An application of corelap algorithm to improve the utilization space of the classroom

A C Sembiring*, I Budiman, A Mardhatillah, U P Tarigan, and A Jawira

Industrial Engineering Department, Faculty of Technology and Computer Sciences, Universitas Prima Indonesia, Indonesia

E-mail: *anitakembaren@unprimdn.ac.id

Abstract. The high demand of the room due to the increasing number of students requires the addition of the room. The limited number of rooms, the price of land and the cost of building expensive infrastructure requires effective and efficient use of the space. The facility layout redesign is done using the Computerized Relationship Planning (CORELAP) algorithm based on total closeness rating (TCR). By calculating the square distance between the departments based on the coordinates of the central point of the department. The distance obtained is multiplied by the material current from the From-to chart matrix. The analysis is done by comparing the total distance between the initial layout and the proposed layout and then viewing the activities performed in each room. The results of CORELAP algorithm processing gives an increase of room usage efficiency equal to 14, 98% from previous activity.

1. Introduction
The high demand of the room due to the increasing number of students requires the addition of the room. The limited number of rooms, the price of land and the cost of building expensive infrastructure requires effective and efficient use of the space. The facility layout redesign is done using the Computerized Relationship Planning (CORELAP) algorithm based on total closeness rating (TCR). This study was conducted for improving good space utilization associated with the facility layout [1-5]. Based on the needs of the faculty room by the computer science faculty, then optimized the layout of the building in order to maintain the balance of land based on the comparison between open space and buildings where required by law in at least 30% open space. Therefore, it is necessary to improve the layout of private universities that become the object of research.

Redesigning the layout of an efficient space facility in overcoming material handling problems has been done in previous research using the CORELAP method as the best method in manufacturing companies [6-12]. The purpose of this improvement is to minimize the distance between departments and improve the effectiveness of labor by using the CORELAP method because it locates the most related activities and then adds other activities based on the desired distance and desired size. Proper room layout in building design should be considered as a functional specification and personal needs of users and fulfillment of final production cost calculations [13-16].

In this research, the authors will evaluate the facility's layout using the CORELAP method as it locates the most related and then progressively activities by adding other activities based on the
desired proximity and the required size. The purpose of this improvement is to minimize the distance between departments and increase the effectiveness of private university workforce by using CORELAP analysis [17-22].

2. Methodology/Experimental

The algorithm was introduced by Robert C. Lee and Moore in 1967 with the foundation of Muther's Systematic Layout Planning (SLP). The procedure there are three that is problem analysis, search stage, and selection stage. The input data of the algorithm include: (a) a relationship chart, (b) the area of each department, (c) the number of departments, (d) the closeness rating. CORELAP's initial step is to calculate the total closeness rating (TCR) of each department. TCR facility 1 is the sum of the numerical values that state the relationship between the facilities with each other. These values are obtained from the relationship diagram shown by the degree of proximity: A (given a value of 5), E (given a value of 4), I (given a value of 3), O (rated 2), U (given value 1), X (given a value of 0).

CORELAP is also a construction algorithm with activity relationship a major consideration. It is designed to accommodate situations when constantly changing conditions prohibit the collection of precise numerical data [21].

CORELAP constructs layouts by locating rectangular-shaped departments when the departmental area and layout scale permit a rectangular representation of the departmental area. It is based on REL chart and the numerical weighted rating assigned to the closeness ratings. The evaluation phase employs a placing rating and a boundary length. Total closeness rating for each department is calculated as:

$$ TCR_i = \sum_{j=1}^{m} V(r_{ij}) ; m = \text{no of departement} $$

CORELAP is a deterministic approach that provides an unique solution. Running the program second time with the same data produces the same final layout. The rectangular shape of the departments is divided into the predefined number of square blocks. In order to make department rectangular the area of the department which results in over utilization of the floor space. Once the relevant input data and information is entered, the entire layout of the development work is fully performed by the program. There is a high possibly that layout generated by CORELAP is not practically implementable.

