World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(CASE REPORT)

Warehouse Layout Design Improvement through 5S Implementation and ABC Classification: A case study at a gas manufacturing company

Diana Puspita Sari, Sri Hartini *, Ananda Rizki Ramadan Sinaga and Faradhina Azzahra

Department of Industrial Engineering, Faculty of Engineering, Universitas Diponegoro, Jl. Prof Soedarto, Semarang, Indonesia.

World Journal of Advanced Research and Reviews, 2025, 28(03), 250–257

Publication history: Received 23 October 2025; revised on 30 November 2025; accepted on 02 December 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.3.4026

Abstract

Ineffective warehouse management often leads to various types of waste, hindering operational efficiency. This study aims to evaluate and improve the warehouse system of the Bulk and Supply Chain Department at a gas manufacturing company by applying the 5S methodology and ABC classification. The initial 5S audit scored 55 out of 75, indicating that the implementation was still below the expected standard. The study identified waste in three key warehouse activities: item retrieval, placement, and manual inventory recording, which led to issues such as excess motion, waiting time, and inventory buildup. Improvements were proposed for each 5S pillar: Seiri was supported by a holding area and red tag usage, Seiton was enhanced with an optimized layout based on ABC analysis, Seiso was reinforced with cleanliness standards, Seiketsu was sustained through a digital dashboard for real-time inventory control, and Shitsuke was strengthened via waste segregation and 5S awareness posters. These efforts are expected to reduce waste, streamline warehouse processes, and establish a culture of continuous improvement.

Keywords: Warehouse; 5S; ABC Classification; Waste; Layout Optimization

1. Introduction

The Indonesian gas industry is a key sector that contributes significantly to the national economy. This sector plays a vital role in supporting the manufacturing industry, which remains the most significant contributor to the national Gross Domestic Product (GDP). According to data from Statistics Indonesia (BPS), the manufacturing industry contributed 18.98% to the GDP in 2024 [1]. Furthermore, data from the Ministry of Energy and Mineral Resources shows that the manufacturing industry is the largest gas user, accounting for 40.5% of total consumption in 2023 [2]. In this context, one of the companies in Indonesia, as part of a world-leading gases group, plays a vital role by providing high-quality industrial gas services and products to the manufacturing, healthcare, energy, and other sectors.

To support efficient operations, this gas manufacturing company has a Bulk and Supply Chain Department that manages the supply chain, including logistics and gas transportation. One key responsibility of this department is managing a dedicated warehouse for spare parts used in gas delivery vehicles. This warehouse plays a strategic role in ensuring the availability of spare parts needed for fleet maintenance and repair, but currently, the 614 spare parts are randomly arranged. This unstructured arrangement makes it difficult for employees to find the necessary items, compounded by manual record-keeping that is prone to errors and data loss. Both of these issues result in waste that can be detrimental to the company, costing time and money.

Therefore, optimizing warehouse systems through lean manufacturing methods is crucial. This approach can be realized by implementing the 5S method and ABC classification analysis. The 5S method, which includes *Seiri* (sorting), *Seiton*

* Corresponding author: Sri Hartini

(arranging), *Seiso* (cleaning), *Seiketsu* (standardization), and *Shitsuke* (discipline), aims to create an organized, clean, and efficient work environment [3]. Meanwhile, the ABC method classified goods by frequency of use, enabling warehouse layout optimization to increase the speed and accuracy of goods retrieval [4].

This research aims to improve the warehouse system by designing the layout of the Bulk and Supply Chain Department of a gas manufacturing company through integrating two methods to minimize waste, enhance inventory management efficiency, and improve overall operational efficiency.

2. Research Methods

The preliminary study is a descriptive qualitative research study aimed at systematically and factually describing warehouse conditions at the Bulk and Supply Chain (BSC) Department of ABC Company, analyzing existing problems, and formulating improvement recommendations. The research was conducted at the BSC warehouse of ABC Company in Indonesia from January to February 2025. The research object is a warehouse that stores spare parts for gas transport vehicles, which plays a vital role in supporting the smooth distribution of gas products.

The data used in this study consisted of primary and secondary data. Primary data were obtained directly through interviews, questionnaires, and 5S audit results for warehouse activities. Meanwhile, secondary data were obtained from literature sources, including internal company archives, journals, and books, as well as historical data on spare parts usage from 2021 to 2022. The research stages began with problem identification, formulation of research objectives and limitations, field and literature studies, and data collection and processing. The results of the data processing were used to assess the extent to which the 5S work culture had been implemented in the warehouse, and, from there, recommendations for improvement were developed that addressed the five main elements of 5S. The recommendation of 5S was combined with the ABC classification. This study concluded with findings that answered the research objectives and provided suggestions for future implementation.

