

DESIGN RELAYOUT COMPANY WITH WEIGHTED DISTANCE METHOD FOR MINIMIZE OF TRAVEL TIME

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Abstract

PT IJS is a company engaged in logistics services in the Perak area of Surabaya. PT IJS was founded in 1984 when the need for container depots was urgently needed around the Tanjung Tanjung port area to unravel the shipping queues and shorten licensing. One of the services provided by PT IJS is bounded warehouse rental services. Bounded warehouse owned by PT IJS is currently not able to provide maximum service because there are still many late deliveries which do not result in the sending of goods to the port and there is a closing time that is detrimental to the customer. The length of the delivery process is due to several factors, one of which is a less effective company layout. Travel time is the time required for a vehicle to carry out goods loading activities at PT. IJS from arrival to exit company. Based on travel time calculations when using the initial layout, the travel time value of $T = 2002$ seconds. The weighted-distance method is a mathematical model used to evaluate the layout based on proximity factors. The design of the relayout design using the weighted-distance method produces alternative layouts that produce shorter travel time calculations, alternative layout with $T = 1849$ seconds.

Keywords: Relayout, Travel Time, Weighted Distance

I. INTRODUCTION

Competition in the business world is now getting tougher, every effort is required to carry out business activities effectively and efficiently. In a factory, effective and efficient can be seen through various aspects including material storage systems. For

example the warehouse of raw materials, the availability of raw materials at the right time and the right amount can affect the smooth production process. (Hidayat, 2012).

The layout of the company is a major aspect in the industrial world because it is closely related to the way the company facilities are managed. Optimal corporate layout settings will contribute to the smooth operation of all company operations. This means that a good corporate layout can place a variety of physical facilities and equipment on a regular basis so as to support the work running productively (Zhenyuan et al, 2011).

Facility layout planning includes determining the location of manufacturing systems and facility planning which includes the design of facilities, layout, and handling of materials that support production activities in a company. Layout is a major foundation in the industrial world. The layout of the plant (plant layout) or the layout of facilities (facilities layout) can be defined as the procedure for regulating factory facilities to support the smooth production process (Johan, 2018).

In the service system logistic companies often require quite a long travel time, which impacts on delays in the supply chain process and causes losses. Travel time within a company can occur due to several factors, one of which is the company layout implemented by the company has not been effective because the layout is applied conditionally. This causes the duration of the process of loading goods in the company. Delivery processes that are scheduled are often late.

PT IJS serves a variety of logistics activities for companies that require export import shipping services. One of the services provided by PT IJS is bonded warehouse rental services. One of the customers who use these services is PT CGR. PT CGR is a manufacturing company that processes cocoa beans and produces various kinds of products in the form of cocoa powder. The Bounded Warehouse system owned by PT IJS is closely related to customs, where all activities carried out in bonded areas must follow all applicable regulations, one of which is on time delivery and speed of service.

Bounded warehouse owned by PT IJS is currently not able to provide maximum services because there are often too many late deliveries which do not result in the delivery of goods to the port and there is a closing time that is detrimental to the customer.

One of the factors causing the hindrance of the shipping process is the company's layout which is considered ineffective because it still maintains the company's layout since the company's inception. There needs to be a change in company layout given the increasing number of goods loading activities within the company every day.

II. LITERATUR REVIEW

a. Layout Company

Facility layout can be defined as an activity to plan or arrange an industry's facilities optimally which includes manpower, transportation equipment, production department, raw material storage warehouse, finished material warehouse and all supporting facilities in accordance with the best structural design consisting of these facilities. . Facility design is the activity of evaluating, analyzing, conceptualizing and realizing a system for the manufacture of goods and services, in other words, an arrangement where physical resources are used to make products (Apple, 1990).

