Selection of Rental Warehouse Using Analytical Hierarchy Process (AHP) Method Based on the Area Requirement Evaluation and the Design of Rental Warehouse Layout Using ABS Analysis and Office Layout Technique at PT. XYZ

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Abstract

PT. XYZ is a building equipment retail company which is located in Alam Sutera, Tangerang. Flooring which consists of ceramic and granite sales was become one of the featured products and has the highest sales frequency. Therefore, flooring has a direct impact on the current warehouse capacity of 85%. Due to limited company warehouse area and capacity, an analysis of warehouse capacity requirements using space requirements tools is conducted. Based on the result of the space requirements tools, the minimum area required reaches 3,717,28 m^2, hence, PT. XYZ should makes the decision to rent a warehouse outside the company area. The method that supports is Analytical Hierarchy Process (AHP). There are 4 preferred locations that have been assigned as an alternative leased warehouse. The selected alternative warehouse with percentage 43,7% is a leased warehouse owned by PT. XYZ located in Daan Mogot Km 21. The design of the chosen leased warehouse uses the ABC Analysis Method to classify the goods and the Office Layout Technique Method to design the office layout. The results from the ABC Analysis are, from the 11 products available, 5 products classified as A, 2 products classified as B, and 4 products classified as C. the results from the Office Layout Technique Method shows that the space and area needed for office space is 71,19m^2

Keywords
ABC Analysis, Analytical Hierarchy Process, Office Layout Technique and Space Requirement.

1. Introduction
PT. XYZ is a company engaged in the retail of building material equipment. Observations while in the company show that 85% of the capacity of the entire warehouse is dominated by flooring (tiles) which have 2 types of materials, including ceramic and granite. 85% of the capacity of flooring products includes 2, 4A, 4B, and 5 warehouses. Variety, resulting in reduced storage space which reduces air circulation due to too high a pallet stack. The company needs to evaluate the safe area needed in 2016. Due to the limited land area of PT. XYZ, the company may need to rent a warehouse outside the company's area, so it needs observation of alternative prospective rental warehouses. When an alternative rental warehouse candidate is selected, the research continues to design the proposed rental warehouse layout.

2. Research Methods
The research methodology begins with conducting field observations at PT. XYZ by looking at the warehousing conditions of ceramic and granite products. After making observations, you can identify the problems in the warehouse. Furthermore, the problem limitation is carried out from the existing problems to be used as a discussion of the problems taken. Furthermore, from problem limitation, several problem formulations can be drawn. Then data collection in the form of primary and secondary data is carried out to support the data processing process in the form of determining the required area using space requirement tools, determining the new rental warehouse using the Analytical Hierarchy Process Method, and designing the rental warehouse layout using the ABC Analysis Method and Office Layout Technique. After processing the data, an analysis can be carried out from the calculation of the

tools space requirement and provide suggestions in the form of selecting a rental warehouse and designing a rental warehouse layout. At the last stage conclusions and suggestions can be drawn for the company.

3. Results and Discussion
3.1 Selling Price Data, Number of Pallet Contents, and Pallet Size
The following is a table data of the price of ceramics per size, the number of contents in one pallet, and the pallet sizes of each ceramic and granite size (Table 1):

Table 1. Selling price data, number of pallet contents, and pallet size

Size	Selling Price/Box	Content per Pallet	P	L	T	EA
20x20 cm	56.300	100	1	1	2	m
25x25 cm	57.700	116	1,05	1,05	2	m
30x30 cm	62.300	108	1,05	1,05	2	m
40x40 cm	61.800	80	1,1	1,1	2	m
50x50 cm	78.100	72	1,3	1,3	2	m
60x60 cm	98.000	40	1,2	1,2	2	m
80x80 cm	216.700	33	1,3	1,3	2	m
100x100 cm	470.300	40	1,3	1,3	2	m
20x25 cm	52.700	96	1,05	1,05	2	m
25x40 cm	76.600	81	1,05	1,05	2	m
30x60 cm	131.500	84	1,05	1,05	2	m

