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The Impact of COVID-19 on Packaging Design and Production: A Case Study

Tran Thi Le Quyen

National Cheng Kung University, Tainan, Taiwan
FPT University, Hanoi, Vietnam

Abstract.

The COVID-19 pandemic was one of the biggest challenges in recent history that affected all aspects of socio-economic life, as well as the ecological environment of our planet. Before the pandemic, the packaging industry captured the interest of governments because of their commitments regarding designs for sustainability. These commitments intended to reduce single-use plastic packaging, increase the use of recyclable materials, and use eco-friendly materials. The crisis, however, has negatively impacted, and changed these priorities. The aim of this study is to provide an overview of the changes in packaging design and production during the COVID-19 pandemic, focusing on a case study in the food packaging industry. A secondary data analysis method was conducted to collect information for the process of comparing and evaluating the factors affecting the change of this industry, and a case study was conducted for the food packaging sector. The obtained research results showed that these companies had the ability to improvise in the context of the COVID-19 pandemic, and suggesst a potential model in order to solve urgent problems in the new context.

Keywords: packaging design, design for sustainability, COVID-19 pandemic, case study analysis

Corresponding Author: Tran Thi Le Quyen; email: EMAIL

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1. Introduction

From an economic perspective, the Covid-19 pandemic has had a strong impact on the packaging industry, fuelling growth due to increased demand for use in the context of social distancing and online purchases (Parashar et al., 2020). However, that growth also means more plastic waste, and essential urban services such as waste collection and treatment have been threatened, especially when there is an unprecedented increase in the amount of plastic waste from medical waste and domestic waste arising due to the Covid-19 crisis.

Therefore, how to limit the use of plastic packaging, reduce waste and increase the ability to recycle and reuse is a big question for the packaging industry, especially in the context of Covid-19. In addition, the research toward innovations in design, creating

products that can both protect people against the Covid-19 pandemic while ensuring the protection of the ecological environment, towards sustainability is a very necessary and urgent requirement today. This article focuses on studying changes in packaging design and production during the Covid-19 pandemic. The study also performed comparative analyses and reviews of a food packaging industry case study, focusing on the Evian brand, to clarify the changes and how the brand is responding to the Covid-19 crisis.

2. Literature review

Packaging has the main function of protecting goods from harmful effects from the external environment such as moisture or light. Since the Stone Age, people have known to use packaging to store daily food or to store excess food. The most primitive packaging is made from materials available in the natural environment such as grass, leaves, bark, seashells and clay. Animal skins are also a material used to better preserve goods. Later, solid packaging materials such as ceramic developed became widely used materials for the storage of solid and liquid goods; glass material was discovered by the Egyptians and brought about major changes in the history of packaging; However, it was not until 500 years later that transparent glass was born. Besides solid materials, paper invented by the ancient Chinese was also used to wrap certain foods. (Robertson, 1990; Brian, & Mark, 2016; Twede, 2016).

As human civilizations developed, the demand for goods increased, and packaging played an important part in this process. For the nature of each product type, there will be suitable packaging solutions, which are the result of many years of research and innovation in packaging design. (Klimchuk & Krasovec, 2013). Canning was an innovation in food packaging in the 1700s and led to the invention of canning in the 1800s that made food last longer and easier to transport. Besides, modern packaging types appear one after another, bringing the functional and aesthetic diversity of the packaging design and manufacturing industry. Marks in the development history of packaging are: the first commercial paper bags appeared (1844), the first carton was accidentally created by a printer in Brooklyn (1879), Cellophane was invented by the Swiss chemist Jacques E. Brandenberger (1908). In particular, in 1912, Brandenberger built a machine for the production of cellophane film. And the most advantageous property of this material is transparency, which made it the most selected packaging in the industry in the 1950s and 1960s. This material had changed the packaging industry. This type of packaging laid the foundation for the development of today's plastic packaging. (Berger, 2003; Brian, & Mark, 2016).

Through the study of changes in the composition of plastics over the past two centuries, humans have created synthetic polymers, mainly using the carbon atoms in petroleum and fossil fuels. Since the 1950s, polymer plastic materials have become a material with outstanding properties such as ease of shaping, light weight, durability and low cost that has quickly conquered other industries. For example, Chemist Nathaniel Wyeth first patented the bottle of Polyethylene Terephthalate in 1973. This first plastic bottle became a cheaper glass alternative as manufacturers expected. Especially its capability of containing carbonated beverages made the plastic bottle the material of choice for that time. (Rooney, 1995; Lopez-Rubio et al., 2004).

