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PACKAGING FACTORY LAYOUT DESIGN USING SYSTEMATIC LAYOUT PLANNING AND COMPUTERIZED RELATIONSHIP LAYOUT PLANNING METHODS

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ABSTRACT

This comparative study analyses some system dynamics models from many authors in the world. This article investigates some system dynamics performance business models and management in the last five years. Their goals behind their strategic business models and encounter for their respective progress. This study presents policy recommendations on how the next study should be assessed for creating a further system dynamics performance business models and management study.

1. Introduction

Manufacturing industries continue to rapidly evolve within global society, supported by ever-advancing technology. In the manufacturing sector, the production process is undoubtedly the primary activity that must be carefully considered and optimized to achieve company targets.

Alongside advanced technology, factory layout also plays a crucial role in determining the optimal level and effectiveness of modern production processes, from raw materials to finished goods. With a good and efficient layout, it will enable optimal production processes, increase productivity, and enable the company to meet customer demand.

PT. XYZ is one of the companies operating in the field of printing and packaging, established in 1992. The company manufactures corrugated carton boxes tailored to customer needs and also caters to requests for corrugated carton sheets. The demand for cardboard packaging as secondary packaging for almost all other industries makes carton box industries like PT. XYZ experience consistently high demand and orders. With an average production target of 3000 tons per month, one of the efforts needed to support smooth business operations is the design of an effective and efficient factory layout. However, the current layout of PT. XYZ is not sufficiently effective in maximizing the flow of production. The distance and position of the raw material warehouse to the production machines are too far, as well as the distance from the production machines to the finished goods warehouse. Additionally, there are workstations that are not sequential, causing material handling to be inefficient. This, of course, results in high material handling costs and long transfer times.

From this research on factory layout design using the SLP and CORELAP methods, it is expected to generate proposals for a more efficient production floor layout arrangement that can serve as a reference for future relocation plans.

2. Literature Review

As a reference in conducting this research, the author read several literature studies in the table below.

Table 1. Comparison Study of Layout Planning Methods

No	Year	Author	Title	Respondent	Conclusion
1	2021	Hubert Wahyudi, Frans Jusuf Daywin, Carla Olyvia Doaly, Lina Gozali, Wilson Kosasih. [1]	Redesigning of Facility Layout in PT. Ocean Centra Furnindo Using Group-Technology, CORELAP and CRAFT Method	Research was conducted at PT. Ocean Centra Furnindo located in Medan, North Sumatra.	The issue in the company is the less-than-ideal facility layout due to the raw materials, work-in-progress items, and finished goods requiring a large placement area. The results found that the currently currently used layout is indeed smaller than the proposed new layout based on the analysis, but it comes with significantly higher costs and distances for relocation compared to the new layout proposal.
2	2021	Aurellia Kharisty Tjusila, Lina Gozali, Carla Olyvia Doaly.[2]	Factory Re-Layout with SLP, CRAFT, CORELAP, Promodel, and FlexSim for Optimization of Material Flow Movement	Research was conducted at PT. Peace Industrial Packaging, which manufactures styrofoam packaging, blow molding bottles, PET bottles, and injection caps.	This research generated four alternatives layout from three planning methods, which were subsequently simulated using two simulation software, namely Promodel and FlexSim. After comparison, the most effective alternative is the one using the SLP method with an efficiency in MH distance of up to 60.21% and a MH cost efficiency of 44.29%.
3	2020	Mirco Peron, Giuseppe Fragapane, Fabio Sgarbossa, Michael Kay.[3]	Digital Facility Layout Planning	A study taht evaluates the introduction of 3D mapping technology, IPS, MoCap, and IR in facility planning layouts and their impact on sustainable facility development.	The research results indicate that these technologies reduce the time, error rates, and costs associated with the five-step layout planning procedures at the departmental, machine, and workstation levels.
4	2015	Anwar, Bakhtiar, S, Riski Nanda. [4]	Proposed Improvement of Factory Layout Using Systematic Layout Planning	Research was conducted at a coffee bean processing plant in the	The results obtained are two new layout alternatives with smaller material movement moments of 23.42% and 21.79% compared to the initial layout, where the material movement

