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Designing Steel Warehouse Layouts: A Comparative Study of Dedicated Storage and Class-Based Storage Methods at PT. BSB

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Abstract. PT BSB is a company engaged in steel fabrication manufacturing. There are various kinds of projects carried out at the company, namely bridges, steel structures, buildings, towers, etc. and the irregular placement of steel in the warehouse results in problems in the steel storage warehouse at PT. BSB where the company does not have an arrangement regarding the layout of raw materials for steel retrieval has difficulty because the steel is stored randomly without paying attention to its type and is only placed in an empty place. Therefore, it is necessary to design a layout using the dedicated storage and class-based storage methods to improve the warehouse layout by designing a warehouse layout so that it can make it easier to find and minimize steel search time. Results of research carried out obtained that distance travelled using the dedicated storage method is amounting to 7790,85 metres with material handling time 15581,7 minutes, whereas with use class based storage method can be obtained distance 8382,05 metres with material handling time 16764,1 minutes. Concluded that design results Select the selected layout is with use possible dedicated storage method reduce distance travel and time at PT. BSB warehouse becomes more practice and efficient

Keywords: Warehouse Efficiency, Dedicated Storage , Class Based Storage

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1. Introduction

Facility layout design is an important aspect of manufacturing and production operations. Facility layout is one of the factors that plays an important role in increasing a company's productivity in carrying out its production activities and involves designing the physical arrangement of machines, equipment, workstations and other elements in production facilities to optimize efficiency, productivity and safety. [1]. Warehouse layout design is an important process that involves structuring the physical infrastructure of the warehouse to maximize operational efficiency, product storage, and speed of order fulfillment. Effective warehouse layout can have a significant impact on overall productivity, cost savings, and customer satisfaction. [2].

Warehouse can be depicted as something system logistics for something company that has role important in keep products and equipment production other as well as provide product for being

processed or moved to next stage. Therefore that warehouse must be managed with good to get it minimize time search goods and save time search goods [3].

PT. BSB is a company engaged in steel fabrication manufacturing. There are various types of projects carried out in the company, namely bridges, steel structures, buildings, towers, and others. At PT. BSB was experiencing problems in the steel storage warehouse, where the process of placing and retrieving the steel was difficult because the steel was stored randomly without paying attention to the type and was just placed in an empty space. In addition, the width of the aisle was not calculated as efficiently as possible, making the search process more difficult [4].

To overcome this problem, companies need to set up a system in the storage room or warehouse to store the raw materials obtained. The variety of types of products produced and the irregular placement of steel in warehouses result in problems with steel storage where the company does not have arrangements regarding the layout of raw materials. There is some steel mixed in the wrong place and the steel is difficult to find at the time of collection which can make the fabrication process inefficient [5].

Seeing these conditions, companies need examples of good warehouse inventory management. The methods used to assist research are Dedicated Storage and Class Base Storage. Dedicated Storage is a method that is often referred to as specific and permanent storage because the location of each item has been determined [6]. Meanwhile, Class Base Storage is a method of storing goods by dividing goods into classes based on the similarity of certain criteria such as type of material [7]. The aim of this method is to improve the warehouse layout by designing a warehouse layout using dedicated storage and class based storage methods and then comparing which is more optimal, the distance and time for picking up steel in the PT warehouse. BSB [8].

For this reason, it is necessary to arrange storage locations in the warehouse so that the warehouse becomes an effective and efficient storage place. Dedicated storage and class based storage methods will help organize products by placing a product in a good and correct storage location [9]. This placement is based on comparing the activities of each product with the space requirements required by that product, then a product order is obtained from largest to smallest. This research aims to design a warehouse layout by comparing dedicated storage methods and class-based storage so that results are obtained and then a layout is selected that produces the layout with the shortest distance and the smallest handling time [10].

2. Methods

Data collection on the research method was carried out in the steel storage warehouse at PT. BSB uses the Dedicated Storage and Class Based Storage methods by looking at the results of data obtained from measurements and observations by looking directly at the problems experienced directly in the steel storage warehouse at PT.BSB. Next, conduct interviews with warehouse staff to obtain the necessary data such as data on receiving and picking up steel, data on the distance between goods moved and data on storage capacity. The following are the steps taken [11].

