LINCS: Leveraging, Integrating, Networking, Coordinating Supplies

WAREHOUSING OPERATIONS CERTIFICATION TRACK

for Entry to Mid-Level Professionals in Supply Chain Management

Developed by the LINCS in Supply Chain Management Consortium, comprised of the following institutions:

Broward College (Lead Institution)
Columbus State Community College
Essex County College
Florida State College at Jacksonville
Georgia Institute of Technology
Harper College
Long Beach City College
Northwestern University
Rutgers, the State University of New Jersey
San Jacinto College
St. Petersburg College
Union County College

In partnership with the Council of Supply Chain Management Professionals.

This material was funded in whole by a $24.5M TAACCCT grant awarded by the U.S. Department of Labor's Employment and Training Administration to the LINCS Consortium.

Title Page

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Title: Warehousing Operations Certification Track

Release Date: 03/03/2017

Version: v2.28

Website: www.LINCSeducation.org

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Preface

The information in this Preface is an overview of LINCS in Supply Chain Management.

Supply Chain Management (**SCM**) as a paradigm is nothing new to business and industry. However, academia and employers have recently seen SCM become a major focus. There are currently several industry-recognized certifications in SCM, largely focused on individuals with experience in management through the executive level. The curriculum in the certification tracks listed below is directed at those who have entry- to mid-level experience.

The curriculum for these certification tracks include eight topics in SCM:

1. SCM Principles
2. Customer Service Operations
3. Transportation Operations
4. Warehousing Operations
5. Supply Management and Procurement
6. Inventory Management
7. Demand Planning
8. Manufacturing and Service Operations

Each certification track can be taken on its own to earn one certification; multiple certifications can be earned in any order. Each certification track covers the basic elements of the primary certification track, which allows the learner to obtain a foundational understanding of the **best practices** and processes associated with each topic.

Common Learning Blocks accompany each certification track, providing an overview of SCM. It is highly recommended both the standalone Common Learning Blocks document **and** the certification track document be thoroughly reviewed **prior** to taking a national certification examination.

The content provided within this certification track relates specifically to **Warehousing Operations**. The national certification examination will include questions on the **Warehousing Operations** content as well as from the **Common Learning Blocks** content.*

*NOTE: Materials listed under *Optional Supplemental Resources* sections (in some certification track documents only) are not included on the national certification examination.

Warehousing Operations
Certification Track Table of Contents

Abstract

Warehousing Operations encompasses the processes, procedures, tools, and equipment within a warehouse facility as enablers for an efficient, effective, and comprehensive supply chain. Warehouses do not operate as stand-alone facilities but function to varying degrees in with Inventory Management, Transportation Operations, Demand Planning, Procurement, Manufacturing, and Customer Service functions.

The charter, mission, and goals developed by an organization will dictate the role of the supply chain to meet those objectives. This role will further define the requirements for warehousing operations ranging from a simple, single storage facility to an elaborate system that makes-up a total distribution or fulfillment network.

This certification track is intended to train students in the basics of warehousing operations and to generate a broader awareness of the role of warehousing operations in distribution networks.

Key elements of this certification track include: an overview of warehousing, the role of warehousing in the supply chain, facility configuration, storage and handling techniques, performance metrics, customer service considerations, and safety concerns across various types of distribution facilities.

The goal of this certification track is to prepare students to successfully pass the warehousing operations national certification examination. The content for this certification track was developed by the LINCS in Supply Chain Management Consortium. **SCPro™ Fundamentals Certification** examinations are owned and administered by the Council of Supply Chain Management Professionals (CSCMP).

Learning Block 1: Warehousing Operations Overview

Learning Block 1 Description

A warehouse is a facility used to store goods and is a critical element in the overall **supply chain**. The primary purpose of the warehousing facility is to receive, store, and process goods for the eventual shipment and distribution to manufacturing operations, other businesses, and consumers. Warehousing operations include internal processes and technology which link to the broader supply chain. These operations help to coordinate the incoming goods, store and track the goods, and ultimately ship and distribute goods to their intended destinations.

In this learning block, these basic, high-level elements of warehousing operations will be reviewed:

- History of Warehousing
- Warehousing Today
- Warehouse Operations
- Warehouse Operational Enablers

Learning Block 1 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Recognize why warehouses were established and why they evolved
- Understand differences between a physical warehouse and warehouse operations
- Describe differing types of warehouse operations and the basic characteristics of each
- Explain many of the enablers necessary to run a warehouse

Unit 1: The History of Warehousing

The warehousing industry has been around for hundreds of years. The genesis for warehouses goes back to the need to store food, but they evolved as European explorers created shipping and trade routes with other nations. Warehouses grew in importance for the storage of products and commodities, and they became terminal points for land, sea, and eventually air routes. As transportation became more sophisticated and diverse, warehouse operations have broadened and become more diverse and complex as well.

Most of the early warehouses were built at sea ports for **temporary storage** of inbound and outbound shipments. As railroads were built to achieve greater amounts of cross-country travel, warehouses were

established along the rail routes. These depots were built in areas and locations that were more convenient and closer to the intended use of the products being stored.

Around the mid-20th century, warehousing underwent another transformation, due to the rise of industrial factories and mass production. The increased volume of products resulted in a need for additional storage facilities and more efficient and effective means of storing, controlling, and retrieving raw materials and finished products. Efficient air transport enabled the timely shipments of goods over longer domestic and international routes, and the demand for warehousing increased at airports.

Within warehousing operations, there is the ever present challenge of linking sea, rail, road, and air to integrate with the flow of goods within the supply chain and the demand created by consumers.

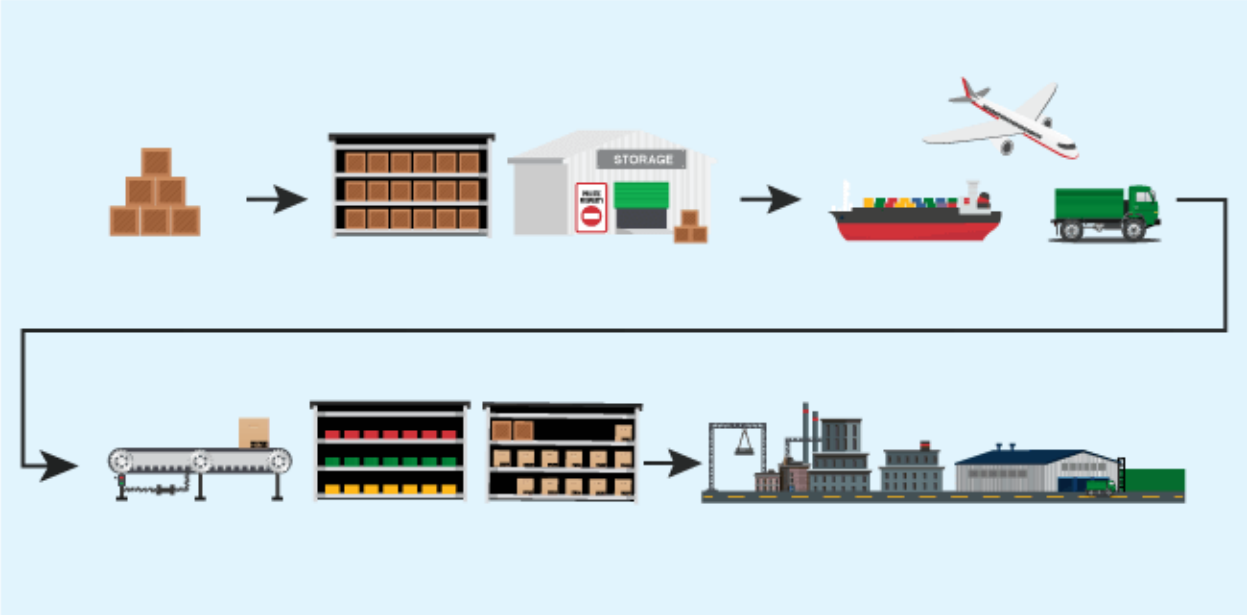


Figure 1. Linking sea, rail, road, and air to warehousing. Developed by LINCS in Supply Chain Management Consortium.

Unit 2: Warehousing Today

Picture a warehouse as a building, or simply a physical asset, used to receive, store, and ship goods. Many warehouses today operate simply for this purpose. While many companies continue to use warehouses solely for bulk storage, a great number of companies are now striving to utilize their warehouses as more than simply storage facilities. Companies are transforming themselves into **third-party logistics providers** (**3PLs**) who provide a wide array of services and functions. 3PLs can best be described as firms who provide services to customers for outsourced, or third party, **logistics** services for part, or the entirety of their supply chain management functions. In addition to packing and staging goods on racks and **pallets**, warehousing facilities offer value-added manufacturing, call centers, labeling, and other value-added functionality.

Figure 2.Exterior view of large warehouse facility. Acquired from pixabay.com.

Warehousing operational processes that integrate basic and value added functions enable a warehouse building to operate as a distribution or fulfillment center. These processes enable the operation of distribution centers (Walmart), fulfillment centers (Amazon), value-added manufacturing centers (Dell Computer), and warehouse-style retail stores (Home Depot). These will be discussed in greater detail in other learning blocks of this certification track.

Figure 3. Distribution and fulfillment centers utilize automation and technology. Acquired from pixabay.com.

Warehouse-style retail stores have large amounts of products stored on industrial racks, rather than only on conventional retail-type shelving. Customers are able to buy products in bulk, and ready to be sold stock is generally placed on bottom racks. Meanwhile, crated inventory, or inventory placed on pallets, is stored higher up and is lowered when it becomes necessary. In this way, these buildings function as both warehouses and retail stores (*Figures 2* and *3*).

Finally, technological innovation coupled with agile manufacturing processes, including **just-in-time (JIT)** manufacturing and innovations in transportation, are making warehousing sometimes unnecessary because products can be shipped directly from manufacturers to customers.

Unit 3: Warehouse Operations

Delivery of goods and materials takes place either by truck, rail, or boat on a dock or loading area. The goods are received, processed, and then sent into the warehouse for storage.

The storage of goods is the primary function for warehouses. Once the goods have been received from the manufacturer or shipper, they are compactly stored to maximize availability within the facility. Products are placed on pallets, or racks, which allow for more consistent stacking and moving within the facility.

Warehouses can be designed to optimize the flow of goods in the supply chain, and there are numerous types of designs companies may use based on the overall strategic mission, goals, and desired customer base. There are five popular warehousing operations used in today's marketplace:

1. Public warehousing involves a company or multiple companies paying a standard fee for the storage and processing of goods. Amazon has taken this concept to a whole new level by creating a network of fulfillment centers in which thousands of manufacturers and suppliers pay a fee to Amazon to stock and process their goods. Amazon, in turn, provides inventory control and other value-added services (receiving, marketing, **picking**, packing, transportation, payment, and customer service) to enable manufacturers to scale their business and reach more customers.

2. Private warehousing is defined as storage and operations controlled completely by a single company. Walmart owns and operates one of the largest retail distribution networks in the world with over 150 regional U.S. distribution centers, and each center is over 1 million square feet.

3. Leased warehousing might be an option for more unstable inventory. Companies who manufacture products with seasonal demand often lease space to accommodate finished goods to prepare for the peak demand periods.

4. Retail warehouses, as previously mentioned, have grown in popularity. Retailers, such as Home Depot and Lowes, provide goods for consumers while maintaining an active warehouse to quickly replenish the consumption. Sophisticated Information Technology and inventory systems enable the retailer to maintain effective linkage to suppliers, manufacturers, and transportation systems.

5. **Contract warehouses** are dedicated facilities with procedures designed for the client's operations. Clients can be charged transactional storage fees, based on fixed cost, or a combination of fees, based on usage agreement (such as fees for specialized labor and equipment). According to Overview of Warehousing in North America (Drickhamer, 2007), contract warehousing accounts for more than 60 percent of the U.S. commercial market.

Contract and **public warehouses** receive goods and products from a multitude of manufacturers and shippers. A crucial aspect of warehouse operations is to safeguard, process and control the inventory. Inventory control systems have the capability to be linked to other supply chain elements, and the systems are also used to store, locate, and track any given product within the warehouse to facilitate quick selection and processing for order fulfillment. Inventory control systems also have built-in processes to maintain and replenish sufficient amounts of product to meet ongoing customer demands, while at the same time balancing the expense of keeping product in storage.

Unit 4: Warehouse Operational Enablers

Public, private, leased, contract, and retail warehouses require operational infrastructure and support equipment to function and operate within the overall supply chain. The degree and complexity of the infrastructure and support equipment is dictated by the overall mission and purpose of the warehouse. For example, Amazon fulfillment centers require a much higher level of technology and process integration than a company who utilizes a warehouse simply as a staging area for incoming materials and goods for subsequent manufacturing operations.

Figure 4. Warehouse. Developed by LINCS in Supply Chain Management Consortium.

Listed next are possible warehouse operational enablers. These will be discussed in greater detail in other sections of the certification track:

- Receiving and shipping docks to accommodate vehicle unloading and loading.
- Staging area and supplies for packaging and packing of goods.
- Racks, pallets, conveyers, and other specialized capital equipment and storage systems to assure the safe and efficient handling and storage of goods.

- Dedicated areas where products from different suppliers are mixed and then distributed to fulfill and complete customer orders.
- Forklifts, overhead cranes, and other materials handling equipment to easily and safely move heavy goods and pallets within the warehouse and to unload and load transportation vehicles.
- Warehouse management systems (WMS) assist warehouse personnel in tracking products computer automation systems to high-end, feature-rich software programs. These systems improve order picking, facilitate better dock logistics, and monitor **inventory management**. Radio Frequency Identification (RFID) systems are linked to the WMS to facilitate inventory tracking. Additionally, voice-activated receiving and packaging allows for warehouse personnel to speak requests into the WMS, thus speeding the entire process. Finally, transportation management systems also linked to WMS provide an advanced level of detail on goods prior to their arrival and they also provide a more specific time of delivery.
- Sales, operations, and customer service offices to support the supply chain.
- Cold storage and temperature control capabilities for the preservation of agricultural products and other perishable goods.

Learning Block 1 Summary

Warehouses are assets used for goods, receiving short and long term storage, control and shipment to satisfy customer, and consumer demands. The warehouse operational processes must be synchronized with demand planning, procurement, inventory management, manufacturing and service operations, and transportation operations. These supply chain elements, working in unison and defined by the broader supply chain mission drive the configuration, layout, location, technology innovations, and financial considerations to operate as a private, public, leased, retail, or contract facility.

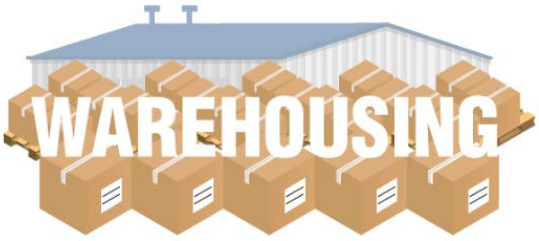


Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

Learning Block 1 Practice Questions

1. The primary purpose of a warehouse in the supply chain is to:

a. Receive, store, and process goods and materials
b. Store obsolete materials
c. Dispose of non-conforming material
d. Train new personnel

2. The key attributes that enables a warehouse building to operate as a distribution or fulfillment center is:

a. Integration of basic functions with value added functions
b. Modern equipment
c. The location
d. The availability of trained personnel

3. Amazon charges suppliers a fee for the storage and processing of products by providing a network of:

a. Distribution centers
b. Fulfillment centers
c. Transportation vehicles
d. Dedicated services to a few small manufacturing companies

4. Warehouses are accountable for:

a. Processing, safeguarding, and controlling inventory
b. Determining optimal transportation options
c. The long-term storage of perishables
d. Promoting international trade

5. Examples of capital equipment in a warehouse include:

a. Receiving and shipping docks
b. Materials and goods in storage
c. Racks, pallets, conveyers, and other handling equipment
d. A sales and operations office and an administrative space

6. Inventory control systems in a warehouse are also referred to as:

a. Material requirement systems
b. Warehouse management systems
c. Manufacturing routing systems
d. Electronic data exchange

7. Warehouses often provide cold and other temperature control capabilities for the:

a. Comfort of employees
b. Rapid changes in the exterior environment
c. Testing of seasonal products
d. Preservation of perishable products

8. Forklifts and other material handling equipment, like overhead cranes, are used to:

a. Easily and safely move heavy goods and pallets
b. Specifically unload delivery trucks
c. Train personnel for new skill certifications
d. Specifically load out-bound shipments

9. An example of a retail warehouse is:

a. Home Depot and Lowes
b. Ace Hardware
c. Advance Auto Parts
d. Sears Department Store

10. Warehousing can become unnecessary because of:

a. Insufficient goods to be processed
b. Flexible manufacturing coupled with innovations in transportation
c. Lack of customer demand
d. Poor supplier output

Learning Block 2: Warehousing Design and Functionality

Learning Block 2 Description

The warehouse is a place in which inventory is held for varying periods of time. In a best case scenario, the supply chain is constantly moving raw materials to be made into finished goods to send to the end customer. However, there are many reasons to interrupt the flow of goods in the supply chain, such as to support quality, value, costs, and efficiency. Warehouses can be used to add value to products and add value for customers. This learning block will explore how the warehousing operations add value to the supply chain.

Learning Block 2 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Recognize the various types of warehouses
- Understand in general terms, the various warehouse decision options
- Explain the major warehouse functions
- Analyze value-added roles of warehouses

Unit 1: Basic Warehouse Decisions

The warehousing strategy for any company needs to be planned and designed to define the role in the overall supply chain. The following are a few of the primary considerations needed to establish a sound, cohesive warehousing operational strategy:

- ☑ Type of warehouse (private, public, retail)
- ☑ Centralized versus decentralized locations
- ☑ Size, location, and material handling equipment
- ☑ Size, type, and quantity of packaging and packing materials
- ☑ Facility layout and flow of goods
- ☑ Types of goods to be processed
- ☑ Employee safety

Warehouse Types

Companies use public, retail, or **private warehouses** to meet their storage and distribution needs. The first decision is based on a financial analysis of available alternatives to satisfy the needs of the overall supply chain in order to meet the strategic needs of the organization. In making this decision, organizations have several alternatives: private ownership, use of public warehouses, leased space, or

retail warehouses. In addition to making this choice, many organizations might even combine the options in a hybrid fashion because of varying regional market conditions, customer volumes, customer requirements, and other factors (e.g., seasonality). For example, in order to effectively operate as a retail warehouse, Home Depot has a network of private warehouses in order to rapidly replenish retail inventory and satisfy consumer demand.

Organizations typically approach the ownership decision in a tradeoff framework. Certain operations tend to lend themselves to private warehousing. Whereas other organizations lend themselves best to public or leased facilities, in which companies rent or lease space or contract basis according to need.

Private Warehouses

Private warehouses are operated by the owner of the goods stored there. Several factors lend themselves to organizations using private warehouses:

Figure 6. Private warehouse. Developed by LINCS in Supply Chain Management Consortium.

- **Stable demand**: Many products have seasonal sales, which tend to create unstable demand. However, many larger firms have multiple product lines, and this helps to stabilize the warehouse throughput cost to build the volume necessary for an economical, private warehouse. For example, think about a company that sells active wear apparel, like Under Armor. When sales of hooded sweatshirts, sweatpants, and jackets drop-off after the cooler weather season, their sales (and distribution) turns to lighter-wear apparel like t-shirts and running shorts.
- **Dense market area**: Another factor conducive to private warehouses is a dense market area relatively close to the warehouse or numerous suppliers relatively close to physical supply warehouses.
- **Control**: Private warehouses might also benefit a firm for control purposes. This includes physical control (e.g., security or temperature control) and service control (e.g., customers and/or manufacturing plants). Certain materials and finished goods are highly susceptible to theft or loss of value from damage or spoilage, so it may be preferable for firms to retain control through the use of private warehouses.

Public Warehouses

Public warehouses are operated by firms engaged in storing and processing goods for a fee, and normally, they do not own the goods (see *Figure 7*). Several factors lend themselves to companies using public warehouses:

Figure 7. Public warehouse. Developed by LINCS in Supply Chain Management Consortium.

- **Financial investment**: The use of public warehousing enables an organization to preserve precious capital funds as they pay a fee for the desired services. This enables an organization to utilize capital funds for product development and innovation in order to stay competitive in the marketplace.
- **Flexibility**: Firms can rent space for shorter or longer periods of time as required, enabling the firm to react quickly to movements in demand or changes in the quality of transportation services. Exploring new markets also requires location flexibility; public warehouses enable firms to immediately launch in, expand in, or pull out of new, untried markets without lingering distribution costs.

Public warehouses are run by **third-party operators** (or providers) who may provide a wider variety of services for manufacturers and suppliers who decide to outsource their warehouse operations, either in part or in whole. Third-party operators can provide a full range of distribution management services for customers and integrate these services within a total logistics system. **Outsourcing** has become more widely available for organizations. Third-party operators currently represent a multibillion dollar, rapidly growing industry.

Leased Warehouses

Organizations generally opt to utilize leased warehouse space to maintain control of the goods and materials, but these same organizations may not have the financial capital resources to privately own the land and improvements. Once again, this decision is derived based on the organizational financial analysis. In addition to making a lease versus buy (own) decision for the land and building, organizations must also determine the financial impact of providing their own labor and infrastructure requirements versus having them provided under a contract with a third-party provider.

Retail Warehouses

Consumer demand for immediate availability of goods and materials has supported the growth of the retail warehouse option for many organizations. While the obvious retail warehouse operations are Home Depot and Lowes, there are also many other organizations that operate using this same concept, referred to as box retailers. Examples include Office Depot, DSW Shoes, Dick's Sporting Goods, Costco and BJ's (Costco and BJ's are club stores that require membership, but the availability of goods are still presented to consumers in a warehouse-type environment) where large amounts of inventory are kept on hand to support consumer demands and prevent loss of sales.

Retail warehouses are also operated in a hybrid fashion and the retail outlet is supported by a network of private, public, or leased facilities that enable efficient **replenishment** based on sales and keeping goods and materials on the shelf, available for consumers.

Centralized vs. Decentralized Locations

Another important warehouse decision is whether organizations will use a centralized (single) location or decentralized (numerous) locations for the warehouse and distribution strategy. The market can be relatively simple, depending on the organization's size; for example, small- and medium-sized companies with a regional market area will often need only one or two warehouses. Larger firms with national or international markets need to develop a more comprehensive strategy. Walmart, for example, could never satisfy consumer demands at their retail outlets with a single warehouse, so they own and operate a network of warehouse distribution centers coupled with transportation resources to continually move products from their suppliers to consumers (see *Figure 8*).

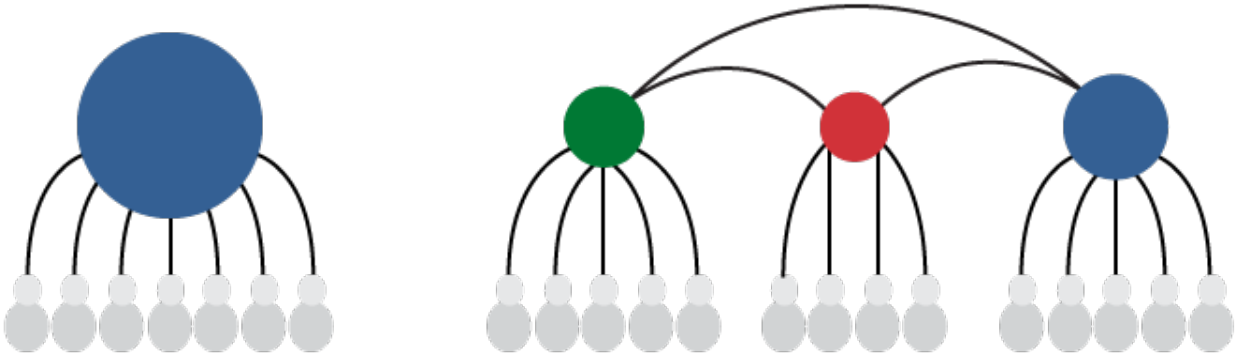


Figure 8. Centralized versus decentralized distribution centers. Developed by LINCS in Supply Chain Management Consortium.

