phase 1 in order to obtain the priority risk events which will be given the recommendations of risk mitigation after going through the selection based on the Pareto diagram that has been made. At this stage, the priority risk event data that has been obtained will enter the calculation of the House of Risk phase 2 regarding what mitigation that will be appropriate to be given to the risk event according to the actual field conditions that occur. After the risk mitigation options are determined, these options will be reprocessed to obtain priority mitigation actions by considering how difficult it is to realize these mitigations in the future.

3.6 Data Analysis Methods

The descriptive analysis methodology is a statistical method for data analysis that involves summarizing or explaining the data that were collected without trying to make any conclusive generalizations (Sugiyono, 2014). Although some of the data in this research may have been acquired qualitatively, but most of the data has largely been investigated quantitatively, with correlations that have been found through statistical analyses such as frequencies, percentages, averages, and others. The quantitative data will next be translated from the qualitative input for comparison and evaluation to improve the company's performance at PT. PLN ULP Kendal.

3.7 Research Flowchart

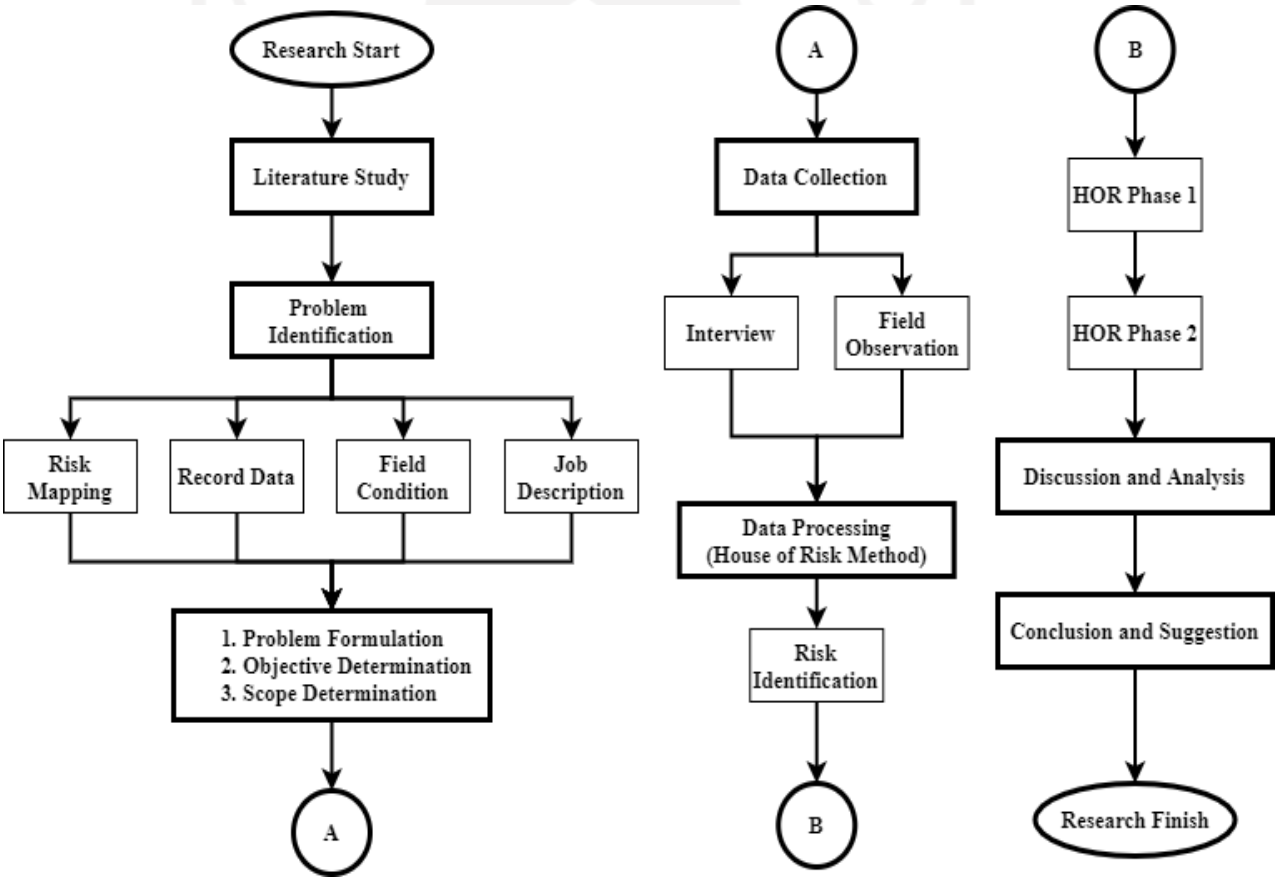

Figure 3.1 Research Framework

Based on figure 3.1 above, the research framework will for this undergraduate research will be explained further as shown below.

1. Literature Study

   Literature study is a step taken to examine the methods that can be used to perform data processing. Literature study in this research will be limited to the risk management, House of Risk, Failure Mode and Effect Analysis and Pareto Diagram.

2. Problem Identification

   At this stage, the researcher is looking for potential problem that might be occur at the company that later will be analysed to looking for the way to solve the problem.

3. Problem Formulation

   At this stage, the issue from the potential problem that already found before will be determined in the field of the risk management at PT. PLN ULP Kendal. The problem formulation needs to be solved in this undergraduate research.

4. Objective Determination

   At this stage, after determining the problem formulation, the objectives will be arranged to solve and achieve the problem formulation. Therefore, all the objectives that already determined should be achieved to provide the solution in form of risk mitigation for PT. PLN ULP Kendal.

5. Scope Determination

   At this stage, the scope determination has a function to limit the research to make the research become specific. For this undergraduate research, the research was conducted from October until December 2022 with the data taken from the observation and interview with the supervisor and staff of PT. PLN ULP Kendal.

6. Data Collection

   At this stage, the data collection that used in this research will be explained as shown below:

   a. Observations

      Observations is conducted by made by visit and observe each location where the business process occurs. Therefore, we could see directly what kind of risk events that might be occur at distribution department of PT. PLN ULP Kendal.

b. Interviews

Interviews is conducted with supervisor and staff from distribution department at PT. PLN ULP Kendal to obtain information and data limits that could be obtained to the author. This interview was also conducted to adjust the information obtained through observation to match the opinions of the experts.

7. Data Processing

At this stage, data processing is carried out after obtaining the results of interviews which are risk events, the causes of risk events, the frequency of occurrence of risk causes, the resulting impact if the risk occurs, as well as the correlation between risk causes and risk events. After the data is complete, the data could be processed using the House of Risk method phase 1 to obtain priority risk events which will be given risk mitigation recommendations after going through the selection based on the Pareto diagram that has been made. At this stage, the priority risk event data that has been obtained will enter the calculation of the House of Risk phase 2 regarding what mitigation that will be appropriate to be given to the risk event according to the actual field conditions that occur. After the risk mitigation options are determined, these options will be reprocessed to obtain priority mitigation actions by considering how difficult it is to realize these mitigations in the future.

8. Discussion and Analysis

At this stage, discussion and analysis will be carried out based on the result of the data processing that already carried out. The analysis then will be used to make improvements for the company to increase their risk management. The improvement that will be proposed will be risk mitigation to prevent the risk to be occur at PT. PLN ULP Kendal using House of Risk method.

9. Conclusion and Suggestion

At this stage, after carrying out all the stage above, as a closing of this research, there will be a conclusion based on the results of the research analysis that has been carried out to answer the problem formulation that has been determined and provide suggestions for improvement of risk management that will be carried out in the future especially for PT. PLN ULP Kendal.

CHAPTER IV

DATA COLLECTING AND PROCESSING

4.1 Pre-House of Risk Steps

4.1.1 Company History

At the beginning of the 19th century, the fields of sugar factories and electricity factories in Indonesia began to be increased when several Dutch companies engaged in the sugar factories and tea factories set up electricity generators for their own needs. Between 1942-1945 there was a shift in the management of these Dutch companies by the Japanese, after the Netherlands surrendered to Japanese troops at the beginning of World War II. The process of transferring power occurred again at the end of World War II in August 1945, when Japan surrendered to the Allies. This opportunity was taken advantage of by the youth and electricity workers through a delegation of Electricity and Gas Laborers/Employees who together with the Head of the Central KNI took the initiative to meet President Soekarno to hand over these companies to the Government of the Republic of Indonesia. On October 27th, 1945, President Soekarno formed the Electricity and Gas Bureau under the Ministry of Public Works and Energy with a power generation capacity of 157.5 MW.

On January 1st, 1961, the Electricity and Gas Bureau was changed to become BPU-PLN (General Board of the State Electricity Company) which was engaged in electricity, gas and coke which was disbanded on January 1st, 1965. At the same time, 2 (two) companies State Electricity Company (PLN) as manager of state-owned electricity and State Gas Company (PGN) as gas manager was inaugurated. In 1972, according to Government Regulation number 18, the status of the State Electricity Company (PLN) is determined as the State Electricity Public Company and as the Holder of Electricity Business Authorization (PKUK) with the task of providing electricity for the public interest. In line with the Government's policy of providing opportunities for the private sector to engage in the electricity supply business, since 1994 the status of PLN has changed to become a Limited Liability Company (Persero).

4.1.2 Company Vision, Mission, Motto, and Core Values

4.1.2.1 Company Vision

The Vision of PT. PLN (Persero) is *"To be the Leading Electricity Company in Southeast Asia and number 1 Customer Choice for Energy Solutions"*.

4.1.2.2 Company Mission

The Mission of PT. PLN (Persero) will be mentioned as shown below:

1. Running the electricity business and other related fields, oriented to the satisfaction of customers, company members and shareholders.
2. Making electricity as a medium to improve the quality of people's lives.
3. Keeping electrical power into driving economic activity.
4. Carrying out environmentally sound business activities.

