Proceeding of International Conference on Multidisciplinary Research for Sustainable Innovation, Vol. 1 No. 1 (2024)
DOI to be assigned soon

Research Paper

Redesign The Layout of Production Facilities at a Garment Company Using the BLOCPLAN Method to Optimize Material Handling

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Received : February 20, 2024	Revised : March 2, 2024	Accepted : March 9, 2024	Online : March 13, 2024

Abstract

Facility layout design is crucial in production layout setups. The composition of facilities that corresponds to the flow of materials between departments will help to ensure the production system's continuity. PT. KMC is a garment company in West Jakarta that manufactures shirts, dresses, and t-shirt bloats. The company's current layout facilities have not run optimally. This is because inefficient movement distances result in wasted material handling costs, and crossing production flows between departments cause production processes to be disturbed. The objective of this project is to rethink facility layouts using the BLOCPLAN approach in order to optimize material handling. The BLOCPLAN approach may examine layout performance and generate new layout ideas for efficient material handling. The discussion is limited because this research was only conducted on one company. Based on the results of the layout redesign using the BLOCPLAN approach, various improvements were obtained, including a 37.12% increase in material handling cost efficiency. The proposed layout with the BLOCPLAN method is able to provide a reduction in material transfer distance of 22.6 meters and a material handling cost of Rp 155,346 when compared to the initial layout, which had a total overall displacement distance of 35.8 meters and an initial layout material handling cost of Rp 247,059, making it much cheaper.

Keywords: *Plant Layout, BLOCPLAN, Material Handling*

INTRODUCTION

A factory layout is an arrangement of physical facilities such as equipment, manpower, buildings, and other facilities with the goal of optimizing the relationship between implementing officers, the flow of goods, the flow of information, and the procedures required to achieve goals effectively, efficiently, economically, and safely (Apple, 1990).

The most important factor to consider when designing a production facility layout is an effective and efficient material transfer system that will provide an orderly sequence of work stations and close material transfer distances in the production process, resulting in a small transfer moment. PT. KMC was founded in 1996 and specialized in the textile business, producing clothes such as shirts and dresses. The company has a production floor area of 450 m2, which is separated into three sections: office, lobby, and manufacturing floor area. PT. KMC is a production method based on orders (job orders), which means that company workers must be time and energy efficient in order to meet the expectations of consumers.

The company is now having difficulty selecting the best facility layout; uneven production layout lengths, such as the 6.65 m between raw material warehouses and cutting work stations, make moving raw materials difficult and inefficient. Another issue is that on the floor of the manufacturing process, there is a flow of moving materials that intersect (cross movement) since the machine layout is less regular. this disrupts the production process. Furthermore, the close relationship between work stations that are not considered causes the flow of material handling to be less optimal, and the material handling used is still manual with operator power, so the distance must be reviewed so that it becomes efficient and optimal.

Layout design studies have been conducted using both traditional methods and software.

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Previous research on layout design includes layout design in culinary business SMIs that use terraces and yards for business, the layout analysis approach used are: Activity Relationship Chart, Activity Relationship Diagram, Activity Template Block Diagram (Henni et al., 2021), layout redesign at Cahaya Bintang Mas company with the Systematic Layout Planning (SLP) method, which resulted in reducing material handling distance by 57.6% (Sunardi et al., 2019), Correcting industrial layout difficulties with the SLP technique (Kumar et al., 2022), and redesigning the layout focusing on the raw material area and production area with the SLP method (Bagaskara et al., 2020), Redesigning the layout at PT Dwi Indah with the BLOCPLAN method, which succeeded in reducing the material handling distance by 55% (Pratama et al., 2015), redesigning the layout with the BLOCPLAN algorithm and the CORELAP algorithm approach, an optimal layout with the BLOCPLAN algorithm resulted in an efficiency value of 88% and an OMH value of Rp 21,205 (Zimartani et al., 2023).

The BLOCPLAN Method was used to rebuild facility layouts in a unique way that included block-based approaches, flexibility, space optimization, compliance to individual needs, efficient grouping, and systematic thinking. The purpose of this study is to redesign the layout of facilities with the BLOCPLAN method that can optimize material handling.