When making decisions about centralized or decentralized warehouses, firms use a tradeoff framework to analyze the need for warehouses in various areas. Supply and demand conditions will make one alternative more attractive than others. For example, a firm manufacturing or distributing a highly competitive product on a national basis may need to use a decentralized warehousing network to provide rapid service in its chosen market areas.

Firms have to closely coordinate the decision about the number of warehouses with their decisions about transportation alternatives. For example, air freight has made rapid national market coverage from one or two strategically positioned warehouses possible.

Foreign Trade Zones

U.S. businesses engaged in international trade often establish warehouse operations in a foreign trade zone (FTZ). FTZs are approved geographical areas which are considered to be outside of the United States, even though they are located on U.S. soil. FTZs are designated for duty and customs purposes. They can be a single building or a complete industrial park, and they do not have to be adjacent to an airport or seaport. Every U.S. state and Puerto Rico have at least one FTZ within their borders, and having warehouse operations within an FTZ can dramatically lower the cost of doing business.

Many U.S. businesses have to import material from around the globe in the form of raw materials, parts, and components. If high tariffs are imposed on the imports, it drives-up the cost of their products and causes their business to become less competitive in the marketplace.

U.S. businesses located in an approved FTZ do not pay import duty and other designated fees on products they import until those products are moved out of the FTZ and into the U.S. marketplace. On

the other hand, if the finished products are moved out of the FTZ for export out of the U.S., no duty is owed.

For example…

BMW has a manufacturing plant located in South Carolina and operates a warehouse in a FTZ. BMW imports parts and components to manufacture cars and sport utility vehicles at their South Carolina assembly plant. Subsequently, they export over $10B worth of overseas-bound vehicles each year. By employing this strategy, BMW qualifies for free or reduced duty fees on the exported vehicles and continues to be a competitive, major employer in Spartanburg County, South Carolina.

Nationally, there are over 3,000 companies that operate warehouses in over 200 designated FTZs, which accounts for over $800B in foreign trade. For companies that use imported goods in their finished products for exports, this organizational strategy is paramount to establishing a competitive business process.

Warehouse Size and Location

Another factor in developing the overall warehouse, distribution and fulfillment strategies is where to locate and the appropriate size of the building. By defining the role of the warehouse in the overall supply chain strategy, organizations can determine location and size requirements. This includes locating warehouses near markets, mixing raw materials close to production, or creating a combination of other factors. Choosing an exact location must rely on several factors; these factors must include access to transportation, the market, and other local characteristics as:

1. Access to desired modes of transportation
2. Proximity to markets and customers
3. Supplier networks
4. Land costs and utilities
5. Availability of desired labor skills

These factors need to be carefully considered, factors affecting this decision are complex, especially where a large national or international distribution network exists.

Warehouse Layout

Warehouse layouts have a critical bearing on overall efficiency and productivity. The objectives of warehouse design and layout include optimum use of space, smooth flow, labor productivity, and adequate protection of goods.

Warehouse managers need to decide aisle space, shelving, racking, handling equipment, and other physical dimensions of the interior of warehouses. Another important decision is how to arrange stock for an efficient use of space and an efficient flow of goods. Main considerations in layout include:

- Cubic utilization and capacity
- Product protection
- Level of mechanization
- Safety
- Product physical characteristics
- Productivity and performance
- Shifts and staffing levels

Items Stocked

Every unique item is commonly referred to as a SKU, defined as a **stock keeping unit**. Attributes associated with a specific item help distinguish it from other item types to make a particular item unique. These attributes could include, but are not limited to, manufacturer, description, material, size, color, packaging, and warranty terms. When a business takes an inventory, it counts the quantity it has of each SKU.

SKU also refers to a unique identifier or code. The identifiers and codes are not regulated or standardized. When a company receives items from a supplier, it has a choice of maintaining the supplier's SKU or creating its own.

Figure 9. SKU. Acquired from pixabay.com.

Other warehousing decisions involve what items firms should stock and how much stock should be assigned to various warehouses. Firms with a number of locations must decide if certain locations will carry the whole product line, if each warehouse will have any specialization, or if warehouses will combine specialization and general stocking.

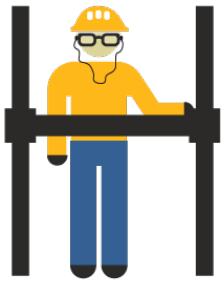


Figure 10. Employee safety. Developed by LINCS in Supply Chain Management Consortium.

Employee Safety

Employee level of risk is often based on the proper equipment and training for proper handling of materials and hazardous materials. Employee safety is a major issue and it influences layout of facilities and quantity and location of safety-related equipment (e.g., sprinklers, fire hoses, etc.). More about employee safety is presented in Learning Block 9.

Unit 2: The Major Functions of Warehouse Operations

Warehouses hold and preserve goods until consumers are ready to receive them. Generally, there is a time gap between the production and consumption of products. The availability of storage enables a firm to carry on production in anticipation of future demands. In an overview of warehouse operational activities, movement and storage functions and information transfer functions will be addressed in this unit of the learning block.

The Movement and Storage Functions

Movement is a vital aspect of distribution. This aspect can be divided into four, somewhat distinct, operations:

1. Unloading and receiving goods into warehouses from the transport network
2. Transferring goods to particular locations
3. Selecting particular combinations of goods for customer orders or raw materials for manufacturing operations
4. Staging, consolidating, and loading goods for subsequent manufacturing operations or shipping to a customer

These four operations involve movement of goods and are shown in *Figure 11*.

Movement

Goods generally move through a warehouse rapidly, resulting in **inventory turnover**. Inventory turnover is usually expressed as ratio showing how many times a company's inventory is sold and replaced over a period, generally a year. The reason for quick movement is because of the high cost of holding finished goods for long periods of time. Finished goods have high value, need more sophisticated storage facilities, and have greater risks for damage, loss, and obsolescence, which contributes to higher **inventory costs**. Moving goods quickly and efficiently through warehouses is, therefore, important in order to optimize the supply chain.

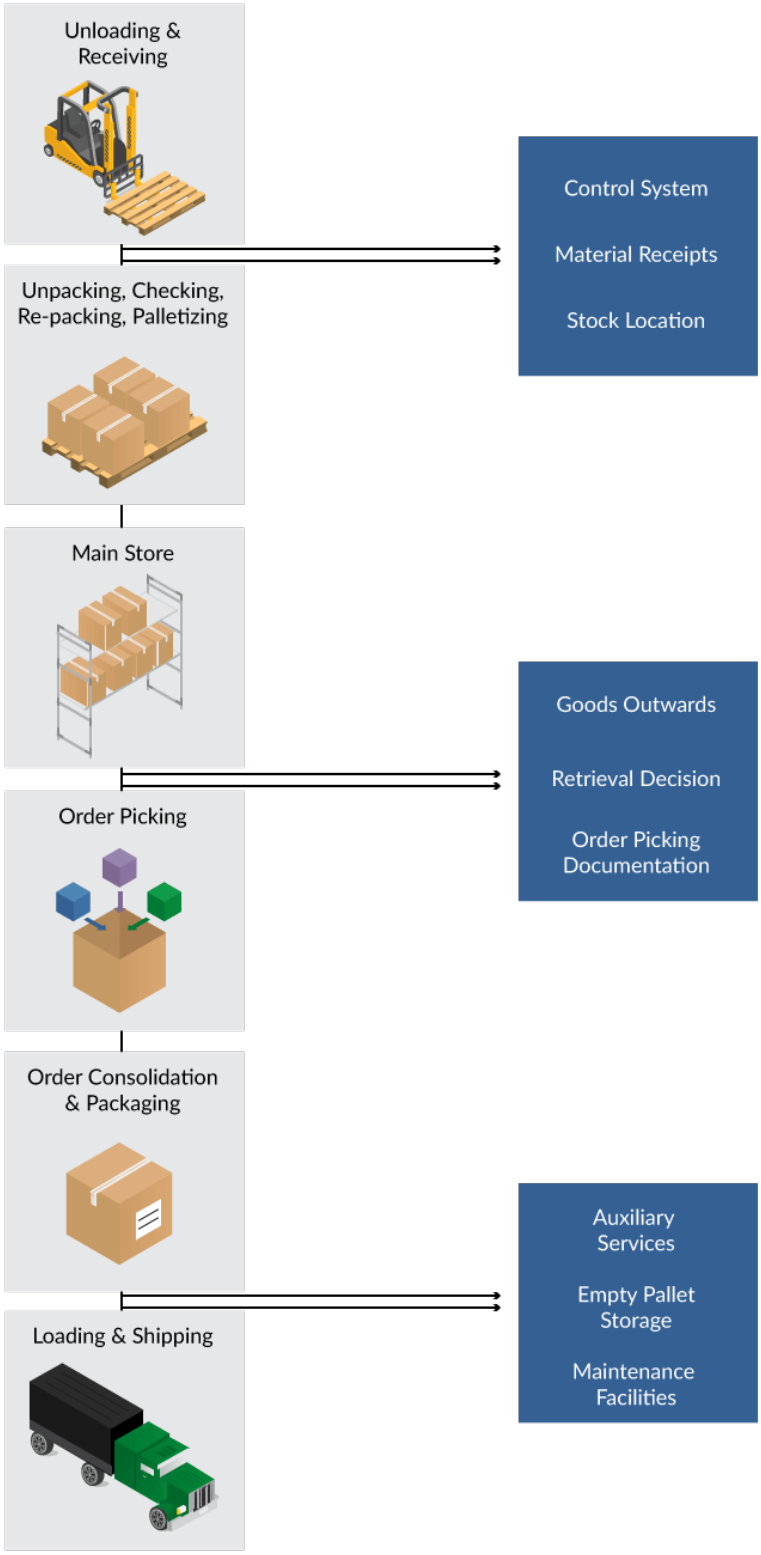


Figure 11. Main warehouse functions related to flow of goods. Developed by LINCS in Supply Chain Management Consortium.

Storage

Warehouses may store goods for longer periods of time for final processing. For example, a wine maker may have to store wine, which could be considered finished after initial processing, for aging purposes. However, accurately forecasting inventory requirements may prove difficult for firms facing erratic demand for their goods. In these cases, firms may need to store relatively large inventories to preclude stock-outs (e.g., warehouses carrying fashion goods).

Another common reason for storing finished goods is because firms are affected by seasonality of demand. For example, a firm that manufactures and distributes ski equipment may need to begin accumulating its inventory for the winter in July and August, which may have been manufactured in June.

Other reasons for carrying stock for relatively lengthy periods of time include speculative, or forward buying of goods in anticipation of future price spikes or shortages (e.g., wheat held in anticipation of future shortages). Other reasons include special deals for businesses, in which goods are held after purchase to take advantage of lot quantity discounts offered by manufacturers.

Information Technology

The amount and quantity of transactions that take place on a daily basis can be overwhelming if it is not properly managed. The WMS integrates computer hardware with specialized software and it enables personnel to receive, stock, pull, and ship orders. The WMS, linked to other supply chain elements like procurement and transportation, is the main operating system in most warehouses, distribution centers, and fulfillment centers today.

The WMS enables personnel to track receipts, assign inventory locations, and plan replenishment orders and customer orders. Replenishment orders re-supply warehouses from manufacturers, and customer orders dictate when to move goods from distribution facilities to customer locations. In either case, order fulfillment requires a series of activities, such as order placement, **order processing**, order preparation, and order shipment, which require effective information management.

Technologies used to facilitate information flow include **barcodes**, radio frequency identification (RFID) tags and systems, and **electronic data interchange (EDI)**. Each of these is briefly described:

Barcodes

Barcodes are labels and they represent the most commonly used automatic-identification technology in distribution. A barcode is a series of parallel black and white bars of varying widths whose sequences represent letters or numbers. This sequence is a code that scanners can translate into important information to communicate with the WMS.

Figure 12. Barcode. Developed by LINCS in Supply Chain Management Consortium.

Radio Frequency Identification (RFID)

RFID is a wireless use of electronic fields to transfer data for the purposes of automatically identifying and tracking tags that are attached to objects. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader and may be embedded in the tracked object.

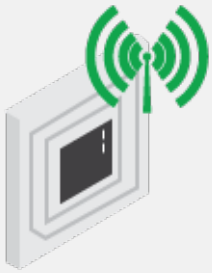


Figure 13. RFID tag. Developed by LINCS in Supply Chain Management Consortium.

RFID tags are used in many industries, for example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; and implanting RFID microchips in livestock allows positive identification of animals.

Electronic Data Interchange (EDI)

EDI is the company-to-company, computer-to-computer exchange of information in a structured, machine process able format. The purpose of EDI is to improve the speed and accuracy of information transfer by linking computer applications between companies.

Figure 14. EDI. Developed by LINCS in Supply Chain Management Consortium.

Optical scanners are also used to read barcodes. Scanners fall into two main categories: fixed and hand held. Fixed scanners are secured into a stationary position and scan packages as they move along a conveyor belt. Conversely, workers carry hand held scanners or wands throughout warehouses. Using barcodes with scanning technology contributes to more effective inventory control. Scanning barcodes in a warehouse improves data collection accuracy, reduces goods receiving operations time and data collection labor, and helps to integrate data collection in the WMS.

At warehouses, information received through the EDI network can be used to drive many distribution functions. The timely and accurate receipt and transmission of data allows for efficiently scheduling and handling inbound shipments, routing goods through warehouses, and measuring throughput levels (and costs) using automated systems.

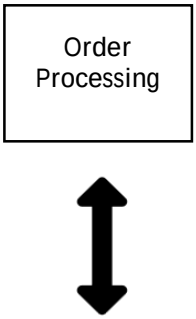
The Order Management System

The order management system represents the principal means by which buyers and sellers communicate information relating to customer orders for goods. The order management system is also one of the most important components of firms' overall management information systems. The overall area of order placement, order processing, order preparation, and shipping has benefited from the enhanced computer information system technologies available today. Each component of the order cycle is described in the following section:

Principal Information Flows

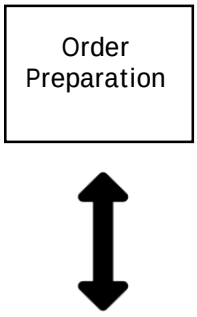
Order placement

Order placement time can vary from days (by mail) to minutes (by phone). Using the internet or EDI, order placement can take place instantaneously from customers directly to suppliers. Another example of using technology to expedite order placement is the use of hand held data entry units by company representatives to transmit order requirements directly to suppliers.



Order processing

The order processing function involves checking customer credit, transferring information to sales records, sending the order to the inventory area, and preparing shipping documents. Improvements in computer and information systems technologies have led to considerable reductions in the times necessary to accomplish these activities.



Order preparation

Depending on the commodity to be handled and other factors, the order preparation process may be very simple and performed manually or may be complex and highly automated. Once the order is picked, it is packed and packaged to prepare for shipment.

Order shipment

Order shipment includes the time it takes from placing the order on a truck for movement to the time it is received and unloaded at the buyer's destination. Measuring and controlling order shipment can be accomplished through receivers of product being given advance shipping notice (ASN) from supplier firms. Shippers may also require proof of delivery documentation from carriers to pinpoint the exact time and location of delivery. Many firms have utilized information technology to provide services such as these. In addition, many carriers have made it easy for customers to track shipments when needed and provide these customers with summary reports of shipment times, service levels, etc.

Unit 3: Value-Added Roles of Warehouses

Warehouses can be used to add value to enhance customer service. Warehouses are the point in the supply chain where stock is held for varying periods of time. A warehouse can be used to add value to products while avoiding disruption and delays in traditional manufacturing. Warehouses also allow for delaying customization and finishing until a customer orders the product. This cuts down on inventory levels and lowers the cost of final products.

Warehouses can be used as a place to add value to goods and customer service, including:

- Transportation consolidation
- **Product mixing**
- **Breakbulk**
- **Cross-docking**
- Protection
- Smoothing
- Staging
- **Kitting**

Transportation Consolidation

Transportation consolidation involves combining smaller shipments to form a larger quantity to realize lower transportation rates. Firms will sometimes need to transport **less than truckload (LTL)** shipments of materials or products. Shipping goods long distances at LTL rates is more costly than shipping full truckloads (LTL requires multiple, costly delivery stops to effectively utilize the truck, but a full truckload requires only one stop).

Moving LTL amounts relatively short distances to or from warehouses can allow firms to consolidate smaller shipments into larger shipments (full truckloads) with significant transportation savings. Here are simple example of **consolidation**:

For the inbound logistics system, warehouses would consolidate different vendors in LTL shipments and ship a volume shipment to the firms' plants.

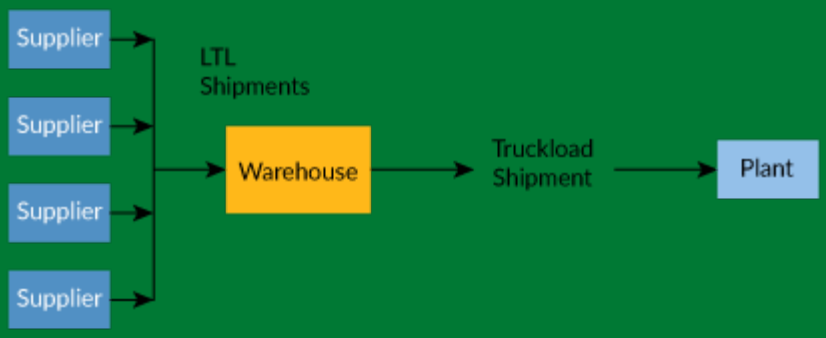


Figure 15. Inbound logistics system. Developed by LINCS in Supply Chain Management Consortium.

For outbound logistics, warehouses would receive a consolidated volume shipment from various plants and ship LTL shipments to various nearby markets.

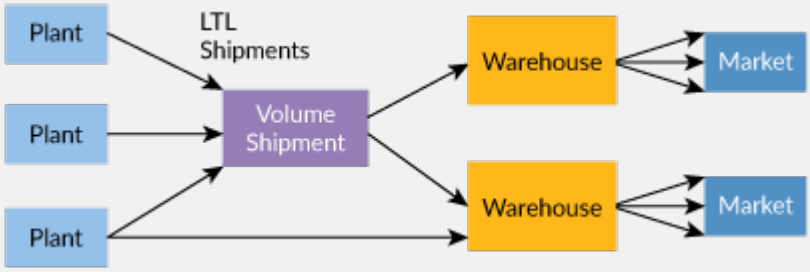


Figure 16. Outbound logistics system. Developed by LINCS in Supply Chain Management Consortium.

Product Mixing

Warehouses can also be used to add value in customer order product mixing. Companies often produce product lines containing thousands of different products, considering color, size, shape, and other variations (e.g., a shirt manufacturer that manufactures and distributes a style of shirt in a multitude of colors and sizes). When placing orders, customers often require a product line mixture (e.g., a clothing store requires different shirts from a manufacturer in different sizes, long and short sleeve, etc.).

Companies often produce items at different physical locations, so companies without warehouses would have to fill orders from several different locations, causing several different arrival times and opportunities for errors to occur. Therefore, product mixing functions at warehouses for multiple product lines lead to efficient order filling and reduced transportation costs through consolidating mixed loads (see *Figure 17*).

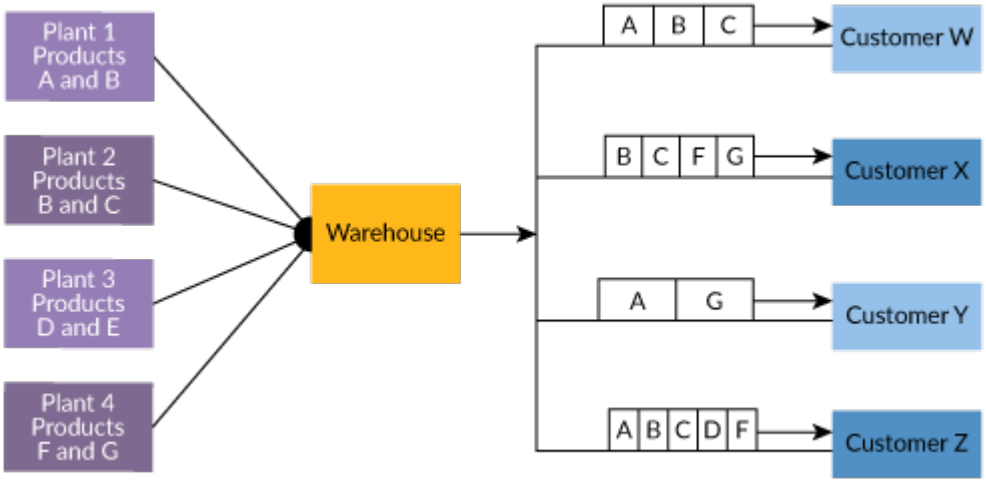


Figure 17. Product mixing. Developed by LINCS in Supply Chain Management Consortium.

Supply mixing entails moving loads of raw materials, mixed from physical supply warehouses, to plants (see *Figure 18*). In addition to product mixing for customer orders, companies using raw materials for semi-finished goods (e.g., auto manufacturers) commonly move truckloads of items mixed from physical supply warehouses. This strategy not only reduces transportation costs through consolidation, but it also allows the firm to avoid using critical plant spaces as warehouses.

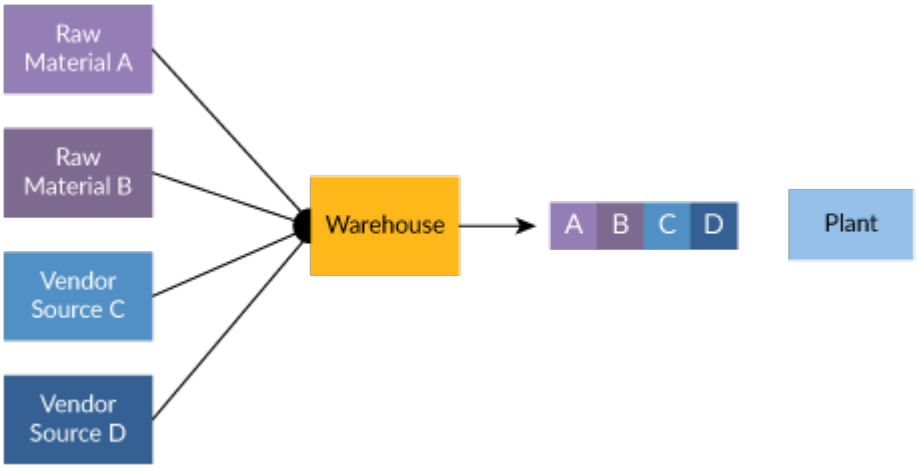


Figure 18. Supply mixing. Developed by LINCS in Supply Chain Management Consortium.

