VERSION 4.4

MODULE 2
SUPPLY CHAIN PLANNING AND EXECUTION

Section C: Reverse Logistics

Section C: Reverse Logistics

This section focuses on integrating returns, recalls, repairs, remanufacturing, and other end-of-life topics into the supply chain so that these can not only be dealt with efficiently but also become a source of revenue. National and local governments are increasing regulations in this area, so getting reverse logistics right will help compliance be just a regular part of doing business and keep waste and hazardous materials out of landfills.

Reverse logistics is often a required cost of doing business. It can be a severe drain on organizational profitability and could eventually contribute to an organization's demise if it is continually just an expensive afterthought. However, if it is handled strategically and the organization invests time and energy in planning the returns, repairs, reuses, recycling, and responsible disposals they are obligated to handle—including the disposal of hazardous waste—they can, in some cases, generate revenue from these sources to offset the costs, and the costs themselves can be kept reasonable by focusing on smart policy and efficient practices.

Processes for managing reverse logistics

The key processes that supply chain managers need to be able to perform related to managing reverse logistics are

- Identifying requirements of reverse logistics
- Designing a reverse strategy and process
- Implementing a reverse strategy and process.

The following is a general overview of these processes. The information required to plan and execute these processes is presented in this section's chapters.

Identifying requirements of reverse logistics

The process of identifying the requirements of reverse logistics involves the following steps:

- Assessing the as-is state of reverse logistics strategy and processes
- Determining the stakeholders for each product or product group's reverse logistics requirements (e.g., customers; finance and other executives; health, safety, and environmental regulators; interest groups; transporters and 3PLs, etc.)
- Gathering requirements from each stakeholder group
- Consolidating and categorizing requirements
- Determining the impact of stakeholder requirements on strategic priorities (e.g., customer service impact)
- Reviewing organizational and supply chain strategy to determine if stakeholders' reverse supply chain requirements necessitate modifications to these strategies (i.e., these requirements are often overlooked during strategic planning)

Designing a reverse strategy and process

The process of designing a reverse strategy and process involves the following steps:

- Prioritizing requirements based on organizational and supply chain strategy
- Designing the to-be state of reverse logistics, either during product development and introduction of new products or as modifications to existing operations

- Analyzing the gaps between the as-is and to-be states
- Developing a quantitative and qualitative benefit-cost analysis to justify strategic choices and tradeoffs
- Generating a reverse logistics strategy, including how the strategy might need to change at various points in the product life cycle
- Influencing executive support to champion and lead the strategy and allocate funding
- Designing information systems and network locations for reverse supply chain activities
- Designing processes and policies for each product, subcomponent, waste item, and raw material entering the reverse logistics hierarchy (i.e., whether to reduce, reuse, recycle, recover energy during disposal, or dispose in a responsible landfill)

Implementing a reverse strategy and process

The process of implementing a reverse strategy and process involves the following steps:

- Gaining final executive approval and funding for specific infrastructure and process changes or contract negotiations to implement the strategy
- Planning and implementing projects to change processes and infrastructure
- Contracting with third-party participants
- Using change management to alter the culture of the organization to support the changes over the long term
- Setting up metrics and goals for monitoring and controlling operations and customer service impact
- Monitoring and controlling the processes and operations
- Gathering feedback and implementing continuous improvement

Note that project management, continuous improvement, and change management are addressed in detail elsewhere.

Chapter 1: Reverse Logistics

This chapter is designed to

- Identify activities supported by reverse logistics
- Enumerate the business advantages and common requirements motivating development of a reverse logistics supply chain
- Describe the strategic impact on reverse logistics and design considerations related to network locations, warranty policies, return authorization policies, logistical network make-or-buy decisions, and product life cycle
- Describe the benefits of a well-organized reverse supply chain.

In this chapter we'll look at the phenomenon of reverse logistics and explore some of the strategic approaches that, in some cases, are not only mitigating the negative impact of product returns but are finding ways to make a profit on the back side of the supply chain.

Topic 1: Introduction to Reverse Logistics

What happens when you throw the supply chain into reverse? You have **reverse logistics,** defined in the *APICS Dictionary,* 16th edition, as

> a complete supply chain dedicated to the reverse flow of products and materials for the purpose of returns, repair, remanufacture, and/or recycling."

The *Dictionary* defines the **reverse supply chain** as

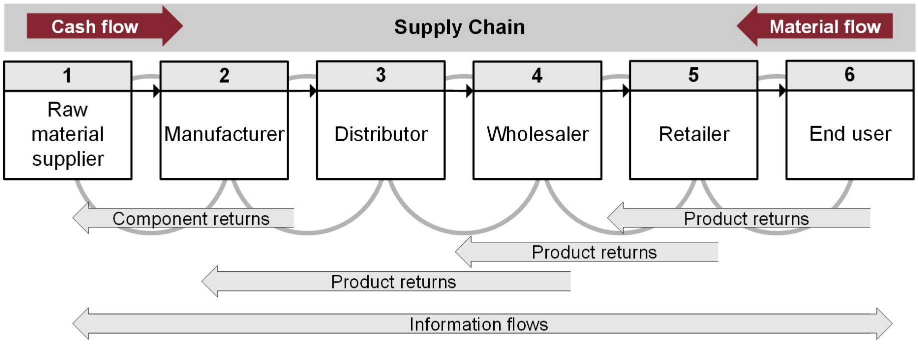
> the planning and controlling of the processes of moving goods from the point of consumption back to the point of origin for repair, reclamation, recycling, or disposal.

