Redesign layout of production floor facilities using Algorithm CRAFT

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Abstract. High productivity is the main thing that must be owned by all companies and industry players in meeting the needs of consumers. To increase the productivity of the company must be supported by the smooth process of production, one of the ways is setting the right plant layout because it affects the cost of the production process. A cracker maker manufacturing company has constraints in layout arrangements that result in inefficiency in production and distance which results in high material handling costs so that a layout redesign has to be done to minimize material handling costs. The design of the production floor facility layout is done by CRAFT algorithm with the help of WinQSB software. The results of the study found that alternative proposals that provide a reduction result of 9.21% or equal to Rp 6,781,236, - per batch of the total cost of material handling initial layout.

1. Introduction
High productivity is the main thing that must be owned by all companies and other industry players in the form of goods. Because of that, productivity is a reflection of companies and other industry players to meet the needs of consumers. Plant layout is a major foundation in the industrial world, therefore spending a little time planning the factory layout before building a plant can prevent unwanted losses [1]. The plant layout and facilities can be defined as the procedures for setting up factory facilities to support the smooth production process, it is known that the material handling distance from one area to another is long, this affects the trajectories and processes of production [2-4]. The purpose of this design is closely related to manufacturing strategies. Layout settings from Production facilities and work areas are problems that are often encountered in the industrial world. This problem is unavoidable, even if it is only managing equipment or machines inside room or production floor, and in a small and simple scope. In planning production floor layout, it must also be thought about the material transfer system (material handling). In the production process that uses machines that work specifically, then transfer of material between machines must be carried out effectively and efficiently. In process manufacturing of products, it is often found that products cannot be completed only through a product machines or production facilities, but must go through several series of processes that use many machines or production facilities. Thus it is unavoidable to do material handling activities. Several studies have been studied in similar studies in research for the manufacture of boilers in minimizing distance and material handling costs in the production floor [5-7]. Research in increasing the utility of production machinery for palm oil production in reducing...
material handling costs [8-10]. Increase the use of classrooms using the CRAFT method [10-15]. All research that has been done is still in the manufacturing industry for machine manufacturing and this research was carried out in the manufacture of food, namely crackers. In this study, the calculation of the moment of material displacement on the production floor and material handling costs will be carried out. In addition, researchers also want to try to find a new alternative layout that has a moment of displacement, material handling costs and a more minimal cycle time. In minimizing material handling costs means increasing productivity and profits for the company.

2. Methodology
This type of research is descriptive research about motion and time studies. The study of motion and time is a study of the observation of the motion of a worker in carrying out his work and the measurement of the time used in each cycle of activity. This research is mostly carried out in manufacturing industry companies that use relatively large amounts of labor. The purpose of this study was to obtain a standard work order, and the standard time for work completion. The research was conducted in the cracker-making industry located in the City of Kisaran Medan.

The steps in this study are: (1) Searching for problems, (2) looking for theories and literature reviews, (3) Determining problem solving methods, (4) Collecting data including primary data, namely the stages of the production process, activity frequency, company map and supporting utilities for the production process; Secondary data consists of: production volume. (4) data processing calculates OMH costs and designs the proposed layout using CRAFT algorithm.

CRAFT (Computerized Real Allocation of Facilities Techniques) exchanges activity locations in the initial layout to find better solutions based on material flow. Subsequent exchanges lead to a layout that approaches the minimum (sub-optimum) cost. Since 1983 the CRAFT technique aims to minimize material transfer costs, wherein the material transfer costs are defined as product flow, distance and freight unit costs. CRAFT was originally presented by Armor and Befa. CRAFT is an example of a type of Heuristic technique program based on the Quadratic Assignment interpretation of the program layout process, which has the basic criteria used to minimize material transfer costs, where this cost is described as a linear function of the displacement distance. The functions and objectives of CRAFT are:

\[ F = \max/\min \sum_{i,j} C_{ij} W_{ij} D_{ij} \]

where:
- \( C_{ij} \) = Cost of flow between departments
- \( W_{ij} \) = Frequency of flow between departments
- \( D_{ij} \) = Distance between departments

CRAFT requires input in the form of material transfer costs. Input of transfer costs in the form of the cost of unifying the distance union (the cost of material handling distance union / OMH distance union). CRAFT can only serve exchanges of up to 40 departments. Calculation of distance between machines i and machine j with two different center points are: Machine i – machine j = \([X_i - X_j] + [Y_i - Y_j]\)

Another advantage, CRAFT allows users to specify the location of several departments (dummy or other departments). CRAFT is able to adjust nonrectangular (non-boxed) or irregular departments placed wherever desired.

