

# The Study of Efficiency and Effectiveness of Warehouse Management in the Context of Supply Chain Management

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## ABSTRACT

In supply chain management, modern warehousing firms and distribution centres are overwhelmed with information related to the flows and storage of goods and services. The efficient and effective utilization of logistics-related information can enhance firms' ability to reduce costs while simultaneously improving customer satisfaction. Warehouse management systems (WMS) are frequently implemented and used with these goals in mind. The current research examines resource-based empirical justification for the pursuit and implementation of WMS. In addition, a research agenda is offered to guide future research efforts related to WMS and the broader area of logistics information systems (LIS). At a same time Inventory management is a science primarily about specifying the shape and placement of stocked goods. It is required at different locations within a facility or within many locations of a supply network to precede the regular and planned course of production and stock of materials. The effective and efficient management of any organization requires that all its constituent elements operate effectively and efficiently as individual SBUs / facilities and together as an integrated whole corporate. In today's competitive market environment companies are continuously forced to improve their warehousing operations. Many companies have also customized their value proposition to increase their customer service levels, which has led to changes in the role of warehouses. This paper highlights the findings of the study to evaluate performance levels and enhance productivity of the warehouses by developing a WMS various distribution and to analyse the impact of effective and efficiency

Warehousing on competitive strength, enhanced preservation & control and overall cost reduction and also to find out various factors affecting efficiency and effectiveness of warehouse system.

**Keywords** - warehouse management, supply chain management, logistic information system

## 1. INTRODUCTION

Warehousing facilities play a vital role in the overall supply chain process. This article will address —back to the basics that are fundamental for warehouses to achieve both efficiency and effectiveness in supply chains, and provide some perspective on current challenges and the future. It is evident that continuing globalization and changes/challenges occurring in such areas as reverse logistics, environmental sustainability, information technology, and overall supply chain integration are further evolving the strategies, roles, and responsibilities

for warehouses. In fact the term —distribution centre (DC) may be much more appropriate in representing the broad range of activities that now occur in modern warehouses that go beyond filling customer orders to provide an ever expanding array of value added services.

Across the supply chains, warehousing is an important element of activity in the distribution of goods, from raw materials and work in progress through to finished products. It is integral part to the supply chain network within which it operates and as such its roles and objectives should synchronize with the objectives of the supply chain. It is not a Stand-alone element of activity and it must not be a weak link in the whole supply chain network.

A warehouse management system or WMS primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, put-away and picking. A warehouse management system (WMS) is a database driven computer application, to improve the efficiency of the warehouse by directing cutaways and to maintain accurate inventory by recording warehouse transactions. The systems also direct and optimize stock based on real-time information about the status of bin utilization. It often utilize Auto ID Data Capture (AIDC) technology, such as barcode scanners, mobile computers, wireless LANs (Local Area Network) and potentially Radio-frequency identification (RFID) to efficiently monitor the flow of products. Once data has been collected, there is either batch synchronization with, or a real time wireless transmission to a central database. The database can then provide useful reports about the status of goods in the warehouse. Warehousing is costly in terms of human resources and of the facilities and equipment's required, and its performance will affect directly on overall supply chain performance. Inadequate design or managing of warehouse systems will jeopardize the achievement of required customer service levels and the maintenance of stock integrity, and result in unnecessarily high costs. The recent trends and pressures on supply chain / Logistics-forever increasing customer service levels, inventory optimization, time compression and cost minimization —have inevitably changed the structure of supply chains and the location and working of warehouses within the supply chains network.

## 2. LITERATURE REVIEW:

Warehousing takes up to between 2% and 5% of the cost of sales of a corporation and with today's highly competitive global business environment organizations are emphasizing on Return on Assets, and hence minimizing warehousing costs has become an important business issue. Many firms are automating their basic warehousing functions to achieve the increase in throughput rates or inventory turns required for their warehousing operations to be cost effective. It is necessary to allocate warehouse resources efficiently and effectively to enhance the productivity and reduce the operation costs of the warehouse. One vital area determining the efficiency of warehouse is the determination of the proper storage locations for potentially thousands of products in a warehouse. Various factors affecting the storage assignment like order picking method, size and layout of the storage system, material handling system, product characteristics, demand trends, turnover rates and space requirements are been extensively studied. It has been suggested that selecting appropriate storage assignment policies (i.e. random, dedicated or class-based) and routing methods (i.e.