The reverse supply chain is also simply referred to as product returns.

Whatever one calls it, the reverse supply chain is a complete chain, a mirror image of the forward chain that carried the product to the customer in the first place. As such, it gives rise to mirror images of operations in the forward chain—customer service (marketing in reverse), warehousing and transportation going in the opposite direction, unpackaging, disassembly, and remanufacturing or recycling (a return to raw materials). The products in the reverse chain won't necessarily move through the same nodes as products in the forward chain because fewer, and different, warehouses, may be required.

Exhibit 2-128 shows the direction of material and cash flows in the reverse supply chain and lists some reverse logistics activities.

Exhibit 2-128: Reverse Logistics



The return of material for the purpose of product returns, repair, remanufacture, or recycling

Reverse logistics can occur not only as customers are returning products that were purchased but also as retailers or distributors return products that failed to sell (e.g., if there are contractual agreements to take back unsold inventory for some amount of refund or rebate on future purchases) or were defective. Similarly, manufacturers might return defective or excess products to suppliers.

As a relatively new concern, reverse logistics does not yet have the same level of support by strategists and software engineers as forward logistics, but it isn't a small phenomenon. In some online businesses, returns can be as high as 50 percent; in addition, returns can include containers, etc., as well as products. At one time, Estée Lauder was dumping about US$60 million worth of its products into landfills every year—more than one-third of the name-brand cosmetics returned by retailers. Some estimates put the total spent on reverse logistics in the United States as high as US$35 billion. Strategic solutions are on the way, though.

Many major companies have taken up the challenge of improving their management of the reverse flow of products, among them Dell, HP, Home Depot, Lenovo, and Google. Since at this point reverse logistics is unlikely to be a core business for many companies, 3PLs and 4PLs are adding reverse logistics to their portfolios. UPS, for instance, features its expertise on its website. GENCO ATC is a 3PL that has been in the reverse logistics business since the 1980s and includes clients such as Walmart, Target, Levi's, Dell, and Kraft-Heinz. It also sells reverse logistics software for the retail industry.

Motivating factors (requirements)

What drives the upsurge of organizations' interest in reverse logistics? There are, in fact, a number of motivating factors that might form the basis for various stakeholders' requirements.

- **Cost avoidance.** A primary purpose of reverse logistics for many organizations is to mitigate loss from returned items. A return is a reduction in sales revenue. Traditional brick-and-mortar retailers experience returns in the range of 8 to 10 percent, while online retailers have it even worse, with 20 to 30 percent of products being returned.

  In addition to the loss of revenue, return processes are typically more expensive than their forward supply chain counterparts. This includes higher transportation costs for handling small shipments of oddly assorted items; warehouse costs that may include testing, refurbishment, repair, and restocking;

and inventory costs of write-down or write-off and proper recycling or disposal. Returned items that are unused and fully functional may or may not be able to be marketed as new, depending on regulatory requirements for the industry, and may need new packaging if they can be resold as new. Since certain items such as electronics become obsolete quickly, the longer the return process takes, the less value returned items have from a resale standpoint.

Administratively, organizations often are unable to properly quantify how much returns are actually costing, because it is difficult to estimate the value of any returned items (if any) until they are actually refurbished and resold or recycled. This results in a lack of priority for reverse logistics and thus inefficiencies in the reverse supply chain.

- **Savings in the aftermarket.** Sometimes there is literally gold in the reverse supply chain, not to mention silver, platinum, copper, zinc, mercury, lead, and the whole range of commercial metals. Returned products can be “mined” for scarce materials—many of which should definitely be kept out of landfills. Products can be repaired for continued use, refurbished for resale, or disassembled for their usable components. AT&T’s Network Systems Division, for example, realizes significant savings by operating a reverse logistics system for telephone switching equipment.
- **Competitive edge.** Consumers can be wooed and won with products that promise good service. For example, if customers have easy and free return experiences, they are far more likely to become loyal and profitable. A 2005 study by Moore et al. placed this value at 5 to 20 times the initial sales price of the returned product. Ease of return, repair, and recycling may add to a product’s value in the consumer’s mind. Many consumers are daunted by the need to pay to dispose of a defunct television or sound system. The idea that a manufacturer or retailer might take responsibility for such items at the end of their days—as AT&T has done with phone equipment—can definitely be attractive to some customers.
- **Consumer and shareholder pressure.** Consumer groups have learned to make themselves heard through direct action and lobbying. As part of this movement, shareholder groups bring resolutions to corporate annual meetings proposing various “green” or consumer-oriented policies. Sometimes these pressures result in changed corporate policies when companies sense an opportunity to turn such sentiments into customer loyalty and sales. (One oil company, for instance, had an ad campaign focusing on the reduced sulfur content of its gasoline in advance of regulatory requirements.) Sometimes consumer pressures result in the adoption of new government regulations at the local, national, or regional level.
- **Growing market for environmentally safe products.** The development of a market for food, cleaning agents, clothing, and other products that promise to go easy on the environment or have “organic” content grows in part out of a long tradition of respect for nature. Though this has its mystical side (and can sometimes be exploited by cynical marketers), the desire for access to products that are simple, clean, and less threatening to the health of the environment can be a legitimate source of ideas for innovative approaches to product design. Some customers will pay a premium for products that promise to protect their health and their world. Some corporations provide incentives for product ideas that incorporate reverse logistics thinking.