LITERATURE REVIEW

BLOCPLAN methods

The BLOCPLAN (Block Layout Overview with Layout Planning) approach is a hybrid algorithm that classifies algorithms with optimal and sub-optimal properties, also known as improvement algorithms. This method's selection tries to minimize the distance between facilities, resulting in numerous different layouts of suggested facilities. The BLOCPLAN Method will make use of BPLAN90 software.

Donaghey and Pire created BLOCPLAN in 1990. BLOCPLAN employs a relationship diagram. Because the logic of BLOCPLAN employs proximity criteria. Finally, the cost factor can be determined. In the BLOCPLAN idea, the previously generated layout can be modified back to a more optimal configuration based on the layout design. Next, the output of BLOCPLAN contains numerous lines joined, forming a box that represents the region of a department.

The objective of the factory layout is to arrange the work space and all production facilities in the most cost-effective, safest, and comfortable manner possible in order to boost employee morale and performance. The advantages of setting an appropriate layout are that it can make more efficient use of the area, facilitate supervisory activities, increase production output, reduce waiting time, reduce inventory-in-process, shorter manufacturing processes, reduce factors that can affect the quality of raw materials and finished products, reduce risks to employee occupational health and safety, improve morale and job satisfaction, and reduce the process of moving materials (Wignjosoebroto, 2009).

Activity relationship chart

Material flow analysis in facility layout design is more likely to obtain or know the cost of transporting materials, making it more quantitative. A more qualitative analysis in layout design can be used, known as an activity relationship chart (ARC). Muther devised an activity relationship chart, which is a basic tool for planning facility layout.

This method connects activities in pairs so that all activities can determine the level of linkage. The relationship between activities in an organization or company can be viewed in terms of organizational linkages, flow relationships (material flows, equipment, people, information, and financial flows), environmental linkages (security and safety, temperature, noise, lighting, and so on), and process linkages.

Material Handling

The primary goal of material handling is to lower production costs. Here are the sub-objectives in cost reduction:

1. Improve product quality, minimize damage, and protect materials.
2. Improve the working conditions.
3. Increase productivity by ensuring that materials flow in a straight line, move the shortest distance possible, move several materials at once, use automatic material handling, and increase material handling or production ratio.
4. Inventory control

RESEARCH METHOD

This study is a descriptive study that aims to build a more effective and efficient layout as well as optimal material handling. The data was collected through observation, interviews, and a review of the literature. The data collected includes a description of the production process, the area of each department or machine, the plant's area, the distance between facilities, the number of machines, the time of material movement, the initial layout conditions, the amount of production output, the length of production time, and the OPC (Operation Process Chart).

The first step in this study is to create an ARC (activity relationship chart) to determine the degree of closeness and describe the relationship of all existing activities, which includes information about the need for activities to be close to one another as well as the reasons for closeness.

Furthermore, the data is processed with the BLOCPLAN Algorithm. The BPLAN 90 application program will automatically build a layout when you enter all of your data. During this process, the facility's position will change until the ideal facility arrangement is found, but only up to 20 iterations. To select the best alternative facilities, three criteria are used: reference score, layout score, R-Score, and score-distance-relative.

The layout is chosen based on the highest r-score. If the r-scores are the same, the selection moves on to the layout with the highest score. If the score-proximity is identical, the selection is determined based on the smallest relative-distance score (Ristono, 2010).

The layout analysis methodologies employed include the Activity Relationship Chart (ARC), layout score, R-Score, and material handling costs.

In the research redesigned the layout of this facility using the BLOCPLAN method. The stages of research in the BLOCPLAN method using BPLAN 90 software Include:

Identify needs and goals

To comprehend the new layout's production requirements and objectives. It entails determining the products to be created, production volumes, environmental standards, and other pertinent details.

Data Collection

Relevant data should be gathered, including information on production processes, equipment needs, material flows, and other associated requirements.

