

Warehouse Layout Optimization of Work in Progress (WIP) Using Class Based Storage (CBS) Method to Improve Storage Efficiency at UD Permata Furni Semarang

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DOI: <https://doi.org/10.61796/ijecep.v3i3.120>



Sections Info

Article history:

Submitted: June 07, 2026

Final Revised: July 15, 2026

Accepted: August 08, 2026

Published: September 26, 2026

Keywords:

Class based storage

Warehouse layout

Work in progress

Storage efficiency

Throughput analysis

ABSTRACT

Objective: Storage efficiency is an important aspect of warehouse management as it affects the effectiveness of operational activities within a company. The problem identified in the Work In Progress (WIP) warehouse of UD Permata Furni Semarang is that items are not stored according to their movement levels, resulting in relatively long material handling distances, suboptimal warehouse space utilization, less effective material flow, and inefficient storage and retrieval processes. This study aims to analyze storage efficiency in the Work In Progress (WIP) warehouse, identify the supporting and inhibiting factors of the implementation of the Class Based Storage (CBS) method, and design a proposed warehouse layout to improve storage efficiency. **Method:** This study employed a qualitative descriptive approach. Data were collected through observation, interviews, documentation, and literature review. The analysis was conducted through throughput calculation, throughput ranking, storage class formation, and warehouse layout design using the Class Based Storage (CBS) method. **Results:** The results indicate that storage efficiency in the WIP warehouse has not yet been optimal. Supporting factors for CBS implementation include item classification data, warehouse capacity and space, and human resources. Inhibiting factors include receiving and issuing activities, high item movement frequency, and the absence of a warehouse layout arranged based on throughput values and storage class formation. **Novelty:** Based on the throughput ranking and storage class formation, Class A, B, and C storage categories were established and used as the basis for designing a proposed warehouse layout to improve storage efficiency in the WIP warehouse of UD Permata Furni Semarang.

INTRODUCTION

Increasing complexity of the manufacturing industry and supply chain systems encourages companies to improve operational efficiency in order to compete in an increasingly competitive business environment. One important aspect of supporting production and distribution activities is the implementation of an effective logistics system, particularly in the management of warehousing facilities. A warehouse not only functions as a place to store goods, but also plays a role in supporting the smooth flow of goods during the production and distribution process. Ineffective warehouse management can cause longer item search times, inefficient material handling, and suboptimal utilization of storage space [1], [2], [3], [4].

Efforts to improve logistics system efficiency in Indonesia are also supported through Presidential Regulation of the Republic of Indonesia Number 26 of 2012 concerning the Blueprint for National Logistics System Development, which emphasizes the importance of improving the efficiency of goods distribution through the use of logistics facilities, including warehousing systems. Several studies have shown that a

disorganized warehouse layout can cause difficulties in finding goods, increase retrieval time, and reduce storage efficiency [5], [6], [7].

In the manufacturing industry, warehouse layout management becomes increasingly important, especially in the Work In Progress (WIP) area – goods still in the production process and not yet finished products. WIP encompasses various components of production costs, including materials, direct labor, and overhead during the production process. Poor WIP management can cause goods to pile up and impede production flow, reducing operational efficiency. Therefore, proper WIP management and storage is needed so that the production process can run more effectively [8], [9], [10].

UD Permata Furni Semarang is a manufacturing company engaged in wood furniture, producing various types of products such as tables, chairs, and other furniture components. In its production process, the company produces semi-finished goods or Work In Progress (WIP) that are temporarily stored in the warehouse area before entering the next production stage. Based on initial data, the WIP storage system has not been structured. Goods are still placed randomly without systematic grouping, and do not consider product type, size, or frequency of use, causing 9 types of WIP items to be mixed in one storage area.

One method that can be used to overcome these problems is the Class Based Storage (CBS) method, a storage method that groups items based on their activity level or movement frequency so that items with high movement rates are placed in areas that are more easily accessible [11], [12], [13], [14], [15], [16]. This study aims to: (1) analyze warehouse layout optimization using the CBS method to improve storage efficiency, (2) identify supporting and inhibiting factors for CBS implementation, and (3) design a proposed warehouse layout based on throughput ranking and storage class formation.

RESEARCH METHOD

This study uses a qualitative descriptive approach aimed at describing and explaining the phenomena occurring in the field systematically, factually, and accurately. The qualitative method was used to gain deeper understanding of the phenomena studied through direct observation of ongoing activities and processes. The research was conducted at UD Permata Furni Semarang, located in Kawasan Industri Tambak Aji, Jl. Tambak Aji V No. 10 A, Tambakaji, Ngaliyan District, Semarang City, Central Java.

