

# Packaging for Logistics

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**Abstract.** Packaging for logistics is an approach where various levels of packaging systems (primary, secondary, and tertiary) interact with logistics systems (pallets, carriers, and warehousing) and adapt to each other. Logistics costs such as pallets, transportation, vehicle size, storage, and handling depend on the sizes and units of packages. Packaging system performance is analyzed considering the impact of the packaging system on overall logistics performance, such as the inter-relationships between primary, secondary, and tertiary packaging essential requirements, warehousing, and transport performance. Logistics performance is affected by the interaction between various levels of packaging and logistics systems. It is not unusual for some goods to be received at a warehouse in less than perfect condition. These damages during shipment are due to improper packaging. Through this case, readers will understand packaging types and their interfaces at various levels and the impact of packaging design on logistics costs and performance.

**Keywords:** types of packaging, palletization, containerization, transportation, loading/unloading, optimization of packaging size.

## 1. Introduction

Whether grown or manufactured, practically every product needs to be packaged to reach the consumer in an acceptable condition. Packaging involves preparing and enclosing goods suitably for handling, transport, distribution, storage, retail, display, selling, and end-use. Packaging is an art, science, and technology. Primarily packaging protects the product or products through its journey starting from origin to destination without losing its intended purpose and function. For example, a food product needs retain its flavours, aroma and freshness during its shelf life, and a glass item needs to be protected from shocks and vibrations, and a consumer electronics item needs to be stable from temperature changes during transport.

From a marketing perspective packaging is considered as part of the product and its brand. Packaging creates an impression of the product itself until the actual product is consumed. Under the self-service retail system, package design plays a vital role in sales, acting as a salesperson on the shelf. Consumers expect the package design to be user-friendly in terms of carrying, ease of opening, closing, handling, security, product integrity, reuse, and disposal, and provide all the necessary information required in purchasing

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decisions. With a solid ethical identity concerning the environment and human relations, the packaging assists the consumers' decision-making and drives purchasing. Usually, marketing managers play a critical role in designing the consumer packaging (primary packaging) from a marketing point of view and collaborate closely with operations managers to check the feasibility of the packaging design in production and distribution processes.

From an operations perspective, the packaging is considered as part of the production process. Operations managers contribute their knowledge in primary packaging design to protect the product from physical, chemical, and biological contamination during production and throughout the product's shelf life. Lack of safety considerations in packaging design may have a severe economic impact due to physical damage to packages, product recalls, brand image, mistrust, loss of sales, and non-compliance with legislation requirements during the distribution process and others. Operations managers are expected to understand and implement Hazard Analysis and Critical Control Point (HACCP) principles, Good Manufacturing Practices (GMP), sustainability, and related safety control processes in the packaging design and manufacturing. Distribution of products requires bundling in suitable lot sizes. Operations managers must pay attention to the primary and secondary packaging materials and their interphases to manage the cost and service implications. Over-packaging to protect the product and damage to packaging material may affect the product's profitability, and under-packaging may result in damage to goods, customer claims, and lost sales, which may exceed the packaging economics.

## **2. Impact of Packaging on Supply Chain and Logistics**

According to Azzi *et al.* (2012) "approximately 9% of the cost of any product is likely to be the cost of its packaging. Hidden costs associated with over-packaging in Europe seem to be 20 times higher than the cost of excessive packaging materials." While the supply chain and logistics departments tend to optimize the logistics system, marketing and production departments tend to optimize the packaging system, resulting in a conflicting situation between the two systems, sometimes impacting the total cost and performance. After conducting a study at Procter & Luca (2016) stated that "between 2% and 10% of products (depending on country and category) ended up damaged due to various warehouse procedures, transportation, and store handling methods." A further study conducted by Van Hoek & Chapman (2006) stated that "the main reasons for these damaged products the packaging was unsuitable for the supply chain." Similarly, a study on retail markets in five European countries (European Organization for Packaging and the Environment, 2009) stated that "the wasted volume between the primary and secondary packaging varied

between 34% and 50%. Between the secondary packaging, which is usually a box, and the pallets, the unoccupied space varies between 46% and 64%". Better packaging can provide efficiencies in terms of packaging design, materials, converting, logistics processes, material handling ergonomics, supplier relationships, and lost sales. For years, the packaging companies have focused on issues such as downgauging and reusing material. To address environmental concerns, various Governments are introducing regulations and waste management policies imposing environmental taxes and insisting on taking back and recovering the packaging material.

