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Determine the warehouse layout design for Minimize Material Handling Costs Using the Systematic Layout Planning Method

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Abstract: PT. Millennium Pharmacon International is a pharmaceutical wholesaler with 32 branches in Indonesia and 1 central warehouse. PT. Millennium Pharmacon International has problems such as the high cost of material handling due to the long distance between areas and in some situations in the distribution area there is a buildup of goods to the point of having to use a storage area with a temperature below 25 degrees Celsius. Data collection techniques used are direct observations and interviews with warehouse managers. With the Systematic Layout Planning (SLP) method, a warehouse layout design can be produced that can help solve warehouse layout problems, minimize material handling costs, consider area proximity relationships, analyze space requirements and is a simple and easy method to implement. The findings of the research show that the resulting proposal can save material handling costs as much as 34% or Rp. 5,213,733 per week. And the analysis of room requirements in the drug storage area with temperatures below 25 degrees Celsius found that the room should be reduced in size so that it can be used for the distribution area and can save air conditioning costs as much as 85% or Rp. 3,746,995 per month.

Keywords: *Costs, Material Handling, Minimizing, Systematic Layout Planning, Warehouse*

1. Introduction

During the Covid-19 pandemic, public consumption of medicines and health equipment is increasing to keep them healthy and protected from Covid-19. Because the high demand for medicines and health equipment is increasing, this is also affecting companies, one of which is pharmaceutical wholesale companies, of course, with the increase in this industry and increasing demand in society, there is a need for warehouse facilities. Warehouse facilities are important in a company because they can determine the company's competitiveness. Therefore, the layout of the warehouse is the most important thing to pay attention to when planning the use of space as a warehouse. Based on previous research, namely "Reducing material handling costs through layout improvements using systematic layout planning" conducted by Mohamad Anik and Aryono Dwi Wibowo (Anik & Wibowo, 2020) which discussed the irregular layout

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of the Kyamas Logam company and inefficient distances between areas work that causes an increase in material handling costs using the systematic layout planning method. The conclusion obtained from this research is that the results of the Systematic Layout Planning method show three alternative suggestions where the third value can reduce OMH. It is known that the initial OMH was IDR. 5,260,186.89 and the total initial layout distance, namely 62,238 meters per week. The proposed layout I can save OMH by 23%, the proposed layout II can save OMH by 35% and the proposed layout III can save OMH by 37%. Based on the values obtained from the three proposals, the recommended layout is the proposed layout with the minimum value, namely the third proposed layout. Based on the need for warehouse layout design, the method used for research to create warehouse layout design is the Systematic Layout Planning (SLP) method (Muther, 1973). The SLP method can be applied because it can minimize material flow and take into account the relationship between space, space requirements and available space and can minimize material handling costs. Furthermore, the SLP method is also a simpler and easier to apply method to achieve the objectives of this research, including finding out the layout of repairs that takes into smaller travel distances resulting in smaller material handling costs (OMH), and find out the value of savings in medicine storage rooms with temperatures of less than 25◦ Celsius

2. Literature review

2.1 Warehouse

Warehouse is building used to store goods. The goods stored can be raw materials, semi-finished products, spare parts, or goods in process that are ready to be produced (Warman, 2012). Depending on the type of goods, there are various types of warehouses according to Purnomo (2004), namely:

1. Raw material warehouse
2. Warehouse for components/ spare parts/ goods in process
3. Finished goods warehouse
4. Office supply warehouse
5. Equipment warehouse

2.2 Warehouse Layout

A good warehouse layout should utilize available space efficiently to minimize storage and handling costs. Several factors that must be considered when designing a warehouse are the shape and size of the aisles, the height of the warehouse, the location and orientation of the loading and unloading areas, the type of shelves that will be used for storage, and their size. related to automation. in storing and retrieving goods. (Heragu, 2008). (Apple, 1990), Apart from being determined by the area of the room, warehouse capacity is also determined by the arrangement of storage goods (warehouse space layout). A warehouse with a messy and

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scattered layout is certainly less efficient than a warehouse with a rational layout. Apart from the above, there are other things to pay attention to, including the type of goods stored:

1. Fastmoving, namely goods that move quickly, usually in the form of goods that sell quickly or are often needed for production.
2. Slowmoving, means goods that move slowly, usually goods that move slowly or are rarely needed for production.

