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CRAFT Method to Minimize Material Handling Cost in Automotive Component Industry

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A B S T R A C T

In automotive component manufacturing, an efficient plant layout minimizes material handling costs (MFCs). The problem is the high material handling costs for the production of 2DIN Radio Bracket MK 56660 at PT XYZ because it is produced at two factories, Factory 1 and Factory 9, which are pretty far apart. Using the Computerized Relative Facility Allocation Technique (CRAFT), this study aims to optimize the plant layout by exploring alternative configurations that facilitate cost-effective material handling. The initial assessment of the 2DIN Radio Bracket MK 56660 layout revealed a material transfer cost. Applying the CRAFT method, two different alternative proposals for layout improvement emerged. The first alternative showed a reduction in material transfer costs of IDR 476.11. In contrast, the second alternative resulted in a slightly higher cost of IDR 476.21. The study findings concluded that the first alternative, with the lowest cost of IDR 476.11, is the preferred choice to improve the plant layout and minimize MMF. This study provides practical insights into plant layout optimization in the automotive component industry and underscores the effectiveness of the CRAFT method in identifying cost-effective solutions to material handling challenges.

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1. INTRODUCTION

In automotive manufacturing, the strategic organization pf production facilities is vital for operational efficiency and cost-effectiveness. A leading automotive company, the company produces 4 (four) wheeled automotive components. Which has five different division in 8 plants: the metal division at Plant 1, the non-woven division at Plant 4, the plastic division at Plant 7, the interior division at plants 2, 3, 6, and 9, and the printing division at Plant 5. Based on observations and discussions, there is a problem with poor layout in the 2DIN MK 56660 Radio Bracket production process, because the production process is carried out in different factories, namely factory 1 and factory 9, where the distance between factory 1 and factory 9 is 569 meters. Plant 9 is the initial production process, namely the shearing process, while the blanking process until the final process is at Plant 1. The process of moving goods using two means of transportation, namely a forklift and a goods trolley, causes the production target not to be achieved. achieved due to the large number of defective products and quite large material movement costs. Namely IDR 82,278.22/day.

The Computerized Relative Allocation of Facilities Technique (CRAFT) method is one method that can be used to optimize factory layout and minimize material handling costs. This method considers various factors such as distance travelled, travel time, workload, and the amount of material handling required at each production stage. Many previous researchers have used CRAFT to reduce the distance and costs of moving materials, including (Supriyadi et al., 2019); CRAFT is used for factory layouts based on material handling data, and it can reduce costs by IDR 298,320 with a distance difference of 26,400 meters. Research by Febianti et al., (2020) CRAFT is used for raw material warehouse layouts, which can reduce the distance travelled from initially 55,072.05 meters to 40,583.26 meters. (Baladraf et al., 2021), CRAFT can reduce costs by 13.8% - 15.1% at the Meatball Factory production facility in Kediri. (Padhil et al., 2021), CRAFT is used for the layout of steel factory facilities in Makassar, which can reduce OMH by 10% (Amrullah et al., 2022), CRAFT is used for container mapping on 500 x 500 meters land. Most recently (Darsini et al., 2023), CRAFT was used for the relayout of the Plywood factory in Pacitan, which showed a reduction in distance and costs of 3,388,270 meters and IDR 29,071,357.

By utilizing the CRAFT method, companies can conduct layout analysis and minimize material handling costs by considering various influencing factors. Good layout analysis can enable companies to optimize the use of space and increase production efficiency, thereby significantly reducing production costs and increasing profits. Based on the production problem of the 2DIN MK 56660 Radio Bracket, this research aims to redesign the layout to produce a good design where reducing the material handling distance can result in a reduction in material movement costs, which will have a big impact on company profits by using the CRAFT method.

2. LITERATURE REVIEW

Facility Layout

According to (Adiasa et al., 2020), *facility layout* can be defined as a procedure for arranging factory facilities, including the utilization of factory land area, placement of machinery and production support facilities, and work personnel to ensure the smooth flow of raw material movement during production which aims to launch the production process, according to (Pramesti et al., 2019). One of the most important things about factory layout is distance, time, cost, and distance of *material* movement. According to (Chaerul et al., 2019), the main purpose of layout design is to organize the work area and all production facilities in it to form the most economical, safe, comfortable, effective, and efficient production process. There are several (Setiawannie et al., 2022). Process layout, b. Product layout, c. Combination layout, d. Fixed position layout,e. Mobile layout. According to (Riswanda, 2018), several factors influence the layout of a company, which are as follows: a. The need for change or expansion,b. The flow of movement, c. Control of raw materials, d. Results to be issued, e. Utilization of *space,* f. Shipping and receiving, g. The need to communicate and support, h. Effect on employee morale and job satisfaction, i. Promotional value, j. Security. The flow pattern is generally divided into 5, as follows (Tahir & dan Sayed Baidhawi, 2015), Straight line shape, b. L shape, c. U shape, d. Circular, e. Odd-angled.