The focus of this research is on the application of the Class Based Storage (CBS) method in optimizing the Work In Progress (WIP) warehouse layout to improve storage efficiency. Data sources consist of primary data obtained through direct interviews with five informants: Head of Material Support & Raw Goods (A-1), Head of Customer Support Division (A-2), Head of Production Division (A-3), Quality Control Staff 1 (A-4), and Quality Control Staff 2 (A-5). Secondary data was obtained from company documentation related to the WIP warehouse layout.

Data collection techniques included observation, interviews, and documentation. Data analysis followed the Miles and Huberman interactive model (in Sugiyono, 2020), encompassing data collection, data reduction, data presentation, and conclusion

drawing. Data validity was tested using technical triangulation by comparing results from observation, interviews, and documentation.

The analytical procedure for Class Based Storage consists of four stages according to Hidayat [17]: (1) analysis of initial warehouse conditions, (2) recording of goods receipt and issuance data, (3) determining movement frequency (throughput = total items in + total items out), and (4) ranking throughput values and forming storage classes. Storage classes are formed using the Pareto principle with three categories: Class A (Fast Moving), Class B (Medium Moving), and Class C (Slow Moving) [18].

RESULTS AND DISCUSSION

Results

Warehouse Layout Optimization Using Class Based Storage

The results of the research on WIP warehouse layout optimization using the CBS method at UD Permata Furni Semarang are analyzed through four aspects according to Apple [19], [20], [21]:

1. Material Transfer Distance

Based on research results, the material transfer distance in the WIP warehouse is still not efficient. Informant A-5 stated: "The current material transfer distance is still quite far because the placement of goods has not been arranged based on production needs. As a result, employees have to move to several warehouse areas to retrieve the required materials, making work time longer." Informant A-3 added that frequently used materials have not been placed in easily accessible locations, causing longer retrieval times. These findings align with Apple's theory [19] that material transfer distance is a key indicator in warehouse layout optimization. The shorter the material transfer distance, the more efficient the warehousing activities [22], [20], [21].

2. Warehouse Space Utilization

Warehouse space utilization in the WIP warehouse is still suboptimal. Informant A-2 noted: "Utilization of warehouse space is still not maximized because company-owned goods and buyer-owned goods are still placed in the same area." Informant A-1 confirmed that goods have not been grouped by category, causing some storage areas to be too full while others still have available space. This is consistent with Apple's theory [19] that good warehouse space utilization aims to maximize the use of available storage capacity so that every warehouse area can be used effectively and efficiently [20], [2], [23].

3. Production Area Flow

Goods flow in the WIP warehouse has not been running optimally. Informant A-3 stated: "Goods flow in the warehouse is still not fully smooth because mixed goods placement makes the process of finding and retrieving goods take longer." Informant A-2 explained that goods distribution is often hampered because storage positions are not organized. However, according to informant A-1, warehouse activities can still meet the company's operational needs. According

to Apple [19], good warehouse layout must create a smooth, orderly, and minimally obstructed material flow so that the goods transfer process can be carried out effectively [1], [3], [10].

4. Storage and Retrieval Time

Storage and retrieval time for goods is also not yet efficient. Informant A-3 stated: "The retrieval process sometimes takes quite a long time because the goods position is not arranged in an orderly manner. When the required goods are at the back or covered by other goods, employees must move several items first." Informant A-4 added that the time required is unpredictable as it depends on the storage position. According to Apple [19], storage and retrieval time is an important indicator of warehouse layout optimization. The shorter the time needed, the more optimal the warehouse layout [22], [2].

Supporting and Inhibiting Factors

Supporting Factors

Three main factors support CBS implementation at UD Permata Furni Semarang:

(1) Item Classification Data — The company has data on item types, quantities, and movement, which can be used as a basis for grouping and determining storage locations. Informant A-1 stated: "The availability of item data is very helpful in warehouse management because the company can find out stock quantities, item types, and item movements." This aligns with Tompkins et al. [18], who state that accurate item classification data is one of the main supporting factors for CBS implementation [24].

(2) Warehouse Capacity and Area — Although the available storage area has limitations, it still allows for re-arrangement and item grouping. Informant A-2 stated: "The warehouse has a storage area that can be used to group items based on type or level of movement." According to Tompkins et al. [18], adequate warehouse capacity enables companies to carry out item grouping into certain classes according to their activity level [25], [23].

(3) Human Resources — Warehouse employees have sufficient understanding and experience in running warehouse operations. Informant A-3 stated that employees already understand the flow of goods storage and retrieval. This is consistent with Tompkins et al. [18], who state that human resources are an important factor in the success of CBS implementation [8].