2.3 Material Handling

Material handling is the movement of materials, which is defined as the movement, lifting, delivery and storage of materials or goods. (Apple, 1990) Material handling is a key logistics activity that cannot be ignored. Investments in materials handling technology and equipment offer significant potential to increase logistics productivity. Material handling processes and their technology influence productivity by influencing capital equipment, space, and personnel requirements. According to (Warman, 2012), moving goods from one place, stopping at another place, and then re-delivering them is a common problem that arises due to demand.

2.4 Systematic layout planning

Systematic Layout Planning (SLP) Layout design using Systematic Layout Planning (SLP) is created to handle problems related to various types of problems, including manufacturing, shipping, warehousing, support, service 17 Trisakti Institute of Transportation and Logistics support, assembly, and back operations other offices. The steps in SLP are:

1. Analyze goods
2. Analyze material flow, Analyze employees and equipment
3. Analyze the area
4. Calculate distance and frequency, Calculate initial OMH
5. Analyze spatial relationships
6. Making a proposed layout, Calculate the distance of the proposed layout
7. Calculate the OMH of the proposed layout
8. Analyze space requirements

3. Research method

3.1 Data collection techniques

Data obtained from observation and measurement direct as well as from interview with logistics and warehouse workers and managers at PT . XYZ. Data during study collected and used as input in solution problem . the data consists from : Data on incoming goods for 3 months

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during warehouse activities , initial layout data PT. XYZ, Available work area, Number and size available tools, Business processes, Capacity warehouse and Salary employee.

3.2 Data Analysis Techniques

A. Systematic Layout Planning (SLP) method

Procedure steps for establishing the Systematic Layout Planning (SLP) method

1. Collecting data and analyzing material flow, to analyze quantitative measurements for every material movement between departments or operational activities. Usually the following maps or diagrams are often used:
   - Process flow map.
   - From to chart.
   - Activity relationship map.
2. Analyzing activity relationships, to obtain or find out the costs of moving materials and is quantitative, while the analysis is more qualitative in layout design, called the Activity Relationship Chart (ARC).
   - Making room relationship diagrams.
   - Create a proposed layout
   - Calculate the proposed material handling costs

B. Activity Relation Chart (ARC)

The relationship between activities in an organization, regarding flow connections (equipment, material, human, information and financial flows), environmental connections regarding security, safety, temperature, noise, lighting, and so on. In ARC there is a variable in the form of a symbol which represents the degree of closeness between one department and another department. Symbols are used to show the degree of interconnectedness of activities. There is a variable in the form of a symbol that represents the degree of closeness between one department and another in ARC. The symbols used are as follows as listed in Table 1.

Table 1.
Degrees ARC proximity

Degrees Proximity	Description
A	It is absolutely necessary to bring these activities closer together
E	It is very important that these activities are brought closer together
I	It is important that activities are close together
O	Usually (proximity), wherever there is no problem

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U	There is no need for any geographical connection
X	It is not desirable for these activities to be close together

Table 2.
ARC Reason Codes

Code	Reason
1	Work flow sequence
2	Degrees connection staffing
3	Collaboration Tools Same
4	Same employee
5	Same information
6	Noise, dust , smell No delicious

C. Activity Relationship Diagram (ARD).
Analysis flow of materials created furthermore namely the Activity Relationship Diagram (ARD). ARD makes more visualization clear related material flow and degree connection activity between work areas. At ARD degree proximity between facility stated with code letters, and colors which mean symbol the explained.

Table 3.
Degrees ARD proximity

Degrees Proximity	Color code
A	Red
E	Orange
I	Green
O	Blue
U	No color code (white)
X	Chocolate

D. Material handling distance measurements
There are several distance measurement systems used. Several types of distance measurement systems between departments are used according to the needs and characteristics of the company that uses it. The distance measurement that can be used is Rectilinear Distance. Rectilinear distance is a distance measured following a perpendicular path. Material handling costs (OMH) are calculated by multiplying the total movement distance and movement

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frequency by the material handling transportation costs per meter (BAM). The equations for calculating BAM and OMH are in equations (1) and (2). Material handling transportation costs per meter can be calculated using the following equation:

$$\frac{OMH}{Meter} = \frac{Gaji\ Perminggu}{Jarak\ Total} \dots\dots\dots\dots\dots (1)$$

After determining the OMH per meter of movement based on tool transport as well as frequency and distance For every transportation, then total OMH can be obtained calculated with formulation :

$$Total\ OMH \sum_{1} (Fij, Cij, Dij) \dots\dots\dots\dots (2)$$

where :
fij = frequency displacement between areas i and j
cij = material handling costs per unit distance
dij = distance between areas i and i

4. Results and discussion

4.1 Initial OMH layout calculation

The design of the warehouse layout at the Company starts from analyzing the material flow sh own in Figure 1, then calculating the distance between sections shown in Figure 2, then calcul ating the frequency of material handling as in Table 4.

