Production Layout Replanning Using Systematical Layout Planning with Shared Storage Method Analysis and Flexsim Simulation in Garment and Textile Company

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Abstract

PT. XYZ is a small to medium business engaged in producing children's apparel that produces various product designs, such as jumpsuits, dresses, and clothes for children from 0-1 years old. PT. XYZ still has problems in the production sector, such as the missed production process, the production layout, which is considered ineffective compared to production standards. The Warehousing system is dangerous and takes massive time and energy. So the researchers conducted direct observations and implementations in the field using data obtained from operations such as the amount of production, flow, time, and the number of employees. The new layout is processed by using a systematic layout planning method. SLP method calculation consists of From To Chart (FTC), Operation Process Chart (OPC), Routing Sheet, Multi-Product Process Chart (MPPC), Activity Relationship Chart (ARC), Activity Relationship Diagram (ARD), Area Allocation Diagram(AAD), and flow processes to design new layouts and use shared storage methods Throughput, Assignment, Calculation of needs and space. After being processed, the results of the 2 alternative designs have effectiveness, distance, and shorter time than the initial layout. From the two alternatives, simulations were carried out using the Flexsim application and compared the time and production throughput. Alternative number one was chosen because the production throughput was 2 more pieces than alternative 2, with an increase of about 11.4% compared to the initial layout. The final step is implementing the final design that has been selected at the production site.

Keywords
Facility Layout, Systematic Layout Planning, Shared Storage, Implementation

1. Introduction
The layout is one of the keys that determine the efficiency of a company's operations in the long term. An effective layout can help an organization achieve a strategy that supports differentiation, low prices, or responsiveness. The layout emphasizes systematic and logical design using multiple analytical processes.

PT. XYZ is a business engaged in textile production, with 2 production sites and 1 sales shop. The product produced by PT. XYZ is clothing for girls aged less than 2 years. Based on observations of the production layout, the main problem is the frequency of technical errors in production such as wrong colors or missed processes due to layouts that confuse workers in processing materials and the distance between the previous machine and the sewing machine is quite far. Also, the road area is very narrow due to the machine's large size. The layout is also considered poor due to excessive activity in the material transportation process. Much time is wasted, making it more costly and less effective. And the distance between the raw material warehouse and the production process is quite far, where the raw materials are large and quite heavy, with many material handling processes making the process quite time-consuming and laborious, as well as dangerous.

Therefore, research was conducted by redefining the layout and emphasizing the shared storage method for warehouses. The research uses a systematical layout planning method in determining the layout and design, with input analysis based on warehousing management so that storage placement is more effective.

1.1 Objective

1. Provide a layout plan designed using a systematic method on PT. XYZ.
2. Analyze and redesign the system layout of the warehouse placement using the Shared Storage method.
3. Improve the workplace that has been systematically arranged and tested

2. Literature Review

The literature reviews that are used in this research are:

2.1 Systematic Layout Planning

Systematic Layout Planning is a series of stages in planning a layout, starting from the pattern outline and placement to the final layout. These stages use several tools such as Routing Sheet, ARC, AAD, MPPC, and ARD. Operation process chart (OPC) is a diagram that describes the process steps experienced by raw materials regarding the sequence of operations and inspections from the beginning to the finished product as a whole or as a component, it contains the information needed for further analysis. So in an operation process chart, only operations and inspection activities are recorded, sometimes at the end of the process storage is recorded (Sutalaksana & Iftikar, 2006). Carry on, Routing Sheet, sequencing of production becomes the backbone of production activities which is the recollection of all data developed by process engineers and the main communication tool between product engineers and production people. A production routing sheet is a tabulation of the steps involved in producing a particular component and the necessary details of related matters. This routing sheet is often referred to as a process or operation sheet (Apple, 1977). The aim is to calculate the number of machines, production quantities and time in detail to determine the theoretical capacity of the tool for the next stage. Multi-Product Process Chart (MPPC) is a diagram that shows the order for each component to be produced. The MPPC map can be useful as a general description of the processing steps. The sequence of production from each component to produce in each machine. Based on the MPPC, it can also be seen that backtracking and flow patterns are not in accordance with the process sequence (Ariana, et al, 2005). From to Chart (FTC) is calculated with the total of material handling costs for each displacement that occurs (Wignjosoebroto & Sritomo, 2003). The final result of the FTC is a number that will be converted into a relationship value that will be used to design the Activity Relationship Chart. Activity Relationship Chart (ARC) is a simple method or technique in planning the layout of a facility or department or based on the degree of activity relationship, often expressed in a "qualitative" assessment and tended to be based on subjective considerations of each individual in each facility/department. ARC will consider the degree of proximity of a department to other departments with qualitative measures such as: absolute or not absolute, must be close together, important enough to be placed close together and so on. Activity Relationship Diagram is a diagram that describes the various activity flows in the system that is being designed, how each data flow begins, the decisions that may occur and how they end. Activity diagrams are special state diagrams, where most of the states are actions and most of the transitions are triggered by the completion of the previous state of internal processing. Therefore, the activity diagram does not describe the internal behavior of a system exactly but rather describes the processes and activity paths from the top level in general. Area Allocation Diagram (AAD) is principally an area template compiled based on ARD. AAD describes the final layout, but each activity centre does not contain facilities yet. Area Allocation Diagram (AAD) is a continuation of ARC where the proximity of the activity layout is determined in Area Allocation Diagram (AAD). AAD is also a global template of information that can be seen only in area utilization. In contrast, the complete image can be seen in the template, which is the final result of the analysis.

