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 & Ifitikar, 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](image)

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

<table>
<thead>
<tr>
<th>Action</th>
<th>Amount</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>54.26</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 6. Routing Sheet

3. **MPPC**
The MPPC of this Research can be seen in Figure 7
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.

Figure 7. Multi Product Process Chart

Figure 8. FTC Inflow

Figure 9. FTC Outflow

Figure 10. Relations From To Chart
5. **Activity Relationship Chart**
The Activity Relationship Chart of this Research can be seen in Figure 11.

![Activity Relationship Chart](image1)

Figure 11. ARC

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

![Activity Relationship Diagram Alternative 1](image2)

![Activity Relationship Diagram Alternative 2](image3)

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.

![Area Allocation Diagram Alternative 1](image4)

![Area Allocation Diagram Alternative 2](image5)

Figure 14. AAD Alternative 1

Figure 15. AAD Alternative 2
8. Layout
The Layout Detail of this Research can be seen in Figure 16.

<table>
<thead>
<tr>
<th>No</th>
<th>Material Type</th>
<th>Goods Amount (Roll)</th>
<th>Period (Months)</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White Cotton Cloth</td>
<td>240</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Light Color Cotton</td>
<td>852</td>
<td>6</td>
<td>142</td>
</tr>
<tr>
<td>3</td>
<td>Dark Color Cotton</td>
<td>372</td>
<td>48</td>
<td>7,75</td>
</tr>
<tr>
<td>4</td>
<td>Printed Cotton Fabric</td>
<td>400</td>
<td>1</td>
<td>400</td>
</tr>
<tr>
<td>5</td>
<td>Furing Cloth</td>
<td>24</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>No</th>
<th>Material Type</th>
<th>Goods Amount (Roll)</th>
<th>Pallet Capacity</th>
<th>Space Requirement</th>
<th>Rounding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White Cotton Cloth</td>
<td>240</td>
<td>144</td>
<td>1,666666667</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Light Color Cotton</td>
<td>852</td>
<td>144</td>
<td>5,916666667</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Dark Color Cotton</td>
<td>372</td>
<td>144</td>
<td>2,583333333</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Printed Cotton Fabric</td>
<td>400</td>
<td>144</td>
<td>2,7777777778</td>
<td>3</td>
</tr>
</tbody>
</table>
### 3. Aisle
The Aisle of this Research can be seen in Table 3.

**Table 3. Aisle**

<table>
<thead>
<tr>
<th>Size</th>
<th>Lenght (M)</th>
<th>Wide (M)</th>
<th>Height (M)</th>
<th>Volume (M3)</th>
<th>Area (M2)</th>
<th>Diagonal/Aisle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pallet Size</td>
<td>1,5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1,802775638</td>
</tr>
<tr>
<td>1 Rack Size</td>
<td>2</td>
<td>1</td>
<td>3,5</td>
<td>7</td>
<td>2</td>
<td>2,236067977</td>
</tr>
</tbody>
</table>

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

**Table 4. Throughput**

<table>
<thead>
<tr>
<th>No</th>
<th>Material Type</th>
<th>Goods Amount (Roll)</th>
<th>Period (Months)</th>
<th>requirement</th>
<th>Throughput</th>
<th>Throughput Rounding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White Cotton Cloth</td>
<td>240</td>
<td>15</td>
<td>16</td>
<td>0,111111111</td>
<td>0,1</td>
</tr>
<tr>
<td>2</td>
<td>Light Color Cotton</td>
<td>852</td>
<td>6</td>
<td>142</td>
<td>0,986111111</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Dark Color Cotton</td>
<td>372</td>
<td>48</td>
<td>7,75</td>
<td>0,053819444</td>
<td>0,05</td>
</tr>
<tr>
<td>4</td>
<td>Printed Cotton Fabric</td>
<td>400</td>
<td>1</td>
<td>400</td>
<td>2,777777777</td>
<td>2,77</td>
</tr>
<tr>
<td>5</td>
<td>Furing Cloth</td>
<td>24</td>
<td>6</td>
<td>4</td>
<td>0,027777777</td>
<td>0,02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No</th>
<th>Material Type</th>
<th>Goods Amount (Dozen)</th>
<th>Period (Months)</th>
<th>requirement</th>
<th>Throughput</th>
<th>Throughput Rounding</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Jumpsuit</td>
<td>1656</td>
<td>2</td>
<td>828</td>
<td>1,38</td>
<td>1,38</td>
</tr>
<tr>
<td>7</td>
<td>Shirt</td>
<td>265</td>
<td>2</td>
<td>132,5</td>
<td>0,220833333</td>
<td>0,22</td>
</tr>
<tr>
<td>8</td>
<td>Dress</td>
<td>624</td>
<td>3</td>
<td>208</td>
<td>0,346666666</td>
<td>0,35</td>
</tr>
</tbody>
</table>

