ISSN 2087-3336 (Print) | 2721-4729 (Online)
TEKNOSAINS: Jurnal Sains, Teknologi dan Informatika
Vol. 11, No. 2, July 2024, page. 373-378
http://jurnal.sttmcileungsi.ac.id/index.php/tekno
DOI: 10.37373

Warehouse material handling layout planning using the activity relationship chart method and blocplan 90

*** Syahreen Nurmutia**

* Industrial Engineering Department, Universitas Pamulang, Jl. Surya Kencana No.1, Pamulang, Tangerang, Banten

*✉ dosen02440@unpam.ac.id

Submitted: 27/04/2024 Revised: 04/06/2024 Accepted: 11/06/2024

ABSTRACT

This research aims to plan the layout of material handling in a warehouse using the Activity Relationship Chart (ARC) method which is supported by the application of Blocplan 90. In warehouse management, the layout of material handling plays a crucial role in operational efficiency and productivity. The ARC method is used to identify relationships between activities in the material handling process and Blocplan 90 is used as a tool to optimally arrange the warehouse layout. This research will involve analysis of various material handling activities, including storing, picking, and moving goods. By paying attention to the interrelationships between activities revealed by ARC, this research will produce layout recommendations that can increase efficiency, reduce travel time, and minimize the risk of accidents and damage to goods. It is hoped that the results of this research can provide practical guidance for warehouse planners to improve operational performance and optimize the use of storage space. Thus, this research provides a significant contribution in the context of logistics management and operational efficiency in warehouses. The results of this research show that there is a difference in OMH produced in the selected proposed layout, namely IDR 23,748/day from IDR 49,085/day. This shows that there is a reduction in OMH of 52%.

Keywords: Warehouse; activity relationship chart; blocplan 90

1. INTRODUCTION

The layout is a plan that determines the arrangement of economic centers for each different process facility, as well as the location of physical resources in product manufacturing [1]. A company's long-term operational efficiency is greatly influenced by an effective layout, which supports differentiation, low cost, and responsive strategies [2]. Workspace arrangement that takes into account good design principles guarantees a high level of efficiency and productivity for employees [3]. This includes the arrangement of workstations and equipment to move work or materials through the system [4]. Decision-making regarding layout and location is very important in determining long-term operational efficiency, with the main aim of optimizing the arrangement of production machines and equipment [5]. The production process in industry converts raw materials into finished or semi-finished goods for consumers, and production management is responsible for creating added value with minimal production costs meeting market demand and following the latest developments according to consumer needs. Companies that can install, organize, and manage production equipment and equipment are classified as companies with good layouts, thereby contributing to reducing material transportation time and material transportation costs, increasing facility output, and increasing business activities.

Currently, problems and regulatory irregularities that occur in the product process affect imperfect material flow. Planning the layout of warehouse material handling is a key aspect of warehouse operational efficiency. Good arrangement can optimize space, increase productivity, and reduce operational costs [6], [7]. The Activity Relationship Chart (ARC) method has been proven effective in planning an efficient layout by taking into account the relationship between activities in the warehouse [2]. Meanwhile, the use of Blocplan 90 as a tool in implementing the ARC method adds a dimension of practicality and accuracy in determining the layout of warehouse material handling.

In the context of this research, it is important to understand the basic concepts of warehouse material handling layout planning and how the ARC method works in analyzing and planning the layout [8]. ARC helps in identifying and mapping relationships between various activities in the warehouse, such as receiving goods, storing, picking goods, and shipping. This information is then used to design optimal layouts, minimizing goods movement and reducing waiting times. Blocplan 90 is the latest technology that allows visualization of warehouse layouts in three dimensions with a high degree of accuracy [9]. The use of Blocplan 90 as a support for the ARC method is expected to speed up the planning process, increase calculation accuracy, and enable better simulations in predicting system performance [10].

Through this research, it is hoped that practical guidance can be obtained for planning the layout of warehouse material handling using the ARC method which is strengthened by the use of Blocplan 90. In this way, companies can optimize the use of warehouse space, increase productivity, and reduce operational costs effectively. This research aims to plan the layout of material handling in a warehouse using the Activity Relationship Chart (ARC) method which is supported by the application of Blocplan 90.

2. METHODS

This type of research is a type of mixed method research, namely a combination of quantitative and qualitative [11], [12]. The type of data obtained in this research is primary data, which is data obtained from direct observation in the field, related data is the process flow in the warehouse, the area of each facility, and the distance moved for each process. Secondary Data is data collected from company documents or archives related to employee salaries, and daily and monthly production schedules, as well as the results of interviews with related parties and also from journals and articles related to previous research.