2.1. The 5S Method

The 5S concept was first introduced in Japan to address industrial issues. It is a method used to continuously improve the workplace using five key aspects: *Seiri, Seiton, Seiso, Seiketsu*, and *Shitsuke*, with the primary goal of eliminating waste, as it can increase company costs [3], [5].

- *Seiri* (Sort) is an activity to sort all equipment, materials, and other items in the workplace to remove unnecessary things that can interfere with work.
- *Seiton* (Set in order) is the activity of arranging and storing items in their proper locations, grouped according to their categories, so that when an item is needed, it can be found easily without having to search for it.
- *Seiso* (Shine), once the unnecessary items have been thrown away and the necessary items have been sorted and set in order, the next step is to clean the work area.
- *Seiketsu* (Standardize) is an activity to continuously maintain seiri, seiton, and seiso that were previously implemented to ensure that the 5S culture is implemented continuously
- *Shitsuke* (Sustain) denotes the ability to do things the way they should be done, fostering discipline while encouraging employees to act in the 5S culture.

2.2. Activity-based Costing (ABC) Classification

ABC analysis is an inventory categorization technique used primarily in inventory management. It divided items into three categories (A, B, and C) based on their importance, determined by consumption value. Category A items are the most valuable and require tight control and frequent review; Category B items have moderate value and require less intensive control; Category C items have the lowest value and require the least control. This method helps businesses prioritize their resources and manage inventory more effectively by focusing on the most critical items [6], [7].

Class A: Items with a cumulative annual usage frequency of approximately 70%-80%. Although these items are small in quantity, accounting for only 5%-10% of the total inventory in the warehouse, these items have a high usage rate.

Class B: Items with a cumulative annual usage frequency of 10%-15%. Items in this category are moderate in quantity, accounting for approximately 20%-30% of the warehouse's total inventory.

Class C: Items with a cumulative annual usage frequency of approximately 5%-10%. These items are the most abundant in the warehouse, accounting for approximately 50% of total inventory, but their usage rate is lower than that of other classes.

3. Result and Discussion

3.1. Preliminary 5S Audit

An initial 5S audit was conducted as a first step to assess 5S implementation in the warehouse department. This activity was conducted by filling out the 5S audit form [8] and took place on Wednesday, January 8, 2025, at 10:00 a.m., at the company's spare parts warehouse, and the condition is shown in Figure 1. Based on the initial 5S audit recap, the warehouse received a total score of 55 out of 75. This indicates that 5S implementation is still far from the standard. As shown in Figure 2, the highest scores are found in the *Seiri* and *Shitsuke* attributes, each achieving a score of 13. *Seiri* shows exemplary implementation, as evidenced by the absence of unnecessary items such as food in the warehouse area and the presence of well-maintained, up-to-date announcements, requiring only minor improvements. Similarly, *Shitsuke* is adequately maintained, as reflected in check sheets completed on schedule, technicians adhering to cleanliness requirements before entering the warehouse, and the warehouse maintaining good air circulation.

Figure 1 Actual condition of the warehouse

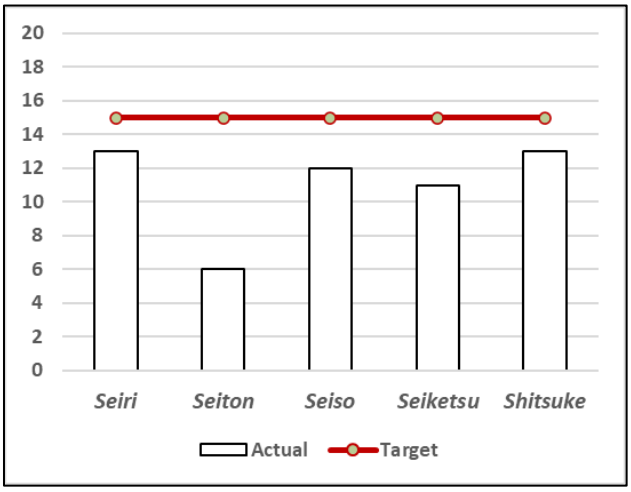

Figure 2 Preliminary 5S audit result

3.2. Activity-Based Waste Assessment

Warehouse main activities can be grouped into three main categories: item retrieval, item placement, and recording and documentation. A waste assessment was conducted based on activities, and the results are depicted in Table 1.