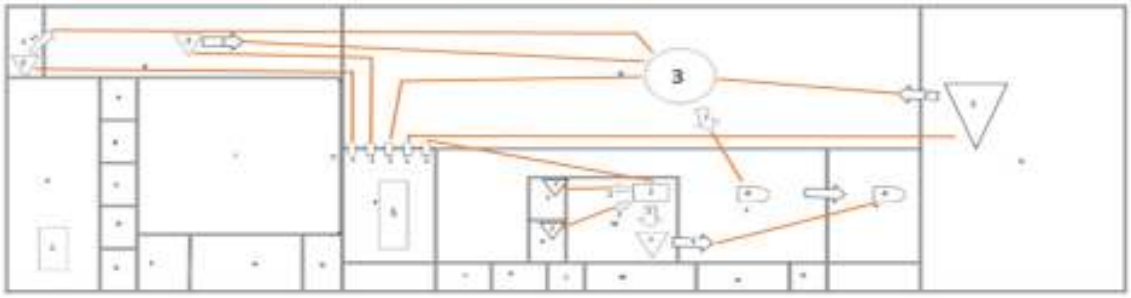

Fig. 1 Distribution Drug Flow Diagram

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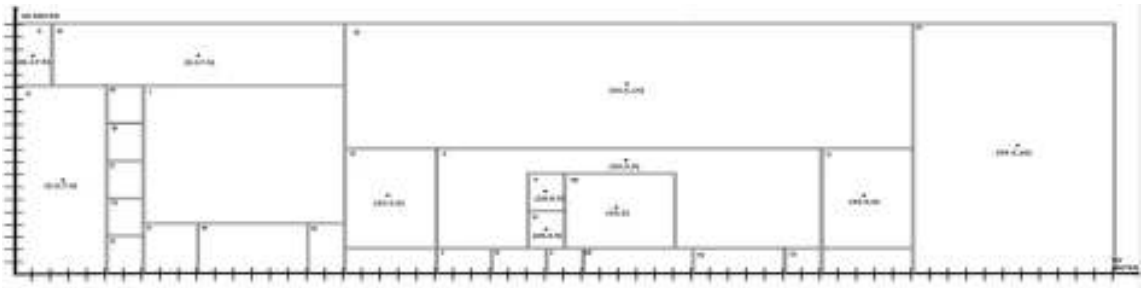

Fig. 2 : Determination distance between part warehouse

After getting it coordinate For each activity area , then distance between activity areas can calculated use formulation as following :
dij = |xi - xj | + | yi – yj |.
Example calculation :
PR area distance:
dpr =| xp - xr | + | yp – yr |.
dpr = |20.5 – 9 | + | 6 – 17.5 |
dpr = 23 m

Table 4.
Calculations frequency *material handling*

From	To	komponen	Frequen / week	Distance (m)	time displacement (seconds)	Distance per week (m)	Time displacement per week (seconds)	Time Movements per week (minutes)
P	S	drug narcotics	25	31	21	775	16275	271,25
P	R	necessary medication saved under temperature 25	35	23	16	805	12880	214,67
P	Q	medicines that are distributed immediately	220	22	15	4840	72600	1210,00

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P	U	stored medication	75	38	26	2850	74100	1235,00
S	Q	narcotic drugs	25	35	24	875	21000	350,00
R	Q	Medicines that must be stored below 25	35	27	18	945	17010	283,50
U	Q	stored medicines	75	26	18	1950	35100	585,00
Q	T	medicines that has been distributed	355	4	3	1420	4260	71,00
T	V	medicines ready to send	355	26	18	9230	166140	2769,00
P	W	expired medicines	5	14	10	70	700	11,67
W	Y	expired medicines that will be destroyed	5	5,5	4	27,5	110	1,83
W	X	damaged expired medicine	5	5,5	4	27,5	110	1,83
W	V	Expired medicines are ready to be returned	5	14,5	10	72,5	725	12,08
								7016,83

In calculations material handling costs (OMH) for every transportation determined in units of OMH/meter where has taken into account cost power work . Cost power Work material handling as percentage of the total time movement of materials and time processing in a week 17700 minutes . Following This results calculation percentage material handling time in One week .