No	Year	Author	Title	Respondent	Conclusion
			(SLP) at CV. Arasco Bireuen.	center of Juang City, Aceh.	moment in the initial layout reached 3,284,700 m/year.
5	2021	Dino Ramadhan, Lina Gozali, Lamto Widodo, Frans Jusuf Daywin, Carla Olyvia Doaly.[5]	Redesigning The Facility Layout With Systematic Layout Planning Method and Lean Manufacturing Approach On The Production Floor At PT. Baruna Trayindo Jaya	Research was conducted at PT. Baruna Trayindo Jaya.	This research provides a redesign of facility layout using the Systematic Layout Planning (SLP) method and Lean Manufacturing approach, which can reduce the distance by 56.56% and reduce the time by 10.07% compared to the initial layout.
6	2019	Ukurta Tarigan, Robby Simbolon, Meilita T Sembiring, Uni Pratama P Tarigan, Nurhayati Sembirin, Indah R Tarigan. [6]	Redesign and Simulation of the Production Facility Layout for Gripper Rubber Seal Using CORELAP, ALDEP, and Flexim Algorithms	Research was conducted at one of the gripper rubber seal manufacturing companies.	The issues in this research were addressed by designing a new facility layout using the CORELAP and ALDEP algorithms, and then simulating it with Flexsim software. The results showed that the CORELAP method reduced the total material movement moment from 14,495.09 m/month to 5,930.19 m/month, with an increased distance efficiency of 93.74%. Meanwhile, the ALDEP method resulted in a distance efficiency of 78.18%.
7	2021	Evelyn Adisurya, Lina Gozali, dan I Wayan Sukania, Frans Jusuf Daywin, Carla Olyvia Doaly. [7]	The Layout of Raw Material Warehouse in PT. Boga Dimsum Indonesia Using Class-Based Storage Method and Promodel Simulation	Research was conducted at PT. Boga Dimsum Indonesia, which has problems with the disorganized arrangement of raw materials in the warehouse.	Based on the aforementioned issues, this research aims to design a new warehouse layout that is efficient and optimal. The method employed is the Class-Based Storage Method, and it is simulated using Promodel software.
8	2020	Bintang Bagaskara K., Lina Gozali, Lamto Widodo, Frans Jusuf Daywin.[8]	Comparison Study of Facility Planning and Layouts Studies	A comparison study analysis from literature review.	There are many methods for improving and creating layout planning in any industry. However, each method has its own advantages and disadvantages, so the choice of method for layout improvement should be synchronized with the specific problem and validated for its effectiveness.
9	2020	Bintang Bagaskara K., Lina Gozali, Lamto Widodo. [9]	Redesign Layout Planning of Raw Material Area and Production Area Using Systematic	A case study from CV Oto Boga Jaya, a Japanese restaurant.	The analysis results reveal two new layout alternatives, with the second alternative having a smaller distance. The new layouts can enhance productivity by reducing distance and material handling costs.

No	Year	Author	Title	Respondent	Conclusion
			Layout Planning (SLP) Methods (Case Study of CV Oto Boga Jaya)		
10	2021	Bethriza Hanum. [10]	Planning of Heavy Equipment Fabrication Plant Layout using CORELAP Software: A case study of Indonesia	A case study from PT. Heavy Equipment Ternama, which requires a redesign of the layout due to the addition of new welding robot machines.	Using the CORELAP method, this research has designed a new layout proposal that can reduce MH cost from Rp. 2,875,040 to Rp. 998,240 (a decrease of 65%) and MH distance from 162m to 98m (a reduction of 39.5%).

3. Research Methodology

The methodology used in this research begins with field studies and literature reviews, followed by data collection and data processing using the SLP and CORELAP methods. Subsequently, it calculates and compares the distances and material handling costs between the initial layout and the proposed layout.