- **Safety and environmental awareness and regulations.** Love of nature and a desire to preserve the health of the human and nonhuman world has long been a literary, philosophical, and, sometimes, political concern. In 1962, with the publication of *Silent Spring* by oceanographer Rachel Carson, that usually quiet undercurrent of concern erupted into public consciousness and merged with concern for human well-being. Carson's subject was the unacknowledged side effects of the use of the pesticide DDT. The world has never again been able to view the impact of our activities on the environment with casual disregard for unintended consequences. That concern is one root cause of the growing attention to the afterlife of commercial products—especially hazardous materials such as pesticides and industrial chemicals. We know now that discarded items don't harmlessly fade away unless they are quickly biodegradable.

  Safety and environmental regulations on hazardous waste or items that need to be kept out of or reduced in landfills provide an reason for logistics managers to pay more attention to the defective or obsolete products that return and move back up the supply chain. The EU has made a strong commitment to waste reduction. For example, Germany requires that all German businesses must accept returns of their packaging. In the Netherlands, a disposal fee is charged when many kinds of new products—appliances, TVs, cars—are purchased. These funds are used to disassemble products at the end of their life. (Waste considerations are discussed in greater detail elsewhere.)

Topic 2: Strategy and Design for Reverse Logistics

When designing the reverse logistics network, one should keep the following factors in mind:

- Cash and information flow backward as well as forward—but not in the same way.
- Warranty and returns authorization policies strongly affect the cost of reverse logistics, so these need to reflect strategy in their designs.
- The infrastructure and processes in reverse logistics networks also need a sound strategy and design.
- Reverse logistics affects all stages of a product's life cycle, not just the last stage.

In this topic, we'll look at how these factors affect the strategy and design of reverse logistics.

Reverse information, cash, and product flow

Earlier Exhibit 2-128 showed how information, cash, and products flow through the reverse logistics chain just as in the forward chain. Software for managing this process does exist but isn't as well adopted as software for forward logistics applications.

- **Reverse information flows and reverse logistics information systems.** Legacy systems cannot effectively be used for tracking returns. It's going to take a new, worldwide data warehouse to do this job effectively. Information flows here require capturing data on product identifiers and linking them to the point of return, the reason for the return (e.g., defective, unsatisfactory, incorrect order, unsold or excess inventory, repairs or refurbishment, remanufacture, or regulatory recycling or disposal), and warranty status. The status of each product also needs to be tracked from its entry into the reverse flow until its final disposition, along with the costs or revenues accumulated at each step. A bill of material for disassembly can be produced to help track the disposition of components. Unique product (and, in some cases, subcomponent) identifiers are needed for this type of information to be tracked. The path that a returned item takes through the reverse supply chain may also require the management of new partners that handle tasks such as material recovery. Additionally, an organization may need to recover information on product failures that may indicate the need for a product redesign or recall, based on a failure rate that exceeds acceptable standards.

  Organizations lacking reverse logistics information systems will need to acquire these to provide the required visibility, possibly as add-ons to existing systems. Such systems should be capable of managing return center operations; repair, remanufacture, and recycling centers; product recalls; vendor returns; and tracking, tracing, and compliance reporting.

- **Reverse cash flows.** Cash flows in the reverse supply chain take the form of credits and discounts. This all needs to be done as simply as possible from the perspective of the customer (who is often not happy while these transactions are taking place) as well as placing the least possible burden on customer service. Product return policies should match strategy. The total cost of returns needs to be calculated in the aggregate by product line.

- **Reverse product flows.** Product returns require reverse forecasting and establishment of locations for collecting, reprocessing, or disposing of the goods on their return trips.

Warranty strategy and design

A product's warranty period creates a liability for an organization since defective products will need to be replaced for no charge during this period. Warranties are offered to promote sales by providing peace of mind for buyers, so both the costs and the benefits of these programs should be estimated. The benefit is the increase in sales from the warranty. The costs are the cost of returns that need to be charged off as well as the financial uncertainty of how many returns there will be. (It could be as much as all products sold, for example, in a recall situation.)

A complication arises when the warranty periods on supplier components differ from the warranty period on the final product offered to customers. A repair on a product warranty may require replacing parts that are not under warranty for the manufacturer, meaning that this cost cannot be passed on to the supplier. This can create a hidden liability that is difficult to calculate when determining the costs of reverse logistics.

Returns authorization strategy and design

Organizations need to set policies for how and when returns will be accepted as part of their overall reverse logistics strategy. Many retail organizations promote liberal returns policies, for example, allowing returns of any unbroken item with no reason needed, given just the receipt or the credit card used to make the purchase. This is a strategic decision to prioritize customer service and thus encourage customer loyalty. The costs and benefits of these policies need to be measured over time. Other organizations will impose more strict returns policies, such as only defective returns or all sales being final.