2.2 Shared Storage

Shared storage is a method of arranging the layout of the warehouse space using the FIFO (First In First Out) principle, where the goods that are sent the fastest are placed in the storage area closest to the exit entry (I/O) door. This method would be better used in types of factories that have the same product dimensions or are not much different because each storage area can be occupied by different types of products based on the product's production time and delivery date (Zaenuri, 2015). The steps taken in solving the problem are as follows (Mulyati, et al, 2020) : Data Collection Average Amount of Goods Out of Warehouse is the first stage in Shared Storage collects data on the entry of raw material goods into the warehouse, from all types of materials calculated separately. The next stage is data collection of goods brought to the production floor, also calculated separately for each material supplied. Furthermore, from the data on the average number of exits from the warehouse and entry into the warehouse, the number of monthly usages with a period of time for each material is calculated, and the number of monthly needs for each raw material is obtained. Next is the space required by calculating the number of raw materials divided by the storage capacity of one pallet of each raw material. Then, Determination of Aisle Width which aims to calculate the best pallet size and the width of the aisle or aisle between each pallet available to store raw materials. The aisle is actually the diagonal of the pallet size. Throughput is a point that shows how often a raw material is moved or material handling. It is calculated from the number of needs per month divided by the number of storage of 1 production pallet. Assignment Calculation is Throughput multiplied by the number of room requirements, usually directly proportional to Throughput. From the previously calculated points, the next step is to design a layout based on the distance from the door to the material pallet, where each material pallet is ordered based on the calculated assignment point. The bigger it is, the closer it should be to the door. Only at this stage was the final layout designed with different numbers and color designs for each material.

2.3 Flexsim

Flexsim is a production simulation application that aims to understand the design and simulate a factory or facility in carrying out the production process. Flexsim aims to minimize a design by simulating it first, from which it can be improved and revised before direct implementation. Using the application starts from placing the production components, such as processor, combiner, separator, queue or docking area, then each component is set production time and setup time. The next step is to connect each component with a connecting line, and each line and component is paired with transporters and workers who can be workers, locomotion equipment, to robots. After everything is designed, the last step is to do a simulation directly and see the selected parameters. If the results are good, then the simulation is declared feasible to be implemented directly.

3. Method

The method that has been done in this research can be seen in the flowchart in Figure 1.

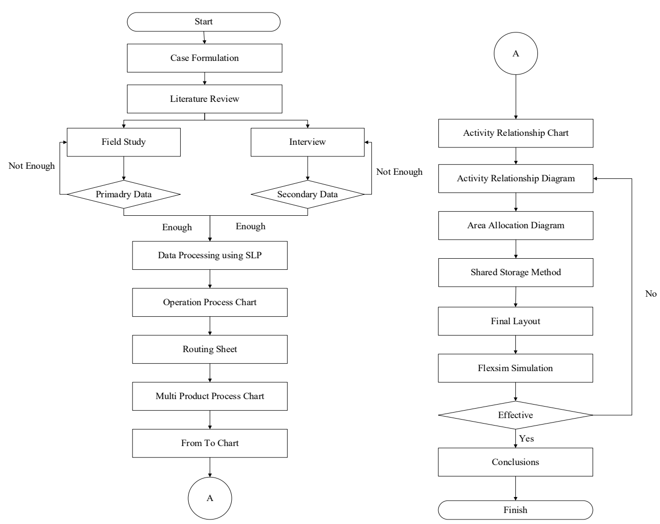

Figure 1. Method Chart

4. Data Collection

Here is the Previous Factory Layout on Figure 2, and with the average of production demand and production planning per month on figure 3 and 4.