Percentage Material handling time for the distribution process :

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$$= \frac{\text{total displacement time}}{\text{processing time}} \times 100\%$$

$$= \frac{6989{,}42}{17700} \times 100\%$$

$$= 39{,}48\% \sim 39\%$$

Percentage Material handling time for processing expired goods :

$$= \frac{\text{total displacement time}}{\text{processing time}} \times 100\%$$

$$= \frac{27{,}42}{840} \times 100\%$$

$$= 3.26\% \sim 3\%$$

Calculation fare *material handling* (OMH) is adjusted with cost wages received at PT . The calculation results for one of the areas as following :

Cost of TK *material handling* narcotics area = 39% x (amount wages and labor work)

= 39% x (1 x Rp. 4,461,854.00)

= 39% x IDR 4,461,854.00

= IDR 1,740,123

$$\frac{\frac{OMH}{meter}\ pengambilan\ biaya\ material\ handling}{\sum frekuensi\ x\ jarak}$$

= IDR 1,740,123 /1,650
= Rp. 1,054.62

Table 5.

Total OMH calculation between areas per week

From	To	component	frequency / week	Distance (m)	Distance per	OMH /meter	total OMH per week

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					week (m)		
P	S	drug narcotics	25	31	775	Rp. 1,055	Rp. 817,331
P	R	necessary medication saved under temperature 25	35	23	805	Rp. 632	IDR 508,454
P	Q	medicines that are distributed immediately	220	22	4840	Rp. 449	IDR 2,174,854
P	U	stored medication	75	38	2850	Rp. 363	IDR 1,033,182
S	Q	narcotic drugs	25	35	875	Rp. 1,055	Rp. 922,793
R	Q	Medicines that must be stored below 25	35	27	945	Rp. 632	Rp. 596,881
U	Q	stored medicines	75	26	1950	Rp. 363	Rp. 706,914
Q	Q	medicines that has been distributed	355	4	1420	Rp. 449	Rp. 638,077
Q	V	medicines ready to send	355	26	9230	Rp. 449	Rp. 4,147,501
P	W	expired medicines	5	14	70	Rp. 678	Rp. 47,443
W	Y	expired medicines that will be destroyed	5	5.5	27.5	Rp. 678	Rp. 18,638
W	X	damaged expired medicine	5	5.5	27.5	Rp. 678	Rp. 18,638
W	V	Expired medicines are ready to be returned	5	14.5	72.5	Rp. 678	Rp. 49,137

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TOTAL	1220	271.5	23887.5	Rp. 8,157	Rp. 11,679,841

Initial layout calculations resulted in a total OMH per week of IDR 11,679,841. then the next process is to make a proposal using the Systematic Layout Planning method, where the initial layout value will then be compared with the proposal made.

The following are the stages in the SLP method.