Although the invention of plastic packaging at this stage has helped people no longer depend on available natural materials such as wood, ivory, horn or metal, overcome the barriers of natural resource scarcity and has contributed to economic development, but until now, it has caused harmful impacts on the environment. The use of plastic packaging, especially disposable plastic waste, has led to overcrowding in landfills, even in the oceans. (Plastics – the Facts, 2019).

Specifically, the global plastic consumption of the packaging industry can be estimated by observing the amount of plastic waste generated. Plastic packaging is mainly used once, most of them are discarded the same year of manufacture. The shift from durable plastic production to disposable plastic products has changed the way we live and consume. More than a quarter of plastic globally is used in the production of single-use plastics. According to UN statistics on global plastic waste over 60 years, from 1950 to 2015 shows that in the first 30 years, from 1950 to 1980, the amount of waste increased from 1 to over 50 million tons. But in the next 30 years, from 1985 to 2015, the amount of waste increased fivefold, from 50 million tons to more than 300 million tons. If humanity keeps plastic production at the current rate, the percentage of using oil for plastics industry could reach 20% of the world total oil by 2050. In 2017 the volume of used resources was estimated up to 90 billion tons in the world, and more than haft of it has been scattered or released as waste, while less than 10% is returned to recycling. (Gourmelon, 2015; Plastics – the Facts, 2019)

Increasing global population that leads to an increase in resourse consumption, increasing waste, especially n domestic waste disposal, has a negative impact on the environment. The consumption of plastic on a global scale is still increasing. In 2016, 480 billion plastic bottles were sold, compared to 300 billion in 2004. Currently, one million plastic bottles are sold every minute, and in 2021, that figure will rise to 583.3 billion. These are the results of research conducted by the worldwide market research organization Euromonitor. Nearly a quarter of all plastic bottles are consumed

worldwide, according to Rosemary Downy, head of packaging at Euromonitor. Nearly 68.4 billion plastic water bottles were sold in China in only 2015 alone. In 2016, this figure increased to 73.8 billion. In 2016, fewer than half of all plastic bottles that were purchased were recycled. Of these bottles, just 7% were used to create new PET bottles. Most plastic bottles ended up in landfills or the environment. An estimated 5 to 13 billion kilos of plastic debris are dumped in the ocean each year; this is equal to one garbage truck being fully loaded every minute. (Plastic Soup Foundation)

Facing the exhausting exploitation of non-renewable natural resources as well as the alarming environmental pollution caused by waste, world organizations as well as countries have taken many measures to prevent and mitigate this situation. Today's packaging designs are starting to incorporate recyclable plastics, and look for reuse functions to extend product life. At the end of 2017 the target of 65% packaging recycling by 2025 to be increased to 70% by 2030 has been agreed in preliminary commitment between The European Parliament and the European Commission. In addition to the preliminary commitment the target 50% of plastic packaging recycling by 2025 to be increased to 55% by 2030. (Emblem, 2012; Ma et al., 2020; Plastics – the Facts, 2019)

However, the Covid-19 pandemic that occurred in 2019 has seriously disrupted plastic reduction policies in the region, as well as caused significant changes in plastic waste management. Prioritizing protecting human health and preventing the spread of the pandemic has reversed policies to reduce plastic and plastic waste (Prata et al., 2020). In many countries the use of disposable personal protective equipment (PPE) in special healthcare, home care and the general population and use disposable plastic items (e.g., boxes, bags, plates, spoons even knives and cups) to keep hotel, restaurants and all businesses open safe action. In addition, the guidance and on-site treatment system for these single-use plastic items is not clear, which leads to negative aspects in the disposal phase. Many media outlets worldwide have reported on waste derived from masks, clothes, visors... and other PPE items spotted on beaches and in the rivers (e.g., CGTN, 2020; CNN, 2020; Euro news, 2020). Recycling plastic is also difficult due to concerns that waste plastic is contaminated, but this waste is released into the environment, which increases the risk of disease spreading (Mushtaq, A.M, 2019; Holland et al., 2020).

