CHAPTER I

INTRODUCTION

This chapter provides the background to the problems addressed in the research, outlines the problem formulation, presents the research objectives, identifies the problem limitations, discusses the research assumptions, and explains the systematic approach to writing in this research.

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1.1 Background

In Indonesia, the manufacturing industry sector is experiencing very rapid development. This development occurred during the New Order period in line with the enactment of Law No. 1 of 1967 concerning Foreign Investment (PMA). The government implemented a liberalization policy to attract foreign investment, aiming to improve the weak economic conditions. One of the key indicators of the manufacturing industry's development is the GDP growth rate in Indonesia. The following graph **Figure 1.1** shows the GDP growth rate of the manufacturing industry in Indonesia from 2020 to 2023.

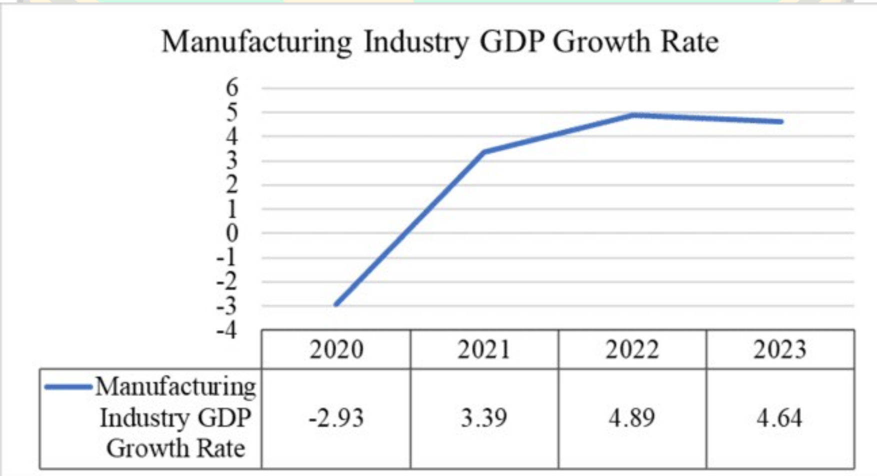

Figure 1.1 Manufacturing Industry Growth Rate Chart
(Source: GDP Growth Rate of the Manufacturing Industry (BPS)

Based on the graph of the GDP growth rate of the manufacturing industry in 2020 above, the GDP growth rate of the manufacturing industry in Indonesia contracted by -2.93%. This is most likely due to the impact of the COVID-19 pandemic, which has hampered industrial activities, disrupted supply chains, and decreased demand. However, in 2021, the manufacturing sector began to recover with positive growth of 3.39%. This recovery was driven by the easing of social restrictions, increased industrial activity, and various government stimuli that helped revive the economy. The positive trend continued in 2022, where growth reached 4.89%, signaling a stronger recovery. Increasing people's purchasing power, rising export demand, and stabilizing global supply chains are the main factors supporting this growth. However, in 2023, although it still recorded a positive growth of 4.64%, there was a slight slowdown compared to the previous year. This slowdown can be attributed to various external factors, including global economic uncertainty, inflation, and higher interest rate policies, which can impact investment in the manufacturing industry. Overall, Indonesia's manufacturing industry has shown a fairly strong post-pandemic recovery. However, the slowdown in growth in 2023 is an indication that global economic challenges could still affect the sector in the future (Harahap et al., 2023)

However, behind this growth rate, there are significant environmental consequences. Based on data from the Central Statistics Agency (BPS, 2022), the processing industry sector is the largest contributor to Greenhouse Gas (GHG) emissions in Indonesia. In 2022, the processing industry generated approximately 340,771 Gg CO_2e, or approximately 38% of total business sector emissions, making it a major contributor to national emissions, followed by the electricity and gas procurement sector. The contribution of the sector to greenhouse gases in Indonesia can be seen in **Figure 1.2** below.