Material Handling

Material handling is formulated by the American Material Handling Society (AMHS) as an art of science that includes handling, moving, packaging, storage, and controlling the supervision (controlling) of materials or materials in all their forms. The transfer of materials is the process of moving these materials from one location to another, either vertically, horizontally, or in a trajectory that forms a curve. Likewise, this trajectory can be carried out in a fixed or changing trajectory (Padhil et al., 2021). According to (Onie Cahya Judha, 2015), Material handling aims to move materials to the right place, at the right time, in the right amount and order according to the expected conditions to minimize production costs. Several distance measurement systems can be used. Several types of distance measurement systems between departments are used according to the needs and characteristics of the companies that use them. Some notation information and distance measurement systems that will be used in Euclidean distance, rectilinear, square Euclidean and Euclidean distance aisle (Tahir & dan Sayed Baidhawi, 2015) a. Euclidean distance, b. Rectilinear distance, c. Square Euclidean, d. Aisle distance. The stage of material handling costs (OMH) is a calculation which will result in the total cost generated by the handling material transportation tool. The calculation formula for material handling costs (OMH) is as follows (Fajri, 2021): a. Maintenance costs, b. material handling costs (OMH), c. Total material handling costs.

Depreciation

Research by Mardjani et al., (2015) explains that the problem of depreciation is an important issue during the utilization period of fixed assets. The definition of depreciation, according to PSAK Number 17, is the allocation of the amount of an asset that can be depreciated over its estimated useful life. According to (Sihombing et al., 2016), the asset in question will provide the same benefits for each period throughout the asset's life, and its charging is not affected by productivity or asset efficiency. According to Imon et al., (2020), there are three factors to consider in determining the amount of depreciation expense for each period, including a. acquisition price, b. residual value, c. estimated economic life. It states that the factors that must be considered in calculating the depreciation expense are: a. acquisition cost, useful life, b. residual value, c. depreciable amount, d. they are carrying amount/book value.

Systematic Layout Planning (SLP)

Systematic Layout Planning (SLP) will provide solutions to layout design problems concerning various problems such as production, warehousing, transportation and other activities. Systematic Layout Planning (SLP) is a method in the layout design system that considers each department's proximity based on the flow of material in the production process. This design has the advantage that the results of the proposed improvements are in the form of a layout following the actual conditions (Kholifah U, 2021).

From to Chart (FTC)

According to Riswanda (2018), From to Chart (FTC) is a graph that shows the relationship between one place and another. From to Chart is a conventional technique commonly used for factory layout planning and material transfer in a production process. According to (Islaha & Cahyana, 2017), FTC is a way to change the layout of production machines for the better after knowing there is waste in certain production areas.

Activity Relationship Chart (ARC)

According to (Jamalludin et al., 2020), the activity relationship map or Activity Relationship Chart is a simple way or technique of planning the layout of facilities or departments based on the degree of activity relationship. This map has many uses, including showing the relationship between activities and their reasons, as input to determine the preparation of the next area and the location of activities in one service business (Ramdan et al., 2021). According to Jamalludin et al., (2020), the value of the proximity relationship is determined based on the degree of the relationship, namely:

- A: Absolutely needs to be brought closer
- E: Very important for closer
- I: It is important to be close
- O: Fair or usual
- U: Not Important
- X: Not desired to be adjacent

Research by Safitri et al., (2018) after completing the ARC filling, proceed with recapitulating it into the worksheet. There needs to be a calculation in filling out the worksheet.

Computerized Relative Allocation Facilities Technique (CRAFT)

The computerized Relative Allocation Facilities Technique (CRAFT) exchanges the location of activities in the original layout to find a better solution based on material flow. Subsequently, exchange a layout that is close to the minimum cost. The inputs used for the CRAFT algorithm, according to (Simanjuntak et al., 2022), include a. Initial layout, b. Flow data (frequency of movement), c. Cost data (*material handling cost* per unit distance), d. The number of departments that do not change (fixed). The number of departments that do not change (*fixed*). The *Computerized Relative Allocation Facilities Technique* (CRAFT) method has a function that is very helpful and easy in the industrial world. The CRAFT method is used to evaluate the layout of an industry in order to get a neater, better and vore optimal layout. Another function of the CRAFT method is to streamline industrial flow and minimize the transfer of *material* costs (Baladraf et al., 2021).

3. RESEARCH METHOD

The steps of this research flow chart are presented in Figure 1.

