# Harm of Delivery Packaging on Environment and Improvements

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**Abstract.** In recent years, environmental problems caused by material production and consumption are attracting more attention. Express delivery packaging is a principal content of them since online shopping is getting more popular. The tendency of wasting resources on delivery packages should be taken seriously. This article summarizes different materials of the delivery package and the harm to the environment of them and accordingly raises several solutions. At present, plastics are the most prominent material of concern in terms of packaging for courier services, as their production and recycling procedures have the most significant negative influence on the environment. The impact of other types of courier packaging materials such as cardboard boxes, woven bags, and others should also not be overlooked. The production, use, and recycling processes of these materials can lead to issues such as microplastic pollution, excessive carbon emissions, and air pollution. Ways to improve and address these issues include using easily recyclable materials, replacing non-biodegradable materials with biodegradable green alternatives, reducing excessive packaging, and implementing relevant regulations and policies. The emphasis on decreasing the negative impact of delivery packages on the environment is significant for sustainable development.

**Keywords:** Packaging materials; express delivery; environmental influence.

## 1. Introduction

The artificial technological developments of the twenty-first century hastened the growth of online retailing and trade, which has increased demand for delivery services. Express delivery swiftly established itself as a growing service sector. However, there was a concurrent rise in packing waste due to the rising demand for quick delivery services. The environment has suffered as a result of this trend due to rising $CO_2$ emissions and energy demand [1]. Continuing to consume resources to the present extent without intervention is not a sustainable choice.

Existing essays have sufficiently researched on sorts of packaging materials and their characteristic but seldom gather in one essay. This article mainly means to introduce the overview of materials and usage conditions of delivery packaging. In order to raise awareness and improve the current situation, efforts are made to attract the attention of people. At the same time, analyzing the advantages and disadvantages of different materials and proposing improvements are also included. The existing solutions mainly include implementing "plastic restrictions" to limit people's use of plastic. Many food packaging materials have already started to widely adopt environmentally friendly and biodegradable materials. However, the express delivery industry still faces the problem of extensive use of non-environmentally friendly materials.

The form of express delivery packaging is various, mainly including plastics, corrugated board, jute, etc. Most of them are recyclable and reusable and are unable to create a great burden on the environment. In contrast, others are undegradable and hard to recover. Plastic is one of the most concerning aspects. Its production consumes non-renewable resources, and the difficulty of recycling and its environmental impact is significant. The excessive usage of those materials can bring a serious load to both the environment and the economy. Some harm is on the way forming and is in dire need of predicting and solving. Both the manufacturing process and the post-consumer process of delivery packages can lead to pollution. Ways to change the present situation contain improving the recycling process, taking reusable materials as replacements, decreasing excessive packaging and making improvements on policies.

## 2. Main Materials of Delivery Packaging

A crucial component of the delivery system is the packaging. Merchants select different packaging materials on the basis of the characteristic and vulnerability of commodities. In order to reduce the quality of delivery packages and protect them from damage, lightweight and wear-resisting materials are often chosen. At the same time, it plays the role of buffering some fragile stuff, therefore amortize wrappers such as air bubble film and air bags are used. In addition, packages are always stuck with cover sheets, which carry ink and glue on them. The following provides an overview of numerous materials that are frequently used in express delivery packaging, their primary chemical compositions, and their manufacturing procedures.

### 2.1. Plastics

Plastic is a kind of widespread material. Nowadays, plastic packages almost occupy one-third of express delivery packages. They are characterized by light, thin and anti-friction. However, as most customers discard the packages and the immature technologies, the recovery rate still keeps at a low value. Due to the non-biodegradable elements found in plastic packaging, such as polyvinyl chloride (PVC), polyester, expanded polystyrene, and polyethene, improper handling of packaging trash can have detrimental effects on the environment. Additionally, plastic packaging materials contain chemical residues from pesticide applications and are partially created from recycled agricultural films, which could be detrimental to expressmen and customers in the express delivery industry chain [2]. Furthermore, these harms are irreversible.