3.2 Calculation of Space Requirements for Ceramic and Granite Warehouses
The following is a calculation of the Space Requirement on the ceramic and granite warehouse at PT. XYZ (Table 2):

Table 2. Calculation of space requirements for ceramic and granite warehouses

Warehouse	Information	P (1)	L (2)	Qty (3)	Area (4)	EA	T (5)	Volume (6)	EA
Warehouse 4A	Area /Volume of Warehouse (A)	70	24	1	1680	m²	5,00	8.400,00	m³
	Area /Volume of Forklift Manuver (B)	70	4	1	(-280)	m²	5,00	(-1.400,00)	m³
	Area /Volume of Between Palet Area 1 (C)	9,5	0,7	10	(-66,5)	m²	3,20	(-212,80)	m³
Warehouse	Information	P (1)	L (2)	Qty (3)	Area (4)	EA	T (5)	Volume (6)	EA
	Area /Volume Antar Palet Area 2 (D)	10,5	0,7	10	(-73,5)	m²	3,20	(-235,20)	m³

Luas/Volume Pemakaian (E1)					1260	m²		6.552,00	m³
Warehouse 4B	Area /Volume of Warehouse (A)	54	17	1	918	m²	5,00	4.590,00	m³
	Area /Volume of Forklift Manuver (B)	54	4	1	(-216)	m²	5,00	(-1.080,00)	m³
	Area /Volume of Between Palet Area 1 (C)	6	0,7	8	(-33,6)	m²	3,20	(-107,52)	m³
Warehouse 4B	Area /Volume of Between Palet Area 2 (D)	7	0,7	8	(-39,2)	m²	3,00	(-117,60)	m³
Area /Volume of Usage (E2)					629,2	m²		3.284,88	m³

Area /Volume of Usage (E2)					629,2	m²		3.284,88	m³
Warehouse 5	Area /Volume of Warehouse (A)	34	28	1	952	m²	3,60	3.427,20	m³
	Area /Volume of Forklift Manuver (B)	12,12	4	2	(-96,96)	m²	3,60	(-349,06)	m³
		11	4	2	(-88)	m²	3,60	(-316,80)	m³
		21,5	3	1	(-64,5)	m²	3,60	(-232,20)	m³
Area /Volume of Usage (E3)					702,54	m²		2.529,14	m³
Warehouse 2	Area /Volume of Warehouse (A)	19,94	6	1	119,64	m²	4,00	478,56	m³
		26	6	1	156	m²	4,00	624,00	m³
		26	5	1	130	m²	4,00	520,00	m³
Area /Volume of Usage (E4)					405,64	m²		1.622,56	m³
Total Warehouse for Ceramic & Granite Products (F)					2.997,38	m²		13.988,58	m³

The description of the alphabet in bold shows that there are examples of calculations that will be given in the report. The calculation above is a standard area adjustment so as not to obstruct air circulation by reducing the area of the flooring product warehouse with the area between the bulkheads and the forklift maneuver area that can be seen in the report. So, the total results of the warehouse for the use of ceramic and granite products at PT. XYZ with a total area of 2,997.38 and in terms of the total volume is 13,988.58. Then after knowing the area and volume of use, the next step is to determine the required area value for each size of ceramic and granite. This calculation is based on the 3-month average inventory on 11 flooring products. The following is a calculation table of the required area of each ceramic and granite size (Table 3).

Table 3. Calculation of space requirements for ceramic and granite warehouses

Ceramic									
Size (Cm)	Average Inventory In 3 Month (A)	Box Content per Pallet (B)	CTP* Average (C)	P (1)	L (2)	T (3)	Area (D)	Area Required (E)	EA
20x20	10.978	100	110	1,0	1,0	2,0	2,0	219,57	m³
25x25	10.979	116	95	1,1	1,1	2,0	2,2	208,69	m³
30x30	49.400	108	457	1,1	1,1	2,0	2,2	1.008,58	m³
40x40	159.175	80	1.990	1,1	1,1	2,0	2,4	4.815,04	m³
50x50	49.400	72	686	1,3	1,3	2,0	3,4	2.319,06	m³
20x25	16.468	96	172	1,1	1,1	2,0	2,2	378,24	m³
25x40	49.400	81	610	1,1	1,1	2,0	2,2	1.344,78	m³
30x60	38.422	84	457	1,1	1,1	2,0	2,2	1.008,58	m³
60x60	-	40	-	1,2	1,2	2,0	2,9	-	m³
80x80	-	33	-	1,3	1,3	2,0	3,4	-	m³
100x100	-	40	-	1,3	1,3	2,0	3,4	-	m³
Total	384.222		4.576					11.302,53	m³