Troubleshooting steps with the OCRELAP algorithm: (a) select one room with the maximum TCR, (b) second allocated space, select the room that has relationship A with the selected space, (c) the third allocated space, select the room which has an A relationship with the first selected chamber, (d) for the next selected chamber having an A, E, I, O, U relationship with the second selected chamber, or the third and the last one being placed if there is an X relationship with the first selected chamber.

This research was conducted at a private university in a medan city requiring a faculty room for lecturer performance improvement. Limited space and the number of students who are highly correlated with high land prices require the effective and efficient use of space. Because the university needs a new layout. Research is descriptive research with method used to describe or analyze research result can’t be used to make wider conclusion. The object of research observed is the actual condition of private higher education such as area space, spatial, and environmental management where the goal to look more tidy. The data collected for this study is the measurement of each initial layout and department, space capacity, and measured directly by using tape measure and visually.

3. Results and Discussion

In this section will discuss the point of coordinates of the room, the distance between rooms, the formation of Activity Relationship Chart (ARC), and calculation of CORELAP.

3.1. Drawing on room Layout

Private higher education layout has 13 sections or spaces used by universities to facilitate students and lecturers on the move. Each room consists of one or more work elements. Each layout has an existing
size and location. In this layout, drawing depicted space at the university. Determination of coordinate points for each room can be seen in Figure 1.

![Image of layout](image)

**Figure 1.** Actual layout of higher private education.

### 3.2. Coordinate Point Determination

Coordinate points can be measured using the formula:

Coordinate $X = X_0 + \frac{X_1 - X_0}{2}$

Coordinate $Y = Y_0 + \frac{Y_1 - Y_0}{2}$

The diagonal intersection that occurs for room A is at the point:

Coordinate $X = X_0 + \frac{X_1 - X_0}{2} = 0 + \frac{7 - 0}{2} = 3.5$

Coordinate $Y = Y_0 + \frac{Y_1 - Y_0}{2} = 0 + \frac{9 - 0}{2} = 4.5$

Coordinate point of room A = (x, y) = (3.5, 4.5)

Similarly, for the other room, the calculation of coordinate points in the same way. Data Work Station, Encoding and Data Size Each Room can be seen in Table 1.

| Department             | Code | Dimension (m) | Area (m²) | X  | Y  |
|------------------------|------|---------------|-----------|----|----|
| Financial Department   | A    | 6.745 x 8.925 | 60,199125 | 3.5| 4.5|
| BAA Office 1           | B    | 6.745 x 10.4  | 70,148    | 3.5| 14 |
| Computer Laboratory    | C    | 6.745 x 11.9  | 80,2655   | 3.5| 25 |
| Classroom 1            | D    | 6.745 x 5.95  | 40,13275  | 13.5| 28 |
| Marketing Department   | E    | 6.745 x 5.95  | 40,13275  | 13.5| 22 |
| BAA Office 2           | F    | 6.745 x 8.33  | 56,18585 | 13.5| 15 |
3.3. Inter Distance Measurement

The distance between rooms is measured using a rectilinear distance, where the distance is measured following a perpendicular path. Room distance is calculated by taking the center point of the room. In rectilinear distance measurement used the following formula:

\[ d_{ij} = |x_a - x_i| + |y_b - y_i| \]

The distance between stations is calculated using the Rectilinear distance formula:

Coordinate A (3.5 ; 4.5) and B (3.5 ;14), then the distance A to B is:

\[ d_{ij} = |3.5 - 3.5| + |14 - 4.5| = 9.5 \]

Likewise, for other distances are calculated in the same way. The results of calculating the distance between stations as a whole for the initial layout can be seen in Table 2.