Plastics are present in many different types of forms in delivery packages. The most common one is tough black bags, which are hard to tear without scissors. They use polyethene (PE) as raw material, added between low-density polyethene (LDPE) and high-density polyethene (HDPE). Air-bubble blister stuffing and air column bags as shown in Fig. 1, are also known as common plastic materials, LDPE, linear low-density polyethylene (LLDPE) and nylon are mainly their raw material [3]. Foam plastic is also a commonly used lightweight and flexible plastic material. High consumption of bubble wrap and mini-polystyrene foams were used to safeguard goods in e-commerce packaging. Almost all of the currently used plastic materials are non-degradable.

**Fig 1.** Air column bag.
https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SLZJ202203017&DbName=CJFQ2022

Another popular plastic product is polylactic acid (PLA). It is a neotype biodegradable material which is produced by starches extracted from degradable vegetation resources. It can be totally degraded to water and carbon dioxide by microorganisms in nature and does not harm the environment. PLA is widely recognized as an environmentally friendly material. Fermentation is the prime step of the manufacturing process of PLA, which is moderate and does not produce as much pollution as industries do.

### 2.2. Corrugated Paperboard Boxes

Cartons are widely used in express delivery, which can effectively protect goods from squeeze and distortion. Its special physical structure allows it to withstand weight far greater than its own, effectively protecting people's packages during the delivery process. However, its drawback is that it is not waterproof. Corrugated and paperboard boxes are made from paper pulp, which contains substantial wood fiber, glue and some intensifiers. Pulp is obtained by cutting and cooking wood or waste paper. After the pulp is pressed to remove excess water and dried, it becomes paperboard. To form a paper box from paperboard, adhesive or tape is typically used for joining the different parts together. Paper boxes are easy to degrade and recycle themselves, but the additives can be harmful to soil and water. Besides, the process of separating paper parts from cover sheets is challenging.

### 2.3. Woven Bags

Woven bags are often used for the delivery of large goods. The raw material is usually polypropylene (PP). The bags are mainly woven by mekralon and formed in reticular structure, which makes them strong and stable. Intensifiers and dyes are added to strengthen their quality. PP is a kind of recyclable material but its manufacture and processing are possibly influential to surroundings. Some of the woven bags are made from cellulose. One of the most plentiful naturally occurring materials and one of the most significant renewable resources is cellulose. Cellulose-based materials have a very low environmental effect in comparison to other options, as evidenced by the research that has already been published. Such a naturally occurring biopolyme may be derived from renewable sources. However, the imperfect recycling system and industry chain can lead to inefficient recycling of woven bags and even result in further resource consumption.

### 2.4. Additives

Except for main materials, there are also many additives sticking on packages, such as ink, tapes, foam padding and polystyrene foams. These additives are troublesome because they are often clung to the principal part. These adhesives can accumulate and persist in the environment, taking up space and potentially polluting soil and water sources, thereby burdening landfills. The inability to completely separate and treat them separately from the main body is also one of the reasons for the difficulty in recycling them. PVC mostly originated from sticky tapes which are hard to degrade. Printing inks can contain a resinous binder, hardener, and fine particulate filler, which are harmful to soil if they seeped into soil. These additives are also one of the sources of microplastic pollution, which can cause environmental burdens invisibly. These burdens accumulate over time and can eventually lead to serious impacts.

## 3. Harm on Environment

According to predictions, the packaging waste from express delivery will continue increasing in the future if people do not intervene. The excessive packing, the packaging's inability to be recycled, and the lack of customer recycling motivation are believed to be the root causes of the consumption issues in rapid delivery [4]. The incineration of delivery packages can cause increasing carbon emissions and air pollution. Furthermore, landfill disposal is considered a conservative option due to its cost effectiveness, but its harm to soil and the environment is irreversible. With the abuse of plastic, animals are suffering from microplastic pollution and that hazard will eventually reflect in mankind itself.

### 3.1. Manufacturing Process

The major process of manufacturing plastic is the complex process of polymerizing monomer to polymer. Monomers are chemically bonded together to form long chains. The resulting polymer plastic resin, usually PE, is then melted and shaped using injection moulding or blow moulding. The bags are cut to the desired length and then heat-sealed or glued at the bottom. The production process

can consume plenty of ingredients and catalysts, and release heat and carbon oxide. Plastic production can also lead to fossil depletion.