Granite									
Size (Cm)	*Average Inventory In 3 Month* (A)	Box Content per Pallet (B)	CTP* *Average* (C)	P (1)	L (2)	T (3)	Area (D)	Area Required (E)	EA
20x20	-	100	-	1,0	1,0	2,0	2,0	-	m³
25x25	-	116	-	1,1	1,1	2,0	2,2	-	m³
30x30		108	-	1,1	1,1	2,0	2,2		m³
40x40	-	80	-	1,1	1,1	2,0	2,4	-	m³
50x50	-	72	-	1,3	1,3	2,0	3,4	-	m³
20x25	-	96	-	1,1	1,1	2,0	2,2	-	m³
25x40	-	81	-	1,1	1,1	2,0	2,2		m³
30x60	-	84	-	1,1	1,1	2,0	2,2	-	m³
60x60	137.220	40	3.431	1,2	1,2	2,0	2,9	9.881,28	m³
80x80	21.956	33	666	1,3	1,3	2,0	3,4	2.251,08	m³
100x100	5.489	40	138	1,3	1,3	2,0	3,4	466,44	m³
Total	164.665		4.235					12.598,80	m³
Total as a whole								23.901,33	m³
Total Area Required for Ceramics (F)								11.302,53	m³
Total Area Required for Ceramics (G)								12.598,80	m³
Total as a Whole (H)								23.901,33	m³
Total Usage of Ceramic and Granite Warehouse (I)								13.988,58	m³
Volume Required (J)								9.912,75	m²
Status								Need Decision	
Area Required (K)								2.478,19	m²
Distance Required For Aisle (L)								1.239,09	m²
Total Area Required (M)								3.717,28	m²

*CTP = Conversion to Pallet

3.3 Processing of Analytical Hierarchy Process Method

The following are the work and weighting steps made based on book sources, namely Models, Methods (Figure 1), Concepts, & Applications of The Analytic Hierarchy Process with authors Saaty and Vargas in 2012. Saaty, L. G. and Vargas, T. L. (2012)
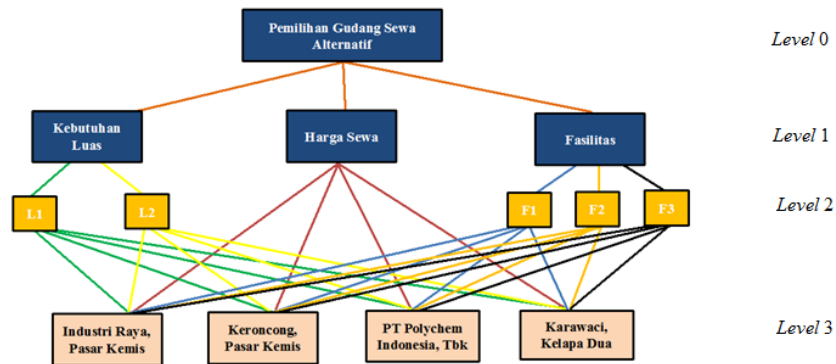

Figure 1. Matrix analytical hierarchy process (AHP)

In the matrix above, level 0 is the overall goal of the AHP method, which is getting the best rental warehouse. Level 1 explains that the criteria are based on the results of interviews with the senior manager. Level 2 is a sub-criteria that only exists in 2 criteria, namely the need for area and facilities. Level 3 is an alternative location that has been selected further which will be explained later. After making the matrix, the research continues by applying the targets of the criteria and sub-criteria. The following are predefined criteria based on the results of interviews with senior managers (Table 4):

