# Analysis of the Application of Automated Storage and Retrieval System (ASRS) in Limited Storage Space Case Study of PT. XYZ

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**ABSTRACT:** The research was conducted using descriptive methods and quantitative approaches to measure operational efficiency, and cost savings. This study evaluates the application of Automated Storage and Retrieval System (ASRS) in warehouses with a storage capacity of 11,660 pallets. The ASRS equipped with 5 automated cranes speeds up the picking and storage time of goods by up to 50% compared to manual systems, significantly increasing warehouse throughput. The implementation of ASRS also allows for the reduction of the number of manual workers from 12–15 to 4–6 people, thereby saving labor costs and reducing the risk of human error. The results of the study show that this system is able to optimize vertical and horizontal storage space, increasing the accuracy of goods management. Thus, Automated Storage and Retrieval System (ASRS) is an effective solution to improve operational efficiency and more effective storage capacity.

**KEYWORDS:** Automated Storage and Retrieval System (ASRS), limited space, warehouse, efficiency, storage capacity, logistics.

## INTRODUCTION

In modern supply chain management, warehouses play a crucial role in the storage, management, and distribution of goods. These facilities are the link between production and consumption, and ensuring the smooth flow of products through the supply chain is essential for organizations across a wide range of industries. Warehouse efficiency is a top priority, as it impacts competitiveness, profitability, and sustainability. This concept involves many factors that affect warehouse efficiency such as costeffectiveness, work efficiency and space utilization.

The use of limited space in the use of storage areas in warehouses is one of the main challenges in the world of logistics and supply chain management. One solution to create an increasingly popular storage area is the use of Automated Storage and Retrieval System (ASRS), which is designed to optimize the use of vertical and horizontal space in a limited area.

Automated Storage and Retrieval System (ASRS) is a key component of a company's supply chain logistics, and it is advantageous given its high space utilization, reduced labor costs, short retrieval times, and better inventory control.[1]. With Automated Storage and Retrieval System (ASRS), goods can be stored and retrieved automatically using cranes controlled by computer systems This article will discuss the application of Automated Storage and Retrieval System (ASRS) in a warehouse with an area of 55 meters long and 41 meters wide (total area of 2,255 m²), with a maximum weight storage capacity of 1300 kg per pallet. The size of the area per storage column is 1,100 mm (width) x 1,300 mm (depth) x 1,400 mm (height).

With a storage capacity designed to accommodate 11,660 pallets, the warehouse is designed to use both vertical and horizontal space very efficiently.

In this analysis, the main focus is to calculate storage capacity, maximize the use of vertical and horizontal space, and evaluate the operational efficiency of the Automated Storage and Retrieval System (ASRS) system for storage space of the company's desired size and specifications.

## LITERATURE STUDY

A. Supply Chain Management and Warehouse Efficiency

Because warehouse efficiency impacts a company's competitiveness, it is crucial in contemporary supply chain management. Main focus        be optimize space utilization, improve work efficiency, and reduce operational costs. Studies show that technology solutions such as Automated Storage and Retrieval System (ASRS) can increase warehouse throughput, reduce operational time, and reduce human error.

B. Automated Storage and Retrieval System (ASRS) Concept and Technology

Automated Storage and Retrieval System (ASRS) is an automated system designed to efficiently manage the storage and retrieval of goods, especially in confined spaces. It uses an automatic crane controlled by a

computer system, which allows for optimal vertical and horizontal space arrangement. ASRS has been shown to increase storage capacity by more than 50% compared to manual methods in relevant studies.

C. Implementation of Automated Storage and Retrieval System (ASRS) in the Space Limited

Related studies show that the Automated Storage and Retrieval System (ASRS) makes full use of vertical space, which makes it ideal for warehouses with limited space. This is especially important for warehouses that have a limited area but require large storage capacity. With certain specifications, as mentioned in the file (a warehouse with an area of 2,255 m2 that can store up to 11,660 pallets), the Automated Storage and Retrieval System (ASRS) can efficiently accommodate a very large number of goods.

D. Advantage Automated Storage and Retrieval System (ASRS) According to literature studies:

- When compared to manual methods, Automated Storage and Retrieval System (ASRS) can speed up the process of picking and storing goods by up to 50%.
- Reduce the need for labor from 12–15 people to 4–6 people, lowering labor costs.
- Lowers the likelihood of human error, such as incorrect storage or damage to goods.

E. Costs and Economic Implications

According to several studies, Automated Storage and Retrieval System (ASRS) has significant economic value for large enterprises, due to its higher throughput and reduced manual labor. However, in the long run, the costs associated with implementing an Automated Storage and Retrieval System (ASRS) may have been compensated by a reduction in operational costs.