Table 1 Waste assessment result

No	Activity	Waste identification
1	Item retrieval	Transportation: Employees need to move around to locate the items they need to retrieve because the items are not organized by category. Inventory: The disorganization of items and the presence of unnecessary materials in the warehouse may lead to excessive inventory accumulation. Motion: Unnecessary excessive movement results from the employee's repeated motions to make sure the objects collected are the desired items. Waiting: When employees cannot find the required item, the employees must wait for confirmation from the warehouse managers regarding whether the item is still available in the warehouse. Defect: Many obsolete or damaged items remain undetected in the warehouse because employees focus only on retrieving visible items. As a result, items stored deeper or farther from the surface continue to accumulate and lose value over time.
2	Item placement	Transportation: The employee responsible for storing goods must move around the warehouse to locate where the previously retrieved items were taken from before placing them back. Inventory: Items with unclear storage locations are frequently missed during inventory counting, prompting repeated procurement by warehouse managers and resulting in inventory buildup. Motion: The many obstacles in the access paths force additional movement, and poorly arranged items must be sorted before an appropriate storage space can be identified. Defect: Many obsolete or damaged items remain undetected in the warehouse because employees focus only on retrieving visible items. As a result, items stored deeper or farther from the surface continue to accumulate and lose value over time.
3	Recording and documentation	Transportation: Inventory recording is still done manually in logbooks; therefore, the books need to be carried when reporting to the warehouse manager. Furthermore, because the warehouse is not organized by category, the person responsible for recording the inventory must move from one location to another. Inventory: Manual recording is often a problem in warehouses. Many employees are negligent in recording items they take, resulting in unrecorded incoming and outgoing items and backlogs. Motion: The manual recording process often involves excessive movement, such as recording errors that require erasing. Furthermore, employees need to flip through the book's pages to find where to record items taken or returned. Waiting: Out-of-stock items frequently go unrecorded, resulting in employees having to wait for restocking when the items are required.

3.3. Improvement Recommendation based on 5S

3.3.1. Seiri

Based on the preliminary 5S audit results, the *Seiri* aspect received the highest score, 13 out of 20 points. However, there are still many unnecessary components or materials in the warehouse, such as plastic, cardboard, chairs, and other used items. In addition, the visual control is relatively low because many unnecessary items are still buried among other items in the warehouse. Based on the audit results, recommendations for improvement include implementing holding areas. A holding area is a designated area for storing obsolete, unused, or damaged items that require a decision on whether to discard or take another action.

First, identify the holding area, prepare the necessary facilities and equipment, and educate all parties on the purpose and procedures for its use. Furthermore, items in the warehouse are sorted to ensure that only relevant items are placed in the area.

Second, regular inspections of the holding area and warehouse are necessary to ensure that stored items meet operational needs. These daily checks aim to maintain order and efficiency in inventory management, ensuring that no items are left behind or piled up, and that their intended use is clear.

Third, a comprehensive evaluation of the holding area is conducted annually, involving all employees, supervisors, and external parties, if necessary. This evaluation aims to assess the effectiveness of the area's use, identify potential improvements, and ensure that holding area management remains in accordance with established standards.

Finally, items that have been in the holding area for an extended period are eliminated or removed. Items that are no longer needed are removed from the storage area, while items that still have utility but are rarely used are moved to lower-priority shelves. This process aims to maintain storage space efficiency and ensure that only relevant items remain in the holding area.

The use of red tags on materials in the holding area is necessary to mark and identify items that are unnecessary, damaged, or need to be moved to improve workplace efficiency, order, and safety, in accordance with the 5S principles [9]. Furthermore, the red tags indicate the decisions that must be made regarding these items: eliminate, return, move to the holding area, and others.

3.3.2. Seiton

The initial 5S audit for the *Seiton* aspect received the lowest score, 6 out of 20, due to the absence of labels, category-based equipment separation, and symbols, labels. These shortcomings made it difficult for employees to locate equipment because the storage system was unclear. To address this issue, improvements were proposed by redesigning the warehouse layout using the ABC analysis, which groups items by frequency of use [7].

Eight categories of items, pumps, electrical components, trailers, teflon seat valves, general items, valves, and drive motors, were classified by usage frequency, as shown in Table 2. Based on this classification, the warehouse layout was arranged as illustrated in Figure 3. Items in classification A are placed at the front of the warehouse because they are used most frequently and require easy access, classification B items are placed behind them, and classification C items are positioned at the back since they are rarely used.