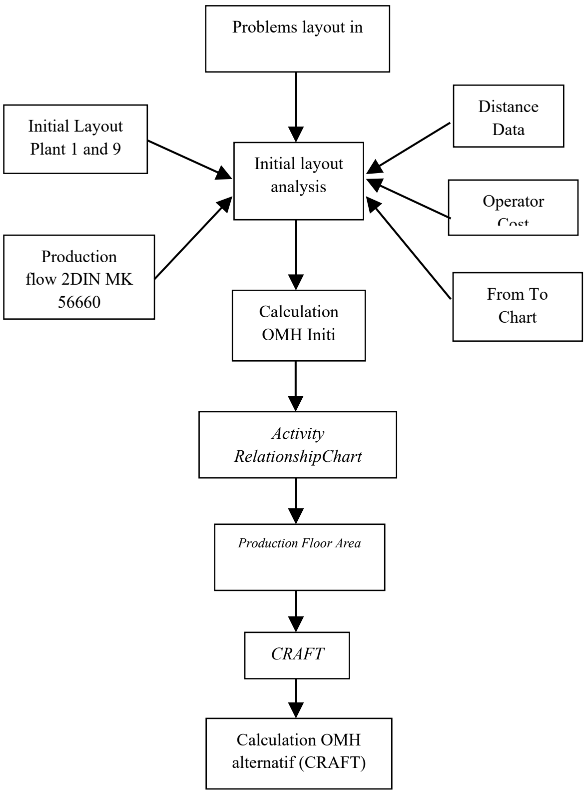

Figure 1. Research framework

4. RESULT AND DISCUSSION

Initial Layout of Plant 1 and Plant *9*

The factory layout used at the company is based on the *process layout*, which *follows* the similarity of each facility function because the products produced are carried out by moving from one group of facilities to another.

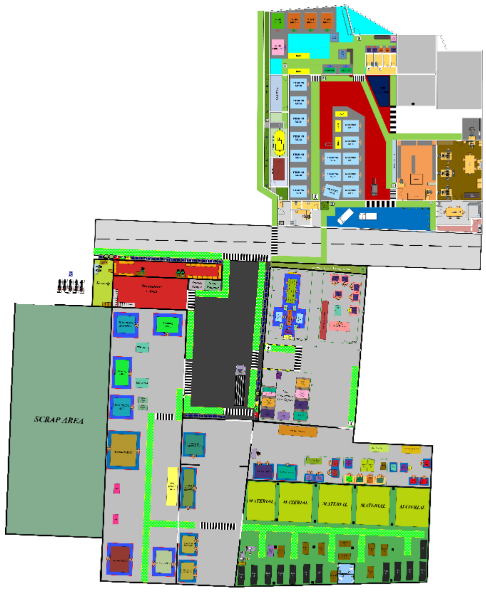

Figure 2. Plant 1 and plant 9

Production Procees

MK 56660 2DIN Radio Bracket is a component installed on the radio. The function of this component is as radio mount on the car.

Figure 3. Bracker radio 2DIN MK 56660

The process of producing the finished product Bracket Radio 2DIN MK 56660 has several stages. The following are the stages of the production process:

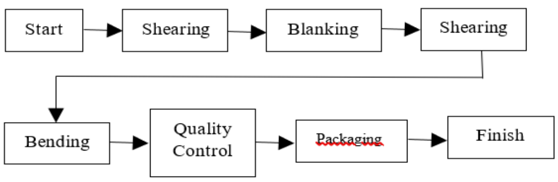

Figure 4. Production process

Distance Data

It calculated the distance needed to distribute plate *material processed shearing* from *plant* 9 to *plant* 1. Distribution: The *material* uses two means of transportation: forklifts and freight trolleys. The distance calculation is carried out using the *aisle distance* formula, where the *aisle distance* is a measurement of the actual track distance passed by the transportation equipment.

Table 1. Distance data

Distance Culculation						
No.	From	To	Tools	Distance (m)	Freq	Sub Total (m)
1	Shearing (23)	Blanking (2)	Forklift	53	1	53
2	Blanking (2)	Piercing (6)	Troly	26.5	6	159
3	Piercing (6)	Bending (12)	Troly	5.5	6	33
4	Bending (12)	Inspection (QC)	Troly	28	6	168
5	Inspection (QC)	Finish Goods (E)	Troly	22	6	132
6	Finish Goods (E)	Blanking (2)	Troly	4	6	24
	Total Forklift			**53**	**1**	**53**
	Total Troly			**86**	**30**	**516**
	Total			**139**	**31**	**569**

Operator Costs

In the production process of *Bracket* Radio 2DIN MK 56660, there are two means of transportation used where these means of transport are *forklifts* and goods trolleys. Of the two means of transportation, only the *forklift* requires an operator to run it. In contrast, the machine operator can move the material for the goods trolley. Therefore, the necessary costs for operators who operate *forklifts are* IDR 80.000/day.

