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Design of Item Layout with Shared Storage Method at PT. Sistama Partner

Moch Arif Hernawan[1*], Siska Amonalisa[2], Johanes Kurniawan Liauw[3], Indra Kurniawan[4]

[1, 2, 3, 4]*Institut Transportasi dan Logistik Trisakti, Indonesia*

***Corresponding author:** arifhernawan1112@gmail.com |

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Abstract

Purpose: This study aims to design an efficient warehouse layout using the shared storage method at PT. Sistama Partner to optimize space utilization and improve order picking speed, ultimately enhancing warehouse productivity.
Research Methodology: The research uses a case study approach with data collection through direct observation and interviews at PT. Sistama Partner. The study analyzes the current warehouse layout and proposes a new layout design using the shared storage method, evaluated through the Structural Equation Model (SEM) using AMOS software.
Results: The implementation of the shared storage method significantly improved warehouse efficiency, reducing order processing time by 11.39% in comparison to the previous layout. The new layout optimized space utilization and reduced the distance for product retrieval..
Conclusions: The shared storage method proved to be an effective solution for improving warehouse efficiency at PT. Sistama Partner. By optimizing the layout, the company can increase the speed and accuracy of order fulfillment, contributing to overall operational efficiency.
Limitations: The study is limited to a single warehouse and does not account for the long-term impact of the new layout. Additionally, the research focuses solely on the shared storage method and does not compare it with other storage methods.
Contributions: This research contributes to the body of knowledge on warehouse management by demonstrating the effectiveness of the shared storage method in optimizing warehouse layout and improving operational efficiency. The findings provide practical insights for companies seeking to enhance warehouse productivity.

Keywords: *AMOS, Order Picking Efficiency, Shared Storage Method, Space Utilization, Structural Equation Model (SEM)*

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1. Introduction

The warehouse is an important part of the company. Warehouses are also used to store company-owned goods, ranging from raw materials to finished goods. Good warehouse conditions can help carry out all activities in a company. According to Agyabeng-Mensah et al. (2020) and Prijono et al. (2021), warehouses play an important role in supporting a company's supply chain. The warehouse mission is to effectively deliver any product to the next step in the supply chain without damaging or changing its original shape (Abushaikha et al., 2018).

PT. Mitra Sistama has a warehouse of approximately 600 m2. This warehouse plays an important role in warehouse process activities and the quick and precise delivery of customer product distribution. The warehouse must be designed such that the product can fill the maximum space capacity both vertically and horizontally. Good warehouse management requires a system that can be built and controlled effectively. A good warehousing system is a warehousing system that is able to utilize space for storage effectively to increase space utilization and minimize distance or material handling costs (Jermsittiparsert et al., 2019; Saputra & Kusnadi, 2021). Companies that provide warehousing services must manage their business well to meet consumer needs and have good warehouse layout management to support activities in the warehouse. Vertical and horizontal are defined as the product being filled on the shelf evenly sideways or piled up so that there is no empty space. Layout is a problem that can always occur in activities.

Figure 1. Early 2020 Warehouse Condition

Source: Personal documents

The process of picking up goods based on the orders. The Picker team will take the item based on the shipping label and submit it to the packer team for packaging. Picking is manual and takes approximately 3-5 minutes for 1-3 SKUs. Depending on the quantity and type of order, the difference in the number of orders can result in different processing times. The process of searching for goods begins by moving the boxes that have piled up, opening the boxes, checking the types of goods in the boxes, and picking up items that match the order list. If the box containing is not the desired item, the process is repeated from the beginning of the box transfer.

Based on the identification of problems that have been carried out, it is known that there are several problems that occur in the warehouse. The problem that occurs is that the layout of the goods in the warehouse is not arranged properly, resulting in suboptimal productivity. These problems can be solved with warehouse layout design and warehouse layout design management systems with shared storage methods. Good warehouse layout design is expected to reduce the time in the process of finding goods so that production time is faster.

Therefore, the layout design and pattern system for storing goods in the warehouse can have a direct impact on the flow of work processes that are more efficient, effective, and well organized. Based on the identification of the problem, it can be formulated as follows: What is the current state of the warehouse layout? What storage layout methods can be applied to warehouses? Research Objectives, Knowing the current warehouse layout and analyzing the most suitable warehouse layout method for application.