The idea is to reduce the number of returns without having too many unintended consequences for customer service and thus sales. Ensuring that this process is fast and easy for customers and clearly communicating the return policy at the time of the sale (setting expectations) can go a long way toward creating a good customer experience. Companies often contract with external returns specialists who provide customer service support while minimizing unnecessary returns.

For B2B returns, a lot-size return policy might make sense. This involves requiring corporate customers to hold returns until full truckload quantities can be sent, to make transportation more economical. In a B2C (business-to-consumer) example, Dell allows products to be returned only after the customer speaks directly with a live customer service representative. While there is a cost for this direct support from what they call "gatekeepers," the representative is given the opportunity to provide instruction on how to properly set up the device, up-sell support devices, or otherwise talk the customer out of the return. This investment is cost-effective because it results in a 5 percent level of returns (as opposed to a 10 percent return rate for its former competitor CompUSA, which eventually went out of business for this and other reasons).

Logistical network strategy and design

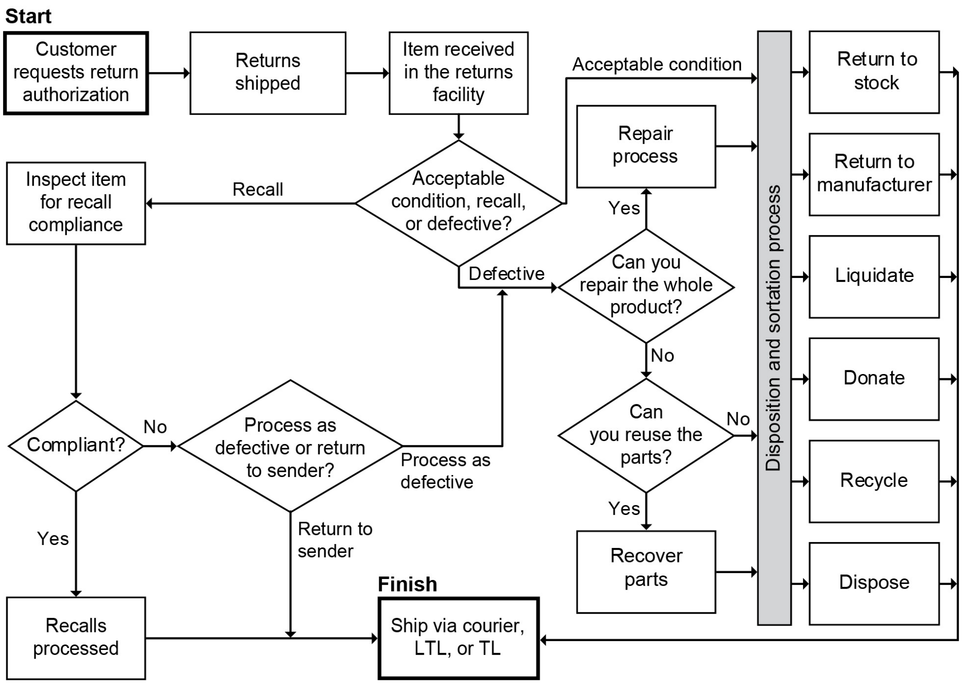
The design of the reverse logistics network involves determining where in the process to locate the various reverse logistics activities. Returns happen at the retail level and back up the chain from there to distribution centers, manufacturers, suppliers, and so on. Determining where products will be tested, remanufactured, and so on requires a total cost of ownership analysis that may involve collaboration among many supply chain partners to determine the best point overall. The location or locations that make the most sense may involve weighing cost, customer service, and speed. These activities could be centralized at one location or distributed among retailers, distribution centers, or suppliers.

Another important consideration in the design of the reverse logistics network is whether all or parts of the function will be contracted out to 3PLs. Organizations such as Frito-Lay remove expired inventory as part of the process of stocking new inventory at retail locations using their own drivers. Transportation might be outsourced to small package services such as UPS or FedEx, while testing and refurbishment is retained as a distribution center responsibility. At the other end of the spectrum, the entirety of the process could be outsourced. Organizations such as GENCO ATC specialize in liquidating returns, which could result in some amount of revenue inflow to the organization or at least lower revenue losses than the organization could achieve on its own.

Handling returns

When handling returns, an organization must first assess and categorize returned items, based on their condition and status. To do so, returned products are first centralized in a single location. Then disposition, the process of determining the appropriate category for each returned item, takes place, as seen in Exhibit 2-129.

Exhibit 2-129: Disposition of Returned Products



Adapted from © "Reverse Logistics Process Flow," Greve-Davis. Used with permission.