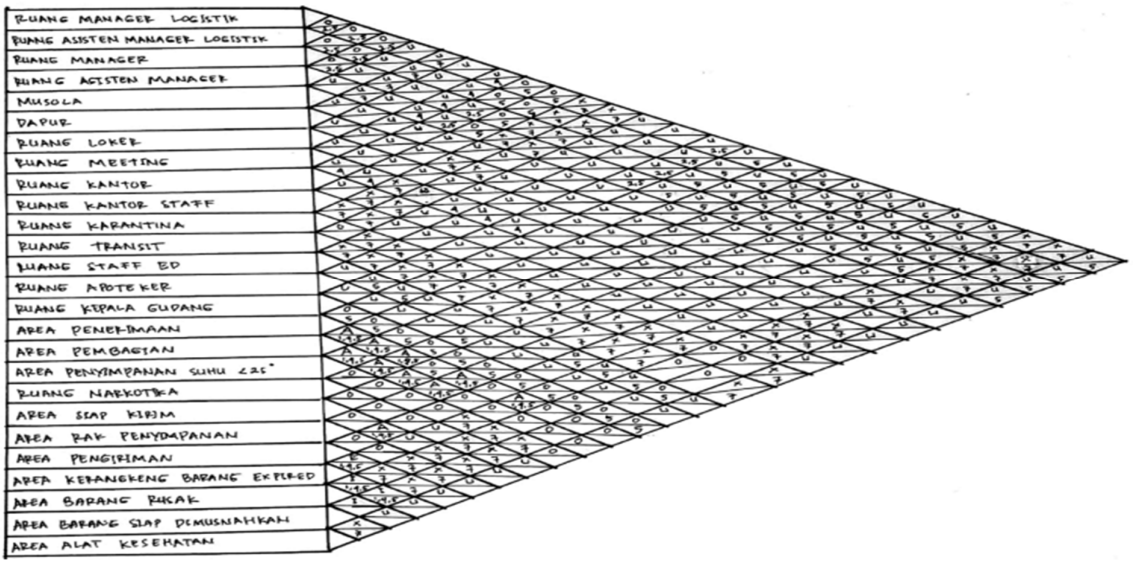

Fig. 3 Activity Relationship Chart (ARC)

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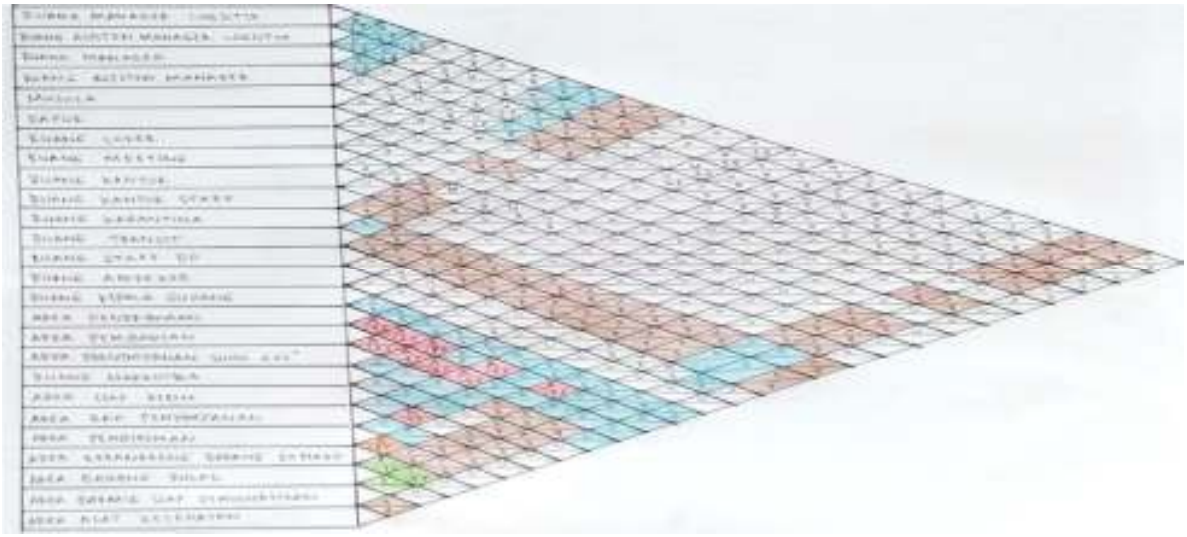

Fig. 4 Activity Relationship Diagram (ARD)

4.2 Layout Proposals

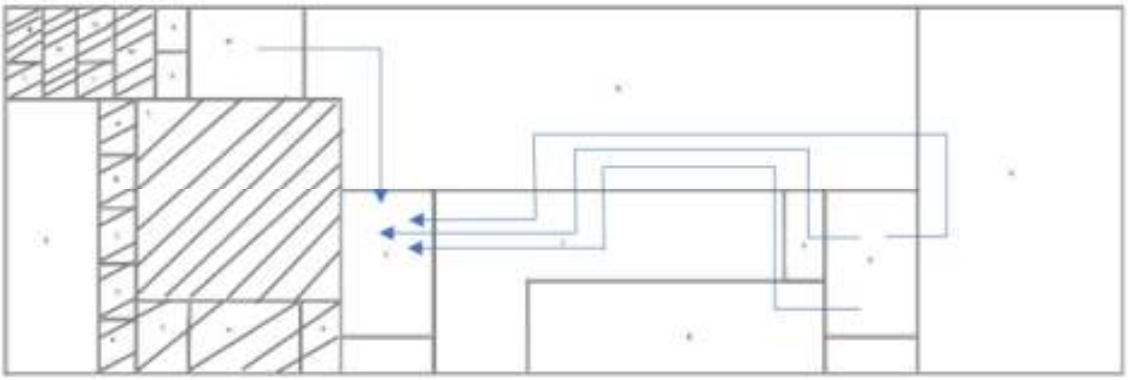

Fig. 5 Layout Proposals

Table 6.