Cardboard production can cause nutrient releases into the water and give rise to freshwater eutrophication. To manufacture paperboard boxes, large rolls of corrugated paper are unwound and fed into a corrugating machine. The liner is glued to the fluted medium, creating a corrugated board in this machine. The corrugated board is then cut into flat sheets of the desired size. These sheets are folded, scored, and glued to form the shape of the box.

To manufacture woven bags, jute or other natural fibers are harvested and processed to remove impurities first. Then spin the fibers into yarns, which are then woven into a fabric on looms. The fabric is then cut into panels of the desired size for bag production. The panels are stitched together using sewing machines and reinforced with handles and edges as needed.

The production processes involved often generate varying amounts of wastewater and exhaust emissions, leading to resource waste. These are all sources of pollution and harm.

### 3.2. Post-consumer Process

The expeditious advancement of the express transportation sector will result in significant utilization of delivery packaging resources. Even by contemplating solely the production and distribution procedures of express packaging resources, the industry will pose a substantial burden on the environment, not to mention the post-consumer process [5]. Despite the recyclability or reusability of various packaging materials like paperboard boxes and jute bags, a major portion of packaging waste generated from express delivery is still disposed of in municipal solid waste channels meant for landfilling or incineration, or alternatively, discarded without appropriate treatment. These lead to heavier burdens to both the economy and the environment. Incinerating paper and cardboard can lead to a reduction in carbon emissions due to the release of biogenic-CO, whereas incinerating plastic results in the significant release of fossil-CO, which offsets the benefits gained from energy recovery [6]. After all, the solution of incineration is not the best choice since it can bring about the waste of resources, low reclamation rate and air pollution. However, there is currently no established economical and efficient recycling system in place.

## 4. Improvements

As the express delivery industry develops fast, the disadvantage which is caused by massive express packaging waste on the environment is more serious and obvious. This phenomenon catches more and more attention of people and they are making efforts to improve the situation. Given the detrimental impact on resources and the environment arising from packaging used in express delivery, we propose the following remedies.

### 4.1. Recycling Process

The process of packaging waste inevitably incurs resource depletion and entails the emission of carbon dioxide, heavy metals, as well as both organic and inorganic pollutants throughout its production, distribution, and handling stages [7]. The usage of returnable ingredients can efficiently make the dilemma that traditional packages were hardly recycled work out. The absence of a proficient recycling infrastructure and exorbitant recycling expenses primarily contribute to the subpar recycling proportion of delivery packaging waste. The quantitative experiment demonstrates that the environmental impacts of manufacturing recyclable packages are higher than those of disposable ones, but the fact that The reuse of recyclable packaging products, occurring numerous times, effectively diminishes their environmental footprint (Fig. 2) [8]. Despite the prevalence of utilizing non-renewable materials like plastics for packaging due to their recyclable nature, it is imperative to refrain from excessive reliance on such resources. Establishing an economically fruitful and efficiently functional recycling system is in demand.

