

CHAPTER 3 – RESEARCH METHODS

3.1 Research Unit Analysis

To obtain comparative data on the impact of Six Sigma implementation in UTE, The scope of this research will be carried out at the UTE Remanufacturing Plant Operation.

The research unit of analysis is all reman Plant in UTE which contribute Pareto to product failure in process which includes:

1. Plant Timika (RTMK).
2. Plant Jakarta (RJKT).
3. Plant Balikpapan Sudirman (RBPS), and
4. Plant Balikpapan Mulawarman (RBPM).

The research subjects as seen in Figure 3.1.

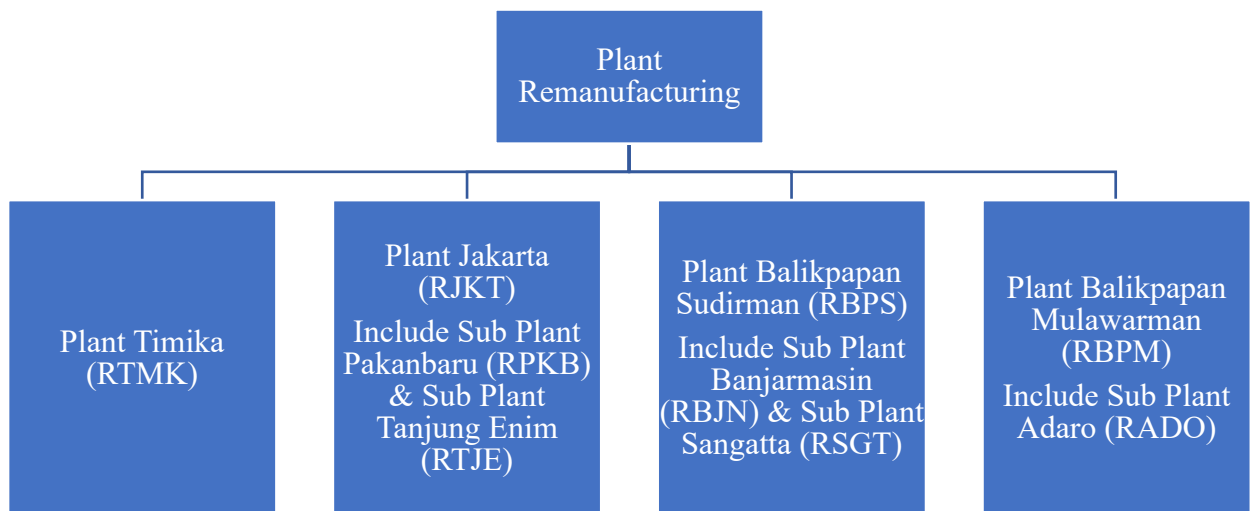


Figure 3.1 Research Subject

3.2 Research Data Sources.

The primary data source used in this research is product failure data that occurred before and after six sigma implementations in UTE Remanufacturing Plant Operation. Product failure data from January to May 2023 is data before six sigma implementation and product failure data from August to November 2023 is data after six sigma implementations. Distribution of products produced by UTE Remanufacturing Plant Operation as shown in table 3.1 below.

Table 3.1 Plant Production Product Distribution

Plant	Product Output
Plant Timika (RTMK)	Cylinder, Fabrication, Powertrain
Plant Jakarta (RJKT)	Cylinder, Powertrain, Engine, Hydraulic
Plant Balikpapan Sudirman (RBPS)	Powertrain, Engine, Hydraulic
Plant Balikpapan Mulawarman (RBPM)	Cylinder, Fabrication

3.3 Research Framework

The method of research is a systematic description of the methods implemented by the researcher during the study, guaranteeing that the research is carried out in a logical and consistent manner, in line with the research objectives.