Company layout can be defined as a procedure for managing company facilities by optimally utilizing area to support the smooth production process. Arrangement of factory layout can improve production efficiency and effectiveness so that the planned production capacity and quality can be achieved with the most economical level of cost. Factory layout is a procedure for managing factory facilities by optimally utilizing the area to support the smooth production process (Hidayat, 2012). Good corporate layout design that is able to shorten the distance and minimize material handling costs so as to provide greater profits to the company (Lukmandono, 2018).

b. Travel Time

Travel Time of a road is one of the references that can be used in planning a trip. Estimated travel time information is very useful for road users to choose travel routes that can make it easier to get to the destination. For this reason, a reliable travel time estimate is needed (Haqqi, 2017). The travel time estimation method can be estimated by a direct survey in the field and can also be obtained from travel time modeling. The travel time measurement model used in this study is the Instantaneous Model which is included in the indirect methods and part of theoretical techniques. Instantaneous Model or Instantaneous Model is a method of estimating travel time that uses local speed data collected from each link at time k. The travel time for each link is calculated as the length of the link divided by the average speed at the upstream and downstream links, with the following formulation:

$$t(i,k) = \frac{2l_i}{v(i,k) + v(i,k)} \quad (1)$$

With:

l_i = link length (km)

$v(i, k)$ = Speed upstream of link i at time k (km / hr)

$v(i, k)$ = Speed downstream of link i at time k (km / hr)

$t(i, k)$ = Travel Time

c. Weighted Distance Method

The weighted-distance method is a mathematical model used to evaluate the layout based on proximity factors. The application of this method can be done using euclidean distance or rectilinear distance. Euclidean distance is the distance measured straight between the center of one facility and the center of another facility. Euclidean distance measurement systems are often used because they are easier to understand and

easy to use (Muslim, 2018). Examples of applications in several conveyor models, as well as transportation and distribution networks (Pratiwi, 2012). Calculation of rectilinear distance between i and j as follows:

$$d_{ij} = [(x_2-x_1)^2 + (y_2-y_1)^2]$$

(2)

$$d_{ij} = x-a + y-b$$

(3)

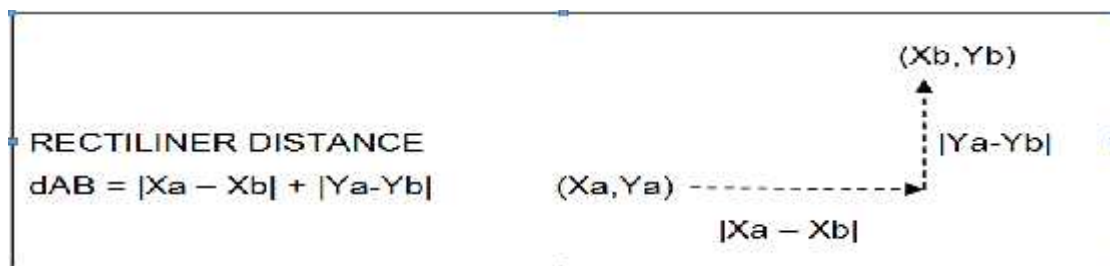


Figure 1 Formula of Rectilinier Distance

III. RESEARCH METHOD

The problem solving step in this research is to design an alternative layout with the weighted distance method and compare the results of the calculation of his travel timeline with the initial layout. In this study

the main objective is to minimize travel time service within the company by rearranging the company's layout using the weighted distance method approach.



Figure 2 Framework

3.1. Data Collection

Data needed for research are as follows:

- a. Company data (profile, location, scope, initial company layout)
- b. Schedule data and loading amount
- c. Data flow of shipping activities within the company

d. Data frequency and flow of goods loading activities

e. Data processing time of loading goods

3.2. Data Processing

After the data is collected then the data is processed by calculating the travel time needed based on the initial layout. Then use the weighted distance method approach to determine the proposed company layout and calculate travel time based on the proposed layout. The final step is to compare travel time between initial layout and travel time calculation using the proposed layout.