2. Literature Review & Hypothesis Development

2.1 Management

Definition of management according to experts: Management is the science and art of managing the process of utilizing other resources efficiently, effectively, and productively, which is the most important thing to achieve a goal (Goswami, 2018; Suyanto et al., 2021). Management as the science and art of managing the process of utilizing human resources and other resources effectively and efficiently to achieve a certain goal (Kmecova, 2018; Razak et al., 2018; Sumaryadi & Kusnadi, 2021). In my opinion, management is a science that regulates the course of an activity or work to be efficient and effective. Operational Management is a mutually sustainable process that is effective in using management functions to efficiently integrate various resources to achieve goals (Al-Hawary et al., 2020; Chakraborty & Biswas, 2019). From this definition, I can conclude that operational management is the management of the use of all existing production factors into various kinds of products or services.

2.2 Warehousing Management System

The definition of the warehousing management system itself according to Laosirihongthong et al. (2018) and Nunuh and Wulandari (2021) is an information system regarding warehousing management that is used to control activities in the warehouse starting from receiving (receiving), storing goods (putaway), moving (moving), choosing (choosing), and shipping (delivery). The warehousing management system aims to control the movement of entry, entry, storage, and retrieval of goods effectively and efficiently. The purpose of warehouse management is to efficiently and effectively activate all processes and activities that exist in the warehouse (Naik & Suresh, 2018; Singh et al., 2018). So researchers from some of the understanding above can be the key to warehousing management that warehousing management does involve so many processes and seems very complex.

2.3 Productivity

According to Danlami et al. (2018), the term productivity has different meanings depending on its use according to certain needs. Productivity is generally defined as the relationship between output (goods or services) and inputs (labor, materials, money). Productivity is a measure of productive efficiency, namely the comparison between output and input (Alaghbari et al., 2019). According to Durdyev et al. (2018) and Kianto et al. (2019), productivity is influenced by several factors such as education, skills, discipline, mental attitude and work ethic, motivation, nutrition and health, income level, social security, work environment and climate, industrial relations (harmonious working relationships), technology, means of production, management, and opportunities for achievement.

2.4 Warehouse

A warehouse is a permanent facility designed to achieve the targeted service level at the lowest total cost. Warehouses are needed to coordinate goods, which arise as a result of an imbalance between supply and demand processes. The portion of supply and demand that is not balanced encourages the emergence of inventory (inventory), which requires space as a temporary storage area known as a warehouse (De Marco et al., 2010; Singh et al., 2018).

The definition of warehouse according to Faber et al. (2013), Önüt et al. (2008), and Wahab et al. (2018) is part of a company's logistics system that stores products (raw materials, spare parts, goods in process, and finished processes) at and between points of origin (point-of-origin) and points of consumption, and provide information to management regarding the status, condition, and position of the stored goods.

2.5 Design, Problem, and Storage Activities

Miranda et al. (2019) solves storage problems across the enterprise, from receipt, to production to delivery. Overall design, problem, and storage activities can be solved in the following categories:

a. Receiving, the process of receiving and before distribution

b. Inventory, storage of raw materials, and purchased finished goods until production is needed

c. Equipment, which is non-productive goods used to support the production function

d. In the middle of the process, namely semi-finished goods and are waiting for the next operation

e. Finished components, which are waiting for assembly (can also be stored in the middle of the process or assembly area)

f. Waste, which is the material or part of the product that will be processed back into a useful form again

g. Building, namely the accumulation, selection, and distribution of goods that are no longer useful

h. Various types of equipment, which are useless for reuse in the future, are also disposed of

i. Finished products are products that are ready for production or stored for a long period of time

j. One factor that greatly affects the function of a warehouse is its capacity of the warehouse itself. In determining the capacity of the warehouse, the maximum state must be considered.

Warehouses that reach maximum conditions at the time of packaging preparation have not been used, material delays, while the order date is faster (Chen et al., 2013).

To calculate the amount of warehouse capacity that must be met, data about:

a. The number of orders (order quantity) in a certain period is done

b. Amount of specified packaging inventory

c. Lead time variation

d. Usage fluctuation

The finished product warehouse is concerned with proper storage and production of finished products. This repository is maintained by.

a. Receipt of finished products from production

b. Store items safely and neatly

c. Taking orders for delivery

d. Packing for shipping process

e. Keeping proper records

The general purpose of this method of storing goods is as follows:

a. Maximum use of building capacity

b. Efficient use of time, need, and completion

c. Ease of finding raw materials

d. Fast and easy transportation of goods

e. Identify good items

f. Maximum item maintenance

g. The appearance is neat and organized.