4.1.2.3 Company Motto

The Motto of PT. PLN (Persero) is *"Electricity for A Better Life"*.

4.1.2.4 Company Core Values

The Core Values of PT. PLN (Persero) is called as AKHLAK, which is the acronym of:

1. AMANAH : Hold fast to the trust given,
2. KOMPETEN : Continue to learn and develop capabilities,
3. HARMONIS : Caring for each other and respecting differences,
4. LOYAL : Dedicated and put interests first nation and state,
5. ADAPTIF : Continue to innovate and be enthusiastic in moving or facing change,
6. KOLABORATIF : Build synergistic collaboration.

4.1.3 PT. PLN (Persero) ULP Kendal

PT. PLN (Persero) UP3 Semarang is a customer service implementation unit office located in the distribution area of Central Java and Yogyakarta. UP3 Semarang consists of 7 Customer Service Units (ULP), namely:

1. ULP Semarang Selatan
2. ULP Semarang Timur
3. ULP Semarang Tengah
4. ULP Semarang Barat
5. ULP Boja
6. ULP Kendal
7. ULP Weleri

Figure 4.1 PT. PLN ULP Kendal Office

For PT. PLN ULP Kendal that used to conduct this research, this company is headed by a ULP Manager (MULP). In addition, at PT. PLN ULP Kendal there are employees who carry out business processes at PT. PLN ULP Kendal. Therefore, the organizational structure will be described in more detail as shown below:

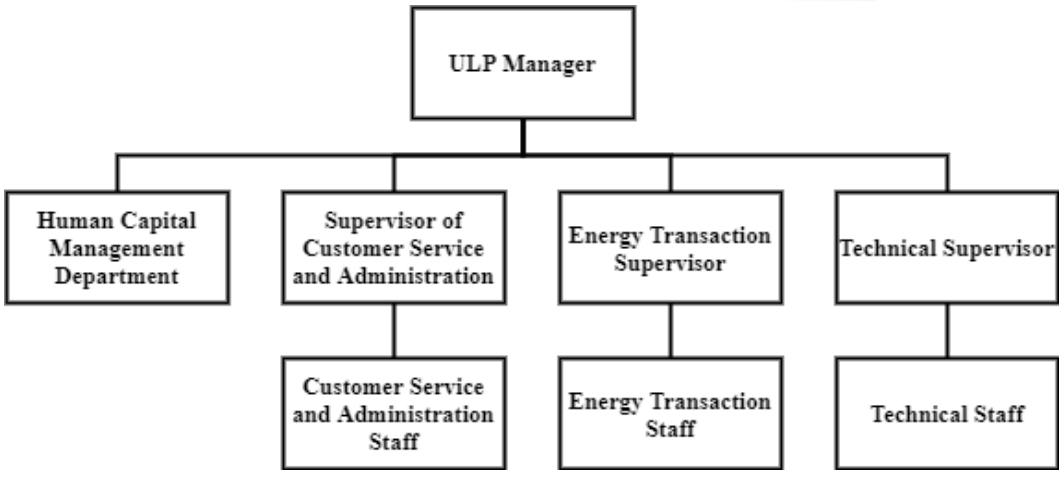

Figure 4.2 PT. PLN ULP Kendal Organizational Structure

PT. PLN ULP Kendal has a working area in Kendal Regency, especially in the District of Rowosari, Kangkung, Cepiring, Gemuh, Ringinarum, Pegandon, Ngampel, Patebon, Kendal City, Brangsong, and Kaliwungu. PT. PLN Kendal has a working area boundary to the east with PT. PLN ULP Semarang Barat and to the east with PT. PLN ULP Weleri. The field of business carried out by PT. PLN ULP Kendal is a service and network service activity that will be described in more detail as shown below:

1. Providing information services about procedures for calculating the amount of electricity costs.
2. Provide information regarding new connections, changes in power, temporary connections, changes in fares, transfer of customer names, and other services, as well as customer control.
3. Serving the payment of Connection Fees (BP), Customer Security Deposits (UJP), Supplementary Bills (TS), temporary fees, change fees, and other fees determined in accordance with applicable regulations.
4. Make receipts for payment of connection fees.

PT. PLN ULP Kendal employees have a schedule of 5 working days, started from Monday to Friday, with Saturday and Sunday off. The working hours are from 07.30 WIB to 16.30 WIB for Monday to Thursday. On Friday, work starts at 07.30 WIB until 15.00 WIB. Working days and hours may change according to regulations from PT PLN Persero.

4.2 Risk Identification

4.2.1 Risk Event Identification

PT. PLN ULP Kendal include in a large scale of company that involved huge amount of process occurred in the distribution process of electricity to the customer. Therefore, there must be several risks that might be occurred because every process will face risks that could present threats to its success. There are 3 departments that consists at PT. PLN ULP Kendal main operation. There are field operation, customer service, and company resources. At risk event identification, the information that will be attached inside the table are the department, risk code, the risk event, and the severity that caused by the risk event.

According to PT. PLN ULP Kendal parameter and standardization, the scale of severity will divide into scores 1 to 5 by severity classification. The parameters of risk severity in this research are divided into 5 categories. The severity categories are catastrophic, severe, moderate, significant, and minor risk. The determination of parameters is based on the company policy and standards will be described as shown below:

Table 4.1 Severity Level Description

Weight	Criteria	Effect
1	Risk that does not affect the system performance and the company operator probably will not notice (Renewable energy, advanced information system)	Minor
2	Risk that would cause slight annoyance to the company operator but would cause no deterioration to the company system performance (Human Capital Management, electrical service disruption, customer service perception)	Significant
3	Risk that would cause high degree of operator dissatisfaction or cause noticeable slight deterioration to the company system performance (Electrical hazard, Service Level Agreement, Supply Chain Management)	Moderate
4	Risk that would cause significant deterioration to the company system performance and leads to minor injuries (Company asset damage, environmental damage, loss to the residents, company's financial drop)	Severe
5	Risk that would seriously affect the ability to complete the task (Serious injury, death, company area destruction, bankruptcy)	Catastrophic

If the risk that does not affect the system performance and the company operator probably will not notice, the value of the severity will be 1. If the risk that would cause slight annoyance to the company operator but would cause no deterioration to the company system performance, the value of the severity will be 2. If the risk that would cause high degree of operator dissatisfaction or cause noticeable slight deterioration to the company system performance, the value of the severity will be 3. If the risk that would cause significant deterioration to the company system performance and leads to minor injuries, the value of the severity will be 4. If the risk that would seriously affect the ability to complete the task or cause damage, serious injury, death, and took a long time to repair the system, the value of the severity will be 5. The detail regarding the risk event identification at PT. PLN ULP Kendal will be described as shown below:

Table 4.2. Risk Event Table

Department	Code	Risk Event	Severity
Field Operation	E1	Workers fell from a height	5
	E2	Workers electrocuted by electrical network	5
	E3	Hazards posed to the environment	3
	E4	Company asset damage	4
	E5	Service disruption to the customers	2
Customer Service	E6	Service Level Agreement (SLA) that did not achieve	3
	E7	Poor customer service perception	2
	E8	Supply Chain Management that did not optimize	3
Company Resources	E9	Renewable Energy business process that did not aligned and adequate	1
	E10	Infrastructure development that not in line with electricity growth	3
	E11	Inadequate capability of information technology systems	2
	E12	Insufficient financial capacity to respond the needs of the stakeholder	2

Department	Code	Risk Event	Severity
	E13	Human capital capabilities and capacities are not aligned with the electricity business development process	2

4.2.2 Risk Agent Identification

Risk agents are any factors that can cause the occurrence of identified risk events that are measured using the scale of occurrence. Occurrence is the possibility that the risk will occur and produce a form of failure during the operational process. Based on PT. PLN ULP Kendal standardization, the score occurrence will be divided into 1 to 5 depending on the probability of the risk happening in 6 months. The parameter of occurrence is divided into 5 categories based on the probability the risk occurs. The higher the occurrence value, the higher the risk has probability to occurs. In the other side, the lower the occurrence value, the lower the risk probability to be occur. The function of the occurrence level degree is to identify the value of the occurrence that are consider based on the possibility of the risk agent to occur. The occurrence level table with its weight and criteria will be described as shown below:

Table 4.3 Occurrence Level Description

Weight	Criteria	Effect
1	Occurs < 1 time in 6 months	Rarely Happen
2	Occurs 2-3 times in 6 months	Probably Happen
3	Occurs 4-6 times in 6 months	Moderate Happen
4	Occurs 7-8 times in 6 months	Frequent to Happen
5	Occurs > 9 times in 6 months	Almost Certain to Happen

If the probability of the risk agent is occurring < 1 time in 6 months, the value of the occurrence will be 1. If the probability of the risk agent is occurring 2-3 times in 6 months, the value of the occurrence will be 2. If the probability of the risk agent is occurring 4-6 times in 6 months, the value of the occurrence will be 3. If the probability of the risk agent is occurring 7-8 times in 6 months, the value of the occurrence will be 4.