Transversal, return or combined) with regards to above factors is a possible solution to improve the efficiency. Various decision support models and solution algorithms have also been established to solve warehouse operation planning problems.

The implementation of WMS for a company demands significant investment and time period (several months) which has to be justified with the benefits obtained after implementation. The justification involves the excellent analysis of the current situation of the warehouse and warehouse operation for a specific period of time tuning the WMS. The firm should be prepared to change the entire process and system storage. Only WMS implementations without changing processes show that does not lead to cost savings or efficiency improvements, it will only reduce errors due to human factors. Another issue that has exercised companies in recent days has been the degree of technology to utilize in warehousing operations. The choice spans from conventional warehousing –racking and shelving with forklift or even manual operations through to fully automated systems with conveyors and automated guided vehicles (AGVs) and from carousels to robotic applications. The reasons for the choice of a particular technology level are not always clear cut, and run the gamut of financial, marketing and other factors, from company's image or flexibility for future change through to personal perception of the appropriateness of a particular technology to a particular business or company.

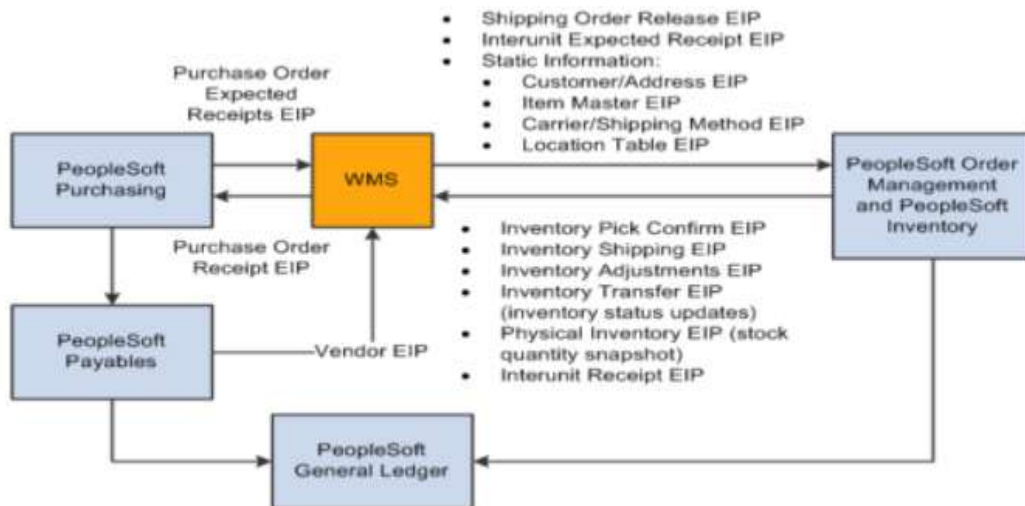
### 2.1 WAREHOUSE FUNCTIONS AND WAREHOUSE PROCESSES

A warehouse has traditionally been viewed as a place to hold or store inventory. However, in contemporary logistical systems, warehouse functionality is more properly viewed as mixing and modifying inventory to meet customer requirements, where storage of products is ideally held to a minimum, the warehousing of products occurs for one or more of the following reasons:

1. Achieving transportation economies
2. Achieving production economies
3. Taking advantage of quantity purchase discounts and forward buys
4. Maintaining a source of supply
5. Supporting the firm's customer service policies –
6. Meeting changing market conditions (e.g., seasonality, demand fluctuations, competition)
7. Overcoming the time and space differentials that exist between producers and consumers.
8. Accomplishing least total cost logistics commensurate with a desired level of customer service
9. Supporting the just-in-time programs of suppliers and customers.
10. Providing customers with a mix of products instead of a single product on each order.
11. Providing temporary storage of materials to be disposed of or recycled (i.e., reverse logistics).

Warehouses decouple supply from demand. They are the points in the supply chain where product pauses, however briefly, and are touched. This consumes both space and time (person-hours), both of which are an expense. Distinguish four basic warehouse functions that add value to the supply chain. The break-bulk function allows for products to arrive in large quantities and then to be shipped in small quantities tailored to the needs of many customers. This adds value as it reduces production costs, purchasing costs, and transport

costs upstream in the supply chain. The storage function adds value since it allows larger quantities to be produced and transported which is more efficient. It also enables orders to be quickly delivered to customers, which provides a better service level and prevents lost sales. The consolidation function implies that the warehouse holds products from various sources, so that customers can order a large product range from a single source.