The activities that dominate in the warehouse are looking for, picking up, preparing, and delivering requested goods (order picking). Therefore, the warehouse layout must be designed to ensure that the process runs smoothly. The warehouse layout design is a layout arrangement that follows the operating system (order-picking system) that has been set. The first is the determination of each other's position (receiving, retrieval, storage, inspection, and delivery) and consideration of the mutual relationship between the parties.

In general, the function and flow of warehouse activities is as follows

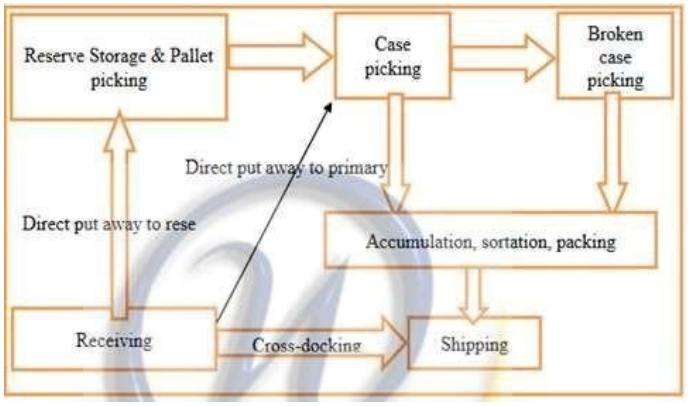

Figure 2. Function And Flow Of Warehouse Activities

The basic warehouse activities are as follows:

a) Receiving (Inbound)

1. Receipt of incoming goods in accordance with warehouse rules and in accordance with delivery orders (DO) from related vendors
2. Quality Control (QC) checking that the goods received are in accordance with the physical and document

b) Putaway
Placement of materials or goods that have been received into certain storage locations according to the category and type of goods. [c)] Storage or inventory
Material storage while waiting for the material to be used in the next process. The storage and handling methods of the product or material depend on the size, quality and characteristics of the product or material. [d)]Order picking
The process of taking goods according to the customer's order list [e)]Order packing
The process of packaging the goods that have been taken according to the order list [f)]Finished good and hanover to 3PL
Goods that have been packaged and passed Quality Control (QC) are then handed over to the relevant shipping company.

The purpose of a warehouse is to store goods, while the general function of warehousing is to maximize service to customers with limited resources. The warehouse and warehousing resources include space, equipment, and personnel. The warehousing function is to obtain the desired goods accurately and

quickly in good condition. So in designing a warehouse and warehouse management system the following things are needed:

1. Maximize the use of space
2. Maximize the use of equipment
3. Maximize the use of labor
4. Maximizing the ease of receiving all materials and goods.

2.6 Layout

The layout is a decision that determines the efficiency of an operation over the long term. The layout has many strategic impacts because it determines the capacity, process, cost, and quality of the work environment, as well as customer contact and the corporate image. An effective layout can help an organization achieve a strategy that supports differentiation, low cost, and fast response. The purpose of the layout is to build an economical layout that meets the competitive needs of the company (Knego et al., 2014; Kovács, 2019).

Effective layouts can help companies achieve the following:

1. Greater use of space, equipment and people
2. Better flow of information, raw materials, and people
3. Make it easier for consumers
4. Improved employee morale and more comfortable working conditions

Layout is one of the decisions that determines the efficiency of the company's operations in the long term (Kovács, 2019).

An effective layout can help company operations achieve the following:

1. Greater utilization of space, equipment, and people
2. Better flow of information, raw materials, and people
3. This will make it easier for consumers
4. Improved employee morale and safer working conditions

Given the importance of the layout factor in a company, layout planning must be done properly to meet the company's needs to remain competitive.