The disposition of each item is an important decision, since about 80 percent of the value of the reverse logistics process depends on matching the product with the best disposition option. The exhibit shows six options for how a returned item can be handled:

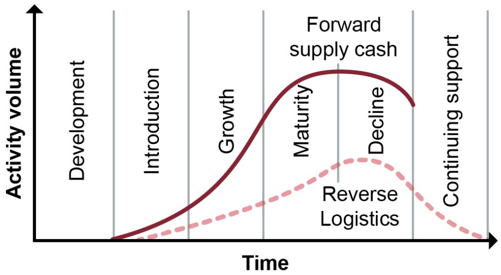
- Return to stock (e.g., an unsold item still in its original package or a sold item that is unused)

- Return to manufacturer or producer (e.g., refillable beverage and liquor bottles, packing crates)
- Liquidate (sell to a secondary seller or market)
- Donate (e.g., to a charitable organization as a tax write-off)
- Recycle
- Dispose (e.g., bury in landfill, incinerate)

Life cycle design

Reverse logistics considerations affect the entire product life cycle, not just the last phase. Exhibit 2-130 shows how the forward product life cycle and the reverse logistics cycle create similar curves when measured as volume of activity over time. However, the reverse logistics curve is shifted forward, since returns don't start until products are shipped, and it is smaller, because only a percentage of products will be returned.

Exhibit 2-130: Product Life Cycle with Reverse Logistics Cycle



A continuing support phase is also added in the exhibit. This is not a traditional phase of a life cycle, but it is added here to illustrate that the reverse logistics cycle may have ongoing costs and revenues. Such a period may be necessary if there is a warranty period, a service contract period, a period of guaranteed service or parts availability for discontinued models, or a period in which products will be accepted for hazardous or other waste recycling or disposal. This period could last indefinitely, depending on organizational policy. For example, Sears famously replaces even very old broken tools as part of a lifetime guarantee.

Design and development

Several aspects of reverse logistics should be built into product design and ramp-up:

- Plans need to be made during product design for potential reuse of the product or its components.
- Avoiding use of hazardous or scarce materials, especially rare earth elements (REE) and metals (REM), can be designed in if substitutes can be found.
- How to make good use of resources, including energy, should be incorporated into design decisions.
- Consideration of how to package and ship the product most efficiently shouldn't be put off until the new product hits the shipping dock.

Not only do locations need to be selected, but forecasts should be done for the products coming back as well as going out. Customer service needs to be trained to handle the procedures and paperwork involved in returns, refunds, and repairs. As supply chains going forward and backward extend across oceans and national boundaries, network design becomes increasingly important.

As an example of a process design, in the Netherlands, DAF Trucks (a PACCAR company) has a long-term relationship with Van Gansewinkel, their garbage and scrap metal collector. Formerly, the garbage bins (rolling containers) were filled in the plant and pulled outside to a garbage compressor. Now a small garbage truck drives into the plant to collect the garbage. Not needing to tow containers back and forth has reduced costs by 5 percent per year. The same trucking company has also redesigned its product packaging. A DAF plant in Belgium produces body parts that are sealed in plastic to prevent scratching. Originally, DAF used the lowest-cost plastic and had to pay to dispose of the used plastic. Van Gansewinkel proposed using a different type of plastic, which was more expensive but had a market value after use. The total cost of plastic has worked out to be lower.

Product introductions

Even in the initial phase of a product introduction, reverse logistics comes into play:

- Customer service has to be prepared for early returns of the new product, since defects and disappointments are more likely during ramp-up than during later stages of a product's life. High-quality customer service can prevent the worst effects of early product failures. (There's a role for sales and marketing here, too.) A flood of early returns can cause serious logistical problems—not to mention the negative impact on reputation and customer loyalty—if the reverse supply chain hasn't been set up to handle such an unpleasant surprise.
- If early product returns are heavy, design engineers need to be prepared to make rapid improvements in the product.
- The service department needs to be in place at this time, as does an inventory of replacement parts.

Maturity

Reverse logistics events continue into product maturity:

- Returns are a high-volume operation in some industries—up to 10 percent for computers.
- Receiving areas need to be designed to accommodate operations required in handling returns, such as repackaging and inspections.
- Packaging for returns needs to be considered along with packaging for forward shipping. For example, HP laser cartridges are delivered to consumers in a box with simple instructions for how to repackage the used cartridge in the same box and give it, free of charge, to any UPS driver or facility for shipping back to the manufacturer. This reverse network, complete with training for UPS, had to be in place and ready to receive cartridges when the first products were shipped to retailers.

Decline, return, and continuing support

The reverse supply chain should be designed to anticipate problems that will arise after the product ceases to be useful. Product continues to be shipped—in both directions—because of returns, recalls, etc. The following are significant concerns relevant to product decline, return, and continuing support:

- Preparation should be made for any environmental and legal exposures. This is especially true with hazardous materials—such as lead used in jewelry—that are subject to extra regulations locally, nationally, and internationally. Hazardous materials are covered elsewhere.

- Nonhazardous materials may also be subject to extra regulations. For example, one beer manufacturer requires its distributors to have a permit to dump recalled beer. The glass and cardboard packaging also have to be recycled at the same time.
- Final disposal needs to be documented and the records kept for a period of years.
- Packaging as well as products should be designed for reuse or made biodegradable.
- Parts, customer service support, and other services may need to be provided for a certain period following the discontinuation of a product.