2.1. Calculating Space Requirement

Calculation of space requirements is the number of locations or spaces that can be occupied by a particular product, Space Requirement will facilitate the division of space and tell how many slots are needed to store goods. With this, it can be used as a benchmark for allocating warehouse space or the number of slots that will be used so that the use of slots and warehouse space becomes more efficient and organized [12].

$$Sj = \left(\frac{Average\ steel\ input}{storage\ capacity}\right) \quad (1)$$

2.2. Calculating Throughput

Calculation of throughput or activity is to know the activities carried out by the company, namely by prioritizing product placement at the highest activity by placing it close to the entrance or exit then following up to the smallest value. The requirement for this calculation is to know the average product entry and product exit In its activities in the warehouse in operating the delivery and receipt of goods

using a crane, in each operation the crane is only able to carry 2 steel each time, so that in determining the number of products that can be transported [13].

$$Tj = \left(\frac{Average\ steel\ input}{steel\ freight\ capacity}\right) + \left(\frac{Average\ steel\ output}{steel\ freight\ capacity}\right) \quad (2)$$

2.3. Comparison of Throughput and Space Requirement

Comparison is done to get the results of the previous calculation, where the highest T/S value will be prioritized to the lowest value in a row as the closest to the farthest area from the in / out aims to divide the products or goods stored into several parts, namely high, low and medium activity. With this division, it will be easier to make a layout plan in the warehouse based on the comparison of Troughput and Space requirements, besides that it will make it easier to group goods according to their specifications.[14].

$$\frac{T}{S} = \left(\frac{Throughput}{Space\ requirement}\right) \quad (3)$$

2.4. Determination of Aisle width

Determination of aisle width is used for making aisles that will be used for warehouse operators in the process of taking steel using material handling cranes. Because this warehouse uses a material handling process crane, the width of the aisle is used for warehouse operators in picking up steel, knowing that the average human shoulder is 37 cm and 180 cm high. This aisle calculation is only intended for aisles between slots. The following is the calculation to determine the width of the aisle:[15].

$$\text{Diagonal } = \sqrt{Long^2 + Wide^2} \quad (4)$$

2.5. Layout design with Dedicated storage

After is known results from ranking comparison of Throughput and Space requirements. Furthermore designing layouts with use dedicated storage method [16].

2.6. Calculating moving distance and handling time

Calculation of movement distance is done by determining points X and Y on the layout then calculating the distance between I/O and blocks from points X and Y to the center point of each destination using . After that, you will get the results of the largest to smallest T/S values for each block. The following is the formula for calculating the travel distance for each slot to the I/O point [17].

$$Dij = |xi - xj| + |yi - yj| \quad (5)$$

Information :

Dij = Distance from slot to I/O point

xi = Starting point for I/O calculations on the X Axis

xj = Distance from the center of the target to the X axis

yi = Starting point for I/O calculations on the Y axis

yj = Distance from the center of the target to the Y axis

Meanwhile, handling time calculations are carried out using cycle time collecting data, namely when the warehouse operator moves the crane to the entrance and exit area of the warehouse [18].

$$\text{Handling time} = \left(\frac{Total\ distance\ from\ temporary\ storage\ area\ to\ warehouse\ door}{average\ handling\ time}\right) \quad (6)$$

2.7. Class Based Storage methods layout design

Once the T/S results are known, the next step is to design a layout using the class based storage method. Class based storage is similar to the Dedicated Storage method but the stored item data is first grouped based on throughput values into classes A (high), B (medium) and C (low), determining the location of the storage location based on class from the closest area to the farthest from the warehouse I/O Point door, design a layout class-based storage method, and calculate the moving distance and handling time [19].

2.8. Selection of the best layout

Selecting the best layout based on the distance per move and the smallest handling time from the calculation results obtained using the Dedicated Storage class based storage method [20].

3. Results and Discussion

Data collection

Data collection was obtained from measurement and observation straight to the warehouse storage steel at PT.BSB. Obtained wide warehouse 1000 m 2, Length = 50 m, width = 20 m, Number of slots = 13 slots, Slot length 12 m, slot width = 3 m with 20 slot capacity which stores 5 types of steel with various size types namely H-Beam steel,WF,CNP,UNP and steel PIPE.And the handling tool used is a crane that can lift 2 steels.

