

Assessing Eco-Efficiency in Production of Polymer Packaging

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Abstract

Eco-efficient packaging emphasises from the beginning of design, i.e., in a cradle to cradle closed loop. The concept of cradle to cradle instead of cradle to grave is the ultimate goal of packaging sustainability. In this research, the eco-efficient practices of polymer packaging manufacturer were assessed with respect to raw material extraction, manufacturing, and distribution stages of life cycle of a package. Packaging waste handling and disposal is a chief indicator of eco-efficient practices referring to waste generated in the unit and methods adopted for its disposal. Current practice in logistics industry is forcing manufacturers to develop packaging that are multi-layered. These are strong and impart barrier from moisture, gases and water. However, the environmental impact of multi-layered films cannot be neglected. It is not possible to separate the layers once they are fused together. The performance of packaging in the complete value chain is completely dependent on the criteria considered important by the manufacturer. The concerns of manufacturers towards adoption of eco-friendly packaging initiatives are important while developing the eco-efficiency indicators. This paper emphasizes that there is a need for manufacturers to identify areas where wastage in their supply chain could be eliminated.

Keywords: Eco-efficiency, Packaging, Practices

Introduction

Eco-efficiency is an aspect of sustainability relating the environmental performance of a product system to its product system value (ISO 14025:2012). Product system value is the worth or desirability associated to a product that may incorporate different value aspects such as functional, monetary, aesthetic, etc. The idea of life cycle approach and eco-efficiency have become increasingly practical and have been applied in various sectors of economy, including

packaging (Kasprzak et al., 2018). Reduction is a key principle of eco-efficiency applied in various processes for cutting the amount of toxic waste created or emitted, reducing the raw material usage or the product size itself also known as dematerialization (McDonough and Braungart, 2002).

In recent scenario, FMCG manufacturing companies are not only concerned about marketing and sale of their brands but also, they are paying equal attention to the product-environment relationship. Companies that desire their product to excel in the market are favouring packaging that is environment friendly and labelled with information for which they get endorsement by celebrities and advertise profusely. The study ‘A consumer definition of eco-friendly packaging’ emphasised that consumer perceptions of eco-friendly packaging can be categorised along three key dimensions: packaging materials, manufacturing technology and market appeal (Nguyen, et. al., 2019).

Research Objective

To assess the eco-efficient practices of polymer manufacturer with respect to raw material extraction, manufacturing, and distribution stages of life cycle of a package.

Methodology

The packaging companies visited for data collection were reserved with respect to disclosing their identity as well as while sharing information concerning manufacturing of packaging materials using polymers. Therefore, due to ethical considerations, the researcher gave the consent that no information will be shared at any platform without the stakeholders’ permission. Only one of the polymer companies allowed sharing of industrial process concerning development of detergent packaging. The process was qualitatively evaluated on the basis of nine eco-efficiency indicators.

Study Findings

The polymer company selected for the study was a private limited firm that came into existence in this decade. The manufacturer developed primary, secondary as well as tertiary packaging. Plastic films that are monolayered or multi-layered were developed by the manufacturer for primary packaging. Monolayered films consisted of single layer of polymer film (LDPE or LLDPE) while multi-layered was a combination of films that were bound together to impart special features to the final packaging. The manufacturer majorly

developed LDPE or LLDPE films for various packaging applications that included pouches and sachets for packaging of grocery and other FMCG.

The eco-efficient practices of the polymer manufacturers were assessed at different stages of development of detergent packaging on the basis of nine eco-efficiency indicators. These are discussed in the following section.

Indicator 1: Primary and Ancillary Raw Material Consumption

The first indicator of eco-efficiency takes into consideration all kinds of raw materials without which the production of desired packaging is not merely possible. The primary raw material for LDPE film consisted of LDPE resin sold in the form of pellets. It was acquired from dealers that were mostly located around 100 km radius. The pellets were available in several colors as well as grades based on resin density and quality of additives. The manufacturer mixed different grades of resin such as LDPE with LLDPE pellets for increasing strength and providing solid base. Clear pellets were used by the manufacturer for detergent pouches. Most low-density films contained additives with special properties. These included heat and light stabilizers, pigments, anti-slip and anti-block agents. Addition of excess anti-slip agents sometimes caused issues in sealing and printing of the packages and there was difficulty in storing the bags as they fall-off the shelves.

Indicator 2: Use of Recycled Raw Material

Manufacturer used recycled raw materials to reduce cost and effectively manage packaging waste. For this purpose, a small set up for LDPE recycling within the facility was installed. All the film trimmings as well as defected pieces were collected and recycled into small flakes to be added to the batch of virgin LDPE pellets during extrusion (film production) process. Small quantity of recycled pellets (4 kg) were added to every 50 kg of virgin LDPE pellets during extrusion. However, the differences in properties and characteristics of the virgin and recycled polymers posed restrictions in its usage. The major limitation in using recycled pellets was its quality, they lack tensile strength, gloss, finish and heat seal properties. Therefore, the usage was limited to secondary packaging in most cases. While increased usage of recycled raw material is the solution, manufacturer find limited value and applications.

Indicator 3: Selection Criteria of Raw Material

During this stage, the packaging manufacturer developed the artwork along with the detergent manufacturer for the choice of graphic design, size, color and printed information. A total of three films (refer Illustration 1) were selected for developing the detergent pouch; LDPE, metallized polyester and non-metallized polyester. The right selection of films is important for imparting selective properties to the pouch such as strength, printability, heat sealing, barrier properties, film thickness, gloss and color as it significantly influenced the cost of the package.