Above Figure shows the typical primary activities in a warehouse. The receiving activity includes unloading products from the transport carrier at a receiving dock, identifying the products, verifying quantities, and (randomly) checking the quality of the products. Warehouse Management plans, controls, and optimizes the material flows and the use of the resources in a warehouse in an everyday context, with the objective of delivering goods in accordance with customer demands while minimizing operational costs (that is eliminating unnecessary work and unnecessary movement of people and equipment).

## 2.2 MEASUREMENT TOOL

The Perfect Order is a calculation of the error-free rate of each stage of a purchase order. When customers have a problem with an order received, they notify their distributor. The distributor then tracks the error in the WMS with "reason codes" assigned to categories such as warehouse pick accuracy, on-time delivery, and invoice accuracy. This data is then calculated to determine the Perfect Order metric. If, for example, five warehouse pick accuracy errors are flagged on 10,000 lines, total warehouse pick accuracy rate is 99.95 percent. If on-time delivery rate is 99.2 percent, invoice accuracy rate is 96 percent, shipped without damage rate is 99 percent, and order entry accuracy rate is 99.2 percent, then the total Perfect Order metric is 94.04 percent.

## 2.3 MADE TO ORDER

Additional recommended metrics to consider when evaluating a warehouse's order performance include the following:

- **Fill rate** - This data measures lines shipped versus lines ordered by a customer. Fill rate encompasses more than just warehouse performance because it also depends on ordered items being in stock and available. From the customer's perspective, fill rate represents the service level a distributor can provide.
- **Ship to promise** - This figure measures the timeliness of order filling, while the shipping accuracy rate measures the accuracy of order filling as viewed by the customer.
- **Customer retention** - This metric charts the number and percentage of customers during the prior time period who are also customers in the current period. Depending on the frequency of purchase, longer time periods, such as six months or one year, provide a more meaningful measurement. Over several years, you can chart the trend of increasing or decreasing retention.
- **New customers** - This record charts the number and percentage of new customers in each time period, where a new customer is one who bought in the current period but not in any preceding time period.

An overall Lean warehousing strategy depends on measuring the right Key Performance Indicators (KPI). Here I describe each warehouse KPI, how it's measured, and how it helps drive savings in the distribution centre.

### 1. Carrying Cost of Inventory:

Every warehouse manager knows the inventory in their warehouse is costing them. Quantifying these specific carrying costs — including capital costs, inventory risk, inventory service costs and obsolescence — help a warehouse manager make smarter buying and forecasting decisions, leading to higher inventory turnover.

$$\text{Inventory Carrying Rate} \times \text{Average Inventory Value} = \text{Carrying Cost of Inventory}$$

### 2. Inventory Turnover:

High inventory turnover is good. But looking at inventory rate also helps gauge your buying practices and product demand. Your Warehouse Management System (WMS) provides visibility and enables forecasting to keep goods moving. Inventory turnover measures how many times per year your distribution centre is able to go through its entire inventory. Compare this rate against industry averages for a clear picture of your distribution centre performance.



Cost of Goods Sold / Average Inventory = Inventory Turnover

### 3. Order Picking Accuracy:

In addition to tracking shipment and delivery status, you should also measure order picking accuracy. An inaccurate order can result in inventory being put back on shelves, increasing shipping time per average order, rate of return, etc. Lean distribution centre practices eliminate waste and streamline order-picking processes – and help maintain a high order accuracy rate.

Industry Best-in-Class:  $\geq 99.9\%$ ; Median:  $99.4\%$  \*

Total Number of Orders / Perfect Order Rate = Order Picking Accuracy

### 4. Inventory to Sales Ratio:

The Inventory to Sales Ratio is affected by economic conditions, and a company's ability to weather unpredicted disruptions. It helps warehouse managers predict early cash flow problems by identifying increasing inventory levels against dropping sales rates. Conversely, it can help prevent back orders by identifying sales influxes and potential for an increase in buying to help satisfy a spike in demand. Inventory to Sales Ratio in a successful warehouse distribution centre will reflect a streamlined order fulfilment process. Warehouse managers should frequently monitor this KPI and use it as a tool in forecasting and predicting inventory needs.