Goods Flow Data (*From To Chart*)

From to chart is a diagram showing the material flow from one *department* to another. The principle of *material* flow analysis *from the from to chart* is to find the minimum possible *material* flow distance. The distance calculation uses the provisions of the *aisle distance,* where the distance measurement is the distance measured based on the distance traversed by the means of transportation.

Table 2. Distance from to chart

Frequency From To Chart							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (Meters)
Shearing Machine (plant 9)		53					53
Blanking Machine			26.5				26.5
Piercing Machine				5.5			5.5
Bending Machine					28		28
Quality Control						22	22
Finished Goods Warehouse		4					4
Total (Meters)	**0**	**57**	**26.5**	**5.5**	**28**	**22**	**139**

Based on the calculation results in Table 2, the total distance of each machine passed by the transportation equipment is 135 meters. This distance is obtained from the calculation of the *aisle distance.*

Table 3. Frequency from to chart

Frequency From To Chart							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (Meters)
Shearing Machine (plant 9)							1
Blanking Machine							6
Piercing Machine							6
Bending Machine							6
Quality Control							6
Finished Goods Warehouse							6
Total (Meters)	**0**	**7**	**6**	**6**	**6**	**6**	**31**

Table 3 shows the number of times the transportation equipment repeatedly moves *material* from one *process* to the next.

Cost/Unit Distance Data

In the previous stage, the distance required by two means of transportation for *material handling* was known from the *shearing process* to the *finished goods* warehouse. Furthermore, to find out the costs incurred by the company to operate two means of transportation as follows:

1. Trolley

Purchase cost: IDR 500.000/unit
Residual value (final): 50.000/unit
Economic life: 5 years
Number of units: 1 unit
Working time: 7 hours/day
: 24-26 days/month
: 294 days/year

Total Maintenance Cost
Maintenance Cost: IDR 50.000
Total Maintenance Cost =
Maintenance cost x number of units
Working days 1 year
Total Maintenance Cost =
IDR 50.000/year x 1 unit
294 days/year
Total Maintenance Cost = IDR 170,077 /day.

Freight trolley price - residual value
Economic Life.
Depreciation Cost =
IDR 500.000/unit – IDR 50.000/unit
5 years
Depreciation Cost = IDR 320,51 /day.

Total maintenance cost

Total maintenance cost =
Maintenance cost x number of units
Working days 1 year
Total maintenance cost = IDR 50.000 x 1 unit
312days
Total maintenance cost = IDR 90.000/year
Total maintenance cost = IDR 306,12/day

Material Movement Cost (OMH)
OMH =
Depreciation cost + total maintenance cost
Total moving distance per day
OMH = IDR 306,12/day + IDR 179,07/day
516 meters/day
OMH = IDR 0,923/meters.

1. *Forklift*

Purchase cost: IDR 185.000.000/unit
Residual Value (final) :18.500.000/unit
Economic life: 10 years
Number of units: 1 unit
Working time: 7 hours/day
: 24-26 days/month
: 294 days/year
Fuel: IDR 6.800 /litre

Total Maintenance Cost
Maintenance cost: IDR 9.250.000/year
Total Maintenance Cost=
Maintenance Cost x Total Unit
Working day per year

Total Maintenance Cost=
IDR 9.250.000/year x 1 unit
294 days/year
Total Maintenance Cost IDR 31.462,59 /day.

Depreciation Cost
Depreciation Cost =
Freight trolley price - residual value
Economic Life
Depreciation Cost =
IDR 185.000.000/unit – 18.500.000/unit
10year
Depreciation cost = IDR 16.650.000/year
Depreciation cost= IDR 56.623,65 /day.

Fuel Cost
Based on the information obtained, the diesel consumption is 5 litres for six days of operation, so the fuel consumption is 5 litres x IDR 6,800 x 1 unit = Rp. 34.000. So that each day takes IDR 34.000 / 6 days = IDR 4.857,14.

Material Movement Cost (OMH)
OMH=
Depreciation cost + total maintenance cost + fuel
Total distance moved per day
OMH =
IDR 56.623,65/day + IDR 31.462,59/day + IDR 4.857,14/day
53 meters/day
OMH = IDR 95.503,40/day
53 meters/day
OMH = Rp 33,999/meters.

Total OMH
Total OMH = OMH Per meter x DistanceTransportation x Frequency

With the following example:
Total OMH = Rp 33,999/meters x 53 meters x 1 = Rp 1.801,95/day

Based on the calculation of costs for both *material handling* and transportation equipment from the initial *process* to the end, Table 4 shows the results of the calculation of *material* movement costs.