The method used to solve one problem formulation is Weighted Distance Method. This method consists of several workmanship sequences as follows:

1. Company Information
 - a. Profile of PT. IJS
 - b. Initial company layout and warehouse layout
 - c. Data on company rooms and facilities
 - d. Travel time data during initial layout
 - e. Frequency of flow and movement of goods
2. Material handling flow, i.e. material flow pattern data at PT IJS and activity relationship with the degree of closeness between rooms.
3. Activity proximity matrix, which is a table that gives a relative measure of the

importance of each pair of spaces that are located close together.

4. Space availability is facility data contained in the room to obtain the required area data.
5. Designing a new layout by developing a block plan considering the frequency of material handling and the proximity matrix of the activities of each space.
6. Evaluation Method, the comparison between the initial layout and the new layout with the results that can minimize travel time.

IV. Analysis and Discussion

4.1. Information of Company

PT IJS is a service company engaged in logistics. PT IJS serves several logistical activities in the Surabaya area and surrounding areas. PT IJS is supported by various transportation facilities and equipment that are complete and modern. For logistics activities, PT IJS serves a variety of activities, the main ones being container depots and bonded warehouse rentals (PLB). The following is the initial layout of PT IJS that is directly related to the loading of goods:



Figure 3. Initial Layout Company PT IJS

Process Flow Activity Loading

The duration of the activity which is used as a research reference is the result of

the average length of the loading process for 20 working days in July 2019. The following are observations of the data processing time in each department:

Table 1.
Data Processing Time Activities Goods Loading

Departemen	Activity	Implementing	Length of process
A	Licensing and Checking Process of vehicle	security guards and container drivers	5 minutes
B	Preparation of customs documents	Admin Customs clearance	30 minutes
C	Taking the queue stuffing number and checking	Admin document Counter	10 minutes
D	Document Legalization Process and collection of customs seals	Customs Officers	10 minutes
E	The waiting place is ready to be called stuffing according to number	the security guard	in 1 hour
F	Picking the container that will be used according to the pass order	Oprator Reachtruck	5 minute
G	Making travel document and finalizing	warehouse Admin document	30 minutes
H	stuffing process	Warehouse Officer	30 minutes
Total	The total time for stuffing		3 hours

To find out the travel time needed to reach one department to another, observations and measurements of travel time in the field were carried out. Travel time between locations above is obtained from the average time required by an officer of each department to travel from one department to another. The

travel time data above is used as a reference for determining travel time for each move between departments in the initial layout and layout layout. Table 2 explains the flow process between departments at PT IJS with the required travel time from one department to another based on the current layout:

Table 2
Travel Time Data between Departments

From	Travel time to the department (s)							
	A	B	C	D	E	F	G	H
A		60	60	120	120	180	210	250
B			60	60	60	120	180	180
C				120	120	180	150	260
D					60	60	120	120
E						100	150	120
F							60	70
G								60

Table 3
Proximity Departments Matrix

Department	Intersection between department							
	A	B	C	D	E	F	G	H
A		2	1	3	3	4	4	3
B			1	1	1	2	2	3
C				1	1	2	2	3
D					1	2	2	3
E						1	2	3
F							1	2
G								1
H								

Tabel 4
Degree of Proximity, Weight, and Description of Proximity

No	Degree of Proximity	Bobot	Description of Proximity
1	Absolute needs to be brought closer	5	There is a flow of important documents and shared contacts
2	It's important to hold it close	4	I frequently move documents and joint contacts
3	Enough / ordinary	3	Ada kontak dan pemindahan dokumen
4	Not important to be brought near	2	Jarang melakukan kontak bersama
5	Not desired to be near	1	Tidak ada pemindahan dokumen dan kontak bersama

Based on the proximity matrix analysis above, information can be obtained that:

- a. Departments that must be placed close together namely departments B and G, B and D, G and H.
- b. Departments that should not be approached, namely departments A and D, B and E.
- c. Dependable departments, namely departments A and C, C and E, E with F with H.
- d. Department which does not need to be approached, namely department A with B, F, G, H. Department B with C, F. Department C with D, H. Department D with F, H. Department F with G.
- e. For the proximity of other departments, based on the proximity matrix which is yellow is optional,

that is, it can be moved or not moved.

