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Warehouse Layout Evaluation using the Activity Method Relationship Chart to Maximize Capacity and Efficiency Material Storage

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Abstract

Partner companies from various industrial sectors often face issues related to warehouse operational efficiency, particularly in managing suboptimal facility layouts. At PT PLN Nusantara Power UP Paiton, this issue is evident in the inefficient flow of materials within the warehouse, resulting in operational delays and increased costs. This report aims to evaluate the warehouse layout using the Activity Relationship Chart (ARC) method to maximize capacity and material storage efficiency. The ARC method is used to analyze the proximity relationships between facilities in a warehouse based on existing operational processes. The evaluation is conducted by comparing the initial layout with proposed alternative layouts, with a focus on optimizing material flow, reducing moving distances, and increasing warehouse operational efficiency. The analysis results show that the proposed alternative layout can improve warehouse space efficiency, reduce material movement distance, and accelerate workflow. The application of the ARC method successfully identified areas for improvement to increase productivity and reduce material management time. Evaluation of warehouse layout using the ARC method can significantly contribute to improving operational efficiency and better warehouse management at PT PLN Nusantara Power UP Paiton. It is recommended to continue implementing this method in improving the layout of other facilities to support smooth operations and reduce company costs.

Keywords: *ARC Method,Inventory,Layout,Optimization,Warehouse*

1. Introduction

Warehousing is a strategic component in the logistics system that acts as a temporary storage location for various types of goods, from raw materials, goods in process to finished goods [1]. In the context of logistics activities, warehousing plays a crucial role. Warehouse management encompasses a series of activities including planning, organizing, and monitoring all warehousing processes and operations to support the achievement of predetermined goals [2]. Warehouse management is an approach used to organize and control all warehousing activities [3]. The implementation of warehouse management is expected to reduce warehouse operational costs, increase the effectiveness and efficiency of receiving and recording goods, and ensure the availability of easily accessible and highly accurate inventory information. In general, the implementation of warehouse management aims to ensure adequate inventory availability, increase efficiency in stock management, and ensure the accuracy and reliability of inventory information. Thus, warehousing activities need to be managed through the implementation of an effective and efficient storage system to support the smooth running of the production process and support the optimal continuity of other operations [4].

This is relevant in the context of PT Pembangkit Jawa Bali (PJB), a company that operates a coal-fired steam power plant with a production capacity of 400 MW per hour [5]. The electricity production process at this company begins with the distribution of coal stored in the stockpile to the conveyor, then a refining process is carried out before entering the boiler. The coal is then refined through an ESP process in the boiler to produce heat energy that is channeled to the turbine, thus producing mechanical energy, which is then converted into electrical energy through a generator and distributed to the Java and Bali regions.

To support the smooth running of this process, a warehouse system evaluation is essential. This evaluation aims to maximize warehouse capacity, reduce operational time and costs, and identify and correct bottlenecks in the material storage and distribution flow. This evaluation is expected to provide benefits in the form of increased operational efficiency and improvements to the overall warehouse management system, thereby optimally supporting the ongoing electricity production process.

2. Literature

2.1. Previous Research

Research in 2022 by Arda Yulistio, Mahmud Basuki, Azhari entitled "Fashion Retail Display Layout Redesign Using Activity Relationship Charts" where in this study the cashier area was moved closer to the warehouse. The meeting room was moved to the center of the store for easier monitoring (customer entry and exit, product testing, transactions, and warehouse access). The warehouse and meeting room were now adjacent, and the meeting room became slightly larger. Based on the proposals provided based on ARC's analysis, there is a space savings of 3.64 m2 (from 50.14 m2 to 46.5 m2), which can be used to create new spaces, such as adding new shelves [6].