Area Mapping

Determine the spaces available for layout design. This includes analyzing the area's size and shape, as well as environmental aspects like accessibility and utility.
Identifying block layout coordinate points

Coordinates X = $X_0 + \frac{(X_1 - X_0)}{2}$
Coordinate Y = $Y_0 + \frac{(Y_1 - Y_0)}{2}$
Distance between workstations was determined using the rectilinear distance algorithm. Rectilinear distance formula = $D_{ij} = |x - a| + |y - b|$

Zone Modeling

In BPLAN90, designers use software to generate models of zones or blocks that reflect various sections or functions of the facility. This comprises areas for machinery, storage, production lines, and other activities.

Location Determination

The produced zones are positioned inside the available area based on a previously obtained analysis of needs and constraints. The software allows designers to simply change and rearrange zones to experiment with different layout options.

Optimization

After completing the original layout, an optimization stage is performed to ensure that needs are met and the target efficiency is achieved. BPLAN90 provides optimization functions that assist designers identify the ideal layout solution. The steps done generate layout options (a maximum of 20 alternatives per iteration), and each alternative is selected by R-Score. The alternative layout picked is the one with the closest R-Score value to 1.

Adjency Score (Layout score) is obtained from the results of dividing the total score in the ARC weighting which can be achieved by the overall total score multiplied by 2.

$$\text{layout score} = \frac{\text{total score yang dapat tercapai}}{total\ score\ keseluruhan} \times 2$$

The *rail-disk score is obtained from the sum of all* rail-disk score *values in each department I to department j*

$$\text{Rel} - \text{disk score} = \sum_{i=1}^{n-1} \sum_{j=1-1}^{n} d_{ij} r_{ij}$$

Information:
Dij = Rectilinear distance between facilities i and j
Rij = The value of the proximity relationship between facilities i and j.
The R-score of each possible layout with the best layout is the one with the largest R-score. The R-score is between 0 and 1 ($0 \leq$ R-score ≤ 1).

$$\text{R} - \text{score} = 1 - \frac{\text{rel dist score} - \text{lower bound}}{\text{upper bound} - \text{lower bound}}$$

Lower bound = D21s1 + D20s0 + ….

This indicates that if the value of d (the distance between the lowest facilities) is the lowest, then the highest value of d is multiplied by the lowest value of s.

Evaluation and Correction

The resulting layout model is evaluated to ensure that all issues have been addressed. If needed, the designer can make corrections or adjustments to the layout. Material Handling Cost Determination (BPM):

BPM/ m = (Operating Cost + Labor Cost)/ Total Distance

Total BPM = BPM/ m x Frequency x Interdepartmental Distance

FINDINGS AND DISCUSSION

Initial conditions for the garment company's layout

PT. KMC is a garment firm that makes shirts, dresses, and t-shirts. The current layout has an unorganized production flow or crossing path in the process of moving goods from the raw material warehouse to the pattern making location, and from pattern making to sewing, resulting in a layout that runs crosswise between departments, making material handling inefficient due to the long distance of material movement. Table 1 provides an overview of PT. KMC's floor area and size.

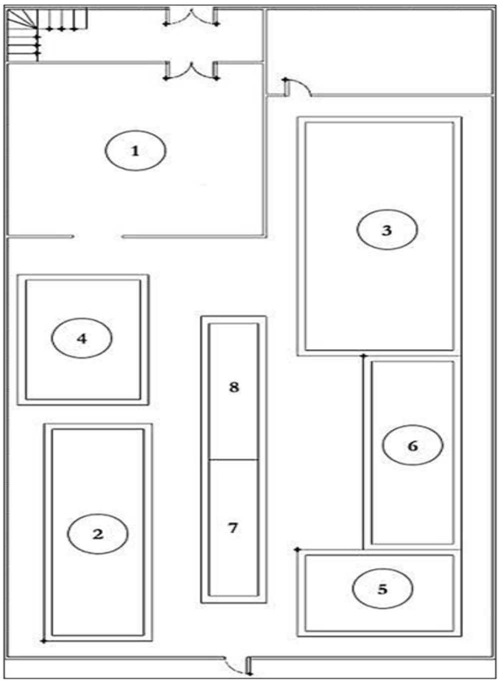
Table 1. Floor Area of PT. KMC

No	Department name	Code area	Length (m)	Width (m)	Area (m^2)
1	Raw material warehouse	A	8	8	64
2	Pattern making and material cutting	B	10	3.3	33
3	Sewing	C	11	5	55
4	Button hole punching	D	6	4	24
5	Rubbing clothes	E	5	4	20
6	Quality Control	F	9	3	27
7	labeling	G	6.6	2	13.2
8	Storage Finished products	H	6.6	2	13.2
					249.4