Table 4. Target warehouse lease criteria

Criteria	Sub Criteria	Target
Area	Building area	Minimum 3.717,28 m^2
	Field Area	60% of the building area according to the Tangerang Regency Regional Regulation No.9 of 2006
Price	Rental price	Minimum Rental Price
Facilities	Electrical power	Cheaper Electricity Usage
	Distance to PT Caturkarda Depo Bangunan	The shortest distance from the rental warehouse to PT Caturkarda Depo Bangunan
	Security	Low crime rate

The following is an alternative warehouse for rent that fits the criteria made in Table 5:

Table 5. Criteria in determining selected rental warehouse alternatives

No	Alternative	Area		Price	Facilities		
		Building area (m^2)	Field Area (m^2)	Rental Price (Rp /year)	Distance to PT Caturkarda Depo Bangunan (Km)	Electrical power (Watt)	Security (cases of criminality occur)
1	Industri Raya, Pasar Kemis	5.300	9.000	Rp2.000.000.000	19,4	10.600	217
2	Kroncong Pasar Kemis	4.200	9.930	Rp1.600.000.000	16,0	52.800	217
3	PT Polychem Indonesia Tbk	3.800	11.000	Rp1.755.600.000	10,3	6.200	147
4	Karawaci, Kelapa Dua	6000	12.170	Rp2.000.000.000	8,1	29.000	353

The results of alternative warehouse calculations are as followsin Table 6:

Table 6. Priority between alternatives in subcriteria

Alternative Locations	L1	L2	H1	F1	F2	F3	Total	Percentage
Industri Raya, Pasar Kemis	0,070	0,010	0,029	0,002	0,005	0,002	0,114	11,8%
Kroncong Pasar Kemis	0,158	0,038	0,129	0,004	0,001	0,002	0,344	33,1%
PT.Polychem	0,234	0,100	0,080	0,012	0,009	0,003	0,450	43,7%
Karawaci, Kelapa Dua	0,040	0,020	0,029	0,023	0,002	0,000	0,092	11,4%

Based on the results of the above calculations, the highest percentage results were obtained at the PT. XYZ rental warehouse with a value of 43.7%. The percentage results indicate that the warehouse for rent at PT. XYZ is the best alternative warehouse based on the priority criteria according to PT. XYZ.

3.4 Data Processing with ABC Analysis Method and Office Layout Technique
At this stage, the data required is sales data in 2016 and prices. Sorting and designing the rental warehouse layout is done using the ABC Analysis Method and the Office Layout Technique.

3.4.1 ABC Analysis Method

Table 7. Results of sorting ceramics and granite using the ABC analysis method

Type	Size (cm)	Annual Sales	Revenue/Unit	Total Revenue	% Of Rev.	Cum. Of % Rev.	Class
G	60x60	540.000	Rp98.000	Rp52.920.000.000	27,72%	27,72%	A
K	40x40	626.400	Rp61.800	Rp38.711.520.000	20,28%	47,99%	A
K	30x60	151.200	Rp131.500	Rp19.882.800.000	10,41%	58,41%	A
G	80x80	86.400	Rp216.700	Rp18.722.880.000	9,81%	68,22%	A
K	50x50	194.400	Rp78.100	Rp15.182.640.000	7,95%	76,17%	A
K	25x40	194.400	Rp76.600	Rp14.891.040.000	7,80%	83,97%	B
K	30x30	194.400	Rp62.300	Rp12.111.120.000	6,34%	90,31%	B
G	100x100	21.600	Rp470.300	Rp10.158.480.000	5,32%	95,63%	C
K	20x25	64.800	Rp52.700	Rp3.414.960.000	1,79%	97,42%	C
K	25x25	43.200	Rp57.700	Rp2.492.640.000	1,31%	98,73%	C
K	20x20	43.200	Rp56.300	Rp2.432.160.000	1,27%	100,00%	C
Total				**Rp190.920.240.000**			

The arrangement of goods based on the investment value has 3 groups, including class A with an investment value of around 80%, Class B with a percentage value of about 15%, and C with a percentage value of 5%. Based on this data (Table 7), the proposed rental warehouse layout will be sorted by a fast-moving category or class A, slow-moving or class B, and non-moving or class C.