The objectives of layout planning include the following:

a) Minimizing Material Handling Cost.
However, a good layout supports the production process efficiently. Furthermore, the implications of an efficient production process are as follows:

1. The efficiency of production equipment can be improved
2. Reduction of waiting time
3. The build-up of work-in-progress can be reduced
4. Maintenance of production facilities is made easy
5. Increased company productivity
6. Effective use of factory space

7. The level of manufacturing labor use
8. Reducing disruption to the smooth running of the production process
9. Communication facilitation

According to Lin et al. (2019), capacity planning is very important, especially during the establishment of a factory or the expansion of operations. Based on the estimated flow of goods, the required warehouse size can be determined. Several factors need to be considered in determining warehouse capacity, including:

1. Dimensions of each item to be stored. The larger the item, the greater the space required.
2. Lead time for ordering goods. If the lead time is shorter, the required storage space must be larger.
3. The number of items stored and the frequency of inbound and outbound goods. The more items stored, the larger the required area. Similarly, low movement frequency can also result in the need for larger storage space.
4. Additional factors considered by warehouse management, such as the risk of insufficient storage space when goods arrive.

In addition to the size of the warehouse space, warehouse capacity is also determined by the method of storing goods. Warehouses with irregular layouts tend to be less efficient. Furthermore, several aspects must be considered, particularly the classification of stored goods into the following groups:

1. Fast-moving goods that circulate quickly.
   Fast-moving items are goods with high turnover rates, often referred to as best sellers.

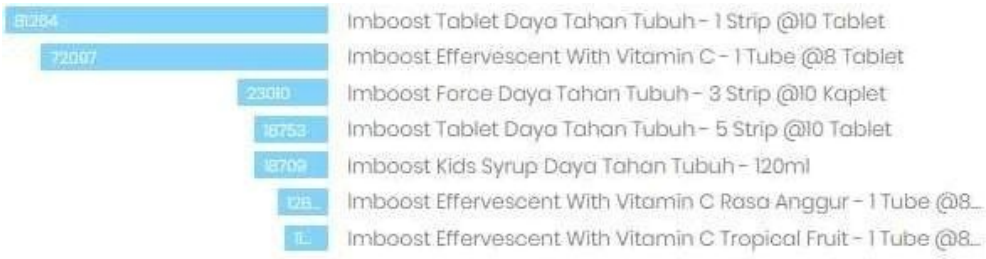

Figure 3. Level Of Purchase Of Goods In The Last 3 Months

Source: Document PT. System Partner

2. Slow-moving goods g,that is,e slow circulation goods,are usually less desirable.
   Layout is closely related to all processes of planning and arranging raw materials and other existing supporting equipment.

2.7 5S Concept

The 5S concept refers to the organization of the workplace, which includes all aspects such as equipment, documents, buildings, and rooms, aimed at developing workers' habits to improve work discipline (Kabiesz & Bartnicka, 2019; Mehta & Dave, 2020). A neat, clean, safe, and comfortable workplace can produce high-quality products, cost savings, time efficiency, safety assurance, high morale, and a conducive work environment (Chandrayan et al., 2019; Randhawa & Ahuja, 2018).

The implementation of 5S consists of the following stages (Kabiesz & Bartnicka, 2019):

1. Seiri (Concise)

The selection of necessary items to complete the work so that the work area becomes more efficient and unnecessary items are eliminated.

2. Seiton (Tidy)
   Arranging items needed for work in an orderly manner so they are easy to find and not scattered.
3. Seiso (Clean)
   Maintaining cleanliness by ensuring that the work environment is always clean.
4. Seiketsu (Standardize)
   This stage focuses on maintaining and standardizing the previous steps to ensure consistency among individuals.
5. Shitsuke (Discipline)
   Maintaining personal discipline through continuous practice and adherence to the established 5S procedures.

2.8 Planning and Design

In building a company, the planning and design must be in accordance with the requirements of the establishment of the company. With the planning and design of the layout of this facility, it is expected that the process flow and material transfer from one place to another will run smoothly. A smooth production process can minimize costs and optimize profit. In addition, planning and designing the layout of this facility is useful for optimizing the relationship between activities (Halawa et al., 2020).

Warehouses must be designed with the speed of goods movement in mind. Fast-moving items are better placed close to the pick-up point, thereby reducing back-and-forth motion. In a storage warehouse, the location and design of the building where the goods are stored significantly affect the handling of existing goods. The general purpose of the method of storing goods is (Peron et al., 2020):

1. Maximum use of building volume
2. Good use of time, labor, and equipment
3. Ease of getting materials
4. Fast and easy transportation of goods
5. Identify good items
6. Maximum item maintenance
7. The appearance is neat and organized

Several retention policies (methods) are commonly used, including:

1. Dedicated Storage Method
   Dedicated storage is also known as fixed storage (fixed slot storage), which places a specific storage location or address for each item stored. This is because one deposit location is assigned to each product.