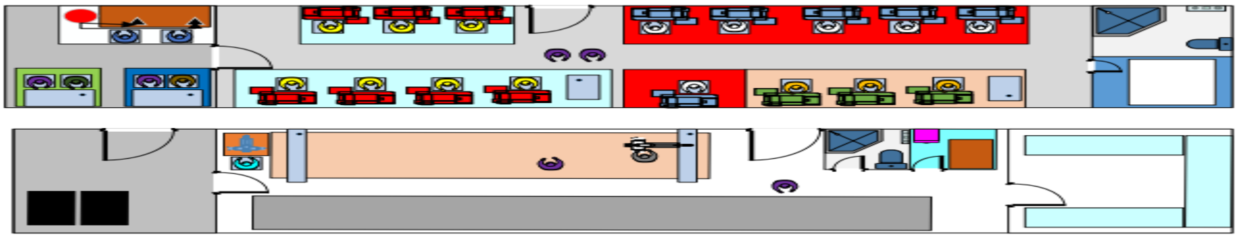

Figure 2. Initial Layout Facility

Assumption Routing Sheet	
Demand	800 Dz x 12 Pieces = 9600 Pieces
Days of Work	30 Days
Hours of Work	30 Days x 10 Hours = 300 Hours
Production per hour	9600 Pieces / 300 Hours = 32 Pieces
Production per day	32 Pieces x 10 Hours = 320 Pieces

Figure 3. Assumption Production

Station	Total	Size		Area (M2)
		L (M)	W (M)	
Raw Material Storage	1	5	3	15
Product Warehouse	1	1,5	10	15
Cutting Machine	1	2,5	14	35
Bis Cutting Machine	1	1,5	0,5	0,75
Sewing Machine	8	1	1	8
Overlock Machine	7	1	1	7
Khamp Machine	4	1	1	4
Scrubbing Machine	1	1	0,5	0,5
Area QC	1	1	0,5	0,5
Area Packing	1	1	0,5	0,5
Others	-			163,75
Total	-			250

Figure 4. Area total

5. Results and Discussion

5.1 Systematical Layout Planning

Systematical layout planning starts with several calculations using OPC, FTC, MPPC, Routing Sheet, ARD, AAD, and final layout.