If the probability of the risk agent is occurring > 9 times in 6 months, the value of the occurrence will be 5. The following are risk agents at PT. PLN ULP Kendal and their scale of occurrence:

Table 4.4. Risk Agent Table

Department	Code	Risk Agent	Occurrence
Field Operation	A1	Workers are not use the Standard Personal Protective Equipment and work not based on the Standard Operational Procedure (SOP)	4
	A2	Workers perform the electrical voltage cut off with error operation and no supervision	3
	A3	Public ignorance regarding the dangers of electrical network	4
	A4	Workers that are not competent in their field with poor tools and equipment condition	2
	A5	Electrical network maintenance	3
Customer Service	A6	Electrical network maintenance that are not systematic with unexpected natural events	4
	A7	A lot of disruption cases occurs to the customer with poor responses from the company	3
	A8	The distribution facilities that are disrupt with limited access and capacity	2
Company Resources	A9	Dependencies of non-renewable natural resources	1
	A10	Lack number of tools and facilities used to support the company activities	3
	A11	Human resources capability limitation toward technological developments	2
	A12	Losses experienced by the company in operational activities for certain period	1
	A13	Minimum periodic evaluation and training	2

4.2.3 Risk Register

Risk register is a list that contains the risks faced by the company. The importance of a risk register for a company is to help the company understand the characteristics of the risks that might occur and make the company aware of the dangers posed by these risks. The detail of the risk register of PT. PLN ULP Kendal will be described as shown below:

Table 4.5 Risk Register

No	Risk Event	Risk Agent	Risk Identification			Rank	Risk Owner
			O	S	RPN		
1	Workers fell from a height	Workers are not use the Standard Personal Protective Equipment and work not based on the Standard Operational Procedure (SOP)	4	5	20	1	Technical Supervisor
2	Workers electrocuted by electrical network	Workers perform the electrical voltage cut off with error operation and no supervision	3	5	15	2	Technical Supervisor
3	Hazards posed to the environment	Public ignorance regarding the dangers of electrical network	4	3	12	3	CSA Supervisor
4	Company asset damage	Workers that are not competent in their field with poor tools and equipment condition	2	4	8	5	Technical Supervisor

No	Risk Event	Risk Agent	Risk Identification			Rank	Risk Owner
			O	S	RPN		
5	Service disruption to the customers	Electrical network maintenance	3	2	6	6	Technical Supervisor
6	Service Level Agreement (SLA) that did not achieve	Electrical network maintenance that are not systematic with unexpected natural events	4	3	12	3	Energy Transaction Supervisor
7	Poor customer service perception	A lot of disruption cases occurs to the customer with poor responses from the company	3	2	6	6	CSA Supervisor
8	Supply Chain Management that did not optimize	The distribution facilities that are disrupt with limited access and capacity	2	3	6	6	Energy Transaction Supervisor
9	Renewable Energy business process that did not aligned and adequate	Dependencies of non-renewable natural resources	1	1	1	9	Energy Transaction Supervisor
10	Infrastructure development that not in line with electricity growth	Lack number of tools and facilities used to support the company activities	3	3	9	4	Technical Supervisor
11	Inadequate capability of information technology systems	Human resources capability limitation toward technological developments	2	2	4	7	Technical Supervisor

No	Risk Event	Risk Agent	Risk Identification			Rank	Risk Owner
			O	S	RPN		
12	Insufficient financial capacity to respond the needs of the stakeholder	Losses experienced by the company in operational activities for certain period	1	2	2	8	ULP Manager
13	Human capital capabilities and capacities are not aligned with the electricity business development process	Minimum periodic evaluation and training	2	2	4	7	HCM Department

4.2.4 Risk Management Plan Matrix

According to Brindley (2004), company risk owner will create a risk management plan strategy to anticipate risks, calculate impacts, and specify actions to risks because the risk is defined as an unpredictable event or circumstance that, if it materializes, has a favorable or unfavorable impact on the company objectives. Therefore, the risk management plan will be determined as shown below:

Table 4.6 Risk Management Plan Matrix

Low Risk Moderate Risk High Risk Extreme Risk

Severity	**Occurrence**				
	Rare	Probably	Moderate	Frequent	Almost Certain
Catastrophic			**E2**	**E1**	
Severe		**E4**			
Moderate		**E8**	**E10**	**E3, E6**	
Significant	**E12**	**E11, E13**	**E5, E7**		
Minor	**E9**				

4.3 House of Risk Phase 1

House of Risk phase 1 is used to determine which sources of risk are prioritized for mitigation actions. The first thing to do is identify the correlation between the risk event and the risk agent. The correlation between the two things is given by value of 0, 1, 3 or 9 as a sign of each correlation.

4.3.1 Correlation Identification

According to Geraldin, P. (2007), the function of correlation level degree is to identify the correlations that exist between risk events and risk agents. The correlation level table with its weight and criteria will be described as shown below:

Table 4.7 Correlation Level Description

Weight	Criteria
0	No Correlation
1	Low Correlation
3	Moderate Correlation
9	High Correlation

The following table are the results of the correlation level of each risk event and risk agent from distribution department work process to identify the value from the correlation from the cause and the risk events that will impact the whole company distribution process. The detail will be described as shown below:

Table 4.8 Correlation Identification

Department	Risk Event	Correlation	Risk Agent
Field Operation	E1	0	
		1	A10
		3	A4, A11, A13
		9	A1, A2
	E2	0	
		1	A6, A10
		3	A4, A13
		9	A1, A2, A11
	E3	0	

Department	Risk Event	Correlation	Risk Agent
		1	A11
		3	A6, A13
		9	A3
	E4	0	
		1	A8, A11
		3	A1, A2, A13
		9	A4, A6
	E5	0	
		1	A4, A6, A10
		3	A8
		9	A5
Customer Service	E6	0	
		1	
		3	A4, A8, A13
		9	A6, A10
	E7	0	
		1	A11
		3	A6, A13
		9	A5, A7
	E8	0	
		1	A4, A11
		3	A5, A6, A10, A13
		9	A8
Company Resources	E9	0	
		1	A13
		3	A10, A11
		9	A9
	E10	0	
		1	A3, A9
		3	A11
		9	A10

Department	Risk Event	Correlation	Risk Agent
	E11	0	
		1	A10
		3	A13
		9	A11
	E12	0	
		1	A13, A10
		3	A8
		9	A12
	E13	0	
		1	A4, A10
		3	
		9	A11, A13

4.3.2 Aggregate Risk Potential Calculation

The next step that will be conducted is calculate the Aggregate Risk Potentials (ARP) which obtained from the multiplication of the probability of the source of risk and the impact of damage when the risk occurs. The Aggregate Risk Potentials calculation will be described as shown below:

Table 4.9 Aggregate Risk Potential Calculation

Aggregate Risk Potential	Calculation Result
ARP_1	$= O_1 (\Sigma Si Ri_1)$
	= 4 x [(3x1)+(4x3)+(2x3)+(2x3)+(5x9)+(5x9)]
	= **468**
ARP_2	$= O_2 (\Sigma Si Ri_2)$
	= 3 x [(3x1)+(3x1)+(4x3)+(2x3)+(5x9)+(5x9)+(2x9)]
	= **396**
ARP_3	$= O_3 (\Sigma Si Ri_3)$
	= 4 x [(2x1)+(3x3)+(2x3)+(3x9)]
	= **140**
ARP_4	$= O_4 (\Sigma Si Ri_4)$

Aggregate Risk Potential	Calculation Result
	= 2 x [(3x1)+(2x1)+(5x3)+(5x3)+(2x3)+(4x9)+(3x9)]
	= **208**
ARP_5	= O_5 (Σ Si Ri_5)
	= 3 x [(4x1)+(3x1)+(3x1)+(3x3)+(2x9)]
	= **111**
ARP_6	= O_6 (Σ Si Ri_6)
	= 4 x [(4x3)+(3x3)+(2x3)+(3x9)+(3x9)]
	= **324**
ARP_7	= O_7 (Σ Si Ri_7)
	= 3 x [(2x1)+(3x3)+(2x3)+(2x9)+(2x9)]
	= **159**
ARP_8	= O_8 (Σ Si Ri_8)
	= 2 x [(4x1)+(2x1)+(2x3)+(3x3)+(3x3)+(2x3)+(3x9)]
	= **126**
ARP_9	= O_9 (Σ Si Ri_9)
	= 1 x [(2x1)+(3x3)+(2x3)+(1x9)]
	= **26**
ARP_{10}	= O_{10} (Σ Si Ri_{10})
	= 3 x [(3x1)+(1x3)+(2x3)+(3x9)]
	= **90**
ARP_{11}	= O_{11} (Σ Si Ri_{11})
	= 2 x [(3x1)+(2x3)+(2x9)]
	= **54**
ARP_{12}	= O_{12} (Σ Si Ri_{12})
	= 1 x [(2x1)+(3x1)+(3x3)+(2x9)]
	= **32**
ARP_{13}	= O_{13} (Σ Si Ri_{13})
	= 2 x [(4x1)+ (3x1)+(2x9)+(2x9)]
	= **86**

After identifying the correlations and calculating Aggregate Risk Potentials (ARP), the final step in the House of Risk phase 1 is create a House of Risk phase 1 table by combining data from risk events, risk agents, correlations between risk events and risk agents data, and Aggregate Risk Potentials (ARP) calculation results into a table. The table of House of Risk phase 1 will be described as shown below:

Table 4.10 House of Risk Phase 1

Risk Event (Ei)	**Risk Agent (Aj)**													**Risk Event Severity (Sj)**
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
E1	9	9	0	3	0	0	0	0	0	1	3	0	3	5
E2	9	9	0	3	0	1	0	0	0	1	9	0	3	5
E3	0	0	9	0	0	3	0	0	0	0	1	0	3	3
E4	3	3	0	9	0	9	0	1	0	0	1	0	3	4
E5	0	0	0	1	9	1	0	3	0	1	0	0	0	2
E6	0	0	0	3	0	9	0	3	0	9	0	0	3	3
E7	0	0	0	0	9	3	9	0	0	0	1	0	3	2
E8	0	0	0	1	3	3	0	9	0	3	1	0	3	3
E9	0	0	0	0	0	0	0	0	9	3	3	0	1	1
E10	0	0	1	0	0	0	0	0	1	9	3	0	0	3
E11	0	0	0	0	0	0	0	0	0	1	9	0	3	2
E12	0	0	0	0	0	0	0	3	0	1	0	9	1	2
E13	0	0	0	1	0	0	0	0	0	1	9	0	9	2
Agent J Occurrence (Oj)	**4**	**3**	**4**	**2**	**3**	**4**	**3**	**2**	**1**	**3**	**2**	**1**	**2**	
Aggregate Potential j	**468**	**396**	**140**	**208**	**111**	**324**	**159**	**126**	**26**	**90**	**54**	**32**	**86**	
Agent Priority Rank	**1**	**2**	**6**	**4**	**8**	**3**	**5**	**7**	**13**	**9**	**11**	**12**	**10**	

After the House of Risk Phase 1 was structured, the result from the calculated Aggregate Risk Potential could be ranked to be prioritized. The result will be described as shown below:

Table 4.11 Aggregate Risk Potential Calculation Rank

Rank	Risk Agent Code	ARP Value
1	A1	468
2	A2	396
3	A6	324
4	A4	208
5	A7	159
6	A3	140
7	A8	126
8	A5	111
9	A10	90
10	A13	86
11	A11	54
12	A12	32
13	A9	26

4.4 House of Risk Phase 2

According to Geraldin, P. (2007), after we conducted data processing in House of Risk phase 1, the next step is designing the House of Risk phase 2 to design strategies to prioritize preventive actions by considering resources and cost effectiveness. The step of House of Risk phase 2 will be explained as shown below.