The distance between departments on the manufacturing floor is determined by calculating coordinate coordinates for each department; the results of this calculation, as well as the basic layout, may be seen in Table 2 and Figure 1.

Table 2. Distance between departments at PT. KMC

Department	Coordinates (m)	
	X	And
1	1,45	8,55
2	1,05	2,2
3	4,2	7,05
4	0,8	5,4
5	4,2	1,1
6	4,5	3,45
7	2,55	2,15
8	2,55	4,55



Information
1. Lobby
2. Office room
3. Raw material warehouse
4. Pattern making and material cutting
5. Sewing
6. Button hole punching
7. Rubbing clothes
8. Quality control
9. Labeling
10. Storage of finished products

Figure 1. *Initial Block Layout* PT. KMC

Table 3. The distance between departments at PT. KMC (meters)

i/j	1	2	3	4	5	6	7	8
1		6,75	4,25	3,8	10,2	8,15	7,5	5,1
2	6,75		8	3,45	4,25	4,7	1,55	3,85
3	4,25	8		5,05	5,95	3,9	6,55	4,15
4	3,8	3,45	5,05		7,7	5,65	5	2,6
5	10,2	4,25	5,95	7,7		2,65	2,7	5,1
6	8,15	4,7	3,9	5,65	2,65		3,25	3,05
7	7,5	1,55	6,55	5	2,7	3,25		2,4
8	5,1	3,85	4,15	2,6	5,1	3,05	2,4	

Determination of initial material handling costs in clothing production at PT. KMC can be seen in table 4 below.

Table 4. The initial material handling cost of PT. KMC

From (Code Area)	To (Code Area)	Component Name	Type of Raw Material	Total Weight (kg)	Transport Equipment	Frequency per day	Distance	OMH/m (Rp)	Total OMH (Rp)
A	B			25	Manual	2	6.75	1397	18859.5
B	C			25	Manual	2	8	1397	22352.0
C	D		Fabric material	2.7	Manual	7	5.05	1397	49384.0
D	E	Shirt		2.7	Manual	7	7.7	1397	75298.3
E	F			2.7	Manual	7	2.65	1397	25914.4
F	G			2.7	Manual	7	3.25	1397	31781.8
G	H			2.7	Manual	7	2.4	1397	23469.6
Total				**63.5**			**35.8**		**247059**

Figure 2 depicts the shirt production process at PT. KMC, beginning with fabric raw materials in the form of designs and ending with shirt packing.

