CHAPTER I
INTRODUCTION

This chapter discusses the final project's background, problem formulation, objectives, research scopes, and systematics.

1.1 Background

The palm oil industry is a major development sector in Indonesia, with 73.83% of the country's agricultural exports, making Indonesia the world's largest palm oil producer. The industry contributes 3.5% of Indonesia's total GDP, 13.5% of total non-oil and gas exports, and employs more than 16 million workers across the supply chain. The rapid expansion of palm oil plantations has spurred economic development, particularly in rural and remote regions, by creating jobs, improving infrastructure, and generating regional income. Indonesia's vast tropical climate and fertile land provide ideal conditions for palm oil cultivation, enabling the country to supply both domestic consumption and international demand. In addition to its role in food and cosmetic products, palm oil is also a key input in biofuel production, positioning it as a strategic commodity in the global market.(Fevriera & Safara Devi, 2023).

A palm oil processing company in Agam is one of the many contributors to Indonesia's palm oil sector. The company specializes in processing Fresh Fruit Bunches (FFB) into Crude Palm Oil (CPO) and palm kernels. It has the capacity to process up to 40 tons of FFB per hour under current operational conditions. Each ton of FFB yields approximately 200 kg of CPO, enabling the company to produce up to 8 tons of CPO per hour. The factory operates continuously for 24 hours a day to maximize throughput and meet production targets, while the workers work based on a three 8-hour shifts to ensure smooth operations while maintaining compliance with labor standards. The company plays a vital role in the regional supply chain and contributes significantly to the agricultural economy of West Sumatra.

The palm oil production process involves several fundamental stages using specialized machines. The process begins with weighing the FFB on the weight bridge, which will be brought to the loading ramp. From the loading ramp, the FFB will then go to the sterilization step, where the fruit is steamed to stop enzymatic activity and facilitate fruit detachment. The next stage, threshing, separates the fruit from the bunches using mechanical thresher drums. The harvested palm fruit is digested using heat and agitation to rupture the cells. Screw presses are then used to mechanically extract the CPO from the digested mixture. This extracted oil is subsequently clarified and filtered to remove impurities before being stored. Meanwhile, palm kernels, obtained from the separated seeds, go through a series of drying and cracking processes before being stored for further processing. This includes depericarping, grading, separating, and drying. The process can be seen in **Figure 1.1** below.