1. Operation Process Chart

The Operation Process Chart of this Research can be seen in Figure 5

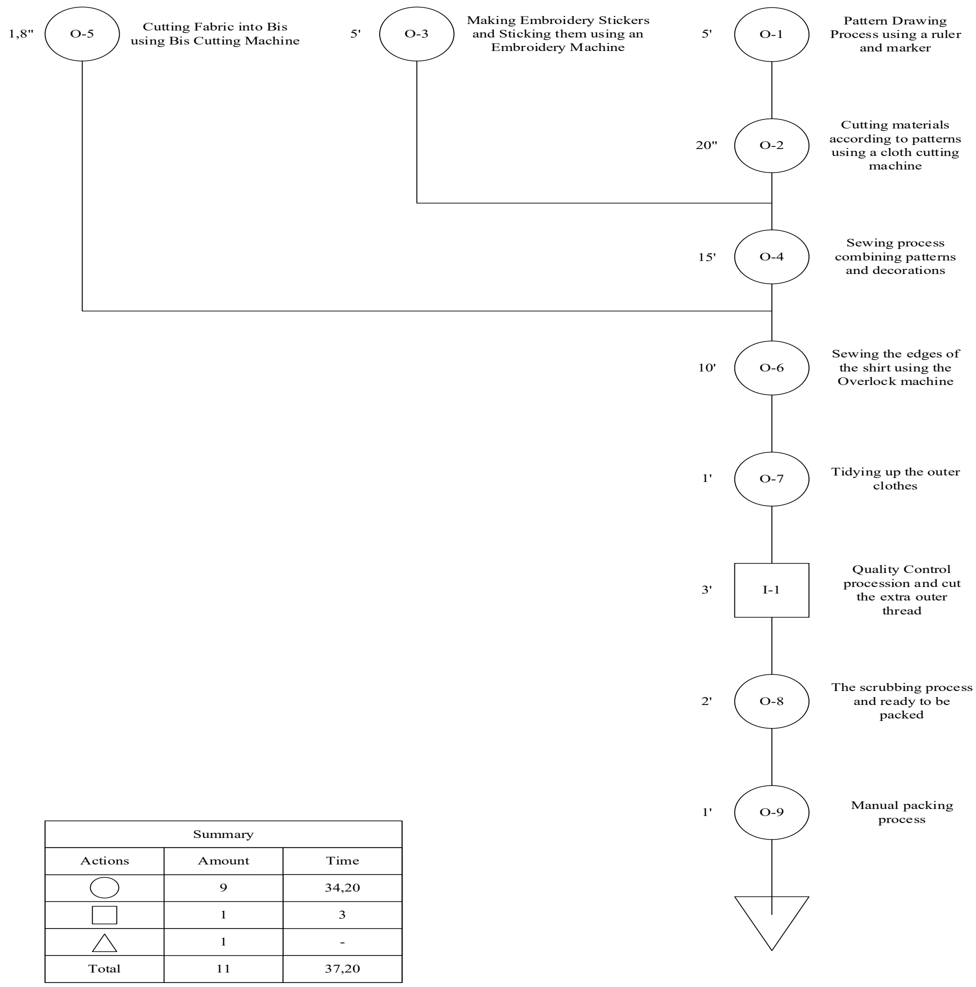

Figure 5. Operation Process Chart

2. Routing Sheet

The Routing Sheet of this Research can be seen in Figure 6

Number	Description	Devices Name	Production unit/Hr	Scrap	Efficiency	Reability	Theoritical Capacity	Units Expected	Unit Provided	Production * Reability	Production * efficiensy	Theoritical Machine
Clothes												
O-1	Set Up Material	Measure Device	30	0%	100%	100%	300	-	-	-	-	-
O-2	Cutting	Cutting Machine	600	5%	90%	90%	5700	320	336	302,4	302,4	0,058947368
O-4	Sewing	Sewing Machine	4	2%	90%	90%	39,2	320	326,4	293,76	293,76	8,326530612
O-5	Ditch	Overlock Machine	6	2%	90%	90%	58,8	320	326,4	293,76	293,76	5,551020408
O-6	Khamp	Khamp Machine	60	2%	90%	90%	588	320	326,4	293,76	293,76	0,555102041
O-7	Quality Control	Scissor	20	1%	100%	100%	198	320	323,2	323,2	323,2	1,632323232
O-8	Scrubbing	Scrubbing Machine	30	0%	90%	90%	300	320	320	288	288	1,066666667
O-9	Packing	-	60	0%	100%	100%	600	320	320	320	320	0,533333333
Accecories												
O-3	Embroidery	Embroidery machine	20	2%	90%	90%	196	320	326,4	293,76	293,76	1,665306122
Outer Clothes												
O-4	Bis Cutting	Bis Cutting Machine	2000	2%	90%	90%	19600	320	326,4	293,76	293,76	0,016653061

Figure 6. Routing Sheet

3. MPPC

The MPPC of this Research can be seen in Figure 7

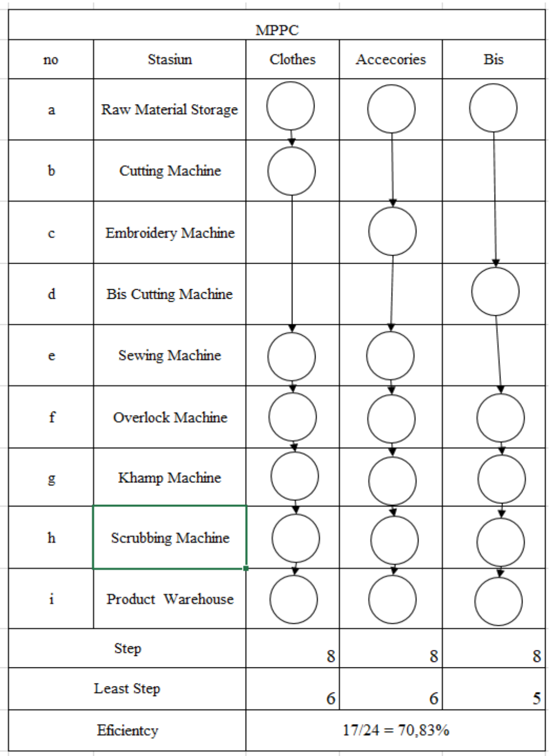

Figure 7. Multi Product Process Chart

4. From To Chart

The From to Chart (FTC) of this Research can be seen in Figure 8 and Figure 9, as well as the relations table in Figure 10

FROM / TO	A	B	C	D	E	F	G	H	I	TOTAL
A		1	1	1						1
B					0,6923					0,6923
C					0,3076					0,3076
D						0,669				0,669
E						0,33				0,33
F							1			1
G								1		1
H									1	1
I										0
TOTAL	0	1	1	1	0,3076	0,33	1	1	1	5,9989

Figure 8. FTC Inflow

FROM / TO	A	B	C	D	E	F	G	H	I	TOTAL
A		0,123	0,685	0,191						0,685
B					1					1
C					1					1
D						1				1
E						1				1
F							1			1
G								1		1
H									1	1
I										0
TOTAL	0	0,123	0,685	0,191	1	1	1	1	1	7,685

Figure 9. FTC Outflow

Symbol	Machine	Relations					
		A	E	I	O	U	X
A	Raw Material Storage	B (1), C (1), D (1)					
B	Cutting Machine		E (0,69)				
C	Embroidery Machine			E (0,3)			
D	Bis Cutting Machine		F (0,69)				
E	Sewing Machine			F (0,33)			
F	Overlock Machine	G (1)					
G	Khamp Machine	H (1)					
H	Scrubbing Machine	I (1)					
I	Product Warehouse						