**METHOD**

In this study, secondary data was collected from journals, published books, reports, articles, and the internet. From secondary data variables such as labor costs, location, transportation costs, operational costs, storage costs, efficient aisle use, overstocking, stockout, efficient personnel use, safety, skills and material handling of equipment were found to be involved in the study of factors affecting warehouse efficiency. In this study we can identify the factors that affect the efficiency of the warehouse and their relationship with each other. The factors are cost-effectiveness, space utilization, work efficiency. And the relationship between these factors is interconnected in the warehouse.

In this analysis, a descriptive analysis method with a quantitative approach is used which consists of two main components:

**Descriptive Analysis:** Presents data in the form of tables, graphs, and visualizations to illustrate the real conditions of the implementation of Automated Storage and Retrieval System (ASRS) in a limited-size warehouse. The data collected includes aspects of capacity, speed of processing goods, as well as operational costs.

**Quantitative Approach:** Using numerical data to measure the effect of implementing an Automated Storage and Retrieval System (ASRS). Some of the variables measured include:

- **Storage Capacity:** How many items can be stored in a confined space after the implementation of the Automated Storage and Retrieval System (ASRS).
- **Operational Efficiency:** Measure the speed of movement of goods and the time required for picking up goods with manual systems and with Automated Storage and Retrieval System (ASRS).
- **Reduced Labor Costs:** Calculate the labor cost savings resulting from the use of Automated Storage and Retrieval System (ASRS).

**DISCUSSION**

In this discussion, we will focus on the application of Automated Storage and Retrieval System (ASRS) in a warehouse with a total storage capacity of 11,660 pallets, which uses 5 cranes as a means of moving goods. This warehouse has a size of 55 meters (length), 41 meters (width), and 30 meters (height).



**Figure 1. ASRS Storage Area**

Specification of Warehouse Area and Storage Capacity

- **Warehouse Size**

Warehouse Length: 55 meters
Warehouse Width: 41 meters

Warehouse Height: 30 meters
Warehouse Area: 2,255 m²
- **Storage Column Size per Pallet**

Column Width: 1,100 mm (1.1 meters)
Column Depth: 1,300 mm (1.3 m)
Column Height: 1,400 mm (1.4 m)
Maximum Weight per Pallet: 1,300 kg
- **Total Storage Capacity**

With a storage capacity designed to accommodate 11,660 pallets, the warehouse is designed to use both vertical and horizontal space very efficiently. Based on previous calculations:

Number of Horizontal Shelf Columns: 50 long columns and 31 wide columns, resulting in 1,550 columns.

Number of Vertical Rack Levels: This warehouse has a height of 30 meters, and each shelf level has a height of 1.4 meters, allowing about 21 vertical shelf levels.

With the calculation of rack capacity, the total storage capacity in this warehouse is 11,660 pallets.

- **The Role of Cranes in** Automated Storage and Retrieval System (ASRS)

Automated Storage and Retrieval System (ASRS) uses automated cranes to move pallets from a storage location to a picking location or vice versa. In this system, there are 5 cranes used to improve operational efficiency, both in terms of speed and reduction of human labor requirements.

- **Speed and Efficiency of Cranes**

Each crane in the Automated Storage and Retrieval System (ASRS) has a speed in picking and storing pallets, which is affected by several factors, such as:

Horizontal Speed: The speed at which the crane moves along the rack.

Vertical Speed: The speed at which the crane lifts or lowers pallets to the appropriate rack level.

Pallet Transfer Time: The time it takes for the crane to pick up or return pallets to the storage location.

An Automated Storage and Retrieval System (ASRS) that uses 5 cranes can significantly reduce the time required for the process of moving goods. Each crane works simultaneously, processing multiple requests at the same time, which increases the overall throughput of the warehouse.

- **Utilization of Crane Use to Improve Efficiency**

With 5 cranes working in parallel, the Automated Storage and Retrieval System (ASRS) can process more pallets in less time. The division of tasks between cranes can be carried out as follows:

Cranes 1 and 2: Handle picking pallets from storage locations and moving them to shipping or processing locations.

Cranes 3 and 4: Storing new pallets to an empty storage location.

Crane 5: Serves as a backup or to carry out the transfer of goods to a storage location in case of errors or operational failures in other cranes.

The combination of these 5 cranes will optimize the use of space and increase the speed of the picking and storage process.