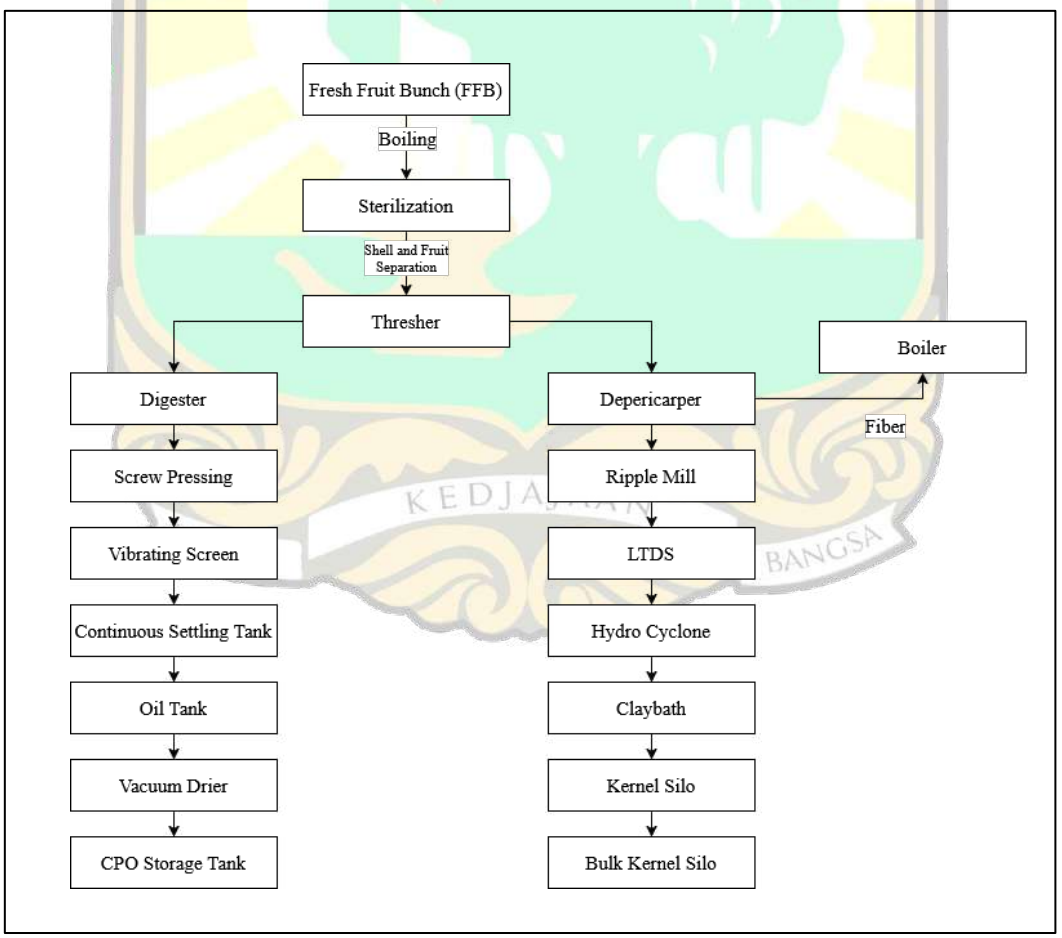

Figure 1.1 Flow Process Diagram of Palm Oil Processing

Each processing stage relies on critical machinery, such as sterilizers, thresher drums, screw presses, clarification tanks, and kernel separators. A breakdown in any of these machines can disrupt the entire production line, causing operational inefficiencies and increased costs. Machine breakdowns can have a direct economic impact, primarily due to lost production. This indicates that if there is a breakdown, they will lose 8 tons of CPO each hour.

From 2023 and 2024 alone, breakdowns in the palm oil processing company have been relatively infrequent but still impactful. In 2023, the company experienced 24.5 hours of downtime due to breakdowns, while in 2024, the downtime was reduced to 8 hours. This indicates an improvement in machine reliability, but any unexpected breakdown can still lead to production losses. The company's machine breakdown frequencies can be seen in **Figure 1.2** below.

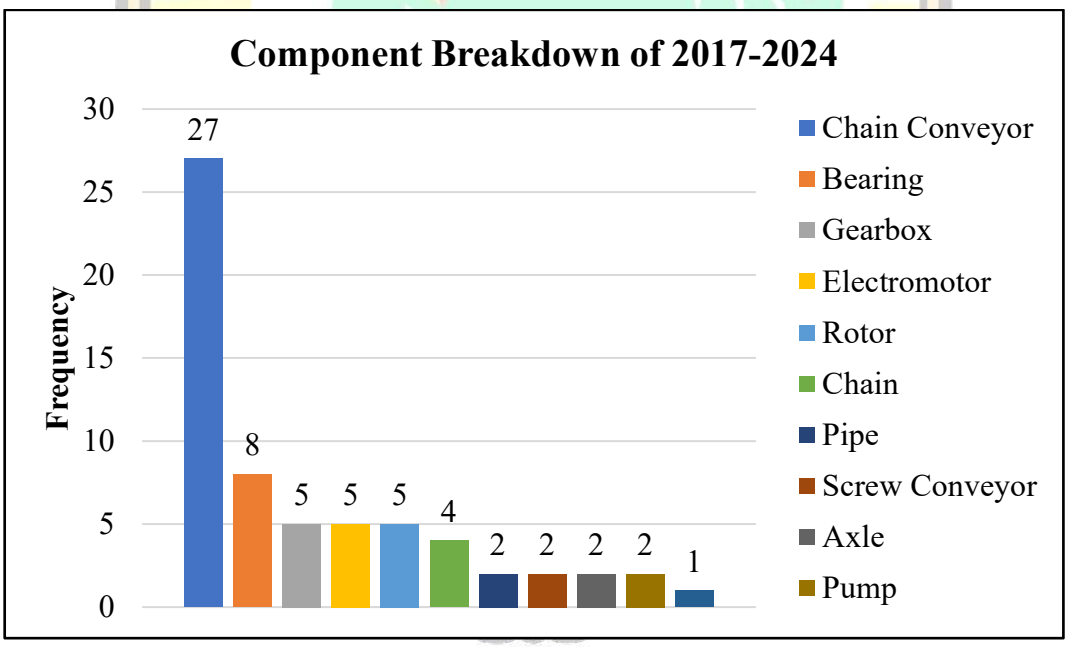

Figure 1.2 Component Breakdown Frequency of 2017-2024

Based on **Figure 1.2**, the component with the most breakdown is the chain conveyor with a frequency of 27 times. A chain conveyor is used in the machines to drive the conveyor to transport the materials needed to produce CPO. Due to varying operational conditions, they are prone to wear and fail. The interconnected process of the palm oil production line means that any breakdown in the production

process will halt the whole production operation. This will lead to unplanned downtime, production delays, and potential economic losses. Moreover, a halted operation can disrupt the timing of FFB processing, affecting the quality of the CPO.

