Chapter-3

Sustainable Material Optimization for Cost Reduction

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ABSTRACT

This chapter provides a thorough analysis of the sustainable material optimization strategies used by the pharmaceutical and cosmetic packaging sectors to cut costs. Despite notable advancements in the field of sustainable pharmaceuticals and cosmetics, the production of sustainable packaging in large quantities has proven to be difficult. It can be challenging to choose the best course of action among diverse supply-chain components located all over the world due to the complexity of environmental, economic, social, technological, and policy considerations, as well as differences in consumer behavior and corporate objectives. Additionally, the expense and effort involved in creating, evaluating, and validating alternative strategies deters empirical research into possible alternatives. One industry that is constantly growing worldwide is pharmaceutical and cosmetic packaging. By 2018, it is projected that the market will have grown to a value of $78.79 billion. Success, safety, and sales all depend on packaging. Pharmaceutical packaging must meet the same standards for quick packing, protection, identification, product quality, patient comfort, display, and security as other packaged commodities. Pharmaceutical research and development advancements have always been reliant on packaging technology. High-quality packaging ensures that drugs maintain their integrity during transportation, storage, and delivery.

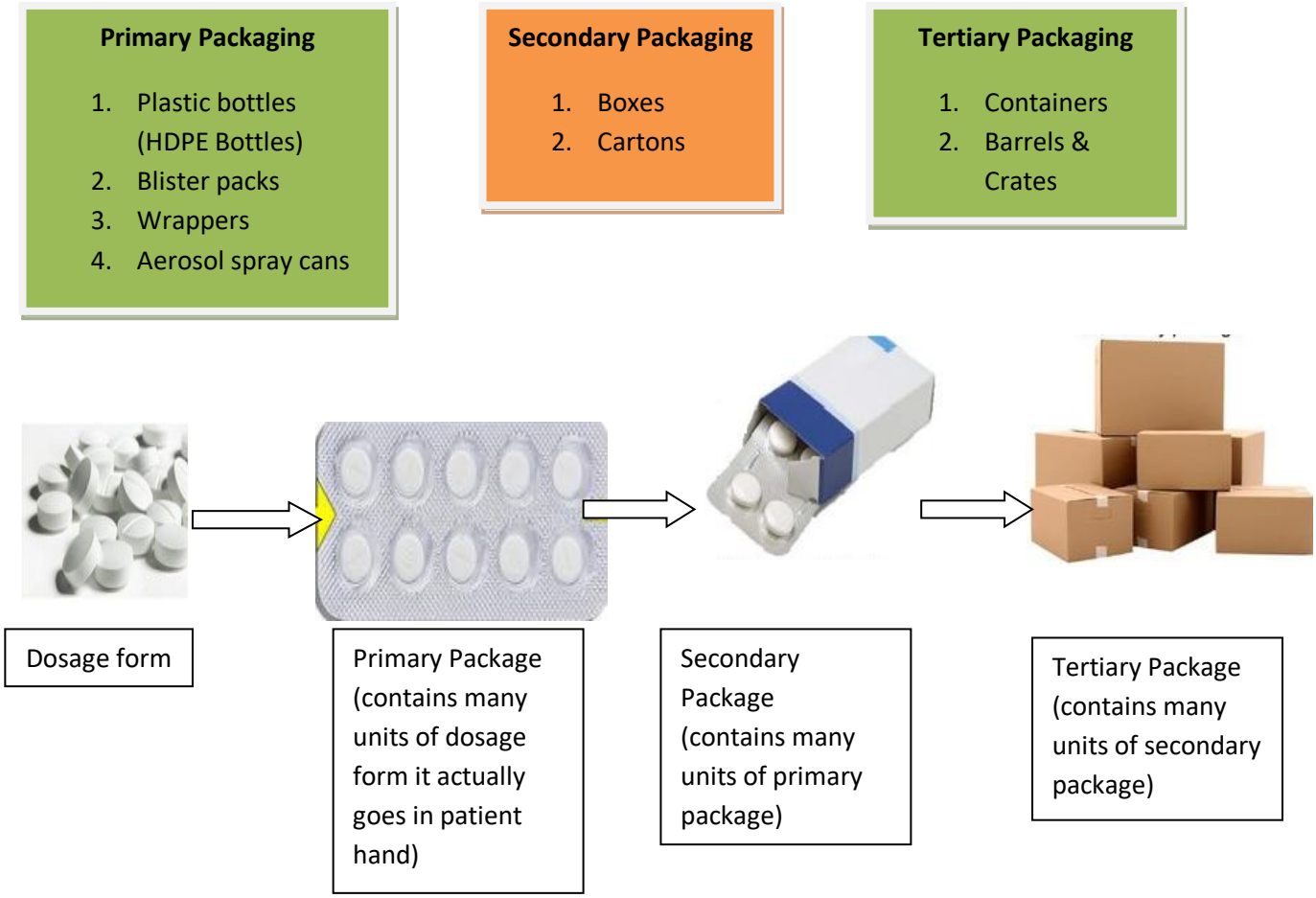
Keywords: sustainable material, cost reduction, pharmaceutical and cosmetic packaging.