End-of-Month Inventory Balance / Sales for Same Month = Inventory to Sales Ratio

### 5. Units per Transaction:

The Units per Transaction (UPI) metric is a metric common to many businesses. Depending on your industry, this number may or may not be realistically expected to increase. Compare your warehouse distribution centre UPI with that of historical averages and trends within your industry for the most useful analysis. In some industries, such as retail and CPG, UPI can be increased by sales trainings and checkout experience improvements that encourage up selling.

Number of Units Sold / Number of Transactions = Units per Transaction

### 6. Inventory Accuracy:

The accuracy of your physical inventory should match that listed in your database, but realistically there's often a disparity in any large distribution centre. A high rate of inaccuracy in inventories can lead to unexpected backorders, customer dissatisfaction and, ultimately, higher overall costs. Visibility is key to a high-performing warehouse. Your Inventory Accuracy can be improved by performing regular checks against your database, using cycle counting as a way to continually validate your database records.

Inventory Count Accuracy by Dollars/Units Best-in-Class:  $\geq 99.9\%$ ; Median:  $99.2\%$  \*

Database Inventory Count / Physical Inventory Count = Inventory Accuracy

### 7. Back Order Rate:

A warehouse's Back Order Rate is a telling indicator of success in forecasting purchases and inventory supplies. A sudden spike in demand will understandably result in a temporarily high back order rate for any given item, but a consistently high or increasing back order rate indicates poor planning and lack of responsiveness. You can decrease your Back Order Rate with more accurate order forecasting and vigilant monitoring of your warehouse's Inventory to Sales Ratio. A high Inventory Accuracy rate will also improve this KPI.

Industry Best-in-Class:  $< 0.14\%$ ; Median:  $2\%$  \*

Orders Unfilled at Time of Purchase / Total Orders Placed = Back Order Rate

## 2.4 WHAT'S IN STOCK

Once these order metrics are well in place, consider key metrics for tracking and managing inventory. With the right inventory tools, distributors and wholesalers know at all times exactly what product is in the warehouse, where it's located, and when it needs to be replenished. Greater inventory accuracy and control results in less overstock/dead stock, higher turnover, and better data for financial planning.

Key inventory metrics include:

- Inventory accuracy - Used to identify product discrepancies, this measurement is typically derived from cycle counts, a function within a WMS that automatically counts a subset of inventory on a daily demand or on a scheduled basis.
- Inventory turnover - This figure measures purchasing management and timeliness of vendor returns. It is the number of times that inventory cycles or turns over per year.

- The next recommended area of measurement, and the one that matters most to CFOs, is expense control. Specifically, this data looks at total warehouse costs as a percent of company sales. Warehouse costs typically include direct and indirect labour, employee benefits, supplies, operating equipment and maintenance, rent, utilities, and depreciation.

Expense control also measures transportation and logistics costs as a percent of sales, as well as sales and lines shipped by each warehouse employee per hour.

## 2.5 ADDING IT ALL UP

Once enough warehouse transaction data points have been accrued, it is easy to establish some realistic productivity standards. Consider benchmarking the warehouse cost structure and productivity per person against other distributors. Or, benchmark against industry survey results such as the annual research survey conducted by Georgia Southern University and consultancy Supply Chain Visions. Measuring progress against the warehouse's own targets is more useful, however, because performance depends on a variety of unique factors such as processes, specific customer expectations, and automated materials handling infrastructure.

Over time, consider leveraging these key metrics by applying new variables. For example, a warehouse employee incentive might spark a dramatic improvement in Perfect Order numbers. Chart the impact. And continue to seek only those key data points that truly demonstrate the warehouse's contribution to the company.

## 2.6 MEASURING WAREHOUSE EFFECTIVENESS

There is only a limited amount of space in your warehouse and you will need to ensure that you are making best use of this space to make the highest profit. The business profits will be very closely linked to the efficiency of your warehouse, so analysing all of these key efficiency factors in detail is a very prudent move to make. Measuring the time it takes to complete each of these processes will help you to determine how efficient your warehousing system is. Delays in any of the steps listed below, can significantly impact the efficiency of your business because it will hold up the other processes within your warehouse.

