Computerized Relative Allocation of Facilities Techniques (CRAFT) Algorithm Method for Redesign Production Layout(Case Study: PCL Company)

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Abstract

PCL Company is a Small - Medium Enterprises industry engaged in the printing sector in Indonesia. The PCL company's production floor's layout problem is crossing production lines. It can hinder workers from doing production, and the long-distance between machines creates an alternating current which causes time and energy to be wasted in moving materials. Workers are hampered and make long distances. This research aims to redesign the production layout to improve the production flow and minimize material handling distances in the production process in Printing. Data processing is carried out using (CRAFT). The CRAFT method is done by swapping areas in the initial layout to find a better solution based on the Activity Relationship Chart (ARC). The area exchange on the ARC will lead to a layout close to the minimum material handling distance. The result of the calculation of material handling for the prefix layout is 20,432 meters. Alternative Layout 1 has a material transfer distance of 5,849 meters, while alternative 2 has a material transfer distance of 7,095 meters. Alternative layout one was chosen as the best proposal because it has the smallest total material transfer distance. After that, the selected alternative proposed layout is used for the initial layout in the craft method processing. After processing the data using the CRAFT method, the optimal proposed layout is obtained.

Keywords

Activity Relationship Chart (ARC), Alternative Layout, Computerized Relative Allocation Facilities Technique (CRAFT), Layout design, Material Handling.

1. Introduction

One way to increase production productivity is to improve the components of production machines or the layout of factory facilities. The layout of the settings is related to the change from input to output. An effective and efficient layout is demonstrated by no backtracking, less overall material transfer, and no bottlenecks in the process. An effective and efficient layout helps reduce production cycle times, idle time, bottlenecks or material handling time and can increase production output, so the layout of production facilities must be done to help smooth the production process.

PCL Company is an industry in Indonesia for Small and Medium Enterprises engaged in the printing sector. The printery has some machinery, including glue binding, cutting, and GTU printing tools. Every month, a defined production goal is established for custom chart items. With a typical processing time of 10 minutes for each bespoke folder sheet, it processes 2500 sheets every month. Based on a direct inspection of the printing location, several problems were found, which can be seen in Figure 1, a layout image of PCL Company that there are still production line crossings that can be seen hindering workers in carrying out production. The distance between machines is far

so that it creates alternating currents. This causes time and energy to be wasted in moving materials, hindering workers and making longer distances. The next problem is the pile of leftover material, the buildup occurs on the production floor on the blue line on the layout, which causes the production floor to become narrow, and the operator is less flexible in carrying out production activities