By implementing the subsequent main stages:

1. Explain the current problem or situation that is occurring.
2. Assess the initial performance or sigma level as a baseline standard for re-manufacturing.
3. Conduct a thorough analysis of the reasons that contribute to product failure in the Remanufacturing process.
4. Identify and implement strategies to enhance the quality of the Re-manufacturing process.
5. Assess and manage the outcomes of repairs.

The 5 stages encompass following the problem-solving principles delineated in the Six Sigma technique, particularly the DMAIC stages (define, measure, analyze, improve, and control).

The study's research approach is illustrated in Figure 3.2

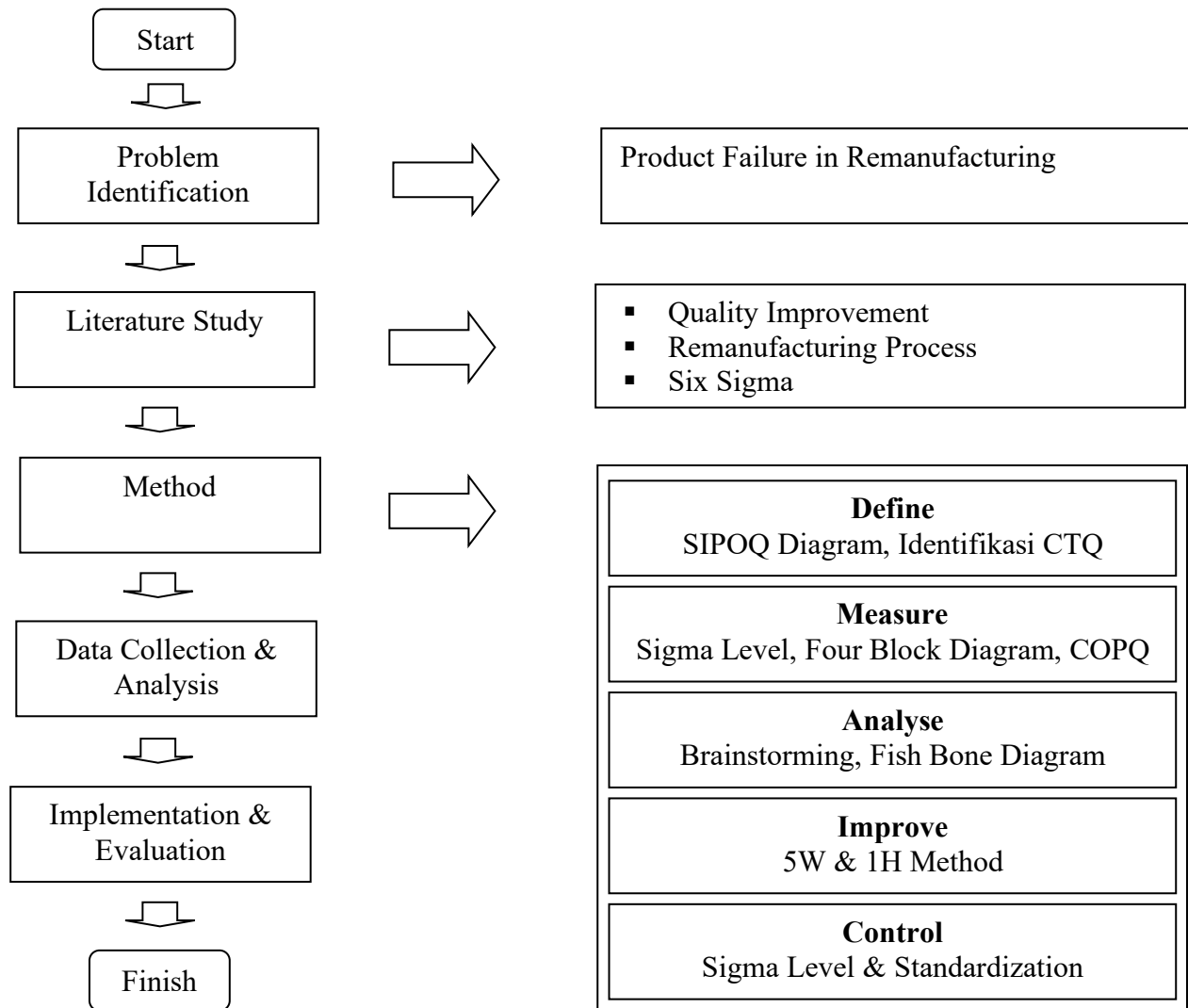


Figure 3.2 Research Methodology of Problem-Solving Process

3.4 Research Time Frame

To ensure the effectiveness of this study, this study will be conducted based on research time frame as indicated in the table 3.2.

