

A Study of Warehouse Efficiency and Effectiveness

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Abstract- This paper examines key strategies for enhancing efficiency and effectiveness in 3PL warehouses, such as layout optimization, inventory management techniques, workforce training, and technology integration. The role of advanced technologies like warehouse management systems (WMS) is highlighted in driving improvements. Furthermore, the significance of performance metrics and continuous improvement initiatives is discussed to sustain and further enhance warehouse operations. Overall, this abstract underscores the importance of balancing efficiency and effectiveness in 3PL warehouses to achieve competitive advantages and customer satisfaction in today's dynamic logistics landscape.

Keywords- Warehousing Effectiveness, Warehousing Management, Warehousing Activity.

I. INTRODUCTION

Logistics refers to the strategic movement of goods and services from one place to another. The term was originally used to describe the transportation of military supplies to soldiers on the front line, but with the rise of e-commerce and online shopping, logistics is now integral to the global supply chain process, and it encompasses the procurement, storage and distribution of materials that power the economy.

Logistics is the process of coordinating how goods and products are obtained, stored and distributed. Manufacturers rely on logistics while overseeing complex operations in order to maintain efficiency, reduce costs and ensure that consumers' needs are met.

Due to the prominence of e-commerce companies, like Amazon, logistics embodies more than the actual movement of products from one place to another. An important part of logistics is the steps taken in order to maximize customer satisfaction. This includes elements such as demand planning, order fulfilment, inventory management and customer service operations. These elements ensure

that the goods consumers need are stocked and orders are fulfilled in a timely manner.

Logistics management software has aided the expansion of what the logistics industry entails and how goods are brought to consumers. Some examples of software for the logistics industry include transportation management systems, enterprise resource planning software, yard management systems and warehouse management systems. The growth of this technology has created a need for specialized roles and companies focused on building and implementing logistics software. As technology continues to transform our world, its influence on the logistics industry will only become greater, prompting a shift in how companies quickly and efficiently deliver their products to consumers.

Why Logistics is Important

Logistics may not be the first thing that comes to mind when a purchase is made online or in a brick-and-mortar store, but it is undeniably intertwined with everything we buy. Logistical considerations affect global supply chains, what items are in stock and when as well as where manufacturers chose to build their facilities. These influences are just one way that logistics displays importance in our global economy.

Utilizing logistics properly is essential to the function of businesses across the globe — and effectively managed logistics typically leads to positive business outcomes. With the growing complexity of the global supply chain, properly implemented and managed logistics are more important than ever. The importance of logistics also stretches to simplifying communication and reducing costs. Effective logistics help foster relationships between suppliers, shipping services and warehousers through automated systems. The connectivity of logistics improves delivery and fulfilment of orders, which in turn reduces overhead costs. Costs are also reduced by the ability to use logistical systems to purchase goods based on supply forecasts and improved inventory management.

Logistics companies plan, implement, and control the movement and storage of goods, services, or information within a supply chain and between the points of origin and consumption. Various logistics companies handle some or all of these supply chain functions, depending on a client's logistical needs. Logistics is a term synonymous with the military. In times of war supplying troops with the proper equipment and supplies was a logistics function. Logistics has evolved since the 1950s with the rise of consumerism and the subsequent growth of more complex supply chains.

Coordinating the movement of supplies and materials is now a globalized process. Today, the business sector uses logistics as a term to describe the efficient flow and storage of goods from point of origin to the point of consumption. The supply chain is a vital part of this process. A proper supply chain may include transportation, shipping, receiving, storage, and management of all or one of these functions. Logistics may also apply to information, transportation, inventory, warehousing, material handling, packaging, disposal, and security within the business sector.

People often use the terms 3PL and freight broker interchangeably, however, this creates confusion regarding the nuances of either service. 3PLs and Freight Brokers are both intermediaries between

the shipper and the carrier, yet their roles differ. A broker focuses primarily on executing a singular shipment and works to meet specific cost and service goals. The 3PL provider thinks about the bigger picture and more strategically. They plan earlier in the supply chain and anticipate the needs of a client through every step of the supply chain, transport, and delivery process.