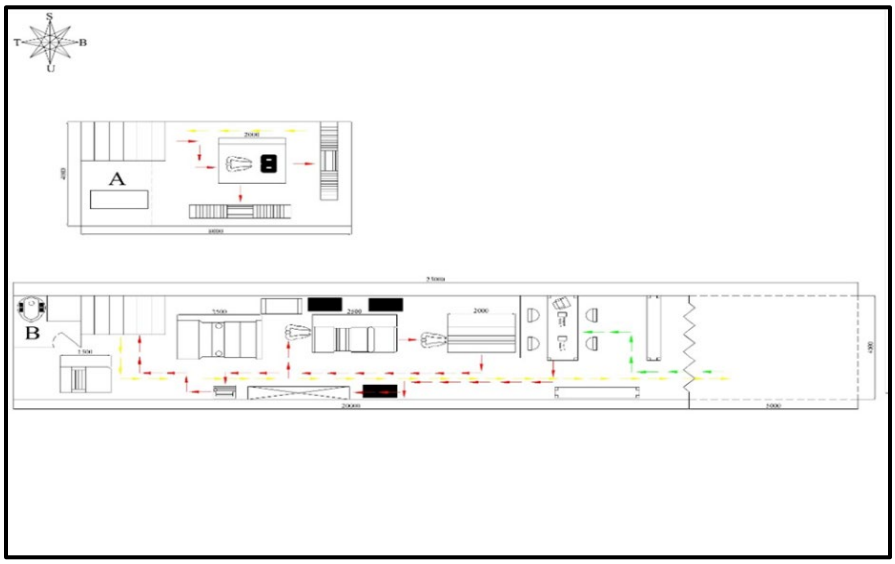

Figure 1. Initial Layout of PCL Company

Due to the condition of the production floor and the long distances required for material handling, it is necessary to redesign the layout at the printing facility continuously. This redesign is necessary based on Appel's (1990) Principle of Minimum Distance, which dictates that the layout be as close to one another as possible to reduce material handling distances. One method that can be used to overcome material handling problems in the PCL Company production process is the CRAFT (Computerized Relative Allocation Facilities Technique) method. The use of this method is because the CRAFT method is a method used to find improvements and optimum design by making improvements to the layout gradually. In addition, CRAFT evaluates the layout by exchanging departmental locations. Research by Yuliana, et al (2017) proves that the design of the facility layout using the CRAFT method can reduce material handling distances

1.1 Objectives

The goal of this study is to layout the PCL Company's production floor more efficiently than it currently is. In addition, the layout design is carried out to enhance the production flow that traverses the floor and further reduce the distance of material handling on the production floor of brilliant sustainable Printing.

2. Literature Review

Facility layout design is one factor that affects a company's performance in supporting production. Businesses today face increasingly difficult challenges. To stay competitive, they need to improve efficiency (Suhardi et al. 2019). Facility layout planning involves physically arranging all the factors of production that improve the production system so that it can be appropriate and efficient in following the organization's strategic objectives. As part of the business operational strategy, the layout is considered one of the most important design decisions (Gosende et al. 2021).

A good facility layout is directly related to the material handling cost. Therefore, the objective function value used to evaluate the layout configuration is also related to the movement between departments. Some distance existing measurements, The rectilinear distance consists of the absolute distance between the two reference points of the section on the x and y axes. On the contrary, the Euclidean distance is the shortest diagonal distance (Kim and chae 2019).

Arc is a pattern of material that can be calculated quantitatively by comparing the degree of closeness between each other's areas (departments) (kolo et al. 2021). An Activity Relationship Chart (ARC) is needed to convert quality into quantity. The ARC setting is determined using the relationship level and interdepartmental reasons. ARC is varied by providing a code based on values and reasons for inter-departmental relationships.

FTC or travel chart is commonly used in manufacturing processes and plant and material planning. The chart is useful when there is a lot of material movement in an area (Chaerul et al. 2021). An activity Relationship chart is a simple technique for planning a facility or department layout based on the relationship between activities. Activity relationship charts are often presented as "qualitative" assessments and tend to be based on subjective judgments (Tampubolon et al. 2020).

Computerized Relative Allocation of Facilities Techniques (CRAFT) is an improvement program that aims to optimize the design by progressively improving the layout. CRAFT assesses facilities with interchangeable departmental locations. Processing of the CRAFT method is carried out using the winsQSB software. The type of exchange carried out is the exchange of two departments using a distance measurement type, namely rectilinear distance. The reason for using this type is because the initial layout used has been redesigned from the initial layout, so it only requires slight improvements to get an optimal layout (Siska and Risman 2017).

According to Yuliana et al. (2017) the principle of departmental exchange based on the CRAFT method must meet one of the following three conditions, namely:
1. The departments must have the same border.
2. Departments must be the same size.
3. The department must have both borders - the same border on all three departments.

The stages in the CRAFT method, according to Yuliana et al. (2017):
1. Make a chart of the relationship between activities/ARC. The activity relationship chart is intended to determine the close relationship between departments.
2. Conduct departmental exchanges based on the /ARC activity relationship chart. According to the CRAFT method, exchanges between departments meet at least one of the three principal requirements of the departmental exchange.
3. Calculate the midpoint of each block. Departmental changes due to exchange will change the central coordinates of the department concerned. The central coordinates of the non-rectangular departments are partitioned into rectangular partitions, so the calculation process is obtained.
4. Calculate the floor area of each block.
5. Create an FTC distance chart.