Figure 10. Relations From To Chart

5. Activity Relationshion Chart

The Activity Relationship Chart of this Research can be seen in Figure 11

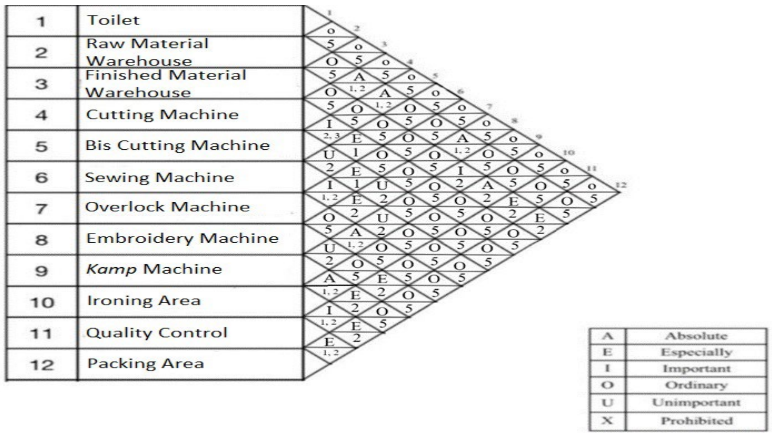

Figure 11. ARC

6. Activity Relationship Diagram

The Activity Relationship Diagram of this Research can be seen in Figure 12 and 13.

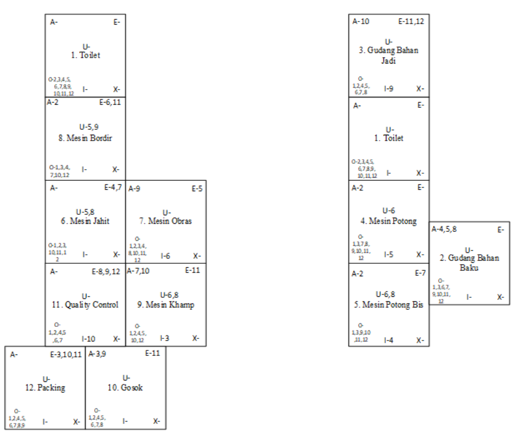

Figure 12. ARD Alternative 1

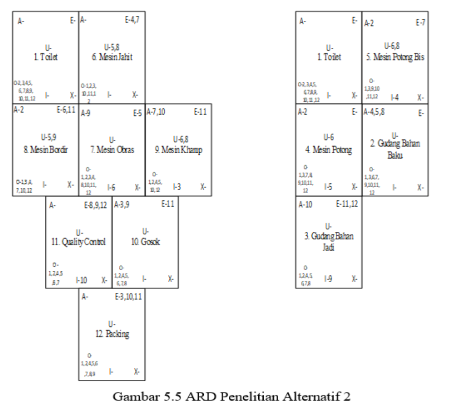

Figure 13 ARD Alternative 2

7. Area Allocation Diagram

The Area Allocation Diagram of this Research can be seen in Figure 14 and 15.

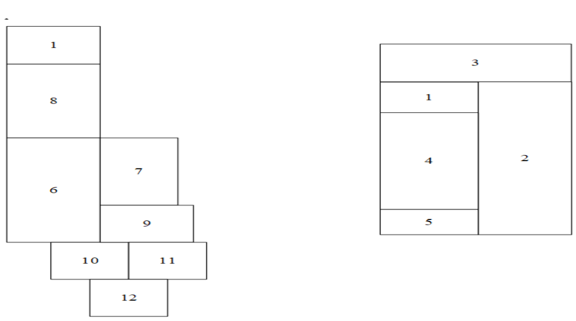

Figure 14. AAD Alternative 1

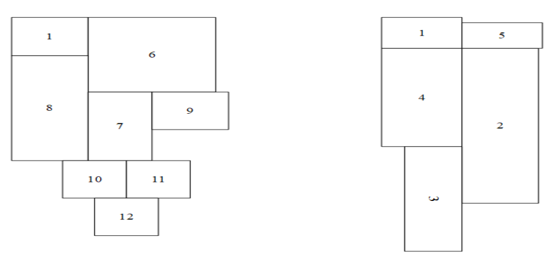

Figure 15. AAD Alternative 2

8. Layout

The Layout Detail of this Research can be seen in Figure 16.

