Comparison of BLOCPLAN and CORELAP algorithm for Material Handling Improvement at M Bakery

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Abstract. It is essential to have a suitable and effective layout design on a production floor. M Bakery is one of the bread industries that has been established since 2010. The core problem in the case study object is the far distance of the material handling movement. One solution to this problem is to improve the layout of facilities in the production area. The study will compare two different algorithms which are BLOCPLAN and CORELAP and choose the best one between these algorithms. The total movement moment of the current layout is 379,932 meters/year and OMH is IDR 1,215,712/year. The results of the BLOCPLAN based layout are the total movement moment of 263,767 meters/year, OMH of IDR 1,054,201/year, and an efficiency rate of 30.57%. While the results of the CORELAP based layout are the total movement moment of 418,710 meters/year, OMH of IDR 1,477,648/year, and an efficiency rate of 10.21%. From the comparison of the result of the two algorithms, the chosen proposed layout design is the BLOCPLAN based layout which has the highest efficiency rate of 30.57%.

1. Introduction
Facility design is one of the core aspects of a successful manufacturing process. The production cost is closely related to the facility design layout. The concept of facility planning successfully decreases the operation fee [1]. The characteristics of an ideal layout for material handling are topmost flexibility, coordination, volume utilisation, visibility, accessibility, and minimum distance [2]. There is no perfect layout. However, in some cases, the productivity rate increase significantly after the layout redesign. In one research, there is half distance left of travel route with the new layout [3]. While on other research, the change of the layout can reduce 55% of total movement and more than 7,000,000 IDR of material handling cost [4].

The facility layout issues remain as one of the growing field areas of research. There is a rise in the number of publications in the topics of facility layout optimisation [5]. This shows that there is a necessity to solve the problem regarding this issue in the real world. One research shows that the ineffective layout design can lead to profit loss due to the total material handling fee [6]. The issues are related to the increase of product demand, the shifting of market direction, the fluctuation of production fee, and many more. Therefore, the facility design should also reflect on the possibility of future expansion [7]. The other research discusses designing a layout that is considered the human factor for adjusting the Industrial Revolution 4.0 trend [8].

There are several methodologies to solve the problem about facility layout design including mathematical methods, CORELAP, Systematic Layout Plan (SLP), BLOCPLAN, Graph-Based Theory, and many more [5]. It is essential to choose which methodologies to solve the problem. The
BLOCPPLAN algorithm has successfully reduced the distance between facilities and the total material handling cost [9]. Then, CORELAP which has a similar concept aims to minimise the total displacement distance and material handling fee [10].

One of the problem in the M Bakery is the far distance despite the busy movement between the half-finished product storage and the final product storage. The other problem is the unbalance space between one aisle to another aisle between facilities. Furthermore, there are three types of product which two of them shares the same production process while the other one share a different one. This study aims to examine the current layout in the M Bakery and choosing the best layout recommendation between one using BLOCPPLAN or the other one using CORELAP.

2. Methodology
2.1. Data Collection
This step is to collect the primary and secondary data for the research. The primary data is including the current layout and the workstation distance, the production floor space, the frequency of movement, the proximity level, and the production movement time. The secondary data are the production capacity, the facility number, and the employee salary fee.

2.2. Data Processing
There are fifteen processes including,
1. Current layout design
2. Calculation of distance between facilities based on the current layout
3. Calculation of the total movement moment based on the current layout
4. Calculation of total material handling cost based on the current layout
5. Activity Relationship Chart (ARC) design
6. Software BLOCPPLAN 90 running
7. Block Layout design based on the Software BLOCPPLAN 90 result
8. Calculation of distance between facilities based on the Software BLOCPPLAN 90 result
9. Calculation of the total movement moment based on the Software BLOCPPLAN 90 result
10. Calculation of total material handling cost based on the Software BLOCPPLAN 90 result
11. Software CORELAP 01 running
12. Block Layout design based on the Software CORELAP 01 result
13. Calculation of distance between facilities based on the Software CORELAP 01 result
14. Calculation of the total movement moment based on the Software CORELAP 01 result
15. Calculation of total material handling cost based on the Software CORELAP 01 result

The aim of the comparison between the two results of the algorithm is to find the best result regarding the minimum distance between facilities and the minimum material handling cost. Then the layout design of the best result will be the suggestion for the company for their improvement.