II. REVIEW OF LITERATURE

1. Ibrahim Hassan Mohamud, Md. Abdul Kafi , Syairah Aimi Shahron , Nizamuddin Zainuddin , Suria Musa (5 February 2023)

"The Role of Warehouse Layout and Operations in Warehouse Efficiency" - Organizations now use warehouse efficiency as a centre of expertise or a strategic weapon. A warehouse that works well can meet customer needs quickly and helps a business do better. So, the goal of this study is to look at how the attributes of a warehouse affect warehouse efficiency. This study looks at two attributes about warehouses: their layout and warehouse operations. A literature review was first conducted to find the role of warehouse attributes (layout and operation) in warehouse efficiency to draw lessons from the literature.

2. Ling-feng Hsieh & Lihui Tsai (04 May 2005)

"The optimum design of a warehouse system on order order picking efficiency" - From literature review and deep understanding on the practical industry, it is understood that the proper use of storage assignment policies can use minimum storage space to reach the purpose of minimum total traveling distance, and this has a direct impact on enhancing the order picking performance. At the same time, proper routing planning can minimize overall order picking cost, and finally reach the goal of picking performance enhancement in unit time. Therefore, this paper considers the effects on the order picking system performance for factors such as quantity and layout type of cross aisles in a warehouse system, storage assignment policy, picking route, average picking density inside an aisle, and order combination type, etc. A software, eM-plant, will be used as a simulation and analysis tool, a warehouse design database will be

developed, which is based on the minimum overall traveling distance as the optimum performance index, the cross aisle quantity, warehouse layout, storage assignment, picking route planning, picking density and order combination type will be optimally integrated and planned in the warehouse system. Finally, we provide this database to the industry as a reference in the warehouse planning or warehouse design improvement in the future .

3. Gino Marchet, Marco Melacini, Chiara Sassi, Elena Tappia (08 Sep 2016)

"Assessing efficiency and innovation in the 3PL industry: an empirical analysis" -The Third-party Logistics (3PL) industry is facing both important growth rates and increasing competitive pressure. 3PL providers are required to continuously sustain a more and more competitive cost structure (i.e. efficiency) and develop capabilities to improve their services (i.e. innovation); hence, the evaluation of these key success factors is considered a key issue. This paper develops a quantitative analysis of 71 Italian 3PL providers by using Data Envelopment Analysis to jointly assess efficiency and innovation. Furthermore, through a case study research, it corroborates the quantitative results by investigating the strategies of best-in-class companies. Results allowed identifying 13 3PL providers as efficiency leaders and 6 as leaders from both the efficiency and the innovation side. Their input composition indicates a diversification of the business models. A breakdown of the analysis by size and industry focus, along with empirical evidence on the strategies enhancing efficiency and innovation, is also provided.

4. Martina Baglio, Alessandro Creazza and Fabrizio Dallari (6 June 2023)

The "Perfect" Warehouse: How Third-Party Logistics Providers Evaluate Warehouse Features and Their Performance - The recent trends in logistics outsourcing have led to the need to investigate the 3PL (third-party logistics) industry better. However, the attention has always been focused on operative performance, and the role of the warehouse has been skimmed over. This research aims to define the relationship between warehouse features and the performance indicators of 3PLs, filling the

literature gap. This research provides insight into 3PLs' way of thinking, helping 3PLs identify the right warehouse features to improve their performance and providing guidance for real estate companies in designing warehouses meeting 3PLs' needs. The analysis uses a case study approach, carried out by interviewing 3PLs that provided data coded according to the dimensions of the Kano model. This methodology was used to generate an indepth understanding of how 3PLs evaluate the different warehouse features that are able to drive their performance. The "perfect warehouse" is placed in an accessible location; it has loading bays, a standard layout, and a height suitable to optimize the flow of goods, and it utilises the spaces to make the service flexible and responsive. In addition, the warehouse should have internal areas, such as mezzanines, to deliver value-added services.