4. Data Collection and Calculation

4.1 Initial Layout

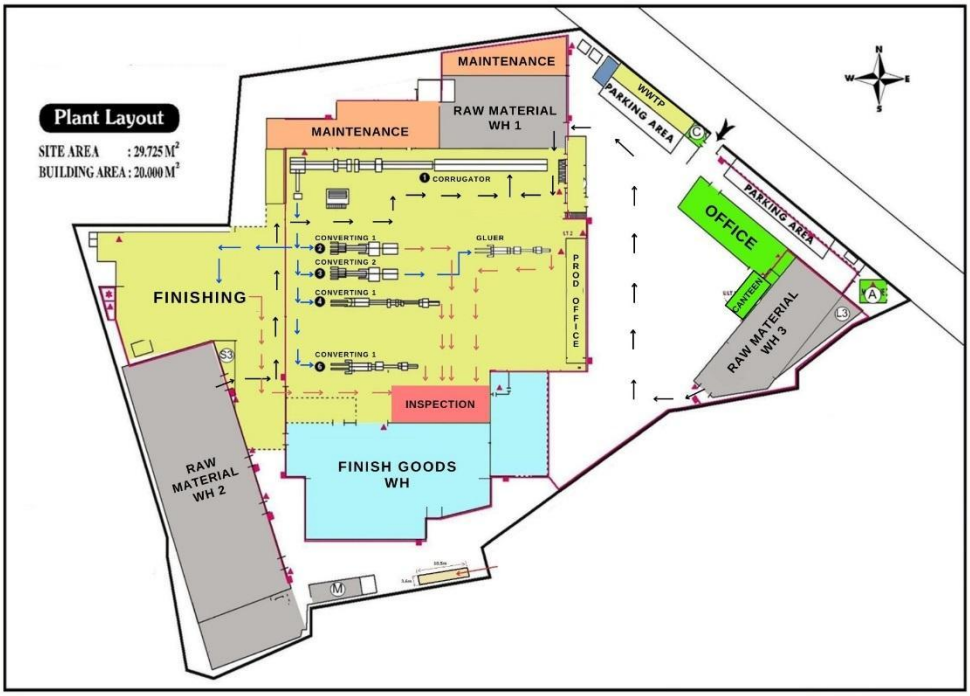

Figure 1. Initial Layout of PT. XYZ

The problem faced by PT. XYZ is an inefficient facility layout that is difficult to change due to the existing building structure from the previous factory, which is not well-suited to PT. XYZ's workflow. The location of the raw material warehouse is too far from the first workstation, which is the corrugator machine. The material flow is also inefficient, resulting in crossovers at some points. As a result, material handling takes longer and incurs high costs.

4.2 Activity Relationship Chart

Activity Relationship Chart (ARC) is a graphical representation used in facility layout planning to depict the relationships and interactions between various activities or workstations within a facility. It helps in understanding how different parts of a process or production line are interconnected, facilitating the design of an efficient and organized layout.

Here are the ARCs for the production floor and the full layout can be seen in Fig. 2 and 3.