Figure 1.3 Chain Conveyor

Furthermore, chain conveyors are essential for maintaining the steady flow of materials during the manufacturing process. They facilitate the movement of palm kernels, Fresh Fruit Bunches (FFB), and other materials across different stages of the palm oil manufacturing process. The plant's overall productivity and throughput are directly impacted by the effectiveness of the chain conveyor.

These conveyors are subjected to heavy loads, repetitive motion, and exposure to harsh environmental conditions, such as high temperatures, moisture, and abrasive particles from the raw materials. These elements eventually lead to corrosion, pin wear, chain elongation, and failure. Furthermore, excessive tension, misalignment, and inadequate lubrication can hasten deterioration and raise maintenance needs. If the chain conveyor breaks down, the repair time is around 1–2 hours, resulting in a total financial loss between Rp 119,104,000 and Rp 238,208,000. This estimate is based on the company’s processing capacity of 40 tons of FFB per hour, which yields approximately 8 tons of CPO per hour, valued at Rp14,888,000 per ton according to market prices as of June 13, 2025 (*TRADING ECONOMICS*, n.d.).

To minimize financial losses caused by machine breakdowns, companies typically adopt several strategies such as preventive maintenance, and predictive maintenance. These strategies aim to reduce unplanned downtime, extend equipment lifespan, and optimize resource usage. One such approach is group maintenance, which is a type of preventive maintenance where it involves replacing multiple components at scheduled intervals, regardless of their individual failure conditions. This method is particularly effective for systems with multiple identical or similar components that are prone to failure over time. In this research, group maintenance is applied specifically to chain conveyors, which are critical components in the palm oil production line and are used extensively to transfer materials between processing stages. Due to their continuous operation and wear-prone nature, chain conveyors are ideal candidates for group maintenance to prevent cascading failures and production halts. This study focuses on developing a group maintenance model that minimizes machine breakdowns and reduces economic losses. By analyzing historical operational data and maintenance records, the research aims to identify key failure patterns and determine the most effective maintenance schedule. Quantitative analysis methods, including failure rate analysis and cost evaluation, are used to establish an optimal maintenance interval that balances group and corrective maintenance costs. The resulting model is intended to support palm oil companies in improving long-term operational performance and reducing financial risk.

1.2 Problem Formulation

Machine breakdowns from the chain conveyor can lead to significant financial loss. Unplanned downtime leads to lost production and increased maintenance costs. Without an optimized replacement strategy, the machines are more likely to fail unexpectedly and cause long-term inefficiencies.

1.3 Research Objectives

The objective of this research is to develop a preventive replacement schedule for the chain conveyor that optimizes machine reliability and minimizes financial losses by reducing unexpected breakdowns and improving replacement efficiency.

1.4 Research Scopes

The scope of this research can be seen as follows.

1. The replacement chain conveyor is assumed to be already assembled and readily available in the company's inventory.
2. Inventory holding costs are excluded from the cost analysis
3. The data used for this research consists of machine specification, CPO production rates, maintenance costs, and the machine's daily operation from 2017 to 2024, including breakdown durations and their corresponding causes.
4. The calculation of replacement cost includes component costs, labor costs, and financial losses resulting from operational interruptions.

1.5 Systematics of Final Project

The systematics of this final project has three chapters that discuss the introduction to the case study and the methodology used to solve the case study, which can be seen as follows.

CHAPTER I INTRODUCTION

This chapter discusses the background, problem formulation, objectives, problem scope, limitations, and outline of the research.

CHAPTER II LITERATURE REVIEW

This chapter discusses the literature review, which includes the theories that will be used in writing this research.

CHAPTER III RESEARCH METHODOLOGY

This chapter discusses the research methodology used in solving the case study of this research.

CHAPTER IV DATA PROCESSING & ANALYSIS

This chapter contains the data processing and result carried out in developing a preventive maintenance model and the analysis of the data that has been processed in the previous chapter.

CHAPTER V CONCLUSION

This chapter contains the conclusion of the research and the suggestion for the next research.