   Two variations of dedicated storage that are commonly used are part number sequence storage and throughput-based dedicated storage. Part number sequence storage is often used because it is simpler to implement. The product storage location is based solely on the specified part number. Low part numbers are assigned to the "best" location in the stockpile and higher part numbers are assigned to less "good" locations. In particular, it presents a randomly generated part number, regardless of the activity. Therefore, if a single section has a very large number of sections with high activity, multiple trips will occur in a very poor storage location.

Throughput-based dedicated storage is a method that considers the differences in activity levels and storage requirements between products to be stored. More types of storage part numbers are used when there are significant differences in the activity or inventory levels of stored items. Because throughput-based dedicated storage is often used, it is now often referred to as dedicated storage.

With dedicated storage, the number of storage locations assigned to a product must meet the product's maximum storage requirements. For some products, the required storage area is the maximum amount of storage required for each product. This rule considers the level of storage and retrieval (S/R) activity developed for different items.

2. Shared Storage Method
   Shared storage can be considered a fast-moving goods system for a product if each pallet is filled in a different warehouse area over time. Shared storage can take advantage of the inherent differences in the time each pallet remains in the warehouse. To reduce the storage space requirements of dedicated storage, some warehouse managers use storage variations, particularly where product placement is managed more carefully. In particular, different products use the same storage slot from time to time, even though the final product occupies that slot only once.

For shared storage, if it comes from 100 pallets with a large number of "fast transfers" of products to be stored. Bulk pallets will be reused and sent as many as five pallets per day over 20 days. Materials can be moved manually or using automated methods, and materials can be moved once or thousands of times.

If there are two work stations/departments i and j whose coordinates are shown as (x,y) and (a,b), to calculate the distance between the two midpoints d_{ij}, several methods can be used:

a. Rectilinear Distance
   The distance is measured along the trajectory using lines perpendicular to each other. An example is the movement of materials along a rectilinear aisle in a factory:

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

b. Euclidean Distance
   The Euclidean distance is measured along a straight-line path between two points. The distance can be illustrated as a straight conveyor crossing two work stations:

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

c. Squared Euclidean Distance
   The distance is measured along the path between two points. For example, in a guided vehicle system, running vehicles must follow the directions set on a controlled track network. So the flow path distance can be longer than rectilinear or Euclidean:

$$d_{ij} = (x-a)^2 + (y-b)^2 8$$

To reduce the storage space requirements of dedicated storage, some warehouse managers use special storage variations in which the final product placement is managed more carefully. In particular, from time to time, different products use the same storage slot, even though the final product occupies the slot only once.

To support co-storage considerations, if there is an arrival of 100 pallets with a large number of "fast-moving" products to be stored in the storage slots, pallets with large quantities will be reused and sent as

many as five pallets per day within 20 days.

With randomized storage, 100 free space slots are selected randomly for the product, and there is no guarantee that the product is fast moving. In contrast, with dedicated storage, at least 100 free slots must be available among the selected primary locations for fast-moving items. If storage is randomized, each time a palletized load is removed from the storage space, a slot becomes available for use by the next product requiring storage space. However, with dedicated storage, every pallet removal leaves an empty slot that cannot be filled until the arrival of the next shipment of the same product.

Shared storage can be considered as a fast movement system for goods, where each pallet is placed in different warehouse locations over time. Depending on the number of products in the warehouse at the time of arrival, five pallets may remain in the warehouse for only one day, while another five pallets from the same shipment may remain for up to 20 days. From the perspective of storage location, some pallets move very quickly, while others appear slower and may shift positions slightly.

Shared storage can take advantage of the inherent differences in the time allotted for each pallet to remain in the warehouse. The variables of the shared storage method are as follows:

a. Processing time
b. Delivery time of each product
c. Number of products per order
d. Frequency of orders per time period
e. The distance of each storage area to the entrance and exit
f. Space requirement

Based on the product and variable setting steps of the shared storage method, several stages are involved in preparing a warehouse layout based on shared storage, namely:

a. Calculation of area capacity in the warehouse (processing time, delivery time, number of products)
b. Classification of products based on customers
c. Calculation of area requirements for each item
d. Determination of the movement order for each area (sorting areas based on distance to the I/O entrance and exit)
e. Determination of layout

The storage space requirements for shared storage range from those required for randomized storage to those required for dedicated storage, depending on the amount of information available regarding inventory levels over time for each product.