INTRODUCTION

Packaging is a term used to describe a method that keeps pharmaceutical and cosmetic products contained from the point of manufacture until they are used. Pharmaceutical packaging is used to supply solid and semisolid dosage forms, powders, poultices, blood and blood products, surgical instruments, life-saving medications, and nutraceuticals[1]. In essence, pharmaceutical packaging offers transportation convenience, drug safety, identity, and confinement. Packaging for pharmaceuticals must strike a balance among several intricate factors. Pharmaceutical packagers have moved on from relatively simple issues like creating attractive designs and interacting with customers to more urgent ones like combating counterfeiting, promoting patient compliance, guaranteeing drug integrity, and striking a balance between accessibility for the elderly and child resistance. A cosmetics product's overall appearance, in addition to its quality, is one of the most critical drivers of its market attractiveness[2].

Sustainability is becoming an increasingly crucial prerequisite for human activity, making sustainable development a key goal in human growth. At its core, sustainable development is the belief that social, economic, and environmental concerns should be addressed concurrently and holistically in the development process[3]. Human well-being, the economy, and the environment are the three primary components of sustainability. These three categories can be viewed as a means of promoting human well-being (i.e., equitable burden-sharing and social fairness) while also preserving the ecosystem's resilience. If the use of virgin resources is decreased and post-consumption products are recyclable or reusable from readily available materials, packaging materials are said to be sustainable. Material sustainability is determined by a variety of aspects ranging from the economic to the environmental, including costs and consequences, the usefulness of aesthetic features, production to end-of-life processing, and effects on a local to global scale[4].