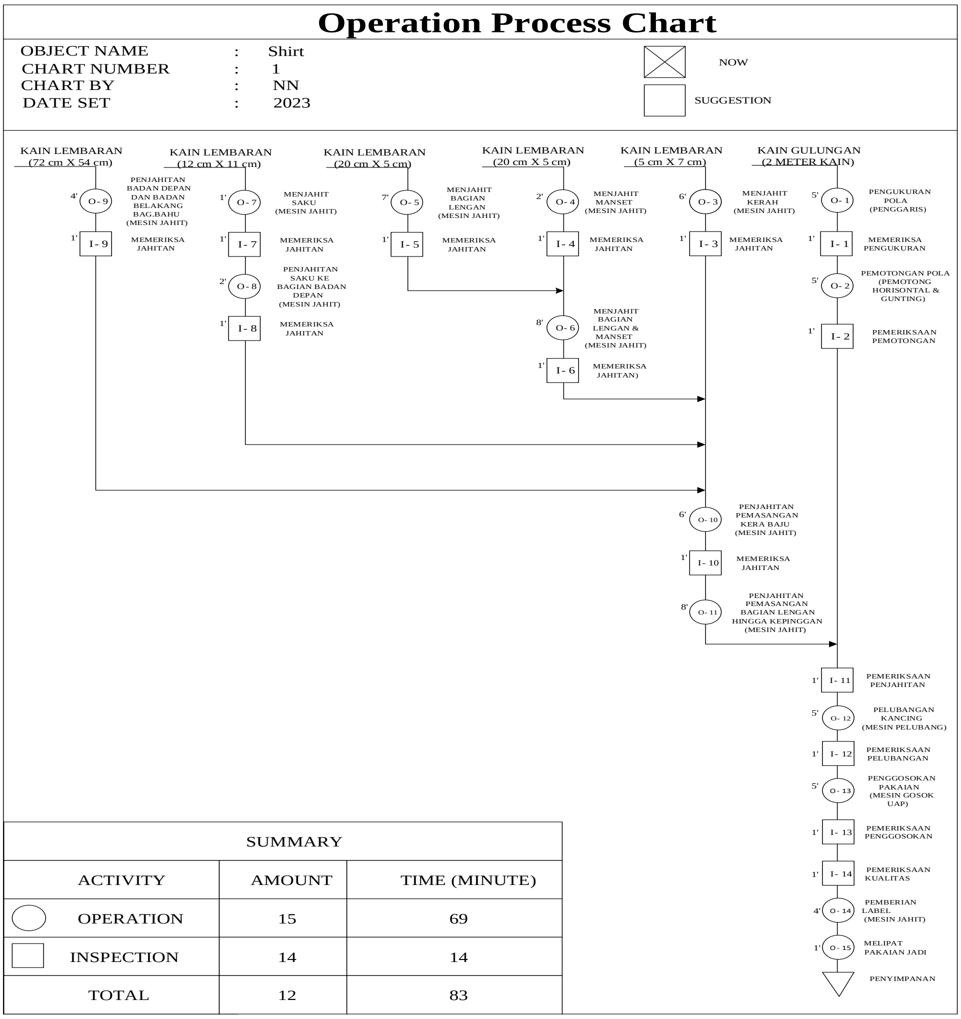
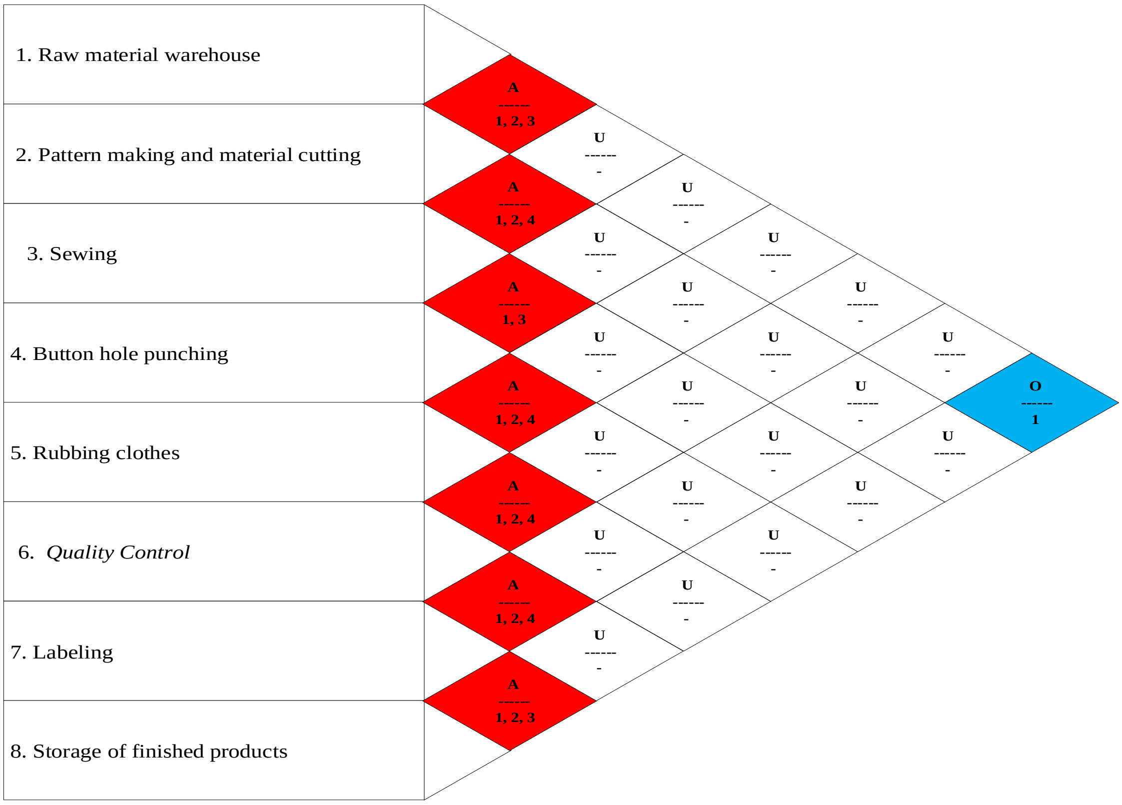


