

WAREHOUSE RELAYOUT DESIGN AT A FURNITURE MANUFACTURER TO MINIMIZE PRODUCT PICKING TIME

THESIS

**Submitted in Partial Fulfilment of the Requirements for the Degree of
Bachelor of Engineering in Industrial Engineering**



Jeremy Brian Pratama

21 14 11379

**INTERNATIONAL INDUSTRIAL ENGINEERING PROGRAM
DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF INDUSTRIAL TECHNOLOGY
UNIVERSITAS ATMA JAYA YOGYAKARTA**

2025

APPROVAL SHEET

Final Project Titled

WAREHOUSE RELAYOUT DESIGN AT A FURNITURE MANUFACTURER TO MINIMIZE
PRODUCT PICKING TIME

authored by

Jeremy Brian Pratama

211411379

Was examined and approved by the final project committee to meet the qualification standard

On July 22, 2025

		Status
Final Project Supervisor 1	: Prof. Ir. The Jin Ai, S.T., M.MT., Dr.Eng, IPM., ASEAN Eng.	Agreed
Final Project Supervisor 2	: Prof. Ir. Ririn Diar Astanti, S.T., M.MT., Dr.Eng, IPM., ASEAN Eng	Agreed
Committee Members		
Examiner Committee 1	: Ir. Yosef Daryanto, S.T., M.Sc., Ph.D., IPM, CSA.	Agreed
Examiner Committee 2	: Mikha Meilinda C., S.Si., M.Sc.	Agreed

Yogyakarta, July 22th, 2025

Universitas Atma Jaya Yogyakarta

Industrial Technology

Dean

signed.

Dr. Ir. Parama Kartika Dewa S.P., S.T., M.T., IPU, ASEAN Eng.

This document is an official UAJY document that does not require a signature because it is generated electronically by the Bimbingan Information System platform. UAJY is fully responsible for the information contained in this document.

DECLARATION OF ORIGINALITY

I, the undersigned below:

Name : Jeremy Brian Pratama

Student Number : 211411379

I hereby declare that my thesis, titled **Warehouse Relayout Design at A Furniture Manufacturer to Minimize Product Picking Time**, is the result of my own research conducted in the Academic Year 2024/2025 and is original in nature, containing no plagiarism from any other work.

If at any point in the future this statement is found to be untrue, I am willing to be held accountable and processed in accordance with the prevailing regulations, including the revocation of the Bachelor's degree granted by Universitas Atma Jaya Yogyakarta.

This statement is made truthfully and in accordance with the facts.

Semarang, July 14, 2025

Author,



Handwritten signature of Jeremy Brian Pratama.

Jeremy Brian Pratama

PREFACE

Praise and gratitude to God Almighty for His blessings and guidance throughout the process of completing this Final Project. This Final Project report was prepared to fulfill the graduation requirements for obtaining a Bachelor's degree in Industrial Engineering at Universitas Atma Jaya Yogyakarta. The author extends sincere thanks and appreciation to all parties who have been very helpful, including:

1. Dr. Ir. Parama Kartika Dewa S.P., S.T., M.T., IPU, ASEAN Eng., as the Dean of the Faculty of Industrial Technology.
2. Dr. Ir. Ign. Luddy Indra P., M.Sc., IPU, as the Head of the Department of Industrial Engineering.
3. Ir. Twin Yoshua Raharjo Destyanto, S.T., M.Sc., Ph.D., IPM, as Head of the Study Program of Industrial Engineering.
4. Prof. Ir. The Jin Ai, S.T., M.MT., Dr.Eng, IPM., ASEAN Eng., as the 1st supervisor lecturer who has patiently guided and supported in writing this thesis.
5. Prof. Ir. Ririn Diar Astanti, S.T., M.MT., Dr.Eng, IPM., ASEAN Eng, as the 2nd supervisor lecturer who has patiently guided and supported in writing this thesis.
6. Ir. Yosef Daryanto, S.T., M.Sc., Ph.D., IPM, CSA, as the 1st examiner lecturer who has given suggestions and direction to accomplish this thesis.
7. Ms. Mikha Meilinda C., S.Si., M.Sc., as the 2nd examiner lecturer who has given suggestions and direction to accomplish this thesis.
8. All lecturers in the Industrial Engineering Undergraduate Program at Universitas Atma Jaya Yogyakarta, who have given the author knowledge, insight, advice, and support during the study.
9. All stakeholders of the furniture manufacturer company in Jepara, who have given permission and have been cooperative in the process of completing this thesis.
10. The author's parents, who have always given support and prayers during the process of writing this thesis.
11. All other parties who have contributed both directly and indirectly in completing this thesis.