4.4.1 Risk Evaluation Prioritizing using Pareto Chart

In the Pareto Principle, we will be advised to choose one of the many tasks. Later, we will be invited to focus on fewer things but can provide optimal results. The Pareto Principle will be useful for determining which areas will be the focus of efforts and resources of a company to achieve optimal results. By utilizing the 80/20 rule, later we can prioritize tasks so that we can focus on 20% (effort) which will produce 80% (result).

The Pareto chart shows that the level of importance in reducing the probability of occurrence of each risk agent varies greatly. Figure 4.7 concludes that 13 risk agents contribute to the existing risks that hinder the business process in the company. In the rules of the house of risk method and pareto, to choose the source of risk to be treated is in a ratio of 80:20. The result shows the rank aggregate risk potential of 13 risk agents that have already been filtered based on the 80% of occurring risk will be explained as shown below:

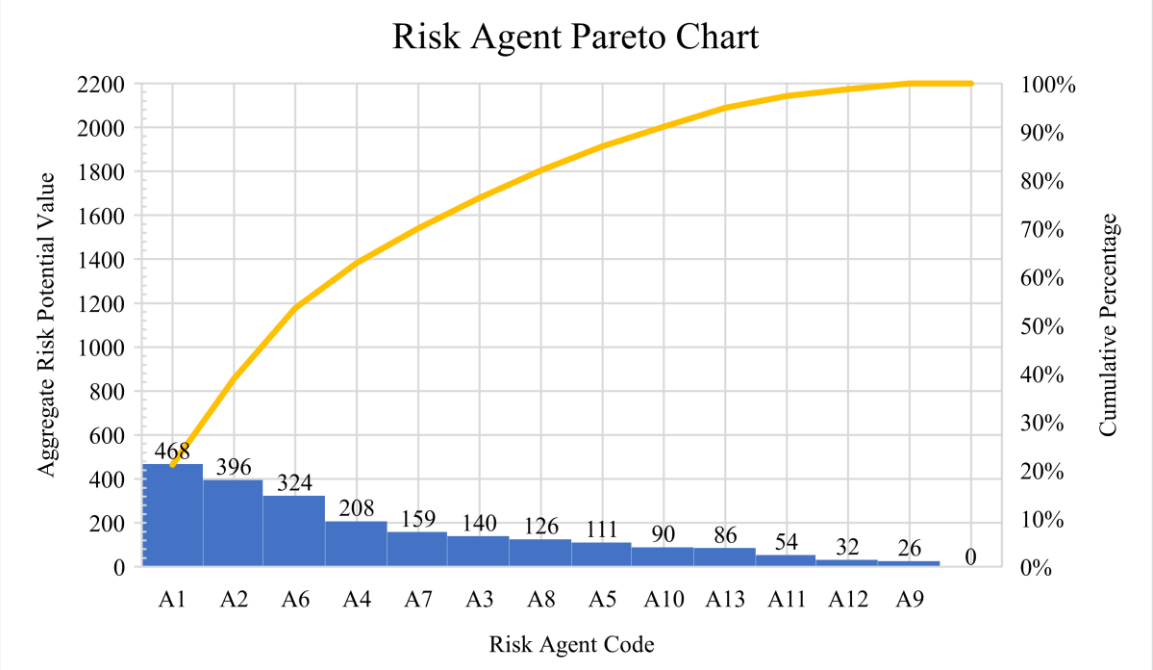

Figure 4.3 Risk Agent Pareto Chart

Table 4.12 Risk Agent Category

Risk Agent Code	ARP Value	Percentage	Cumulative Percentage	Category
A1	468	16%	16%	Priority
A2	396	13%	29%	
A6	324	12%	41%	
A4	208	11%	52%	Non Priority
A7	159	10%	62%	
A3	140	8%	70%	
A8	126	6%	76%	

Risk Agent Code	ARP Value	Percentage	Cumulative Percentage	Category
A5	111	6%	82%	Non Priority
A10	90	5%	87%	
A13	86	4%	91%	
A11	54	4%	95%	
A12	32	3%	98%	
A9	26	2%	100%	

Based on the result of Pareto Chart category prioritization, the risk that need to prioritized is risk agent with the code of A1, A2, and A6 with the value of Aggregate Risk Potential of 468, 396, and 324 respectively. After the risk prioritization was determined, every risk will be determined to be avoid, transfer, mitigate, accept, or escalate using risk response strategy. The detail of the risk response strategy will be described as shown below:

Table 4.13 Risk Response Description

Risk Response Strategy	Description
Avoid	Eliminate the project risk
Transfer	Transfer the risk to a third party (another department)
Mitigate	Reduce the probability or impact of the risk
Accept	Accept the risk by taking no action
Escalate	Escalate a risk to higher levels of authority because the risk is out of a scope

Table 4.14 Risk Response Strategy Matrix

Risk Event	Response	Contingency Plan	Risk Owner
E1	Mitigate	Standard Operational Procedure evaluation	Technical Supervisor
E2	Mitigate	Electrical network inspection	Technical Supervisor

Risk Event	Response	Contingency Plan	Risk Owner
E6	Mitigate	Personnel training and upskilling	Energy Transaction Supervisor
E4	Mitigate	Personnel certification	Technical Supervisor
E7	Mitigate	Increase the level of service to customers	CSA Supervisor
E3	Escalate	Escalate the risk to Haleyora Powerindo	CSA Supervisor
E8	Escalate	Escalate the risk to UPT Department	Energy Transaction Supervisor
E5	Mitigate	Maintain the electrical network systematically	Technical Supervisor
E10	Transfer	Tools and equipment proposal to UPT Department	Technical Supervisor
E13	Mitigate	Personnel training and upskilling	HCM Department
E11	Mitigate	Personnel certification	Technical Supervisor
E12	Escalate	Manage and consult the financial capacity to UP3 office	ULP Manager
E9	Avoid	Company's limitation authorities	Energy Transaction Supervisor

After the risk response strategy based on the priority risk are determined, the next step that will be conducted is design the fishbone diagram and the mitigation strategy to take a preventive action from the prioritized risk agent.

4.4.2 Fishbone Diagram

Fishbone diagram is a cause-and-effect finding tool that helps to find out the various reasons for failures or breakdowns in a process. It can also be said, fishbone analysis is a method to help solve a problem at every layer to the potential root causes that contribute to its effects. This diagram was introduced by an engineering professor from Japan, named Kaoru Ishikawa (Scott, 2017).

The fishbone diagram based on the priority risk agent that already prioritized will be described as shown below:

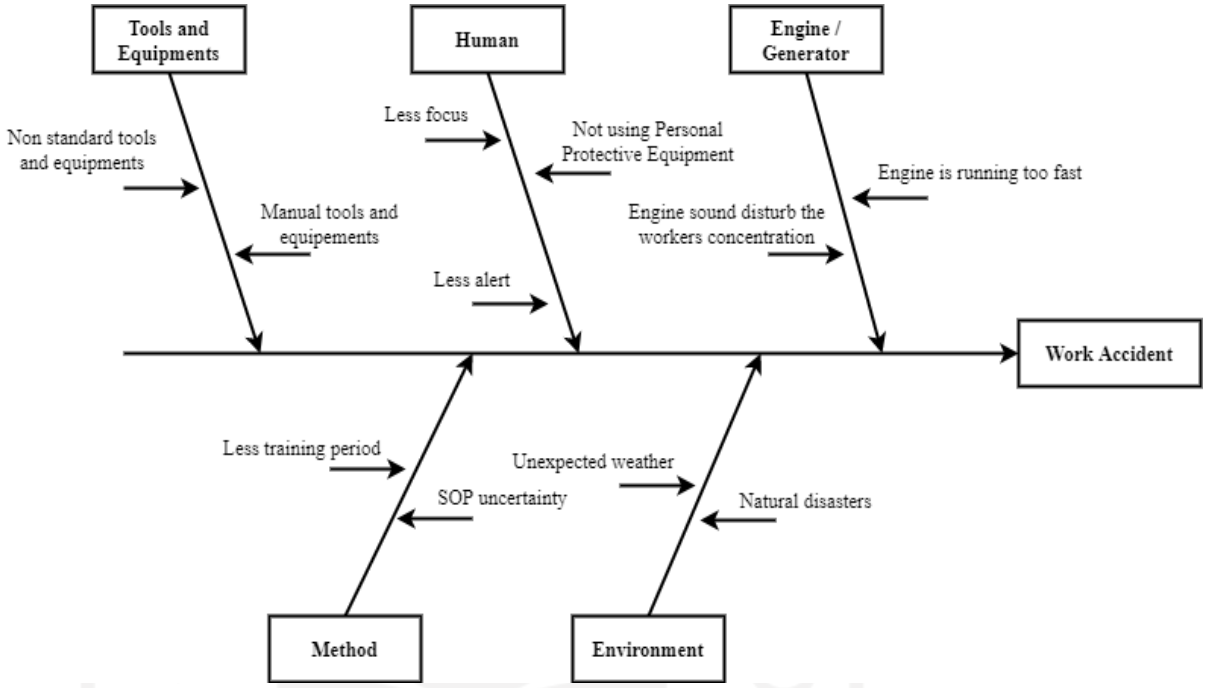

Figure 4.4 Fishbone Diagram Risk Agent A1 and A2

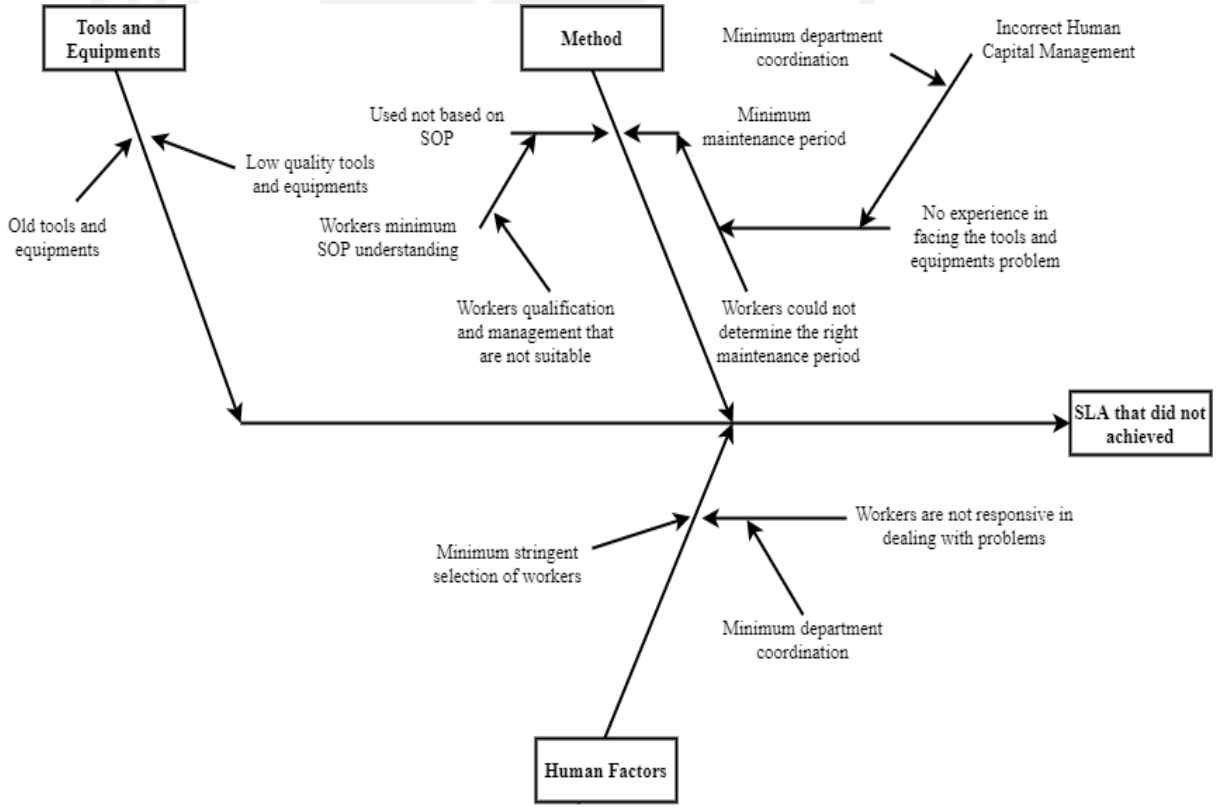

Figure 4.5 Fishbone Diagram Risk Agent A6

4.4.3 Design Mitigation Strategy

The first step that need to do to design the mitigation strategy is with looking for possible preventive action that could be achieved and implemented by the company to obtain appropriate the action mitigation with the selected priority risk agent. The first step that must be done is designing a mitigation strategy by consider the cause and the effect to get mitigation actions that are appropriate for the selected risk agent. The alternative mitigation actions that can be taken by arranging preventive action that will be described as shown in the table below:

Table 4.15 Preventive Action Correlate to Prioritized Risk Agent

No	Preventive Action	Preventive Action Code
1	**Standard Operational Procedures Evaluation** • Each work processes are supervised • Workers do the work based on SOP	PA1
2	**Personnel Certification** • Workers are certified by LSPK3	PA2
3	**Personnel Training and Upskilling** • Workers skill and ability are honed • Training events is conducted	PA3
4	**Electrical Network Inspection** • Electrical network inspection is conducted at remote and developed area	PA4
5	**Tools and Equipment Maintenance** • Tools and equipment maintenance is conducted based on the standard period • Replacement of inadequate equipment into proper tools	PA5
6	**Occupational Safety and Health Implementation** • Workers used complete PPE • Workers used safety equipment for heavy and light work	PA6

No	Preventive Action	Preventive Action Code
	Improvement of Non-Standard Electrical Network Construction	
7	• Maintenance for non-standard electrical network are conducted using third parties (Haleyora)	PA7

From the table above, we could find and determine there are 7 preventive mitigation action that could be applied to overcome the selected risk agent. The preventive action are the Standard Operational Procedures evaluation, personnel certification, personnel training and upskilling, electrical network inspection, tools and equipment maintenance, Occupational Safety and Health implementation, and improvement of non-standard electrical network construction. After the preventive action was developed, at the next step the correlation of each preventive action will be determined.

4.4.4 Correlation Identification

After developing the preventive action table that already done before, the next step is determining the correlation between the risk agent that has the priority with the preventive action agent that already developed before based on the scale of correlation as already mentioned before at table 4.7. The correlation of each preventive action with the selected risk agent will be described in the table as shown below.

Table 4.16 Risk Agent and Preventive Action Correlation

Risk Agent	Correlation	Preventive Action Code
A1	0	
	1	PA5
	3	PA2, PA3, PA4
	9	PA1, PA6, PA7
A2	0	
	1	
	3	PA2, PA3, PA5

	9	PA1, PA4, PA6, PA7
A6	0	
	1	PA1
	3	PA2, PA5
	9	PA3

Based on the table above, we could obtain the result that the low correlation at risk agent A1 was found at PA5, and for risk agent A6 was found at PA1. The moderate correlation at risk agent A1 was found at PA2, PA3, and PA4, and for risk agent A2 was found at PA2, PA3, and PA5, and for risk agent A6 was found at PA2 and PA5. The high correlation at risk agent A1 was found at PA1, PA6, and PA7, and for risk agent A2 was found at PA1, PA4, PA6, and PA7, and for risk agent A6 was found at PA3. The next step that will be conducted is calculate the degree of difficulty measurement to measure how difficult the preventive action to be implemented at the company.

4.4.5 Degree of Difficulty Measurement

Degree of Difficulty is a rating which reflects the difficulty from the preventive action that already determined before to be implemented by the company to avoid the risk to be occurs. The detail explanation of the risk mitigation degree of difficulty will be described as shown in the table below:

Table 4.17 Degree of Difficulty Explanation

Value of Degree	Explanation
3	The mitigation action is easy to be applied
4	The mitigation is quite difficult/medium to be applied
5	The mitigation action is difficult to be applied

Degree of Difficulty is measured with some consideration which are cost, time, and worker skill to do it. The determination of degree of difficulty action at distribution department of PT. PLN ULP Kendal will be described on the table as shown below:

Table 4.18 Preventive Action Degree of Difficulty

Preventive Action Code	Degree of Difficulty (D)
PA1	3
PA2	4
PA3	3
PA4	5
PA5	4
PA6	3
PA7	5

Based on the degree of difficulty measurement above, the preventive action that are easy to be implemented are PA1, PA3, and PA6. The preventive action that are medium/quite difficult to be implemented are PA2 and PA5. And the preventive action that are difficult to be implemented are PA4 and PA7. After measure the degree of difficulty, the calculation of the total effectiveness will be conducted to measure the highest value of preventive action that will be implemented.

4.4.6 Total Effectiveness Measurement

Total Effectiveness (TEk) is calculated with each of risk agent ARP value that multiplied with the correlation value of preventive action that was determined based on formula as shown below:

$$TEk = \Sigma j \; ARPi \; Ejk$$

1. **Total Effectiveness A1 Calculation**

Table 4.19 Total Effectiveness A1 Calculation

Total Effectiveness Calculation	
TE $A1_1$	$= \Sigma j \; ARP_1 \; Ejk_1$
	= (468x9)
	= **4212**
TE $A1_2$	$= \Sigma j \; ARP_1 \; Ejk_2$
	= (468x3)
	= **1404**

Total Effectiveness Calculation	
TE $A1_3$	= $\Sigma j\ ARP_1\ Ejk_3$
	= (468x3)
	= **1404**
TE $A1_4$	= $\Sigma j\ ARP_1\ Ejk_4$
	= (468x3)
	= **1404**
TE $A1_5$	= $\Sigma j\ ARP_1\ Ejk_5$
	= (468x1)
	= **468**
TE $A1_6$	= $\Sigma j\ ARP_1\ Ejk_6$
	= (468x9)
	= **4212**
TE $A1_7$	= $\Sigma j\ ARP_1\ Ejk_7$
	= (468x9)
	= **4212**

Based on the calculation of total effectiveness for risk agent A1 at Table 4.19 that already conducted, the result for the total effectiveness $A1_1$, $A1_2$, $A1_3$, $A1_4$, $A1_5$, $A1_6$, and $A1_7$ respectively are 4212, 1404, 1404, 1404, 468, 4212, and 4212.