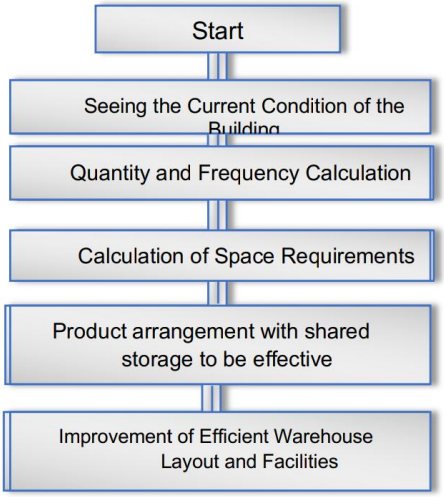

Figure 4. Framework Research

2.9 Hipotesis Penelitian

Based on the theoretical basis and previous research that has been described, the hypothesis in this study is formulated as follows:

H_1: The application of the shared storage method significantly improves warehouse efficiency at PT. Sistama Partner.

H_2: A well-designed warehouse layout using the shared storage method reduces the time required for order picking and product retrieval.

H_3: The efficiency of warehouse operations can be significantly enhanced by optimizing the storage capacity and layout of goods.

3. Methodology

3.1 Research Design

This study employs a quantitative research design using a survey approach. The research aims to analyze the relationships among variables using the Structural Equation Model (SEM).

3.2 Data Collection

The data collection method is carried out by processing literature, articles, journals, and other written media related to the discussion topic of this research. The data collection method is carried out by processing literature, articles, journals, and other written media related to the discussion topic of this research. The number of respondents was 200. The data collection method involved collecting all primary data from the interviewees and direct observations in the field. The data sources passed the publication test by PT. System Partner.

3.3 Data Analysis

The analytical method used in this study is the Structural Equation Model (SEM) using the AMOS version 23 program. SEM is a set of statistical techniques that allow the simultaneous testing of a relatively complex series of relationships. In addition, the SEM method can also identify the dimensions of a concept and simultaneously measure the influence of the relationship between each factor whose dimensions are identified.

4. Results and Discussion

Data processing was performed using the Shared Storage method at the warehouse PT. Mitra Sistama Indonesia is irregular warehouse conditions. The absence of a racking system makes the location of the goods unclear, and the laying of pallets is also irregular and makes work maneuvers narrow. This made it difficult for the picking officer to find the ordered items. The time required to process the order is long. The method used is a storage method with the Shared Storage method, where goods that are quickly sent are placed in the storage area closest to the I/O entrance and exit. An alternative layout design based on the forklift diagonal so that the process of removing goods is effective and efficient. The results based on the area of the storage area for all goods to the door from layout proposal 1 obtained a value of 79m and proposal layout 2 with a value of 70m, the author then uses proposal layout 2 to compile the warehouse layout because layout 2 is more efficient in terms of distance. This resulted in a savings of 11.39%.

5. Conclusions

The conclusions obtained from this research are:

1) The application of the shared storage method is very good for the company, because the company produces to order, which requires high activity in the warehouse for on-time delivery.
2) Companies can use the proposed storage with the Share Storage method if they want to rearrange the warehouse layout to be more efficient and effective.
3) The current warehouse capacity is sufficient; however, if there is an increase in market share in the future, the company needs to consider using a racking system that has not been described in detail in this study.

5.1 Research Limitations

This study is limited by its focus on a single warehouse at PT. Sistama Partner, which may not be generalizable to other industries or companies. Additionally, the study only explores the shared storage method, and further research could consider other storage methods for comparison. The study also lacks long-term data on the impact of the new layout, as it was conducted within a relatively short timeframe.

5.2 Suggestions and Directions for Future Research

Future studies could explore the impact of various warehouse management systems (WMS) in conjunction with layout design, comparing shared storage with other methods like dedicated or randomized storage. Further research should also evaluate the long-term effectiveness of warehouse layout designs and storage methods across different industries. Additionally, investigating the role of technology, such as automated systems for material handling, could provide deeper insights into optimizing warehouse operations.

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Author Contributions

MAH contributed to conceptualization and final approval of the manuscript. SA contributed to study design. JKL contributed to data collection and writing—review and editing. IK contributed to formal analysis and writing of the original draft.

Conflicts of Interest

The authors declare no conflicts of interest. The research was conducted independently, with no financial or personal relationships influencing the results.

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