Table 1. Average data on acceptance and collection steel

No	Name	Code	Type (mm)	Average Input Steel	Average Output Steel	Total Frequency
1	WF	NM.WF-00972	150X75X5X7X12000	18	16	34
2	WF	NM.WF-00469	200X100X5.5X8X12000	23	23	46
3	WF	NM.WF-26158	250X125X6X9X12000	16	14	30
4	H-Beam	NM.HB-03090	100X100X6X8X12000	14	27	41
5	H-Beam	NM.HB-04521	125X125X6.5X9X12000	18	15	33
6	CNP	NM.CN-44629	125X50X20X2.3X6000	19	19	38
7	CNP	NM.CN-90312	125X50X20X2.3X6000	20	20	40
8	CNP	NM.CN-73521	100X50X20X2.0X6000	22	18	40
9	UNP	NM.UN-09758	250X90X9X13X6000	24	19	43
10	UNP	NM.UN-23428	200X80X7.5X11X6000	23	22	45
11	PIPE	NM.PP-10862	3/4'X2.9X6000	42	20	62
12	PIPE	NM.PP-29162	2X3.9X6000	30	29	59

Data processing

Calculation space requirements

Space Requirement where this section explains about the division of storage space or specific place for 1 type of item in the storage or warehouse. with the following calculation:

$$Sj = \left(\frac{Average\ steel\ input}{storage\ capacity}\right) = \left(\frac{18}{20}\right) = 0{,}9 \text{ or } 1 \text{ slot}$$

Table 2. Calculation of Space Requiments

No	Name	Code	Average Input Steel	Storage Capacity	Space Requirement Teoritis	Space Requirements
1	WF	NM.WF-00972	18	20	0,9	1
2	WF	NM.WF-00469	23	20	1,15	1
3	WF	NM.WF-26158	16	20	0,8	1
4	H-Beam	NM.HB-03090	14	20	0,7	1
5	H-Beam	NM.HB-04521	18	20	0,9	1
6	CNP	NM.CN-44629	19	20	0,95	1
7	CNP	NM.CN-90312	20	20	1	1
8	CNP	NM.CN-73521	22	20	1,1	1
9	UNP	NM.UN-09758	24	20	1,2	1
10	UNP	NM.UN-23428	23	20	1,15	1
11	PIPE	NM.PP-10862	42	20	2,1	2
12	PIPE	NM.PP-29162	30	20	1,5	1

Calculation Throughput

With using average data on income and expenses monthly . Where is the power support a crane can bring 2 pieces steel . Throughput calculations are used For know activity steel in and out on time That . With calculation as following :

$$Tj = \left(\frac{Average\ steel\ input}{steel\ freight\ capacity}\right) + \left(\frac{Average\ steel\ output}{steel\ freight\ capacity}\right) = \left(\frac{18}{2}\right) + \left(\frac{16}{2}\right) = 17 \text{ Activity}$$

Table 3. Calculation Throughput

No	Name	Code	Average Input Steel	Average Output Steel	Throughput (Activity)
1	WF	NM.WF-00972	18	16	17
2	WF	NM.WF-00469	23	23	23
3	WF	NM.WF-26158	16	14	15
4	H-Beam	NM.HB-03090	14	27	20,5
5	H-Beam	NM.HB-04521	18	15	16,5
6	CNP	NM.CN-44629	19	19	19
7	CNP	NM.CN-90312	20	20	20
8	CNP	NM.CN-73521	22	18	20
9	UNP	NM.UN-09758	24	19	21,5
10	UNP	NM.UN-23428	23	22	22,5
11	PIPE	NM.PP-10862	42	20	31
12	PIPE	NM.PP-29162	30	29	29,5

Calculating the Comparison of Throughput and Space Requirements

After obtaining the results of the calculation of throughput and Space Requirement, the placement of products in the warehouse will be adjusted to the comparison between Troughput and Space Requirement where the largest will be placed in the place closest to the front of the I / O so as to minimize the distance traveled by the goods.