Research in 2022 by Nataya Charoonsri Rizani, Fajar Dwi Adistra entitled "Facility Layout Analysis Using The Activity Relationship Chart (Arc) Method At PT.XYZ" where in this study facility design improvements were implemented using the activity relationship chart (ARC) method, a method that uses activity relationship maps. Prior to designing using the ARC method, the strengths and weaknesses of the existing layout were first mapped. After designing the proposed layout, the effectiveness of the proposed layout was calculated. The results showed that the proposed layout increased efficiency by 32.8% in distance, increased efficiency by 19% in processing time, and increased productivity by 25% [7].

Research in 2023 by Fitri Nur Aziz, Yusup Kurnia entitled "Facility Layout Redesign Using The Arc Method To Maximize The Production Process In Making Rubber Sandals" where in this study The Activity Relationship Chart (ARC) method results in a more effective and efficient production flow, eliminating backtracking or backflow. The production process becomes more organized and maximized. Material movement distances are more effective and efficient, and the time required to move production materials is reduced from the initial 75 meters required for the production process. The design time required for a single production process is 45 meters. In each production run, the distance can be reduced by approximately 7 meters [8].

2.2. Activity Relationship Chart

The Activity Relationship Chart (ARC) is a method that plays a crucial role in facility layout design because it illustrates the level of interrelationship and proximity between activity groups or departments commonly found within a company. In its application, ARC does not use distance as the primary variable but instead uses symbols or codes based on qualitative assessments to represent relationships between facilities. Furthermore, ARC is understood as an approach that can be used to formulate new configuration alternatives in production facility layout design, thereby contributing to efforts to increase productivity and efficiency of the production process.

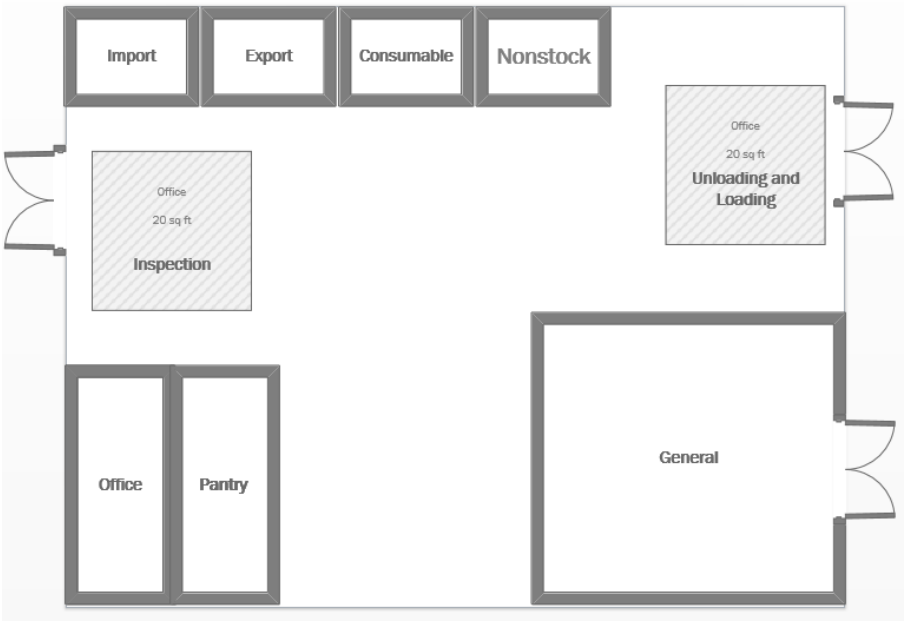


Fig 1: Initial Layout of Warehouse Unit 9

This research applies the Activity Relationship Chart method. ARC is used to identify problems and analyze the proximity relationships between each area in the warehouse. This is expected to maximize the capacity and efficiency of material storage, thereby minimizing operational time and costs.