5. Gunasekaran, H.B. Marri, F.Menci (01 Dec 1999)

"Improving the effectiveness of warehousing operations" - The warehouse is the interface area for production lines, market, customers and suppliers, and the business environment in general. Goods inwards (GI), constituting part of the warehouse activities, is the department responsible for booking-in the incoming parts from external suppliers. After the production process is improved, the resources in the warehouse are balanced to link the internal/ external transfer of physical items. With a broader view of the GI activities, and a look into its future, the actual problems may become clear, understandable, and hence easy to solve. The aim of this paper is to study the problem areas in GI and provide solutions to increase the performance of warehousing operations. First, a conceptual framework has been developed to improve the effectiveness of warehousing operations. Second, a case study has been conducted with the help of the model to minimize the through-put time in warehousing operations. Finally, a summary of findings and recommendations are presented.

6. Ling- feng hsieh, Lihui Tsai (2005)

"The optimum design of a warehouse system on order picking efficiency" - This review consider of the effect on the order picking system performance

for factor such as quantity and layout type of cross aisles in a warehouse system, storage assignment policy, picking route, average picking density inside an aisle, and other order combination type etc. A software, eM- plant, will be used as a simulation and analysis tool, a warehouse design database will be developed, which is based on the minimum overall traveling distance as the optimum performance index, the cross aisle quantity, warehouse layout, storage assignment, picking route planning, picking density and order combination type will be optimally integrated and planned in the warehouse system.

7. Duque-Jaramillo, J. C., Cogollo-Flórez, ET.AL.,(2024) "Warehouse Management Optimization Using a Sorting-Based Slotting Approach".

They said One of the key functions of warehouse management is slotting. Its foundation is the effective distribution of stock-keeping unit (SKU) slots. Improving order picking and slotting results in significant performance savings because these tasks account for a large portion of overall logistics expenses. The goal of this research is to create an allocation model that incorporates the physical characteristics of SKUs, the layout, size, and material handling equipment of warehouses, as well as the demand for diverse products

8. A.C. Sembiring Et Al. (2019) "Improvement of Inventory System Using First in First Out (FIFO) Method".

The company must contact inventory recording to track available stock, facilitating timely order from suppliers. A well-established inventory system simplifies planned and controlled processes for goods management. However, a chemical distributors raw materials inventory recording reminds rudimentary, leading to numerous product expirations. This research aims to aid companies in systematically collecting precise inventory data to mitigate product expiration.

Rene de koster, Tho le duc, kees jan roodbergen (2011) "Design and control of warehouse order picking" - Order picking has long been identifying as the most labour intensive and costly activity for

almost every warehouse; the cost of order picking is estimated to be as much as 55%of the total

9. Vellian Vatumalae, Premkumar Rajagopal, V. Sundram (25Aug2020)

"Warehouse management system of a third party logistics provider" - This study aims to explore the significant benefits gained from the implementation of the warehouse management system in 3rd party logistics service provider. A qualitative research approach been adopted by conducting an in-depth case study in one of Halal third party logistics company in central Malaysia. As a result of the highly competitive in 3rd party logistics market, environmental companies are continuously forced to improve their warehouse operation into a system based application, may 3rd party logistics companies have also customized their value proposition to meet better customer demand which has led t changes in the role of warehouse.

10. Masoud Mirzaei, Nima Zaerpour, Rene de koster (2020)

"The impact of integrated cluster-based storage allocation on parts-to-picker warehouse performance" - Order picking is one of the most demanding activities in many warehouse in terms of capital and labour. In parts-to-picker system, automated vehicles or cranes bring the parts to a human picker. The storage assignment policy, the assignment of the products to the storage location, influence order picking efficiency. Warehouse can use product has affinity to make informed decision and assign multiple correlated product to the same inventory "pod" to reduce retrieval time.

Objectives of the Study

Primary Objective

- To study the objectives of warehouse efficiency and effectiveness with respect 3PL company under study and gain practical knowledge and concept of 3rd party logistics.

Secondary Objectives

- To identify the major challenges in warehouse efficiency and effective inventory classification.
- To study the warehouse inventory management and demand control.