3. Results and discussion
3.1. Current layout design and calculation
Figure 1 shows the current layout. The layout design refers to the observation during the production process in M Bakery’s production floor. Then the design used as the reference for the calculation of the distance between facilities, total distance moment, and total material handling cost (table 1).
Legends:
A = Half-finished product storage
B = Packaging table
C = Raw material storage
D = Dough scale table
E = Dough mixing machine
F = Cooling table II
G = Cooling table I
H = Oven machine I
I = Oven machine II
J = Dough rising area
K = Finished product storage
L = Rolling machine
M = Dough moulding table
N = Dough cutting table

Colour:
1. Red = Production line bread A and B
2. Green = Production line bread C

Figure 1. Current layout design.

Table 1. Calculation of distance between facilities, total distance moment, and total material handling cost based on current layout.

| No | Start Workstation | End Workstation | Worker | Movement Frequency/Year (times) | Distance Between Facilities $d_{ij}$ (m) | Total Movement Moment/Year (times) | OMH/Meter | Total OMH/Year |
|----|-------------------|-----------------|--------|---------------------------------|----------------------------------------|-------------------------------------|-----------|----------------|
| 1  | C                 | D               | Nanda  | 12,045                          | 0.21                                   | 2,529                               | 8.55      | 21,622         |
| 2  | D                 | E               | Riki, Herman | 12,045                        | 1.79                                   | 21,561                              | 8.55      | 184,346        |
| 3  | E                 | N               | Zami   | 9,490                           | 2.00                                   | 18,980                              | 3.35      | 63,583         |
| 4  | N                 | L               | Riki and Herman | 1,825                         | 1.20                                   | 2,190                               | 2.94      | 6,438          |
| 5  | N                 | M               | Zami   | 6,570                           | 0.80                                   | 5,256                               | 2.94      | 15,452         |
| 6  | L                 | M               | Zami   | 8,395                           | 3.72                                   | 31,229                              | 3.35      | 104,617        |
| 7  | M                 | J               | Roji   | 2,190                           | 5.75                                   | 12,593                              | 5.73      | 72,157         |
| 8  | J                 | I               | Tama   | 7,300                           | 2.30                                   | 16,790                              | 5.73      | 96,206         |
| 9  | I                 | G               | Tama   | 10,950                          | 4.15                                   | 45,443                              | 3.30      | 149,961        |
| 10 | G                 | F               | Riki, Herman | 10,950                        | 3.06                                   | 33,507                              | 2.94      | 98,510         |
| 11 | F                 | B               | Tama   | 2,920                           | 1.92                                   | 5,606                               | 3.30      | 18,499         |
| 12 | B                 | A               | Fahmi  | 2,920                           | 1.84                                   | 5,373                               | 2.94      | 15,796         |
| 13 | A                 | K               | Tama   | 13,870                          | 2.03                                   | 28,156                              | 1.52      | 42,797         |
| 14 | A                 | K               | Tama   | 13,870                          | 5.96                                   | 82,665                              | 1.52      | 125,650        |
| **TOTAL** |                  |                 |        | 127,385                         | 42.38                                  | 379,932                             | 59.60     | 1,215,712      |
3.2. Activity Relationship Chart (ARC) design
The aim of designing the Activity Relationship Chart (ARC) is to connect activity in pair for understanding the relationship between activities in the production floor of M Bakery. The symbols of each relationship between facilities are A, E, I, O, U, and X with the reason for close or far distance at each facility.

3.3. BLOCPLAN layout design and calculation
For running the BLOCPLAN 90 software, the input data are the total floor space and Activity Relationship Chart (ARC). The result of twenty iterations for looking at the highest r-score is layout number 9 with the score of 0.76.

![Activity Relation Chart](image1)

**Figure 2.** Activity Relation Chart (ARC).

![BLOCPLAN result and block layout](image2)

**Figure 3.** BLOCPLAN result (left) and block layout (right).
Table two shows that the calculation of total material handling based on BLOCPLAN per year is 1,054,201 IDR. The farthest distance is the distance of half-finished product storage (A) to the final product storage (K) which is 57,699 meters/year. Meanwhile, the highest material handling cost per year is for the activity from the raw material area (C) to dough scaling table (D) which is IDR 254,372 OMH/year.

3.4. CORELAP layout design and calculation
The CORELAP layout designing process is including the layout drawing, coordinate point determination, the distance between facilities determination, total movement moment calculation, and total material handling cost calculation. There is only one result from the CORELAP 01 software which based on the value of Total Closeness Rating (TCR). That one result is the core data for thirteen iterations to determine which facilities should be the first one laying in the production floor.