Table 2 Spare part classification based on usage frequency

No	Product	Usage frequency	%Usage frequency	Cumulative	Classification
1	Teflon seat valve	241	38,44%	86,76%	A
2	Pump	134	21,37%		
3	Trailer	169	26,95%		
4	General	45	7,18%	12,60%	B
6	Electric	16	2,55%		
8	Valve	18	2,87%		
5	Drive motors	3	0,48%	0,64%	C
7	Instrument	1	0,16%		
Total		627	100%	100%	

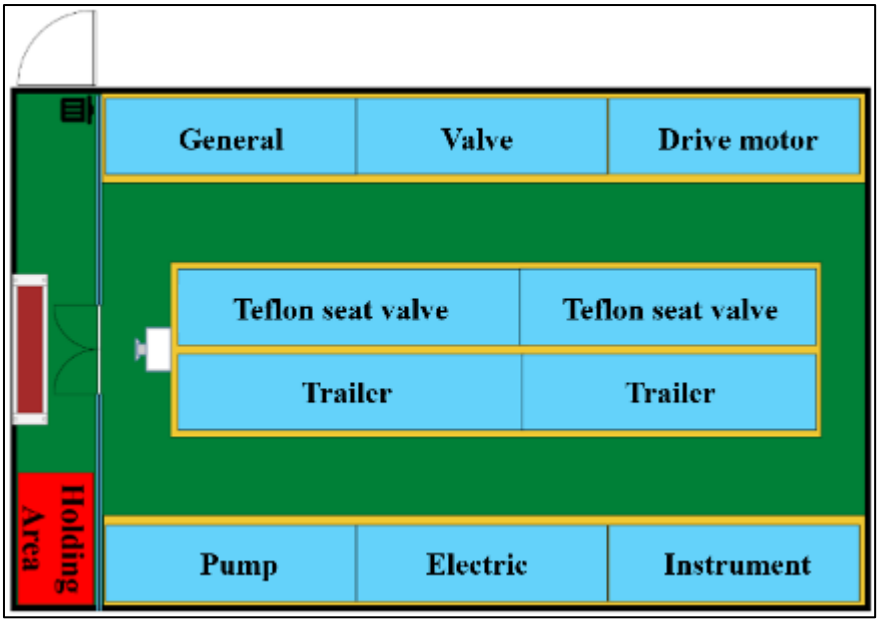

Figure 1 Warehouse layout design

3.3.3. *Seiso*

The Seiso aspect received a score of 12 out of 20 due to insufficient cleaning of the warehouse. Therefore, it is recommended that cleanliness criteria be established as a guideline for maintaining warehouse cleanliness and preventing rapid depreciation of inventory [8]. The proposed cleanliness guidelines are shown in Table 3.

Table 3 Proposed cleanliness guidelines

No	Cleanliness Guidelines
1	No food or drinks in the warehouse.
2	No trash around the warehouse area, including near storage racks and the entrance.
3	No signs of rodents such as rats or cockroaches in the warehouse area.
4	No leftover goods or materials unrelated to the storage process are in the warehouse.
5	Goods are not placed haphazardly and do not block access routes.
6	All goods are placed according to labels or the designated storage system.
7	No plastic or improperly managed waste is in the warehouse.
8	No trash bins are overloaded.
9	Work tools, materials, and goods in the warehouse must not be dusty or dirty.
10	No mold is present in the warehouse area because the warehouse is damp.
11	No warehouse users enter the warehouse in a dirty condition.
12	There are always cleaning tools such as brooms, mops, and dusters in the warehouse area or in front of the warehouse.
13	No unnecessary documents are in the warehouse area.
14	No defective items on storage racks must be moved to the holding area.

3.3.4. Seiketsu

The *Seiketsu* aspect received a score of 11 out of 20 due to the absence of posted standards in the warehouse area to guide maintenance activities. This condition may have negative consequences, as it can reduce users' adherence to maintenance rules and diminish their awareness of proper warehouse upkeep. To overcome this problem, several improvements are needed, namely by posting applicable standards [8] and creating an information system that includes a dashboard for recording goods in the warehouse [10].

The proposed dashboard's primary function is to record incoming and outgoing goods from the warehouse, streamline inventory management, store historical data on inventory usage, and provide real-time inventory information. This dashboard will be highly effective in maintaining the previous 3S, as it will prevent shortages, reduce the number of unused and useless items, prevent worker negligence in inventory recording, and accelerate the process of picking and returning items to the warehouse.