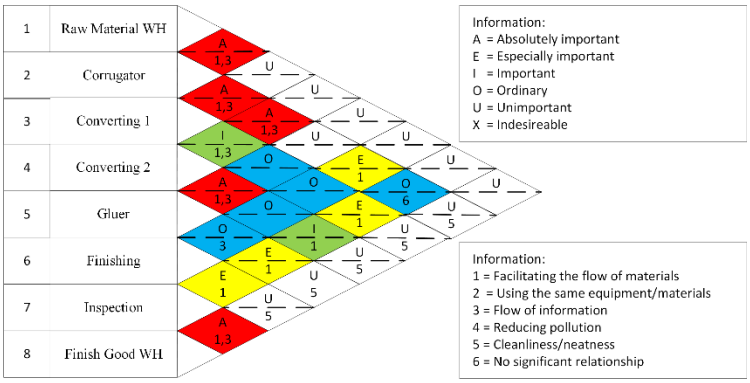

Figure 2. Production Floor ARC

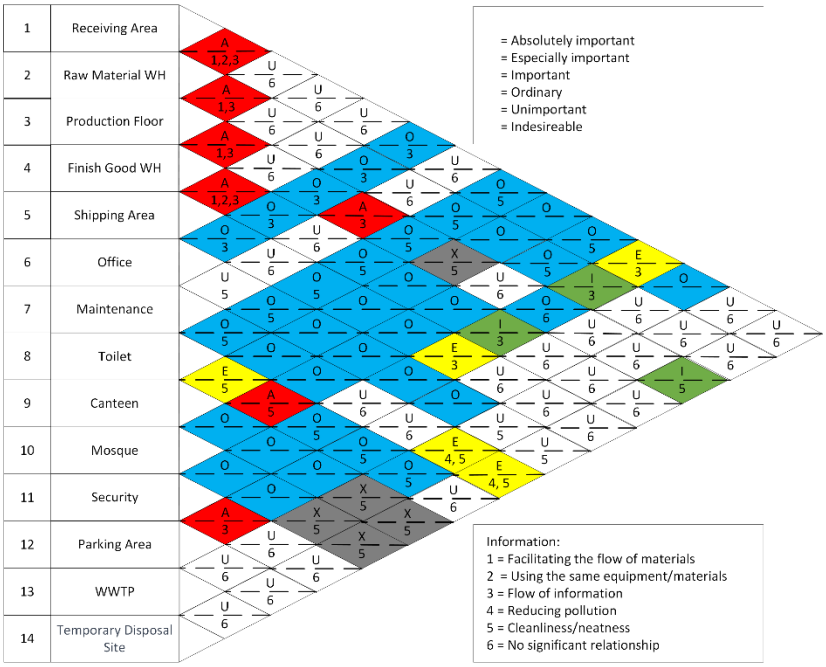

Figure 3. Full Layout ARC

4.3 Systematic Layout Planning Method

The SLP method is a method used to design a layout by considering product design and is a conventional approach to the design of production processes and basic facilities.

From the ARC before, ARD for the production floor and the full layout can be created as seen in Fig. 4 and 5.