Table 4. Material cost calculation

Material Handling Cost (MHC)										
No	From	To	Tools	MCH/M (IDR)	Distance (M)	MHC (IDR)	Freq/Day	Sub Total (M)	Sub Total MHC (IDR)	Operator Cost (IDR)
1	Shearing (23)	Blanking (2)	Forklift	33.999	53	1,801.95	1	53	1,801.95	80,000.00
2	Blanking (2)	Piercing (6)	Troly	0.923	26.5	24.46	6	159	146.73	
3	Piercing (6)	Bending (12)	Troly	0.923	5.5	5.08	6	33	30.45	
4	Bending (12)	Inspection (QC	Troly	0.923	284	25.84	6	168	155.04	
5	Inspection (QC	Finish Goods (E)	Troly	0.923	22	20.30	6	132	121.82	
6	Finish Goods (E)	Blanking (2)	Troly	0.923	2	3.69	6	24	22.25	
	Total Forklift			**33.999**	**53**	**1,801.95**	**1**	**53**	**1,801.95**	**81,801.95**
	Total Troly			**4.615**	**86**	**29.37**	**30**	**516**	**476.27**	**476.27**
	Total			**38,614**	**139**	**1881,32**	**31**	**569**	**2,278.22**	**82,278.22**

***Activity RelationshipChart* (ARC)**

Activity Relationship Diagram (ARC) is created to determine the relationship between paired activities in each region. This relationship can be seen in several aspects, including inter-departmental relationships, material flow, equipment used, employees, information, and environment. Based on the relationship between activities and causes, ARC for all available regions in PT AAA can be seen in Figure 5:

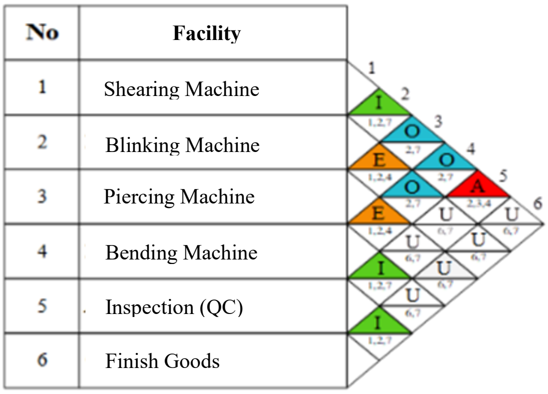

Figure 5. Activity relationship chart (ARC)

Each letter code is then accompanied by a reason code, which is the basis for determining proximity. The different reasons can be adjusted according to the conditions of the problems in the study area.

Production Floor Area

On the production floor area, several things need to be used as a basis in determining the area requirements that will be used in the case of the number of machines, the size of the machines, and the operators who work in the area. Figure 6, Table 5, and Table 6 below show the names of the machines and the size of each machine used in the production process.

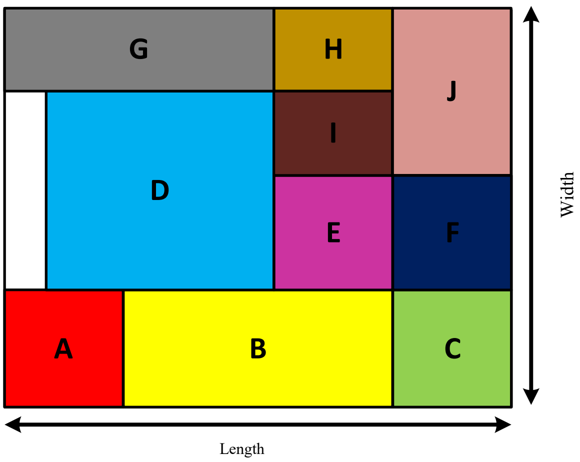

Figure 6. Production area

Table 5. Production floor area

Production Floor Area (Plant 1)				
No.	Description	Length (m)	Width (m)	Area (M^2)
1	Delivery Note (A)	5.5	3	16.5
2	Receiving and Shipping (B)	15	3.5	52.5
3	Meeting Room (C)	6	4	24
4	Production (D)	1	16.5	231
5	Finished Goods (E)	5	8	40
6	Office (F)	6	8	48
7	Dies Shop (G)	16.5	8	132
8	Room H	5	5	25
9	Room I	3	5.5	16.5
10	Quality Control (J)	6	11.5	69
	Total	**82**	**73**	**654.5**

In Plant 1, there is a size of the existing production floor area in each current production area, as shown in the table above, which we will use to place the shearing machine.

Table 6. Machine size

Machine Size					
No.	Plant	Machine	Length (m)	Width (m)	Area (m^2)
1	9	Shearing Machine	2.5	3.5	8.75
2	1	Blinking Machine	2.5	1.5	3.75
3		Piercing Machine	2.5	1.5	3.75
4		Bending Machine	2.5	1.5	3.75
5		Inspection (QC)	2	1	2
6		Finish Goods warehouse	7	5	35
		Total	**19**	**14**	**57**

On the Shearing machine, we can see that the size of the machine required is an area of 8.75 with a length of 2.5 and a width of 3.5. In Plant 1, there is an empty room that can be filled with the shearing *m*achine, namely in room H, room I, and the *quality control area* (J), but what we can use is only in rooms H and J, which in this room is quite spacious. There are no obstacles that interfere with the laying of the shearing machine.