![CORELAP result (left) and block layout (right).](image)
Table 3. Calculation of distance between facilities, total distance moment, and total material handling cost based on CORELAP result.

| No | Start Workstation | End Workstation | Worker            | Movement Frequency/Year (times) | Distance Between Facilities \(d_{ij}\) (m) | Total Movement Moment/Year (times) | OMH/Meter | Total OMH/year |
|----|-------------------|-----------------|-------------------|---------------------------------|-----------------------------------------------|-----------------------------------|------------|----------------|
| 1  | C                 | D               | Nanda             | 12,045                          | 1.18                                          | 14,213                             | 8.55       | 121,522        |
| 2  | D                 | E               | Riki, Herman      | 12,045                          | 1.81                                          | 21,801                             | 2.94       | 64,096         |
| 3  | E                 | N               | Zami              | 9,490                           | 0.50                                          | 4,745                              | 3.35       | 15,896         |
| 4  | N                 | L               | Riki and Herman   | 1,825                           | 0.90                                          | 1,643                              | 2.94       | 4,829          |
| 5  | L                 | M               | Roji              | 6,570                           | 1.40                                          | 9,198                              | 2.94       | 27,042         |
| 6  | M                 | J               | Zami              | 8,395                           | 2.82                                          | 23,674                             | 3.35       | 79,307         |
| 7  | J                 | H               | Tama              | 2,190                           | 0.53                                          | 1,161                              | 5.73       | 6,651          |
| 8  | J                 | I               | Riki, Herman      | 7,300                           | 3.63                                          | 26,499                             | 5.73       | 151,839        |
| 9  | I                 | G               | Tama              | 10,950                          | 6.06                                          | 66,357                             | 3.30       | 281,978        |
| 10 | G                 | B               | Zami              | 10,950                          | 4.86                                          | 53,217                             | 2.94       | 156,458        |
| 11 | H                 | F               | Tama              | 2,920                           | 0.43                                          | 1,256                              | 3.30       | 4,143          |
| 12 | F                 | B               | Riki, Herman      | 2,920                           | 2.53                                          | 7,388                              | 2.94       | 21,719         |
| 13 | B                 | A               | Fahmi             | 13,870                          | 3.01                                          | 41,749                             | 1.52       | 63,458         |
| 14 | A                 | K               | Zami              | 13,870                          | 7.23                                          | 100,280                            | 1.52       | 152,425        |
| TOTAL |  |  |  |  |  |  |  | 127,385  | 40.67 | 418,710  | 59.60 | 1,477,648 |

Table 3 shows that the total material handling cost per year is IDR 1.477,648. The farthest distance is the distance of half-finished product storage (A) to the final product storage (K) which is 100,280 meters/year. Meanwhile, the highest material handling cost per year is for the activity from dough scaling table (D) to dough mixing machine (E) which is IDR 389,282 OMH/year.

3.5. Comparison between BLOCPLAN and CORELAP

Table 4 shows the comparison between the current layout, BLOCPLAN based layout, and CORELAP based layout. The total movement moment of BLOCPLAN algorithm and the total material handling cost is 263.767 times/year and 1.054,201 OMH/year respectively. Therefore, the efficiency rate for this algorithm is 30.57% than the current layout. Meanwhile, the total movement moment of CORELAP algorithm is 418.710 times/year and the total material handling cost is 1.477,648 OMH/year. Therefore, the efficiency rate for this algorithm is -10.21% than the current layout.

| No | Layout              | Total Movement Moment/year | Total OMH/year | Efficiency Rate |
|----|---------------------|----------------------------|----------------|-----------------|
| 1  | Current layout      | 379,932                    | 1,215,712      | -               |
| 2  | BLOCPLAN based layout | 263,767                  | 1,054,201      | 30.57%          |
| 3  | CORELAP based layout | 418,710                  | 1,477,648      | -10.21%         |
The main reason for the large gap between the two algorithms is because of the high rectilinear distance between the half-finished product storage to the finished product storage of CORELAP algorithm compare to others. The other reason is the result of CORELAP algorithm shows that there is an inefficiency process flow where there is a back and forth movement in the area of packaging table and cooling table two. This inefficiency may disturb the whole production process which can lead to longer production time and higher material handling cost.

4. Summary
Based on the comparison between the two algorithms, the best-proposed layout improvement is the BLOCPLAN based layout. That is because the calculation shows that the layout proposed a minimum total movement moment, a minimum total material handling fee, and the highest efficiency rate than the CORELAP based layout. It is highly possible for the M Bakery to applies the modification to the production floor because all facilities is a moveable machine, tables, and storages.

5. References
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