- f. Note from PT IJS that for department H, the main warehouse must not be moved because the facilities and structure of the building are permanent and cannot be moved.

4.1. Arangge Block Plan and Alternatif Layout

A block plan is a design that is used to arrange a room or departmental block by showing the placement of each room. Based on information on the availability of space that has been obtained from observations and considering the proximity matrix between departments, a block plan can be prepared as an easier reference to determine the proposed layout. The current block plan preparation based on the current layout is as follows:

A	B	D	F	G
C	E			H

Figure 4 Block Plan Based Initial Layout

Based on the current block plan and the proximity matrix, the first proposed block plan can be prepared with the records that department H or the warehouse may not be moved as in the previous information and taking into account conclusions 1 and 2 of the proximity matrix, namely:

- 1) Departments that must be placed close together namely departments B and G, B and D, G and H.
- 2) Departments that should not be approached, namely departments A and D, B and E.

The above considerations are implemented in the first proposed block plan as follows:

A	F	D	B	G
C	E			H

Figure 5 Proposed Block Plan 1

The next step is to design the proposed block plan into a layout according to the needs of the department and the availability of available space. Based on the needs of each room, the first proposal layout can be arranged based on the proposed block plan, which is as follows:

4.2. Evaluation of Method

To determine whether the proposed block plan is acceptable or not, we evaluate the weighted distance method by measuring rectilinear distance (d) and distance weight (wd). For rectilinear distance calculations use the following formula:

$$d_{ij} = |x-a| + |y-b| \tag{4}$$

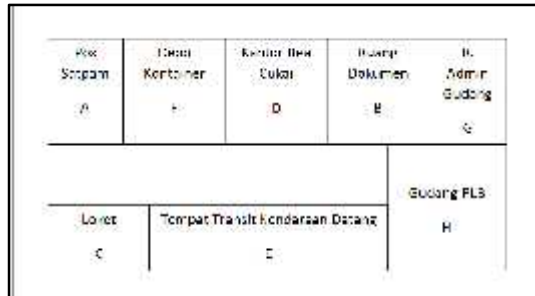


Figure 6 Alternatif Layout Based Proposed Block Plan

While the distance weight (wd) is obtained by multiplying the distance distance (d) by the proximity factor (w). So we get the formula of distance weight or weighted distance as follows:

$$wd = (d) * (w) \tag{5}$$

Based on the formula above, we obtain the value (wd) for each relationship between departments as follows:

Table 5 Calculation results of weighted distance

Space pair	Proximity Factor, (w)	Current Block Plan		Proposed Block Plan I	
		Distance (d)	Wd score	Distance (d)	Wd Score
A,B	2	1	2	2	4
A,C	4	1	4	1	4
A,D	1	2	2	2	2
A,E	3	2	6	2	6
A,F	2	3	6	1	2
A,G	2	4	8	4	8
A,H	2	5	10	5	10
B,C	2	1	2	3	6
B,D	5	1	5	1	5
B,E	1	1	1	2	2
B,F	2	2	4	2	4
B,G	5	3	15	1	5
B,H	3	4	12	1	3
C,D	2	3	6	3	6
C,E	4	2	8	2	8
C,F	3	3	9	1	3
C,G	3	4	12	4	12
C,H	2	4	8	4	8
D,E	1	1	1	1	1
D,F	2	1	2	1	2
D,G	3	2	6	2	6
D,H	2	3	6	3	6
E,F	4	2	8	1	4
E,G	3	3	9	3	9
E,H	4	3	12	3	12
F,G	2	1	2	3	6
F,H	4	1	4	4	16
G,H	5	1	5	1	5
Total Load Distance (LD)			175		165

Based on the results of calculations and weighted distance analysis for each relationship between departments, the value of Load distance for the current block plan is LD = 175 while for the proposed block plan the Load Distance value is LD = 165. From this value it can be concluded that the first proposed block plan is acceptable because the LD value of the proposed block plan is smaller when compared to the LD Current block plan. A smaller load distance value indicates the efficiency obtained because the workload during the activity will be lower because the distance between departments that are closely related to each other and the distance of departments that are not related further.