3. Result and Discussion
Based on data collection conducted in the cracker industry, the available area is ± 980. The following is data on the floor area of each department / work station based on the initial layout.
Figure 1. Actual Layout

Table 1. Dimensions of department and work station area

| Nama departemen/stasiun kerja         | Symbol | Long (m) | Wide (m) | Large ($\text{m}^2$) |
|---------------------------------------|--------|----------|----------|----------------------|
| Warehouse of raw materials            | A      | 10       | 3        | 30                   |
| Base dough making station             | B      | 4        | 3        | 12                   |
| Station for making crackers           | C      | 4        | 3,5      | 14                   |
| Mixing dough station                  | D      | 1        | 2        | 2                    |
| Cracker printing station              | E      | 2        | 1        | 2                    |
| Steaming station                      | F      | 1,5      | 2        | 3                    |
| Cooling & cutting station             | G      | 0,5      | 3,7      | 1,85                 |
| Drying Station 1                      | H      | 26       | 7,7      | 200                  |
| Drying Station 2                      | I      | 6        | 27,5     | 165                  |
| Packing Station                       | J      | 3        | 2,1      | 6,3                  |
| Finished product warehouse            | K      | 3        | 6        | 18                   |
| Boiler                                | L      | 1        | 1        | 1                    |
| Toilet                                | M      | 2,1      | 2,5      | 5,25                 |

3.1. Total Initial Material Handling Costs

Calculate the total material handling costs incurred on the production floor calculated in 1 batch of cracker making. From the calculation it is known that the total material handling costs for 1 day is Rp. 7,469,551. And for material handling costs per work station can be seen in table 2 below.
### Table 2. Total initial material handling costs

| From | To  | Frequency | Tools | OMH (Rp/m) | Distance (m) | Total (Rp) |
|------|-----|-----------|-------|------------|--------------|------------|
| A    | B   | 4         | man   | 13,020     | 10.00        | 520.8      |
| A    | C   | 4         | man   | 13,020     | 15.25        | 794.22     |
| B    | C   | 8         | man   | 13,020     | 4.00         | 416.64     |
| C    | D   | 8         | man   | 13,020     | 4.25         | 442.68     |
| D    | E   | 8         | man   | 13,020     | 7.00         | 729.12     |
| E    | F   | 8         | man   | 13,020     | 2.25         | 234.36     |
| F    | G   | 1         | trolley | 26,070 | 9.65         | 251,575.5 |
| G    | H   | 2         | trolley | 26,070 | 26.25        | 1368,675  |
| G    | I   | 2         | man   | 13,020     | 5.63         | 146,605.2 |
| H    | J   | 2         | man   | 13,020     | 23.6         | 614,544    |
| I    | J   | 2         | man   | 13,020     | 23.7         | 617,148    |
| J    | K   | 4         | man   | 13,020     | 4.95         | 257,796    |
| G    | C   | 1         | trolley | 26,070 | 11.15        | 290,680.5 |
| H    | C   | 1         | trolley | 26,070 | 15.1         | 393,657    |
| I    | C   | 1         | trolley | 26,070 | 15           | 391,05     |

TOTAL POSTAGE OF HANDLING MATERIAL 1 BATCH Rp 7469,551

3.2. Layout settings using CRAFT

The results of data processing with CRAFT algorithm for exchanging 3 departments are after 7 iterations. The iteration can be seen in Figure 2:

![Figure 2. Final Layout with CRAFT](image)

3.3. Total cost of material handling proposals

From the results of the calculation, it can be seen that the OMH reduction is 9.21%. Which can be seen in table 2 below.