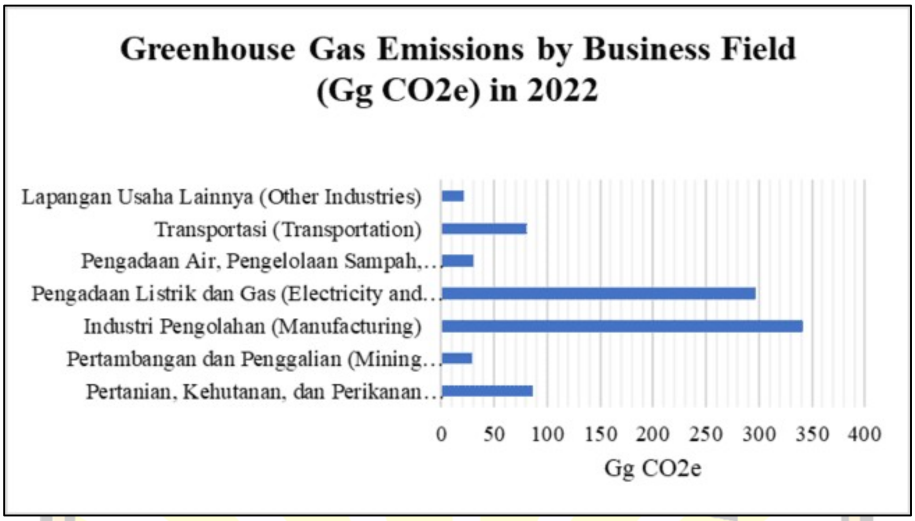

Figure 1.2 Distribution of Greenhouse Gas (GHG) Emission Contribution by Business Sector in Indonesia in 2022
(Source: Energy Current Balance and Greenhouse Gas Emissions Balance of Indonesia, BPS)

PT. Kunango Jantan is a company in the ready-to-install metal goods industry group. The company is located on Jalan Bypass Km 25 Kasang, Padang Pariaman Regency, West Sumatra. The company produces products made from steel and cement raw materials. The company supplies, processes, and distributes products made from ready-to-use steel and concrete plates for the construction, electrical, mining, telecommunications, and transportation industries. The products produced by this company include concrete pipes, mini piles, wall panels, guardrails, concrete slabs, concrete electric poles, spun piles, PJU poles, tetrapods, Telkom poles, PLN poles, light bricks, sheet piles, and box culverts.

One of the products from PT. Kunango Jantan is a PLN steel pole that plays a crucial role in Indonesia's infrastructure, particularly in supporting the country's electricity distribution and transmission systems. PLN steel poles are widely used in the provision of power grids. The need for PLN steel poles continues to increase. This can be seen from the data on the production of PLN PT. Kunango Jantan steel pole products from February 5 to July 22, 2025, as shown in **Table 1.1**.

Table 1.1 PLN PT. Kunango Mantan Steel Pole Production Data

Detailed Contract Months	**Number of Units (Poles)**
February	4000
March	734
April	150
May	3657
June	492
July	250

The production process of PLN steel poles at PT. Kunango Jantan consists of three main stages: pressing, assembling, and coating. In the pressing stage, there are 6 machines, each producing with the time required to process one pole on the pressing machine being 1.4 minutes. The next stage, assembling, uses 18 stations that require 36 minutes of work per pole. The final process is coating, which is carried out in 4 stations, and the time required to coat one pole is 1.4 minutes, the same as in the pressing process and the time it takes to dry the pole in the coating area is 105 minutes. Details of the process to produce PLN steel poles can be seen in **Appendix A**. The transfer that occurs on the production floor uses 3 material handling forklifts. The total number of poles moved by these forklifts is 20 poles. After these three processes are completed, the final product will be transferred to the rack in the finished product area. The production process of PLN steel poles at PT. Kunango Jantan can be seen in **Figure 1.3** below.