Computerized Relative Allocation of Facilities Technique (CRAFT*)* Initial Layout

Computerized Relative Allocation of Facilities Technique (CRAFT) is an improvement program that seeks the optimal design by making improvements. Improvement layout layout in stages. CRAFT evaluates the layout by exchanging department locations.

Table 7 shows the distance from each department, starting from the shearing machine to the finished goods. There are rooms H and J, where this room is an alternative to exchanging departments with the shearing machine located in Plant 9.

Table 7. Distance from to chart

Distance From To Chart (Meters)									
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Room H	Room J	Total (Meters)
Shearing Machine (plant 9)		53							53
Blanking Machine			26.5						26.5
Piercing Machine				5.5					5.5
Bending Machine					28				28
Quality Control						22			22
Finished Goods Warehouse		4							4
Room H		30							30
Room J		32							32
Total (Meters)	**0**	**119**	**26.5**	**5.5**	**28**	**22**	**0**	**0**	**201**

Table 8. Frequency from to chart

Frequency From To Chart (Times)									
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Room H	Room J	Total (Meters)
Shearing Machine (plant 9)		1							1
Blanking Machine			6						6
Piercing Machine				6					6
Bending Machine					6				6
Quality Control						6			6
Finished Goods Warehouse		6							6
Room H		1							1
Room J		1							
Total (Meters)	**0**	**9**	**6**	**6**	**6**	**6**	**0**	**0**	**33**

Table 8 shows the frequency or the number of transportation tools moving from one machine to the next machine; there is an alternative frequency in rooms H and J, which will be an exchange *department* with a *shearing* machine where the resulting frequency is the same, namely 1.

Table 9. Cost matric from to chart

Cost Matric From To Chart (IDR)									
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Room H	Room J	Total (Meters)
Shearing Machine (plant 9)		81,801.95							81,801.95
Blanking Machine			146.73						146.73
Piercing Machine				30.45					30.45
Bending Machine					155.04				155.04
Quality Control						121.82			121.82
Finished Goods Warehouse		20.15							20.15
Room H		26.16							26.16
Room J		27.81							27.81
Total (Meters)	**0**	**81,876.07**	**146.73**	**30.45**	**155.04**	**121.82**	**0**	**0**	**82,330.11**

Based on Table 9, the results of the calculation of material displacement are made in the generated from the *shearing process* to the finish goods warehouse.

The alternative proposal, the CRAFT method

After processing, the Computerised Relative Allocation of Facilities Technique (CRAFT) method in the initial layout has shortcomings where the movement of materials far away makes the costs incurred even greater. This alternative proposal can be done by moving the shearing machine, which is in plant 9, to plant 1, which can be placed in rooms H and J.

Table 10. Initial department

Plant 1				
No.	Description	Length (m)	Width (m)	Area (M^2)
1	Delivery Note (A)	5.5	3	16.5
2	Receiving and Shipping (B)	15	3.5	52.5
3	Meeting Room (C)	6	4	24
4	Production (D)	1	16.5	231
5	Finished Goods (E)	5	8	40
6	Office (F)	6	8	48
7	Dies Shop (G)	16.5	8	132
8	Room H	5	5	25
9	Room I	3	5.5	16.5
10	Quality Control (J)	6	11.5	69

Table 10 shows the size of each department or room in Plant 1 and the shearing machine department of Plant 9, where later exchanges will be made between departments. With the exchange of the shearing machine department to the H and J departments, the production process for the MK 56660 2DIN Radio Bracket part becomes one plant, namely plant 1.

Table 11. Room exchange H

Plant 1			
Description	Length (m)	Width (m)	Area (M^2)
Delivery Note (A)	5.5	3	16.5
Receiving and Shipping (B)	15	3.5	52.5
Meeting Room (C)	6	4	24
Production (D)	1	16.5	231
Finished Goods (E)	5	8	40
Office (F)	6	8	48
Dies Shop (G)	16.5	8	132
Shearing Machine	5	5	25
Room I	3	5.5	16.5
Quality Control (J)	6	11.5	69

Plant 9			
Description	Length (m)	Width (m)	Area (M^2)
Room H	4.5	5	22.5

The first department swap based on Table 11 can be seen by moving the department to make the shearing machine process much closer to the following process, affecting the distance and costs incurred.

Based on Tables 13, 14, and 15, after making an exchange in room H, the distance is 116 meters with a frequency of 31 times back and forth, and the costs incurred in one day of production are IDR 476.11.