Table 2. Distance between rooms.

| i/j | A   | B   | C   | D   | E   | F   | G   | H   | I   | J   | K   | L   | M   |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| A  | 9.5 | 20.5| 33.5| 27.5| 20.5| 14.5| 9.5 | 12.5| 39  | 34  | 31  | 33  |
| B  | 11  | 18  | 11  | 15  | 17  | 21  | 29.5| 24.5| 21.5| 23.5|     |     |
| C  | 13  | 6   | 13  | 26  | 28  | 32  | 18.5| 13.5| 10.5| 12.5|     |     |
| D  | 19  | 24  | 19  | 24  | 25  | 6.5 | 12.5| 16.5| 19.5|     |     |
| E  | 17  | 28  | 11  | 12  | 19  | 19  | 12.5| 18.5| 22.5| 25.5|     |     |
| F  | 23  | 18  | 6   | 7   | 18  | 19  | 19  | 19  | 19.5| 25.5| 29.5| 32.5|
| G  | 25  | 11  | 5   | 11  | 12  | 15  | 5   | 6   | 25.5| 31.5| 35.5| 38.5|
| H  | 28  | 18  | 11  | 5   | 4   | 29.5| 33.5| 37.5| 40.5|     |     |
| I  | 25  | 12  | 19  | 12  | 6   | 4   | 31.5| 37.5| 41.5| 44.5|     |     |
| J  | 31  | 25  | 25  | 25  | 25  | 29.5| 29.5| 31.5| 6   | 10  | 13  |     |
| K  | 37  | 19.5| 35.5| 37.5| 41.5| 4  | 4   | 10  | 4   | 3   |     |     |
| L  | 33  | 23.5| 12.5| 19.5| 25.5| 32.5| 38.5| 40.5| 44.5| 13  | 7   | 3   |
| M  |     |     |     |     |     |     |     |     |     |     |     |     |     |

3.4. Determination of Total Moving Distance

Total displacement distance is obtained by:

Total distance of displacement = frequency x distance of room

Example: Total distance of displacement = frequency x distance of room = 10 x 9.5 = 95 m

Likewise for the total distance of other displacements is calculated in the same way.

3.5. Activity Relationship Chart

ARC is made on the basis of the frequency of the flow of the room's displacement, the frequency of carrier/labor displacement, the similarity of material handling tools used and also the factors of comfort and safety at work. The ARC between rooms can be seen in Figure 2.
3.6. Data Processing With Corelap Algorithm

Calculations with the CORELAP Algorithm use a significant proximity rating in the Proximity Rating Total (TCR) in the selection of workplace placements. The TCR calculations are performed based on the qualitative data of ARC in Figure 4, which is converted into figures, in Table 3.

Table 3. Scale of ARC score.

| Kode | Value |
|------|-------|
| A    | 5     |
| E    | 4     |
| I    | 3     |
| O    | 2     |
| U    | 1     |
| X    | 0     |

Step-by-step data processing with CORELAP: Select one of the room that has the value with the highest Total Closeness Rating (TCR) and the largest area of the room as the first room, then select the second room that has relationship A with the first room, then the third room that has the relationship of the value of A to the first and subsequently selected chambers is chosen which has the relationship A, E, I, O, U with the second and third elected.

So using the same way all the rooms are allocated so as to generate allocations from the entire room so that all the rooms are correctly allocated according to the CORELAP algorithm. The layout image of CORELAP algorithm design can be seen in Figure 3.
3.7. Initial Condition Analysis

In the initial conditions, the arrangement of the layout at the private University has been seen optimally. This can be seen from the location of the room and the frequency of displacement in the University of Prima Indonesia. However, there are some rooms that are not proportional to the frequency of movement resulting in the total distance travelled to be longer.

3.8. Design Results Analysis

To compare the initial layout and proposed design, total displacement distance is used as a reference. The total distance of the displacements occurring in accordance with the initial conditions of the enterprise can be calculated by multiplying the frequency of displacements by their displacement distance

\[ \text{Correction} = \frac{\text{Total initial distance} - \text{Total final distance}}{\text{Total initial distance}} \times 100\% \]

\[ = 14.98\% \]

From this calculation, it can be seen that the design with CORELAP algorithm gives an efficiency of 14.98%.

4. Conclusion.

Based on the results of the study, the total initial distance of 2062.5 meters from the initial layout was reduced to 1753.5 meters. The result of CORELAP algorithm processing gives 14.98% efficiency and minimum class activity is converted into lecturer room. So that space J which was originally classroom converted into lecturer room.

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