Break Bulk

The warehouse can be used to add value through break bulk services. In break bulk, large shipments of manufacturers' products are broken down into smaller units, which are shipped to multiple customers. For example, a firm can purchase hand cleaning fluids in bulk containers (e.g., barrels) and repackage this fluid into smaller plastic bottles. The firm then distributes these new bottles to various automotive service centers around the United States for use by automotive mechanics.

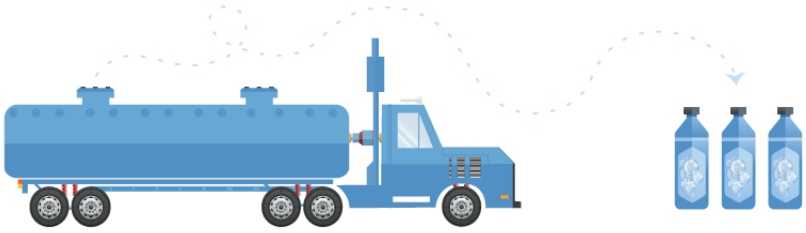


Figure 19. Breaking bulk. Developed by LINCS in Supply Chain Management Consortium.

Cross-Docking

As an alternative to placing items into storage, cross-docking is used on the highest velocity and demand items (*Figure 20*). When products are received, this process enables immediate sorting and shipping without ever being placed in storage. In cross-docking operations, the storage, or holding, function is temporary and short term. In fact, items can turn (move through warehouses) in as little as 12 to 24 hours. In addition, many merchandisers and small retailers use a quick response, or minimal

storage inventory strategy, which uses **point-of-sale** information to notify warehouses when inventories need to be replenished. In this system, when a certain amount of inventory is used, or sold, at the customer site, an electronic message is sent to warehouses and the inventory is replenished on a JIT basis.

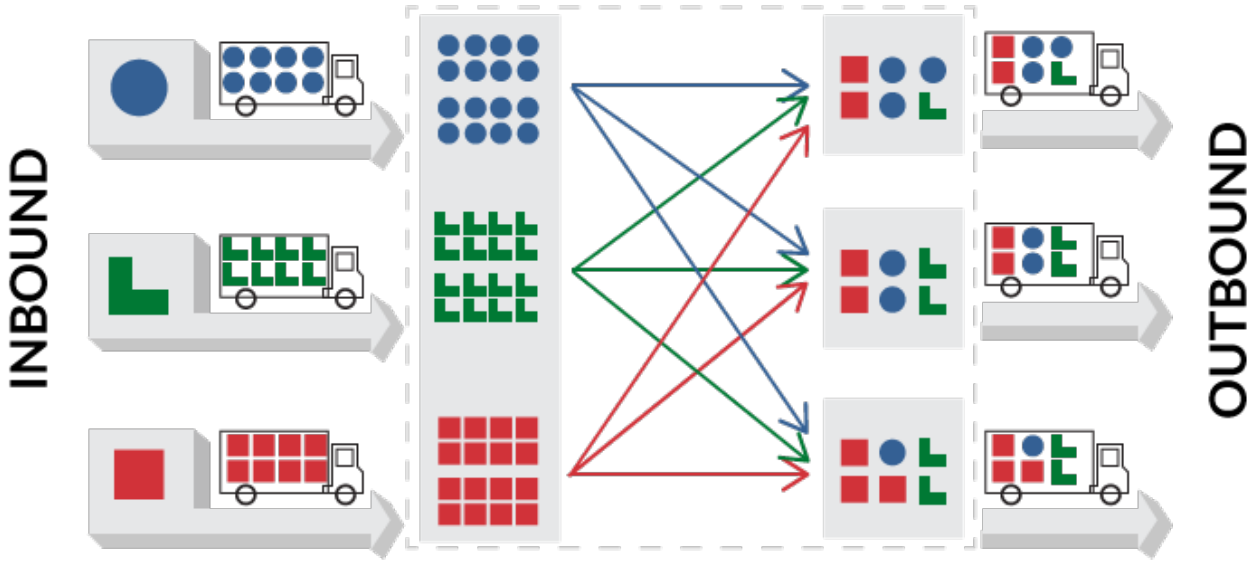


Figure 20. Cross-docking. Developed by LINCS in Supply Chain Management Consortium.

An example of cross-docking materials can be presented by a chain of office supply retailers. Incoming materials are picked from delivering trucks or from temporary storage locations to fill specific customer orders and are moved across the dock to trucks destined for specific retail stores. The whole process can be completed in a matter of hours, reducing the need for storage space and reducing inventory holding costs. Excess product and small items that come in can also be stored temporarily to await scheduled store deliveries and to permit sorting of inbound loads of mixed products.

Cross-docking is focused on efficient movement of goods from inbound receiving to outbound shipping. A major benefit of cross-docking is the elimination of the stocking and picking functions, as well as the elimination of storage and its associated equipment. These are costly operations, which also increase exposure to damage.

Manufacturing also uses cross-docking to move materials directly from receiving to Work in Process cells. This eliminates the same costs and risks as traditional cross-docking. Once goods have completed the manufacturing processes, there is an additional cross-docking opportunity to move Finished Goods directly to shipping.

Customer Service

Customer service provides a competitive advantage to companies. Having goods available in warehouses when customers place orders (particularly if warehouses are reasonably close to customers, including retail warehouses) will usually lead to customer satisfaction, enhance future sales, and contribute to customer retention.

Figure 21. Customer satisfaction. Developed by LINCS in Supply Chain Management Consortium.

Protection

Protection against contingencies, such as transportation delays, supplier stock-outs, strikes, or inclement weather is important for physical supply warehouses because delays in the delivery of raw materials can delay manufacturing operations. An example of the contingency benefit in action is when an automotive manufacturer is able to continue operations after a natural disaster impacts supplier operations by utilizing stockpiles of materials kept in a warehouse near the plant.

Smoothing

Smoothing out production and distribution operations is a sixth warehouse function. Consider a snowboard manufacturer as an example of an organization that employs a smoothing technique. The demand is seasonal, but materials are fed from the warehouse to the manufacturing line at a constant rate to achieve a smooth level rate of production. This prevents overtime labor costs in manufacturing, while enabling materials suppliers to develop a continuous flow of materials to the warehouse. Another example of smoothing can be examined for specialty holiday items that have peak demands (e.g., fireworks for the 4th of July). Here, manufacturers must begin producing the product well in advance of the holidays, and they must store the product in warehouses until they are needed.

Staging

Oftentimes, a wide variety of products, materials, and equipment are required to be gathered over a period of time to meet customers' requirements; this is sometimes referred to as project logistics. Fitting out furniture in a new office building is an example of the need for staging because the furniture company gathers the needed product prior to delivery and installation.

Kitting

Kitting is a value-added process performed in warehouses where individually separate, but related, items are grouped and packaged together to create a special single product (see *Figure 22*). In a manufacturing environment, for example, an enclosure, circuit cards, amplifier, digital display, cooling fan, and connectors are used to assemble a digital entertainment controller for an in-home theater.

Kitting is also used for on-line ordering of personal computers. Customers select memory, drives, peripherals, and software from a menu of options. The value-added **distribution center** groups and kits the items into one consolidated shipment.

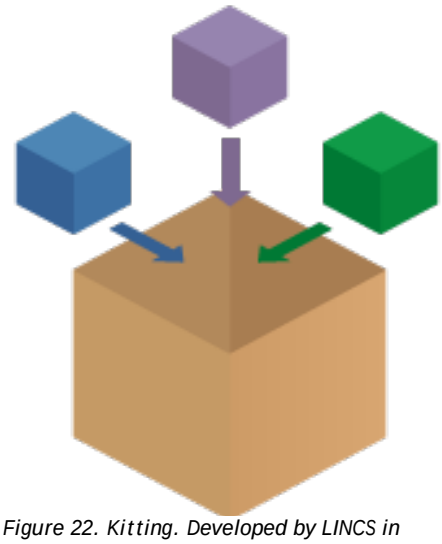


Figure 22. Kitting. Developed by LINCS in Supply Chain Management Consortium.

Learning Block 2 Summary

There are various forms of warehousing and associated operational processes that enable organizations numerous options to optimize the supply chain. The value-add activities (e.g., product mixing, staging, etc.) are defined by the broader goals for an organization and its supply chain.

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

In developing distribution strategies, companies must address questions regarding the merits of private, public, and leased warehouses and centralized versus decentralized networks, location, number, layout, and size, including proximity to transportation options.

Warehouses generally consist of movement, storage, and administrative functions supported by information systems to facilitate flow inside the facility and with customers and suppliers.

Information technology, such as barcode scanners, are important in order to ensure effective and error-free operations.

Learning Block 2 Optional Supplemental Resources

The optional supplemental resources listed below may be used to reinforce the content covered within this learning block.

Students are encouraged to view the video at the links below, which provides an overview of warehousing operations in action:

Phillips, C. (Director). (2012, September 12). *Warehouse & distribution* [Online video]. In D. Mason (Producer), Just the job (Season 5). Available from http://www.youtube.com/watch?v=QTrzEZJEX0c

ProLogistix (Producer). (2008, September 17). *1 understanding distribution centers part 1 – Introduction* [Online video]. Available from http://www.youtube.com/watch?v=v04bYC2X3Xo

ProLogistix (Producer). (2008, September 17). *2 understanding distribution centers: Types* [Online video]. Available from http://www.youtube.com/watch?v=Ocajsbbv7cA

ProLogistix (Producer). (2008, September 17). *4 Understanding distribution centers: Ownership* [Online video]. Available from http://www.youtube.com/watch?v=RolBuLYEoX8

Bloomberg News (Producer). (2013, December 1). *A day in the life of an Amazon package* [Online video]. Available from http://www.youtube.com/watch?v=8-DgmfMa5Zk

National Geographic (Producer). (2011, January 9). *National Geographic ultimate factories UPS worldport 3 of 3* [Online video]. Available from http://www.youtube.com/watch?v=dc9jVYqoES8

Learning Block 2 Practice Questions

1. Which of these is NOT a key function of a warehouse?

a. Mix products from multiple suppliers to ship to customers
b. Manufacture products
c. Move materials from suppliers to customers
d. Store materials

2. A cross-dock process is used to:

a. Store material for a long period of time
b. Pick very tall and narrow items
c. Move products from receiving to shipping without being placed into storage
d. Augment manual storage processes

3. The movement of less than truckload shipments for a relatively short distance to a warehouse and then combining these shipments into a larger shipment is known as:

a. Product mixing
b. Cross-docking
c. Smoothing
d. Transportation consolidation

4. Which of these would not be expected to be stored in a warehouse?

a. Packaging materials
b. Raw materials and parts
c. Finished goods
d. Delivery vehicles

5. A benefit of owning a private warehouse is:

a. Control of materials and finished goods
b. Lower costs
c. Higher sales
d. Tax advantages

6. Public warehouses:

a. Charge fees for their services
b. Own the goods and materials
c. Are located in remote locations
d. Are too expensive to be feasible for small companies

7. The primary benefit of a Foreign Trade Zone is to:

a. Increase imports from international suppliers
b. Ensure a high level of exports
c. Avoid duty payments on parts imported to the U.S. when those parts are used to manufacture products that are exported
d. Bypass customs at airports and seaports

8. A manufacturer's product is broken down into smaller units, which are shipped to multiple customers. This process is known as:

a. Smoothing
b. Kitting
c. Break bulk
d. Consolidation

9. The best location option for warehouse distribution locations for a large, national or international firm would probably be:

a. Decentralized locations
b. One central location
c. Locations near major airports
d. Remote locations to avoid congestion

10. A third-party operator specializes in providing:

a. Warehousing personnel
b. Transportation routing consultation
c. A full range of distribution management services
d. Air freight services

Learning Block 3: The Receiving Function

Learning Block 3 Description

This learning block will investigate the activities that take place in the receiving area of warehouses by taking an integrated view toward learning. This integrated view will include discussions of the processes, equipment, and technology used to speed the flow of materials and goods through warehouses as they are handled during receiving, sorting, value-adding services, storage, order selection, and shipping. It is important for warehouse associates to be familiar with warehouse activities and related terminology to contribute effectively as employees and to be able to communicate effectively with customers and other team members.

The receiving function is essential to warehousing operations because it is difficult to handle subsequent functions unless goods and materials are properly received. The receiving function allows warehouse operators to receive goods and materials in accordance with the applicable ordering documentation.

Learning Block 3 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Remember the main objectives of the receiving function in warehouses
- Understand the detailed steps of receiving goods and materials
- Explain three major types of receiving dock locations
- Apply key performance metric examples and describe best practices in receiving goods into warehouses

Unit 1: The Receiving of Goods and Materials

The objective of the receiving function is to assure that goods and materials delivered to warehouses are verified against ordering documentation and checked for shipping damage.

In the receiving area, incoming goods and materials are normally unpacked, checked for quantity accuracy and product damage, repackaged, organized into a storable format (where required), entered into the inventory system, have markings/labels applied, and staged for movement to a storage area. Cross-docking and certain value-added activities could also take place here.

Goods Receipt

The receiving area needs to be designed to assure the space, tools, and equipment are allocated to accommodate and process the intended receipts. Poor design planning can often lead to congestion and chaos, which may create a serious bottleneck and adversely affect the overall efficiency, cost, and performance of the distribution network.

Figure 23. Goods receipt. Developed by LINCS in Supply Chain Management Consortium.

Receiving Activities

Typical activities carried out in the receiving of goods include:

- Scheduling delivery vehicles and yard control
- Unloading product from the delivery vehicles
- Checking product quality and quantity
- Entering data into the warehouse management inventory system
- Safeguarding and labeling
- Completing JIT and cross-dock activity

As is the case with warehouse operations, the receiving function will vary greatly from industry to industry. For example, companies in the chemical and petroleum industry receive inbound supplies in bulk quantities (e.g., rail tanker cars and tanker trucks) rather than in boxes flowing over a **conveyor** on a receiving dock.

Figure 24. Receiving activities. Developed by LINCS in Supply Chain Management Consortium.

Scheduling Delivery Vehicles and Yard Control

Yard control activities include scheduling inbound vehicles for offloading, restraining vehicles, checking seals, opening of the truck door, and inspecting the trailer or load condition. Yard control and scheduling inbound delivery vehicles determines when delivery trucks are due to be positioned at the warehouses unloading dock. Whenever possible, this dock location minimizes the internal transportation distance between the dock door and the storage location.

Other yard control activities include:

- Using chocks behind the trailer driver side rear wheels or other means of vehicle restraint
- Checking the seal and opening the truck door
- Inspecting the trailer or load condition for damage or contaminants

When trucks arrive at the dock, they generally find one of three types of warehouse dock configurations: combined, scattered, or separated.

In the combination docks arrangement (see *Figure 25*), receiving and shipping activities are performed in one common area, so fewer dock positions are needed. These activities use the same docks, building area, equipment, and employees and lead to a more productive use of resources. For best results, this combination concept requires a truck dock schedule in which inbound and outbound products do not conflict. Receiving and shipping docks are on the same wall, so product tends to flow through the facility in a horseshoe pattern.

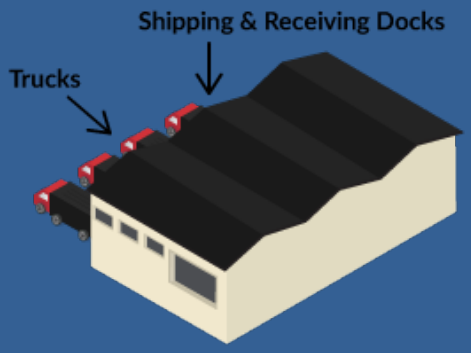


Figure 25. Combination docks. Developed by LINCS in Supply Chain Management Consortium.

The disadvantage of using combination docks is that it tends to increase in-house movement of goods and requires exact scheduling of inbound and outbound trucks, and it may also lead to vehicle congestion in the yard. With this method, it becomes more difficult to compensate for product delivery problems and business fluctuations.

A scattered dock arrangement has incoming goods delivered to a number of points on the perimeter of a warehouse close to the point of use. This dock arrangement allows the product to flow directly from the delivery dock area to the assigned storage use/area. Shipping docks are located along the opposite building wall from the receiving docks, allowing product to flow from use/storage areas into the shipping dock area. This arrangement is particularly suitable for warehouses that operate a cross-docking operation. Disadvantages of the scattered dock layout include duplication of services and back-up facilities, requirements for increased labor, the need for increased management control, lack of flexibility for rearranging the layout during an expansion program, and under-utilization of mechanical handling equipment (i.e., duplicate capital investments).

In the separated dock arrangement (see *Figure 26*), incoming goods are delivered to a number of points on the perimeter along one exterior wall. This dock arrangement allows the product to flow directly in a straight line from the receiving dock area to the assigned storage area. Shipping docks are located along the opposite exterior wall from receiving, allowing product to flow from storage areas into the shipping dock area. This arrangement is particularly suitable for warehouses that operate cross-docking operations.

A disadvantage of the separated dock arrangement is that it not only requires the use of opposite ends of the building, but also utilizes separate equipment, employees, and supervision.

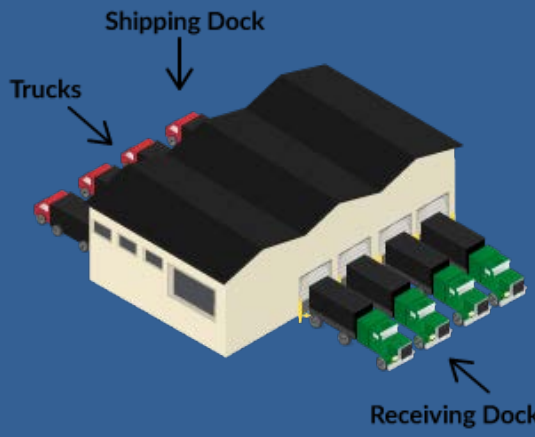


Figure 26. Separated docks. Developed by LINCS in Supply Chain Management Consortium.

Check Product Quality and Verify Quantity

The third main receiving activity is to verify that incoming goods and materials are not damaged or contaminated and that the quantity is verified against what was ordered. This activity ensures that the product delivered to warehouses is what was ordered, the quality is acceptable, and the quantity is correct.

Once a receipt has been verified for quality and quantity, it is entered into a WMS.

At this point, any discrepancies are documented using the designated process. Any missing or damaged cartons in transit may become the responsibility of the freight carrier or transport company. Suppliers and manufacturers would be notified if the order is damaged, contaminated, has incorrect quantities, or has missing or wrong products.

Organizations can also use a total quality program with their suppliers. This type of program aims for quality at the source, or doing it right the first time at the supplier's site. This reduces or eliminates the need for performing quality checks on receipts.

In cases when the product is incorrect or damaged, it will normally be held in a separated, clearly demarcated holding area for disposition. This disposition normally takes the form of either:

- Returning the entire shipment to the supplier
- Inspecting 100% of the incoming items and separating acceptable quality items from the poor quality items. Acceptable quality items are processes for storage, and poor quality items are returned to the supplier.

Entering Data into the Warehouse Management System

The next receiving activity is to update the inventory system. Receiving department employees enter the SKU quantities into the system and transfer the goods from the receiving department staging area to the designated storage or staging area.

In warehouses that use barcode scanners or other means of capturing receipt information, employees ensure that data is automatically entered during the scanning process. However, in warehouses that use paper-based transactions (e.g., receiving documents), employees may need a more extensive key entry to input product and quantity data.

Figure 27. Barcode Scanners. Developed by LINCS in Supply Chain Management Consortium.

Safeguarding and Labeling

In certain retail warehouse operations, a sub-activity of product receiving is the SKU labeling activities, in which a unique label is placed onto each SKU. In this activity, the procedure includes a mechanical printer that prints labels, which are then glued, clipped to, stitched into, or hooked onto the SKU.

Figure 28. Unpacking for load transformation. Acquired from pixabay.com.

Repackaging and other safeguarding operations may take place prior to further processing and storage. The purpose of this activity is to convert the product from a bulk form (e.g., products tossed into a large bin without individual packaging or wrapping) to a form that is ready to be placed into storage. These activities can involve unit load transformation. For example, parcels might be unpacked into individual cartons, pallet loads containing unstable loads might be stabilized, or it might be necessary to change the height (quantities per pallet) of a pallet to conform to storage or building constraints.

Value-Added Activities in Receiving

Receiving functions also include activities, such as repacking products, repackaging into customer-specific cartons, and possibly in customer-specific quantities. Depending on the type of company, industry, and the nature of the operation, kitting might also take place during receiving operations.

As previously discussed, kitting is a process where individually separate but related items are grouped and packaged together to create a special single product or to create one unique item.

Cross-Dock Activity

Another activity performed in the receiving area is the cross-dock activity. This type of operation changes the traditional sequence of activities and product flow in warehouses, as previously discussed.

Items are received and then distributed to the customers' staging-shipping area directly, without being placed into storage. This flow concept reduces the distribution facility number of product handlings and number of days of flow from suppliers to final customers but emphasizes inbound-outbound dock and sorting activities.

Place Product into Staging Area

Goods arrive and are stored in warehouses in varying types of storage locations and containers, depending on the product characteristics and the amount of product to be transported or stored. These locations and containers have specific industry-related and accepted names, and specialized pieces of equipment (i.e., material handling equipment) are used to handle the various types of containers. The following is a list of names and characteristics of common storage containers:

Intermodal containers

Intermodal containers (shipping containers) are used for the efficient transportation of goods. Standards specify the volume and dimensions of containers to facilitate efficient handling.

Figure 29. Intermodal container. By Pil56 at it.wikipedia [Public domain], from Wikimedia Commons.

Wood pallets

Wood pallets are one of the most commonly used means to store and move product in warehouses. Tow motors, forklifts, and other specialized equipment are used to move pallets. Pallets may be stored in a number of ways, including single tiers on the floor, stacked on the floor, or stored in pallet racking.

Figure 30. Wood pallets. Acquired from pixabay.com.

Plastic containers

Reusable plastic containers are used to hold and transport goods. These are generally one size and used to move items within a warehouse or manufacturing facility. They are sturdy and their reuse prevents waste caused from cardboard boxes that deteriorate and have to be replaced.

Figure 31. Plastic containers. By NordGen/Dag Terje Filip Endresen [Public domain], via Wikimedia Commons.

A Receiving Scenario

Many companies use ASNs to ensure efficient receiving operations. An ASN is a document that is transmitted via EDI after the replenishment goods have been consigned to a carrier. To begin, the ASN for a particular order arrives at the warehouse before the order so staging instructions and staffing level plans can be generated before the goods arrive. Warehouse staff are allocated to handle the incoming shipment, and the optimal routing flow for the incoming goods is determined. If storage is required, the storage location is designated.

Computer-generated information will then alert warehouse personnel about the quantity of goods that will be arriving, whether they are to be cross-docked or stored, and if they will require staging at an intermediate area prior to cross-docking or storage. The computer also uses information provided by ASNs to schedule and coordinate the use of receiving docks. Before the incoming carrier arrives at the warehouse, it may receive information via its on-board computer about which receiving dock to back into.

The Computerized Receiving Function

A worker meets the truck at the receiving dock to receive and check-in incoming goods. The worker uses a **Radio Frequency Terminal (RFT)** which has a keyboard, a small printer, and an attached barcode scanner; it also receives information from, and sends information to, the WMS. RFTs can be hand held or mounted on a cart for mobility.

If there are computer or communications issues, a computerized warehouse may resort to paper-based tracking of receipts as a back-up until the computer is online. In fact, many smaller warehouse operations still work on a paper-based system, in which warehouse activities are noted on paper (rather than captured on an RFT), and receipts are manually typed into a computer by a receiving, shipping, or inventory clerk.