- To analyze how the receiving, unloading, product storage, handling, inventory management.
- I observes the benefits of warehouse operations.

Scope Of The Study

1. Warehouse Design and Layout

Analysing the design and layout of warehouses within warehouse to ensure optimal space utilization, efficient material flow, and effective storage solutions. This includes assessing the layout for accessibility, storage density, and workflow optimization.

2. Inventory Management Systems

Evaluating the inventory management systems employed by to track, monitor, and manage inventory levels accurately. This involves assessing the use of technology such as Warehouse Management Systems (WMS), barcode scanning, RFID, and real-time tracking to improve inventory accuracy and reduce stock discrepancies.

3. Technology Integration

Assessing the integration of technology solutions such as automation, robotics, and data analytics within warehouse operations to optimize efficiency. This involves evaluating the effectiveness of technology investments in improving process automation, labor productivity, and decision making capabilities.

4. Customer Satisfaction and Service Levels

Evaluating the impact of warehouse efficiency on customer satisfaction and service levels. This includes assessing order accuracy, on-time delivery performance, and responsiveness to customer inquiries or requests, and identifying opportunities for improvement to enhance overall customer experience.

5. Cost Optimization

Analysing cost drivers within warehouse operations and identifying opportunities to reduce costs while maintaining or improving efficiency. This includes assessing labor costs, inventory carrying costs,

transportation expenses, and overhead costs, and implementing cost-saving.

III. METHODOLOGY

1 Research Design

Research design refers to the overall strategy utilized to answer research questions. A research design typically outlines the theories and models underlying a project; the research question of a project; a strategy for gathering data and information; and a strategy for producing answers from the data. It is the plan or framework used to conduct a research study. It involves outlining the overall approach and methods that will be used to collect and analyse data to answer research questions or test hypotheses.

IV. RESULT AND ANALYSIS

1. Abc Analysis Of Inventories

The ABC inventory control technique is based on the principle that a small portion of the items may typically represent the bulk of money value of the total inventory used in the production process, while a relatively large number of items may from a small part of the money value of stores. The money value is ascertained by multiplying the quantity of material of each item by its unit price.

According to this approach to inventory control high value items are more closely controlled than low value items. Each item of inventory is given A, B or C denomination depending upon the amount spent for that particular item. "A" or the highest value items should be under the tight control and under responsibility of the most experienced personnel, while "C" or the lowest value may be under simple physical control. It may also be clear with the help of the following examples:

"A" Category – 5% to 10% of the items represent 70% to 75% of the money value.

"B" Category – 15% to 20% of the items represent 15% to 20% of the money.

"C" Category – The remaining number of the items represent 5% to 10% of the money value.

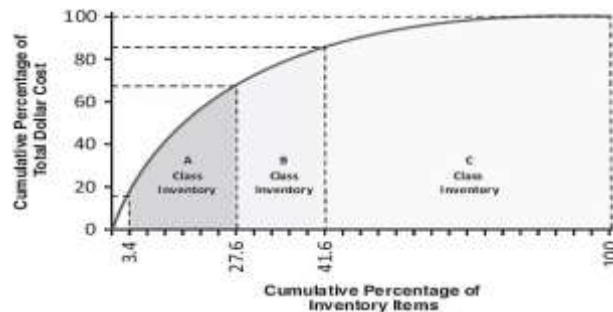


Figure 1: ABC analysis of inventory

2. VED Analysis

VED stands for Vital, Essential, and Desirable. VED analysis is a method for classifying inventory items based on their importance to a business. VED analysis can be used to categorize items into three groups:

Vital

These are products that are absolutely crucial for business operations. They are essential materials whose non-availability while putting a halt to business operation. Vital items are most critical and must always be available.

Essential

These items are important but not critical. Essential items can be unavailable for 2-3 days.

Desirable

- These products, while not essential, enhance the customer experience or business efficiency.
- Desirable items can be unavailable for longer periods.