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

**Table 5. Assignment**

<table>
<thead>
<tr>
<th>No</th>
<th>Material Type</th>
<th>Throughput</th>
<th>Throughput Rounding</th>
<th>Space Requirement</th>
<th>Space Requirement Rounding</th>
<th>Assignment</th>
<th>Assignment Rounding</th>
</tr>
</thead>
</table>
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.

<table>
<thead>
<tr>
<th>No</th>
<th>Material Type</th>
<th>Throughput</th>
<th>Throughput Rounding</th>
<th>Space Requirement</th>
<th>Space Requirement Rounding</th>
<th>Assignment</th>
<th>Assignment Rounding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White Cotton Cloth</td>
<td>0.111111111</td>
<td>0.1</td>
<td>1.666666667</td>
<td>2</td>
<td>0.055555556</td>
<td>0.06</td>
</tr>
<tr>
<td>2</td>
<td>Light Color Cotton</td>
<td>0.986111111</td>
<td>1</td>
<td>5.916666667</td>
<td>6</td>
<td>0.164351852</td>
<td>0.16</td>
</tr>
<tr>
<td>3</td>
<td>Dark Color Cotton</td>
<td>0.053819444</td>
<td>0.05</td>
<td>2.583333333</td>
<td>3</td>
<td>0.017939815</td>
<td>0.01</td>
</tr>
<tr>
<td>4</td>
<td>Printed Cotton Fabric</td>
<td>2.777777778</td>
<td>2.77</td>
<td>2.777777778</td>
<td>3</td>
<td>0.925925926</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Furing Cloth</td>
<td>0.027777778</td>
<td>0.02</td>
<td>0.166666667</td>
<td>1</td>
<td>0.027777778</td>
<td>0.02</td>
</tr>
</tbody>
</table>

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.
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.

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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Biographies
James Laurent is an Industrial Engineering Student from Tarumanagara University. Born in Jakarta, 15 September 2000 as the first of three siblings. Graduated from Ricci 1 Elementary, Middle, and High School with a major in Science, participated in OSN (National Science Olympiads) in Astronomy and achieved the 5th position of all Jakarta students. Entered Tarumanagara University in 2018 and dream to be a Bussinesman in the future.

Lina Gozali is a lecturer at the Industrial Engineering Department of Universitas Tarumangara since 2006 and a freelance lecturer at Universitas Trisakti since 1995. She graduated with her Bachelor's degree at Trisakti University,
Jakarta - Indonesia. She got her Master's Degree at STIE IBII, Jakarta – Indonesia, and she recently got her PhD at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia, in 2018. Her apprentice college experience was in the paper industry at Kertas Bekasi Teguh, shoe industry at PT Jaya Harapan Barutama and automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects. She researched the Indonesian Business Incubator for her PhD. She has written almost 70 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant Layout, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had worked at PT. Astra Otoparts Tbk before she became a lecturer.

**Carla Olyvia Doaly** is a lecturer in the Industrial Engineering Department at Universitas Tarumanagara graduated with my bachelor's degree from Institut Teknologi Nasional Malang, which study the Industrial Engineering program, then continued my Master Degree at Institut Teknologi Bandung majoring in Industrial engineering and management and a special field of Enterprise Engineering. She is very interested in studying industrial engineering by doing research related to System Design and Engineering, Supply Chain Management, Operations Research and Analysis, Information System Management, Occupational Health and Safety, Facilities Engineering, Quality and Reliability Engineering

**Ricky Farrel** is a Industrial Engineering Student from Tarumanagara University. Born in Tangerang, 20th of April 2003 as the second of two siblings. Graduated from Poris Indah Elementary, Middle, and High School with major in Science, and participated in singing competitions and managed to be finalist. Entered Tarumanagara University in 2021 and dreams to be an Entrepreneur in the future.