3. Methods

The research was conducted at PCL Company located on Jl. KH. Ahmad Dahlan No. 43. Central, Sukajadi district, Pekanbaru City. This research applies the CRAFT algorithm with the help of WinQSB 2.0 software. The following is a chart of the research stages from beginning to end:

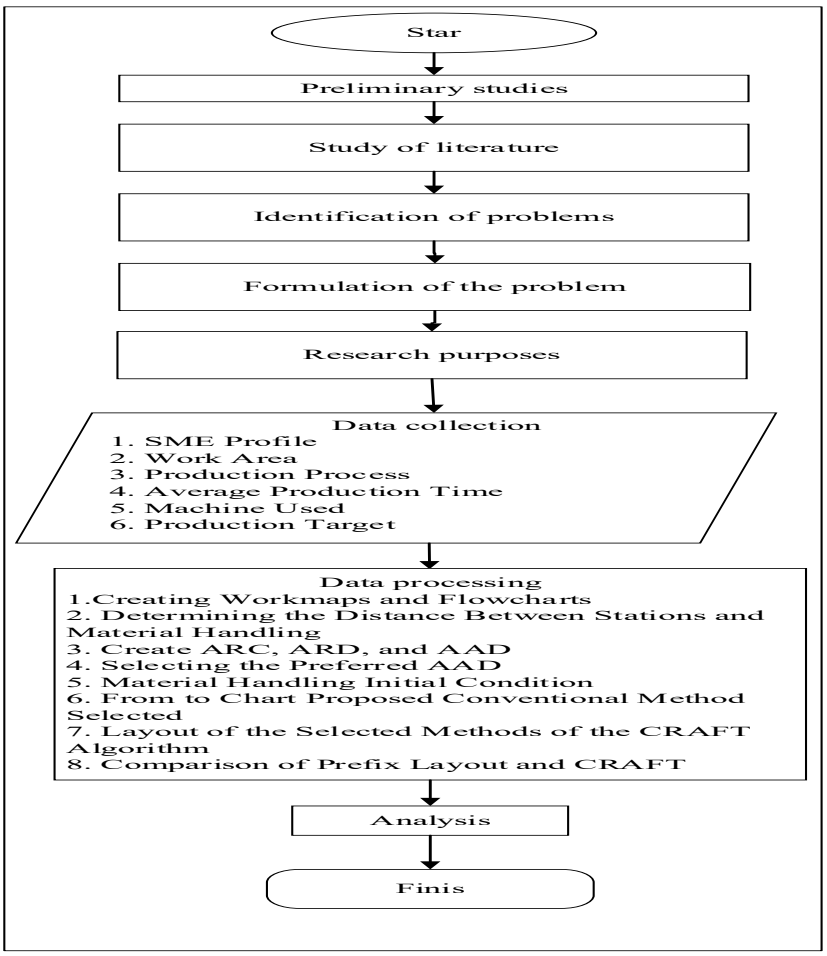

Figure 2. Flowchart Research

The explanation of Figure 2 is as follows:

1. This preliminary study is the initial stage of research, the data obtained in the form of data to support such as prefix layout data, average operating time, and material handling distances, planning and layout design of PCL Company facilities
2. Contains reviews and explanations of useful theories to help solve problems in the planning and design of PCL Company facilities
3. Based on data from research and theoretical foundations, the problems that can be seen are the distance between machines that are far so that material handling is large. Crossover occurs during production. The distance between machines is far so that it creates an alternating current which causes time and energy to be wasted in material transfer
4. The formulation of the problem obtained is how to redesign the layout of the production facility to minimize material handling on the production floor of PCL Company using the CRAFT method.
5. Based on the results of the preliminary survey conducted, it is known that the main issue of this survey is how to take steps to get the optimal layout proposal for the production floor
6. Data collection for this research was conducted using interview techniques and direct measurements in the field. Interviews are conducted with employers, employees, and other parties who can provide information orally or in writing
7. The resulting data is used as auxiliary data and initial data in designing the layout of the PCL Company facility using the Craft Method (Computerized Relative Allocation Facilities Technique).
8. Data analysis in this study is defined, including basic data analysis, human resource planning analysis, spatial planning requirements analysis, operation alignment, up to calculations, length of proposed processing arrangement, and analysis results comparing the prefix layout and the selected layout proposal of the CRAFT method.

9. The final stage is concluding and making recommendations. The conclusions drawn include the results of the design and analysis of the survey results. This conclusion must be adapted to the research objectives. The suggestions given should be constructive for the next level of improvement

4. Data Collection

In this study, the company took part, and PCL Company conducted direct observations of the company's production data, production capacity, number of machines, machine sizes, production sites, and supporting data, among other data. Additionally, some statistics were directly obtained from the business. In this study, the company took part, and PCL Company conducted direct observations of the company's production data, production capacity, number of machines, machine sizes, production sites, and supporting data, among other data. Additionally, some statistics were directly obtained from the business.