Figure 1.3 The Production Process of PLN Steel Poles at PT. Kunango Jantan (Source: Data Processing)

PT. Kunango Jantan measures 67 m x 229 m with an area of 15343 m2. The length and width of the initial storage area are 42 m x 22 m, the press workstation is 19 m x 9.5 m long and wide, the assembly line is 13 m x 9 m wide, the coating area is 15.5 m x 9.5 m long and wide, and the finished product storage area is 68 m x 13 m long and wide. The PLN steel pole production floor is carried out using a process layout by stacking the same machine in a department. A material flow diagram of the steel pole production floor can be seen in the following **Figure 1.4**.

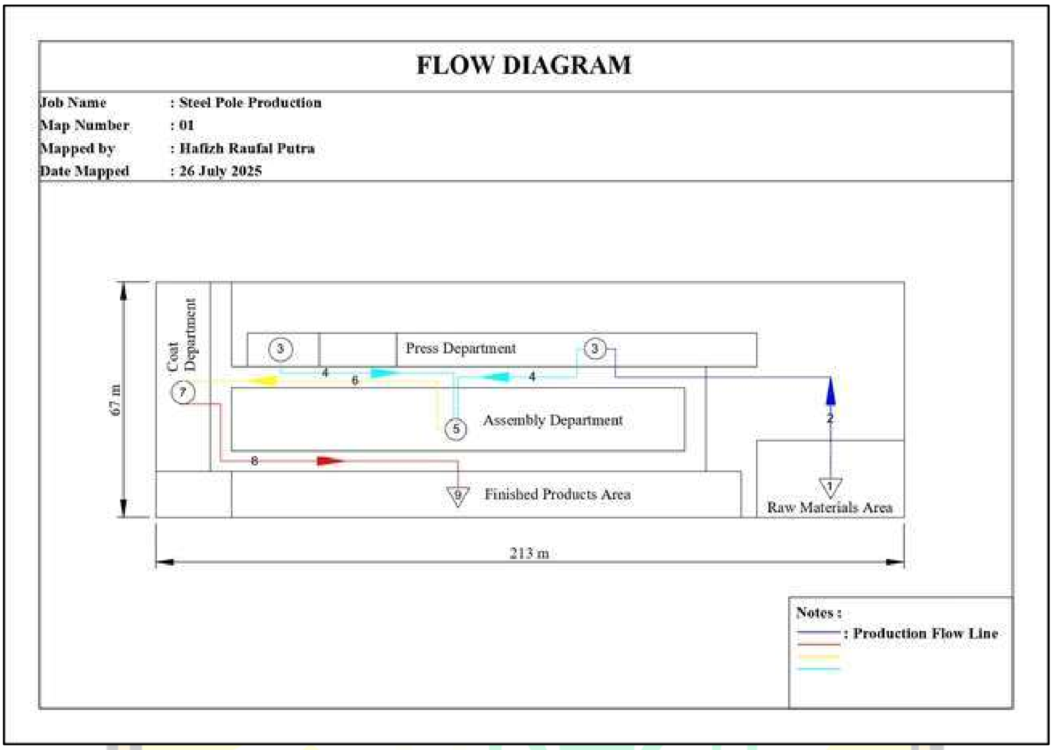

Figure 1.4 Steel Pole Production Flooring Material Flow Diagram
(Source: Data Processing)

Based on the flow diagram in the existing condition, it can be seen that some distance of displacement from the press department to the assembly line runs around most of the assembly department before going to one of the assembly lines, this results in the flow of materials in the steel pole production process to be less efficient and does not meet the characteristics of a good layout, namely moving materials closer to the delivery area to shorten the distance of displacement(Hadiguna & Setiawan, 2008). The distance of movement from each workstation to the intended workstation is measured using aisle distance, which accounts for the movement of materials through hallways or alleys. The frequency of material displacement refers to the number of material displacements that occur during the production process, along with the calculation of this frequency.

$$\text{Transfer Frequency} = \frac{\text{Production/Cycle}}{\text{Quantity of material carried/transfer}} \quad \text{... (1)}$$

$$\text{Transfer Frequency} = \frac{\text{720 Steel pipe}}{\text{20 Steel pipe}} = 36 \text{ times}$$

Based on the frequency that has been calculated, a recapitulation of material displacement on the steel pole production floor is obtained, also known as a from-to chart, which can be seen in **Appendix B**.