Packaging Materials in Pharmaceuticals and cosmetics



Types of Packaging Materials

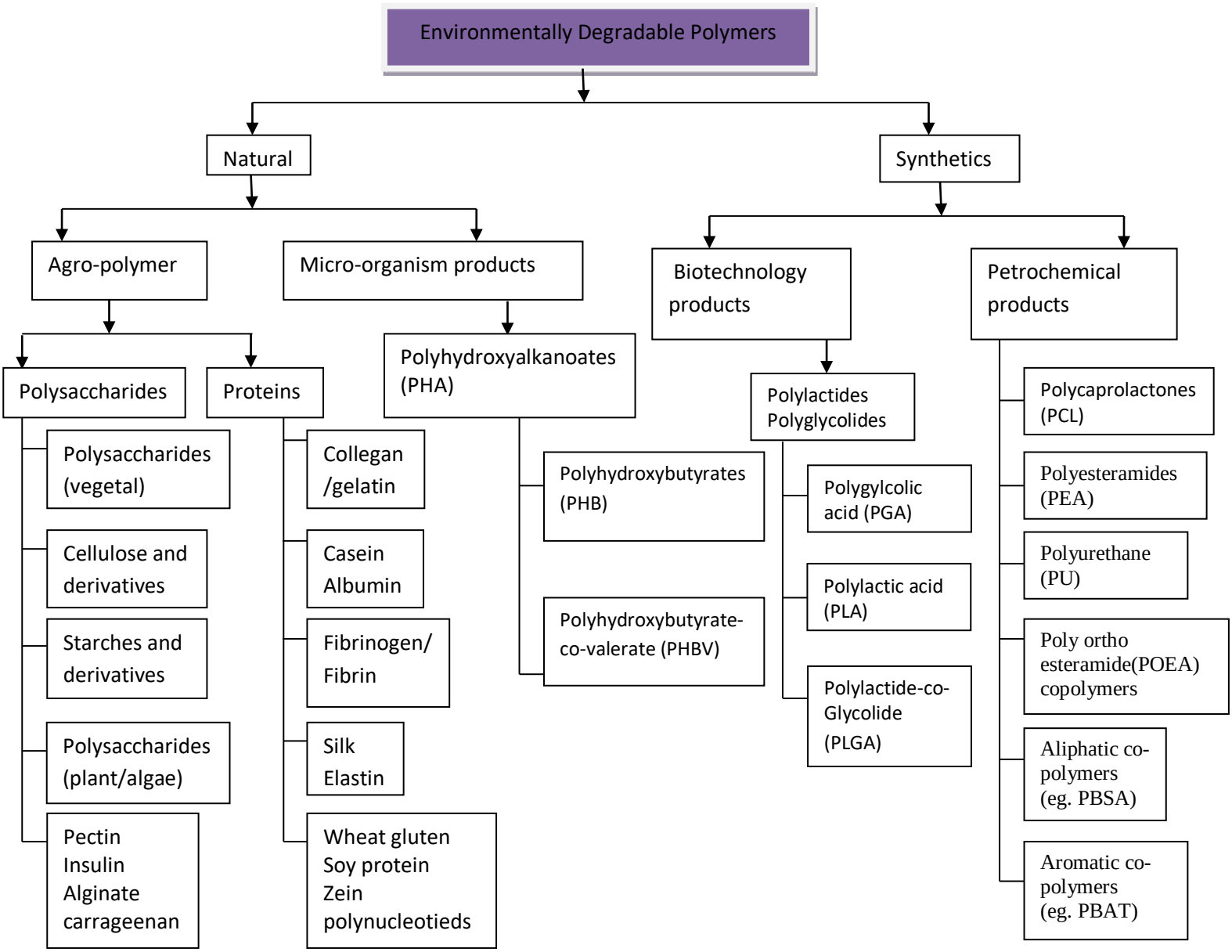
The link between the customers and the manufacturer is the quality of the packaging material, which guarantees the confidence the customers have in the product[5]. The selection of materials used for packaging is an important aspect of product presentation and preservation. The type of product is equally a determining factor when it comes to the choice of packaging materials. Various industries (food, cosmetics, pharmaceuticals, meat, etc.) have specific materials that are best suited to their products and services. Hence, there is a need for the discussion of different materials in detail[6].

1. Plastics

Petroleum-based polymeric materials have been widely used as packaging materials. Most of these polymers are polyethylene (PE), polypropylene (PP), polystyrene (PS) and polyester (PET). Plastic-based materials are the most used packaging materials, and about 26% of the total usage of polymers in packaging makes it the largest application of plastic materials[7, 8]. The usage of plastics is expected to double within the next duration of 20 years since it is fast replacing other materials used for packaging. This is due to inherent characteristics, such as good barrier properties, a lightweight quality, low cost, etc. With all the numerous benefits of plastic packaging materials but the production of petroleum-based materials comes with the release of carbon dioxide (CO_2) into the atmosphere[9]. The improper handling of packaging plastics or collection/recycling will make them end up in landfills and water bodies, therefore, polluting and contaminating the land and the oceans. Many industries are looking into alternative sustainable and environmentally friendly

materials. The recycling of plastic materials with several layers of different materials is challenging and not cost-effective. Hence, there is an urgent need for sustainable and environmentally friendly materials to overcome these challenges[10].