Figure 2. Chart of the process of shirt making operations at PT. KMC

Results of reworking the layout of the garment company using the BLOCPLAN approach

The BLOCPLAN Algorithm requires two inputs: the area of each workstation and an activity relationship chart (ARC). Table 1 shows the size of each workstation, while Figure 3 shows the ARC.

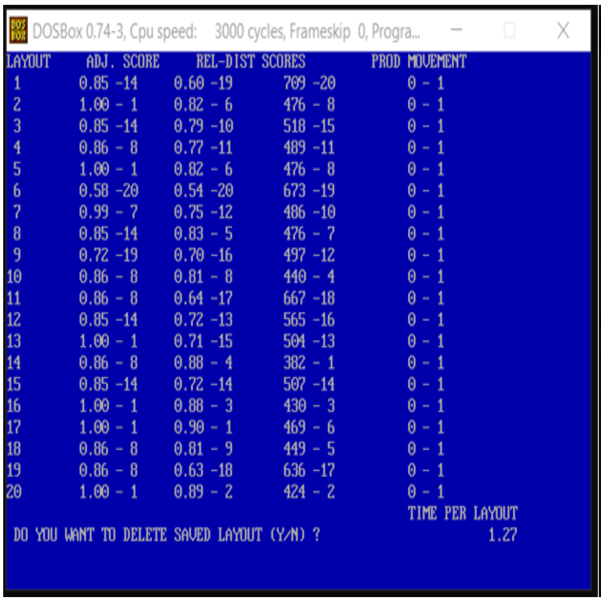


REASON CODE	DESCRIPTION OF REASON	COLOR CODE
A	Relationships are absolutely necessary	red
E	Relationships are very important	Yellow
I	Relationships matter	Green
O	Casual/common relationships	Blue
U	Relationships don't matter	White
X	Unwanted relationship	Chocolate

REASON CODE	DESCRIPTION OF REASON
1	Ease of supervision
2	Work flow
3	Using the same workforce
4	Employee transfer

Figure 3. Activity Relationship Chart at PT. KMC

The outcome of redesigning the layout with BPLAN90 software in the form of alternative layouts and R-score values, based on user preferences (maximum 20 possibilities). Each department will be randomly assigned to a specific plan area. BPLAN90 will present each possible plan, along with its score. The optimal layout can be determined by the R-score value that is closest to 1. If the value is near to 1, it can be offered as the best choice.



DOSBox 0.74-3, Cpu speed: 3000 cycles, Frameskip 0, Progra...