2. Total Effectiveness A2 Calculation

Based on the calculation of total effectiveness for risk agent A2 that already conducted, the result for the total effectiveness $A2_1$, $A2_2$, $A2_3$, $A2_4$, $A2_5$, $A2_6$, and $A2_7$ respectively are 3564, 1188, 1188, 3564, 1188, 3564, and 3564. Same as previous calculation formula, the detail regarding the calculation will be attached in appendix at Table 4.20.

3. Total Effectiveness A6 Calculation

Based on the calculation of total effectiveness for risk agent A1 that already conducted, the result for the total effectiveness $A6_1$, $A6_2$, $A6_3$, $A6_4$, $A6_5$, $A6_6$, and $A6_7$ respectively are 324, 972, 2916, 0, 972, 0, and 0. Same as previous calculation formula, the detail regarding the calculation will be attached in appendix at Table 4.21.

Therefore, after we calculate each of the Total Effectiveness (TE) value of each risk agent A1, A2, and A6, we could calculate the total value of Total Effectiveness of every risk agent as shown below:

Table 4.22 Total Value of Total Effectiveness Calculation

Total Effectiveness Calculation	
TE_1	= TE $A1_1$ + TE $A2_1$ + TE $A6_1$
	= (4212 + 3564 + 324)
	= **8100**
TE_2	= TE $A1_2$ + TE $A2_2$ + TE $A6_2$
	= (1404 + 1188 + 972)
	= **3564**
TE_3	= TE $A1_3$ + TE $A2_3$ + TE $A6_3$
	= (1404 + 1188 + 2916)
	= **5508**
TE_4	= TE $A1_4$ + TE $A2_4$ + TE $A6_4$
	= (1404 + 3564 + 0)
	= **4968**
TE_5	= TE $A1_5$ + TE $A2_5$ + TE $A6_5$
	= (468 + 1188 + 972)
	= **2628**
TE_6	= TE $A1_6$ + TE $A2_6$ + TE $A6_6$
	= (4212 + 3564 + 0)
	= **7776**
TE_7	= TE $A1_7$ + TE $A2_7$ + TE $A6_7$
	= (4212 + 3564 + 0)
	= **7776**

After we conducted Total Effectiveness (TEk) calculation, and Degree of Difficulty (Dk) assessment, the next step is calculating the ratio of Effectiveness to Difficulty (ETD) from proposed mitigation strategy. The detail will be explained in the next step.

4.4.7 Effectiveness to Difficulty Calculation

Effectiveness to Difficulty Calculation (ETD) was calculated from all of mitigation action strategy total effectiveness that was divided by the value of degree of difficulty of each preventive mitigation action that is proposed with formula as shown below:

$$ETDk = TEk/Dk$$

Table 4.23 Effectiveness to Difficulty Value Calculation

Effectiveness to Difficulty Calculation	
ETD_1	$= TE_1/D_1$
	$= 8100/3$
	$=$ **2700**
ETD_2	$= TE_2/D_2$
	$= 3564/4$
	$=$ **891**
ETD_3	$= TE_3/D_3$
	$= 5508/3$
	$=$ **1836**
ETD_4	$= TE_4/D_4$
	$= 4968/5$
	$=$ **993,6**
ETD_5	$= TE_5/D_5$
	$= 2628/4$
	$=$ **657**
ETD_6	$= TE_6/D_6$
	$= 7776/3$
	$=$ **2592**
ETD_7	$= TE_7/D_7$
	$= 7776/5$
	$=$ **1555,2**

For the last step of House of Risk Phase 2 method is to make the House of Risk phase 2 table with combined data of mitigation strategy design, risk agent, correlation, Aggregate Risk Potential (ARP) result, Degree of Difficulty (Dk) scale,

Total Effectiveness (TEk), and Effectiveness to Difficulty (ETD) into a table. The House of Risk phase 2 table will be described as shown below:

Table 4.24 House of Risk Phase 2

Treated Risk Agent	Preventive Action (PA)							ARP Value
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	
A1	9	3	3	3	1	9	9	468
A2	9	3	3	9	3	9	9	396
A6	1	3	9	0	3	0	0	324
Total Effectiveness of Action k	**8100**	**3564**	**5508**	**4968**	**2628**	**7776**	**7776**	
Degree of Difficulty Preventive Action	**3**	**4**	**3**	**5**	**4**	**3**	**5**	
Effectiveness of Difficulty Ratio	**2700**	**891**	**1836**	**993,6**	**657**	**2592**	**1555,2**	
Rank of Priority	**1**	**6**	**3**	**5**	**7**	**2**	**4**	

After arranging the House of Risk Phase 2 Table, we could determine the rank of mitigation from the preventive action to be prioritize as shown below:

Table 4.25 Rank of Priority Mitigation Action

Code	Preventive Action	Effectiveness to Difficulty Value	Rank of Priority
PA1	Standard Operational Procedures evaluation	2908	1
PA6	Occupational Safety and Health implementation	2800	2
PA3	Personnel training and upskilling	2460	3

PA7	Improvement of non-standard electrical network construction	1596,8	4
PA4	Electrical network inspection	1368	5
PA2	Personnel certification	1359	6
PA5	Tools and equipment maintenance	1125	7

Based on the rank of priority mitigation action table above, we could get the result that from 7 preventive mitigation action strategies that will be applied, it can be obtained the prioritization based on the company's parameter consideration based on the time, cost, and worker skills that the Standard Operational Procedures evaluation (PA1) is on rank number 1 with the ETD value of 2908 followed by Occupational Safety and Health implementation (PA6) on rank number 2 with the ETD value of 2800 and personnel training and upskilling (PA3) on rank number 3 with the ETD value of 2460 and improvement of non-standard electrical network construction (PA7) on rank number 4 with the ETD value of 1596,8 and electrical network inspection (PA4) on rank number 5 with the ETD value of 1368 and personnel certification (PA2) on rank number 6 with the ETD value of 1359. For the last rank of the preventive mitigation action is tools and equipment maintenance (PA5) with the ETD value of 1125.

4.4.8 Risk Preventive Action Implementation Matrix Comparison

After several risk preventive action already determined, the preventive actions are consulted and discussed to each risk owner and the manager of PT. PLN ULP Kendal, whether the risk preventive action are possible or not to be conducted at the company. After all of those risk preventive actions are approved by the manager and the risk owner, the implementation matrix comparison will be arranged to compare the conditions before and after the risk preventive actions are implemented at the company. The observation time after the risk preventive actions implementation is observed in 2 weeks from March 10th-24th, 2023. The detail will be described as shown below at table 4.26.

Table 4.26 Risk Preventive Action Implementation Matrix

PA Code	Before Implementation	After Implementation	Implementation Period
PA1	• No supervision for certain work • Workers do not complete the work based on SOP	• Each work processes are supervised • Workers do the work based on SOP	2 weeks (March 10^{th} – 24^{th}, 2023)
PA6	• Workers do not use complete PPE • Workers neglect safety equipment for the light work	• Workers used complete PPE • Workers used safety equipment for heavy and light work	
PA3	• Workers skill and ability are not honed • No such training events at the company	• Workers skill and ability are honed • Training events is conducted	
PA7	• No maintenance for non-standard electrical network construction	• Maintenance for non-standard electrical network are conducted using third parties (Haleyora)	
PA4	• Electrical network inspection is not conducted at remote area	• Electrical network inspection is conducted at remote and developed area	
PA2	• Workers not yet certified	• Workers are certified by LSPK3	
PA5	• Uncertain tools and equipment maintenance • No replacement for inadequate equipment	• Tools and equipment maintenance is conducted based on the standard period • Replacement of inadequate equipment into proper tools	

CHAPTER V

DISCUSSION

5.1 Discussion

The risk management using House of Risk method is important to be implement for PT. PLN ULP Kendal, because the electrical distribution process used several stages and a lot of process to be implemented from different department such as Human Capital Management department, energy transaction, customer service and administration, and the technical department until the electricity is ready to be transferred to the customers. Therefore, from those various kinds of business stage process, electricity industries have a big potential to the work accident, service disruption, environmental hazards, and other risky activities that include at PT. PLN ULP Kendal. At Distribution Department of PT. PLN ULP Kendal, there are 13 risk events and 13 risk agents that already determined in this research. Therefore, the conclusions that can be drawn from the results of House of Risk method analysis will be described as shown below.

1. **Risk Events**

   Based on the research result analysis that already conducted using House of Risk method, we could find 13 risk events that will be described as shown below:

   1. Workers fell from a height **(E1)**
   2. Workers electrocuted by electrical network **(E2)**
   3. Hazards posed to the environment **(E3)**
   4. Company asset damage **(E4)**
   5. Service disruption to the customers **(E5)**
   6. Service Level Agreement (SLA) that did not achieve **(E6)**
   7. Poor customer service perception **(E7)**
   8. Supply Chain Management that did not optimize **(E8)**
   9. Renewable Energy business process that did not aligned and adequate **(E9)**
   10. Infrastructure development that not in line with electricity growth **(E10)**
   11. Inadequate capability of information technology systems **(E11)**
   12. Insufficient financial capacity to respond the needs of the stakeholder **(E12)**
   13. Human capital capabilities and capacities are not aligned with the electricity business development process **(E13)**

2. Risk Agents

Based on the research result analysis that already conducted using House of Risk method, we could find 13 risk agents that will be described as shown below:

1. Workers are not use the Standard Personal Protective Equipment and work not based on the Standard Operational Procedure (SOP) **(A1)**
2. Workers perform the electrical voltage cut off with error operation and no supervision **(A2)**
3. Public ignorance regarding the dangers of electrical network **(A3)**
4. Workers that are not competent in their field with poor tools and equipment condition **(A4)**
5. Electrical network maintenance **(A5)**
6. Electrical network maintenance that are not systematic with unexpected natural events **(A6)**
7. A lot of disruption cases occurs to the customer with poor responses from the company **(A7)**
8. The distribution facilities that are disrupt with limited access and capacity **(A8)**
9. Dependencies of non-renewable natural resources **(A9)**
10. Lack number of tools and facilities used to support the company activities **(A10)**
11. Human resources capability limitation toward technological developments **(A11)**
12. Losses experienced by the company in operational activities for certain period **(A12)**
13. Minimum periodic evaluation and training **(A13)**

3. Risk Management Response

The risk management response that already determined before based on the risk owner authority and responsibility produce several different responses that will be described as shown below:

1. Priority Risk Response

At priority risk response, there are four risks that need to be prioritized. There are workers fell from a height (E1), workers electrocuted by electrical network (E2), and company asset damage (E4) with the risk owner of technical supervisor. There is also Service Level Agreement (SLA) that did not achieve (E6) with the risk owner of energy transaction supervisor. All those 4 priority risks are responded with *"mitigate"* which means the company needs to reduce the probability or impact of the risk by preventive mitigation action that are determined.