Automated Storage and Retrieval System (ASRS) Process Speed and Efficiency Estimation

To understand more about the efficiency of the Automated Storage and Retrieval System (ASRS) with 5 cranes, we need to estimate the time it will take to pick up and store goods. Here are some estimates based on industry data and operational simulations:

- **Pickup and Storage Time**

Manual System: The manual picking time of a single pallet can take about 3-5 minutes, depending on the distance and number of operators.

Automated Storage and Retrieval System (ASRS) with Crane: With an automatic moving crane, the picking or storage time of a single pallet can be shortened to 1-2 minutes.

For example, if there are 100 pallets that need to be moved in a day, an ASRS system with 5 cranes can complete this task in a much shorter time compared to a manual system. Example:

Manual Pick Time:
100 pallets × 4 minutes/pallet = 400 minutes
100 pallets × 4 minutes/pallet = 400 minutes (about 6.5 hours)

Pickup Time with ASRS:
100 pallets × 1.5 minutes/pallet = 150 minutes
100 pallets × 1.5 minutes/pallet = 150 minutes (about 2.5 hours)

This time difference represents significant savings in operating time, which will improve the overall efficiency of the warehouse.

- **Reduced Labor Costs**

The Automated Storage and Retrieval System (ASRS) with 5 cranes allows for a reduction in the need for labor in the warehouse. For example, if previously it took 12-15 workers to handle pallet removal, using ASRS, the number of workers can be reduced to just 4-6 people, who are in charge of supervising and maintaining the system.

This reduction in the number of workers contributes to significant labor cost savings. In addition, with the Automated Storage and Retrieval System (ASRS), the risk of human error is reduced, which can also reduce the loss or damage of goods.

- **Reduced Processing Time**

Another advantage of Automated Storage and Retrieval System (ASRS) is the reduction in processing time for goods. Because the system is automated, frequent human error in picking or storing goods can be minimized. In addition, with

the crane that can move quickly, the time of picking and storing goods can be shortened, improving the efficiency of the entire warehouse system.

Some of the savings that can be taken into account include:

- Labor Cost Savings: Reduction in the number of workers and labor-related costs.

- Operational Time Savings: Reduction in the time required for picking and storing goods.

- Reduced Goods Loss: Because the automated system reduces the risk of human error in handling goods[2].

**RESULT**

We can draw some key results that demonstrate the advantages and efficiencies gained from the implementation of this system. Here are the results that can be concluded:

**1. Optimal Utilization of Warehouse Space**

This warehouse has a size of 55 meters (length), 41 meters (width), and 30 meters (height), with a total floor area of 2,255 m². By making efficient use of vertical and horizontal spaces, the ASRS system can accommodate 11,660 pallets in this limited space.

Rack Column Setup: The warehouse can load about 1,550 rack columns, with a capacity of 21 vertical tiers per column, so each rack column holds 21 pallets.

Storage Capacity: With this arrangement, the warehouse can reach a capacity of 11,660 pallets according to the planned storage needs.
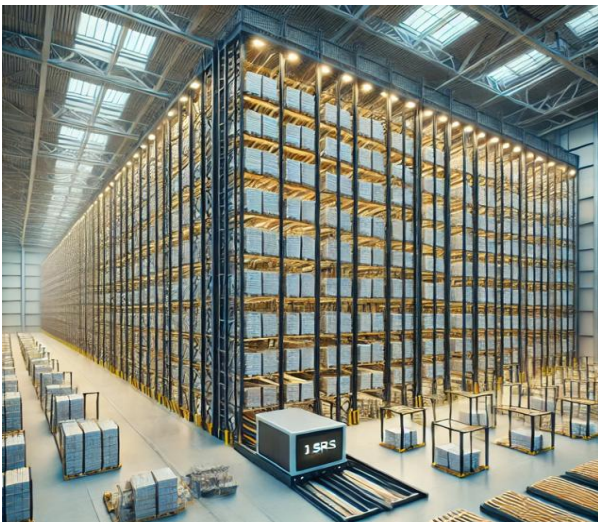

**Figure 2. Vertical ASRS Racking**

In conventional shelves, a larger area is needed because there is still a lack of vertical area utilization in a storage area.


**Figure 3. Horizontal Conventional Racking**

**2. Speed and Efficiency of Picking and Storage Processes**

The Automated Storage and Retrieval System (ASRS) using 5 automated cranes allows for faster and more efficient picking and storage of pallets, when compared to manual systems. Based on the estimated calculations, the use of Automated Storage and Retrieval System (ASRS) with cranes accelerates the picking and storage time of pallets as follows:

Manual System: The time it takes to manually pick and store 100 pallets is about 400 minutes (about 6.5 hours).