Activity relationship chart (ARC)

An activity relationship chart (ARC) is a simple technique used in designing the layout of department facilities based on the degree of activity relationship. This approach generally uses qualitative assessments and considers factors that are subjective to each facility or department involved. The main purpose of ARC is to help determine which activities should be efficiently located close together within a department or facility [13]. ARC determines the relationship between machines/test facilities discusses and interviews with test operators. Relationships between facilities are often interpreted as requiring proximity. If two machines/facilities have a strong relationship, then these machines/facilities need to be placed close to each other. The value of a close relationship is determined based on the degree of closeness [14].

Blocplan 90

Blocplan 90 is a software program developed by Donaghey and Pire in 1991 to optimize facility layout [15]. This program focuses on developing spatial planning with the ability to handle data in both quantitative and qualitative forms. Blocplan 90 uses algorithms to solve facility layout problems and can process quantitative data as well as qualitative data [16]. Blocplan-90 is used to design factory layouts for all production department facilities. This Blocplan requires activity relationship chart (ARC) data between departments. The results obtained from designing the facility layout using BLOCPLAN showed several alternative facility layouts that could be selected based on three types of existing criteria, namely *adjacency score*, *R-score,* and *product movement* [17].

3. RESULT AND DISCUSSION

In the Buffing Panel UP work group, there are currently 17 workstations which are sorted and coded with letters of the alphabet. The following is the initial layout of the UP-Buffing Panel working group, which can be seen in Figure *2*. The x symbol in Figure *2* is a workstation that is not optimal in terms of proximity to other stations, so changes to the layout need to be made.

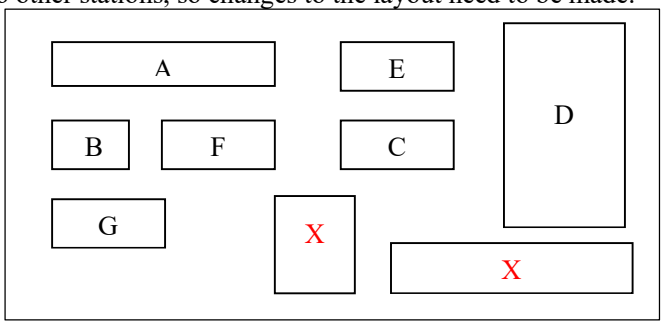

Figure 1**.** The initial layout of the warehouse

To complete the initial layout information in Figure 1, below is data which is a description of each workstation and its area which can be seen in Table 1.

Table 1**.** Area of each facility

No	Code	P (m)	L (m)	Square (m²)
1	A	17.30	1.57	27.16
2	B	2.69	1.17	3.15
3	C	2.69	1.17	3.15
4	D	6.04	1.92	11.60
5	E	4.73	1.51	7.14
6	F	5.72	1.46	8.35
7	G	5.72	1.46	8.35

Material Handling Costs (OMH)

Based on the OMH calculation per meter, it can be used to calculate the overall material handling costs for the initial layout. The following is the overall OMH calculation in the initial layout which can be seen in Table 2.

Table 2**.** Initial OMH layout

From	Frequency per day	Distance (m)	Distance/day	OMH/day (Rp)
A-B	28	5,8	38,4	Rp8,99
A-D	10	5,1	60,7	Rp1,80
A-F	9	8,3	114,5	Rp2,92
B-A	17	14,1	244,4	Rp6,36
B-G	8	14,2	172,8	Rp4,33
C-F	15	8	180,4	Rp3,15
C-G	15	12,2	144,4	Rp3,60
D-A	15	4,4	53,8	Rp1,35
D-C	8	4,2	54,8	Rp1,35
Total		76,3	1064,2	33,835

Blocplan 90

Data processing using blocplan 90 software was carried out to find alternative solutions to computerized layout design. The process of using the Blocplan 90 software can be described as follows: 1) Enter department data and room area. Users are asked to enter data about the departments

in the company along with the space of each department. 2) Enter close relationship data (Activity Relationship Chart). Users are also asked to enter close relationship data between departments based on the Activity Relationship Chart (ARC). ARC is a diagram that shows the relationship between departments in terms of adjacent needs or interactions. 3) Creating alternative layouts. After the input data has been entered, the Blocplan 90 software will generate several alternative facility layouts based on the algorithm used. Each layout alternative will be assessed based on the highest score in the r-score table, which will then be identified as the best layout alternative.

To optimally select the proposed layout, this research will carry out the search process for alternative layouts using blocplan software 3 times. The search procedure is the same as previously explained, where the results that will be obtained will be taken into consideration in selecting the best-proposed layout.