4.1 Production Target

The following is the production data of PCL Company in 1 month in the process of making a Custom folder. (Table 1)

Tabel 1. Production Target

Date	Day	Order
1 February 2022	Friday	125
4 February 2022	Monday	100
6 February 2022	Wednesday	125
9 February 2022	Thursday	120
10 February 2022	Friday	100
13 February 2022	Monday	200
15 February 2022	Tuesday	50
17 February 2022	Thursday	200
22 February 2022	Monday	200
24 February 2022	Wednesday	200
26 February 2022	Friday	100
30 February 2022	Monday	250

4.2 Production Flow

The process of creating a custom chart is as follows: (Figure 3)
1. Consumers place orders at the cashier desk
2. Customer orders are designed on the computer
3. The product will be printed on a GTU printer
4. The product is cut and trimmed in the cutting machine
5. Products are glued and put together using a glue machine
6. Products are placed in the warehouse.

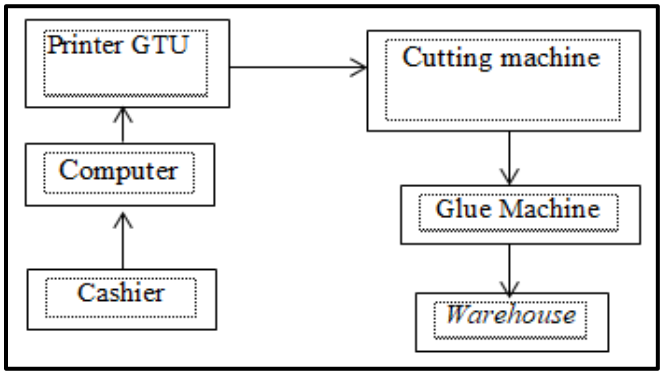

Figure 3. Production Flow

5. Results and Discussion

5.1 *Work Station Planning*

Workstations are one of the determining factors for a company's productivity. A workstation includes space for equipment, materials, and people like all other facilities. Specific space requirements for the operator and material handling can be determined based on the method of operation. The following is a recapitulation of the workstation planning for machines on the production floor: (Table 2)

Table 2. Recapitulation of Production Floor Area

Level	Station Name	Machine size		Machine area (m^2)	Stacking area	Operator area (m^2)	Machine area (m^2)	total machine	Total machine area (m^2)
		P (m)	L (m)						
Production Floor	GTU Printing Machine	2,5	1	2,5	0,142	0,412	3,804	1	5,7
	Cutting machine	2	1	1,2	0,142	0,412	3,304	1	4,96
	Glue Machine	0,74	0,51	10	0,142	0,27	1,682	1	2,53
Total		5,24	2,51	13,7	0,426	0,554	8,79	3	13,19

5.2 Activity Linkage Planning

ARC measures flow qualitatively using the value of the close relationship between activities at PCL Company.(Figure 4)

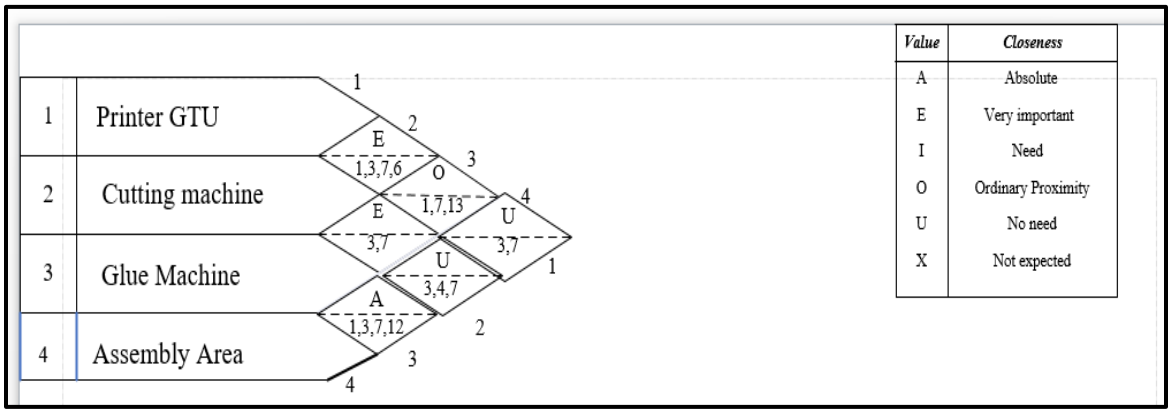

Figure 4. Activity Relationship Chart

After the preparation of the ARC, the next step is the preparation of the template block. The following is a PCL enterprise block template plan (Figure 5)