2. Non Priority Risk Response

At non-priority risk response, there are several risks that will be mitigate, escalate, avoid, or even transferred. For the risks that are mitigate, there are poor customer service perception (E7) with the risk owner of customer service and administration supervisor, service disruption to the customers (E5) with the risk owner of technical supervisor, human capital capabilities and capacities are not aligned with the electricity business development process (E13) with the risk owner of human capital management department, and inadequate capability of information technology systems (E11) with the risk owner of technical supervisor. The risks are responded with *"mitigate"* which means the company needs to reduce the probability or impact of the risk by preventive mitigation action that are determined.

For the risks that are escalate, there are hazards posed to the environment (E3) with the risk owner of customer service and administration supervisor, Supply Chain Management that did not optimize (E8) with the risk owner of energy transaction supervisor, and insufficient financial capacity to respond the needs of the stakeholder with the risk owner of ULP manager (E12). The risks are responded with *"escalate"* which means the company needs to escalate a risk to higher levels of authority because the risk is out of a scope.

For the risk that will be avoided, there is renewable energy business process that did not aligned and adequate (E9) with the risk owner of energy transaction supervisor. The risk is responded with *"avoid"* which means the risk could be eliminated because it does not impact the company whole process significantly. For the risk that will be transferred, there is infrastructure development that not in line with electricity growth (E10) with the risk owner of technical supervisor. The risk is responded with *"transfer"* which means the company could transfer the risk to a third party (another department) that have more related authority.

4. Appropriate Preventive Action Plan

The appropriate action based on House of Risk method analysis to overcome the selected priority risk agents will be described as shown below:

1. Standard Operational Procedures Evaluation (PA1)

The risk preventive action with the highest rank is PA1 which is Standard Operational Procedures evaluation with total effectiveness value of 8724, the effectiveness value of degree of difficulty of 2908 and the value of the degree of difficulty is 3 which means this preventive mitigation action is easy to be implemented at the company. The Standard Operational Procedure evaluation is needed to evaluate the Standard Operational Procedure implementation in the company. If the Standard Operational Procedure already implemented, the workers at distribution department of PT. PLN ULP Kendal will have the standards of the operational to do their task. Therefore, the process of the electricity distribution at distribution department could be run smoothly as expected. the company could prevent the priority risk which is work accident to be occur and increase company's safety environment.

2. Occupational Safety and Health Implementation (PA6)

The risk preventive action with the second rank is PA6 which is Occupational Safety and Health implementation with total effectiveness value of 8400, the effectiveness value of degree of difficulty of 2800 and the value of the degree of difficulty is 3 which means this preventive mitigation action is easy to be implemented at the company.

Implement the Occupational Safety and Health environment will aim the company to make the workers feel safe and comfort when do their job. Therefore, the company could prevent the priority risk which is work accident to be occur and increase company's safety environment.

3. **Personnel Training and Upskilling (PA3)**

   The risk preventive action with the third rank is PA3 which is personnel training and upskilling with total effectiveness value of 7380, the effectiveness value of degree of difficulty of 2460 and the value of the degree of difficulty is 3 which means this preventive mitigation action is easy to be implemented at the company. The personnel training and upskilling is crucial to make the worker at PT. PLN ULP Kendal has a proper experience to do their tasks based on their expertise. Therefore, the risk of work accident could be avoided because the workers are competent and well experienced at their expertise.

4. **Improvement of Non-Standard Electrical Network Construction (PA7)**

   The risk preventive action with the fourth rank is PA7 which is improvement of non-standard electrical network construction with total effectiveness value of 7984, the effectiveness value of degree of difficulty of 1596,8 and the value of the degree of difficulty is 5 which means this preventive mitigation action is difficult to be implemented at the company. The improvement of non-standard electrical network construction is needed to prevent the electrical hazard that are caused from the electrical network. Therefore, the impact of the electricity hazard could be prevented from the public and society also with the workers.

5. **Electrical Network Inspection (PA4)**

   The risk preventive action with the fifth rank is PA4 which is electrical network inspection with total effectiveness value of 6840, the effectiveness value of degree of difficulty of 1368 and the value of the degree of difficulty is 5 which means this preventive mitigation action is difficult to be implemented at the company.

The electrical network inspection is needed to prevent damage to the electrical network, act on conditions that can cause danger and disruption of the electrical network and make plans for repairs to the electrical network. Therefore, all the electrical network facilities at PT. PLN ULP Kendal work area are in a good function and could distribute the electricity in a safety condition, to avoid work accident to be occurs.

6. **Personnel Certification (PA2)**

The risk preventive action with the sixth rank is PA2 which is personnel certification with total effectiveness value of 5436, the effectiveness value of degree of difficulty of 1359 and the value of the degree of difficulty is 4 which means this preventive mitigation action is quite difficult/medium to be implemented at the company. The personnel certification is needed to make the workers are considered competent according to their fields so that the division of tasks is much easier to do and also aims the worker could prove their abilities have been recognized by professional examiners. Therefore, the workers could know their capability when doing their job and know kind of risk probability at their fields to be prevented.

7. **Tools and Equipment Maintenance (PA5)**

The risk preventive action with the last rank is PA5 which is tools and equipment maintenance with total effectiveness value of 4500, the effectiveness value of degree of difficulty of 1125 and the value of the degree of difficulty is 4 which means this preventive mitigation action is quite difficult/medium to be implemented at the company. The tools and equipment maintenance at PT. PLN ULP Kendal is needed to guarantee the availability and operational readiness of tools and equipment that installed for distribution activities. Therefore, all the tools and equipment at PT. PLN ULP Kendal are in a good condition, could gain the maximum result, and prevent the work accident to be occurs.

CHAPTER VI

CONCLUSION AND SUGGESTIONS

6.1 Conclusion

From data processing that already conducted before, we could know that there are 13 risks potential that can occur and affect PT. PLN ULP Kendal success in achieving goals. The potential risks that might be occur are workers fell from a height, workers electrocuted by electrical network, hazards posed to the environment, company asset damage, service disruption to the customers, Service Level Agreement (SLA) that did not achieve, poor customer service perception, Supply Chain Management that did not optimize, renewable energy business process that did not aligned and adequate, infrastructure development that not in line with electricity growth, inadequate capability of information technology systems, insufficient financial capacity to respond the needs of the stakeholder, and human capital capabilities and capacities are not aligned with the electricity business development process.

There are also 13 risk agents that are found at PT. PLN ULP Kendal. The risk agents that could cause the risk to be occurs are workers are not use the Standard Personal Protective Equipment and work not based on the Standard Operational Procedure (SOP), workers perform the electrical voltage cut off with error operation and no supervision, public ignorance regarding the dangers of electrical network, workers that are not competent in their field with poor tools and equipment condition, electrical network maintenance, electrical network maintenance that are not systematic with unexpected natural events, a lot of disruption cases occurs to the customer with poor responses from the company, the distribution facilities that are disrupt with limited access and capacity, dependencies of non-renewable natural resources, lack number of tools and facilities used to support the company activities, human resources capability limitation toward technological developments, losses experienced by the company in operational activities for certain period, and minimum periodic evaluation and training. After identifying the risk events and agents, the correlation of each risk events and agents are determined and calculated using Aggregate Risk Potential calculation. After Aggregate Risk Potential calculation already conducted, the priority risk will be prioritized using Pareto Chart.

After considering the selected priority risk, there are 7 preventive mitigation action that could be determined. The preventive action that could be determined by consider the selected priority risk are Standard Operational Procedures evaluation, personnel certification, personnel training and upskilling, electrical network inspection, tools and equipment maintenance, Occupational Safety and Health implementation, and improvement of non-standard electrical network construction. Those preventive action are determined based on the consideration of the degree of difficulty with the cost, time, and the workers skill to do the mitigation. If the company could implement those preventive action, the company could take the right and proper action to overcome the risk if its occurs to the company in its business process. Therefore, the company could gain some benefits such as the company could identifies and evaluates risks, reduce and eliminate harmful threat, supports efficient use of resources, gain better communication of risk within the company, reassures stakeholders, and support company's continuity in the future.

6.2 Suggestions

Based on the research result, there are some suggestions that could be obtained for this undergraduate research that will be described as shown below:

1. **For PT. PLN ULP Kendal**

   The suggestion for PT. PLN ULP Kendal will be described as follows:

   1. The company could consider the proposals given by the researcher, which can be submitted to be able to prevent risks, especially at Distribution Department at PT. PLN ULP Kendal.
   2. The company could consider the other methods in the risk management process, as an improvement in the effectiveness of the risk management process itself.

2. **For Further Research**

   The suggestion for the further research will be described as follows:

   1. Developing research that has been made, especially related to the scope of research.
   2. Using integrated advanced information technology. Therefore, the House of Risk method could be used as an alternative solution to manage more effective risk management in the company's business processes.