Table 3.2 Research Time Frame

No.	Description	Sep	Oct	Nov	Dec	Target
1.	Problem Identification	x				Product Failure In Remanufacturing
2.	Literature Review		x			- Quality Improvement - Remanufacturing Process
3.	Method		x			Design of Experiment using DMAIC
4.	Data Collection & Analysis			x		- Define Data - Analysis Existing Condition
5.	Implementation & Evaluation			x		- Sigma Improvement - Improvement Result (Before vs After Sigma Implementation)

3.5 Data Processing

3.5.1 Define.

At this stage the researchers carried out Pareto product remanufacturing which contributed to 80% of product failures in UTE. From data from January to May 2023, the data as shown in table 3.3 were obtained.

Table 3.3 Product Failure in Qty

Product Hierarchy	Product Failure (Qty)	% Accumulation
Hydraulic Cylinder	82	51
Engine	50	81
Power Train	20	94
Hydraulic System	10	100
Grand Total	162	

After the researcher got the Pareto product failure, the researcher carried out a diagnosis to get the Pareto cause of product failure using 4 classifications which included the Man, Method, Machine (Tools), and Material (Parts) factors as shown in table 3.4.

Table 3.4 Causes of Product Failure in Qty

Product Failure in Process	Qty	% Accumulation
Man	84	52
Method	60	89
Machine/Tools	10	95
Material/Parts	8	100
Grand Total	162	

3.5.2 Measure

After the researcher obtains the Pareto product hierarchy and the Pareto causes of product failure which contribute to 80% of product failures, the next stage is to carry out Sigma calculations through the following stages:

- Calculation of critical processes that have the potential to cause product failure based on Pareto remanufacturing processes that contribute to product failure during January to May 2023.
- Calculation of total opportunity by multiplying the production qty from January to May 2023 by the number of critical processes.
- Calculation of DPMO (defects per million output) by comparing the number of product failures to the total opportunities in one million productions.
- Convert DPMO to Sigma value using table Z.

After we get the sigma value, we can map the four-block diagram & COPQ (cost of poor quality). The primary purpose of the four block diagram is to identify areas for improvement in order to achieve the Company's goal sigma value. On the other hand, the Cost of Poor Quality (COPQ) serves to estimate the expenses incurred by the Company as a result of product failures.

3.5.3 Analyse.

In this stage, researchers analyzed the causes of product failure using a fishbone diagram. The principle of cause & effect in the fishbone diagram is very appropriate for identifying the root of the problem which is the main cause.

3.5.4 Improve.

In this stage the researcher identifies alternative solutions and determines the best alternative solution by considering costs & benefits. The best alternative solution to be implemented next.

3.5.5 Control.

In this stage, researchers carry out a review and monitoring process to see the impact of implementing improvements on reducing product failure, increasing Sigma values, and reducing COPQ.

To ensure the sustainability of the quality improvements carried out, standardization is carried out through the preparation of SOPs (standard operational procedures).

3.6 Data Analysis Technique

To derive meaningful conclusions, this research endeavours to do data analysis to transform raw data into valuable insights. Data analysis is a valuable tool for addressing issues pertaining to enhancing the quality of remanufactured products. The information collected in this research will be examined and analyzed utilizing the DMAIC methodology. By employing DMAIC, a statistical methodology, one can identify the underlying cause of the problem and enhance the quality of the production process.