Finally, the author hopes this thesis can be useful for both society and readers. Since there are still potential errors in this report, any helpful critiques and suggestions for future improvements are welcome.

Semarang, July 11, 2025

Author,

A handwritten signature in black ink, appearing to read 'J. Pratama', with a stylized, cursive script.

Jeremy Brian Pratama

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	COVER	i
	APPROVAL SHEET	ii
	DECLARATION OF ORIGINALITY	iii
	PREFACE	iv
	TABLE OF CONTENT	vi
	LIST OF TABLE	viii
	LIST OF FIGURES	ix
	ABSTRACT	xi
1	INTRODUCTION	1
	1.1. Background	1
	1.2. Problem Exploration	2
	1.3. Problem Statement	6
	1.4. Research Objectives	6
	1.5. Scope of Limitations	6
2	LITERATURE REVIEW AND BASIC THEORY	7
	2.1. Literature Review	7
	2.1.1. Internal Warehouse Problems Causing Product Picking Up Delay	7
	2.1.2. Common Problem of Picking Activity in Warehouse	7
	2.1.3. Warehouse Operations Disruptions by Order Changes and Blocked Aisle	8
	2.1.4. Picking Process Delay Due to Inefficient Storage Assignment	9
	2.2. Theoretical Background	10
	2.2.1. Systematic Layout Planning (SLP)	11
	2.2.2. Facility Design Layout by Process Layout	11
	2.2.3. Warehouse Storage Policy	12
	2.2.4. ABC Classification	13
	2.2.5. Storage Area Calculation	14
	2.2.6. Lead Time	15

3	ROOT CAUSE IDENTIFICATION AND ALTERNATIVE SOLUTION SELECTION	16
	3.1. Root Cause of the Problem	16
	3.2. Identification and Alternative Solutions	19
	3.3. Solution Selection	22
	3.4. Methods and Tools Selection	25
4	RESEARCH METHODOLOGY	28
	4.1. Research Stages	28
	4.2. Standard and Ethical Codes	36
	4.3. Uniqueness	37
5	IMPROVEMENT DESIGN	38
	5.1. Finished Good Warehouse Data	38
	5.1.1. Product SKU Data	38
	5.2. Material Handling Tools	43
	5.3. Storage Layout Planning	44
	5.3.1. Storage Capacity	44
	5.3.2. Storage Area Calculation	44
	5.3.3. Layout Design Method	46
	5.4. Warehouse Relayout	47
6	IMPLEMENTATION	58
	6.1. Simulating and Result	58
	6.2. Stakeholders Feedback	60
7	CONCLUSION AND SUGGESTION	61
	7.1. Conclusion	61
	7.2. Suggestion	61
	REFERENCES	62
	APPENDIX	xii

LIST OF TABLE

CHAPTER	TITLE	PAGE
1	INTRODUCTION	
	Table 1.1. Shipment Data Recap of The Furniture Manufacturer in Jepara	4
	Table 1.2. Stakeholders' Issues and Needs	5
2	LITERATURE REVIEW AND BASIC THEORY	
	Table 2.1. Summary of Literature Review	10
3	ALTERNATIVE SOLUTION SELECTION	
	Table 3.1. Alternative Solutions Comparison	21
	Table 3.2. Criterion Weighth	22
	Table 3.3. Alternatives Solution Scores	23
	Table 3.4. Method Selection	26
5	IMPROVEMENT DESIGN	
	Table 5.1. Stored Finish Good Data	39
	Table 5.2. Storage Capacity for Each Product	43
	Table 5.3. ABC Classification	46
	Table 5.4. ABC Classification Sequence	46
	Table 5.5. Area Distance Matrix	48
	Table 5.6. Area Distance Matrix 2	50
	Table 5.7. Space Needed for Each Product	51
6	IMPLEMENTATION	
	Table 6.1. Implementation Result and Comparison	58