### Table 3. Total cost of material handling proposals

| From | To  | Frequency | Tools | OMH (Rp/m) | Distance (m) | Total (Rp) |
|------|-----|-----------|-------|------------|--------------|------------|
| A    | B   | 4         | man   | 13,020     | 8.00         | 416,64     |
| From | To  | Frequency | Tools | OMH (Rp/m) | Distance (m) | Total (Rp) |
|------|-----|-----------|-------|------------|--------------|------------|
| A    | C   | 4         | man   | 13.02      | 8.75         | 455.7      |
| B    | C   | 8         | man   | 13.02      | 6.75         | 703.08     |
| C    | D   | 8         | man   | 13.02      | 6.25         | 651        |
| D    | E   | 8         | man   | 13.02      | 6.00         | 624.96     |
| E    | F   | 8         | man   | 13.02      | 4.75         | 494.76     |
| F    | G   | 1         | trolley | 26.07   | 13.85         | 361,0695  |
| G    | H   | 2         | trolley | 26.07   | 23.75         | 1238,325  |
| G    | I   | 2         | man   | 13.02      | 6.65         | 173,166    |
| H    | J   | 2         | man   | 13.02      | 20.10        | 523,404    |
| I    | J   | 2         | man   | 13.02      | 23.70        | 617,148    |
| J    | K   | 4         | man   | 13.02      | 4.95         | 257,796    |
| G    | C   | 1         | trolley | 26.07   | 8.85         | 230,7195  |
| H    | C   | 1         | trolley | 26.07   | 20.10        | 524,007    |
| I    | C   | 1         | trolley | 26.07   | 6.25         | 162,9375  |

TOTAL POSTAGE OF HANDLING MATERIAL 1 BATCH Rp 7434,713

**Figure 3. Proposal Layout**

4. Conclusion
Based on the results of the study, the proposed alternative layout using CRAFT is a total reduction in material handling costs by 9.21% per batch and the smallest total material handling costs to Rp. 7434,713 per batch. Therefore, it can be proposed as a proposed layout.
References

[1] Apple J M, 1990, Tataletak Pabrik dan Pemindahan Bahan, Bandung: Penerbit ITB.

[2] Sinulingga S, 2011, Metodologi Penelitian, USU Press of Indonesia.

[3] Sembiring A C, 2012, Perancangan Ulang Tata Letak Pabrik untuk meminimalisasi material handling di PT. Atmindo, Medan: Universitas Sumatera Utara.

[4] Sembiring A C, 2017, Perancangan Ulang Tata Letak Pabrik untuk Meminimalisasi Material Handling pada Industri Pembuat Boiler, Prosiding SNTI dan SATELIT 2017, pp. C242-247), Malang: Jurusan Teknik Industri Universitas Brawijaya.

[5] Sembiring A C, 2018, Redesigning Layout in the manufacture of machine spare parts oil palm to Enhance Utility, Bandung.

[6] Sembiring A C, 2018, An application of corelap algorithm to improve the utilization space of the classroom, J. Phys.: Conf. Ser. 1007 012026.

[7] Dwianto Q A, dkk, 2016, Usulan Rancangan Tata Letak Fasilitas dengan Menggunakan Metode CORELAP di Perusahaan Konveksi. Jurusan Teknik Industri Itenas No.1, Vol.4

[8] Langgihadi D, dkk, 2016, Usulan Rancangan Ulang Tata Letak Fasilitas dengan Menggunakan Metode CORELAP di Perusahaan Distribusi Bahan Bakar Pesawat Udara. Jurusan Teknik Industri Itenas No.1, Vol.4.

[9] Rubianto C N dkk, 2014, Penentuan Lokasi dan Perancangan Tata Letak Fasilitas Tempat Packging PT ABC. Titra No.2, Vol.2

[10] Siregar M, 2012, Perancangan Ulang Tataletak Fasilitas Produksi Dengan Menerapkan Algoritma Blocplan Dan Algoritma Corelap Pada PT. Voltama Vista Megah Electric Industry. Medan: Universitas Sumatera Utara.

[11] Suhendar D dkk, 2012, Usulan Perancangan Ulang Tata Letak Fasilitas Produksi Dengan Menggunakan Metode Algoritma CRAFT. Teknik Industri Universitas Bina Darma.

[12] Wignjosoebroto S, 1996. Tata Letak Pabrik dan Pemindahan Bahan. Jakarta: PT Guna Widya.

[13] Amelia, 2007, Aplikasi Metode Group Technology dalam Memperbaiki Tata Letak Mesin untuk Meminimalkan Jarak Perpindahan Bahan Studi Kasus di Perusahaan Mebel Logam”, Jurnal Teknik Mesin Vol. 9 No. 2 Oktober 2007, Surabaya.

[14] Sahroni, 2003, Perencanaan Ulang Tata Letak Fasilitas Produksi dengan Metode Algoritma CRAFT, Optimum Vol. 4 No. 1, Februari – Agustus 2003.