Environmental protection on account of packaging is emerging as a challenge for operations managers. The social sustainability of packaging design can be associated with innovation and ethics in packaging that encourage:

- a) Recycling activities including minimising the usage of multiple layers of material, reducing the weight and size of packages, etc.
- b) Conveying proper information on safe disposal of the packaging material after consumption of the product.
- c) Designing innovative packaging which discourage "throw-away mentality."

Many designs and decision support tools are available for the packaging designers to compare different packaging formats based on Life Cycle Assessment (LCA) and to assess the sustainability of the designed packaging systems. For example, "Packaging Impact Quick Evaluation Tool" (Verghese *et al.* 2010) and Comparative Packaging Assessment (<https://greenblue.org/work/compass/>).

Logistics involves manual handling and lifting to different degrees depending on package sizes, shapes, and weight. For handling multiple or large size packages, they need to be unitised appropriately. The term unitization is used for combining the products as multiple packs such as secondary packages and tertiary packages as unitized loads with the objective of efficient handling, storage, and shipping. When the unitized loads are kept on wooden and plastic pallets, boxes, and bags of standard sizes, they can save handling, loading, and unloading of the goods in trucks or containers and save the labor time and cost. Packaging designers can adopt international standards to choose the best design solutions to meet ergonomic and manual handling principles for weight limits and optimal handling configurations. For example, ISO 11228 standards provide information on designing a packaging system for all types of manual handling activities (<https://www.iso.org/standard/26520.html>).

Standardizing packaging material and the sizes will decrease handling costs, vehicle loading-unloading time, and reduced the need for specialized equipment. The right information on packages decreases the handling duration, and labour cost. The size and density of packages impact transport

and storage costs, unit loading techniques, and automatic identification of inventory.

Various stakeholders along a supply chain have their own interest in the packaging design for efficiency in product handling and the economics of the package cost. This may result in a conflict of interest along the supply chain resulting in inefficiencies; for example, suppliers prefer a package that is easy to handle and transport to minimize the logistics costs, a manufacturer would consider machinability of the packaging material, safe transportation, handling, and environmental protection. The wholesaler may be mainly interested in a package that is easy in warehousing and transportation rather than of attractive shape and size. A retailer considers marketing and environmental aspects. End-users are typically interested in the right portion pack, easy storage, handling, reuse, safe disposal, etc.

### 3. Packaging System

Shapiro and Heskett (1985) argued that “the packaging system assures the availability of the right product, in the right quantity, in the right condition, in the right place, at the right time, to the right customer, at the right price.” Hellstrom and Saghir (2006) recognize packaging as “a hierarchical system, the performance of which is affected by the interactions between levels.” Based on the type of product and distribution system, packaging can be broadly classified as primary packaging (or “sales packaging”, or “consumer packaging”), secondary packaging (or “group packaging”, or “distribution packaging”), and tertiary packaging (or “transport packaging”).

#### 3.1. Primary Packaging

**Primary** packaging is the packaging that holds the product or contains it in an enclosure made of paper, plastic, metal, glass, metal, wood, rubber, etc., to protect the product physically and its characteristics from the production or manufacturing stage until it reaches the customer and is consumed (see Figure 1). Primary packages are mostly printed with colorful graphics directly on the package to attract the customer and provide product information, usage, safety, and disposal instructions. If the product volumes are low, the variable is high; printed labels are fixed onto the boxes. Primary packaging is also referred to as retail packaging, consumer packaging, and sometimes as a “salesman on the shelf”. From the marketing perspective, primary package design depends on the four ‘Ps’ of marketing (product, place, price, and promotion), and from the operations perspective, it depends on material characteristics, machinability of the packaging material, and handling. For example, fresh milk can be packed