3.4.2 Office Layout Technique Method
Below are the results of some of the techniques used to create office layouts below.

3.4.2.1 Organizational Chart in Rental Warehouse
The figure below is an organizational body formed to provide an accountability structure for each division. Besides, the graph shows the quantity in each division so that you can find the area needed in the space for each 6 division (Figure 2).
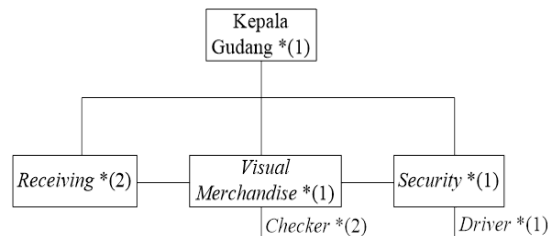

Figure 2. Organizational chart in rental warehouse

Based on the organizational structure above, the warehouse head is in charge of 3 divisions, namely the receiving division, visual merchandise, and security. On the receiving division, there are 2 operators on duty. In the visual merchandise division, there is 1 operator in charge of the checker division with 2 operators. In the security division, there is 1 operator on duty every shift, and in charge of the driver division. The organizational structure will determine the work process flow in the rental warehouse.

3.4.2.2 Flow Chart of Incoming and Exiting Goods Process
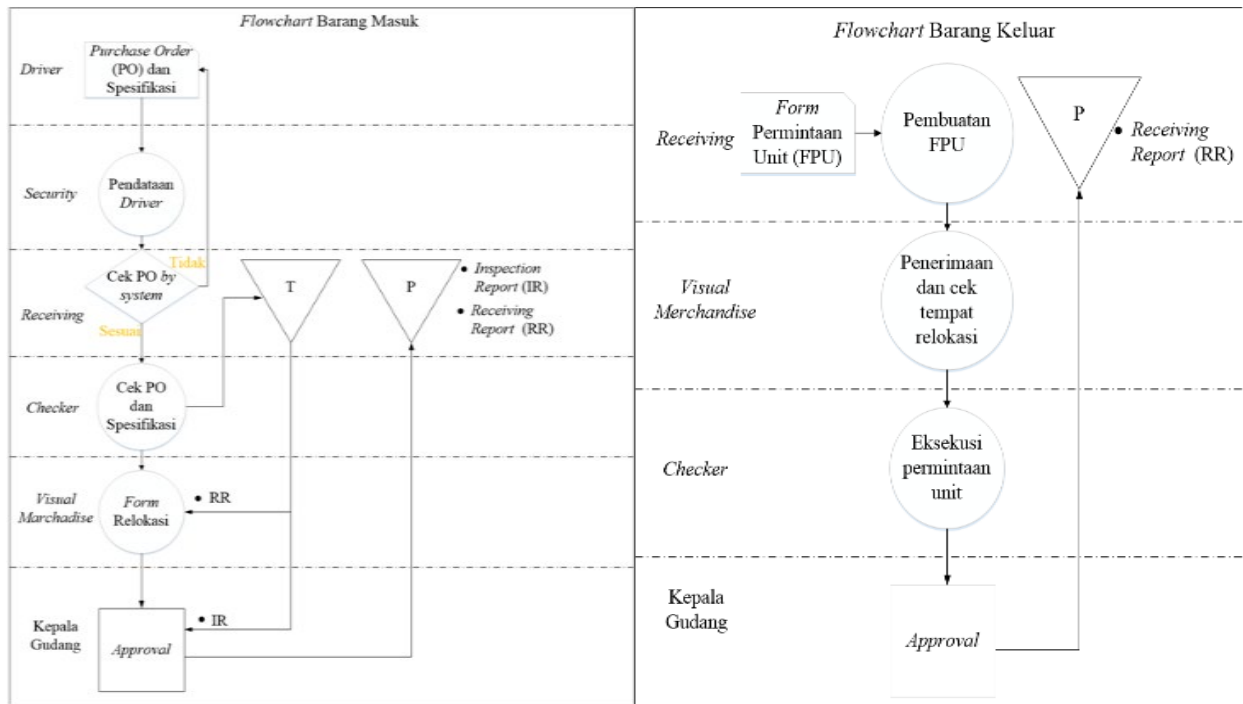The following is the process for goods entering and leaving the rental warehouse in Figure 3 :