3. Result And Discussion

3.1. Activity Relationship Chart

The facility layout evaluation in this warehouse was conducted using an Activity Relationship Chart (ARC). The ARC method is used to assess the level of proximity that should be maintained between the import area, export area, consumables, non-stock, general, office, pantry, inspection, and loading/unloading areas. Each pair of areas is assigned a proximity code of A, E, I, O, U, or X, accompanied by a rationale, such as high material flow requirements, communication intensity, safety aspects, or supervision requirements. The results of the

ARC are then compared with the existing layout on the first floor plan. From this comparison, areas that meet the expected proximity relationships and areas that are not optimal can be identified. The ARC serves as the basis for formulating recommendations for improving the warehouse facility layout.

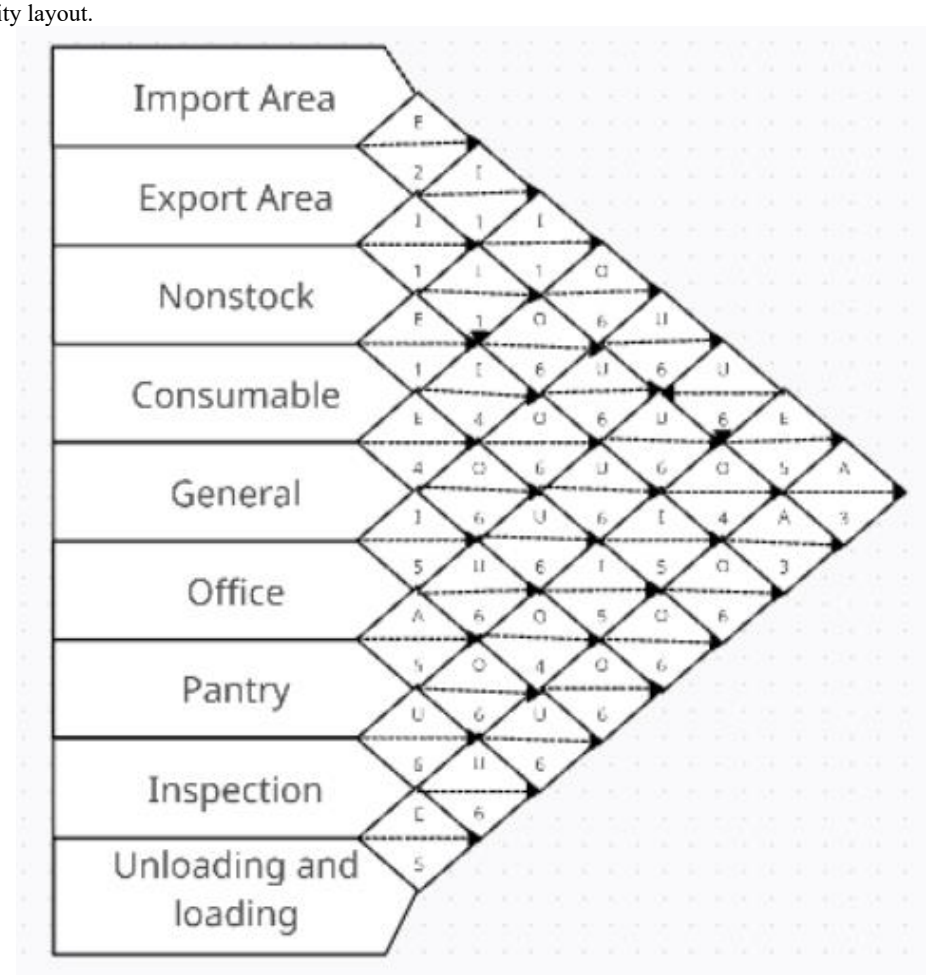
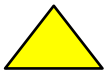
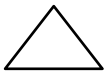


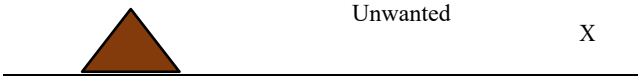
Fig 2: Activity Relationship Chart

Table 1: ARC Proximity Degree Code and Reasons

Code	Reason
1	Uniform products per category (group of material types or similar operational functions)
2	Using the same tools/handling equipment in logistics activities
3	Using the same area / need to be close together to keep material flow efficient
4	Makes it easier to find items that are frequently used together
5	Facilitates supervision, safety, and quality control
6	There is no relationship (activities are not related to each other)