Topic 3: Reverse Logistics Benefits and Costs

Benefits

The benefits of a carefully designed reverse logistics supply chain that maximizes resource conservation, reuse of components, and recycling of materials include

- Potential for highly lucrative customer service contracts and extended warranties (especially if the products are well designed and reliable)
- Mitigation or elimination of the unprofitable effects of high-volume returns
- Enhanced customer loyalty and corporate reputation
- Return of valuable raw materials for other industrial uses
- Development of more efficient products and logistical tactics
- Profits from resale of refurbished products and parts that would otherwise go into landfills at a cost to the company
- Creation of new types of jobs
- More efficient use of energy
- Conservation of resources for future generations
- Reduced emission of many greenhouse gases and water pollutants
- Development of "greener" technologies
- Reduced need for new landfills and incinerators.

A key benefit of reverse logistics is that many activities can generate revenue. These revenues come from several sources:

- Service contracts and extended warranties bring in substantial cash flows and provide peace of mind for customers.
- Remanufactured products and recovered materials are finding profitable markets.
- Repair fees can be in excess of repair costs.
- Recycling fees can offset any costs involved in taking back products. Charges for recycling motor oil after an oil change, for example, are now taken for granted in some markets.

Costs

Costs from several sources have to be considered when determining profitable fees and prices, for example, costs for providing return labels in packaging. Other associated expenses affect the supply chain in the following ways:

- Warranty repairs have to be charged off.
- Spare parts may be needed for repairs.
- There may be special processing and handling costs involved in returned materials.
- Freight costs can be high for sporadic, low-volume shipment, and extra transportation legs may have to be added to the network to accommodate destinations specific to returns and recycling.
- Warehousing costs can be higher for small numbers of items that need to be restocked or stored in separate locations.

Total cost calculations for returns sum the various revenues and deduct the various expenses. This amount can be tracked for benchmarking purposes and for comparison to other options in a make-versus-buy analysis.

The total cost of reverse logistics can be calculated as follows:

+	Returned product liquidation revenue
+	Recycling revenue
+	Repair revenue
+	Restocking charges and warranty/service program fees
+	Increase in sales from warranties, remanufacture programs, environmental reputation, etc.
+	Capture of tax savings or incentive program benefits
-	Returned product cost of goods sold
-	Processing and handling costs
-	Transportation costs
-	Repair and spare parts costs
-	Warranty expenses and returns credits
	Total cost of reverse logistics

Chapter 2: Waste Considerations

This chapter is designed to

- Explain how the waste hierarchy provides various options for handling waste but places prevention ahead of mitigation
- Show how in some cases waste exchange can repurpose the organization's waste and provide an additional revenue stream
- Explain how a waste exchange is also a market exchange that links buyers with sellers of waste and by-products
- Define hazardous waste and describe how it requires special transportation, storage, and disposal.

The *APICS Dictionary,* 16th edition, defines **waste** as follows:

> 1) Any activity that does not add value to the good or service in the eyes of the consumer. 2) A by-product of a process or task with unique characteristics requiring special management control. Waste production can usually be planned and somewhat controlled. Scrap is typically not planned and may result from the same production run as waste.

Waste is a consideration not only for compliance and ethical reasons but also for economic ones. Some forms of waste may be inevitable given the nature of a manufacturing process. Some options for processing or disposing of waste will result in significant costs, with some being more expensive than others. The idea is to find the best option that addresses compliance, organizational risks, liabilities, ethics, and reputation while remaining a cost-effective choice. Dealing with waste in this way is called total waste management. The *APICS Dictionary,* 16th edition, defines **total waste management (TWM)** as

> a methodology that enables finding solutions to waste issues while keeping in mind financial elements and the business case.

Organizations that produce less waste have more of their cost of goods sold going into what the customer considers to be value-added. (Proper handling of toxic wastewater is an example of something that the customer indirectly pays for but does not value.) This is why the definition of waste discusses how waste "can usually be planned and somewhat controlled." The following discussion of the waste hierarchy looks at how preventing waste in the first place is the best option for keeping an operation profitable.

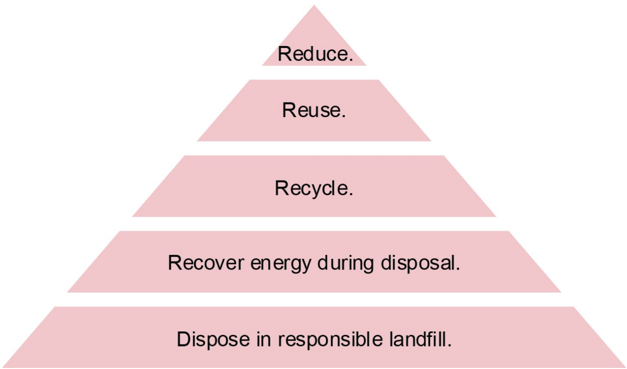
Topic 1: Waste Hierarchy

The *APICS Dictionary,* 16th edition, defines **waste hierarchy** as

> a tool that ranks waste management options according to what is most environmentally sound. It gives top priority to preventing waste in the first place, and can be applied to various applications.

The waste hierarchy is sometimes called the reverse logistics hierarchy or the four Rs. In order of importance, the Rs are reduce (use of resources), reuse, recycle, and recover (energy). Exhibit 2-131 shows the relationship of the four Rs and places an additional item, the least desirable option—disposal in a landfill—at the bottom. We'll look briefly at each of these activities to see why they are considered beneficial to business, society, and the environment.