RFTs may scan barcodes or other identifiers and transmit the data to the computer system to reconcile received goods with purchase orders. Specific products and quantities are identified, and any damage or suspected damage is recorded. Trailers are then unloaded according to RFT instructions.

RFTs can also generate carrier receipts, RFTs provide detailed instructions to operators. These on-screen instructions specify the sequence of activities that should take place. Shipments are received in various types of containers, but the **shipment container markings** of one kind or another are generally attached to goods that have been unitized.

A **unitized load** is a consolidation of a number of items into one shipping unit to make handling easier. Loads can be unitized by banding, binding, or wrapping. The shipment container marking may even be attached to a trailer that has been sealed and secured prior to shipment. Goods are commonly unitized on pallets, which are typically wooden platforms used for stacking and transporting products as a unit load. They are commonly four foot squares and constructed to place forklifts' forks between the platform levels.

RFTs can also print barcode labels, which are used to direct and track the movement of goods. Information required for barcode labels are sent from the WMS to the RFT, which prints a barcode label. This label is attached to the goods in the receiving area.

Figure 32. Computerized receiving function. Developed by LINCS in Supply Chain Management Consortium.

Key Metrics Used in Receiving

Receiving activity is essential to warehousing operations. Unless product is properly received, it will be difficult to handle subsequent functions. The receiving function allows warehouse operators to receive product against appropriate ordering requirements. The receiving process could include goods received at the warehouse and stored, delivered at customer sites, or cross-docked.

Key Performance Indicators (KPIs) are used throughout this certification track at the end of each learning block to identify applicable metrics. KPIs are measurable values that demonstrate how effectively a company is achieving key business objectives. Organizations use KPIs to evaluate their success at reaching desired targets and goals.

The relevant KPIs for the receiving function may include:

1. **Cost:** Cost of receiving per receiving line
2. **Productivity:** Volume received per labor hour measured in terms of pallets, cases, etc.
3. **Utilization:** Receiving dock door utilization percentage
4. **Quality:** Accurate receipts percentage
5. **Cycle Time:** Time taken to process a receipt

Learning Block 3 Summary

Comprehensive design planning of the receiving area and adherence to defined procedures and processes are essential to the flow, handling, and security of incoming goods and materials. The correct allocation of methods, manpower, and equipment will ensure employee safety, effective and efficient yard control, transportation vehicle off-loading, assurance that correct items are being received, and appropriate checks are performed to determine if there is product damage or contamination.

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

Beyond the basic receiving functions, receiving personnel are additionally responsible for entering acceptable product into the warehouse management inventory system, safeguarding and labeling the items for further processing, and staging the items for storage or alternate steps, like cross-docking.

Learning Block 3 Practice Questions

1. **Incoming goods are _____ in the receiving area.**

a. Stored for relatively lengthy periods of time
b. Picked against customer orders
c. Stored in specialty storage
d. Checked for quality and quantity and then staged for further processing

2. **When designing a dock system for receiving and shipping goods. The dock layout will most likely be:**

a. Separated docks
b. Combination docks
c. Scattered docks
d. Separated or scattered docks

3. As items are off-loaded from a delivery vehicle, receiving personnel should be checking for:

a. Obvious shipping damage
b. Condition of the delivery vehicle
c. Required need dates
d. Sufficient warehouse space

4. _____ is a **function often performed in receiving.**

a. Kitting for manufacturing
b. Cross-docking
c. Preparing out-bound shipping paperwork
d. Placing the items in storage

5. If received items appear to be damaged, receiving personnel should:

a. Repackage the items
b. Document the condition and move the items to a holding area for disposition
c. Attempt to correct the damage
d. Accept the items if the damage is minor

6. One major benefit of a Total Quality Program is that it:

a. Reduces or eliminates the need for a detailed receiving quality checks
b. Prevents shipping damage or contamination
c. Assures on-time delivery
d. Works best for large organizations

7. After the receipt of items, repackaging operations may be necessary to:

a. Safeguard the items for processing or storage
b. Improve item appearance
c. Correct shipping damage
d. Cover-up item contamination

8. Intermodal containers (shipping containers) are commonly used for the:

a. Movement of product in a distribution center
b. Efficient transportation of goods
c. Long-term storage of products within a distribution center
d. Staging of items for manufacturing operations

9. Items are initially entered into the Warehouse Management System when:

a. A customer order is received
b. It is off-loaded from the delivery vehicle
c. Quality and quantity have been verified
d. Cross-docking operations begin

10. Computerized and automated systems are utilized to:

a. Enhance productivity, processing and inventory accuracy
b. Compensate for lack of personnel skills
c. Promote market awareness
d. Eliminate errors

Learning Block 4: Stocking and Restocking

Learning Block 4 Description

This learning block provides a basic overview of the methods for allocating storage and the types of storage systems and equipment used in warehouses. Stocking and restocking are part of the daily warehouse processes of replenishing and storing goods.

Learning Block 4 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Recognize the fixed and random storage location systems and differences
- Understand the main methods for identifying storage locations
- Explain three methods for assigning fixed (dedicated) storage
- Compare factors that favor fixed location systems and random location systems
- Summarize and briefly describe various types of storage equipment
- Identify key metrics used to measure storing, storage, and restocking performance

Unit 1: Transfer of Product into the Storage Area

Goods and materials may be processed from the receiving area to a storage location by a number of mechanisms. A few more common methods of processing are on operator-controlled vehicles or **Automatic Guided Vehicle Systems**.

Figure 33. Forklift truck. Developed by LINCS in Supply Chain Management Consortium.

Operator-controlled vehicles include:

Fork vehicles (e.g., forklifts; see *Figure 33*) can handle loads at a variety of levels (e.g., floor, conveyor, and rack).

As shown in *Figure 34*, tractors tow flatbed trailers that are loaded either manually or with forklifts. Once loaded with pallets or unitized loads, pallet and unit load carriers are pulled either manually or with a tow vehicle (depending on size) to the appropriate destination.

The operator-controlled vehicles on *Figure 34* have an automatic guided vehicle (AGV) equivalent. AGVs can receive material handling directions input by an operator directly to the AGV's on-board computer. These vehicles can receive, store, and process information, and their guidance systems operate under the control of the host computer. AGVs may also use on-board computers or operate under the control of a central computer.

Figure 34. Tractors pallet and unit load carriers. Acquired from pixabay.com.

Goods may also be loaded onto conveyors, one of the most common types of handling/sorting equipment (see *Figures 35* and *36*). Conveyors may be automated and computer controlled, and goods may be moved from the receiving area on conveyors.

Figure 35. Belt conveyor moving boxes. By KevinHannessen (Own work) [CC BY-SA 4.0], via Wikimedia Commons.

Figure 36. Roller conveyor. Acquired from pixabay.com.

Unit 2: Stocking Operations and Determining the Storage Location

The stocking operation includes the physical movement of goods and materials from the receiving area to assigned storage locations in the facility. Handling equipment operators check the item configuration to validate quantities and product safety, verify the storage location on the pallet/storage unit label, pick up the pallet storage unit, and scan the barcode on the label.

The items are moved to the designated storage location (or sometimes directly to a pick location) and placed into a storage position. This placement could be in the form of storage media (e.g., racking, shelving, and binning) or on the floor in a demarcated area. The handling equipment operator will verify that placement is in the correct location. Once the process is complete, inventory records are updated to reflect the receipt of the item, its storage location, and availability for demand orders.

Stock Location - Fixed vs. Random Location

A decision in determining inventory location is whether to have a fixed storage location for each line item in the warehouse or to have a random storage location. In a fixed location system, specific slots, or lanes, are allocated and dedicated to items. A random storage location system is one in which stock locations are assigned on a random basis, and stock is placed wherever a space opens up.

Fixed storage location warehouses may not make the best use of available space because specific slots/lanes must be dedicated to items that may fluctuate substantially in volume. When this issue is multiplied across the total line items stored in the warehouse, a totally fixed location system may waste a large amount of space.

On the other hand, a random location system uses space in an optimal fashion; however, it is dependent on a computer system that allows for the automatic and accurate identification of alternative picking/placement slots. For example, when a random slot location is exhausted, the picker must be able to find another location in which the inventory can be found. In addition, this type of system works best when the inventory records are precisely maintained and are updated on a real-time basis.

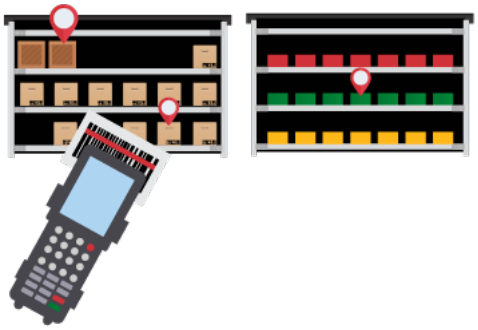


Figure 37. Determine stock location. Developed by LINCS in Supply Chain Management Consortium.

It should be noted that in practice, many systems are a mixture of fixed and random location. For instance, one product family may be located in a fixed area (e.g., men's shirts, size 17), but certain members of that family may be placed in random locations (e.g., men's shirts, size 17, red, short sleeves).

Most computer software allocates storage space using either fixed or random methods.

Product Destination in the Warehouse - How to Identify Aisles and Storage Positions and Stocking Locations

Information on material identification labeling or barcodes affixed during receiving is analyzed by the host computer to direct the goods and the operator to an exact storage location. Every warehouse requires a storage location system with an address designation system, which allows each storage position to be easily and quickly identified by operators as they store and retrieve stock.

To ensure an accurate and on-line product transaction, proper signs must clearly identify the aisles and stock/pick positions within those aisles. One common method is where a placard is placed: lying flat against the end of the aisle in an upright frame or hanging from the ceiling. This labeling allows employees entering the aisle to identify the aisle.

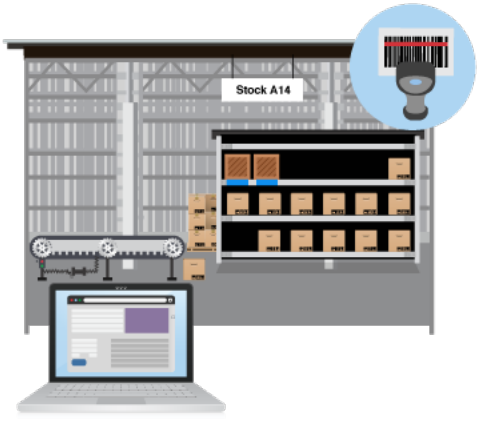


Figure 38. Product destination. Developed by LINCS in Supply Chain Management Consortium.

Methods required for identifying pallet/stock positions in warehouses include:

- Numbers painted on racking
- Self-adhesive labels
- Paper/card label affixed to the rack structure
- Placard hung from the ceiling

In addition, identifying actual pallet/stock position is required, which normally takes the form of characters and digits to identify the position. In a fixed location system, characters, digits, and SKU descriptions with a barcode label identify each position and specific product stored there. Outlined next are the main methods are used for identifying actual storage positions within aisles:

- Location numbers/letters painted onto the racking itself
- Pre-printed self-adhesive labels
- Cardboard or paper labels in a plastic holder affixed to the rack structure
- Placard hung from the ceiling
- Digital display

Fixed or Dedicated Storage Assignment

With fixed storage assignment, products' storage locations are determined using one of three methods:

1. **Popularity storage** (or **ABC analysis**)
2. **Similarity storage** (also known as **complementary storage**) or
3. **Product characteristics storage**

Popularity Storage

This term refers to one method of storage, in which items' storage locations are determined by their velocity of inventory turnover. Category A items account for the majority of SKUs moved; B items are less frequently moved; and C items are least frequently moved. The greater the velocity, or popularity, of a product, the closer it is kept to the staging area. This storage type reduces the distance and travel time required for stocking and retrieval.

Similarity or Complementary Storage

With this method, items commonly received or shipped together are stored together. For example, one manufacturer may make laser and inkjet printers. They may be received together and stored together, even though they differ in weight, size, and product demand.

Product Characteristics Storage

Using this storage method, location is determined by the basis of products' special attributes. For example, if the product is heavy, bulky, or hard to handle, it would be stored close to the area where it will next be staged. Oddly shaped or fragile items may also require special storage locations. Also, expensive, easy to steal, or desirable items may require extra security storage.

Factors That Tend to Favor Fixed Location Systems

Factors that tend to favor fixed location storage systems include:

- Low product range (i.e., relatively few line items in the product range)
- Large number of pallets/cartons per product line (high volume/throughput)
- Regularly shaped unit load
- Relatively little variation between maximum and minimum stock levels
- Relatively homogeneous range of products (e.g., men's shirts)

With these factors present (particularly those of little variation between maximum and minimum stock levels), it becomes possible to dedicate storage positions/lanes to product line items and not experience a great deal of lost space through excessive **honeycombing**. Honeycombing is the lost storage space in front of partial stacks of goods or above goods in storage positions.

If these factors are not present, warehouses with fixed storage locations may lose space because, in a fixed location system, space is allocated based on the maximum stock level per line item. Therefore, because specific storage slots/lanes must be dedicated to items that may fluctuate substantially in volume, space will be lost overall.

Random Storage Assignment

When a **random storage assignment** method is used, products are stored in the closest available locations that can accommodate their specific product characteristics. Sometimes, zones that take into account the inventory velocity for those products are created within those locations.

The term *random* is a loose term, and it should not imply lack of order. In fact, the random method provides the optimal use of storage space. The tradeoff in this type of system is the increased complexity of the system. Also, because of the increased travel distance required to retrieve goods in response to customer orders, this method is often used in conjunction with automated materials handling systems.

With automated random storage allocation, products' dates of arrival, descriptions, and precise locations are tracked by the warehouse computer using SKU identification labeling. The computer software also maps the location of the products within their zones, so honeycombing can be reduced. Honeycombing can be reduced using software designed to handle random storage allocation.

Software that creates efficient honeycombs incorporates a number of variables related to the goods being stored. In a software-controlled random allocation process, identical items may be stored in different areas to create efficient use of space and to reduce honeycombing. As they are selected for shipping, the storage maps are analyzed, and new items are placed in available space. These variables are considered:

1. First in, first out and last in, first out is taken into consideration for various reasons (designated financial model, shelf-life, perishables, etc.).

2. The relative velocity of these items. For example, anchovy pasta sauce is order-selected less often than is mixed herb pasta sauce. Computer software will determine the relative rate at which these two products are order-selected and the direct stacking of mixed herb pasta sauce on top of anchovy pasta sauce in a number of locations and/or closer to the staging area/point of use. This relative velocity will be

determined using ABC analysis to determine those items that are picked most frequently, less frequently, and so on.

3 Size and weight of an item

Factors That Tend to Favor Random Location Systems

Random location storage generally requires approximately 30% less space than does fixed location storage, so relatively smaller warehouses are required for random location storage versus fixed location. Factors that tend to favor the use of a random storage location system tend to be the opposite of those that favor a fixed location system:

- ☑ Relatively large range of products
- ☑ Relatively low number of pallets/cartons per product line
- ☑ Irregularly shaped unit loads
- ☑ Relatively high variation between maximum and minimum stock levels for line items

Given these factors, not adopting a random location system would result in a great deal of lost space and difficulties in allocating space for line items and in designing the layout and storage compartment sizes to accommodate these line items (because of irregularity in unit load sizes, large fluctuations in stock levels between maximum and minimum levels, etc.).

Figure 39. Random storage. Developed by LINCS in Supply Chain Management Consortium.

Unit 3: Types of Storage Systems and Equipment

There are a number of different types of storage systems available. Systems can be combined and more than one system can be used depending on the stock. The benefits of selecting the right storage system include a better use of space, easier work processes, and better overall business efficiency. Storage systems must be accessible for safe and quick access to the stored goods.

Moving Goods To and From Storage

Once the storage location has been assigned, goods are moved to and from their location using one of the following transportation devices:

- Operator-controlled, manual hand trucks and carts
- Operator-controlled, power-assisted devices (e.g., **forklift trucks**, platform trucks, and cranes)
- Automatic handling systems (e.g., conveyors and AGVs)

Simple Block Stacking

The goods are then simple block stacked, or placed in different types of manual or automated storage devices. Simple block stacking, depicted in *Figure 40*, is a system in which pallets are stored several pallets deep in rows and on the floor of the warehouse. Pallet loads are generally stacked directly on top of one another, and the load height is generally constrained by crushability of stored materials and shape regularity of unit loads for even stacking.

Figure 40. Simple block stacking. Developed from an image acquired from pixabay.com.

Manual Storage Devices

Manual storage devices include a variety of racks, bins, shelves, drawers, and **mezzanines**, as described below. Several types of **pallet racks**, which are designed to handle palletized or containerized loads, are shown in *Figures 41 – 43.*

Various types of pallet racks are designed to handle palletized or containerized loads. Operator-controlled, power-assisted devices are typically used for storing and retrieving into and out of pallet racks. Single-sided adjustable pallet racking, which allows access to each individual pallets and is one of the most common forms of storage media, is shown in *Figure 41*.

Double-deep pallet racking, also a fairly common form of storage media, is shown in *Figure 42*.

Figure 41. Adjustable pallet racking. Acquired from pixabay.com.

Figure 42. Double deep pallet racking. By Cortes003 (Own work) [CC BY-SA 3.0], via Wikimedia Commons.

Another type of racking, which allows for relatively dense storage of pallets, is drive-in racking (see *Figure 43*).

Gravity flow racks are used for high-demand items, usually in cartons, of uniform size and shape. The racks are sloped, and items are loaded at the back (higher end) of the racks. When item is picked from the front (lower end), the next higher item flows down to replace it (see *Figure 44*).

Figure 43. Drive-in racking. By Markj52 (Own work) [Public domain], via Wikimedia Commons.

Figure 44. Gravity flow rack. By Markj52 (Own work) [CC BY-SA 3.0 or GFDL], via Wikimedia Commons.

Use of strongly constructed **polypropylene containers** has increased recently; these containers may be stored on shelves or attached to specially design louvered panels (see *Figure 45*).

Bin shelving is designed to handle non-palletized loads and is generally used for small parts. Because items are hand-picked, bin height usually does not exceed seven feet, which may lead to cube space underutilization. Bin shelving is shown in *Figure 45*.

Modular storage drawers protect parts from the outside environment and allow for a higher concentration of stored items and increased picking accuracy. They also lead to underutilization of cube space. The drawers and their cabinets come in many sizes and combinations to accommodate one SKU or many SKUs.

Specific SKUs are stored in each compartment, so picking accuracy should increase; however, because pickers have to reach into the drawers, the structure is usually limited to a height of about five feet, which can lead to an underutilization of cube space.

Mobile racks and shelves (non-mechanized) are manual storage devices that can be easily moved. These are similar to the storage devices described above, but they are constructed so they can be easily moved.

Mezzanines provide a second level for storage, above the ground floor space. Various sizes of mezzanines provide additional space for racks, shelves, and drawers as shown in *Figure 46*.

Figure 45. Polypropylene containers on bin shelving. By John Mills [CC BY 2.0], acquired from Flickr.com.

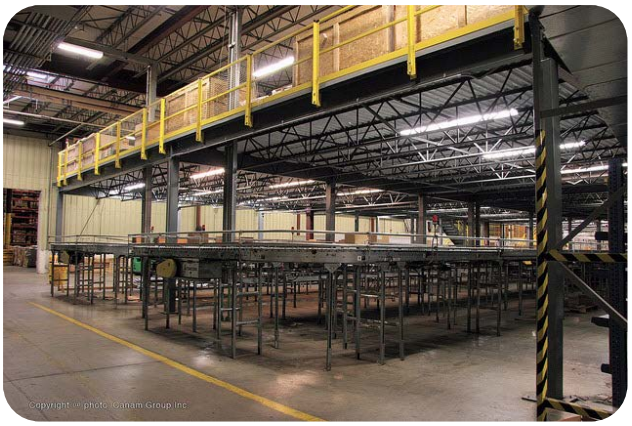


Figure 46. Mezzanine. By Groupe Canam [CC BY-ND 2.0), acquired from Flickr.com.

Unit 4: Automated Storage Devices

Automated storage systems are designed for automated storage and retrieval of parts and items in manufacturing, distribution, retail, and wholesale. It consists of a variety of computer-controlled systems for automatically placing and retrieving loads from defined storage locations.

Automated Storage and Retrieval System

Automated storage devices include a variety of **automatic storage and retrieval systems (ASRS)**, **carousels**, and **man-ride machines**, described below. ASRSs combine storage equipment with automated handling technology and interfaces with manual (e.g., forklifts) or automated (e.g., conveyors) handling systems.

Goods are delivered to a staging area by these manual or automated systems, and the ASRS removes the goods from the staging area to place them in a storage location within the ASRS. The three ASRS types, which are differentiated by the size of the items handled, are unit load, miniload, and microload.

Figure 47. Unit load ASRS. Developed by LINCS in Supply Chain Management Consortium.

Unit Load ASRS handle large palletized or unitized loads. They are typically large structures that move loads weighing up to 1,000 pounds and can operate at heights of up to 100 feet, as shown in *Figure 47*.

Microload and Miniload ASRS handle smaller packages and individual items that can be placed into containers 24 inches wide and 48 inches deep or smaller. A miniload ASRS is shown in *Figure 48*.

Figure 48. Miniload ASRS. Developed by LINCS in Supply Chain Management Consortium.

Carousels are mechanical structures that house and rotate items to facilitate stocking and order selection. Following are the two major types of carousels:

- **Horizontal carousel:** consists of a series of revolving bins or shelves driven by a motor (see *Figure 49*)
- **Vertical carousel:** carousel that rotates bins or shelves along a vertical enclosed loop

Man-ride machines are vehicles with a cab for the operator and storage compartments for small, frequently handled parts. These vehicles use a combination of manual labor and automation.

Many of the devices described in this section have similar, though usually smaller, versions in everyday life. Below are everyday examples where you would see each device:

- **Gravity flow racks:** These are shown in grocery store refrigerated cases, where a beverage containers slide forward to replace one selected from the front.
- **Bin shelving:** In retail warehouses, these are used to hold cans of paint or other items.
- **Mobile rack/shelves:** In large doctor's offices or hospitals, filing cabinet systems are on wheels and can be moved to conserve space.
- **Horizontal carousels:** These are shown in sandwich, yogurt, or drink dispensers that rotate horizontally. After the carousel has revolved to the proper location, you make your selection by sliding open the plastic door to reach the item you want.
- **Vertical carousels:** Ferris wheels are vertical carousels, and jewelry stores use vertical carousels to display selected items.

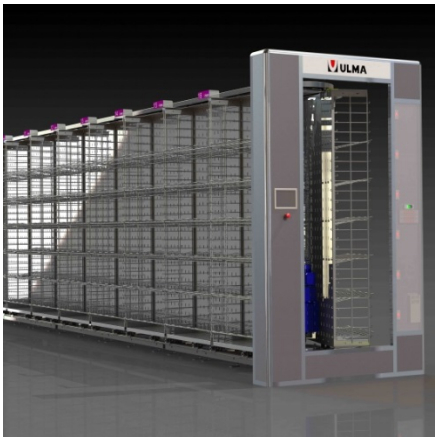


Figure 49. Horizontal carousel. By Ingenieria-logistica (Own work) [CC BY-SA 4.0], via Wikimedia Commons.