Table 2: Letter Code on the Activity Relationship Chart

Color Proximity	Information	Code
	Absolute	A
	Very important	E
	Important	I
	Fairly ordinary	O
	Not important	U



3.2. Worksheet

This worksheet contains an Activity Relationship Chart (ARC) which is designed to describe the relationship between departments in the PT PLN Nusantara Power UP Paiton warehouse, as well as the degree of proximity between areas and reason codes for more efficient spatial planning.

Table 3: Worksheet

No	Activity	Degree of Attachment					
		A	E	I	O	U	X
1	Import Area	9	2,8	3,4	5	6,7	
2	Export Area	9		3,4	5,8	6,7	
3	Nonstock		4	5,8	6,9	7	
4	Consumable		5	8	6,9	7	
5	General			6	8,9	7	
6	Office	7			8	9	
7	Pantry					8,9	
8	Inspection		9				
9	Unloading and Loading		8				

3.3. Comparison of Initial Layout and Alternative Layout

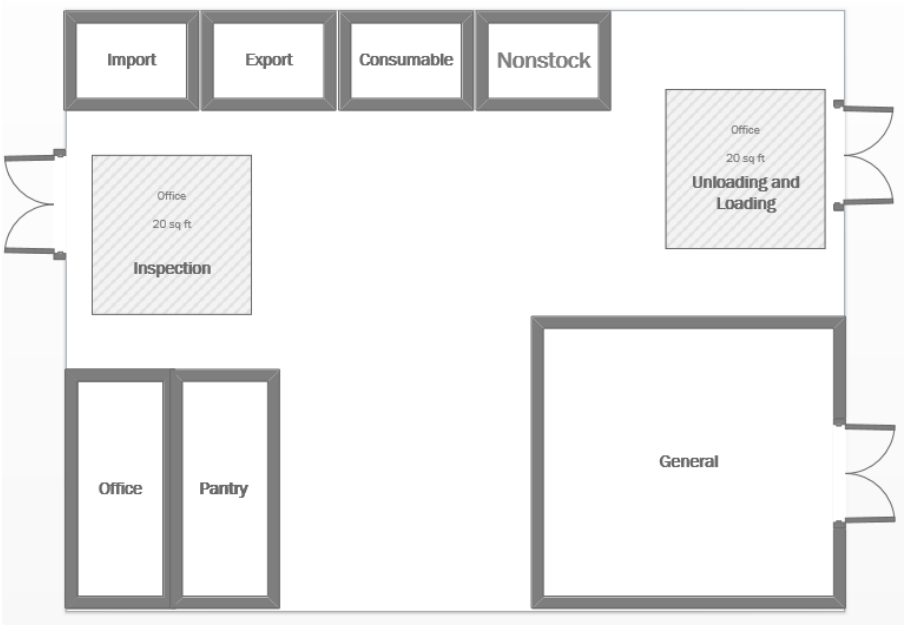


Fig 3: Initial Layout

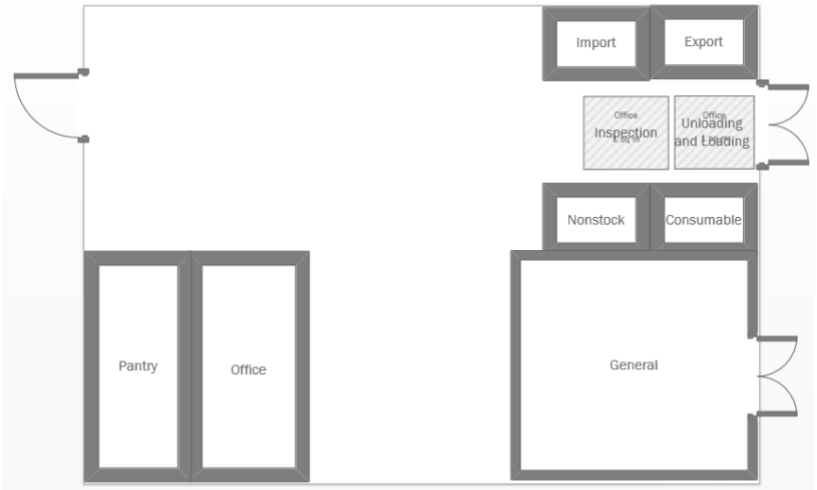


Fig 4: Alternative Layout

Table 4: Warehouse Area of Unit 9 UP Paiton Based on Alternative Layout

No	Area	Size (PxL)	Amount	Wide (m2)
1	Import Area	2,3 x 4	1	9,2
2	Export Area	2,3 x 4	1	9,2
3	Nonstock	2,3 x 4	1	9,2
4	Consumable	2,3 x 4	1	9,2
5	General	15 x 7,5	1	112,5
6	Office	4 x 6	1	24
7	Pantry	3,5 x 6	1	21
8	Inspection	2,5 x 7,5	1	18,75
9	Unloading and Loading	2,5 x 7,5	1	18,75
	Alternative Space Area Layout			335,5
	Initial Space Area Layout			343,45
	Minimized space area			7,95

Based on the initial layout design, the area of warehouse unit 9 was recorded at 343.45 m². After improvements were made through the implementation of an alternative layout, the effective area became 335.5 m² which was divided into several zones, namely the import, export, nonstock, and consumable areas, each covering an area of 9.2 m², a general area of 112.5 m², an office area of 42 m², a pantry of 21 m², an inspection area of 18.75 m², and a loading and unloading area of 18.75 m². With these changes, a space savings of 7.95 m² was achieved. Each zone in the alternative layout underwent a rearrangement that was adjusted to the warehouse process flow so that it appeared more structured. One of the main changes was seen in the export area which was positioned closer to the loading and unloading area and placed in the corner of the warehouse to facilitate the activities of goods entering and leaving, the loading and unloading process, transactions, and picking up