3.3. Analisis Of Travel Time

To know the travel time minimization that occurs in alternative layouts, it is necessary to calculate the travel time for the initial layout. Because travel time is the total time in stuffing activities, the definition of travel time is the accumulation of the travel time and the duration of the activity in each department, so the above formula can be derived as follows:

$$T_{total}(1,2) = T_{process}(1,2) + T_{travel\ time}(1,2) \tag{6}$$

$$\text{with, } T_{Process}(1,2) = \frac{2X(1,2)}{v(1)+v(2)} \tag{7}$$

$$T(1,2) = \frac{2D(1,2)}{v(1)+v(2)} + T_{travel\ time} \tag{8}$$

$$\text{with } V(1) = \frac{X1}{t1}, V(2) = \frac{X2}{t2} \tag{9}$$

then obtained the complete formula for travel time, i.e.:

$$T(1,2) = \frac{2D(1,2)}{\frac{X1}{t1} + \frac{X2}{t2}} + T_{travel\ time} \tag{10}$$

Is known :

T t = total travel time (s)

T p = activity processing time (s)

T travel time = travel time between departments (s)

D = Distance between departments (m)

V (1) = Process speed in department 1 (m / s)

V (2) = Speed of activity in department 1 (m / s)

X1 = Length of department room (1)

X2 = Length of department room (2)

t1 = processing time of the ministry activities (1)

t2 = processing time of department activities (2)

Based on the formula above, the travel time calculation results according to the flow of stuffing activities for the initial layout at PT IJS are as follows:

Tabel 6
Counting Travel Time of Inditonal layout

D 1	D 2	D(1,2) (m)	X(1) (m)	X(2) (m)	t(1) (s)	t(2) (s)	V(1) (m/s)	V(2) (m/s)	T(1,2) Process (s)	T (1,2) (s)	T(1,2) total (s)
A	C	1	25	15	300	600	0,833	0,250	18	60	78
C	E	2	15	75	600	3600	0,250	0,208	87	120	207
F	F	1	75	30	3600	300	0,208	0,167	15	60	75
F	II	1	35	50	300	3600	0,111	0,184	61	190	251
G	II	1	20	50	1800	3600	0,111	0,180	80	60	140
II	G	1	50	20	3600	1800	0,184	0,111	80	60	140
G	D	1	20	35	1800	1800	0,111	0,167	72	60	132
H	D	1	35	30	1800	600	0,167	0,500	80	60	140
D	G	2	30	20	600	1800	0,500	0,111	65	120	185
C	C	4	20	15	1800	600	0,111	0,250	222	250	472
C	A	1	15	25	600	300	0,250	0,833	18	60	78
Total		10	335	365	16800	18600	0,304	0,187	729	1100	1829

Based on the results of the travel time calculation above, the travel time value obtained on the alternative layout is $T = 1849$ seconds. From these results when compared to the travel time at the initial layout that is $T = 2002$ a larger second so as to obtain a travel time minimization of 153 seconds if an alternative layout is applied.

4. Conclusion

Based on the results of data processing and discussion, this study produced an alternative layout proposal for PT IJS that could maximize the loading of goods within the company. Calculation of travel time at the initial layout of $T = 2002$ second while the alternative layout produces a value of $T = 1849$ second, this shows that the alternative layout of the proposal succeeded in minimizing travel time. Then it can be suggested to PT IJS to use an alternative layout in this study to rearrange the layout of the company.

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