Figure 3. Flow chart of incoming and outgoing goods

3.4.2.3 Communication Force Diagram for Each Rental Warehouse Division

The following is the Communication Force Diagram in the rental warehouse (Figure 4).
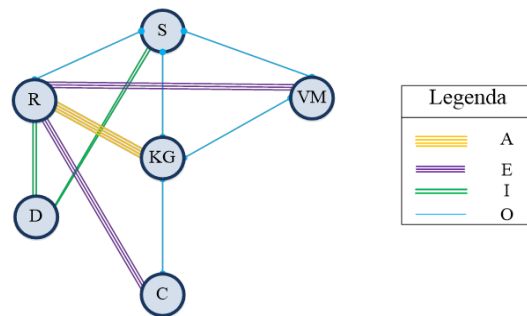

Figure 4. Communication force diagram between each division

The degree of closeness between each division is determined by the level of dependence of each division with other divisions to streamline the process of incoming and outgoing goods. Based on the graph above, it can be seen that the symbol "A" is between the receiving division with the warehouse head and the checker with visual merchandise. This is because the frequency of information that occurs is very high. The symbol "E" indicates that the frequency of information occurring is not higher than "A" but the processes of each division are connected. The symbol "O" indicates that the frequency of information that occurs in each division is not high but can still be connected.

3.4.2.4 Activity Relationship Chart

This tool requires a department that will be tied to each other in each rental warehouse division. The following is an ARC that has been made based on the degree of closeness between departments (Figure 5 and Table 8).
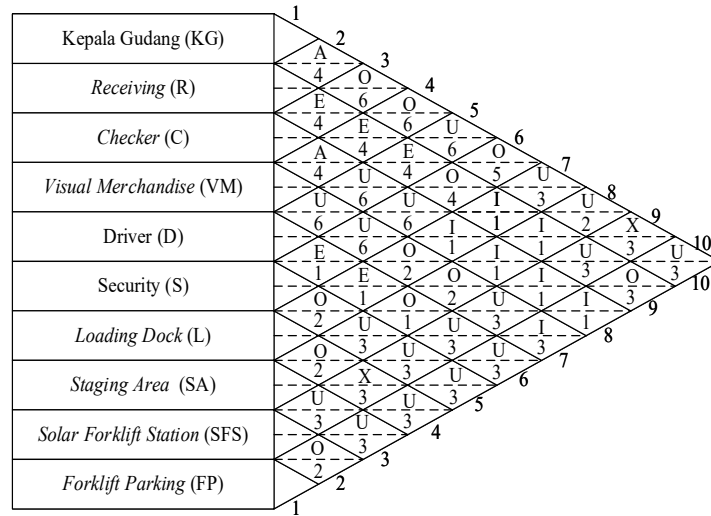
Figure 5. Activity relationship diagram (ARC) between each division

Table 8. Calculations in the activity relationship diagram (ARC) tools

Calculation of the Number of Facility Relationships	Calculation of Degree of Proximity between Departments
$$N = \frac{10(10-1)}{2}$$ N= 45 (There are 45 Relationships)	A= 5% × 45 = 2,25 ≈ 2 E = 10 % × 45 = 4,5 ≈ 5 I = 15% × 45 = 6,75 ≈ 7 O = 25% × 45 = 11,25 ≈ 11 U = remains X = remains

3.4.2.5 Activity Worksheet

This tool only describes the results of the ARC that was created. The following is the ARC result in tabular form (Table 9).