LAYOUT	ADJ. SCORE	REL-DIST SCORES		PROD MOVEMENT
1	0.85 -14	0.60 -19	709 -20	0 - 1
2	1.00 - 1	0.82 - 6	476 - 8	0 - 1
3	0.85 -14	0.79 -10	518 -15	0 - 1
4	0.86 - 8	0.77 -11	489 -11	0 - 1
5	1.00 - 1	0.82 - 6	476 - 8	0 - 1
6	0.58 -20	0.54 -20	673 -19	0 - 1
7	0.99 - 7	0.75 -12	486 -10	0 - 1
8	0.85 -14	0.83 - 5	476 - 7	0 - 1
9	0.72 -19	0.70 -16	497 -12	0 - 1
10	0.86 - 8	0.81 - 8	440 - 4	0 - 1
11	0.86 - 8	0.64 -17	667 -18	0 - 1
12	0.85 -14	0.72 -13	565 -16	0 - 1
13	1.00 - 1	0.71 -15	504 -13	0 - 1
14	0.86 - 8	0.88 - 4	382 - 1	0 - 1
15	0.85 -14	0.72 -14	507 -14	0 - 1
16	1.00 - 1	0.88 - 3	430 - 3	0 - 1
17	1.00 - 1	0.90 - 1	469 - 6	0 - 1
18	0.86 - 8	0.81 - 9	449 - 5	0 - 1
19	0.86 - 8	0.63 -18	636 -17	0 - 1
20	1.00 - 1	0.89 - 2	424 - 2	0 - 1

TIME PER LAYOUT 1.27

DO YOU WANT TO DELETE SAVED LAYOUT (Y/N) ?

Figure 4 shows the R-Score value of 20 potential layouts

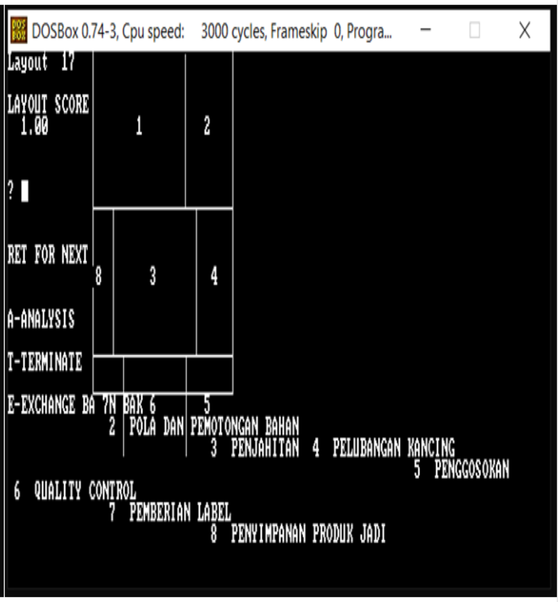


Figure 5: Alternative Layout 17 (Selected Layout).

The results of the 17th iteration obtained the layout of the production floor of PT. KMC then draws a block layout to calculate the total moment of displacement. The selected alternative layout can be seen in Figure 7 below.