Illustration 1: Sample of three-layered detergent pouch developed by the manufacturer

Indicator 4: Technologies used in Production

Technology refers to the kind of technique used for packaging development, for example, traditional or the modern techniques. Use of technology effect the efficiency, quality and time employed during any process. In the polymer film manufacturing, production was largely dependent on the machines installed by the manufacturer. Production capacity of the operating machine was nearly 50kg/hour. However, the dimensions of the film were controlled during later developments in production process.

Technology played an important role in deciding several production factors. Various additions could be done during the inline process with the use of technology:

- a. The film during production could be printed with company logos, images, instructions, warnings, etc. by installing a printing machine alongside. However, electronic treatment is necessary for achieving rough texture for the printing to happen.
- b. The film could be laminated with Polyester or BOPP.

- c. A bag making machine could be installed within the process itself for faster production.
- d. Vent holes in a variety of patterns and sizes could be punched through the film.

Indicator 5: Labelling and Printing on Packaging

Packaging labels characterize the most significant information about the product. It exhibits information about the contents, weight, quality, ingredients, date of manufacture & expiry, code or batch number of the product and so on. Labels also acts as a marketing tool which assists in enticing customers with the help of designs and colour schemes (JK Labels, 2019).

Polymer films like LDPE, Polyester, and PVC were reverse printed with rotogravure printing machine installed by the manufacturer. Resin based inks were preferred as they were inexpensive and were appropriate for printing polyester. The three films; LDPE, metallized polyester and printed polyester film were laminated with the help of adhesive. For packaging applications, a bag making machine was installed to cut the film rolls in required lengths and sealed into pouch. These pouches were left open on one end for filling of the detergent powder which could be heat sealed after filling operation.

Indicator 6: Quality Check Measures

Testing the quality of packaging helps the manufacturers to keep a check on the characteristics, properties and several other features of packaging. Manufacturers analyse the quality of packaging at different levels of production to maintain their quality standard (Presto Testing Equipments, 2018). The polymer manufacturer used various quality check measures to test the raw material and performance of the final package. Tensile strength of the film plays an important role in its overall performance. For a product with long distribution chain, the film should be such that it is tough and does not tear at any point in the distribution. The grades of polymer pellets are the major decision makers in determining the strength, gloss, heat seal, moisture and gas barrier properties of the film.

Indicator 7: Logistics in Packaging

The concept of packaging logistics focuses on the combined effect achieved by integrating the packaging system with logistics for the purpose of increased supply chain efficiency and reduction in damages caused to moving goods (Saghir, 2004). The polymer films are

transported in trucks wherein there are chances of damages if the films are not packed properly. There are more chances for the package to get impacted when it contained the product. Damages were also caused to the detergent pack during loading and unloading for distribution such as tear and leak due to frequent drops.

Current practice in logistics industry is forcing manufacturers to develop packaging that are multi-layered. These are strong and impart high barrier from moisture, gases and water. However, the environmental impact of multi-layered films cannot be neglected. It is not possible to separate the layers once they are fused together. Manufacturer focused on market demands and the profit made from multi-layered films is much higher as compared to a simple LDPE film.

Indicator 8: Waste Handling and Management

This is a chief indicator of eco-efficient practices referring to waste generated in the unit and methods adopted for its disposal. Packaging wastes in the polymer film manufacturing unit consisted of trimmings and defected films produced during the film formation. These were generated due to two major reasons:

- a. Trimmings from the edges were considered waste
- b. When problems raised up due to bubble breakdown or machinery faults

Printing inks disposed in wastewater stream also contributed to the waste generated during production. However, the waste films were recycled by the manufacturer in the same unit.

Indicator 9: Eco-friendly Packaging Initiatives

Packaging waste is creating a massive environmental pollution and it is important for all stakeholders to take measures particularly for companies that want to hit sustainability goals. Removing the polymer film from waste was a significant step that helped the manufacturer in reducing the volume of waste needed to be taken away from the manufacturing unit for disposal and also reduced the cost significantly.

Conclusion

The performance of packaging in the complete value chain is completely dependent on the criteria considered important by the manufacturer. The idea of using recycled raw material for food grade products was not supported because of contamination and low quality of granules.

However, recycled LDPE could be used for packaging of products like detergents to achieve sustainability in packaging design. It was observed that the manufacturer used three different polymer layers to develop a detergent pouch which could be replaced with one single layer to encourage recycling after the content has been consumed. The challenges with multi-layered packaging is leading to development of single layered innovative packaging solutions.

Moreover, various additions could be done during the inline process with the application of technology. Printing technologies have proven their functionality in the processing and exhibiting information on polymer films. Testing of packaging and quality checks at different levels of production are important in assuring the quality of packaging that will withstand all the wear and tear during entire supply chain. With the extensive usage of packaged products, it is vital for manufacturers to use high quality testing machines and standardized test procedures.

Packaging also plays an integral role in supply chain management as it represents an interface between the supply chain and the end user. Manufacturers need to identify areas to eliminate wastage in their supply chains. Packaging must be designed such that the volume of material content is minimized without compromising its strength, adopted to the transport requirements, identification, and applicable regulations. The right mode of transport and storage conditions helps to avoid hazards like vertical and horizontal impact, drops, loss of compression, damage by temperature and humidity etc. It ensures that the packaging reaches to the point of sale in safe and sound manner.

Reducing overall packaging waste is imperative to mitigating further environmental damage for several reasons like conserving energy and resources, reducing GHG emissions and minimising the amount of waste going to landfill. The concerns of manufacturers towards adoption of eco-friendly packaging initiatives are important while developing the eco-efficiency indicators. This study therefore highlighted the areas for improvement in the production of polymer packaging and also generated valuable insights for the packaging manufacturers so as to minimize the wastage in their supply chain.

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