Table 9. Activity worksheet for rent warehouse ARD

Department	A	E	I	O	U	X
Head of Warehouse (KG)	2	-	-	3,4,6	5,7,8,10	9
Receiving (R)	1	3,4,5	7,8	6, 10	9	-
Checker (C)	4	2	7,8,9,10	1	5,6,	-
Visual Merchandise (VM)	3	2	10	1,7,8	5,6,9	-
Driver (D)	-	2,6,7	-	8	1,3,4,9 10	-
Security (S)	-	5	-	1,2,7	3,4,8,9,10	-
Loading Dock (L)	-	5	2,3	4,6,8	1, 10	9

Staging Area (SA)	-	-	2,3	4,5,7	1,6,9,10	-
Solar Forklift Station (SFS)	-	-	3	-	2,4,5,6,8,10	1,7
Forklift Parking (FP)	-	-	3,4	2	1,5,6,7,8	9

3.4.2.6 Dimensionless Block Diagram

This tool is made based on activity worksheets from 10 departments. The following is the result of the Dimensionless Block Diagram for 10 Rental Warehouse Departments (Figure 6).
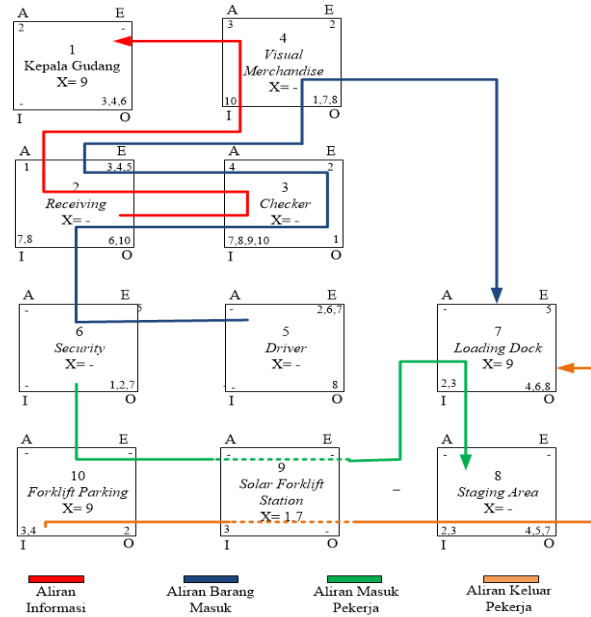

Figure 6. The flow of goods, information, and workers

3.4.2.7 Detailed Master Layout

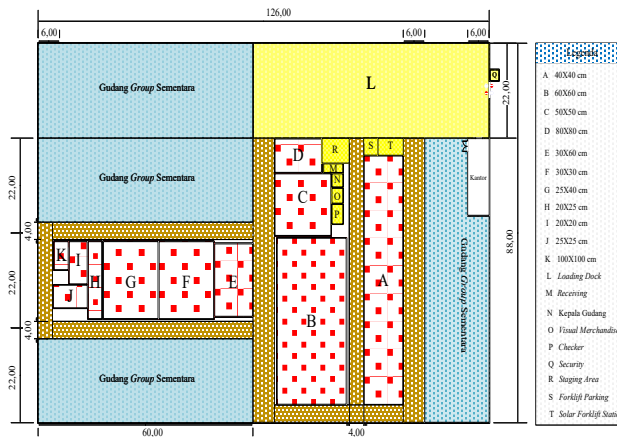The following is a proposed layout based on the office layout design stages (Figure 7).

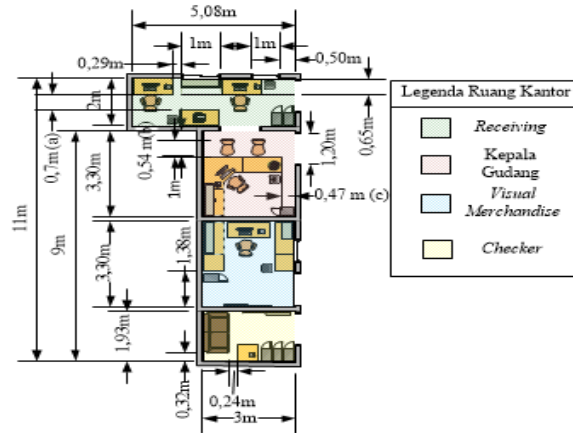Figure 7. Proposed layout using office layout techniques