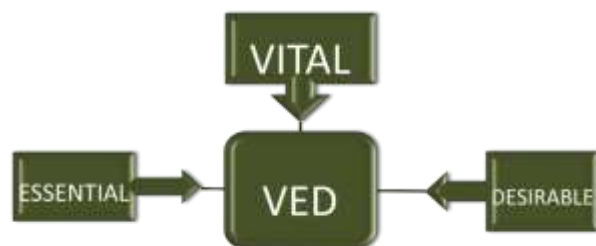


Figure 2: VED analysis

3. FSN Analysis

FSN Analysis helps to classify the inventory into three types based on the flow of product used or sale and how long they stay in location.

- FAST MOVING (Items that are issued or used frequently)
- SLOW MOVING (Items that have a slow usage frequency)
- NON- MOVING (Items that are not frequently issued and consumed over a period of time.

Table 1: Classification Table of Ved and Fsn

	V	E	D
F	FV	FE	FD
S	SV	SE	SD.
N	NV	NE	ND

Table 2: Classification of Parts as Per VED and FSN

<u>Server Hardware</u>	
Random Access Memory (RAM)	F/V
Graphics card	F/E
Storage (Hard Drive and Solid state Drive)	F/V
<u>MERGING PARTS</u>	
Processor (CPU)	S/E
Keyboard	F/D
Display Screen	F/V
Touchpad	F/V
Laptop Bag	S/D
Battery	S/E
<u>CHASSIS</u>	
Power Connector Cable	S/E
Camera	F/E
System board	F/V
Cooling Fan	F/V
Panel	F/V
Speakers	S/E
IC chip & Other Chip	S/D

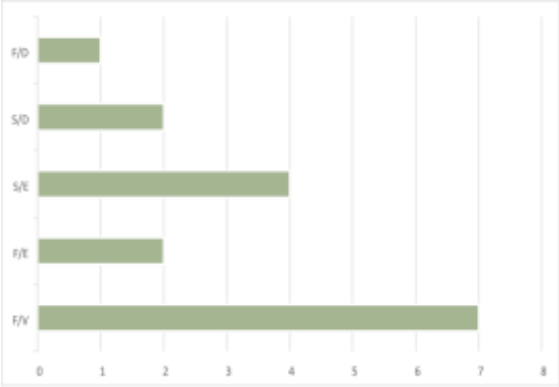


Figure 3: FSN Aanlysis

The above bar chart all about the FSN and VED category related to the component. The x axis shows measure of FSN and VED, y axis shows the analytical tools (FSN, VED).

Table 3: F/V Category

Random Access Memory (RAM)	F/V
Storage (Hard Drive and Solid state Drive)	F/V
Display Screen	F/V
Touchpad	F/V
System board	F/V
Cooling Fan	F/V
Panel	F/V

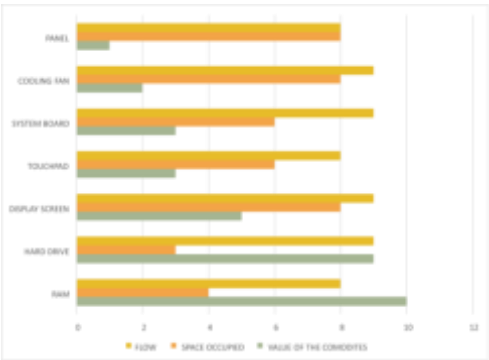


Figure 4: F/V analysis

The above chart all about the fast and vital category related to the component or parts of various model of warehouse. The x axis shows the value and y axis

Table 4: Problem in Warehouse

Problems in warehouse	Percentage
	73%
Labor problem	13%
Space	9%
Safety	5%



Figure 5: problem in warehouse

The chart and table shows the details about some problems faced in this warehouse. The main problem faced here is warehouse travel so that we recommend here to apply ABC method for inventory management. Also second problem is 13%labour efficiency. Space allocation is 9% and 5% for safety measures.