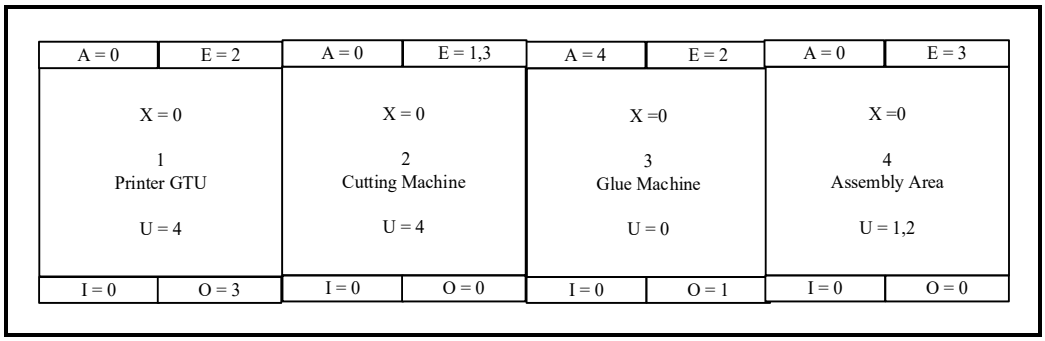

Figure 5. Block Template Plan

The name ARD is also used to determine the extent of the relationship between activities or activities. The planning area relationship diagram (ARD) of the entire PCL Company is as follows (Figure 6)

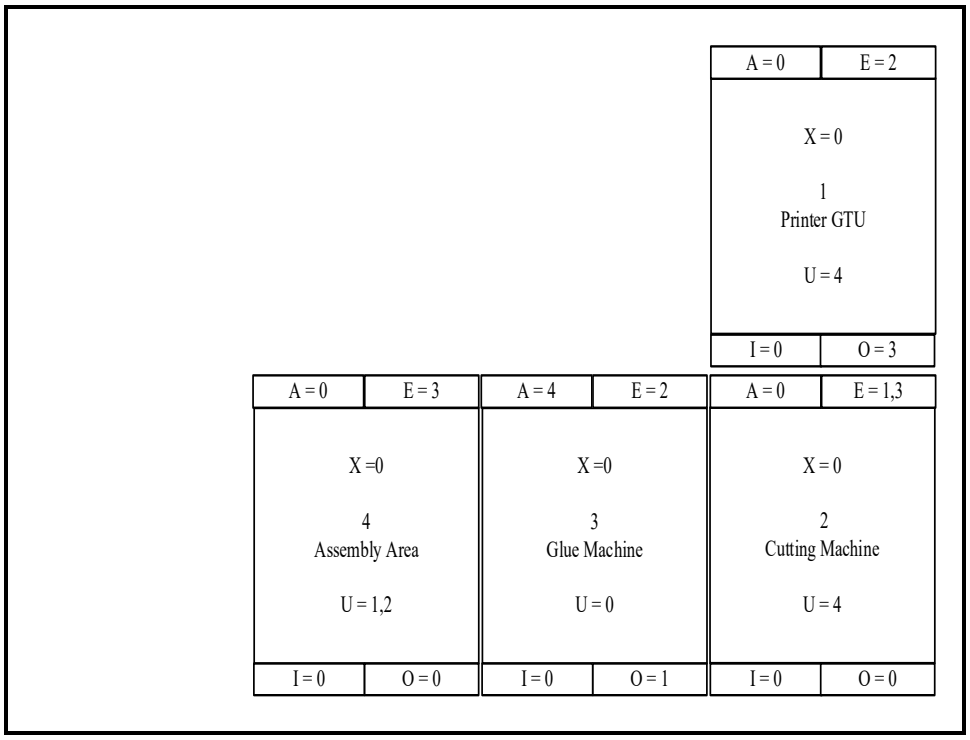

Figure 6. ARD

From the next ARD, the AAD or departmental arrangement is made using the actual dimensions that have been scaled, as shown in Figure 7