Figure 8. The layout of office proposal

To plan an office layout in a rental warehouse, several considerations are made in determining the distance of a safe area in carrying out operational activities in the office area (Figure 8). The determination of the distance from each office area is based on the personal space zone and the dimensions of the human body in determining the size of the table width and the distance from the table to the chair. An explanation of the personal space zone is as follows in Table 10:

Table 10. Personal space zone

Code	Information	Distance	Zone
(a)	The distance between the table to the table	0,7 m	Circulation
(c)	The width of the hallway in the warehouse head's room	0,47 m	Without Touch

(a) The distance between the table and the table has a distance of 0.7 m in the Receiving division room, where the distance is included in the circulation zone. The distribution zone for the distance between the table and the table in the Receiving division room is because there are 2 operators on duty. The Receiving Division has high task mobility so that it needs a wide area distance to carry out its activities.

(b) The distance from the table to the chair in the section given a distance of 0.54 m based on Indonesian anthropometric data on dimension 13, namely knee length with P95.

The dimensions of the body used in determining the distance from the table to the chair and the width of the table use the 13th dimension, namely the knee length with P95 and the 24th dimension of the length of the arm span forward P50 with the width of the work table base used according to official data from Indonesian anthropometry as follows in Table 11-13:

Table 11. Dimensional data of knee length

Dimension	Information	P5	P50	P95
D13	Knee Length	50,48 cm	52,12 cm	53,77 cm

Table 12. Dimensional data of length of arm-based on the width of the base of the office table

Dimension	Information	P5	P50	P95
D24	Outer Table Pedestal Width	47,88 cm	65,54 cm	83,21 cm

Table 13. Body dimension and percentile data used

Code	Information	Distance	Dimension	Percentile
(b)	Distance from table to chair	0,54 m	13 (knee length)	P95
(d)	Table width	0,65 m	24 (Length of forward hand)	P50

(c) The hallway to the head of the warehouse is given a distance of 0.47 m which includes the no-contact zone. In this area, it can still be tolerated using the contactless zone because this area is only used for the place where the head of the warehouse moves to his work table.

(d) Based on Indonesian anthropometric data, the design of the table width uses the dimensions of 24 long arms span forward with percentile P50 0.65 m.

4. Conclusions and Suggestions
Based on the processed data, here are the conclusions of this study.
1. Determination is determined based on the dimensions of pallets of each size and the number of requests on average for 3 months. In addition, the calculation is also determined from the distance between the forklift maneuvers and the distance between the bulkhead and aisle. The results of the calculation for the required area of at least 3,717 m².
2. The determination is made by identifying the criteria that support the achievement of the company's goals for renting a warehouse. An alternative to the calculation results of the AHP Method is the location of PT. XYZ which is located at Jl. Daan Mogot Km 21 with a percentage of 43.7%.
3. The design is based on the ABC Analysis Method and the Office Layout Technique Method. The results of the analysis using the ABC Analysis Method are the sorting of flooring products based on classes A, B, and C. The results obtained from 11 ceramic and granite products are 5 class A products, 2 class B products, and 4 class C products. will be placed in locations close to entrances and exits, class B products will be placed behind class A products, and class C products will be placed at the back end of class A and C products. Office Layout Technique method in designing office layouts with the need for an office area of 71.19 and the determination of a circulation zone with a distance between desks and desks in the Receiving division room of 0.7 m and a contactless zone with a hallway width in the warehouse head's office of 0.47 m. Then to be able to know the width of the table base and the distance from the table to the chair, the dimensions of the human body are used with dimensions of 24 based on the width of the table base using P50 and dimensions 13 with P95.

Based on the processed data, here are suggestions that can be considered for PT. XYZ.
1. Research can be used as a reference for renting a warehouse, especially alternatives obtained from the AHP method, namely the location of PT. XYZ is located on Jl. Daan Mogot Km 21.
2. If the company is going to rent a warehouse, it is necessary to consider the trend of each product by distributing service quality questionnaires to the products sold by the Depo Bangunan Supermarket. Therefore, the company can carry out a marketing strategy for the next 6 months and evaluate the warehouse capacity needed to achieve these targets.

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