Table 5: Goods Hand linf Facility

Goods handling facility	Percentage
Good	80%
Average	15%
Bad	5%

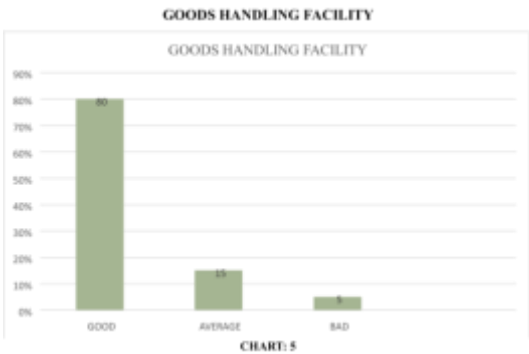


Figure 6: goods handling facility

The graph shows that the most of the customer are satisfied with the perishable goods handling facility in this warehouse.

Table 6: Customer Satisfaction

Customer Satisfaction Level	Percentage
High	88%
Average	10%
Low	3%

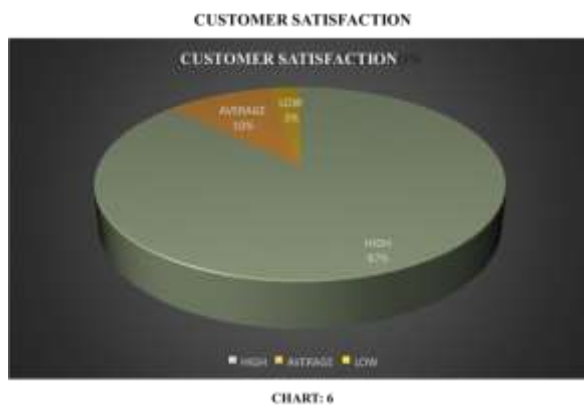


Figure 7: customer satisfaction

In this chart we are able to see that customer satisfaction is very high in the case of warehouse facility like the space, service material handling, communication, accessibility etc.

Findings

- The evolving role of 3PL in optimizing supply chain efficiency and supporting business growth.
- key operations within a warehouse, such as receiving, storage, picking, packing, and shipping.
- The role of WMS in optimizing warehouse processes.
- Common challenges faced by warehouse managers (e.g., labour shortages, space constraints, inventory management issues).
- Their types of services offered by 3PL providers, including transportation, warehousing, inventory management, order fulfillment, and value-added services.

- Benefits that companies gain from utilizing 3PL warehouses, such as cost savings, scalability, expertise, and access to advanced technologies.
- Features and capabilities of 3PL warehouses, including flexible storage options, integrated technology platforms, and value-added services like kitting and assembly.

Suggestions

Improve Packing Efficiency

Implement measure to reduce packing lead time, such as optimizing packing process, providing additional training to staff, or invest in technology to streamline

Inventory Management

Our inventory management practices require closer attention, with a focus on reducing excess stock, minimizing stock outs, and implementing better forecasting methods to align inventory levels with demand fluctuations. Adopting just-in-time principles and leveraging demand forecasting tools can help us achieve optimal inventory levels.

Employee Training

Develop comprehensive training programs to empower employees with the necessary skills and knowledge to excel in their roles, fostering a culture of continuous improvement and innovation.

Develop and Implement Safety Policies

Establish comprehensive safety policies and procedures that cover all aspects of warehouse operations, including material handling, equipment operation, emergency response, and personal protective equipment (PPE) usage. Ensure that all employees are trained on these policies and adhere to them rigorously.

Apply Abc Analysis

Adopt ABC analysis to categorize inventory items based on their importance, such as value, demand frequency, or contribution to revenue. Allocate resources and prioritize efforts accordingly, focusing on high-value or critical items while optimizing storage and handling for low-value items. That will reduce the warehouse travel and eliminate bottleneck in out bound.

V. CONCLUSION

By doing this project the researcher was able to understand all the basic working of a warehouse. Inventory handling is the most important part of warehouse management. Many types of equipment like forklift and stackers are the most commonly used tools for inventory handling in most of the warehouses.

These facilities are curtailed due to the day by day demand of this field/ sector. There is high potential for this company in the future due to the high customer satisfaction provided by company. warehouse strategy is evolving to more focus and flexibility. The main objective of this project report is to get practical knowledge of warehouse process and functions. It help to study the warehousing, inventory management and damage control as well as understand 3PL's . warehouse.

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