Unit 5: Other Storage-Related Activities

Stock Adjustment and Replenishment

Other activities generally performed in the storage area include:

- **Stock adjustment**
- Replenishment activities

Each of these is described below.

Stock Adjustment

Stock adjustments are required when storage-related errors are detected. Once an error has been detected, the number and/or location of products is reconciled to determine the reason for the discrepancy.

Sometimes, errors may be system related. For example, physical inventory may not match what the system says should be in stock at that particular location. Then, the stock is found and moved to its proper location or left where it is, and the inventory count is adjusted for that location.

Shrinkage is the unexpected reduction in inventory due to theft, loss, damage, or spoilage. If the discrepancy is due to shrinkage, the problem is recorded, and the stock count is adjusted.

Stock Replenishment

Another activity carried out in warehouses is replenishing stock. In this process, a warehouse employee transfers product from a storage position to a given pick position.

Replenishment is carried to ensure that SKUs are removed from the assigned storage area on schedule and in the proper quantity. These SKUs are then placed in the correct SKU stock position to help ensure a constant availability of stock at a given stock position.

Replenishment activities include listing SKU positions in warehouses that require replenishment, withdrawing the product from the storage position, and transferring or placing the SKU in the SKU pick position.

Unit 6: Key Metrics Used in Restocking and Storage Operations

The ability to accurately manage inventory, monitor stock, and fill customer orders quickly and efficiently separates successful distribution operations. Here are some of the key metrics used in restocking and storage operations.

Restocking

1. **Cost:** cost per stocked line
2. **Productivity:** stocks per labor hour
3. **Utilization:** utilization percentage of labor and equipment
4. **Quality:** perfect stocking percentage
5. **Cycle time:** time taken for each stocked item

Storage

1. Storage cost per item
2. Average warehouse capacity used
3. Peak warehouse capacity used
4. Dock-to-stock cycle time in hours
5. Lines received and stocking per labor hour
6. Number of units filled as a percentage of the total ordered (fill rate)

Learning Block 4 Summary

After goods and materials are received and accepted, the process of stocking is initiated. This learning block focused on the three key processes of stocking and restocking, as necessary. The three processes are equipment used to move and transport, differing storage location systems, and the racks and bins used to store and protect the goods.

Figure 5. Warehousing Operations. Developed by LINCS in Supply Chain Management Consortium.

Learning Block 4 Optional Supplemental Resource

The optional supplemental resource listed below may be used to reinforce the content covered within this learning block.

Honeywell (Producer). (2012, September 17). *Vocollect Voice at work - Put-away full case with override function* [Online video]. Available from https://www.youtube.com/watch?v=I_V2ysw6M2k

Learning Block 4 Practice Questions

1. **A warehouse storage location system that uses the storage space in the most optimal fashion is referred to as a:**

   a. Popularity storage stock system
   b. Dedicated system
   c. Random system
   d. Forward and reserve system

2. **Factors that tend to favor using a random storage location system DO NOT include:**

   a. A relatively large product range
   b. A relatively low number of pallets/cartons per product line
   c. Irregularly shaped unit loads
   d. A small variation between minimum and maximum stock levels

3. **Associates working in the stocking area are not involved with which of these stages?**

   a. Restocking shelves
   b. Rearranging product locations
   c. Retrieving product from a staging area
   d. Loading delivery vehicles

4. **Goods may be carried from the receiving area to a storage area using which type of materials handling equipment?**

   a. Dock levelers
   b. Operator-Controlled Vehicles
   c. High rise order pickers
   d. Gravity flow racks

5. **The stocking process is defined as the physical movement of an item between which two areas?**

   a. Receiving and storage
   b. Receiving and shipping
   c. Storage and shipping
   d. Shipping and transportation

6. **A forklift is an example of:**

   a. An operator-controlled vehicle
   b. An Automated Guidance Vehicle
   c. A specialized type of trailer
   d. A conveyor

7. A characteristic of a fixed location inventory storage system includes:

a. Small quantities of pallets per product line
b. Product ranges that are not homogeneous
c. Large variations between minimum and maximum stock levels
d. Dedicated spaces where items are continually stored

8. The fixed storage approach provides:

a. Item-specific slots or lanes
b. Optimal use of storage space
c. For only unit loads with an irregular shapes
d. Less accuracy of inventory records

9. Gravity flow racks are used for:

a. Longer term storage
b. Bins or shelves that rotate along a vertical enclosed loop
c. Second level for storage above the ground floor space
d. High-demand items, usually in cartons, of uniform size and shape

10. Popularity storage is:

a. Determined by item velocity of inventory turnover
b. Based on the product or item attributes
c. Chosen when items are similar or have complementary characteristics
d. Only utilized in large and complex warehouse systems

Learning Block 5: Picking, Packing, and Packaging

Learning Block 5 Description

The purpose of this learning block is to provide information that is involved in the picking, packing, and packaging processes within a warehouse. Personnel working in these areas must have a thorough understanding of the processes and tools for perfection, because mistakes and errors can lead to poor customer order satisfaction and potentially loss of business.

Learning Block 5 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Recognize the process and techniques of order picking
- Understand the main objectives of the picking function
- Explain the main functions carried out in packing and packaging operations
- Interpret the key metrics used to measure performance

Unit 1: Picking Operations

What Is Picking?

The process of converting individual products held in a warehouse to what is required by the customer is known as order fulfillment. The picking process is essentially a descriptive term used to pick or select an item from a storage location to fulfill the customer's requirements. There are different methods for picking, and a combination of these methods can be used within a single warehouse.

The picking process includes selecting goods to fulfill customer orders. Personnel who fulfill orders may travel through a facility to pick goods and pull the requested quantity of each product identified on a pick list. The pick list shows customers' orders and may take the form of a paper checklist, labels placed on cartons, a computer display, or a voice-activated picking system. Once picked, the items may be labeled and put on a conveyor system to be transferred to the shipping area or assembled on a pallet or cart designated for a customer.

Figure 50. Picking Operations. Developed by LINCS in Supply Chain Management Consortium.

For many organizations, order picking is the most labor-intensive and expensive warehousing activity. This function may require a great deal of travel throughout the facility and a great deal of handling items. It is important for this operation to be productive, safe, and accurate while designing the process to minimize the movement of personnel as a key objective.

In general, when an order is received, the location of the required items are determined, and a list is generated to direct the picker to the exact location. If an automated device is being used, it may bring the item to the order picker. If picking is done using a computer, the software will evaluate the most efficient route for picking the desired items.

Replenishment operations is also important to picking operations, which entails moving product from storage locations in a distribution facility to designated pick areas. In specific distribution operations, this might be a separate picking area. Specialized order picking equipment is often required to retrieve product which is defined based on the industry and types of items in the warehouse.

Objectives of Order Picking

When picking for a customer order, the objective is to present a full range of stock in the smallest area possible without unnecessary congestion. The basics of effective order picking include:

- ☑ Minimizing movement
- ☑ Reducing order processing time
- ☑ Reducing ineffective time

Reducing Movement Time

Following are the methods of picking that are used to reduce movement time.

One method frequently used to reduce personnel movement time to pick items is called popularity storage. For a given range of products in a warehouse, it's estimated that 20% of the SKUs, or unique items, result in approximately 60% to 90% of the total throughput. Many companies will dedicate a space and group the 20% of the most popular or fast moving items to reduce walking and movement times. *Figure 51* shows splitting the popular items for planning purposes. It should be noted that additional productivity can be achieved by placing the fastest moving items within this dedicated space at the most convenient height for easy personnel access.

One forward and reverse stock system often used is to have a separate forward stock, in which a product range is duplicated in a separate picking area. The advantage of a separate forward stock is a smaller picking area and less movement; however, the disadvantage is that it requires additional controls and double handling to move the stock from the reserve position to forward storage position.

Movement can be reduced in order picking by consolidating the fast movers together.

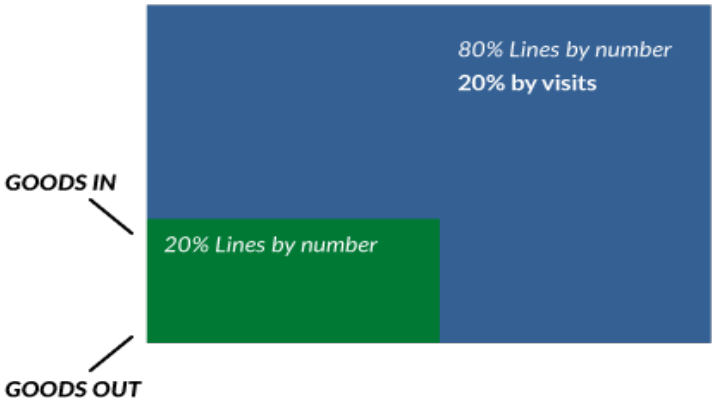


Figure 51: Popularity storage—plan view. Developed by LINCS in Supply Chain Management Consortium.

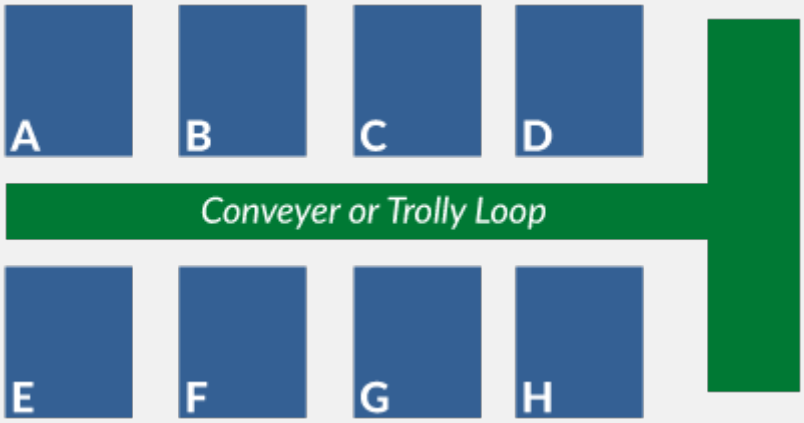
The decision to have a separate **forward picking** area is based on a tradeoff between the cost of picking from total stock and the cost of picking from a smaller area including the cost of moving items from the bulk stock to a separate picking area. A reserve stock, which is separated from a forward stock, is shown in *Figure 52*.

Figure 52: Forward and reserve stock. Developed by LINCS in Supply Chain Management Consortium.

Picking Techniques

Several techniques exist for picking orders, including:

Individual order picking	An order picker picks a complete, individual order on each circulation through the store/order picking area.
Batch picking	An order picker chooses products for several orders at the same time on one circulation of the stores area and then to sort them by customer order. The sort may take place immediately (e.g., the picker may have a cart with separate compartments, each compartment holding one order), or the sorting may take place in a separate order assembly area.

Zone picking	The **zone picking** system is typically used in warehouses that have a large inventory range and where the throughput is high. Each picker is responsible for a small section and orders flow from section to section, until the order has been completed (see *Figure 53)*.  *Figure 53. Zone picking—one picker would be responsible for each distinct zone from A to H. Developed by LINCS in Supply Chain Management Consortium.*
Goods to picker technique	In this picking technique, the principle is to keep the picker in a fixed (or limited area) location and to deliver the goods to the picker by using a mechanical device. The travel time, in this case, is for the mechanical device to bring the items, not for the picker to go get them. The advantage of this type of system is that it eliminates travel time for the picker almost entirely.
Wave picking	This is a variation on zone picking and batch picking in which zones are picked at the same time and the items are later sorted and consolidated into individual orders/shipments, rather than orders moving from one zone to the next for picking. Wave picking is the quickest method for picking multi-item orders; however, sorting and consolidating can be complex. Operations with high total number of SKUs and moderate to high picks per order may benefit from wave picking. Wave picking may be used to isolated orders by specific carriers, routes, or zones.

Unit 2: Types of Picking Systems/Equipment Used

Methods for order picking vary greatly, and the level of difficulty in choosing the best method for an operation will depend on the type of operation, industry, and customer base. Below are a few factors that will affect decisions about methods for order picking:

- Characteristics of the product being handled
- Total number of transactions

- Total number of orders
- Picks per order
- Quantity per pick
- Picks per SKU
- Total number of SKUs
- Orders requiring value-added processing (e.g., private labeling)
- Orders from piece pick, case pick, or full pallet loads

In many instances, a combination of picking methods is needed to handle diverse product and order characteristics. Three key forms of order picking are outlined below.

Piece picking	Case picking	Full pallet picking
Piece picking, also known as broken case picking or pick/pack operations, describes systems in which individual items are picked. Piece pick operations usually have a large SKU base in the thousands or tens of thousands, small quantities per pick, and short cycle times. Mail order catalog companies and repair parts distributors are good examples of piece pick operations.	Case picking operations are based on picking full cases of product and tend to have less diversity in product characteristics than do piece picking operations. Case picking operations also have fewer SKUs and higher picks per SKU.	Full pallet picking is also known as unit load picking. The systematic methods for full pallet picking are much simpler than either piece pick or case pick; however, there are many choices in storage equipment, storage configurations, and types of lift trucks used.

After the items have been picked, they are directed to their next destination for order consolidation, packing, and packaging in preparation for shipment or movement to a customer location.

Unit 3: Preparation for Shipment

When a warehouse is set up for shipment processing, items can ship based on documents released to the warehouse for action. Source documents for shipments include sales orders, service orders, purchase return orders, and outbound transfers.

Order Consolidation, Packing, and Packaging

In its simplest form, order consolidation is the grouping or combining of individual picked items for a unique customer order. This process of order consolidation brings together the total independent demands into one, individual consolidated order.

During the process of consolidation, several types of value-adding activities may be performed. Filling an order may require combining various quantities of a single item, mixing various quantities of different items, and kitting several unique items.

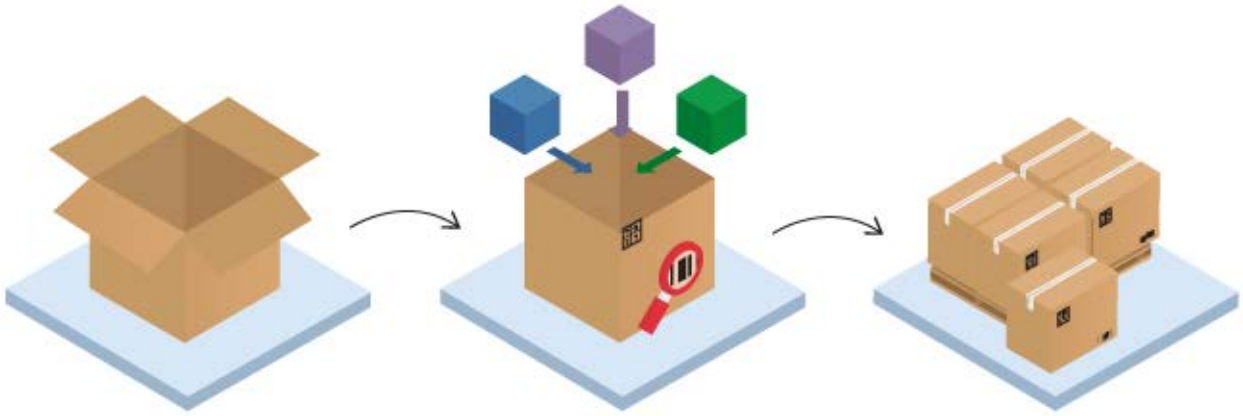


Figure 54. Preparation for shipment. Developed by LINCS in Supply Chain Management Consortium.

Kitting is a process in which a group of specific, individual items are packed together inside a package. Kitting is routinely performed to prepare the necessary items to a manufacturing cell or operation to complete final assembly. For example, a lighting fixture manufacturer would require mechanical parts, wire, and assembly hardware. These kits are made from various line items and then supplied, as a kit, directly to the manufacturing assembler on a JIT basis.

Another example of value-added activity performed could be application of customer-specific labels, price tags, or barcodes to cartons on the individual items and packaging.

The items must also be checked for completeness in accordance with the order requirements and also verified that no damage exists. If damaged items are found, they need to be replaced before the order is processed.

Item Packaging and Packing

The objective of packing and packaging is to ensure those items are properly protected during further processing and delivery and that items are received by the customer in satisfactory condition. There are numerous considerations to determine effective packing and packaging such as fragility (how easily might the item break during movement and transport), temperature control, and exposure to elements (e.g., moisture).

In many cases, the terms packing and packaging are used interchangeably. Packing is generally the first step after picking and consolidation, and it defines the methods by which items are individually wrapped and protected for subsequent processing. Typically, bubble-wrap, tissue paper, and other protective materials are used to pack individual items.

Packaging, on the other hand, is the process of placing in the individually packed items into a larger unit container, possibly supplemented with foam peanuts or other protective materials. This packaged container is designed to withstand rough handling, including accidental drops and other forms of mishandling.

For example

When the lighting fixtures previously discussed have been assembled and inspected, they are processed for shipment. Each fixture is packed individually with protective materials and glass globes may even be further packed individually. When items are packed sufficiently, they are further packaged in a shipping container, possibly with additional protective materials to avoid damage from rubbing, vibration, and rough handling.

Many items are packaged in corrugated boxes or Kraft boxes as the outer package used for shipping. These boxes come in a variety of styles and thicknesses depending upon the components and characteristics of the products being shipped. On the bottom of each box there is also a manufacturer's circular seal or stamp that denotes the performance characteristics of the shipping container (including how much strength and crush resistance it has).

The combinations of the inner and outer packaging make up the total packaging for a product. Together, these primary and secondary packaging materials have multiple objectives, including marketing, protecting, shipping, and merchandising of a product.

It is the responsibility of the warehouse personnel to pack and package items in an efficient manner so they reach the customer in a perfect condition

Unit 4: Key Metrics Used in Picking and Packaging

Metrics are a valuable measuring tool but they can be overwhelming if tracking too many of them. Each business must decide what metrics are useful and track for production purposes. Metrics need to be evaluated interdependently. The key KPIs for picking and packing include:

1. **Cost:** cost of per order line
2. **Productivity:** order lines per hour
3. **Utilization:** labor and equipment utilization percentage
4. **Quality:** perfect lines percentage
5. **Cycle time:** **order cycle time** per order
6. **Waste reduction:** minimize scrap and promote reuse

Learning Block 5 Summary

This learning block outlined processes for picking and discussed various approaches, such as zone and batch options. Specific processes used within a warehouse are dependent on the types of items processed and customer requirements.

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

The differences between packing and packaging were also outlined to show the importance of properly protecting items for further processing and transportation to ensure high levels of customer satisfaction.

Learning Block 5 Optional Supplemental Resources

The optional supplemental resources listed below may be used to reinforce the content covered within this learning block.

DCT-TV (Producer). (n.d.). *9000 Series Swing Reach Raymond Truck* [Viewer contributed video]. Available from http://www.dcvelocity.com/dcvtv/viewercontributed/2327621211001/

Channel 1: DC Velocity News and Exclusives (Producer). (n.d.). *Staples in Orlando – Shipping the right-sized package every time* [Online video]. Available from http://www.dcvelocity.com/dcvtv/news/2474878749001/

DCV-TV (Producer). (2007, June 1). *Going with the flow* [Online video]. Available from http://www.dcvelocity.com/velocityvideo/vv20070601_creativestoragesystems/

DCV-TV (Producer). (2006, October 1). *Fashionably early* [Online video]. Available from http://www.dcvelocity.com/velocityvideo/vv20061001_alsystems/

Learning Block 5 Practice Questions

1. A key objective in order picking is to:

a. Reduce honeycombing
b. Carry at least one of each of the items stocked in the warehouse in a separate picking area
c. Minimize movement of personnel
d. Use the least number of people in the warehouse

2. The purpose of kitting is to:

a. Group individual items into one common package
b. Save storage space
c. Fulfill metrics requirements
d. Store items more easily

3. Identify the picking method frequently used to reduce moment time:

a. Shift
b. Common
c. Popularity
d. Backlog

4. Which of these is the principle in batch picking?

a. Pick one complete order on each circulation
b. Pick for several orders on each circulation and then sort them by customer order
c. Consolidate required items by batching at receiving
d. Consolidate items to reduce transportation costs

5. After picking and consolidating items for shipment, the next step is to:

a. Package the items
b. Pack the items
c. Notify the customer about the pending shipment
d. Notify the shipper to arrange pick-up

6. Which statement is correct?

a. It is best to package products as soon as they are picked
b. Picking operations are best done on the shipping dock
c. The order-picking process focuses on the selection of goods to fulfill customer orders
d. Damage verification is not important when picking items

7. Replenishment operations are best defined as:

a. Necessary for medical device manufacturers
b. The second stage of receiving
c. The activities associated with moving product from storage locations to the designated pick area
d. An inventory control technique

8. Consolidating the locations of fast moving items:

a. Reduces inventory
b. Can reduce required movements
c. Is required with pallet racks
d. Supports the use of forklifts

9. Metrics are important in order to:

a. Determine the efficiency and effectiveness of the operations
b. Determine if customers should be charged higher rates
c. Describe methods for picking
d. Measure carbon emissions inside the warehouse

10. In zone picking,

a. Customer orders are prioritized into zones
b. A team of employees, called the zone, pick customer orders
c. The most difficult orders are picked first
d. Each picker is responsible for a small section and orders flow from section to section until the order has been completed

Learning Block 6: Goods Shipment

Learning Block 6 Description

The key objectives of the shipping process include the consolidation and staging of customer orders, preparation of required documentation, ensuring that final packaging is sufficient, and loading orders onto outbound vehicles.

Additionally, various value-added activities may be performed in this area. Shipping function activities include:

- Sorting batches and consolidating orders
- Weighing and manifesting orders
- Selecting modes of shipment transportation
- Consolidating outbound vehicles
- Loading delivery vehicles

Learning Block 6 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Recognize activities to process customer orders for outbound shipments
- Explain how transportation modes are selected
- Understand variations in the order weighing process
- Summarize types of equipment and techniques used in loading outbound vehicles
- Identify the key metrics used in the shipping function

Unit 1: Batch Sorting and Order Consolidation

Sorting includes separating one or more of customers' ordered items from other customer-picked items in a batch picking environment. The activity may include a step that verifies that the SKU was withdrawn from the pick position and was transported to the packaging or shipping area.

Sorting requires that an operator or machine reads the label/markings on the SKU's outer surface, which identifies the contents and transfers the customer's SKU from the batched SKUs into a specific customer order for temporary holding, or sorting, at a location. No storage other than temporary accumulation is required because this is simply a sorting function.

Unit 2: Weight and Manifest Activities

The objective of this activity is to ensure that each outbound shipment is sent by the most cost-effective transportation method and has proper documentation to support the specifics of the order (e.g., export documentation, proper freight carrier documentation requirements, and product descriptions). In warehouses, information technology systems maintain detailed weight information for each product that is stored and shipped from the warehouse (see *Figure 55*).

In this environment, warehouse associates may not need to weigh products manually. Shipment documentation may be generated automatically based on the computer-calculated total weights of the product and based on what has been confirmed as being picked by warehouse personnel.

However, for many companies that use computer-calculated shipment weights, an additional weighing step is included in the work flow. The purpose of weighing the outbound order components in this activity is to serve as a validation and to help prevent errors. When the shipping personnel weigh the components of an order or shipment and inputs it into the computer, the system will compare what the expected weight is versus what has been entered. If there is a variance, personnel are directed to resolve the discrepancy before printing shipping documents. This is a final quality check that assures high-quality customer service.