3. Methodology

The research was based on the analysis and evaluation of published secondary data from stakeholders in the packaging industry. Based on case studies, the research has

deeply figured out the innovation in food packaging design and manufacturing since the COVID-19 pandemic has broken out.

As case study research involves defining the case, determining the research issues, sample selection, data collection and analysis stage. The study used a case study method to find a way to build a theory by analyzing the data that was collected during the research (Yin, 2014). The qualitative data will be often categorized to create quantitative data that can then be analysed using statistical methods. The fundamental goal of case study research is to conduct an in-depth analysis of an issue, within its context with a view to understand the issue from the perspective of participants.

Using data from food companies around the world, the study carried out an international comparative study, analyzing cases according to criteria related to packaging design and manufacture. Then food company Evian was selected to clarify how the brand is responding to the impacts of the Covid-19 pandemic. The study then analyzed the results obtained and compared the factors that promote or inhibit the shift towards sustainability in packaging design and manufacturing, and how to transform conventional packaging design to smart and multi-functional design to suit the new context.

4. Results and Discussion

4.1. From traditional to modern: the change of packaging design

In the early stages, the packaging only acted as a layer of protection for its contents, making it easy to store and transport. However, at a later stage, packaging has other functions such as information transmission, anti-counterfeiting, and product marketing. Therefore, packaging design and production go hand in hand with each brand's product and service development. The packaging industry is also developing rapidly along with the development of goods on a global scale, especially with the strong rise of the food industry in the past centuries. This study explores packaging changes in the food industry, focusing on the bottled water market. This is a large and fast-growing market.

Indeed, water is an essential nutrient for life on the planet. Since the beginning of time, people have known how to store and distribute water, with the continuous increase of human population, the supply of water from these resources became insufficient, and they began to think about storage, distribution, and transport of water in metal or nonmetallic vessels. In 1621, water from the Holy Well was available to bottle, using for therapeutic properties. The history of bottled water begins here. Great Britain was

a pioneer to bottle the water in The Holy Well factory. In Ireland, the first mineral spring water bottles began to be produced in 1621. Commercial distribution began in Boston (USA) in 1767 at Jackson's Spa. In the late 18^{th} century, many brands of bottled mineral water were marketed for bathing and drinking, and by the early 19^{th} century, these bottles became very popular. In 1809, Joseph Hawking from a company called "Carbonated Water" filed a patent for mineral water to replace natural spring water.

It can be seen that the storage and distribution of drinking water are complicated tasks as water quality is very important for public health. Bottled beverages have partly solved the problems in the urban water supply systems of most cities in the world when they have not met the strict hygiene requirements and cannot be drunk directly as a beverage, especially in a number of developed areas today. Historically, the outbreak of Typhoid and Cholera in the mid-19th century was a driving factor in the growth of this industry.

The main contribution to the development of the bottled water market is a material shift from glass to PET, which has impacted the entire production and consumption process. Bottles are made from plastic with lightweight, low cost, high durability, making it easier to transport water from the bottled source to distant locations, helping businesses distribute products, suitable for a wide range of consumers. Since plastic bottles were replaced, the bottled water market has been growing very fast. The total product sales in liters, counting between 2001 and 2015, increased from 121 to 310 billion. As a result, revenues increases from 1 billion USD to 183 billion USD, and consumption per capita doubles to 43L. Plastic has changed not only social life but also the way people drink bottled water, hence affects the formation of this beverage market. In addition to the quality of bottled water, the marketing strategy, design and label design on the bottle are factors that influence consumers' purchasing decisions.

French bottled water can be considered an iconic case of the food industry. This beverage sector has reshaped the market structure as well as the marketing and communication strategies of purified water products. The cultural meaning of water has been reshaped, from an essential commodity for life into one that contains many cultural images, lifestyles, as well as changing tastes and behaviors of consumers. Designs in terms of size, shape, and transparency are essential in creating brand images and symbolic associations in consumers' minds. The bottles are clear most of the time, with the color blue or green. It is hard to find a bottle that is red, brown, black, or yellow. They give a feeling of the inherent purity of water. The design of bottles and labels also changes flexibly and is suitable for ongoing events such as New Year, Christmas, or sports events. These designs use images of celebrities to influence the client as a

lifestyle idol. Some mineral waters have created their own customers who are eager to buy and collected special kinds of bottles, for example, Evian and Perrier. These special water bottles are very limited and are often products of well-known fashion designers, in which Jean-Paul Gaultier is a good example.