Material handling costs are calculated when a material handling moves materials. Factors that affect the cost of material handling include the type of material handling, required costs such as maintenance and fuel, the operator's salary, and the total distance traveled by the material handling equipment. After knowing these data, the cost of material handling can be calculated using **Formula 8**, so that the material handling cost per cycle is Rp1,532,041.67 and the recapitulation of calculation of material handling can be seen in **Appendix C**. The cost of material handling is the basis for evaluating efficiency, where a plan is considered effective if it can reduce the cost by 10–30% without significantly compromising operational performance (James A. Tompkins, 2010).

In addition, material flow efficiency is also a key factor in improving operational performance. Inefficient layouts on the production floor, such as long distances between workstations, lead to longer time for material transportation and increase material handling costs. Therefore, the redesign of the production layout at PT. Kunango Jantan aims to minimize material transfer distances, reduce operational costs, and minimize environmental impact. As a result, operational efficiency can be improved, operational costs are reduced, and the environmental impact caused by energy use can be minimized.

Based on the displacement distance from the following existing conditions, to calculate the impact on the environment, it must first be calculated about how much fuel is consumed in covering the total distance traveled by material handling. It is known that the total distance traveled in producing 360 steel poles is 18420 m, the average speed of the forklift in transporting materials is 6 Km/Hour, and based on the description of the material handling used, it is known that the fuel consumption per hour is 5 L/Hour. The total fuel consumption required to cover the distance is calculated using the following formula for calculating fuel consumption.

$$\text{Travel Time} = \frac{\text{Distance}}{\text{Speed}} \quad \ldots(2)$$

$$\text{Fuel Consumption} = \text{Travel Time} \times \text{Fuel Consumption per Hour} \quad \ldots(3)$$

$$\text{Travel Time} = \frac{18{,}420 \text{ km}}{6 \text{ Km/H}}$$

$$= 3.07 \text{ H}$$

$$\text{Fuel Consumption} = 2{,}07 \text{ H} \times 5 \text{ L/H}$$

$$= 15{,}35 \text{ L}$$

15,35 L Based on the calculations above, it is known that to travel the distance of the material requires of industrial diesel to travel the distance. The emissions produced from the energy to travel the total distance are calculated using SIMAPRO software of 7.08 Kg/CO2eq. Each step of reducing material travel distance has the potential to reduce energy consumption and reduce the emissions produced (Li & Cao, 2024), thus supporting the sustainability principle of the environmental pillar.

Sustainability is a concept that encompasses three main pillars: economic, environmental, and social, aiming to ensure current well-being without compromising the capabilities of future generations. The economic pillar emphasizes the importance of financial sustainability through cost efficiency and innovation, supporting long-term growth. The environmental pillar focuses on nature protection, energy efficiency, and emission reduction. In contrast, the social pillar focuses on the well-being of people with policies that are just, inclusive, and support human rights. Sustainability integrates these three pillars to create end-to-end sustainable performance in industry and organizational development.

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In the context of sustainability, economic aspects are crucial for ensuring the continuity and competitiveness of the manufacturing industry, including the concrete pile industry. Sustainability is not only about cost efficiency and productivity, but also about environmental responsibility. An efficient facility layout has the potential to reduce excessive energy consumption and optimize resource utilization, thereby contributing to the reduction of emissions from the production process. This research aims to redesign the layout of the production facilities at PT. Kunango Jantan to improve operational efficiency and reduce material handling costs, while supporting the reduction of energy emissions. This design is expected to serve as an example of integrating sustainability into reducing emissions through the arrangement of production facilities. Inefficient layouts, such as excessively long distances between machines, can lead to higher material handling costs and increased energy consumption. Therefore, rearrangement of facility layouts is a key solution to optimize material flow, reduce mileage between workstations, and reduce transportation costs. Suboptimal distances not only impact cost efficiency but also emissions production, as the energy used in material transportation increases with the distance traveled.