Table 4. Comparative Calculation of Throughput and Space Requirements

No	Name	Code	Throughput (Activity)	Space Requirements	T/S
1	PIPE	PP-10862	29,5	1	29,5
2	WF	WF-00469	23	1	23
3	UNP	UN-23428	22,5	1	22,5
4	UNP	UN-09758	21,5	1	21,5
5	H-Beam	HB-03090	20,5	1	20,5
6	CNP	CN-90312	20	1	20
7	CNP	CN-7321	20	1	20
8	CNP	CN-44629	19	1	19
9	WF	WF-00972	17	1	17
10	H-Beam	HB-04521	16,5	1	16,5
11	PIPE	PP-29162	31	2	15,5
12	WF	WF-26158	15	1	15

Determination of the width

Determination of the width of the aisle is used as a way for warehouse operators in the process of taking steel using a material handling crane. Which is only known by calculating the width of the

shoulder and the height of the Warehouse operator as a road access in facilitating the extraction of steel material. The width obtained is known to be 37 cm shoulder width and 180 cm height, then the calculation of the width of the aisle is as follows.

$$\text{Diagonal } = \sqrt{(Long)^2 + (Wide)^2} = \sqrt{(180)^2 + (37)^2} = 1{,}83 \text{ m}^2$$

Method layout design dedicated storage

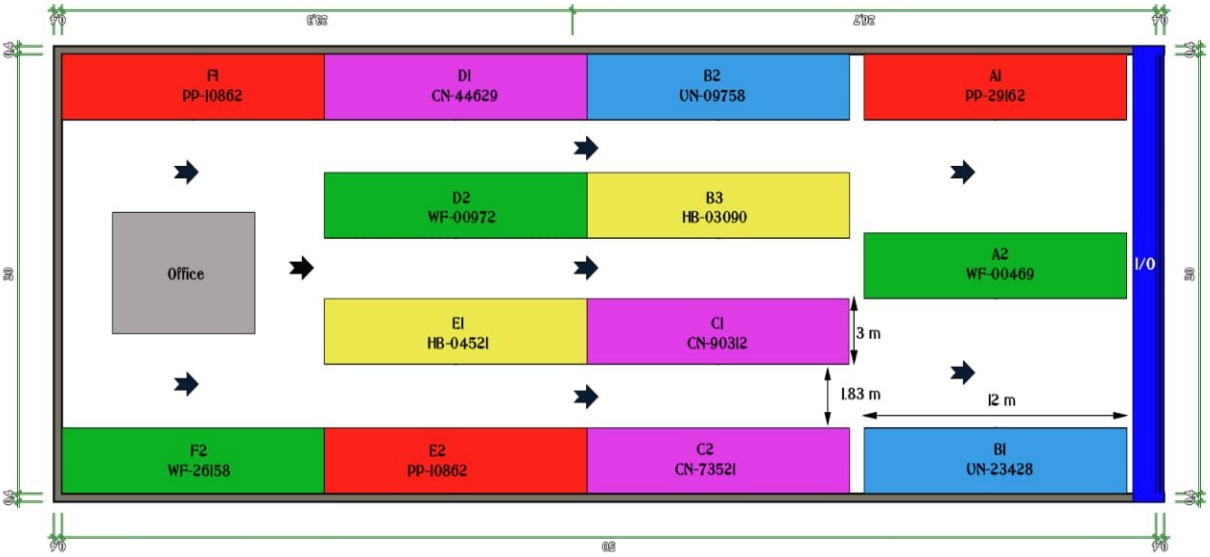

Figure 1. Layout Dedicated storage

Calculation of the distance between each storage slot and I/O Point

After make design layout models with Dedicated Storage method , then count movement each slot goes I/O point , computation done with method rectilinier distance.