Marketing of bottled water often relies on creating a specific theme of "on the go" hydration, placing the product as an important ingredient in healthy living and selfpreservation. Besides, label design is used to develop a company's brand image, along with marketing strategy. A number of large companies have begun to practice a popular marketing method that connects sales with social responsibility. For example, "1L = 10L for Africa" is the first of Volvic's campaigns (2005–2010), linking the sale of each liter of bottled water in the developed world with the words of Danone, the owner of Volvic. , providing 10L of clean water to people in Africa. In addition, companies also use different ways to present an image of bottled water such as the history of the origin of pure water, which stems from its geographical connection and class in prestige and health as well as the miraculous healing power of famous spas, hydrological basins, areas with natural mineral water sources. These are reflected in advertisements relating to the location and natural origin of the Evian brands from The Alps melting ice, the strength and purity of the Volvic brand from Central Massif volcanoes, or the power of the geyser in the Arvie water bottle image. It's no coincidence that Danone's drinking water brand has associated its image with the Alps, embodying purity, motherhood, and infant wellness for decades through media branding. Evidence proved that this strategy was a success in influencing customers' familiar and personal choice and taste of drinking water, effectively changing them.

4.2. Packaging in the Challenge of Covid-19 Pedamic

"We don't have a plastics problem. We have a plastic waste problem."

- Baca of the American Chemistry Council -

The Covid-19 pandemic caused an unprecedented crisis in history. The lockdown or state of emergency imposed during the pandemic in many countries has left people relying on online shopping services and stocking up on essential items, including food and groceries (Grashuis et al., 2020; Laato et al., 2020; Wang et al., 2020; Farashar et al., 2021). Majority of these items are plastic packaging (see more in Figure 1). Singleuse plastics are usually plastic packaging used to package or preserve items that are only used once, and then discarded or recycled. The majority of single-use plastic is used

for plastic packaging and water bottles. Global plastic production in the total packaging industry sector, the largest industry sector is plastic packaging. The growth of plastic packaging is expected to increase, between 2019 and 2021, from 909.2 billion USD 1012.6 billion. That coresponds to a 5.5% yearly growth rate, that's equivalent to the effect of the pandemic on consumption of plastic products (Business Insider, 2020; Parashar et al., 2020).

However, that growth also means more plastic waste. Without specific guidelines and regulations, waste will end up in landfills or end up in rivers, seas and oceans. The problem, according to environmentalists, is that the efforts of businesses to reduce waste, including the goal of recycling all plastic packaging by 2040, are not enough to restore the human-made pollution. Garbage from disposable bottled water floating in the oceans is being collected for recycling (in Adidas or Bottle Top campaigns). However, a large amount of plastic waste has decomposed into micro-plastics particles that are floating in the water, and considered a major threat to both wildlife and human life, plastic pollution is now widespread across oceans (UN Environment, 2018). The environmental crisis is related to plastic waste with an estimated 10 million tons of waste entering the marine environment each year (Boucher and Friot, 2017).

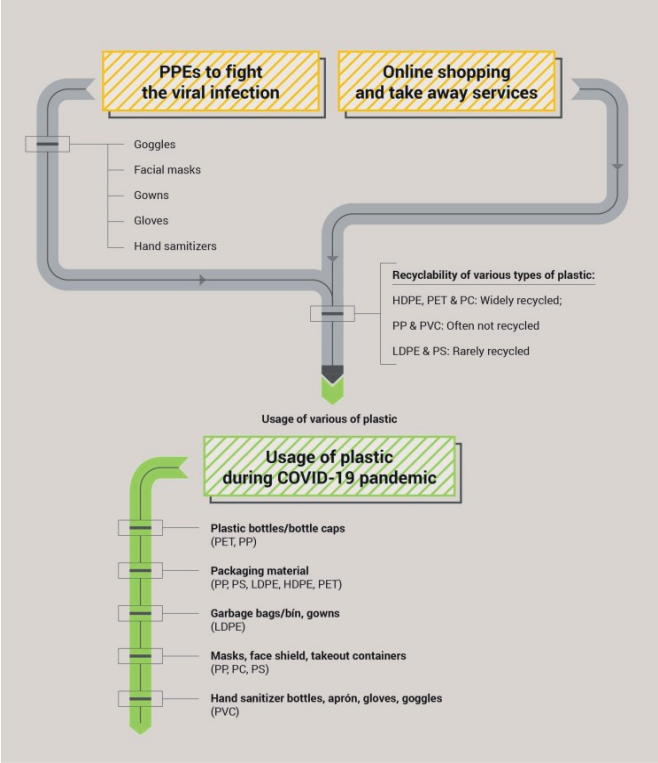

Figure 1: Recyclability of various types of plastic in Covid-19 pademic (adapted from Farashar et al., 2021(.