- **Product turnover time:** The product turnover time is basically the amount of time that it takes for a product to be sent out of your warehouse to a customer after it has arrived. If the product turnover time is too slow then you will be losing money and limiting the amount of products that your company can process through the warehouse.
- **Unloading and recording the product:** When a delivery first arrives in your warehouse, you will need to unload the goods and record what you have received. The time it takes to unload the delivery is important as if it is slow you will create a bottleneck of goods and will be unable to process them. The efficiency of this process will depend upon the organisation of the warehouse and the lifting device that you have available for the job.
- **Organising and storing the delivery:** Unloaded the delivery and determined what it is that you have received; you need to organise and store the products. How you do this depends upon your storage setup and will be a significant factor in overall product turnover time. The racking systems and picking processes put into action will impact the speed of product turnover.
- **Processing orders:** Final stage in warehouse product turnover is the receipt and processing of orders. The time it takes in receiving an order and it being sent to the warehouse will impact turnover times and the organisation of product picking processes will too.

An efficient warehouse is critical for customer satisfaction because it helps ensure quick, accurate shipments.

Some tips to improve the warehouse operations, consider the following:

### 1. Maximise and optimise all available space.

Rather than expand the footprint of your warehouse, consider better use of vertical space. Adding taller storage units and the right equipment to pick and store material can help you keep more in the same square footage, rather than adding expansion costs. In addition, think about the type and variety of shelving used. Storing small items on pallet racks wastes space, and makes it easy to misplace items. Rather than using the same racks throughout your warehouse, you may need various types of shelving for different materials. Also, try using standardised bins to help keep shelves neat and orderly.

### 2. Lean Inventory.

Adopting lean inventory for the warehouse is just as important as it is in manufacturing. The basic premise of lean is only what you need, and nothing more. Possibly reduce or eliminate safety stocks, and try to get suppliers to deliver smaller quantities more frequently.

### 3. Adopt enabling technology.

A warehouse management system (WMS) or an ERP system with a strong WMS module can improve efficiency by suggesting the best routes and methods for picking or put-away. In addition, the system provides automated pick lists that can be sent to mobile readers and devices to help eliminate mistakes and reduce wasted time and paper. The warehouse will be neater and

greener. Using barcode or radio frequency identification (RFID) readers can improve accuracy of transactions, and reduce picking errors. In fact, research conducted at the University of Arkansas shows that using RFID increased inventory accuracy by 27 per cent in just 13 weeks.

#### 4. Organise workstations.

Organising workstations improves productivity because workers do not have to search for tools or equipment. Use the —5S method from lean manufacturing to ensure the workstations are as organised as possible. It consists of: Sort; Set in order; Shine; Standardize; and Sustain — all techniques designed to keep clutter at bay, reduce errors, and improve safety and organisation.

#### 5. Optimise labour efficiency.

If the WMS doesn't have the ability to generate efficient picking plans, create them manually. Analyse the material usage patterns, and store high-volume items together near the front of the warehouse to eliminate travel time. Also, store items that are frequently sold together near one another. Basically, you will streamline operations if you try to keep the items you pick most often in the most accessible locations to eliminate picking delays.

Improving warehouse efficiency is as much important the right storage equipment as it is about fancy picking algorithms. There are different types of Warehouses. In order to meet the efficiency and effectiveness there are requirement of various types of warehouses came into existence, which may be classified as follows.

- ✓ Private Warehouses
- ✓ Public Warehouses
- ✓ Government Warehouses
- ✓ Bonded Warehouses
- ✓ Co-operative Warehouses

**1. Private Warehouses** - The warehouses which are owned and managed by the manufacturers or traders to store, exclusively, their own stock of goods are known as private warehouses. Generally these warehouses are constructed by the farmers near their fields, by wholesalers and retailers near their business centres and by manufacturers near their factories. The design and the facilities provided therein are according to the nature of products to be stored.

**2. Public Warehouses** - The warehouses which are run to store goods of the general public are known as public warehouses. Anyone can store his goods in these warehouses on payment of rent. An individual, a partnership firm or a company may own these warehouses. To start such warehouses a license from the government is required. The government also regulates the functions and operations of these warehouses. Mostly these warehouses are used by manufacturers, wholesalers, exporters, importers, government agencies, etc.