LIST OF FIGURES		
CHAPTER	TITLE	PAGE
1	INTRODUCTION	
	Figure 1.1. The Furniture Manufacturer Entrance	1
	Figure 1.2. Warehouse Appearance	3
	Figure 1.3. Product Flow Activity	3
2	LITERATURE REVIEW AND BASIC THEORY	
	Figure 2.1. ABC Classification Graphical Representation	13
3	ALTERNATIVE SOLUTION SELECTION	
	Figure 3.1. Interrelationship Diagram	17
	Figure 3.2. Warehouse Initial Layout	18
	Figure 3.3. Initial Layout of The Furniture Manufacturer Finished Goods Warehouse	19
4	RESEARCH METHODOLOGY	
	Figure 4.1. Phase of Empathize Flow Chart	28
	Figure 4.2. Business Process Map	29
	Figure 4.3. Phase of Defining Flow Chart	31
	Figure 4.4. Phase of Ideating Flow Chart	32
	Figure 4.5. Phase of Prototyping Flow Chart	33
	Figure 4.6. Phase of Implementing Flow Chart	35
5	IMPROVEMENT DESIGN	
	Figure 5.1. Rectangle A Finished Product	39
	Figure 5.2. Rectangle B Finished Product	39
	Figure 5.3. Rectangle C Finished Product	40
	Figure 5.4. Oval Board Type Finish Product	40
	Figure 5.5. Table Type Finish Product	41
	Figure 5.6. Table Type Finish Product	41
	Figure 5.7. Lift Truck with Fork-Shaped Extension	42
	Figure 5.8. Hand Truck Pallet Jack	42
	Figure 5.9. Warehouse Zoning Visualization	47

	Figure 5.10. Receiving Area Layout Design	48
	Figure 5.11. Storage Area Classification Zoning Design	49
	Figure 5.12. Storage Area Visualization Design	52
	Figure 5.13. Packing Area Layout Design	54
	Figure 5.14. Warehouse Improvement Layout Design Visualization	55
	Figure 5.15. Improvement Design Key Layout	55
6	IMPLEMENTATION	
	Figure 6.1. FlexSim Settings	57

ABSTRACT

This research was conducted in a furniture manufacturer in Jepara. The company is considered as one of the biggest teak wood furniture producers and exporters in Jepara. Several products of teak wood are produced and stored in a finished goods warehouse. In the warehouse, several activity is conducted related to the product from the production floor until the shipping process. According to the interview with stakeholders, the shipping process is often delayed, which means that the shipping truck can not be boarded on time based on the schedule. Since August 2024, 85% of shipping trucks have been delayed, with the average delay time of 60 minutes. This issue could lead to a late shipment abroad. Through an interrelationship diagram, it is known that the possible root cause is the blocked products due to the inappropriate warehouse layout, which leads to difficulty in the product picking process. Based on several considerations, the selected alternative solution is to do relay layout design of the finished goods warehouse.

The tools used are Systematic Layout Planning (SLP), which focuses on product flow through several activities. This method also considers material handling facilities, such as forklifts, and the travel distance between zones. It also includes defining the space requirements for stored products. The product flow, as well as the transporter flow distance, is arranged and drawn before proceeding with the implementation.

The implementation is simulated using FlexSim software. Based on the implementation, the average picking-up time was successfully reduced by 52%. Compared to the initial time of the picking up process, which averages 72.47 minutes, the new layout needs 34.91 minutes in total. Therefore, it can be concluded that the new layout significantly minimizes the product picking-up time and reduces the delay that happens in the shipping process.

Keywords: shipping delay, warehouse layout, Systematic Layout Planning (SLP), FlexSim software