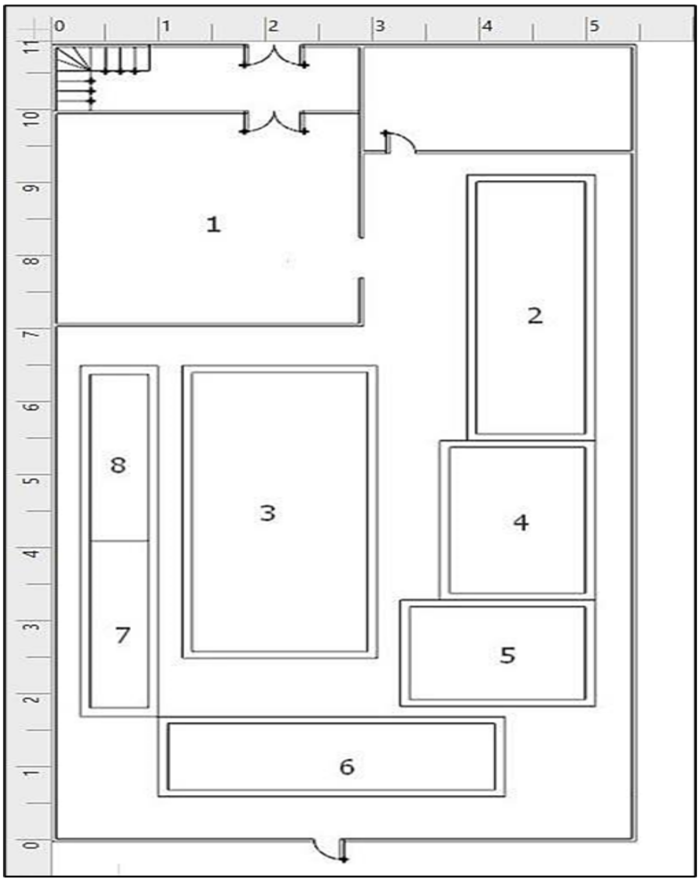


Figure 7. Block layout selected PT. KMC

Table 5 shows the distance traveled from each industrial step. The distance value is used to determine the material handling costs for the proposed arrangement. The distance figure after making layout changes was 22.6 meters.

Table 5. The distance between departments of the proposed layout at PT. KMC (meters)

i/j	1	2	3	4	5	6	7	8
1		4.3	4.8	6.95	8.7	8.6	6.4	4
2	4.3		5.1	3.05	5	8	8.2	5.8
3	4.8	5.1		2.15	3.9	3.8	3.1	2.3
4	6.95	3.05	2.15		1.95	4.95	5.15	4.45
5	8.7	5	3.9	1.95		3	3.8	6.2
6	8.6	8	3.8	4.95	3		3.7	6.1
7	6.4	8.2	3.1	5.15	3.8	3.7		2.4
8	4	5.8	2.3	4.45	6.2	6.1	2.4	

Material handling costs will be used to determine the recommended layout, and a total material handling cost of IDR 155,346 will be obtained. Table 6 displays the comprehensive material handling cost calculation findings.

Table 6. The cost of handling material layout proposals at PT. KMC

From (Code Area)	To (Code Area)	Component Name	Type of Raw Material	Total Weight (kg)	Transport Equipment	Frequency per day	Distance	OMH/m (Rp)	Total OMH (Rp)
A	B	Shirt	Fabric material	25	Manual	2	4.3	1397	12014.2
B	C			25	Manual	2	5.1	1397	14249.4
C	D			2.7	Manual	7	2.15	1397	21024.9
D	E			2.7	Manual	7	1.95	1397	19069.1
E	F			2.7	Manual	7	3	1397	29337.0
F	G			2.7	Manual	7	3.7	1397	36182.3
G	H			2.7	Manual	7	2.4	1397	23469.6
Total				**63.5**			**22.6**		**155346**

The condition of the initial production floor at PT. KMC has several departments that are not in accordance with the order of the production process; there are several departments that should be close together but are actually located far apart, increasing the number of material transfer points. A department that is located far apart is the storehouse of raw materials for patterning and cutting. These two stations should be near together since they share a relationship in the form of a series of production processes. This results in a high number of displacement moments, totaling 35.8 meters and costing the corporation Rp 247,059.

CONCLUSIONS

The layout provided by PT. KMC shows that various departments' locations have changed from the initial layout; nevertheless, the raw materials department has not changed. Changes in departments would effect the distance between departments; in the initial layout, the total total distance is 35.8 meters, however in the suggested arrangement, it is 22.6 meters. This modification in total distance between workstations resulted in a 13.2-meter reduction. Redesigning the layout at PT. KMC utilizing the BLOCPLAN approach resulted in material handling costs of Rp 155,346.00, with a material transfer distance of 22.6 meters and a material handling efficiency of 37.12 percent.

LIMITATION & FURTHER RESEARCH

Although the BLOCPLAN technique can be used to rebuild facility layouts in a systematic, effective, and efficient conduct, this study focuses on a single small and medium-sized firm. The

BLOCPLAN technique was employed primarily in this study to redesign an effective and efficient layout as well as optimal material handling in a shirt and dress manufacturing facility. Future research should include comparison approaches like as CRAFT (Computerized Real Allocation of Facilities Techniques) or genetic algorithms to attain the highest ideal facility architecture for companies.

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