Several researchers are focusing on biodegradable materials with keen attention to enhancing the physical and mechanical properties of bio-based packaging materials. Biodegradable polymers can either be of natural or synthetic origin. There is a difference between biopolymer materials and biodegradable materials. All biopolymer materials are biodegradable, but not all biodegradable materials are biopolymers. Biopolymers can be made from renewable resources, e.g., starch, while biodegradable materials are materials that can decompose into inorganic compounds, such as carbon dioxide, methane, water, or biomass[11, 12].



2. Metals

Most of the time, the packaging materials and their contents come into direct touch, particularly with can drinks. When it comes to metal-based packaging materials, manufacturers put consumers' health and safety first. To prevent dangerous interactions between the content and container, it's important to follow fundamental regulations and conduct regular risk assessments[13]. Several metals are commonly used for packaging. These include aluminium, tin, lead, and chromium, among others. Aluminium is the most commonly used metal for packaging due to its cost-effectiveness, lightweight, flexibility, recyclable nature, and great heat resistance[14].

Applications of Packaging Materials

Packaging materials enhance product quality and prevent contamination. The product will determine the type of packaging material to employ. Similarly, the cost of generating packaging materials and environmental considerations are important deciding factors. Various regulations govern the selection of materials for dry and moist packaging. The subheadings below cover the various applications of sustainable packaging materials[15].

Cosmetics

Plastic and glass are the most commonly used packaging materials in the cosmetics business. This is due to their direct interaction with the product. Paper/paperboard can be used, but must be coated with polymers or aluminium foil to prevent it from absorbing the contents[16]. Packaging protects material from microbial contamination and light while also providing product information for marketing purposes. When constructing packaging materials for cosmetics, food, or pharmaceuticals, it's crucial to address leaching, which occurs when specific compounds migrate from the packaging material to the contents.

Priority should be given to carefully selecting and improving materials during manufacture. The necessary qualities necessitated the creation of biodegradable polymers for cosmetic packaging. The heart of this is the increased demand for new and superior materials, as well as the sustainability of packaging materials.Glass is another essential material for cosmetic packaging. Glass is thought to be one of the oldest packing materials. Glass is impermeable, nonporous, chemically inert, non-biodegradable, and recyclable. Cosmetic glass containers vary in shape and size. Glass containers have multiple applications, including perfume jars, lip balms, eye shadow, and liquid foundation. It can also be transparent or coloured glass, depending on the content and appeal to customers[17].