The linear economy is a traditional economic model that follows the "take-make-use-dispose" pattern, where resources are extracted, produced into goods, consumed, and then discarded after use. This model assumes that resources are unlimited, leading to unsustainable practices such as material waste, excessive resource exploitation, and pollution. These practices result in major issues such as resource depletion, environmental contamination, and widespread waste generation, ultimately threatening both environmental and economic sustainability (Mihai & Minea, 2021). In contrast, the circular economy offers a more sustainable framework with principles such as waste reduction, recycling, and extending the lifecycle of materials through strategies like *Refuse*, *Rethink*, *Reduce*, *Reuse*, *Repair*, and others, aimed at closing material loops and reducing environmental impact (Article, 2020)(Mora-contreras et al., 2023).

However, the subject of this study, PT. Kunango Jantan, currently operates within the linear economy framework, where production and resource management have not fully embraced the principles of the circular economy, which focus on sustainability and resource efficiency. The company still follows a model of extraction and consumption that is oriented toward short-term outcomes, without considering the reuse or processing of materials in a more environmentally friendly way.

1.2 Problem Formulation

Based on the discussion in the background, it can be formulated that the problems of this study are how to design the optimal layout of production facilities, especially in terms of minimizing the distance of material handling transfers, as well as increasing the cost efficiency of material handling and reducing the environmental impact resulting from energy use emissions?

1.3 Research Objectives

This research aims to design an efficient production facility layout, focusing on reducing the distance material handling moved and moving distances, minimizing operational costs, and minimizing emissions and environmental impacts, while supporting sustainability in the production process of PLN's steel poles.

1.4 Research Scopes

The limitations of the problem in this study are as follows:

1. The design of the repair layout was only carried out on the production floor of the PLN steel pole workshop at PT. Kunango Jantan.

2. The proposed repair layout design is only carried out on the production floor of the PLN steel pole workshop at PT. Kunango Jantan has not reached the implementation stage.
3. Not performing the necessary cost calculations for the proposed layout implementation plan.
4. The sustainability aspect studied is only on the economic pillar which discusses the cost of material handling and the environmental pillar discusses the emissions produced by the use of material handling and the abiotic depletion(fossil fuels).
5. The study does not cover the concept of circular economy, nor does it analyze how circular economy principles could be integrated into the proposed layout design.

1.5 Outline of Report

The systematics of writing this final project research report are as follows.

CHAPTER I INTRODUCTION

This chapter provides the background of the research, formulates the research problem, outlines the puRpose of the research implementation, and identifies the limitations of the research implementation, as well as the systematic approach to writing good and correct research reports.

CHAPTER II LITERATURE REVIEW

This chapter contains the literatures that will be used in the research. These literatures will support the work on the final project and become a guideline for researchers. The literature used is sourced from a wide range of literature, including books, journals, articles, and previous research related to facility layout, material handling, and CRAFT.

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CHAPTER III RESEARCH METHODOLOGY

This chapter provides an explanation of the stages involved in implementing systematic research, starting from preliminary surveys and literature studies, through problem identification and formulation, to data collection, data processing, and analysis of research results. And ended with conclusions and suggestions.

CHAPTER IV DATA COLLECTING AND PROCESSING

This chapter explains the collection and processing of data based on the data that has been obtained to obtain results and solve problems in research.

CHAPTER V DISCUSSION

This chapter contains an explanation of the data processing that has been carried out. The analysis provided is in accordance with the results of the previous processing, namely the design of the workstation, the design of the layout, the calculation of the total displacement distance, the cost of OMH, GHG emissions, implementation of alternative material handling in the proposed layout, and the comparison of the initial layout with the designed layout.

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CHAPTER VI CONCLUSIONS

This chapter serves as the conclusion, containing explanations of the conclusions drawn from the research conducted and recommendations for future studies