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OMH calculation of proposed *layout*

From	To	component	frequency / week	Distance (m)	Distance per week (m)	OMH /meter	total OMH per week
P	S	drug narcotics	25	4.5	112.5	Rp. 1,055	Rp. 118,645
P	R	necessary medication saved under temperature 25	35	14	490	Rp. 632	Rp. 309,494
P	Q	medicines that are distributed immediately	220	22	4840	Rp. 449	IDR 2,174,854
P	U	stored medication	75	10	750	Rp. 363	Rp. 271,890
S	Q	narcotic drugs	25	17	425	Rp. 1,055	Rp. 448,214
R	Q	Medicines that must be stored below 25	35	15	525	Rp. 632	IDR 331,601
U	Q	stored medicines	75	26	1950	Rp. 363	Rp. 706,914
Q	Q	medicines that has been distributed	355	8.5	3017.5	Rp. 449	Rp. 1,355,914
Q	V	medicines ready to send	355	13	4615	Rp. 449	Rp. 2,073,750
P	W	expired medicines	5	45	225	Rp. 678	Rp. 152,494
W	Y	expired medicines that will be destroyed	5	4.5	22.5	Rp. 678	Rp. 15,249
W	X	damaged expired medicine	5	5.5	27.5	Rp. 678	Rp. 18,638
W	V	Expired medicines are ready to be returned	5	14.5	72.5	Rp. 678	Rp. 49,137
TOTAL			1220	199.5	17072.5	Rp. 8,157	Rp. 8,026,793

Based on table 6, the total proposed OMH layout is IDR 8,026,793. Apart from material movement costs, storage costs also include material handling costs (OMH) and storage costs

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which can be calculated, namely in drug storage areas with temperatures below 25 degrees Celsius. In this area there are a total of 4 AC units to keep the temperature below 25 degrees Celsius. There are a total of 4 AC units with a total PK of 6 PK to maintain the temperature in a room of 80 m2. It can be said that the capacity of 1 PK of AC can cool a room of 13.3 m2. Meanwhile, according to the analysis of space requirements, the need for space in drug storage areas with temperatures below 25 degrees Celsius only requires 10.5 m2 of space, meaning that the need for air conditioning in drug storage areas with temperatures below 25 degrees Celsius can be reduced to only using 1 AC unit with 1 PK capacity only.

Table 7.
Calculations air conditioning costs

No	PK AC	Power (watts)	Power per day (watts)	KVA	Cost electricity industry per KVA	Cost Per day	Cost Per month
1	1	840	20160	20.16	Rp. 1,112	Rp. 22,418	Rp. 672,538
2	1	840	20160	20.16	Rp. 1,112	Rp. 22,418	Rp. 672,538
3	2	1920	46080	46.08	Rp. 1,112	Rp. 51,241	Rp. 1,537,229
4	2	1920	46080	46.08	Rp. 1,112	Rp. 51,241	Rp. 1,537,229
Total		5520	132480	132.48		Rp. 147,318	IDR 4,419,533

For 4 ACs with a total capacity of 6 PK the costs that must be spent per month are IDR 4,419,533, while for 1 AC with a capacity of 1 PK it only costs IDR 627,538 per month. There is a difference of IDR 3,746,995.

5. Conclusion

Conclusions that can be drawn from the analysis that has been carried out are as follows:

1. Layout of the resulting proposal has consider material flows, relationships linkages room , needs room and available space , so distance generated in the proposed layout become more small from the previous one amounting to IDR 11,679,841 to IDR IDR 8,026,793 or save as much as 31%. so that can minimize material handling costs (OMH).
2. The result of analysis need room can reduce cost electricity in the storage area drug with temperature below 25 degrees Celsius previously amounting to IDR 4,419,533 to IDR 627,538 per month or save as much as 85%.

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