A1 = | 0,5 – 18,5 | + | 1,5 – 7,5 | = 23 x 29,5 = 708 x 2 = 1416

Table 5. Calculation of distance and handling time with the dedicated Storage method

Block	Code	Xi	Xj	Yi	Yj	Dij(m)	T/S	T/S(Dij)	Total time	Handling time
A1	NM. PP -29162	0,5	18,5	1.5	7,5	24	29,5	708	2	1416
A2	NM.WF-00469	0,5	10	1.5	7,5	15,5	23	356,5	2	713
B1	NM.UN-23428	0,5	1,5	1.5	7,5	7	22,5	157,5	2	315
B2	NM.UN-09758	0,5	18,5	1,5	20	36,5	21,5	784,75	2	1569,5
B3	NM.HB-03090	0,5	12,5	1,5	20	30,5	20,5	625,25	2	1250,5
C1	NM.CN-90312	0,5	8,5	1,5	20	26,5	20	530	2	1060
C2	NM.CN-73521	0,5	1,5	1,5	20	19,5	20	390	2	780
D1	NM.CN-44629	0,5	18,5	1,5	30,7	47,2	19	896,8	2	1793,6

D2	NM.WF-00972	0,5	12,5	1,5	30,7	41,2	17	700,4	2	1400,8
E1	NM.HB-04521	0,5	8,5	1,5	30,7	37,2	16,5	613,8	2	1227,6
E2	NM.PP-10862	0,5	1,5	1,5	30,7	30,2	15,5	468,1	2	936,2
F1	NM.PP-29162	0,5	18,5	1,5	43	59,5	15.5	922,25	2	1844,5
F2	NM.WF-26158	0,5	1,5	1,5	43	42,5	15	637,5	2	1275
Total								7790,85		15581,7

Class Based Storage method layout design

Done with grouping steel based on class , grouping class done based on similarity type steel so that makes it easier in search goods . Grouping class based on types and shares become a number of color can seen in Figure 2.

Determine location place storage based on his class from the nearest area until farthest from door warehouse I/O point. Stage furthermore calculate throughput with sort mark from the biggest until smallest , for determine group which class should be placed near with I/O point . Calculation need room done based on class that has determined . The next step is calculate T/S with calculate throughput and space requirements .

Table 6. Class Grouping, Throughput Calculation, Space Requirement and T/S Comparison

No	Name	Colors in layout	Code	Average Input	Average Output	Throughput	Space Requirements	T/S
1	WF		N.M. WF-00469	23	23	23	1	23
2	WF		NM. WF-00972	18	16	17	1	17
3	WF		NM. WF-26158	16	14	15	1	15
4	HBeam		NM. HB-03090	14	27	20,5	1	20,5
5	HBeam		NM. HB-04521	18	15	16,5	1	16,5
6	CNP		NM. CN-73521	22	18	20	1	20
7	CNP		NM. CN-90312	20	20	20	1	20
8	CNP		NM. CN-44629	19	19	19	1	19
9	UNP		NM. UN-23428	23	22	22,5	1	22,5
10	UNP		N.M. UN-09758	24	19	21,5	1	21,5
11	PIPE		N.M. PP-29162	30	29	29,5	1	29,5
12	PIPE		N.M. PP-10862	42	20	31	2	15,5

Method layout design Class Based Storage

The next step is to create a warehouse layout design using the class based storage method based on Tj, and Sj. The warehouse layout design using the class based storage method uses a First in First Out (FIFO) system which functions to prevent goods that have been stored for a long time.