Besides, products to protect health workers and people during the Covid-19 pandemic such as masks, eyeglasses, protective clothing made of plastic are also a big threat to the ecological environment. In particular, these products are only used once, then must be discarded to ensure hygiene requirements. The WHO has estimated that on a monthly basis, the worldwide supply chain of medical safety products during the pandemic has increased by 40%. Similarly, the CAGR for PPE production is forecast to increase sharply by about 20% from 2020 to 2025. This will put the packaging industry to face a shortage of input materials and exhausting exploitation for oil - the limited natural resource. Therefore, we need to consider the impacts of plastic on the environment in terms of infrastructure and waste management, financial constraints and human behaviors.

In the case of the Evian brand, the natural mineral water bottling company has been affected by the Covid-19 pandemic and how it responded to this crisis. Evian is one of the brands of Natural Mineral Water (NMW), the leading bottling company in France, exporting worldwide and becoming a model for others in many countries with its long experience in sustainable management of NMW source areas. The experience of bottled water companies in France shows that they are constantly moving forward with proactive and innovative ideas to meet environmental challenges, especially during this pandemic. In September 2020, Evian released important information in response to ecosystem changes, contributing to reducing the burden of the Covid-19 pandemic on the environment. With the goal of becoming a brand in the circular economy, they designed and manufactured new recycled bottles made from 100% recycled plastic. This is already operated in a number of EU countries. All of these mineral water bottles are recyclable and contain about 40% recycled material (a material known as rPET), which contributes to a reduction in carbon footprint in production by up to 50%, compared to Bottles made entirely from virgin plastic. Evian is moving from a linear model to a cyclic model, adopting a sustainable design approach in materials use, all bottles using recycled plastic materials and not using virgin plastic materials. Indeed, in the circular economy, plastic grows from waste with the potential to become a valuable resource. Evian has a strategy of redesigning its packaging, taking into account the input materials and the multifunctional design (e.g., removing labels, printing information directly onto the packaging).

For corporate sustainability, companies strive to improve their environmental performance through planned and effective resource management. Evian is also working with the local community in a spirit of co-ownership to invent and conserve water resources and realize the ambition of sustainable industrial practice. During the Covid19 crisis, the

TABLE 1: The usage of virgin and recycled plastic material in reduction carbon footprint in Covid-19 pandemic.

Participants	Water bottles made from virgin plastic material	Water bottles made from recycled plastic material	Reduction in Carbon footprint in production
Evian	0%	100%	50%
EU countries	60%	40%	

brand is supporting the pandemic response by supporting urgent needs and supplies; supporting health workers who are on the front lines. In France, Evian has produced 120,000 plastic bottles to help distribute hand sanitizer in pharmacies to ease the shortage of these items during the pandemic.

4.3. The evolution of sustainable packaging in the new context

We are facing a big challenge of environmental pollution related to plastic waste management, especially in the context of the ongoing Covid-19 pandemic. Therefore, packaging design in the new context poses a changing requirement towards sustainability.

Indeed, the problem of pollution from plastic waste derived from food packaging is a big issue that needs to be solved by this industry. Sustainable packaging has impacts related to the environment and the food value chain, so the concept of packaging sustainability is discussed around perspectives relevant to the entire value chain of packaging. The supply chain starts with the origin of the raw materials for sustainable packaging, the production, distribution, use, and finally the end of its life cycle. Some argue that sustainable packaging only needs to meet the requirements of sustainably sourced or recyclable materials such as natural, compostable materials, while other criteria The implications for social morals and economic benefits are often overlooked. As a result, the views on sustainability have been continuously discussed by organizations, corporations, NGOs, and policymakers and given definitions suitable for many different fields (Sonneveld et al., 2005; Guillard et al., 2018; Ma et al., 2020).