Pharmaceuticals

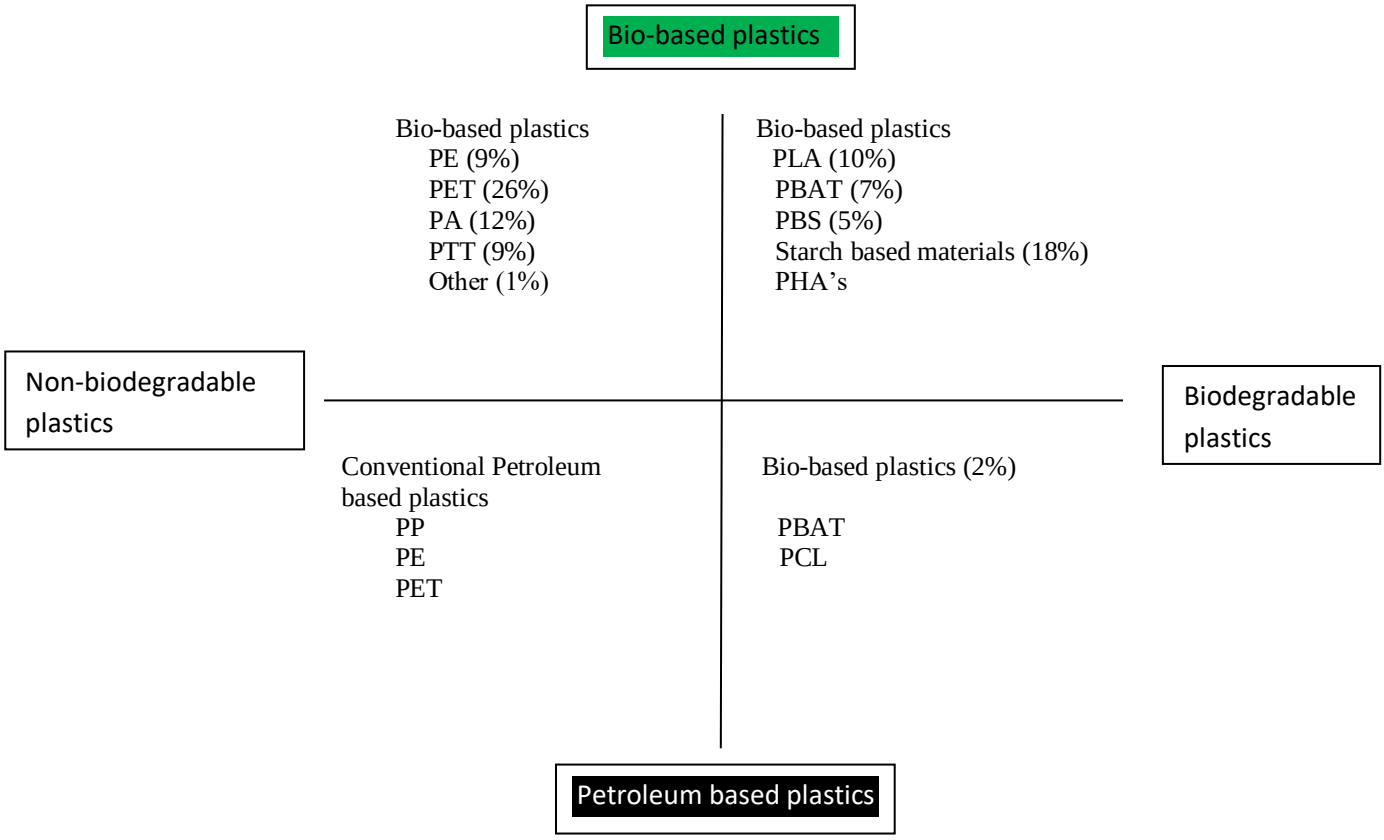
pharmaceutical products are chemical substances that can be synthetic or natural and have pharmacological or medical effects on the body. These products are categorized based on their therapeutic effects, the way they are administered and their chemical properties. Another important aspect to note, as explained by the author, is that they consist of antipyretics, analgesics, antibiotics, antiseptics, stimulants, antimalarials, stabilizers, statins, contraceptives, and tranquillizers[18]. Furthermore, they have several targeting potentials, such as cardiovascular, digestive, central nervous, endocrine, respiratory, reproductive, urinary, and immune systems and organs (skin, musculoskeletal, ear, eye, and nose). Thus, pharmaceutical packaging plays an important role in ensuring that the product meets the required goals. This could be during production, transportation, storage, sales, delivery, and use. Packaging materials protect pharmaceutical products from spoilage, loss of potency, contamination, unwanted environmental conditions (light, moisture, and oxygen) and provide information regarding the product and dosage. Pharmaceutical products are largely packaged in plastics, paper, and glass. Pharmaceutical packaging is divided into three parts, namely: primary, secondary, and tertiary systems of packaging. The primary system of packaging has direct contact with the medication, while the secondary system is the packaging outside of the primary container. The secondary packaging system could be a box, cardboard, or plastic crates. HVAX Viable Pharma Infrastructure described the tertiary system of packaging in the pharmaceutical industry as the package housing the secondary packaging system [19].