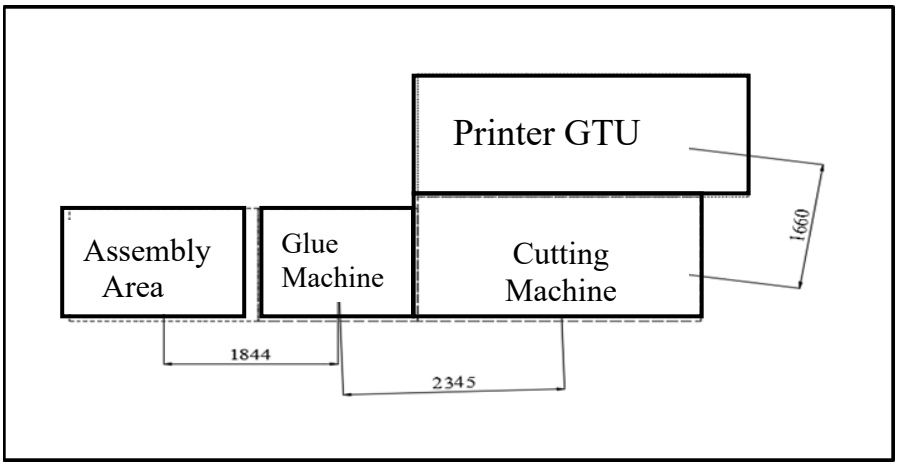

Figure 7. AAD

5.3 Material Handling Calculation

The main objective of material handling planning is to reduce the displacement distance. In addition, material handling is very influential on the operation and design of the implemented facilities. After doing the Activity Linkage Planning, the next step is to calculate material handling from to chart as shown in Table 3:

Table 3. FTC

Factory: PCL Company			Date: May 25, 2022		
From / To	**A**	**B**	**C**	**D**	**Jumlah**
A					
B	28,4				28,4
C		38,4			38,4
D			43,2		43,2
Jumlah	28,4	38,4	43,2		**100**

The next stage compares the smallest alternative in the calculation of material handling to chart for use in the CRAFT method. The following Table 4 summarises the initial and proposed form to chart layout calculations.

Table 4 Comparison of material handling distance

Product	**Material Handling**		
	Initial Layout	**Alternative 1**	**Alternative 2**
Custom Folder	20,432	5,849	7,095

From Table 4, it can be seen that the comparison of the initial handling distance layout and the proposed alternative 1 and 2. Where, the total displacement distance for the initial layout is 20,432 m from the material handling comparison so that alternative layout proposals 2 on conventional techniques are used as the initial layout of the layout design using the method CRAFT

5.4 Processing CRAFT Method

Processing of the CRAFT method aims to get an effective proposal layout and efficiently by exchanging different departments have the same area between the same department with others to reduce the total moving distance.(Figures 8 & 9)