The concepts of packaging sustainability have evolved with the increasing incorporation of sustainability principles at different levels. With the main function of food packaging being to protect food, having identified food protection options, sustainable packaging options can be evaluated on many complex criteria. Packaging that integrates sustainable elements reduces food waste as food waste often has a greater impact on the environment than packaging waste. And in the current period, under the

influence of the Covid pandemic, creating packaging that can protect health against this virus and reduce waste, and protect the living environment is a matter of concern..

To integrate Sustainable Design into packaging design and production, designers and stakeholders need to take into account sustainable design principles and criteria. Several principles have been proposed to outline the definition of sustainable packaging, guiding the research and product development of packaging companies. The Australian Sustainable Packaging Alliance has suggested four principles for a sustainable packaging as follows:

1. Effective - packaging products are designed for economic and social benefits;
2. Efficient - packaging products are designed to benefit by optimizing the use of raw materials, minimizing the use of energy and resources;
3. Cyclic - packaging products are designed to participate in the circular economy, which can be recovered through industrial or natural systems; and
4. Safe - product packaging does not use harmful chemicals, is not harmful to use or pollutes when disposed of or goes on to another life cycle. (The Australian Sustainable Packaging Alliance, 2007)

A scenario on applying Sustainable Design in packaging design and production is proposed by The Sustainable Packaging Coalition (SPC), which considers the 3 pillars of sustainable development: Environment (Planet) – Society Society (People) – Economy (Profit). This is a project by GreenBlue that envisions a planet where all packaging is produced responsibly, designed to deliver an efficient and safe life cycle of a package. These packages need to satisfy market criteria for performance and after use will be efficiently recycled to become a resource for the next life cycle (Green Blue, 2011; Lebreton et al., 2019). To evaluate sustainable packaging, Green Blue has discussed eight criteria related to the life cycle of packaging as follows.

1. Sustainable packaging is a type of packaging with a life cycle that brings benefits to users and safes for the environment and society;
2. Sustainable packaging needs to meet the criteria related to performance and competitiveness in the market;
3. Sustainable packaging needs to meet the requirements of source, production, transportation, and recycling with renewable energy;
4. Sustainable packaging should optimize the use of input materials from renewable or recycled sources;

5. Sustainable packaging meets production requirements with green and smart technology;
6. Sustainable packaging is made from eco-friendly materials, for easy recycling or disposal;
7. Sustainable packaging needs to be designed to optimize functionality, minimizing the use of materials and energy; and
8. Sustainable packaging must be recovered at the end of the life cycle to continue biological and/or industrial closed loop cycles (Green Blue, 2011).

Indeed, in the current context, more than ever, packaging needs to meet sustainability criteria, research and apply new approaches, new support tools to help promote and spread the concerns for the environment and social responsibility. In the context of the Covid-19 pandemic, packaging and products to support pandemic response should be prioritized using innovative packaging materials and systems, with functions to ensure safety, public health and ecological environment.

5. Conclusions

This research explores and clarifies the problems that the packaging industry, focusing on food packaging, is having to deal with in the context of the Covid-19 pandemic. The study also points out the influencing factors and potential values in applying sustainable design to packaging systems. Through a case study analysis, the study revealed some of the challenges that bottled water brands face and how they respond during this crisis. To address these challenges, several key proposals have been identified not only to address the existing problems of this industry but also to support the industry's development towards sustainability. The results of this study show that the shift in the entire supply chain is needed, so that the packaging value chain can move towards the shared vision of the systemic nature of sustainability for design, product and service, packaging production, distribution and disposal/recycling. Close collaboration among stakeholders is required to be able to provide a win-win model for all.

Based on the findings of the analysis in this study, other recommendation for future research is to look into the role of the designer in research and examine design options for the complete product lifecycle before products are made. The design of that product is based on the principle of "design to reduce waste" from the beginning. To promote the development of consumer goods in a more sustainable manner, future designers

should enter the value chain as a link between upstream producers and downstream consumers.

However, in addition to the various policy support from governments, it is essential to spread and disseminate the interest in sustainable packaging and to make effective use of sustainable packaging with the participation of consumers. The packaging industry needs to spread the ideas and convince their customers to take action to raise awareness, identify opportunities and pursue strategies to develop more sustainable packaging systems, especially in the context of a fast changing world.

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