Measures for Improving Sustainability in Packaging

High usage of virgin resources may cause their depletion. Another consequence of the depletion of virgin materials is a scarcity of raw materials for the creation of packaging materials. Exploiting raw resources (from extraction to refinement) for packaging causes global environmental challenges. To promote sustainability in packaging, it's important to recycle discarded materials into new products. Packaging materials include paper, plastic, metal, and glass [20]. The packaging industry's sustainability depends on various aspects, including raw material availability, recycling methods, renewable resource use, and efficient product packaging policies. Plastic packaging, manufactured from petroleum-based polymers including PE, PP, PS, and PET, has been in

use for decades. These petroleum-based polymers are not biodegradable and have a recycling rate of less than 14%. Exploring ecologically friendly biodegradable polymers is crucial for the sustainability of plastic-based packaging products. Biodegradable polymers, including proteins, polysaccharides, lipids, and vegetal sources (e.g., cellulose, starch, chitosan, maize zein, whey protein, waxes, collagen) have been extensively studied [21]. These materials should be encouraged for packaging purposes. The government should adopt and implement policies promoting the use of biodegradable and recyclable materials. Similarly, packaging material manufacturers should endeavour to make their products 100% recyclable.

Investigating the impact of biodegradable and non-biodegradable plastics on packaging.



Manufacturers of packaging materials (e.g. glass, metals, paper/paperboards) should prioritize environmental sustainability by using recyclable and reusable materials. Metals such as aluminum are 100% recyclable [22]. Recycled paper is less water and energy-intensive than virgin pulp, with a lower environmental impact. Glass can be reused for several purposes, including fine aggregate in concrete and mortar. The % recyclability of packing materials is an excellent indicator of their sustainability. Manufacturers of packaging materials should prioritize adopting biodegradable and sustainable materials with high recycling rates [23].

Strategy to Reduce Cost of Packaging

1. **Improving Materials Storage and Packaging Lines**

   Is there a method to streamline your designs and speed up the packing process? If you'd like to improve your current operations, take these steps:

   - Analyze your current inventory of product packing
   - Identify similar items that could be grouped together
   - Identify infrequently used packing materials and group them together

2. **Reduce the Amount of Packing Time with Automation**

An automated packaging line will improve your operations in the following ways:

- **Increased output:** Automation speeds up your picking and packaging process, making your business more profitable.

- **Reduce your carbon footprint:** Manual sealing produces ample waste. An automated machine only uses the exact amount of material needed.
- **Reduce workplace injuries:** Automation reduces the likelihood of repetitive strain injuries, minimizing the risk of absenteeism and workplace injury claims.
- **Enhance your brand reputation:** Machinery introduces precision, giving you perfectly packaged and secured products. So you get to present a better-looking product to your customers, and reduce the likelihood of damage.

3. Optimize Packaging by Using Smaller Boxes

When you ship relatively tiny products in enormous boxes, you miss out on a simple cost-cutting opportunity. Consider the following ways to improve packaging and lower delivery costs:

- Maximize packing space: Ship as many things as feasible in a single packaging box.
- Diversify your packaging materials: Rather than using the same three box sizes, assess your average shipping size and ensure that you have appropriate packaging that does not incur dimensional volume rates.
- Use cushioned envelopes: Some of your products may be tiny enough to fit in large, padded envelopes instead of small cartons.
- Automate your processes: Automated packing technologies can instantly determine the best box for each product based on size.
- Negotiate shipping rates: If you send a significant number of products frequently, contact your account manager to negotiate preferred pricing. Remember, everything is negotiable. Before negotiating with your carrier, review your shipping data to gain a better understanding of your profile.

4. Minimize Returns by Ensuring Products are Properly Packaged and Transported

Another possible transit damage cause is poor load stability. If a carrier doesn't properly stack its loads or stacks its pallets too high, products can get damaged. Some causes, like prolonged vibration, are hard to avoid. In these cases, investing in durable packaging like heavy-duty boxes or protective stuffing materials is important. Poor load stability, while the carrier's fault, is harder to prove. A recommended approach is to use multiple carriers and determine which carrier manages your highest volume of damaged and returned products. If you identify such a carrier, you can either bring it up with your account manager or use a different, more reliable carrier altogether.

5. Redesign to Optimize Packaging

Cutting unit costs at the expense of product safety is never a good idea. That said, sometimes product packing is costly due to style, not substance. Consider redesigning your current packaging to optimize it for space. Moreover, you can eliminate pricey add-ons like labels by printing graphics or logos directly onto the packaging.

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