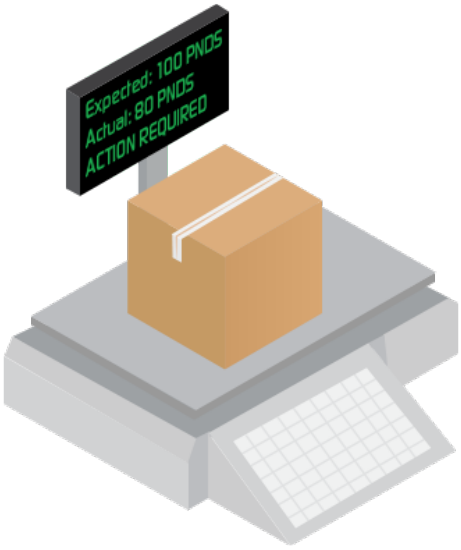


Figure 55. Shipment weight comparison. Developed by LINCS in Supply Chain Management Consortium.

In companies that do not maintain accurate product weights and use a system to accumulate the weights to determine a predicted order or shipment weight, personnel must determine the weights by running cases across a scale and inputting the weight. For industries in which large products or full pallet loads are shipped, the weighing process may entail using large scales on the floor with forklifts that place the products on the scale.

Unit 3: Shipment Transportation Mode Selection

Defining package order shipment weights is important and generally the first step because the package weight is often used to determine which mode of transportation will be used to ship the product (e.g., parcel, LTL, or truckload). Additionally, the package shipment weight is often used as a key component to determine which specific transportation carrier will be used and an important variable in determining freight costs.

Additionally, different characteristics may be used to determine the mode of transportation and freight costs. For example, the size of the order (length, width, and height dimensions) dictates the mode selection and freight cost more than the weight alone.

Other key determinants are used to decide the best transportation mode for a specific order. The expected customer required date of the order is also an important factor. For example, if a customer expects an order to reach their location in two days, but standard ground service takes five days, then using express parcel service may be required to achieve the deadline.

Furthermore, product characteristics (e.g., hazardous materials) may dictate using a specific mode or carrier. Exporting materials to another country will also lead to the use of specific modes, carriers, and documentation. In the case of export shipments, shipping personnel must be cautious to follow company-specific regulations regarding preparation of shipment paperwork, because paperwork for exports is more complex than for domestic shipments. Once the order weight and mode/carrier selection activities have been completed, documentation is prepared for the specific order and shipments at the shipping staging area.

A shipment and an order may require only one vehicle (e.g., when a single order to a single customer fills up an entire trailer); however, an outbound shipment from the warehouse dock may consist of multiple specific customer orders/shipments (e.g., when dozens of individual, consumer-specific case orders/shipments are loaded into a UPS trailer for delivery through their network).

Finally, temperature controls (i.e., perishable goods) and product security (company proprietary items) also need to be considered when selecting modes and carriers.

Figure 56. Mode selection characteristics. Developed by LINCS in Supply Chain Management Consortium.

Unit 4: Outbound Vehicle Consolidation

Consolidating outbound vehicles is the process of collecting goods that are awaiting dispatch and allows for the preparation of individual vehicle loads. These loads are collected in storage lanes, or bays, that are immediately adjacent to the loading dock where delivery vehicles for those loads are waiting to be loaded or where vehicles will arrive.

Consolidating has the effect of buffering the flow rates of goods arriving from the order picking/packing stage against the uneven flows required to satisfy vehicle movement on dispatch. In addition to the goods received from the pick/pack operations, goods received for cross-docking will also be staged/consolidated in this area for shipment.

In general, the dispatch area is a single-level storage operation. Where there are space limitations or excessive space costs, available height is often utilized with the aid of pallet racks, drive-in racks, gravity live storage for pallets or cartons, and raised storage platforms

Unit 5: Loading to the Delivery Vehicle

The package loading and shipping function ensures that customers' orders are placed on the correct delivery vehicle. The process of loading the vehicle is accomplished using the manual and mechanized, or automated, methods used in the receiving function (as described in Learning Block 3). Methods of loading vehicles are outlined below.

Level Bays

Vehicles may be loaded in an open yard. Forklift trucks can remove pallets from the side of the truck and run them directly into the warehouse. Weather protection is generally required, so a canopy is provided.

Figure 57. Dock leveler. Developed by LINCS in Supply Chain Management Consortium.

Raised Docks

Raised shipping docks are typically used in warehouses, which are set at the height of the vehicle. The truck backs onto the dock, and pallet trucks or low profile forklifts enter the vehicle for loading. Vehicles tend to differ in height, so a **dock leveler** will be required to take up the differences in height between the dock and the vehicle; additionally, a dock shelter or seal will probably be used to shield the warehouse from wind and rain. A dock leveler is shown in *Figure 57*.

In situations where there is no raised dock, mobile ramps can be used. Mobile ramps are made from steel construction and are typically about 36 feet long by about 6 feet wide. Pallet trucks and forklift trucks use them for gaining access to end load containers or trailers. The ramps can be moved by forklifts or wheeled into position by hand. A mobile ramp in use is shown in *Figure 58*.

Figure 58. Mobile ramp in use. Developed by LINCS in Supply Chain Management Consortium.

Loading/Unloading Conveyors

Extending conveyors are used when containers need to be manually loaded or unloaded. There are many designs, and the general style depends on whether the container is being loaded to a raised dock or to a level dock. In the former case, gravity roller conveyors are often used. When loading or unloading containers from a level bay, telescopic boom conveyors are required. These conveyors can accommodate the difference in height. Two people are required to use conveyors: one person is on the vehicle and the other is at the foot of the conveyor. A telescopic conveyor is shown in the diagram in *Figure 59*.

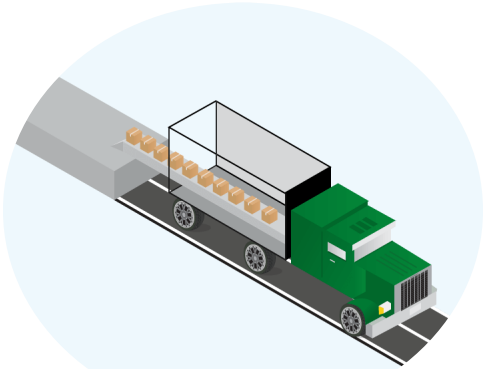


Figure 59. Diagram of a telescopic conveyor. Developed by LINCS in Supply Chain Management Consortium.

Rapid Loading Systems

Rapid loading systems are aimed at dramatically reducing the time needed to load or unload a vehicle, minimizing vehicle turnaround time. Most of these systems are based on fitting the vehicles with a roller conveyor. A typical system might consist of a bed of roller conveyors on the vehicle and a similar bed on the loading dock.

A vehicle load is pre-assembled on the bed of conveyors on the loading dock; then, a vehicle arrives and backs into position, and the complete load transfers on the conveyor from dock to vehicle. The actual load transfer time can take as little as 90 seconds; however, time is added to this 90 seconds for opening the vehicle, removing any empty pallets, backing on, closing doors, and sealing the vehicle.

The roller conveyor can be raised and lowered so that the rollers are raised when loading/unloading and can be lowered so that the pallets are resting on the vehicle floor when in transit. The loads do not need to be pallets, but they must have a firm, flat base suitable for roller conveyors. Loads can also be pushed into position by hand.

The advantages of the system are that the labor of loading and unloading vehicles is reduced, especially if the dock equipment is fed automatically by conveyors or AGVs, and vehicle turnaround is dramatically reduced, which saves money.

Unit 6: Key Metrics Used in Shipping

Shipping is the last step in warehouse activity in handling shipping goods for the customer, or handling stock transfers. The KPIs for shipping would include:

1. **Cost:** cost of shipping per order
2. **Productivity:** order process for shipping per labor hour
3. **Utilization:** percentage utilization of shipping docks
4. **Quality:** percentage perfect shipping
5. **Labor**: cases/pallets loaded per labor hour
6. **Efficiency:** truck turnaround time
7. **Cycle time:** shipping time per order (from picking the order to physically moving the truck)

Learning Block 6 Summary

In this learning block, a number of order characteristics used to determine which transportation mode and carriers should be used subsequent to item picking, packing, and packaging were outlined.

In doing so, order weight is an important element in determining shipment mode, and the process for determining weight may vary from company to

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

company. Depending on the type of products, weight, cube, and other factors play a wide array of equipment to load outbound vehicles. Shipping paperwork is critical and has to precisely match the customer order requirements and significant differences exist for domestic versus international shipments. Customer required dates may also often dictate the mode of transportation, which takes precedence over making decisions solely based on freight costs.

Finally, the metrics used in the shipping function include, among others, cost, productivity, and utilization. These metrics are useful management tools to assess the efficiency and effectiveness of the operations, including process improvement initiatives.

Learning Block 6 Optional Supplemental Resources

The optional supplemental resources listed below may be used to reinforce the content covered within this learning block.

DCV-TV (Producer). (n.d.). *End of Line Shipping and Manifest Systems. Scan, Weigh, Dimension, Verify* [Viewer contributed video]. Available from http://www.dcvelocity.com/dcvtv/viewercontributed/3630425437001/

Gems on Display (Producer). (2012, November 14). *Our warehouse: The packaging and shipping process* [Online video]. Available from http://www.youtube.com/watch?v=skU8IvDqz94

Learning Block 6 Practice Questions

1. When items have been batch picked, the sorting activity:

a. Combines products that have been picked to fill a unique customer order
b. Ensures that the stock keeping unit is protected from damage during delivery to the customer
c. Separates one customer's ordered items from other customer-picked stock keeping units of the batch
d. Groups specific, individual items together in the container for the consumer

2. Outbound vehicle consolidation is the process of:

a. Weighing loads to determine shipping charges
b. Collecting goods that are awaiting shipment for individual vehicle loads
c. Applying customer-specific labels, price tags, and barcodes to packages
d. Ensuring that the customer's order is placed on the correct delivery vehicle

3. Rapid loading systems are used:

a. Where there are space limitations or excessive space costs
b. Where there are no operators available to load vehicles
c. To dramatically reduce the time needed to load or unload a vehicle
d. Only in large warehouses

4. Product characteristics (e.g., hazardous materials) may dictate the use of:

a. A specific mode or carrier
b. Combined docks
c. Conveyors
d. Advanced shipping notice

5. While several factors are used to determine freight costs, the first consideration is generally:

a. Weight
b. Cube
c. Distance
d. Transportation mode

6. The package loading and shipping function:

a. Includes item kitting
b. Includes item receipt from suppliers
c. Is always facilitated by the use of conveyors
d. Ensures that outbound orders are placed on the correct delivery vehicle

7. Barcodes may be used during shipping process to:

a. Seal boxes
b. Assign truck parking
c. Generate shipping documentation
d. Check item quality

8. Mobile ramps may be necessary for loading/unloading when:

a. There are no raised docks
b. There is inclement weather
c. There is a shortage of personnel
d. The items are fragile

9. Dock levelers are generally used in conjunction with:

a. Raised docks to accommodate differences in vehicle heights
b. Conveyers
c. Mobile ramps
d. Older warehouse designs

10. What is the purpose of the order weight and manifest activity?

a. Ensure cost effective transportation choice and proper documentation exists
b. Check that items have been properly packed and packaged
c. Verify that there is no damage to the items being shipped
d. Provide training for new warehouse personnel

Learning Block 7: Inventory in the Warehouse

Learning Block 7 Description

The effective control of inventory is a critical aspect in the success of every organization. Organizations are continually attempting to provide improved customer service levels at reduced costs, so the amount, types, and control within the supply chain has a direct impact on both service levels and costs.

Inventory control and process optimization in the warehouse is critical to the overall success in a supply chain and therefore an overview is presented in this learning block. A more comprehensive description of inventory management is offered in the separate inventory management certification track.

Learning Block 7 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Remember the role and importance of inventory to support a supply chain
- Recognize the main reasons for carrying inventory
- Explain how inventory items can be classified
- Understand how counting inventory is performed
- Identify the key metrics used for managing inventory

Unit 1: Rationale for Inventory

The greatest challenge in managing inventories is balancing customer demand with item availability. Organizations try to minimize or eliminate inventory wherever it is possible, but understanding why businesses stock inventory is important in helping organizations become more productive and efficient is essential within the supply chain process.

In essence, stock of raw materials, components, semi-finished product, maintenance items, and repair items can be found at supplier locations, warehouses, and in a manufacturing facility. Similarly, inventories of finished or intermediate (semi-finished/processed) products may be found at locations such as manufacturing facilities, warehouses, retail, or other point-of-sale/use locations.

One way of identifying why firms hold inventory is to view inventory in terms of the functions they serve:

Cycle stock	This portion of a company's inventory is depleted through normal use or sale. Firms hold cycle stock to respond to demand or normal usage.
In-process stock	This inventory type includes goods in-process and goods in-transit. Goods in-process are goods being manufactured or goods between manufacturing processes (also known as work in-process or semi-finished goods). Additionally, inventory in-transit refers to inventory that a carrier is transporting to a customer.
Safety stock	Firms hold safety stock (or buffer stock) to protect against uncertainties in demand rate, lead times, or both. Holding safety stock helps a firm to avoid the negative, sometimes customer-related, consequences of being out of stock.
Seasonal stocks	This type of stock is accumulated by firms and held in advance of the season that the firm will need it. Industries that typically require significant seasonal stock include apparel and holiday items.
Promotional stock	This type of stock is held so that firms' logistics/distribution systems may respond quickly and effectively to a marketing promotion or price deal that a firm intends to offer to its customers.
Speculative stock (hedge stock)	Speculative stock is most commonly associated with companies involved in manufacturing or assembly. This type of inventory is held to protect against expected/possible price increases or constrained availability. For example, U.S.-based firms stockpile component parts and subassemblies purchased from firms in areas such as Korea, Japan, and Singapore. This protects the U.S. firms against the uncertainties mentioned earlier and others (e.g., increased import tariffs and import quotas).

Unit 2: Inventory Costs

Inventory costs are important for three main reasons. First, inventory costs represent a significant component of total costs of goods sold in many organizations (the cost of inventory comprises up to 80% of the total costs of goods sold). Most organizations are graded by investors on their stock value, which is based largely on cash flow and profitability. Excessive and obsolete inventory build-up has a negative impact on cash flow and profitability of a company, which makes it a distractor to stock value and potential investors.

Second, the inventory levels may affect the level of service the firm is capable of providing to its customers. Too much of the wrong inventory might limit a company's ability to stock the right items.

Third, the cost tradeoff decisions frequently depend on and ultimately affect inventory **carrying costs**. Carrying costs can be further defined as:

- Capital Cost: Generally the largest cost and also referred to as interest or opportunity cost. It is simply a comparison of what was spent to acquire inventory versus what other organizational projects that money could have been used for.
- Storage Space Cost: Handling costs associated with moving goods into and out of storage, rent, heat, and lighting.
- Inventory Service Cost: Predominately taxes and insurance
- Obsolescence Cost: Typically based on inventory value loss or losing value altogether, and therefore having to be scrapped

Figure 60. Investment costs. Developed by LINCS in Supply Chain Management Consortium.

Unit 3: Inventory Control Systems

Good data management is, to a large extent, a reflection of the capabilities and disciplines in the designated inventory system. A more comprehensive description of inventory management systems are presented in the Inventory Management Certification Track. However, the key points, as they pertain to warehouse operations, are outlined below:

Manual vs. Computerized Inventory Control Systems

Computer systems, referred to as WMS, can often have a positive impact on phases of inventory processing and control, including identifying stocking locations, item availability, item retrieval, updating changes due to usage, and providing signals for replenishment.

Although lower costs, wider availability, improved features, and increased user-friendliness have made warehouse systems and inventory control software more accessible, a few companies still rely on manual systems.

At the core of a manual system for inventory control is the stock card, which is an item record for filing, control, and visibility. These include index cards, rotary card files, hand-operated sorting systems, and microfilm.

Numbering Schemes

Most organizations assign item numbers as identifiers, which are generally incorporated into a barcode. The utilization of barcodes will also employ the use of automated scanning equipment to read the barcodes, which are normally linked to a WMS (see *Figure 61*).

Inventory and Stock Location Control

An inventory locator system facilitates the task of finding a product location for stock a particular item, stocking, and retrieval. Every warehouse should have a visual letter/numbering system in place for identifying stock locations for products stored in the warehouse (storage/picking address).

The row of a rack is typically assigned a letter and/or number (e.g., A1, A2). Even numbers might be assigned to the right side of the aisle and odd numbers to the left side of the aisle. Companies can choose to assign a number to the aisle itself. Sections of racks, levels, and individual storage bays may also be assigned numbers.

A pick address might look like this sequence: A2.1.1.1.1.

Figure 61. Scanner used to read barcodes. By Liz Roll (This image is from the FEMA Photo Library.) [Public domain], via Wikimedia Commons.

Unit 4: Counting Inventory

At periodic and defined intervals, the inventory is counted to reconcile the inventory records as a way to assure that the system shows an accurate depiction of what is actually in stock. This is usually done either by counting the entire inventory at the same time (called a physical inventory) or by counting the total number of items at varying times on a prescheduled basis (called cycle counting).

The general trend is that companies are moving from performing physical inventories counts to **cycle counts**. Cycle counting is generally believed to be less expensive and more conducive to promoting accuracy. In recent years, external auditors have allowed cycle counting to replace an annual physical inventory count as the basis for verifying existence and accuracy.

Periodic Physical Inventories

The planning, preparing for, and conducting of a physical inventory count can take a great deal of time and be extremely expensive to accomplish. In addition, a major opportunity cost is associated with counting because it usually requires production and warehousing operations to be shut down. This also means that sales may be interrupted, and customer service might be affected.

One advantage that physical inventory counts have over cycle counts is that freezing operations might improve the chances of getting a clean cutoff in regard to reconciliation of the physical stock versus what is shown in the WMS.

Figure 62. Physical inventory. Developed by LINCS in Supply Chain Management Consortium.

Cycle Counting

Cycle counting is a very useful tool for the inventory manager in maintaining and improving inventory accuracy. Cycle counting entails systematically counting each item carried in stock at least once per year at a planned interval or frequency, which is often based on velocity or ABC analysis classification (i.e., A items are counted more frequently than are B items, which are counted more frequently than are C items). Cycle counting is also used to correct known errors or to handle special situations.

Unit 5: Tools for Inventory Control

Inventory control personnel have several methods and tools to enable accurate transactions for greater control.

Velocity Classification

Managing large numbers of SKUs can be difficult and very time-consuming. Controls, updates, checks, counts, forecasts, and ordering decisions have to be accomplished for each SKU.

Warehouse personnel can take advantage of a principle called Pareto's law to aid in this task since most of the warehouse activity is generally concentrated with a relatively small number of items. This is also known as the 80-20 rule, which states that 80% of the sales, value, or velocity of a group of items will be accounted for by 20% of the items. Therefore, if a warehouse has 1,000 SKUs that represent $1 million in inventory value, 200 of these SKUs could represent $800,000.

Warehouse personnel can take advantage of this principle by identifying those items at the upper end of the activity spectrum and then apply special effort to maintain accuracy.

Automatic Identification/Barcoding

Transaction accuracy is one of the principal objectives for organizations that have adopted barcode capabilities in order entry, production, warehousing, and transportation. Using barcodes for order fulfillment in warehousing, for example, will help to greatly eliminate common errors, such as picking the wrong item. Barcode systems also allow double-checking for accuracy (e.g., systems that will work to correct errors quickly) before the transaction is completed or the order is shipped. In warehouse systems, products are scanned when they are received, stocked, moved to replenish picking locations, picked, and shipped.

Warehouse Management Systems

It is difficult to manage a warehouse effectively without an information system. Many warehouses use a WMS to manage a warehouse effectively, including management of inventory. The combined computer and associated software links elements in the supply chain with the ability to track inventory, locate product, measure productivity, and evaluate other performance elements.

Using WMSs has become key to the efficient management of warehouses today. Basic warehousing functions, such as receiving, labeling, stocking, locating stock, picking, and shipping, require software that is programmed specifically for these tasks.

Major types of available software applications and what they can do for distribution management are described below.

Item and Package Labeling

Labeling applications are sometimes part of a WMS system. This software enables printers to produce the various types of barcode labels that must be applied to SKUs and packages.

Packaging and Shipping

When a warehouse ships products using several carriers (e.g., FedEx, Roadway, UPS, etc.), shipment or package rating software is usually required to calculate shipping costs and maintain shipping records. Many parcel carriers provide software for free for costing out their own shipments, but warehouse/distribution personnel often need a specific package to make carrier cost comparisons based on weight, cube, and other factors.

Transportation

Warehouses must often schedule the arrival and departure of trucks to and from the facility, so warehousing managers sometimes require transportation management software. Transportation software can route shipments, select carriers based on certain criteria, provide reports, and even perform weight and cube analysis to find the best method of loading a trailer (transportation software features, such as cube utilization and local route delivery, are sold as separate packages of their own). Transportation software often coordinates inbound shipments and manages delivery requirements.

Yard Management

A yard management application helps warehouse personnel to manage the flow of vehicle traffic to prevent congestion and delays at the receiving and shipping docks. It also helps personnel to schedule trailers for specific dock doors and to understand the content in trailers waiting to be unloaded. Yard management has also become a standard feature of WMS, as it allows personnel to match truck arrival and departure schedules with workflow.

Inventory Deployment Systems (Slotting)

A relatively new application in WMS is called slotting, or **inventory deployment** systems. These applications analyze inventory requirements and consider layout modifications to store items. They work by taking information about warehousing activities according to SKU or product codes from the WMS and then develop recommendations for redeploying inventory in the warehouse to reduce picking time and to improve overall efficiency.

Unit 6: Key Metrics Used in Warehouse Inventory Control

This unit discusses measuring performance in inventory control (i.e., calculating accuracy levels) and measuring overall performance in inventory management. Overall performance is measured in terms of both inventory service levels to customers and controlling inventory investment.

Inventory Control Performance

The primary measure of inventory control performance is to maintain accurate inventory records. This is usually stated as an accuracy level in terms of the percent accuracy found in an audit or sampling program. It might also be expressed as an error rate, which would simply be 100% minus the accuracy level; therefore, a company with a 95% accuracy level would have a 5% error rate.

As noted before, organizations engaged in an ongoing cycle count program automatically have a way to measure accuracy levels. The accuracy level is the percent of the total correct counts for a given period. If a company makes 10,000 counts in a year and 9,750 are correct, its accuracy level is 97.5%.

For companies taking a periodic physical inventory only, the accuracy level becomes the number of SKUs counted that exactly match the computer count. If a physical inventory is taken annually, this matchup will often be low; even the best organizations only achieve a 50% accuracy level. Recognizing that small deviations over a long period of time are not significant, companies will calculate the accuracy level based on the physical count being within a tolerated deviation, which is often

determined in days of supply. Such a tolerated accuracy level might then be the percentage of items counted that was within the computer count, plus or minus a five-day supply.

Organizations engaged in an ongoing cycle count program automatically have a way to measure accuracy levels. The accuracy level is the percent of the total counts in a given period that were correct. Not performing cycle counts might augment accuracy measurement by implementing a sampling procedure for counting. Organizations occasionally use accuracy levels (e.g., recording deviations found) in the form of in-stock omits or negative on-hand inventories.

Inventory Service Levels

Companies have adopted many ways to measure inventory system performance in regard to satisfying customers. Measures differ depending on the type of organization and industry. Manufacturers' measures differ from service or merchandising organizations, such as wholesalers or retailers.