No	Room	Nu. Of Rooms	Tools and Kit	Total	Size		Area (m²)	Allowance		Area of Use (m²)	Traffic Allowance		Area (m²)	Total Area (m²)
					L(m)	W(m)		%	m²		%	m²		
1	Toilet	2	Closet	2	0,5	0,5	0,5	20	0,1	0,6	50	0,3	0,9	4,563
			Bucket	2	1	1	2	20	0,4	2,4	50	1,2	3,6	
			Soap Rack	2	0,2	0,1	0,04	5	0,002	0,042	50	0,021	0,063	
2	Product Warehouse	1	long Material Rack	1	4	0,5	2	50	1	3	50	1,5	4,5	13,2
			Short Material Rack	3	2	0,5	3	50	1,5	4,5	50	2,25	6,75	
			Stair	1	0,5	0,5	0,25	30	0,075	0,325	50	0,1625	0,4875	
			Chair	1	0,5	0,5	0,25	30	0,075	0,325	50	0,1625	0,4875	
			Desk	1	1	0,5	0,5	30	0,15	0,65	50	0,325	0,975	
3	aw Material Storag	1	Stair	1	0,5	0,5	0,25	10	0,025	0,275	50	0,1375	0,4125	42,4875
			Material Rack	1	17	1,5	25,5	10	2,55	28,05	50	14,025	42,075	
4	Cutting Machine	1	Cutting Desk	1	14	2,25	31,5	15	4,725	36,225	50	18,1125	54,3375	56,8875
			Chair	1	0,5	0,5	0,25	30	0,075	0,325	50	0,1625	0,4875	
			Cutting Machine	1	0,5	2	1	10	0,1	1,1	50	0,55	1,65	
			Garbage	1	0,5	0,5	0,25	10	0,025	0,275	50	0,1375	0,4125	
5	Bis Cutting Machine	1	Desk	1	1	0,5	0,5	30	0,15	0,65	50	0,325	0,975	2,925
			Chair	1	0,5	0,5	0,25	30	0,075	0,325	50	0,1625	0,4875	
			Bis Cutting Machine	1	1,5	0,5	0,75	30	0,225	0,975	50	0,4875	1,4625	
6	Sewing Machine	1	Sewing Machine	8	1	0,5	4	50	2	6	50	3	9	9,975
			Thread Desk	1	1	0,5	0,5	30	0,15	0,65	50	0,325	0,975	
7	mbroidery Machin	1	Embroidery Machine	2	7	1	14	50	7	21	50	10,5	31,5	31,5
8	Overlock machine	1	Overlock machine	6	1	0,5	3	50	1,5	4,5	50	2,25	6,75	7,725
			Thread Desk	1	1	0,5	0,5	30	0,15	0,65	50	0,325	0,975	
9	Khamp Machine	1	Khamp Machine	3	1	0,5	1,5	50	0,75	2,25	50	1,125	3,375	3,375
10	Scrubbing Machine	1	Scrubbing Machine	1	0,5	0,5	0,25	25	0,0625	0,3125	50	0,15625	0,46875	19,03125
			Scrubbing Desk	1	4	2	8	50	4	12	50	6	18	
			Gas Tube	1	0,5	0,5	0,25	50	0,125	0,375	50	0,1875	0,5625	
11	Quality Control	1	Desk	1	2	1	2	30	0,6	2,6	50	1,3	3,9	4,875
			Chair	2	0,5	0,5	0,5	30	0,15	0,65	50	0,325	0,975	
12	Packing	1	Desk	1	2	1	2	30	0,6	2,6	50	1,3	3,9	4,875
			Chair	2	0,5	0,5	0,5	30	0,15	0,65	50	0,325	0,975	
Total														201,41925

Figure 16. Layout Details

5.2 Shared Storage

Shared Storage starts from calculating production needs, space requirements, aisle width, Throughput, assignment, and area distance in determining the final warehousing layout.

1. Production Needs

The Production needs of this research can be seen in Table 1.

Table 1. Production Needs

Production Needs				
No	Material type	Goods Amount (Roll)	Period (Months)	requirements
1	White Cotton Cloth	240	15	16
2	Light Color Cotton	852	6	142
3	Dark Color Cotton	372	48	7,75
4	Printed Cotton Fabric	400	1	400
5	Furing Cloth	24	6	4
Production Needs				
No	Material Type	Goods Amount (Roll)	Period (Months)	requirements
6	Jumpsuit	1656	2	828
7	Shirt	265	2	132,5
8	Dress	624	3	208

2. Space Requirement

The Space Requirement of this Research can be seen in Table 2

Table 2. Space Requirement

Space Requirement					
No	Material type	Goods Amount (Roll)	Pallet Capacity	Space Requirement	Rounding
1	White Cotton Cloth	240	144	1,666666667	2
2	Light Color Cotton	852	144	5,916666667	6
3	Dark Color Cotton	372	144	2,583333333	3
4	Printed Cotton Fabric	400	144	2,777777778	3

5	Furing Cloth	24	144	0,166666667	1
Space Requirement					
No	Material Type	Goods Amount (Roll)	Pallet Capacity	Space Requirement	Rounding
6	Jumpsuit	1656 Lusin	600	2,76	3
7	Shirt	265	600	0,441666667	1
8	Dress	624	600	1,04	1

3. **Aisle**
The Aisle of this Research can be seen in Table 3.

Table 3. *Aisle*

Size	Lenght (M)	Wide (M)	Height (M)	Volume (M3)	Area (M2)	Diagonal/Aisle
1 Pallet Size	1,5	1	2	3	1	1,802775638
1 Rack Size	2	1	3,5	7	2	2,236067977

4. **Throughput**
The Throughput of this Research can be seen in Table 4.