goods. Furthermore, the previously separate inspection and loading and unloading areas are now located adjacent to each other to avoid stock separation and facilitate worker mobility during retrieval activities. Several other departments have also undergone significant layout adjustments. These changes have positively impacted work comfort, operational efficiency, and ease of oversight. The new alternative layout eliminates the overlap between export, import, non-stock, and consumable areas. This more organized spatial arrangement allows all warehouse activities, particularly those related to the flow of goods, to run more optimally, effectively, and efficiently.s

4. Conclusion

The evaluation of the layout of the Unit 9 Warehouse of PT PLN Nusantara Power UP Paiton through the application of the Activity Relationship Chart (ARC) method not only resulted in general spatial improvements, but also revealed structural findings that were specific and contextual to the characteristics of warehousing activities in the unit. The main findings showed that the integration and placement of the inspection area directly adjacent to the loading and unloading area was a key factor in eliminating backtracking in the material workflow, which previously caused repetitive and inefficient goods movements. This rearrangement allowed the material flow to take place in a linear and continuous manner, thereby reducing the distance of movement, accelerating the inspection process, and improving the smoothness of goods entry and exit activities. In addition to improving workflow, the implementation of ARC also has a significant impact on the efficiency of warehouse space utilization. The evaluation results show that the alternative layout is able to reduce the warehouse area requirement from 343.45 m² to 335.5 m², resulting in a space savings of 7.95 m². This savings reflects the success of grouping areas based on the level of activity interconnectedness without reducing the operational function of each zone. Thus, the ARC method is proven not only effective as a tool for analyzing activity proximity, but also capable of producing a more rational, efficient, and quantitatively evidence-based layout design, thus making a real contribution to improving the operational performance of the Unit 9 warehouse of PT PLN Nusantara Power UP Paiton.

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