Different measures are also applicable to different types of inventory. Service levels for finished goods inventories are regarded differently from service levels for raw materials or work-in-process. Finally, service level measures incorporate time factors (e.g., percent of orders shipped on schedule), inventory availability conditions (e.g., a fill rate, such as percent of lines shipped versus total lines ordered), or a combination of both (e.g., percent of lines shipped on schedule).

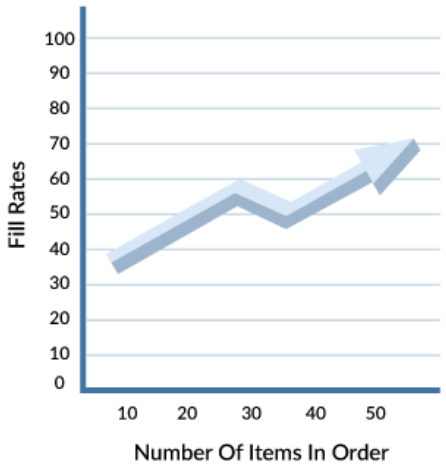


Figure 63. Number of items vs fill rates. Developed by LINCS in Supply Chain Management Consortium.

To further demonstrate the many types of measures available, various measures a firm might use are outlined below:

- Order days out of stock
- Line item days out of stock
- Total item days out of stock
- Dollar volume days out of stock
- Inventory accuracy levels by ABC analysis categories
- Fill rates
- Stock value by category against target values
- Weeks/days of supply
- Inventory turnover
- Cycle time
- Lost sales

It is important to consider the customer's needs in selecting service criteria to measure. Firms have sometimes selected standards only to learn later that they have no relevancy for their customers. For example, many companies measure inventory service levels on the basis of dollars shipped to dollars ordered because this metric is important internally, in terms of profit performance. However, many of these companies' customers view their performance on the basis of a line or case fill rate.

Learning Block 7 Summary

Accurate inventory management is an essential element of warehouse operations in order to provide excellent customer service and to control costs. Inventory is held in a warehouse for a number of different reasons that is be specific to a given industry or type of organization. The use of barcoding, barcode readers, and the linkage to a WMS are typical tools used to manage inventory and control accuracy in warehouses. Metrics are employed to depict inventory accuracy and other important warehouse operations and functions to achieve efficient and effective process improvement initiatives that stimulate continuous improvement.

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

Learning Block 7 Practice Questions

1. Stock-outs can be a concern because they:

a. Call attention to the fact that a company's stock price is out of line
b. Require railcars to bring in additional stock
c. Result in lost sales and poor customer service
d. Require more space than normal stock does

2. Inventory management is an essential element of warehouse operations to:

a. Operate a sophisticated warehouse management system
b. Effectively control items that usually represent large dollar volumes
c. Provide a point of receipt for in-bound shipments
d. Justify capital equipment

3. Safety stock is acquired to;

a. Protect warehouse employees from workplace hazards
b. Protect against uncertainties in demand rate, lead time length, or both
c. Provide warehouse protection in inclement weather
d. Load a truck during the busiest shifts

4. Seasonal stock is:

a. Used to fill vacant space
b. Where temporary employees are used to move to load vehicles
c. Accumulated by firms and held in advance of peak demands
d. Required when storing spices

5. Promotional stock is best described as:

a. Stock that is provided free of charge by suppliers
b. Stock used primarily in promoting upcoming social events
c. Stock allocated for kits
d. Stock held so that a firm's demand system may respond quickly and effectively to a marketing promotion

6. Speculative stock is most commonly held by organizations to:

a. Safeguard against constrained availability or price increases
b. Account for transportation times
c. Build inventory in advance of seasonal demands
d. Allocate funds before they are assigned to another project

7. Obsolescence cost is:

a. Determined at receiving if incoming product is damaged
b. Inventory value may decline, lose value and have to be scrapped
c. Caused by careless handling
d. Generated when there is a stock-out condition

8. Barcodes may be used in inventory control to:

a. Seal final packaging prior to shipment
b. Communicate system outages to suppliers
c. Support the control and processing of inventory
d. Justify the cost of purchasing barcode readers

9. The largest inventory cost is found in which aspect?

a. Capital cost
b. Storage space cost
c. Inventory service cost
d. Obsolescence cost

10. The purpose of counting inventory is to:

a. Give personnel a break from their normal jobs
b. Verify inventory records with actual quantities
c. Collect data in advance of formal audits
d. Satisfy management metric requirements

Learning Block 8: Beyond the Basic Warehouse

Learning Block 8 Description

In this learning block, characteristics of warehouses and distribution centers will be explored. The warehouse is a place in which inventory is held for varying periods of time. The distribution/fulfillment centers are designed for the rapid flow of goods to customers. This learning block will also explore the impact of ecommerce on the supply chain and distribution and fulfillment networks.

Learning Block 8 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Understand the differences between a static warehouse and a distribution/fulfillment center
- Explain a few examples between distribution and fulfillment networks
- Analyze the impact of ecommerce on the supply chain

Unit 1: Warehouse vs. Distribution Center

Many professionals use the terms warehouse and distribution/fulfillment center interchangeably. Looking at a building from the outside, it not physically obvious to distinguish one from the other. They each have walls, a roof, floor, truck doors, and docks. It is what happens on the inside that makes the building function as more than a static storage warehouse.

In the previous learning blocks in this certification track, the basic functions that *can* occur inside the four walls were detailed. This flow of goods begins with the receiving function and progress through the subsequent processes of stocking, picking, packing, packaging, and, eventually, goods shipment. Additional value-added functions were reviewed such as cross-docking and labeling along with support elements like WMS that integrate computer hardware with specialty software.

Think of the difference in this way. The distribution or fulfillment center integrates the basic functions, with many of the value-added functions including a sophisticated WMS, with other key functions of the supply chain. This integration provides a much greater capability and supply chain value than a static storage warehouse.

It sometimes gets confusing to people outside of the industry because the terms are used interchangeably. To complicate matters, organizations label their centers differently. For example, Walmart has a network of distribution centers, and Amazon has a network of fulfillment centers and

while there are a few glaring differences between the two, there are also many similarities. Those similarities and differences will be explored in a subsequent unit in this learning block.

Characteristics of a warehouse

- Basic space for storage (speculative and seasonal stock)
- Space to protect goods from the environment (extreme heat, cold, storms)
- Space for long-term storage (wine, liquor, cheese aging)

Figure 64. Warehouse. Developed by LINCS in Supply Chain Management Consortium.

Characteristics of a distribution/fulfillment center

- Fulfill wholesale and retail orders
- Fulfill direct consumer orders
- Provide a wide array of value-added services
  - For example, JIT kits to manufacturing cells and cross dock operations to rapidly mix inbound receipts to outbound shipments
- Runs on a sophisticated WMS
- Linked real-time to the broader supply chain elements (e.g., procurement, transportation, etc.)
- Operate with velocity and agility

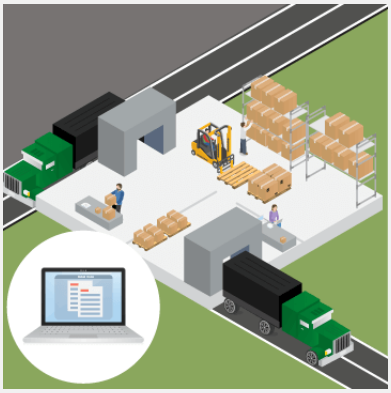


Figure 65. Distribution center. Developed by LINCS in Supply Chain Management Consortium.

In summary, a basic warehouse functions to stockpile and safeguard inventory while the distribution/fulfillment center functions to facilitate the rapid flow of goods, materials, and products from manufacturers and suppliers to customers.

Unit 2: Distribution Center Profiles

Walmart Company Overview

Walmart has grown substantially over the past 40 years and they now operate over 11,500 retail outlets in 28 countries and they employ 2.2 million people around the world and 1.4 million in the U.S. alone. Their goal is to have consumers shop anytime and anywhere on-line, through mobile devices, and in retail stores (Walmart Stores, Inc., 2016). Think of that in terms of the demands placed on their distribution network.

Walmart privately owns and operates 158 regional distribution centers supported by a fleet of 6,500 tractors, 55,000 trailers, and more than 7,000 drivers. Each distribution center is in excess of 1 million square feet in size and uses more than 5 miles of conveyor belts to keep products moving through the facility.

Every distribution center supports 90 to 100 retail stores in a 200-mile radius.

There are eight import distribution centers that are strategically located near major ports on the east coast, west coast, Houston, and Chicago. These import centers receive products from around the globe and in turn, distribute the products to the regional distribution centers

Additionally, there are nine disaster distribution centers, strategically located across the country, and they are stocked to provide rapid response to struggling communities in the event of a natural disaster.

Distribution Success

In a study published by the University of San Francisco, it was noted that Walmart's success in distribution is based on several factors (University Alliance, 2016).

The publication notes that Walmart's evolution and success of today's sophisticated distribution center network has been based on continuous improvement of distribution practices, operation of its own fleet of trucks, and technology. Walmart began using basic computers in 1975 for inventory control and their systems now collect point-of-sale data from retail stores that is continually fed to suppliers and the distribution center WMS for replenishment.

Beyond technology, Walmart routinely uses numerous value-added processes to enable rapid deployment of incoming goods to outbound freight.

As an example, cross-docking is routinely used at their distribution centers. This enables the rapid movement of arriving products from suppliers to placement on outbound trailers designated for retail stores.

Also, since products arriving at a distribution center might not be conveyable, or in a package ready for a retail store, they perform a full case split. This process enables the shipment to fulfill retail store demands and the remaining split is stocked and subsequently picked whenever there is a new demand.

Distribution Linked to the Broader Supply Chain

In the same study published by the University of San Francisco, it was also noted that Walmart's success in distribution is at least partially due to their supply chain integration (University Alliance, 2016).

Walmart's supply chain begins with a purchasing organization who determines which products will sell and find suppliers to negotiate the best value for the company.

The operations portion of the supply chain emphasizes demand planning, forecasting, and inventory management. Forecasts estimate consumer demand and demand planning, which are used to create accurate forecasts critical to inventory management, distribution center work flow, and customer satisfaction.

Walmart is a great example of linking the power of supply chain elements to run a highly effective and efficient distribution network. Their distribution centers employ the functions presented in this certification track and beyond.

Amazon Company Overview

Amazon, began as an online bookstore and, like Walmart, has grown substantially over the past 20 years; they are now the largest internet-based retailer in the U.S. (Amazon.com, 1996–2015). Until very recently, Amazon had not owned or operated any retail stores, but they do operate a worldwide network of 237 public fulfillment centers with 138 of those in the U.S. alone. Amazon is considered to be a public distribution center because they are engaged in storing and processing goods for profit. In Amazon's case, they own a portion of the goods in the centers, and provide space and services for a fee to suppliers and supply those goods when there is a consumer demand. Additionally, Amazon operates 23 smaller sortation centers.

The purpose of the smaller sortation centers are a result of implementing a recent change to the distribution network. Eligible parcel shipments are now sent to one of the 23 regional sortation centers where they are sorted by zip code and transferred to the applicable United States Post Service delivery location. United States Post Service delivery is used for reducing delivery costs and taking advantage of Saturday deliveries.

Amazon, unlike Walmart, does have their own products, such as Kindle e-book readers, Fire Tablets, Fire TV, and Fire Phones.

Amazon also sells and processes hundreds of other products across approximately 20 product categories from merchant and other third-party sellers. Product categories range from consumer electronics to kitchen items and sporting goods to automotive parts. These suppliers pay Amazon a fee for online marketing, storing, shipping, and other value-added services directly to consumers. This enables the suppliers to concentrate their effects and resources on core product development and manufacturing processes, and suppliers pay a fee to Amazon for online marketing, stocking, order processing, and customer service directly with consumers. Amazon calls this process "Fulfillment by Amazon."

Fulfillment centers employ hundreds of people, are located in major cities, and are often located near airports. Much like any other distribution center, employees are engaged in four primary functions

1. Receiving, unpacking, and inspecting incoming goods from suppliers
2. Storing goods and updating inventory records
3. Picking goods to fulfill customer orders and demands
4. Packing, packaging, and shipping orders to customer

As you can see, these functions are common to what can be performed in other warehouses as described in the prior learning blocks and what is often performed in other distribution centers, like Walmart. The levels of value-added services (storing goods for a fee, packing, packaging, labeling, online advertising, customer service, and extensive decentralized distribution network) enable Amazon to provide extremely responsive service on an extremely high number of items. It is not unusual for consumers to receive their order one or two days after order placement, often with free shipping.

Unit 3: Ecommerce Warehousing and Distribution

Ecommerce Growth

The rapid growth of ecommerce (also referred to as etailing instead of retailing) by online consumers in market areas has been unprecedented. The U.S. Census Bureau reported that ecommerce sales reached $304.9B in 2014, up 15.4% from the year before, compared with a 3.8% increase in overall U.S. retail sales of right below $4.7B. (U.S. Department of Commerce, 2016) As this unprecedented growth continues, it is forcing changes to traditional supply chains and specifically to the distribution and fulfillment center function within the supply chain. A percentage of the ecommerce growth is being driven by the ease of mobile shopping; consumers are using smartphones and tablets to order and even using those same devices in stores for competitive pricing and then to place the order.

Figure 66. Impact of ecommerce. Developed by LINCS in Supply Chain Management Consortium

Traditional warehousing and fulfillment processes successfully used by retail stores (such as meeting consumer's expectations for delivery in one day, or even less) may not be the best option for ecommerce.

In order to effectively compete in this virtual arena, fulfillment centers need to quickly and accurately process single items and small orders through the pick, pack, and shipping processes while juggling thousands of SKUs.

Organizations must have robust supply chain processes that support the right-sizing of thousands of SKUs through forecasting and demand planning in order to satisfy these consumer expectations and demands. They must also manage highly efficient fulfillment and distribution centers. In many cases, organizations have established dedicated distribution networks to satisfy these consumer expectations and demands.

Impact of Ecommerce

To support ecommerce, the distribution center has to be thought of in terms of a comprehensive fulfillment environment that can process orders from the time they are placed to the actual delivery to the customer in very short time frames. Every step in the process must be handled quickly and efficiently and this requires a seamless linkage to customer service, transportation networks, and procurement for rapid SKU replenishment from suppliers and manufacturers. Ecommerce consumers

expect a wide array of product offerings, mobile technology ordering capabilities, free and fast delivery, and an easy return process supported by a robust customer service function staffed every day around the clock.

Ecommerce is also driving the need to convert vacant, small, and older properties that are close to the larger population centers so that filled orders can be delivered more easily. Real-estate brokerage Commercial Business Real Estate Services, Worldwide recently reported this as one of the reasons that nationwide warehouse available space continues to fall which has been trending for several years (Whelan, 2016).

Response by Retailers

As a result of the unprecedented growth of ecommerce that has been embraced by consumers, retailers are beginning to dedicate distribution and fulfillment centers and networks to support online ordering and sales.

For instance

Walmart has established a facility based in California called @WalmartLabs where they have assembled bright and leading technology personnel to continue to innovate the technologies that are used so that customers can shop anytime and anywhere online with mobile devices. In conjunction with improvements to technology, Walmart has built dedicated distribution and fulfillment centers to meet the demands of online shopping and they have plans to build additional centers.

Figure 67. Response by retailers. Developed by LINCS in Supply Chain Consortium.

These facilities have the basic functions and capabilities discussed in this certification track but are fine-tuned to pick, pack, and ship small orders of individual items. These facilities will also hold more than an estimated 500,000 unique items, which is much larger than their traditional distribution centers that hold between 30,000 to 50,000 items.

In addition, Home Depot opened two dedicated ecommerce fulfillment centers and each can hold over 100,000 unique items. Employees in those centers wear headsets that allows them to listen to a computer that dictates which items need to be picked from stock. The goal is to get 90% of orders placed by customers delivered within two days using ground shipping.

Learning Block 8 Summary

It is hard to argue that warehousing operations is not a critical function of the supply chain. Basic warehouses will always be needed to age wine and store seasonal and other static goods.

The concept of the basic warehouse has continued to transform into sophisticated distribution and fulfillment centers that require skilled employees, dynamic processes, and highly complex WMS that satisfy customer expectations for responsive and accurate delivery.

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management Consortium.

Ecommerce is taking the shopping experience to a whole new level. The technology is in place to make shopping easy anytime and anyplace, and this has placed demands on retailers to also deliver goods at any time.

It is difficult to predict how distribution and fulfillment centers will evolve over time to meet consumer needs. However, even with change in this very dynamic environment, a certain level of basic functionally will always be required inside the warehouse. Goods will still need to be received, stocked, cross-docked, picked, packed, packaged, and delivered, and skilled employees will be needed to perform those functions.

Learning Block 8 Practice Questions

1. What distinguishes a warehouse from a distribution center?

a. Warehousing operations linked to supply chain elements
b. Physical location
c. Overall size
d. Number of employees

2. A key characteristic of a distribution center is the:

a. Number and size of receiving docks
b. Dedicated space for long-term storage
c. Ability to operate without personnel
d. Ability to provide value-added services

3. Walmart's success is partially based on:

a. Staying out of international markets
b. Procuring goods from only U.S. suppliers
c. Operating automated centers with very few personnel
d. Operation of over 150 U.S. regional distribution centers

4. The system used in warehousing operations to integrate computer technology with specialized software is best described as a:

a. Warehouse material system
b. Warehouse management system
c. Work measurement system
d. Walmart made system

5. Amazon's success is partially based on their focus to:

a. Efficiently operate over 200 fulfillment centers world-wide
b. Effectively staff retail stores
c. Deliver shipments directly from fulfillment centers
d. Locate fulfillment centers only in remote areas

6. To support ecommerce, distribution centers need to:

a. Quickly and accurately process single items and small orders
b. Maintain high quantities of operational forklifts
c. Operate in remote areas away from congestion
d. Stock only a few, fast moving stock keeping units

7. To support the growth of ecommerce, many retailers are:

a. Attempting to ship orders directly from retail stores
b. Building dedicated fulfillment centers with advanced ordering technologies
c. Waiting to see if the growth trend continues before making changes to the distribution processes
d. Relying on older, established technology and fax machines for consumers to place orders

8. An on-going need for a basic warehouse might be to:

a. Store wine barrels for long-term aging
b. Perform cross-docking for fast moving stock keeping units
c. Integrate a customer service function
d. Install a sophisticated warehouse management system

9. Examples of value-added services include:

a. Receiving goods from suppliers
b. Yard control for incoming and outbound trucks
c. Cross-docking, labeling, packing, and packaging
d. Picking items from stores

10. To be successful, warehouses, distribution centers and fulfillment centers must be:

a. Linked to other supply chain elements, like transportation operations
b. Able to operate as a stand-alone facility
c. At least 1 million square feet in size
d. Run only by third party operators

Learning Block 9: Working Environment and Jobs

Learning Block 9 Description

This learning block provides an overview of the elements to maintain a safe and secure workplace for employees. Many of the policies are required by various regulatory agencies are adapted procedurally and used to train employees. The goal of maintaining a safe and secure workplace is to protect employees, safeguard inventory, and proactively run the business to achieve a high level of customer satisfaction.

Information for this learning block was adapted from the website for the Occupational Safety and Health Administration (OSHA). OSHA safety standards are rules that describe the methods that employers are legally required to follow to protect their workers from hazards. Employers often use the rules as a basis for workplace procedures and add additional rules and safeguards to fit the specific environment.

Finally, this learning block provides a summary of the types of jobs that are necessary in a warehouse operation to function as part of a broader and more comprehensive supply chain.

Learning Block 9 Learning Objectives

Upon completing this learning block, the learner will be able to:

- Understand and assume workplace responsibility for a safe and secure environment
- Apply knowledge of employees rights to a safe and secure work environment
- Understand OSHA standards to protect employees from workplace hazards
- Execute OSHA procedures to maintain control over workplace safety hazards
- Interpret available information and education from OSHA
- Understand available assistance for employers from OSHA

Unit 1: Warehouse Safety and Security

Occupational Safety and Health Administration (OSHA) Mission

As a result of the Occupational Safety and Health Act of 1970, Congress created the OSHA to ensure safe and healthy working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance (see *Figure 68*).

OSHA Coverage

The Occupational Safety and Health Act covers most private sector employers and their workers, public sector employers and workers in the U.S., and certain territories and jurisdictions under federal authority. Those jurisdictions include the District of Columbia, Puerto Rico, the Virgin Islands, American Samoa, Guam, Northern Mariana Islands, Wake Island, Johnston Island, and the Outer Continental Shelf Lands, as defined in the Outer Continental Shelf Lands Act.

Figure 68: OSHA logo. Retrieved from OSHA.org.

OSHA Organization

OSHA is part of the U.S. Department of Labor. The administrator for OSHA is the Assistant Secretary of Labor for Occupational Safety and Health. OSHA's administrator answers to the Secretary of Labor, who is a member of the cabinet of the President of the U.S.

OSHA Standards

OSHA standards are rules that employers are legally required to follow to protect their workers from workplace hazards. Before OSHA can issue a standard, it must go through an extensive process that includes substantial public engagement, notice, and comment. The agency must show that a significant risk to workers exists and that there are feasible measures employers can take to protect their workers.

Construction, general industry, maritime, and agriculture have standards that protect workers from a wide range of serious hazards. These standards limit the amount of hazardous chemicals workers can be exposed to, require the use of certain safety practices and equipment, and require employers to monitor certain workplace hazards.

Examples of OSHA standards include requirements providing fall protection, preventing trenching cave-ins, preventing exposure to infectious diseases, ensuring the safety of workers who enter confined spaces, preventing exposure to harmful substances (e.g., asbestos and lead), putting guards on machines, providing respirators or other safety equipment, and providing training for certain dangerous jobs.

Employers must also comply with the General Duty Clause of the Occupational Safety and Health Act. This clause requires employers to keep their workplaces free of serious recognized hazards. The clause is generally cited when no specific OSHA standard applies to the hazard.

Employer Responsibilities and Employee Rights

EMPLOYER RESPONSIBILITIES	EMPLOYEE RIGHTS

According to the act, employers must:

- Follow relevant OSHA safety and health standards
- Find and correct safety and health hazards
- Inform employees about chemical hazards through training, labels, alarms, color-coded systems, chemical information sheets, and other methods
- Notify OSHA within 8 hours of a workplace fatality, or when three or more workers are hospitalized (1-800-321-OSHA [6742])
- Provide required personal protective equipment at no cost to workers
- Keep accurate records of work-related injuries and illnesses
- Post OSHA citations, injury, and illness summary data, as well as the OSHA "Job Safety and Health: It's The Law" poster, in the workplace where workers will see them
- Never discriminate or retaliate against any worker for using their rights under the law

Employees have the right to:

- Receive working conditions that do not pose a risk of serious harm
- Receive information and training (in a language workers can understand) about chemical and other hazards, methods to prevent harm, and OSHA standards that apply to their workplace
- Review own personnel records of work-related injuries and illnesses
- Receive copies of test results to find and measure hazards in the workplace
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA rules (when requested, OSHA will keep identities confidential)

Employees are entitled to use their rights under the law without retaliation or discrimination. If an employee is fired, demoted, transferred, or discriminated against in any way for using their rights under the law, they can file a complaint with OSHA. This complaint must be filed within 30 days of the alleged discrimination.