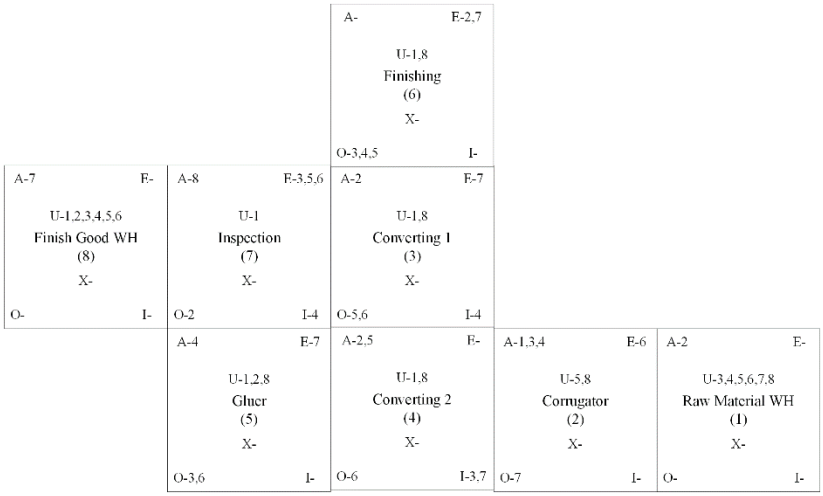

Figure 4. Production Floor ARD

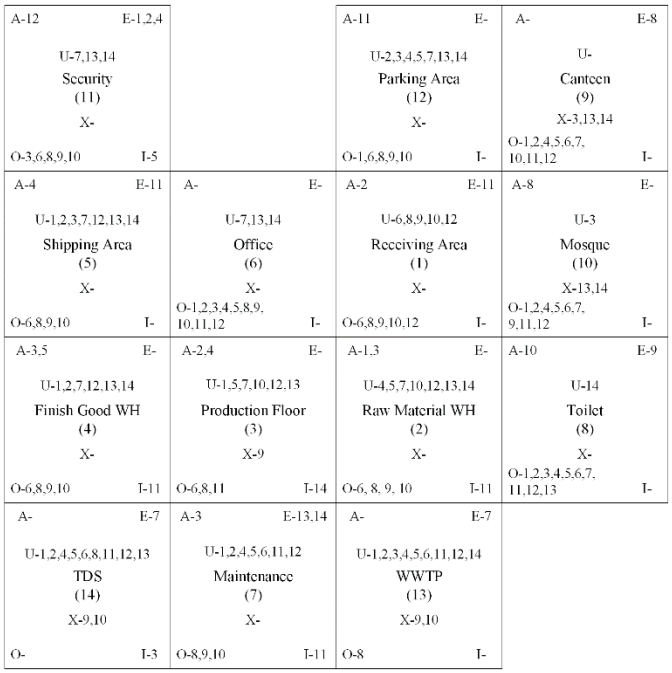

Figure 5. Full Layout ARD

After creating the ARD, proceed to create the layout design in the form of AAD as seen in Fig. 6 and 7.

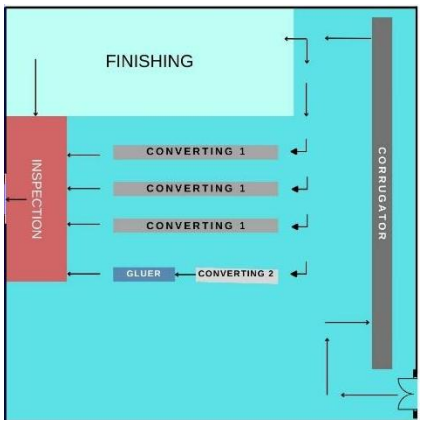

Figure 6. Production Floor AAD

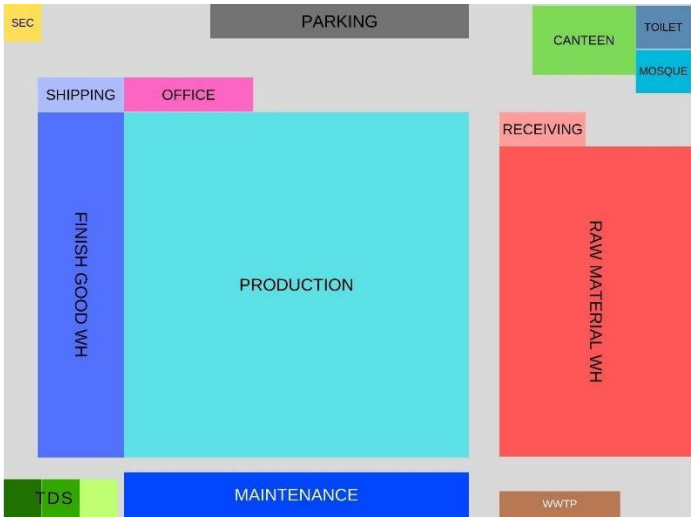

Figure 7. Full Layout AAD

4.4 Computerized Relationship Layout Planning Method

CORELAP is a facility layout algorithm that calculates the most active or most interconnected activities in a layout. The total closeness rating for each department is compared by considering the sum of the closeness ratings of activities with other activities. The activities with the highest total closeness rating are placed first in the layout matrix. Next, an activity that needs to be close to it is selected, considering the total closeness rating for each department.

The creation of ARD in the CORELAP method is carried out by iterating until all workstations are completed. The final iteration results for the production floor layout and the full layout can be seen in Fig. 8 and 9.