Exhibit 2-131: Waste Hierarchy



Reduce resource use.

Reducing the use of resources in the first place is considered the most responsible option in the waste hierarchy. Companies can incorporate this principle into their business in the following ways:

- Reduce costs by designing products and packaging that make the most efficient use of physical resources.
- Design products with an eye to reducing the consumption of energy in their manufacture and use.
- Design the logistics network for efficient use of resources and energy in warehousing and transportation. (This is a straightforward matter of cost containment.)
- Reduce excess inventories by investing in supply chain demand management, visibility, and other processes discussed elsewhere in these materials.
- Repair or restore products and return them to the customer for an appropriate fee (unless under warranty). This strategy requires maintaining a repair department, contracting this service out, and/or allowing the market to provide these services independently (e.g., automotive repair shops).

The reduce step in the hierarchy is a preventive measure that ideally takes place during the design and development phase of a product’s life cycle but could be implemented as part of a continuous improvement initiative. For example, a clean technology such as a new machine press that produces less waste could be included in production plans or as an upgrade. The *APICS Dictionary,* 16th edition, defines **clean technology** as

> a technical measure taken to reduce or eliminate at the source the production of any nuisance, pollution, or waste and to help save raw materials, natural resources, and energy.

The importance of considering waste during product design and development is illustrated by the 40/30/30 rule. The *APICS Dictionary,* 16th edition, defines the **40/30/30 rule** as

> a rule that identifies the sources of scrap, rework, and waste as 40 percent product design, 30 percent manufacturing processing, and 30 percent from suppliers.

While this is a rule of thumb and could differ depending on the product, it shows how up-front work during the design of products and manufacturing processes and supplier selection will have big payoffs in waste reduction, which will lead to efficiency improvements and thus to higher profitability.

Reuse products or components.

Potential reuse of products or parts of products is considered second in importance to resource conservation. The payoff is a reduction of the costs involved in purchasing, transportation, and disposal. This can be accomplished in several ways.

- Resell returned products that pass quality control, repackaging and relocating products as needed (to new selling locations, including resellers).
- Donate excess inventory to charities as appropriate and allowed, which may provide a tax benefit. (For example, Habitat for Humanity, a charity that builds homes, is a common recipient of excess building materials.)
- Remanufacture products to like-new condition by replacing worn parts with new parts and sell at a discount or as part of a trade-in program. This is especially appropriate for big-ticket items; for example, Caterpillar has a program like this for industrial equipment.
- Sell by-products to organizations that can use them as raw materials (discussed in detail elsewhere).
- Design products so materials and components can be more easily separated for reuse. This is called design for disassembly and recycling.

In addition, intelligently designed product upgrades can extend the life of durable components if they are easy to install. Software upgrades delivered online, for example, extend the life of programs without requiring physical delivery. Such upgrades result in savings in the logistics network and for the consumer. Rechargeable batteries make possible reuse of a battery that would otherwise be dead and ready for recycling.

Recycle materials.

After resource conservation and reuse, recycling is the third most important aftermarket principle. The concept of recycling isn't easily separable from the concept of reuse, and, in fact, the two can be combined. When containers (bottles, barrels, totes, drums, etc.) are cleaned, sterilized, and filled again, they are reused. When containers are reprocessed into other products, such as landscaping materials, they have been recycled. When a product is broken down into components, some parts may be reused, some recycled, and some sent to the landfill. Recycling reduces disposal costs; reuse can reduce purchasing and transportation costs as well.

Recycling can run into problems when different regions enact different requirements, creating diseconomies of scale. Organizations are often forced to customize programs for multiple local areas, which entails different methods, different training, and so on.

Recycling requirements can also change. For example, while lead acid batteries from cars have a 99 percent recycle rate, the new Lithium-ion batteries used in electric cars (such as Tesla) have not yet developed a recycling stream. In ten years or so, when these electric cars reach their end of life, this issue will become critical. Advocating now for solutions at the federal levels of government would allow this process to be consistent.

Recover energy.

Disposal with energy recovery doesn't put a product's physical materials or components back into service, but it can still provide benefits. "Trash to energy" facilities essentially harvest the energy contained in products that are no longer usable in their physical form. This results in savings for the community. Organizations might directly benefit from this practice as well, for example, by using oil that has already been used to the maximum extent as a lubricant as fuel to run generators.

Dispose in responsible landfill.

The *APICS Dictionary,* 16th edition, defines a **responsible landfill** as

> landfill operations designed to turn waste into recoverable resources, minimize the amount of space consumed, and maximize the operational life of the landfill.

Some physical products must go to the incinerator or the landfill, but this is the least desirable option. Incineration is generally considered the preferable alternative. Many modern incinerators, such as those found in Europe, generate very low emissions. If the landfill is the only possible way to dispose of a product, it’s still important to choose the best available one. Not all landfills are equal, so the final leg of a product’s reverse journey should end in a responsible landfill that prevents degrading items from leaching into a water source or polluting the air.