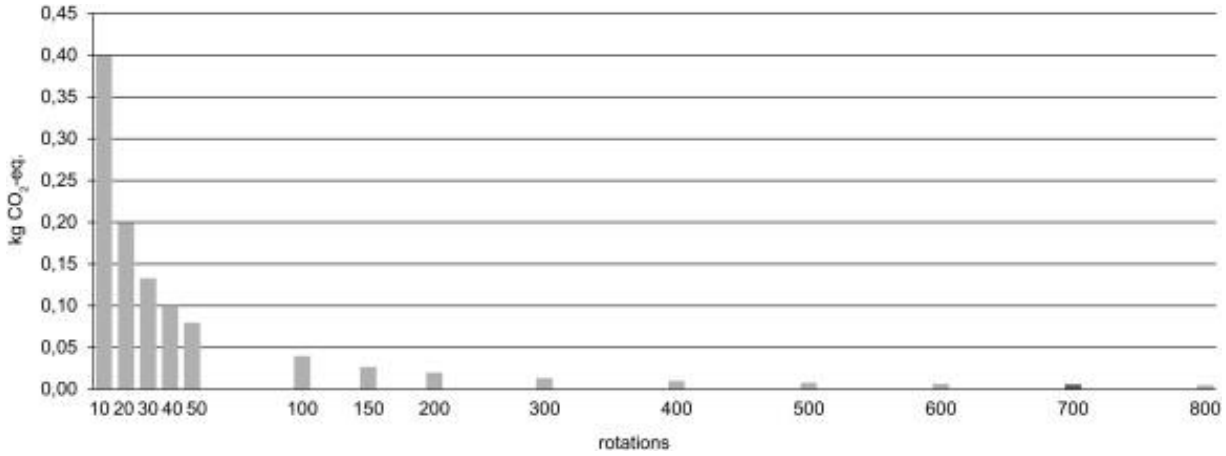


**Fig 2.** Environmental change influences of recyclable packages manufacturing (3.99 kg $CO_2$-eq/package) allocated per number of circulations.
https://www.sciencedirect.com/science/article/pii/S0959652614000584

### 4.2. Substitutable Reusable Materials

The utilization of recyclable plastic containers has demonstrated itself as a superior alternative when contrasted with the use of disposable packaging. Taking some environmentally friendly materials such as biodegradable plastic to substitute traditional materials, is one of the solutions to change the status. Reusable materials are widely admired, they can strikingly lighten the burden of disposal. In the current era, there has emerged an enduring inclination to explore novel substances derived from biomass or renewable resources, in order to supplant non-renewable materials such as petroleum-based plastics. The implementation of versatile receptacles represents an ecologically sound substitute, yet it is crucial to acknowledge the drawback of this approach, namely the substantial escalation in production expenditures when juxtaposed with alternative options [9].

### 4.3. Reduce Excessive Packaging

It is desirable for packages to be crafted employing the minimal amount of material feasible. Excessive packaging is not only a waste of resources but also an attack on the economy and a burden on the environment within the framework of global carbon emission reduction. Excessive packaging leads to the unnecessary consumption of resources and energy, consequently affecting the ecological footprint of manufacturing and transportation procedures. Using standardized box sizes and designing packaging to fit products more efficiently can minimize waste. Encouraging the reuse of packaging materials, such as boxes and cushioning materials, can also be effective. Educating both shippers and recipients about the importance of reducing packaging waste and providing guidelines for responsible packaging practices can contribute to a more sustainable courier industry.

### 4.4. Improvement of Policies

The Civil Code of China mentions that every citizen should behaviour based on the advantage of environmental protection and resource-saving. Relevant departments issued the “Opinions on Accelerating the Green Transformation of Express Packaging” in December 2020. The document proposes that by 2025, the application scale of recyclable express packaging should reach 10 million, and the use of non-degradable materials will be gradually banned. Numerous developed nations have implemented policy frameworks and strategies with the objective of reducing packaging waste and mitigating its environmental consequences [8]. Meanwhile, governments of multiple countries have issued plastic reduction orders to regulate and restrict various aspects of the production, distribution, consumption, and recycling of plastic products. Implementing a packaging waste reduction target can also incentivize companies to adopt sustainable practices. Introducing a system of penalties or rewards based on packaging efficiency and waste reduction can encourage compliance. Establishing mandatory reporting on packaging waste and recycling rates can ensure transparency and

accountability. Encouraging collaboration between government agencies, courier companies, and environmental organizations can facilitate the development of innovative and sustainable packaging solutions [10].

## 5. Conclusion

In the context of the express delivery industry developing rapidly, the environmental problem its packages bring is getting more serious. This is closely intertwined with both human society and the natural environment. Existing challenges are not only the excessive consumption of resources but also the pollution caused by the waste of manufacturing and post-consumer processes. It is supposed to follow solutions aiming at changing the present situation such as using recyclable materials and improving the recycling system. Policies are also required to correspondingly improve and be perfect. This article provides several suggestions for decreasing the hazard of delivery packaging on the environment. While improving waste recycling systems, it is important to maximize the use of environmentally friendly materials like PLA as alternatives to non-renewable and difficult-to-recycle materials. Although these materials may have higher production costs, in the long run, their environmental and economic costs are lower compared to non-recyclable materials.

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