Unit 2: Information and Education

OSHA Training Institute

The OSHA Training Institute Education Centers are a national network of nonprofit organizations authorized by OSHA to deliver occupational safety and health training to private sector workers, supervisors, and employers (see *Figure 69*).

Figure 69: OSHA Training Institute Education Centers. Retrieved from OSHA.org.

Information and Publications

The OSHA has a variety of educational materials and electronic tools available on its website at www.osha.gov.

These materials include safety and health topic pages, safety fact sheets, expert advisor software, copies of regulations and compliance directives, videos, and other information for employers and workers. OSHA's software programs and *e*tools provide training and orientation processes for safety and health issues and common problems to find the best solutions for your workplace.

OSHA's extensive publications not only help explain OSHA standards, job hazards, and mitigation strategies, but they also provide assistance in developing effective safety and health programs. For a listing of free publications visit OSHA's website at www.osha.gov or call 1-800-321-OSHA (6742).

OSHA Online Quick Takes Publication

Quick Takes is OSHA's free online newsletter that is sent out bi-monthly, and it offers the latest news about OSHA initiatives and products to assist employers and workers in finding and preventing workplace hazards. To sign up for Quick Takes, visit OSHA's website at www.osha.gov and click on Quick Takes at the top of the page.

Unit 3: Who Does OSHA Cover?

Private Sector Workers

OSHA covers most private sector employers and workers in the U.S., the District of Columbia, and other U.S. jurisdictions either directly through federal OSHA or through an OSHA-approved state program. State-run programs must be at least as effective as the federal OSHA program.

State and Local Government Workers

Federal OSHA does not cover state and local government workers, but they do have protections in states that operate their own programs. Approximately half of the 50 states have approved state programs including Puerto Rico and the Virgin Islands.

See *Figure 70* below for a summary of states with approved programs.

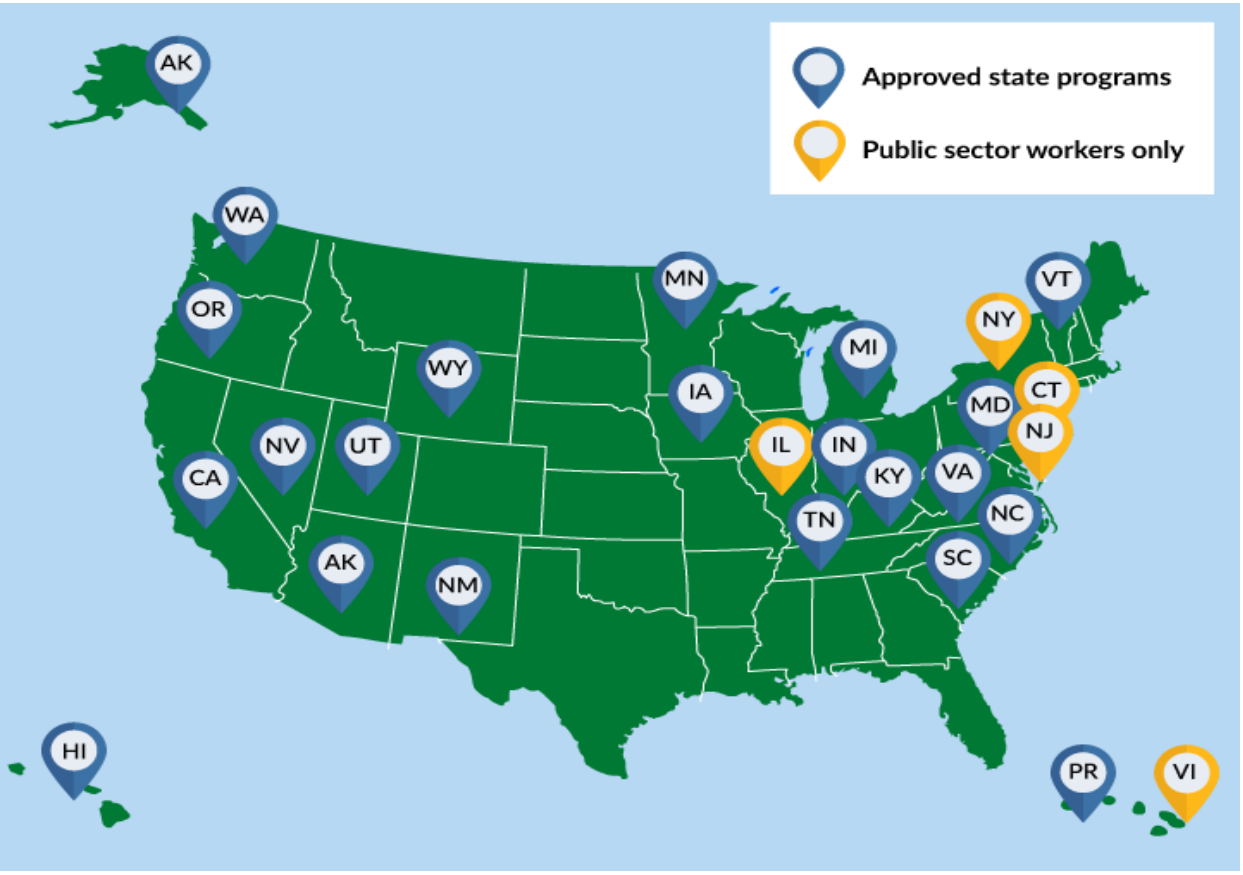


Figure 70. Approved programs by state. Developed by LINCS in Supply Chain Management Consortium.

Federal Government Workers

OSHA's protection applies to federal agencies. Although OSHA does not fine federal agencies, it does monitor federal agencies and responds to workers' complaints.

Entities Not Covered by the OSHA Act

Employees who are not covered by the OSHA Act include self-employed workers and workers whose hazards are regulated by another federal agency (e.g., the Mine Safety and Health Administration, Federal Aviation Administration, and Coast Guard).

OSHA Hand Book

OSHA offers cooperative programs to help prevent fatalities, injuries, and illnesses in the workplace. In the Alliance Program, OSHA works with groups committed to worker safety and health to develop compliance assistance resources and to educate workers and employers. As part of their safety program to prevent fatalities, injuries, and illnesses in the workplace, OSHA has prepared a pocket guide that can be utilized for class and training discussions, but, more importantly, it is an excellent source of workplace safety references.

Unit 4: Warehousing Jobs

As previously discussed, warehouse operations are critically important to the efficiency, effectiveness and success of the supply chain. The level of personnel skills and proficiency require a detailed understanding of warehouse operations and how those operations are linked within the supply chain to the other functions of procurement, inventory management, transportation operations, and customer service to form an integrated, cohesive supply chain that enables high levels of customer satisfaction.

Additionally, inter-personal skills are extremely important to enable workers to effectively communicate and work in a team or group environment. Effective speaking, listening, and ability to value diversity and collaboration are essential to achieve a productive work environment.

There are numerous employment opportunities in a warehouse operation, and while there are numerous automated systems to manage inventory, transportation and other critical functions, people continue to be a critical aspect of any good warehouse operation.

Generic and common warehouse positions and jobs are outlined below. Industries may require specific jobs not mentioned below based on their unique market or operations. Finally, many warehouse operations may employ personnel in dual positions. For example, an unloader in the receiving area may also be responsible for also loading in the shipping area.

- **Receiving unloader:** unloads incoming items from trucks and breaks down pallets and bulk receipts
- **Receiving clerk:** processes incoming goods and materials by verifying that the correct items and quantities were received. Performs inspections to ensure there was no shipping damage. Enters data into the warehouse management inventory system.
- **Hauler:** transports pallets with goods and materials from the receiving dock to storage racks
- **Forklift driver:** places items onto racks with forklift
- **Stock mover:** moves stock from one location to another throughout warehouse processes
- **Warehouse clerk:** maintains accurate inventory logs, supply lists, and invoice records. Files invoices and other paperwork and performs necessary inputs to the warehouse management inventory system.
- **Order picker:** picks goods to fulfill customer orders
- **Order packer:** checks the order for completeness and damages, labels, packs and packages items to prepare for shipment.
- **Hauler:** transports pallets with equipment from the staging area to the delivery
- **Shipping clerk:** updates and maintains inventory logs, supply lists, and invoice records including inputs to the warehouse management inventory system.

- **Shipping loader:** loads outgoing packaged goods onto delivery vehicles
- **Supervisor or manager:** represents management; manages warehouse processes and personnel
- **Facilities personnel:** maintains the physical structure and capital equipment
- **Quality assurance:** inspects and audits incoming and outgoing products

Learning Block 9 Summary

The safety and health standards for warehouse operations ensure that worker safety and business processes are significantly important and required by OSHA.

Employers and employees, working together, have a combined responsibility to maintain workplace safety and health and security.

Warehouse jobs and trained employees are important to the overall success in operating a warehouse and supply chain.

Figure 5. Warehousing operations. Developed by LINCS in Supply Chain Management.

Learning Block 9 Optional Supplemental Resources

Review the optional supplemental resources listed below, as a reinforcement of the content covered within this learning block.

Occupational Safety and Health Administration. (2004). *Worker safety series: Warehousing* [OSHA 3220-10N]. Retrieved from https://www.osha.gov/Publications/3220_Warehouse.pdf

Occupational Safety and Health Administration. (2002). *Material handling and storage files* (Revised) [OSHA 2236]. Retrieved from https://www.osha.gov/Publications/osha2236.pdf

Costal Video Communications (Producer). (1996). *Warehouse safety, it's no joke* [VHS]. Available from http://www.youtube.com/watch?v=wY57d7exnKA

PublicResourceOrg. (2009, May 2). *Forklift - Pedestrian safety* [Online video]. Available from http://www.youtube.com/watch?v=_0vuIPA6bt8

Learning Block 9 Practice Questions

1. OSHA stands for:

a. Office Safety Hazards Association
b. Optional Standard Handling Act
c. Occupational Standards and Health Alliance
d. Occupational Safety and Health Administration

2. The Occupational Safety and Health Administration rules set standards that employers must follow:

a. To protect workers from hazards and reduce the risk of injury
b. When hiring new personnel
c. Only during the manufacturing processes
d. Solely in a warehouse operation

3. An employer is required to first attempt to reduce hazards by:

a. Providing protective gloves, masks, earplugs, or other protective equipment
b. Training employees in how to use personal protective equipment
c. Providing ventilation fans to dispel hazardous particles or fumes
d. Making changes in working conditions

4. Potential hazards to workers in a warehouse operation include:

a. Forklifts
b. Computer networks
c. Restroom Hygiene
d. Filing Paperwork

5. Which of these is NOT a potential hazard for workers in warehouses?

a. Unsafe use of forklifts
b. Failure to use personal protective equipment
c. Repetitive motion injuries
d. Classroom training

6. Poor ergonomics refers to:

a. Ineffective financial planning
b. Crowded break and lunchrooms
c. Improper lifting, repetitive motion, or ineffective process flows in the workplace that can lead to health issues
d. Poorly maintained equipment

7. Which of these does an employer's emergency plan not have to include provisions for?

a. Accounting for employees and visitors
b. Emergency conditions: food and water supply
c. Emergency exit locations
d. Locations and use of fire extinguishers and other emergency equipment

8. What do hazardous material containers not have to be labeled with?

a. Identity of the chemical
b. Manufacturer's name and address
c. Appropriate hazard warnings
d. Storage bin number

9. Warehouse operations jobs are important because they are:

a. Required by the Occupational Safety and Health Administration
b. Mandated by the Department of Labor
c. Necessary to operate a warehouse and supply chain
d. Billable to a customer

10. What best describes an Occupational Safety and Health Administration standard?

a. Suggested rules issued by the Occupational Safety and Health Administration to limit workplace hazards
b. Rules that employers are legally required to follow to protect their workers from workplace hazards
c. Key Performance Indicators used to measure productivity
d. Rules issued to promote worker safety when working in a non-domestic location

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University Alliance. (2016). *RFID Technology Boosts Walmart's Supply Chain Management*. Retrieved from University of San Francisco website: http://www.usanfranonline.com/resources/supply-chain-management/rfid-technology-boosts-walmarts-supply-chain-management/

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Practice Questions Answer Key

Learning Block 1

1. A
2. A
3. B
4. A
5. C
6. B
7. D
8. A
9. A
10. B

Learning Block 2

1. B
2. C
3. D
4. D
5. A
6. A
7. C
8. C
9. A
10. C

Learning Block 3

1. D
2. B
3. A
4. B
5. B
6. A
7. A
8. B
9. C
10. A

Learning Block 4

1. C
2. D
3. D
4. B
5. A
6. A
7. D
8. A
9. D
10. A

Learning Block 5

1. C
2. A
3. C
4. B
5. B
6. C
7. C
8. B
9. A
10. D

Learning Block 6

1. C
2. B
3. C
4. A
5. A
6. D
7. C
8. A
9. A
10. A

Learning Block 7

1. C
2. B
3. B
4. C
5. D
6. A
7. B
8. C
9. A
10. B

Learning Block 8

1. A
2. D
3. C
4. B
5. A
6. A
7. B
8. A
9. C
10. A

Learning Block 9

1. D
2. A
3. D
4. A
5. D
6. C
7. B
8. D
9. C
10. B

Warehousing Operations Certification Track Glossary

*: Indicates terms coming, in part or in whole, from the Supply Chain Management Terms and Glossary from August 2013.

0–9

3PL: See *Third-Party Logistic Provider*

A

ABC Analysis: See *Popularity Storage*.

Advance Shipping Notice (ASN): Document transmitted via EDI that alerts the recipient to, and provides details about, a pending shipment.

ASN: See *Advance Shipping Notice*.

ASRS: See *Automatic Storage and Retrieval System*.

Automatic Guided Vehicle System: Vehicles that are routed automatically, not operator controlled, including tractors, pallet trucks, unit load carriers, and assorted fork vehicles.

Automatic Storage and Retrieval System (ASRS): A device that combines storage equipment with automated handling technology and interfaces with manual (e.g., forklifts) or automated (e.g., conveyors) handling systems. Goods are delivered to a staging area by these manual or automated systems. The ASRS removes the goods from the staging area and places them in a storage location within the ASRS. The three ASRS types, which are differentiated by the size of the items handled, are unit load, miniload, and microload.

B

Barcode: Printed bars and white space that contain optical characters with information that can be read by a scanner.

Bin Shelving: Manual storage device designed to handle non-palletized loads and generally used for small parts.

Breakbulk: The process of breaking a bulk load into smaller units for shipment.

C

Carousel: Mechanical structure that houses and rotates items to facilitate put away and order selection. Two major types include horizontal (i.e., a series of revolving bins or shelves driven by a motor) and vertical (i.e., rotating bins or shelves along a vertical enclosed loop).

Carrying Costs: The costs of holding inventory. The term is derived from carrying the inventory on the books.

Complementary Storage: See *Similarity Storage*.

Consolidation: In its simplest form, consolidation is the combination of products that have been picked to fill a unique customer order.

Contract Warehouse: A variation of a public warehouse in which a fixed amount of space or an entire building is dedicated to a specific customer, and services can be customized to satisfy a specific client's needs.

Conveyor: Mechanism used to unload/load vehicles and/or route items through the warehouse. Also can be used as an automated sorting system, of which there are four major categories: pop-up sorter, surface sorter, tilt slat sorter, and tilt tray sorter.

Cross-Docking: A distribution method where products from a supplier or a manufacturing plant are delivered directly to the customer with little or no handling or storage time.

Cycle Count: The physical count of products in a given location to ensure that they equal the amount recorded through the computer system for that specific location.

D

Distribution Center: There are two main of distribution centers: physical distribution center and physical supply distribution center.

Direct Plant Shipment: Shipment of products directly to their ultimate destination, rather than storing them in a warehouse.

Dock Leveler: A device used to bridge the gap between the dock and the trailer bed of the vehicle. It may be mechanically, hydraulically, or manually operated.

E

Ecommerce: Is the buying and selling of goods and services, or the transmitting of funds or data, over an electronic network, primarily the Internet.

EDI: See *Electronic Data Interchange*.

Electronic Data Interchange (EDI): Computer integration that allows different companies and industries to break through outdated boundaries by automating standard business transactions electronically instead of via traditional voice and paper methods. The benefits are increased in accuracy, speed, and cost reductions across the board. A key enabling technology is barcode technology, which provides a fast way to enter data into a computer, usually at the point-of-sale.

Etailing: See *Ecommerce.*

F

Fixed Stock Location: A location system in which specific slots or lanes are allocated and dedicated to stock items.

Forklift Truck: A machine-powered device used to raise and lower freight. It is also used to move freight to different warehouse locations.

Forward Picking: Inventory is moved from a reserve or bulk storage location to a primary picking location. Order-processing patterns are analyzed to determine the minimum and maximum levels of stock to be kept in the primary picking location.

G

General Merchandise Warehouse: The most common form of warehouse, used by manufacturers, distributors, or customers for storing products.

Gravity Flow Rack: A manual storage device used for high-demand items, usually in cartons, if uniform size and shape. The rack is sloped, and items are loaded at the back (higher end) of the rack. When an item is picked from the front (lower end), the next higher item flows down to replace it.

H

Honeycombing: An aspect of storage that results from partial depletion of a lot and leads to underutilization of storage space.

I

Inventory: The number of units and/or value of the stock of goods a company holds.

Inventory Cost: The cost of holding goods, usually expressed as a percentage of the inventory value; includes the cost of capital, warehousing, taxes, insurance, depreciation, and obsolescence.

Inventory Deployment: The logistics component that brings value to the customer by efficiently and effectively staging and distributing goods while reducing or eliminating storage.

Inventory Management: Inventory administration through planning, stock positioning, monitoring product usage, and ensuring product availability.

Inventory Turnover (Turns): The rate at which raw materials move from the beginning of the manufacturing process to the point of purchase by the consumer. It is calculated by dividing the cost of goods sold for the year by the average cost of inventory for the year.

J

JIT: See *Just-In-Time*.

Just-In-Time (JIT): A method of supplying production lines using a strategy of shipping in smaller, more frequent lots with deliveries that arrive as they are needed, rather than stockpiling materials or parts.

K

Kitting: The process of creating one unique item from a group of specific, individual items that are packed together in the container the consumer will handle.

L

Less Than Truckload (LTL): Shipments of materials or products. Shipping goods long distances at LTL rates is more costly than shipping full truckloads; also, LTL requires multiple, costly delivery stops to effectively utilize the truck, but a full truckload requires only one stop.

Logistics: The process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements.

LTL: See *Less Than Truckload*.

M

Man-Ride Machine: A vehicle with a cab for the operator and storage compartments for small, frequently handled parts. It uses a combination of manual labor and automation.

Mezzanine: A structure that provides a second level for storage, above the ground floor space.

Modular Storage Drawers: Used for small, hand-picked parts. These storage components provide protection from the outside environment and allow for a higher concentration of stored items. Limited height of the structure can lead to underutilization of cube space.

O

Order Cycle Time: The time that elapses from placement of order to receipt of order. This includes time for order transmittal, processing, preparation, and shipping.

Order Processing: The trigger for the distribution process, including order entry, scheduling, invoicing, status inquiries, tracing, expediting, information requests, credit checking, and accounts receivable processing and collection. Order processing is an important part of customer service.

Outsourcing: Functions or activities that were formerly company managed and are now handled by outside sources (e.g., third-party operators).

P

Pallet*: The platform that cartons are stacked on and then used for shipment or movement as a group. Pallets may be made of wood or composite materials. Pallets have electronic tracking tags, and most are recycled.

Pallet Rack: Manual storage device designed to handle palletized or containerized loads. Includes a variety of types of operator-controlled and power-assisted devices that are typically used to move and place these racks.

Picking: The process of collecting the appropriate items in the right quantities to fill a customer order. A combination of different methods can be used within a single warehouse.

Point-of-Sale: Refers to data that is generated through barcodes at the retail level, representing actual sales of specific products. Point-of-sale data is transmitted back to the warehouse and manufacturer.

Polypropylene Containers: Strongly constructed containers made of polypropylene material. Normally used for the storage of small parts and can be attached to specially designed louvered panels.

Popularity Storage: An item's storage location is determined by its velocity of inventory turnover.

Private Warehouse: A distribution center operated by the owner of the goods stored there. A private warehouse can be a privately owned or a leased facility.

Product Characteristic Storage: Storage location is determined on the basis of a product's special attributes.

Product Mixing: Products received from several manufacturers are mixed and shipped to multiple retailers in the combinations they specify.

Public Warehouse: This is a distribution center operated by a firm engaged in the business of storing goods for profit. The word public refers the warehouse renting space to the public; it does not

necessarily indicate public ownership of the warehouse. A public warehouse does not own the goods it stores. Types include general merchandise, temperature controlled, bonded, household goods, special commodity, bulk storage, and food grade.

R

Radio Frequency Terminal (RFT): Hand-held radio frequency communication device with a keyboard, digital read-out, small printer, and attached barcode scanner. RFT receives information from and sends it to a central computer.

Random Storage Assignment: Products are stored in the closest available locations that can accommodate their specific product characteristics.

Receiving Dock: Where trucks arrive to unload goods. Three basic configurations are combined, separated, and scattered.

Replenishment: Items from the bulk storage area are picked to re-stock the primary picking area as stock levels reach a pre-determined minimum.

RFT: See *Radio Frequency Terminal*.

S

Shipment Container Marking: A barcode that identifies the precise items inside each shipping container. The containers are likely to contain SKUs.

Shrinkage: Unexpected reduction in inventory due to theft, loss, damage, or spoilage.

Similarity Storage: Items commonly received or shipped together are stored together, even though they may differ in weight, size, and product demand.

SKU: See *Stock Keeping Unit*.

Stock Adjustment: The number and/or location of products is reconciled to determine the reason for the discrepancy if an error has been detected during cycle counting.

Stock Keeping Unit (SKU): Package that contains a number of individual items identified by the Universal Product Code.

Supply Chain: Processes from end user through original suppliers that provide products, services, and information that add value for customers.

T

Temporary Storage: Traditional warehousing, used primarily because trading partners still rely on push distribution strategies. Items are stored for subsequent use in the supply chain in case they are needed.

Third-Party Logistics Provider (3PL)*: Outsourcing of a company's logistics operations to a specialized company. Services they provide are transportation, warehousing, cross-docking, inventory management, packaging, and freight forwarding.

Third-Party Operator (Provider): Provides a wide variety of services for manufacturers and suppliers who decide to outsource their inventory deployment operations.

Throughput Cost: Part of total warehousing cost. This is the cost (primarily labor) of moving materials in and out of the warehouse.

U

Unitized Load: Consolidation of a number of items into one shipping unit to make handling easier. Loads can be unitized by banding, binding, or wrapping. A trailer can be a unitized load if it has been sealed and secured prior to shipment.

Z

Zone Picking: A system for order picking where the warehouse is divided into sections, or zones, and each picker is responsible for a small section of the warehouse. Orders flow from section to section, gradually being built up.

Notes Page

Addendum

Warehousing Operations Revision Notes

To V2.22

The previous document version was V2.22 (file name LINCS.WO.v2.22.05022016).

Current version is v2.28 (file name LINCS.WO.v2.28.03032017) and contain the following updates:

- Replaced all CanStock images
- Replaced all unnecessary instances of “above” and “below”.
- Added definition of “Third-Party Logistic Providers (3PL) to the glossary
- In the Optional Supplemental Resources pages changed first sentence to "The optional supplemental resources listed below may be used to reinforce the content covered within this learning block." to match other tracks.
- The abstract page was corrected to match all other tracks
- All non-working links were replaced or deleted
- Updated reference page