	14	13	12	11	
16	15	Gluer	Finishing	10	9
17	FG WH	Inspection	Converting 2	RM WH	8
18	1	Corrugator	Converting 1	6	7
	2	3	4	5	

Figure 8. Production Floor ARD

	18	17	WWTP	15	14
20	19	Canteen	Office	TDS	13
1	Parking Area	Security	Toilet	Receiving	12
2	3	Raw Material WH	Production Floor	Finish Good WH	11
	4	Mosque	Maintenance	Shipping	10
	5	6	7	8	9

Figure 9. Full Layout ARD

After creating the ARD, proceed to create the layout design in the form of AAD as seen in Fig. 10 and 11 below.

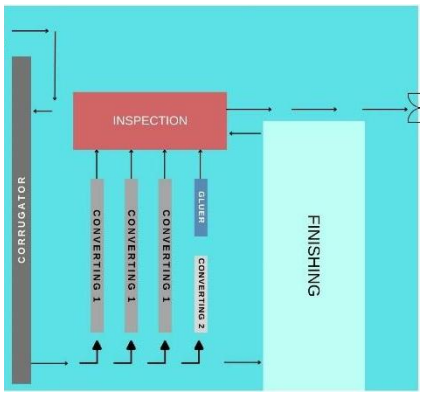

Figure 10. Production Floor AAD

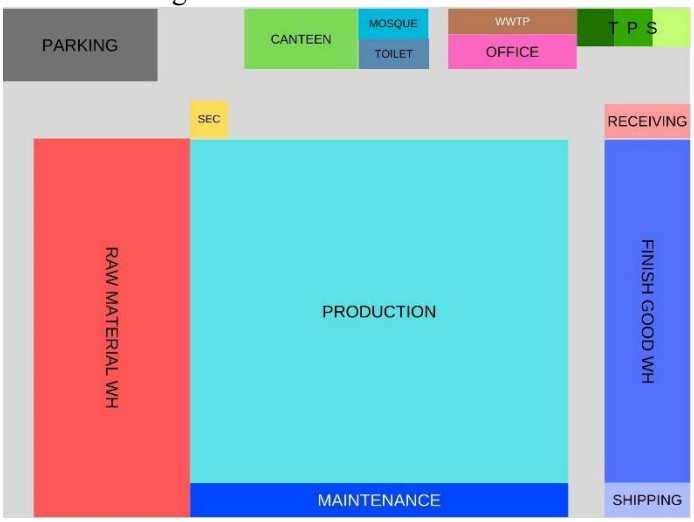

Figure 11. Full Layout AAD

4.5 Material Handling Calculation

Table 1. Initial Layout Material Handling Calculation

From	To	Distance (m)	MH	The Amount to be Transfered	Unit	Unit Load	Frequency /day		Moving Moments/day	MH Cost/m	MH Cost/day	Total Cost/day	Total Cost/month
Raw Material WH	Corrugator	100,0	Clamp-lift	144,50	ton	1	144,5		14450	82,41	Rp 1.190.841	Rp 1.190.841	Rp 26.198.500
Corrugator Machine	Finishing	52,0	Conveyor	14,45	ton	-	108	mins		0,00	Rp -		
Corrugator Machine	Converting 1	35,0	Conveyor	101,15	ton	-	756	mins		0,00	Rp -	Rp -	Rp -
Corrugator Machine	Converting 2	55,0	Conveyor	28,90	ton	-	216	mins		0,00	Rp -		
Finishing	Inspection	80,0	Fork-lift	14,02	ton	0,35	40		3200	60,93	Rp 194.978		
Converting 1	Inspection	73,0	Fork-lift	98,12	ton	0,35	280,3		20462	60,93	Rp 1.246.758		
Converting 2	Gluer	17,0	Fork-lift	27,19	ton	0,35	77,7		1321	60,93	Rp 80.483	Rp 2.629.159	Rp 57.841.500
Gluer	Inspection	32,0	Fork-lift	28,03	ton	0,35	80,1		2563	60,93	Rp 156.178		
Inspection	Finish Good WH	40,0	Fork-lift	136,54	ton	0,35	390,1		15604	60,93	Rp 950.762		
							Total		57600			Rp 3.820.000	**Rp 84.040.000**