Table 4. *Throughput*

Throughput						
No	Material type	Goods Amount (Roll)	Period (Months)	requirements	Throughput	Throughput Rounding
1	White Cotton Cloth	240	15	16	0,111111111	0,1
2	Light Color Cotton	852	6	142	0,986111111	1
3	Dark Color Cotton	372	48	7,75	0,053819444	0,05
4	Printed Cotton Fabric	400	1	400	2,777777778	2,77
5	Furing Cloth	24	6	4	0,027777778	0,02
Throughput						
No	Material Type	Goods Amount (Dozen)	Period (Months)	requirements	Throughput	Throughput Rounding
6	Jumpsuit	1656	2	828	1,38	1,38
7	Shirt	265	2	132,5	0,220833333	0,22
8	Dress	624	3	208	0,346666667	0,35

5. **Assignment**
The Assignment of this Research can be seen in Table 5

Table 5. *Assignment*

Assignment							
No	Material Type	Throughput	Throughput Rounding	Space Requirement	Space Requirement Rounding	Assignment	Assignment Rounding

1	White Cotton Cloth	0,111111111	0,1	1,666666667	2	0,055555556	0,06
2	Light Color Cotton	0,986111111	1	5,916666667	6	0,164351852	0,16
3	Dark Color Cotton	0,053819444	0,05	2,583333333	3	0,017939815	0,01
4	Printed Cotton Fabric	2,777777778	2,77	2,777777778	3	0,925925926	1
5	Furing Cloth	0,027777778	0,02	0,166666667	1	0,027777778	0,02
Assignment							
No	Material Type	Throughput	Throughput Rounding	Space Requirement	Space Requirement Rounding	Assignment	Assignment Rounding
6	Jumpsuit	1,38	1,38	2,76	3	0,46	0,5
7	Shirt	0,220833333	0,22	0,441666667	1	0,220833333	0,2
8	Dress	0,346666667	0,35	1,04	1	0,346666667	0,3

5.3 Validation

A. Alternative 1

The following is the 3D design of alternative layout one that has been pre-designed, with sufficient Throughput or production quantities produced, and the division of the working process of each machine that works. After the design is done in the Flexsim application, test the layout model with parameters, namely the amount of Throughput or the number of production and the state bar that shows the state of the machine time from start to finish. Run time on the simulation is 10 hours of work. Following is the result of the simulation of alternative layout model 1 on figure 17, 18, and 19.

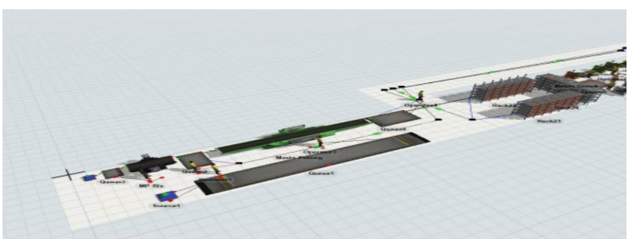

Figure 17. Floor 2 Alternative 1

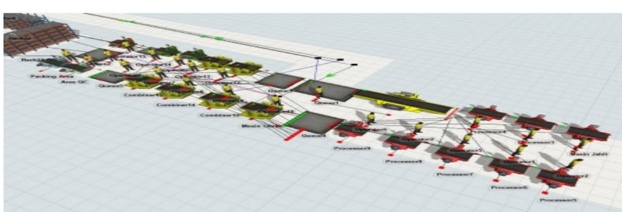

Figure 18. Floor 3 Alternative 1

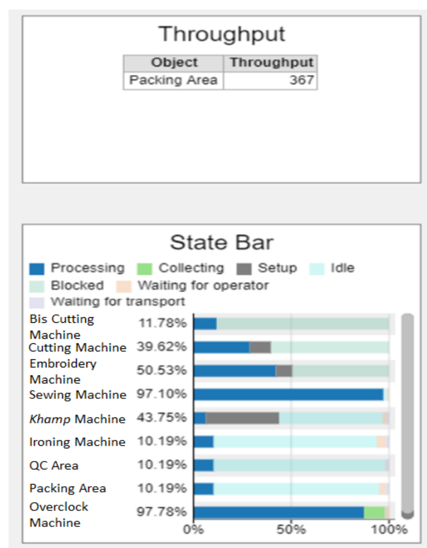

Figure 19. Simulation 1

B. Alternative 1

The following is the 3D design of alternative layout 2 that has been pre-designed, with sufficient Throughput or production quantities produced, and the division of the working process of each machine that works. After the design is done in the Flexsim application, test the layout model with parameters, namely the amount of Throughput or the number of production and the state bar that shows the state of the machine time from start to finish. Run time on the simulation is 10 hours of work. Following is the result of the simulation of alternative layout model 1 on figure 20, 21, and 22.