Automated Storage and Retrieval System (ASRS) with Crane: The time required for the same process with an Automated Storage and Retrieval System (ASRS) is 150 minutes (about 2.5 hours).

Benefits: With Automated Storage and Retrieval System (ASRS), uptime can be shortened by up to 50%, which significantly increases warehouse throughput.
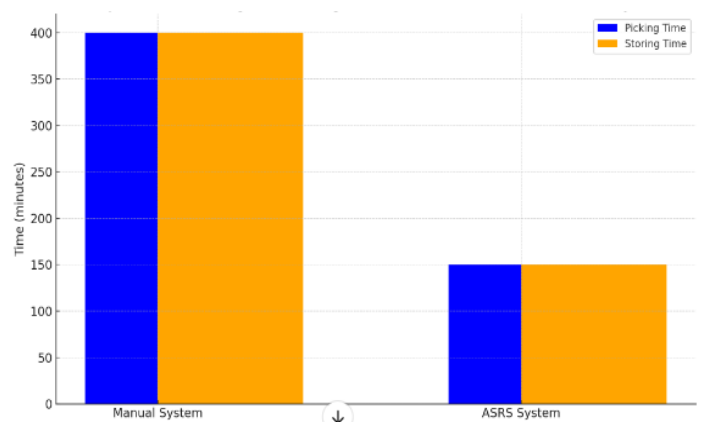

**Figure 4. Storage and Retrieval Comparison Chart**

### 3. Reduced Labor Costs

One of the great advantages of implementing Automated Storage and Retrieval System (ASRS) is the reduction in labor requirements. Automated systems with cranes allow for more efficient warehouse management without relying on multiple manual workers. Example:

Manual System: Previously, it took about 12-15 workers to handle pallet transfer manually.

Automated Storage and Retrieval System (ASRS): By using an Automated Storage and Retrieval System (ASRS), the number of workers can be reduced to just 4-6 people, which focuses on the maintenance and supervision of automated systems.

Advantages: This reduction in the number of workers reduces operational costs and also reduces the risk of human error that can cause damage to goods.

### 4. Reduced Goods Loss and Increased Accuracy

Automated Storage and Retrieval System (ASRS) reduces the possibility of human error in picking and storing goods. This is important to reduce the loss of goods due to human error, such as misplacement or damage to goods during the picking process.

Risk of Human Error: With an Automated Storage and Retrieval System (ASRS), the risk of errors that often occur in manual systems (such as misstorage or damage to goods) can be minimized.

Increased Accuracy: Automated systems are more accurate in handling pallets, improving the integrity and safety of stored goods.

**Table 1. Before and After the Use of ASRS**

| Aspects | Before the Implementation of ASRS | After the Implementation of ASRS |
|---|---|---|
| **Storage Capacity** | Not optimal, capacity is limited to horizontal storage | Optimal, can accommodate up to 11,660 pallets with vertical utilization |
| **Processing Speed** | Picking and storage time of 100 pallets $\pm$ 400 minutes (manual) | Pick-up and storage time of 100 pallets $\pm$ 150 minutes (automatic) |

| | | |
|---|---|---|
| **Number of Employees** | 12–15 manual workers | 4–6 workers for supervision and maintenance |
| **Labor Costs** | High due to the large number of manual workers | Lower due to a reduction in the number of workers |
| **Human Error** | High, risk of misstorage and damage to goods | Minimal, more accurate with automated systems |
| **Operational Efficiency** | Low, takes a lot of time and effort | High, with warehouse throughput increased by up to 50% |

### CONCLUSION

The implementation of Automated Storage and Retrieval System (ASRS) in a warehouse with a storage capacity of 11,660 pallets and the use of 5 cranes as a means of moving goods brings many significant advantages, including:

1. Increased storage capacity for more optimal use, by making efficient use of vertical and horizontal spaces.
2. Up to 50% reduction in picking and storing time compared to manual systems.
3. Significant labor cost savings, reducing the need for workers in the field.
4. Reduction of human error, thus reducing the risk of damage or loss of goods.

Although the initial investment in the implementation of Automated Storage and Retrieval System (ASRS) was substantial, it provided substantial operational savings. With increased efficiency, reduced labor costs, and reduced goods losses, the implementation of Automated Storage and Retrieval System (ASRS) in warehouses has become a very profitable solution for large companies that need to manage goods efficiently. In addition, future research may explore the assignment and sequencing of requests as well as the problem of selecting storage and picking locations in other types of AS/RS, such as multi-shuttle AS/RS, which is also an interesting, realistic, and challenging problem.

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