Table 12. Proposed distance of room H

Proposal Distance of Room H							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (Meters)
Shearing Machine (plant 9)		30					30
Blanking Machine			26.5				26.5
Piercing Machine				5.5			5.5
Bending Machine					28		28
Quality Control						22	22
Finished Goods Warehouse		4					4
Total (Meters)	**0**	**34**	**26.5**	**5.5**	**28**	**22**	**116**

Table 13. Proposed frequency of room H

Proposed Frequency of Room H (Times)							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (Times)
Shearing Machine (plant 9)		1					1
Blanking Machine			6				6
Piercing Machine				6			6
Bending Machine					6		6
Quality Control						6	6
Finished Goods Warehouse		6					6
Total (Meters)	**0**	**7**	**6**	**6**	**6**	**6**	**31**

Table 14. Proposed cost matric of room H

Proposed Cost Matric of Room H (IDR)							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (IDR)
Shearing Machine (plant 9)		26.16					26.16
Blanking Machine			138.65				138.65
Piercing Machine				28.78			28.78
Bending Machine					146.50		146.50
Quality Control						115.10	115.10
Finished Goods Warehouse		20.93					20.93
Total (Meters)	**0**	**47.09**	**138.65**	**28.78**	**146.50**	**115.10**	**476.11**

Table 15. Room exchange J

Plant 1			
Description	Length (m)	Width (m)	Area (M^2)
Delivery Note (A)	5.5	3	16.5
Receiving and Shipping (B)	15	3.5	52.5
Meeting Room (C)	6	4	24
Production (D)	1	16.5	231
Finished Goods (E)	5	8	40
Office (F)	6	8	48
Dies Shop (G)	16.5	8	132
Room H	5	5	25
Room I	3	5.5	16.5
Shearing Machine	6	11.5	69
Plant 9			
Description	Length (m)	Width (m)	Area (M^2)
Quality Control (J)	4.5	5	22.5

Based on Table 15, the second exchange is that the shearing machine department J. In contrast, the department's resulting distance is closer.

Table 16. Proposed distance of room J

Proposal Distance of Room J							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (Meters)
Shearing Machine (Room J)		32					32
Blanking Machine			26.5				26.5
Piercing Machine				5.5			5.5
Bending Machine					28		28
Quality Control						22	22
Finished Goods Warehouse		4					4
Total (Meters)	**0**	**36**	**26.5**	**5.5**	**28**	**22**	**118**

Table 17. Frequency proposed room J

Proposed Frequency of Room J (Times)							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (Times)
Shearing Machine (Room J)		1					1
Blanking Machine			6				6
Piercing Machine				6			6
Bending Machine					6		6
Quality Control						6	6
Finished Goods Warehouse		6					6
Total (Meters)	**0**	**7**	**6**	**6**	**6**	**6**	**31**

Table 18. Cost matric of proposed room J

Proposed Cost Matric of Room H (IDR)							
From/To	Shearing Machine (plant 9)	Blanking Machine	Piercing Machine	Bending Machine	Quality Control	Finished Goods Warehouse	Total (IDR)
Shearing Machine (plant 9)		27.81					27.81
Blanking Machine			138.17				138.17
Piercing Machine				28.68			28.68
Bending Machine					145.99		145.99
Quality Control						114.71	114.71
Finished Goods Warehouse		20.86					20.86
Total (Meters)	**0**	**48.66**	**138.17**	**28.68**	**145.99**	**114.71**	**476.21**

Based on Tables 16, 17, and 18, after making an exchange in room J, the distance is 118 meters with a frequency of 31 times back and forth, and the costs incurred in one day of production are IDR 476.21.

Making an Alternative Layout Proposal

Based on the calculations that have been carried out on the Computerized Relative Allocation of Facilities Technique (CRAFT) algorithm, alternative layout proposals can be made where this alternative layout proposal based on the results that have been. Two alternatives can be used in the proposed layout: department H and department J.

In the first proposed layout to move the shearing machine, which was initially in plant 9 and is now placed in plant 1 in department H. Moving the shearing machine to plant 1 makes the distance of material movement, which was initially 53 meters now becomes 30 meters. Costs have decreased to see how much the costs incurred if the shearing machine is moved can be seen in Table 19.