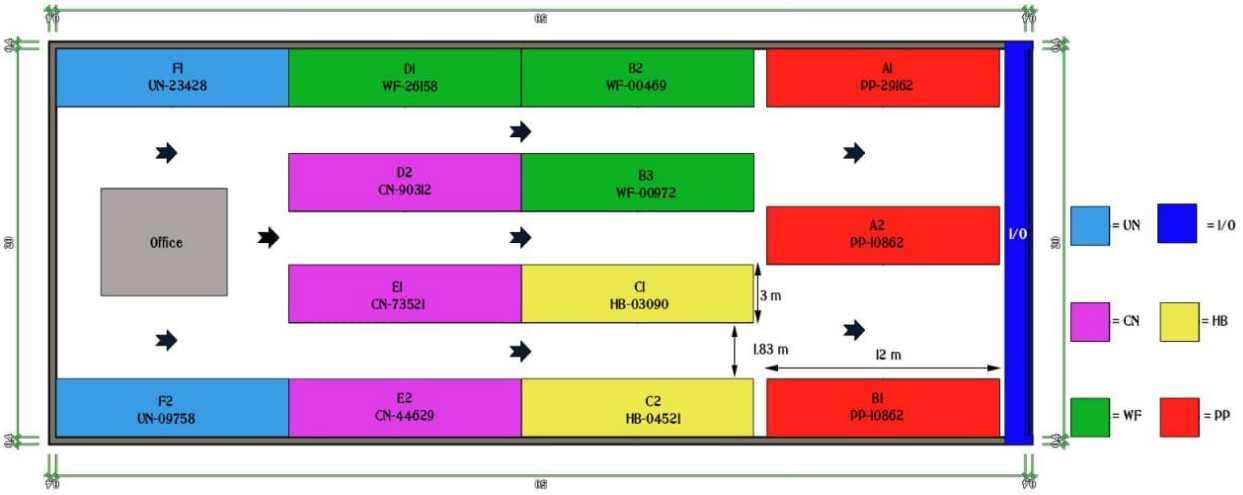

Figure 2. Layout design with Class Based Storage

Calculation distance movement and handling time for the Class Based Storage method

After After make design layout models with Dedicated Storage method , then count movement each slot goes I/O point , computation done with method rectilinier distance.

A1 = |0,5 – 18,5| + |1,5 – 7,5| = 23 x 29,5 = 708 x 2 = 1416

Table 7. Calculation of distance and handling time with the Class Base Storage Method

Block	Code	Xi	Xj	Yi	Yj	Dij (m)	T/S	T/S(Dij)	Total time	Handling time
A1	NM. PP-29162	0.5	18,5	1.5	7,5	24	29,5	708	2	1416
A2	NM. PP-10862	0.5	10	1.5	7,5	15,5	15,5	240,25	2	480.5
B1	NM. PP-10862	0.5	1,5	1.5	7,5	7	15,5	108,5	2	217
B2	NM. WF-00469	0.5	18,5	1,5	20	36,5	23	839,5	2	1679
B3	NM. WF-00972	0.5	12,5	1,5	20	30,5	17	518,5	2	1037
C1	NM. HB-03090	0.5	8,5	1,5	20	26,5	20,5	543,25	2	1086.5
C2	NM. HB-04521	0.5	1,5	1,5	20	19,5	16,5	321,75	2	643,5
D1	NM. WF-26158	0.5	18,5	1,5	30,7	47,2	15	708	2	1416
D2	NM. CN-90312	0.5	12,5	1,5	30,7	41,2	20	824	2	1648
E1	NM. CN-73521	0.5	8,5	1,5	30,7	37,2	20	744	2	1488
E2	NM. CN-44629	0.5	1,5	1,5	30,7	30,2	19	573,8	2	1147,6
F1	NM. UN-23428	0.5	18,5	1,5	43	59,5	22,5	1338,75	2	2677,5
F2	NM. UN-09758	0.5	1,5	1,5	43	42,5	21,5	913,75	2	1827,5
			Total					8382,05		16764,1

Selection of the best layout

Layout design in a warehouse with a storage area of 1000 m2 which stores 12 types of steel material which requires 13 block areas. A comparison of the distance traveled between the two types of methods can be seen in table 8.

Table 8. Comparison distance travel and material handling time

No	Layouts	Total Distance	Total Handling Time (minutes)
1	Dedicated Storage Method	7790,85	15581,7
2	Class Base Storage Method	8382,05	16764,1
	Difference	591,2	1182,4

4. Conclusion

In research that has been done done there is a number of the results achieved that is, the total distance traveled with Dedicated Storage method is 7790,85 meters with handling time is 15581,7 minutes . Distance traveled with proposed Class Based Storage method is 8382,05 with handling time is 16764,1 minutes meters. For results comparison use Dedicated Storage and Class Based Storage methods were obtained difference distance as big as 591,2 meters and handling time 1182,4 minutes . So comparison second results method This is the selected layout is with use Dedicated Storage method.

Based on the conclusions obtained, the advice given in this study is to use the Dedicated Storage method for designing the layout of the PT BSB steel storage warehouse, which is able to shorten the distance and shorten the time in retrieving steel from the warehouse, as well as grouping steel according to each type of steel to be more practical and efficient and also make it easier to find the type of steel for the steel fabrication process.

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