3.3.5. Shitsuke

The *Shitsuke* aspect received a score of 13 out of 20 due to the lack of waste segregation in the warehouse. To address this issue, several improvements are needed, including planning for the provision of trash bins for three types of waste: organic, inorganic, and hazardous. Furthermore, posters on the 5S rules can serve as reminders to warehouse users of the 5S culture.

4. Conclusion

Based on a 5S audit at a gas manufacturing company in Indonesia, various types of waste were identified across the three main warehouse operations activities: retrieval, placement, and recording. The main factor causing this waste is that the 5S method has not yet been fully implemented in the warehouse. Many unnecessary items are still found in the warehouse; work paths are blocked; there is no grouping or labeling of goods by category; and the warehouse is not clean enough, with a lot of dust and trash scattered around. In addition, the process of recording incoming and outgoing goods is still done manually, which carries a high risk of errors and delays in information. The absence of clear cleanliness standards and warehouse users' unfamiliarity with the 5S principles are also the main reasons the current warehouse work system is not optimal.

This research proposed several improvements based on each aspect of the 5S method. In the *Seiri* aspect, it was proposed to use a holding area as a temporary storage location for obsolete, damaged, or unused goods before further action was taken. In the *Seiton* aspect, the warehouse layout was rearranged using the ABC classification method to make goods placement more efficient and aligned with their frequency of use. The development of warehouse cleanliness standards strengthened the *Seiso* aspect, ensuring a more secure and comfortable work environment. To support the sustainability of the previous 3S practices, the *Seiketsu* aspect was enhanced by developing a dashboard-based information system to record incoming and outgoing goods in real time digitally. Finally, in the *Shitsuke* aspect, educational media in the form of 5S posters were provided in the warehouse area as reminders and to consistently cultivate the 5S principles among all warehouse users.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Ikatan Konsultan Pajak Indonesia, "Industri Manufaktur Indonesia Tunjukkan Pertumbuhan Positif di Tengah Tantangan Global." [Online]. Available: https://ikpi.or.id/en/industri-manufaktur-indonesia-tunjukkan-pertumbuhan-positif-di-tengah-tantangan-global/

[2] Ministry of Energy and Mineral Resources Indonesia, "Capaian Kinerja Sektor ESDM Tahun 2023," Jakarta, 2024. [Online]. Available: https://www.esdm.go.id/assets/media/content/content-capaian-kinerja-sektor-esdm-2023-dan-target-2024-.pdf

[3] K. M. Senthil Kumar, K. Akila, K. K. Arun, S. Prabhu, and C. Selvakumar, "Implementation of 5S practices in a small scale manufacturing industries," Mater Today Proc, vol. 62, pp. 1913–1916, 2022, doi: 10.1016/j.matpr.2022.01.402.

[4] D. P. Ardiansyah, F. A. O. Reynaldi, and D. L. Widaningrum, "Improving Warehouse Layout Effectiveness and Process Picking Efficiency with the Discrete Event System Simulation Approach," Procedia Comput Sci, vol. 234, pp. 1753–1760, 2024, doi: 10.1016/j.procs.2024.03.182.

[5] M. M. Shahriar, M. S. Parvez, M. A. Islam, and S. Talapatra, "Implementation of 5S in a plastic bag manufacturing industry: A case study," Clean Eng Technol, vol. 8, p. 100488, Jun. 2022, doi: 10.1016/j.clet.2022.100488.

[6] J. Heizer, B. Render, and C. Munson, Operation Management Sustainability and Supply Chain Management, 12th ed. United States of America: Pearson Education, Inc., 2017.

[7] D. D. Bedworth and James E. Bailey, Integrated production control systems: Management, analysis, design, 2nd ed. New York: Wiley, 1987.

[8] R. S. Agrahari, P. A. Dangle, and K. V. Chandratre, "Implementation of 5S Methodology In The Small Scale Industry: A Case Study ," International Journal of Scientific &Technology Research, vol. 4, no. 4, 2015.

[9] M. Tohari and M. Mahachandra, "Warehouse Arrangement Improvement Based on 5S Method for CV Javatech Agro Persada ," in Proceedings of the Second Asia Pacific International Conference on Industrial Engineering and Operations Management, Surakarta, 2021.

[10] S. Wani and D. K.Shinde, " Study and Implementation of '5S' Methodology in the Furniture Industry Warehouse for Productivity Improvement ," International Journal of Engineering Research & Technology, vol. 10, no. 8, 2021.