Table 19. Calculation results of proposed alternative H

Cost Material Handling Room H									
No	From	To	Tools	MCH/M (IDR)	Distance (M)	MHC (IDR)	Freq/Day	Sub Total (M)	Sub Total MHC (IDR)
1	Shearing (23)	Blanking (2)	Troly	0.872	30	26.26	1	30	26.16
2	Blanking (2)	Piercing (6)	Troly	0.872	26.5	23.11	6	159	138.65
3	Piercing (6)	Bending (12)	Troly	0.872	5.5	4.80	6	33	28.78
4	Bending (12)	Inspection (QC	Troly	0.872	28	24.42	6	168	146.50
5	Inspection (QC	Finish Goods (E)	Troly	0.872	22	19.18	6	132	115.10
6	Finish Goods (E)	Blanking (2)	Troly	0.872	4	3.49	6	24	20.93
	Total Troly			**5.232**	**116**	**101.15**	**31**	**546**	**476.11**

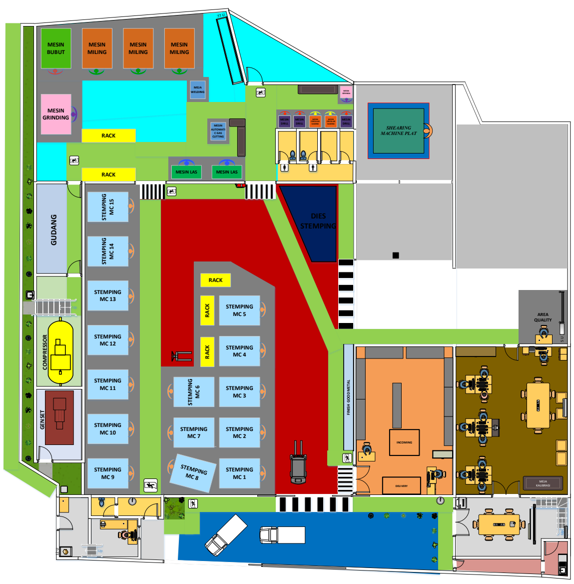

Figure 7. Proposed alternative H

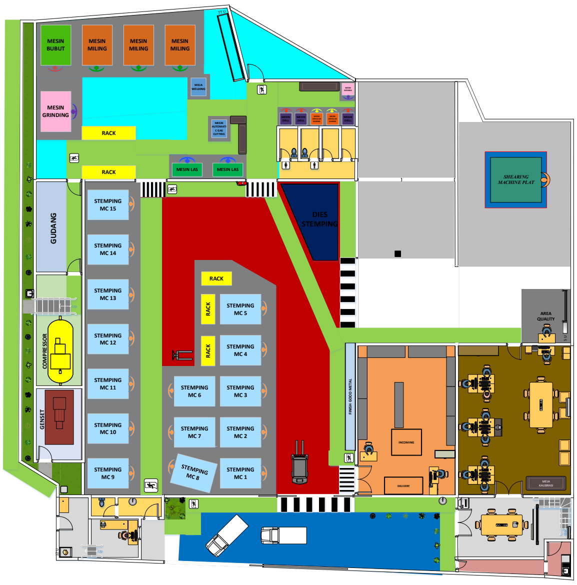

Figure 8. Proposed alternative J

In the second proposed layout, the shearing machine was initially moved to plant 9 and is now placed in plant 1 in department J. Moving the shearing machine to plant 1 makes the distance of material movement, which was initially 53 meters, now becomes 32 meters. The cost has decreased. To see how much the costs are incurred if the shearing machine is moved, it can be seen in Table 20.

Table 20. Calculation results of alternative proposal J

Cost Material Handling Room J									
No	From	To	Tools	MCH/M (IDR)	Distance (M)	MHC (IDR)	Freq/Day	Sub Total (M)	Sub Total MHC (IDR)
1	Shearing (23)	Blanking (2)	Troly	0.869	32	27.81	1	32	27.81
2	Blanking (2)	Piercing (6)	Troly	0.869	26.5	23.03	6	159	138.17
3	Piercing (6)	Bending (12)	Troly	0.869	5.5	4.78	6	33	28.68
4	Bending (12)	Inspection (QC	Troly	0.869	28	24.33	6	168	145.99
5	Inspection (QC	Finish Goods (E)	Troly	0.869	22	19.12	6	132	114.71
6	Finish Goods (E)	Blanking (2)	Troly	0.869	4	3.48	6	24	20.86
Total Troly				**5.21**	**118**	**102.54**	**31**	**546**	**476.21**

Of the two alternatives, when compared with the initial material handling costs using two means of transportation, forklifts and freight trolleys, the total material handling incurred in one production day is IDR 82,278.22. From the results of the comparison of the two alternative proposals that have been made, the first alternative proposal is the most optimal improvement proposal, where of the two alternatives, the first alternative is the smallest material handling distance and material handling.

5. CONCLUSION

Based on the data processing and analysis results, it can be concluded that using the CRAFT method, an improved redesign of the plant 1 layout is obtained, resulting in a total material transfer distance of 546 meters and a total material transfer cost of IDR 476.11. The initial layout gets a total material transfer distance of 569 meters and a material transfer cost of IDR 82,278.22. Based on the results of data processing, analysis and research conclusions, several suggestions can be made as follows: It is expected that the company can implement an efficient re-layout design; the company should consider cost and distance in determining the machine layout; and company should consider using the CRAFT method to minimize OMH in deciding the layout.

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