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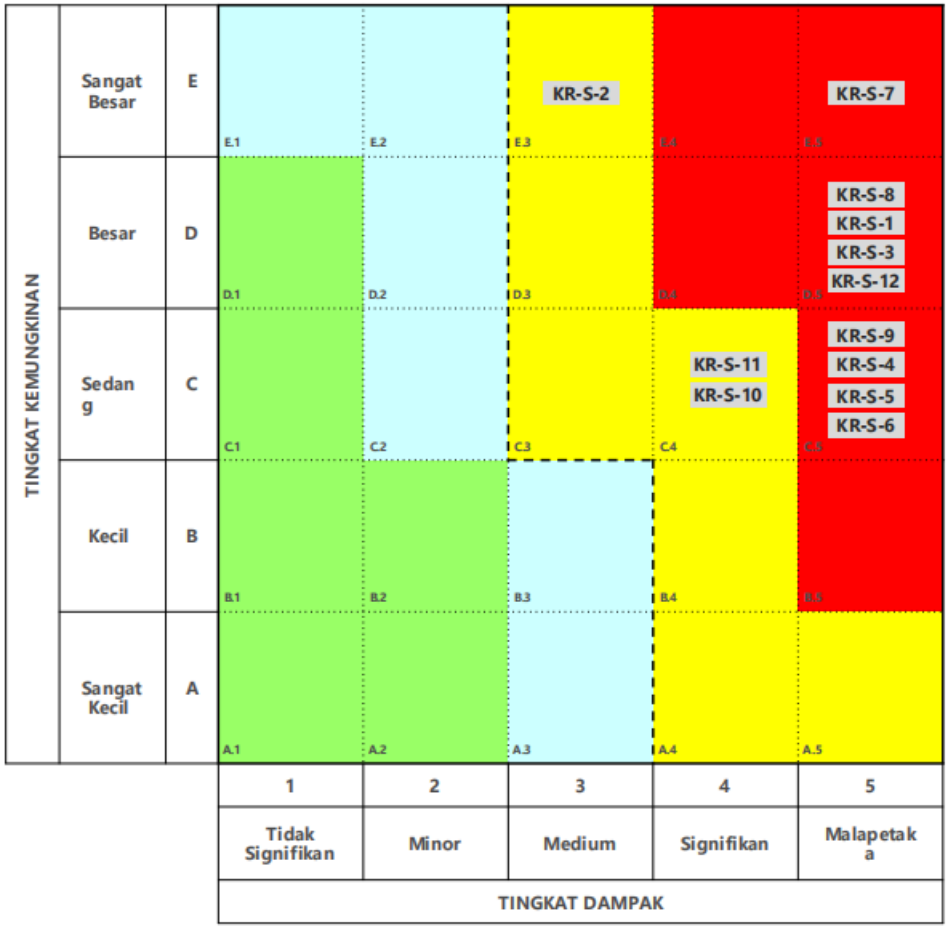
APPENDIX

RISIKO STRATEGIS SERTA PENILAIAN DAMPAK & KEMUNGKINAN NYA

ID RISIKO	PERISTIWA RISIKO	KEMUNGKINAN	DAMPAK	EKSPOSUR	KATEGORI RISIKO
KR-S-1	Proses bisnis pengembangan EBT belum selaras dan memadai	Besar	Sangat Signifikan	Ekstrem (D.5)	Strategis
KR-S-2	Disruptive Technology yang berdampak pada bisnis ketenagalistrikan	Sangat Besar	Medium	Tinggi (E.3)	Strategis
KR-S-3	Persepsi pelayanan pelanggan yang buruk	Sedang	Sangat Signifikan	Ekstrem (C.5)	Operasional
KR-S-4	Keandalan Sistem Kelistrikan belum memenuhi ekspektasi Pelanggan	Sedang	Sangat Signifikan	Ekstrem (C.5)	Operasional
KR-S-5	Pengembangan Infrastruktur Ketenagalistrikan tidak selaras dengan Pertumbuhan Ketenagalistrikan	Sangat Besar	Sangat Signifikan	Ekstrem (E.5)	Proyek
KR-S-6	Ketergantungan sistem ketenagalistrikan dengan sistem IPP	Besar	Sangat Signifikan	Ekstrem (D.5)	Operasional
KR-S-7	Ketidakleluasaan dalam mengakses energi primer yang efisien	Sedang	Sangat Signifikan	Ekstrem (C.5)	Strategis
KR-S-8	Tidak Optimalnya Supply Chain Management	Sedang	Signifikan	Tinggi (C.4)	Strategis
KR-S-9	Dampak hukum ketidakpatuhan terhadap regulasi lingkungan	Besar	Sangat signifikan	Ekstrem (C.5)	Operasional
KR-S-10	Kapabilitas dan kapasitas *human capital* tidak selaras dengan Perkembangan Bisnis Ketenagalistrikan	Sedang	Signifikan	Tinggi (C.4)	Operasional
KR-S-11	Kemampuan Finansial tidak mencukupi untuk merespon kebutuhan *stakeholders*	Besar	Sangat Signifikan	Ekstrem (D.5)	Finansial
KR-S-12	Kemampuan sistem Teknologi Informasi kurang memadai	Sedang	Sangat Signifikan	Ekstrem (C.5)	Operasional

PETA RISIKO:
CURRENT RISK (KIRI) VS. RESIDUAL RISK (KANAN)



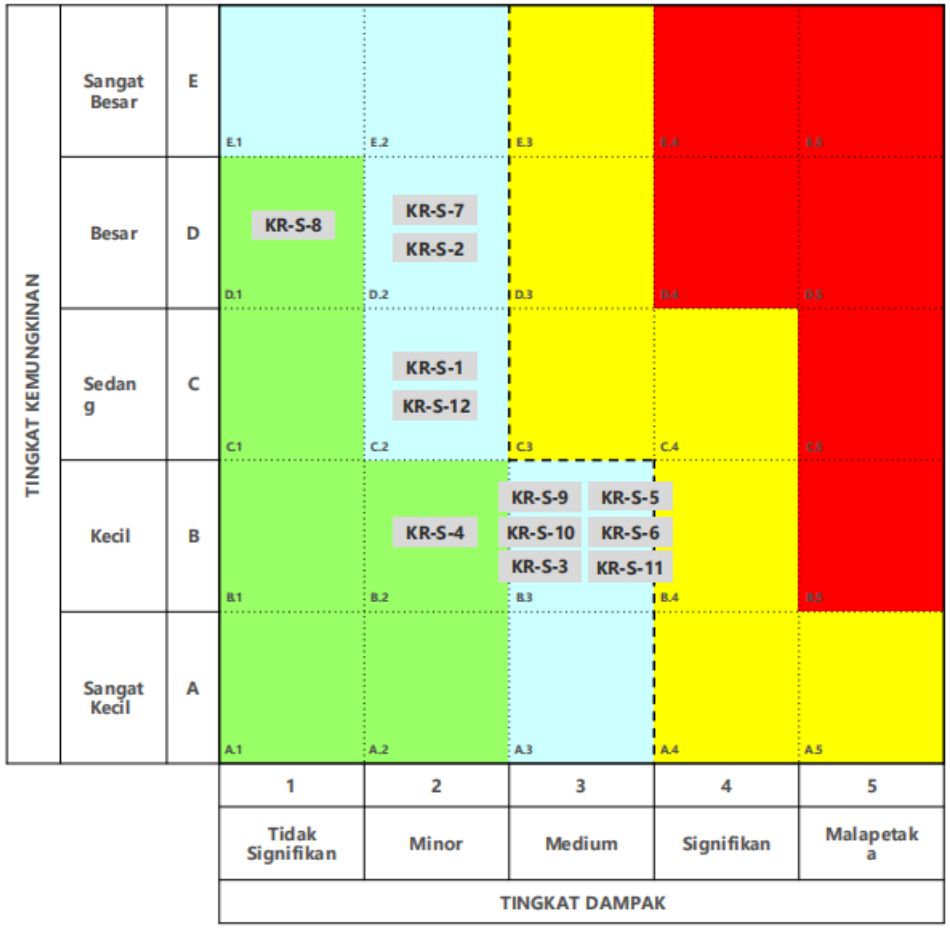


Table 4.20 Total Effectiveness A2 Calculation

Total Effectiveness Calculation	
TE A2$_1$	= Σj ARP$_2$ Ejk$_1$
	= (396x9)
	= **3564**
TE A2$_2$	= Σj ARP$_2$ Ejk$_2$
	= (396x3)
	= **1188**
TE A2$_3$	= Σj ARP$_2$ Ejk$_3$
	= (396x3)
	= **1188**
TE A2$_4$	= Σj ARP$_2$ Ejk$_4$
	= (396x9)
	= **3564**
TE A2$_5$	= Σj ARP$_2$ Ejk$_5$
	= (396x3)
	= **1188**
TE A2$_6$	= Σj ARP$_2$ Ejk$_6$
	= (396x9)
	= **3564**
TE A2$_7$	= Σj ARP$_2$ Ejk$_7$
	= (396x9)
	= **3564**

Table 4.21 Total Effectiveness A6 Calculation

Total Effectiveness Calculation	
TE A6$_1$	= Σj ARP$_6$ Ejk$_1$
	= (324x1)
	= **324**
TE A6$_2$	= Σj ARP$_6$ Ejk$_2$
	= (324x3)

Total Effectiveness Calculation	
	= **972**
TE A6$_3$	= Σj ARP_6 Ejk_3
	= (324x9)
	= **2916**
TE A6$_4$	= Σj ARP_6 Ejk_4
	= (324x0)
	= **0**
TE A6$_5$	= Σj ARP_6 Ejk_5
	= (324x3)
	= **972**
TE A6$_6$	= Σj ARP_6 Ejk_6
	= (324x0)
	= **0**
TE A6$_7$	= Σj ARP_6 Ejk_7
	= (324x0)
	= **0**