Table 2. Alternative 1 (SLP Method) Material Handling Calculation

From	To	Distance (m)	MH	The Amount to be Transfered	Unit	Unit Load	Frequency/ day		Moving Moments/day	MH Cost/m	MH Cost/day	Total Cost/day	Total Cost/month
Raw Material WH	Corrugator	65,0	Clamp-lift	144,50	ton	1	144,5		9393	91,79	Rp 862.103	Rp 862.103	Rp 18.966.275
Corrugator Machine	Finishing	45,0	Conveyor	14,45	ton	-	108	mins		0,00	Rp -		
Corrugator Machine	Converting 1	45,0	Conveyor	101,15	ton	-	756	mins		0,00	Rp -	Rp -	Rp -
Corrugator Machine	Converting 2	55,0	Conveyor	28,90	ton	-	216	mins		0,00	Rp -		
Finishing	Inspection	22,0	Fork-lift	14,02	ton	0,35	40		880	74,22	Rp 65.310		
Converting 1	Inspection	12,0	Fork-lift	98,12	ton	0,35	280,3		3364	74,22	Rp 249.632		
Converting 2	Gluer	4,0	Fork-lift	27,19	ton	0,35	77,7		311	74,22	Rp 23.066	Rp 988.377	Rp 21.744.296
Gluer	Inspection	12,0	Fork-lift	28,03	ton	0,35	80,1		961	74,22	Rp 71.336		
Inspection	Finish Good WH	20,0	Fork-lift	136,54	ton	0,35	390,1		7802	74,22	Rp 579.032		
							Total		22710			Rp 1.850.481	**Rp 40.710.571**

Table 3. Alternative 2 (CORELAP Method) Material Handling Calculation

From	To	Distance (m)	MH	The Amount to be Transfered	Unit	Unit Load	Frequency /day		Moving Moments/day	MH Cost/m	MH Cost/day	Total Cost/day	Total Cost/month
Raw Material WH	Corrugator	60,0	Clamp-lift	144,50	ton	1	144,5		8670	94,02	Rp 815.141	Rp 815.141	Rp 17.933.100
Corrugator Machine	Finishing	116,0	Conveyor	14,45	ton	-	108	mins		0,00	Rp -		
Corrugator Machine	Converting 1	27,0	Conveyor	101,15	ton	-	756	mins		0,00	Rp -	Rp -	Rp -
Corrugator Machine	Converting 2	44,0	Conveyor	28,90	ton	-	216	mins		0,00	Rp -		
Finishing	Inspection	49,0	Fork-lift	14,02	ton	0,35	40		1960	60,91	Rp 119.385		
Converting 1	Inspection	11,0	Fork-lift	98,12	ton	0,35	280,3		3083	60,91	Rp 187.806		
Converting 2	Gluer	4,0	Fork-lift	27,19	ton	0,35	77,7		311	60,91	Rp 18.931	Rp 2.637.118	Rp 58.016.587
Gluer	Inspection	11,0	Fork-lift	28,03	ton	0,35	80,1		881	60,91	Rp 53.669		
Inspection	Finish Good WH	95,0	Fork-lift	136,54	ton	0,35	390,1		37060	60,91	Rp 2.257.326		
							Total		51965			Rp 3.452.259	**Rp 75.949.687**

5. Conclusion

Layout	Total Distance (m)	Moving Movements (m)	MH Cost/month	MH Cost/month	% Efficiency (From initial)
Initial Layout	484	57600	Rp 84.040.000	$ 5.463,64	0
SLP Method	280	22710	Rp 40.710.571	$ 2.646,69	51,6
CORELAP Method	417	51965	Rp 75.949.687	$ 4.937,67	19,9

The best analysis result for this layout research is the SLP method alternative with an efficiency improvement in moving movements from 57,600 meters per day to 22,710 meters per day. This results in a 51.6% reduction in material handling costs per month, from $5,463 to $2,646.

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