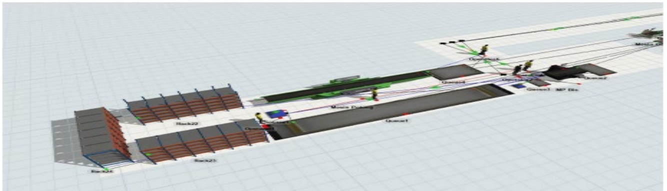

Figure 20. Floor 2 Alternative 2

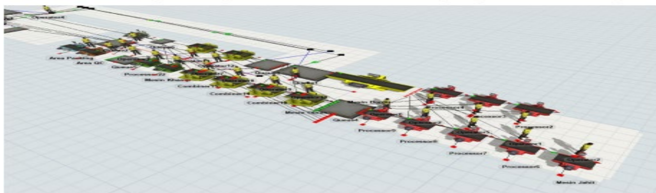

Figure 21. Floor 3 Alternative 3

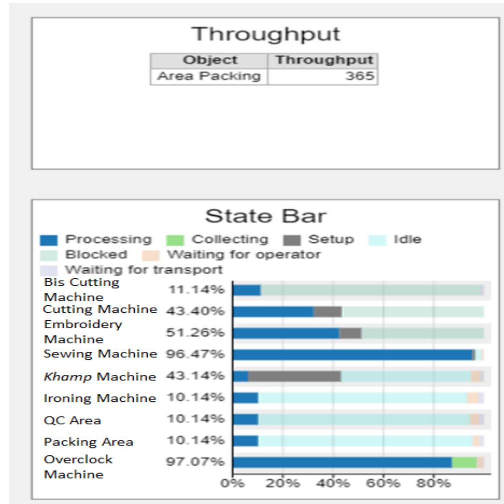

Figure 22. Simulation 2

C. Comparison

From the simulation results that have been carried out, alternative 1 is chosen due to the amount of Throughput that exceeds alternative 2 by 2 piece dress. The main changes are obtained from the flow of the production and the number of machines. The new layout design, resulting in an increase of 11.36% higher than the layout before rearranging (322 Pieces). Another comparison is that the state bar of alternative 1 has the number of products in the MP Bis machine, Sewing Machine, Overlock, Khamp, Rub, QC, and Packing are slightly higher than alternative 2. However, alternative 2 reaches the cutting machine with a higher processing result. In this study, the researcher used the amount of production as the important factor to choose the best alternative as a new design used for the final implementation. Here are the results selection and final layout of the layout design.

5.4 Proposed Improvements

Proposed Improvements of Final layout after Calculations using Systematical Layout Planning and Shared Storage, and the Simulations using Flexsim can be seen in Figures 23.

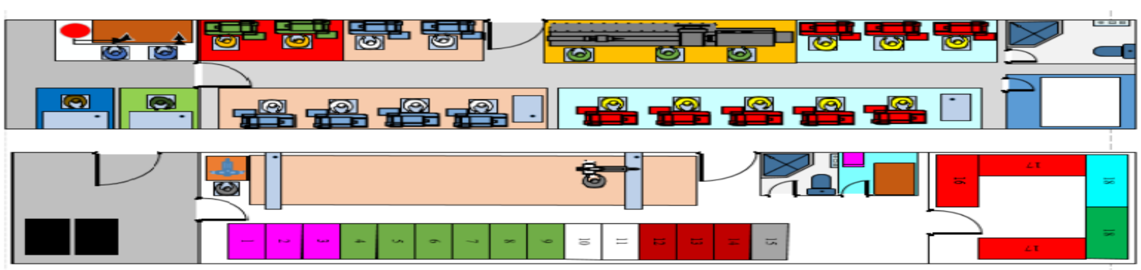

Figure 23. Final Layout

6. Conclusion

This research provides several alternative layout results with the calculation of shared storage and systematic layout planning. The result calculation obtained two alternative design layouts. The chosen design layout is obtained from the number of productions and better simulation results, The output obtained from layout 1 is 367 pieces, more than the result of design layout 2, which is 365 pieces. The average number of products in cutting, Kamp, and ironing machines shows higher results than the average production of alternative 2 which only shows high production in cutting and embroidery machines. The average production time in design layout 1 increased by 6.16% improvement. The simulation results show that Alternative 1 is 11.39% more productive than the initial layout. The results of the warehouse layout using the Shared Storage method. The structure of a warehouse rack using calculations such as Assignment, Throughput, and others For fabrics that have the largest Assignment value, Cotton Printing is 0.92 and the smallest assignment value is Dark Cotton Fabric with 0.01 points. The value of printing cotton fabrics with a high assignment value is placed close to the door to make it easier to handle the material. And for finished materials, the highest Assignment is Jumpsuit with 0.46 points, and the lowest is T-shirt with 0.22, so the Jumpsuit is placed close to the door.

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