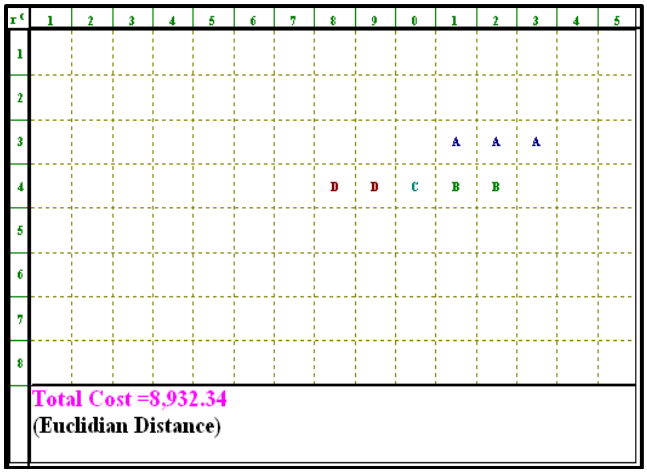

Figure 8. Initial Layout

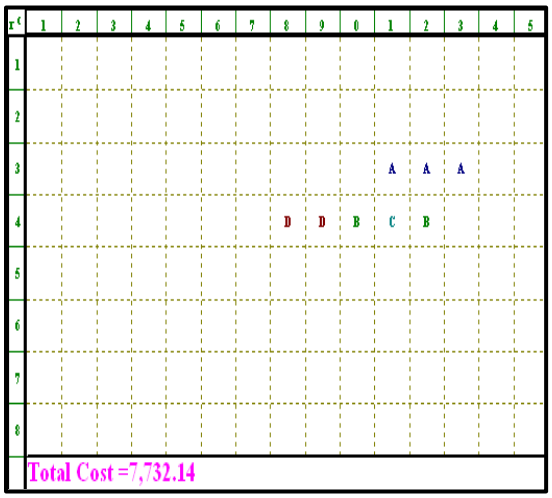

Figure 9. Final Iterate

After solving and analyzing, the optimal proposed layout is obtained, namely until the 1st iteration. Where up to this point, no more iterations can be done, so this layout is what serves as a proposed layout in the PCL Company, as in Figure 10

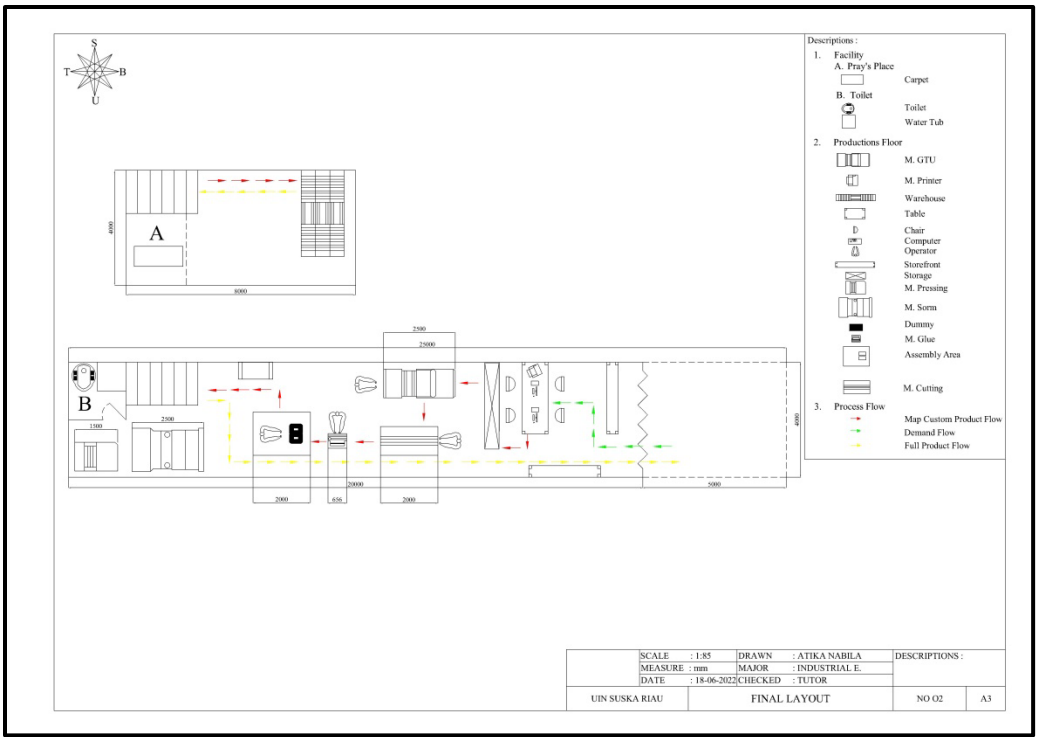

Figure 10. PCL Company Proposal Layout

6. Conclusion

After processing, then an effective and efficient proposed layout is obtained. Layout redesign is essential to increase productivity and reduce material handling distances. The material handling distance in the initial layout is 20,432 m. In the alternative, one layout is 5.8 m and 7.09 m in alternative 2. Then alternative one is used as the initial layout in the Winqsb application. It can be seen that after redesigning, the material handling becomes smaller, and after that, data processing is done using CRAFT to get a more effective layout.

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