Topic 2: Waste Exchange and Hazardous Waste

Waste exchange

Waste exchange is a way of reusing waste so that it does not need to be recycled or disposed of. The *APICS Dictionary,* 16th edition, defines **waste exchange** as follows:

> 1) Arrangement in which companies exchange their wastes for the benefit of both parties. 2) An exchange service of valuable information between generators and potential users of industrial and commercial wastes, whereby a beneficial use rather than disposal is the end result. This service identifies both the producers and potential markets for by-products, surpluses, unspent materials and other forms of solid waste that is no longer needed.

One organization's by-product or other type of waste may be another organization's raw material. Long ago, tanners would collect chamber pots around the community each morning to use when tanning leather, which provided a side benefit of reducing the amount of human waste flowing through the streets. Today, many organizations seek to sell their by-products or other waste at market rates, both generating revenue and reducing disposal costs. In the waste hierarchy, this would qualify as reuse of materials, so it is quite high on the scale of effective responses.

The second part of the definition of waste exchange reveals that organized information exchanges are the key to finding or creating a market for certain waste products. Tyson used to discard its chicken feet until it discovered that there was a huge demand for them in Asia. Now it ships these overseas. In fact, every part of the chicken gets used for something. Even the feathers are baked and become a powder additive to pet food.

Nonprofit information exchanges exist on a regional basis to help connect buyers with sellers and thus create a market. Either party can specify what they have or need. Buyers may specify how frequently they need it and in what quantity. Transportation and handling could be part of the negotiated price; for example, a low-value waste product could be offered for free provided that the buyer pays for shipping and handling.

Hazardous waste

Materials that have no known alternative use and could harm the human or natural environment are considered hazardous waste. The *APICS Dictionary,* 16th edition, defines **hazardous waste** as

> waste, such as chemicals or nuclear material, that is hazardous to humans or animals and requires special handling.

Hazardous material includes chemicals; wastewater; various forms of human and agricultural waste and sewage; radioactive, construction, electronic, and biohazard waste; and many other types. In many cases, hazardous waste is more than one type because multiple types of pollutants are mixed together. Some hazardous waste is relatively safe for humans but highly toxic to other organisms such as fish or bees. The waste hierarchy applies just as much or more to hazardous waste. Reduction or avoidance of hazardous waste is the best method for dealing with it.

Compliance with regulations

Various government agencies enact regulations based on legislation regarding hazardous waste. These agencies will monitor or audit organizations for compliance in addition to requiring reporting and record keeping. Monitoring and audits may include plant inspections, testing discharge sources at the point of discharge or in the local area (such as downstream from a river discharge point), or testing nearby groundwater.

Hazardous waste regulations also specify the means to be used for its transportation, storage, and disposal. These methods will differ by type of material. Necessary safety procedures take into account whether the waste could be explosive or corrosive, form a toxic gas cloud, and so on.

Compliance with hazardous waste regulations requires keeping careful records of what categories of hazardous waste are being processed along with a chain of custody that provides evidence that the materials were properly processed. When it comes to disposal, options may include supervised incineration on site or transportation to a specially designated hazardous waste disposal site with the proper permits for handling the type of hazardous waste in question. Proof of delivery needs to be provided in reports and retained in archive records.

To assist with compliance efforts, the United Nations has created an international standard for identifying hazardous chemicals. The *APICS Dictionary,* 16th edition, defines the **Globally Harmonized System of Classification and Labeling of Chemicals (GHS)** as

> an international standard, created by the United Nations Economic Commission for Europe (UNECE), for classifying chemicals according to their health, physical and environmental hazards. The system defines and classifies the hazards of chemical products, and communicates health and safety information on labels and material safety data sheets.

While this system exists primarily for hazardous materials used in products, it does specify how to properly dispose of hazardous waste once the product has been used or is no longer needed. In either case, safety data sheets (SDS) indicate proper safety gear to use, what to do if exposure occurs, and the possible effects of any exposure on humans or other animals or plants. When products with hazardous ingredients are provided to consumers, they also need to be educated as to their proper use and disposal. Note that there is a link to an example of an SDS in the Resource Center.

Strict waste regulations exist in the European Union and in many other places. Let’s look at two regulations used in the EU as examples.

- The Wastes of Electric and Electronic Equipment (WEEE) legislation in the European Union places the burden of disposing of computers, monitors, televisions, printers, and other devices and peripherals on the manufacturers. Consumers can deliver the devices to the manufacturer, and the manufacturer cannot charge a fee. The manufacturer is required to properly identify and dispose of the materials. This legislation provides incentives to rely more on the higher activities in the waste hierarchy, for example, recycling before responsible landfill. A large number of U.S. states have similar “e-waste” legislation.
- The EU’s Restriction on Hazardous Substances (RoHS) Directive is aimed at the apex of the waste hierarchy—reduce—and the product development life cycle stage. It limits the amounts of lead,

cadmium, mercury, hexavalent chromium, polybrominated biphenyl, and polybrominated diphenyl ether that new electrical and electric equipment can contain for it to be sold within the EU from any source.

Organizations can partner with regulatory agencies to make compliance easier. They can also exert lobbying influence on the regulations themselves or through an industry nonprofit association to ensure the regulations are clear and easy to follow.

Index

A

C

D

F

G

H

I

L

P

R

T

W