**3. Government Warehouses** - These warehouses are owned, managed and controlled by central or state governments or public corporations or local authorities. Both government and private enterprises may use these warehouses to store their goods.

### 3. RESEARCH METHODOLOGY

#### 3.1 RESEARCH HYPOTHESES:

Based on extensive review of literature the following hypotheses had been framed for the present study:

**Hypothesis 1:** Effective warehouse management & control improves competitive strength.

**Hypothesis 2:** Warehouse management has positive impact on enhanced preservation & control

**Hypothesis 3:** Proper warehouse management is directly related to overall cost reduction.

**Objective:** To analyse the impact of effective and efficiency warehousing on competitive strength, enhanced preservation & control and overall cost reduction and also to find out various factors affecting efficiency and effectiveness of warehouse system.

#### 3.2 SAMPLE SIZE:

The sample size of the research study is 5 Warehouse in MIDC Nagpur operations. The sample as contained some of the leading warehouses in Nagpur.

#### 3.3 DATA COLLECTION INSTRUMENT AND DATA ANALYSIS:

Research techniques had to be clearly identified in order to conduct research successfully. These techniques could be discussed under two broad types as data collection techniques and data analysis techniques. Data will be obtained primarily through on-site visits to warehouses. Personal interviews are to generate the information. The respondent are the key person in the operation such as operation manager, executive or logistics manager. Telephone interviews will also be used to collect additional information. And it has planned to interview the key personnel in the each warehouse for about 10-15 minutes to gather required data.

**3.4 THERE IS A POSITIVE RELATIONSHIP BETWEEN:**

1. Time taken to bring goods from loading bay to the staging area-seconds per pallet (Receiving) with Time taken to complete a receipt (min).
2. Time taken to bring goods to the loading bay from the staging area (Issuing) with Order to dispatch time (hours).
3. Times taken to put away from the staging area(s) with Time taken to complete a receipt (min).
4. Times taken to bring good from racks to the staging area(s) with Orders after the cut-off.
5. Total time taken to put away a lorry load= un-loading staging+ put away (s) with Time taken to complete are receipt (min).
6. Usage of the Product slotting techniques for the Warehouse operations was only 66% and there is 34% to be introduced.

**3.5 THERE IS A NEGATIVE RELATIONSHIP BETWEEN:**

1. Times saving due to effective product slotting techniques per one picks (s) with orders after the cut-off.
2. Time saving due to effective product slotting techniques per one picks (s) with Order to dispatch time (hours).
3. Time saving due to effective product slotting techniques per one put away with time taken to complete a receipt (min).

**3.6 ANALYSIS AND INTERPRETATION:**

1. 53% of the respondent says there is a low level of layout optimization of the Warehouses while 47% says there is moderate layout optimization in most of the warehouse in MIDC Nagpur.
2. 67% of the respondents were agreed that Handling of fast moving item can be improved in terms of efficiency while 27% of them not sure and 6% of them were not agreed.
3. 30% respondents were agreed that Cycle time is a critical measure to determine service and efficiency. Dock to stock cycle time is a critical measure of how long it takes to make material available following receipt. It also measures the elapsed time from order receipt until order shipment. Order cycle time may also include transportation to measure the total elapsed time until the customer receives the product. Cost and inventory performance measurements include total distribution centre cost per unit handled, distribution centre cost as a percentage of sales, and inventory turnover.

**4. CONCLUSION**

As a result of global competition and supply chain concepts, including a focus on integral inventory control, warehousing has become a critical activity in the supply chain to outperform competitors on customer service, lead-times, and costs. Timely and accurate information about products, resources and processes are essential to operationalize a planning and control structure that effectively and efficiently achieves the high performance of warehouse operations required in today's marketplace.

Warehouse complexity affects the planning and control structure through the comprehensiveness of the work to be done. In highly complex warehouses, feeding organizational actors with the right type of information and knowledge at the right time is difficult. Nonetheless, a complex warehousing operation requires a control structure that has a great deal of information, data, and knowledge about products, processes, customers, and resources readily available. Thus, Optimization strategies are utilized to position product availability and delivery as a competitive advantage while also optimizing the cost trade-offs associated with transportation, facilities, equipment, workforce, and other critical cost variables. Distribution centre also facilitate time utility by storing product until it is demanded.

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