Inhibiting Factors

Three main factors inhibit CBS implementation:

(1) Goods Receipt and Issuance Activities — High goods flow that is not supported by an organized storage system causes goods to be placed in available empty areas without considering their movement levels. Informant A-3 stated: "The receipt and issuance process is still carried out according to production needs and has not been supported by a fixed storage location arrangement." This is consistent with Tompkins et al. [18], who state that goods receipt and issuance activities influence the effectiveness of the warehouse storage system [1], [3].

(2) Goods Movement Frequency – Total goods movement frequency in October 2025 reached 2,107 movements, but this has not been matched by an appropriate storage location arrangement. The product with the highest movement frequency was STOEL STAPEL HARDLEY (STACK CORDOVA) with 1,064 movements, while some products had only 2 movements. This significant difference shows that goods placement must be based on movement frequency level to optimize warehouse efficiency [26], [24], [14].

(3) Absence of Throughput-Based Warehouse Layout – The current warehouse layout has not been arranged based on throughput values and storage class formation, causing items with different movement levels to be stored mixed together. Informant A-2 stated: "There is no storage grouping based on goods movement frequency. Goods placement still adjusts to available space." According to Tompkins et al. [18], the CBS method requires goods grouping based on their activity or movement frequency [11], [13], [16].

Throughput Ranking and Storage Class Formation

Based on throughput calculation and ranking of 50 WIP item types, three storage classes were formed using the Pareto principle [17], [18]:

Class A (Fast Moving): Items with cumulative throughput percentage of 0-75.38%, consisting of 11 item types. The item with the highest throughput is STOEL STAPEL HARDLEY (STACK CORDOVA) with 1,064 movements (50.50%), followed by SEDIA C-BR ADRIEL with 120 movements (5.70%).

Class B (Medium Moving): Items with cumulative throughput percentage of 75.38-95.55%, consisting of 27 item types. These include CONSOLE STROM SMALL, GRAZ BANK, VENETIE BAR TABLE, and others.

Class C (Slow Moving): Items with cumulative throughput percentage of 95.55-100%, consisting of 12 item types with the lowest movement frequency, including BONE LOVESEAT 1 SEATER, KLOSTER TABLE OUTDOOR 300 X 100, and CONSOLE TABLE.

Based on the throughput ranking and storage class formation, a proposed warehouse layout was designed. In the proposed layout, Class A items are placed closest to the main warehouse activity point (entry/exit area), Class B items in the middle area, and Class C items furthest from the activity point. This proposed layout is expected to reduce unnecessary transfer activities, facilitate goods search and retrieval, and optimize storage space utilization [26], [12], [5], [9], [6], [25], [7], [14], [15], [23], [16].

Discussion

The findings indicate that the main source of inefficiency in the WIP warehouse is not merely limited storage capacity, but the absence of a placement policy that connects item movement frequency with storage location. The concentration of throughput in a small number of items supports the use of Class Based Storage because high-movement products require faster access than medium- and slow-moving products [11], [12], [13], [14], [15], [16]. Positioning Class A items near the entry and exit points, followed by Class B and Class C items, is consistent with facility-planning principles that seek to reduce travel distance, handling effort, and retrieval time while improving the use of available

space [18], [19], [20], [21], [22], [23]. However, the proposed layout should be interpreted as an operational design rather than evidence of realized efficiency gains because the study did not measure material-handling distance, retrieval time, or space utilization before and after implementation. Its practical success will therefore depend on disciplined location assignment, clear storage labels, periodic recalculation of throughput, and employee compliance when receiving, storing, and issuing WIP items [24], [25], [26].

CONCLUSION

Fundamental Finding: WIP warehouse layout optimization at UD Permata Furni Semarang using the Class Based Storage (CBS) method has not been running optimally. Based on the aspects of material transfer distance, warehouse space utilization, goods flow, and storage and retrieval time, it is known that goods placement has not been based on movement level or item characteristics. Through CBS implementation, item grouping into Class A, B, and C based on throughput values was obtained and used as the basis for the proposed warehouse layout to improve storage efficiency. **Implication:** Supporting factors for CBS implementation include the availability of item classification data, warehouse capacity that still allows re-arrangement, and experienced human resources. Inhibiting factors include high receipt and issuance activities, high movement frequency without appropriate storage arrangement, and the absence of a throughput-based warehouse layout. **Limitation:** This study uses qualitative descriptive approach with data limited to October 2025. Future studies may consider using quantitative measurement of efficiency improvement after CBS implementation to provide more measurable results. **Future Research:** Future research can focus on evaluating the efficiency improvements after actual CBS implementation, periodic updating of item classification data, and exploring digital warehouse management systems to support real-time throughput monitoring.

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