Analysis of the proposed layout

Layout of the 1st proposal

In the first proposed layout, after calculating the moving distance and calculating the material handling costs using the method previously explained, we get the moving distance with the cost of each move in Table 3

Table 3. Calculation of distance and OMH 1st proposal

From	Frequency per day	Distance (m)	Distance/day	OMH/day (Rp)
A-B	28	4,3	123,2	Rp2,99
A-D	14	5,5	63,2	Rp1,91
A-E	14	8,1	222,1	Rp2,84
B-F	18	1,6	30	Rp731
B-G	9	4,8	42	Rp1,08
C-H	14	4,5	64,2	Rp1,59
C-I	14	5,2	72,3	Rp1,82
D-C	14	0,4	5,2	Rp130
E-C	14	3	43,2	Rp1,06
Total		37,4	665,4	Rp874,30

Based on the calculations in Table 3, it can be seen that the overall OMH for the proposed layout is Rp. 874.30 with a total distance traveled per day of 665.4 m.

Layout of the 2nd proposal

In the second proposed layout, after calculating the moving distance and calculating the material handling costs using the method previously explained, we get the moving distance with the cost of each move in Table 4.

Table 4. Calculation of distance and OMH 2nd proposal

From	Frequency per day	Distance (m)	Distance/day	OMH/day (Rp)
A-B	28	9,9	138	Rp3,46
A-D	10	3,9	70,4	Rp1,77
A-F	9	1,9	17,4	Rp436
B-A	17	0,1	2,1	Rp53
B-G	8	5,1	71,5	Rp1,79
C-F	15	2,2	39,1	Rp980
C-G	15	3,2	28,4	Rp713
D-A	15	4,3	21,3	Rp534
D-C	8	14	3	Rp 43,2
Total		44,6	391,2	Rp2,766

Based on the calculations in Table 4, it can be seen that the overall OMH for the proposed layout is IDR 2,766.22 with a total distance traveled per day of 44.6 m.

Comparative evaluation of the initial layout and the proposed layout

Based on the previous calculations of distance and material handling costs, a comparison of the analysis results was carried out between the initial layout and the proposed layout based on the results of the blocplan software, which can be seen in Table 5.

Table 5. Comparison of initial layout and proposed layout

Layout	Distance (m)/ day	OMH/day
Initial Layout	1064,2	Rp 33,835
First Layout	37,4	Rp 874,30
Second Layout	44,6	Rp 2.766

Table 5 it can be seen that there is a difference in reduction between the initial layout and the proposed layout. Based on these calculations, the distance traveled and OMH which have the largest reduction percentage values are in the 2nd proposed layout. A clearer comparison between the initial layout and the selected proposed layout can be seen in Table 6.

Table 6. Comparison of initial layout and selected proposed layout

Layout	Distance (m)/ day	OMH/day
Initial Layout	1064,2	Rp33,84
Selected Layout	44,6	Rp2,766
Efficiensy	1019,6	Rp31,07

Based on data processing and analysis, the results of this research suggest implementing the selected proposed layout from Blocplan software in the warehouse section. The value of the difference in savings between the initial layout and the selected layout is the travel distance of 1019.6 m per day and the value of material handling costs of IDR 31.07 per day. The following layout of the selected proposals can be seen in Figure 2

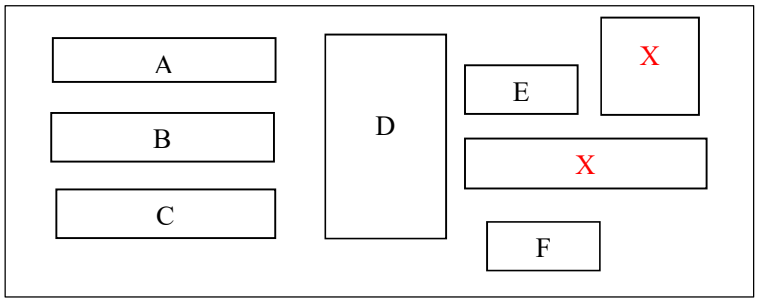

Figure 2. Layout of selected proposals

4. CONCLUSION

Based on the results of research on the layout of facilities in the Raw Materials Warehouse group, it can be concluded that the layout of the Raw Materials Warehouse facilities is still less than optimal, this can be seen in the problem of accumulation of goods because this causes the production flow to be hampered due to blocked roads to enter the next process. The research results show that this method can take into account the relationships between activities more systematically, allowing for optimal placement of handling facilities and equipment, as well as reducing time and costs in the material handling process. Based on the initial layout, the distance traveled/day is 1064.2, and material handling costs are IDR 33.84, in the proposed layout with 6b bvr, the distance is 4.6 m/day with material handling costs IDR 2,766. Thus, this research makes to important contribution in improving warehouse operational efficiency.

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