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ORIGINAL PAPER

CURRENT TRENDS IN THE GERMAN PACKAGING INDUSTRY

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ABSTRACT. Background: Germany is the largest plastic consumer in Europe. On average some 400g of plastics are used by its citizens. Despite promoting circular economy (CE) systems almost 60% of plastics are burned, recovering the thermal energy, however leaving an additional CO_2-Footprint. This increased emission does not only negatively contribute to climate change but also translates to poor sustainability metrics, lacking behind industry trends. The objective of this article is to review and provide an overview of the current trends of the German packaging industry with a focus on sustainability. This is important to understand the future opportunities and risks concerning the industries' economic development.
Methods: This review article is based on a primary literature review of key authors within the respective field. As an additional criterion, only articles published not before 2013 have been included.
Result: The German packaging industry is experiencing decreasing production rates and prices between 2018 and 2021. While general trends are shifting towards sustainability and responsible consumption, the majority of plastics are used for energy recovery. Following that the German packaging industry is driven by three key trends, (i) Packaging Materials, (ii) Packaging Design and (iii) Smart Packaging. Improving sustainability can be identified as the leading driver in all the mentioned trends. The industry is rapidly shifting towards circular systems giving high importance to social value and well-being.
Conclusion: This study analyses and contributes to our understanding of the German packaging industry. It provides a deeper insight into the current market, its challenges and discusses overall key trends.

Keywords: Circular Economy, Sustainable development, Packaging Industry, Trends

INTRODUCTION

The plastics and packaging industry is a growing concern to the public, worldwide. Hence the industry faces increasing pressure from the public and legislation to reduce plastic waste, emission and its carbon footprint, thus to becoming more sustainable. Energy recovery, waste management and recycling are just a few examples of current challenges. Global relevance is given as the plastic industry is contributing about 19% of the total remaining carbon budget before reaching the 1.5°C goal [Bailey et al., 2021; Fuhr et al., 2019].

Germany is the largest plastic consumer in Europe, responsible for over 24% (12Mt p.a. in 2019). The German consumer uses about 400g of plastics a day. The amount of packaging material is increasing in past years given the retail development and logistics, accelerated by COVID at the Business-to-Customer (B2C) market.

Over 40% of plastics are manufactured for packaging materials [*Plastics - the Facts 2020*, 2020]. The second-largest consumer of plastic is construction with 20%. Polyethylene (HD/LD PE) and polypropylene (PP) are the two most common polymers used in 40% of all materials [*Plastics - the Facts 2020*, 2020].

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Notably, the majority of plastics is used in energy recovery once their primary purpose (e.g., packaging) has been completed. Almost 60% of plastics in Germany are used for energy recovery, compared to the European average of 43% [*Plastics - the Facts 2020*, 2020]. Thirty-nine percent are recycled (vs. 32% in EU) and less than 1% disposed (vs. 25% in EU) [*Plastics - the Facts 2020*, 2020]. Whilst production of plastic in Germany decreased by 5% between 2018 and 2021, prices declined by 11% during the same period [Herrmann et al., 2021].

These recent developments and increasing social focus led to a renewed interest and pose disruptive threats to the German packaging industry. Sustainability e.g., a revised product life cycle, product innovation and socially responsible consumption are believed to be the main industrial domains.

The purpose of this paper is to review current trends in the German packaging industry and to highlight their effects on climate change. The remaining part of the paper proceeds as follows: The next chapter will lay out the fundamentals in the packaging industry based on a recent survey, followed by a discussion of the implications for the future.

TRENDS IN THE PACKAGING INDUSTRY

The German packaging industry is under continuous development. The large number and variety of its customers led to a multifactorial market environment for this industry. Nevertheless, general trends can be seen and described. Based on a recent survey performed by Blass et. al in 2021 with 108 Industry representatives, key trends could be identified [Blass and Feeß, 2021], presented in Table 1.

Table 1. Trends in the packaging industry highlighting their impact areas.

Trends	Impact areas
Packaging Material	Circular Economy
	Increased use of Recycled material
	Mono materials
Packaging Design	E-Commerce optimized design
	Ecologically optimized design
	Brand experience
Smart Packaging	Quality Control
	Watermark
	Track & Trace

PACKAGING MATERIAL

The Packaging Material and chemical composition is the key element defining characteristics [Dobrucka, 2019]. Sustainable development starts with the selection of the proper material. Climate change and resulting legislation thereof emphasize the importance to consider a products life cycle, with Circular Economy (CE) as the leading area of influence in the industry, being supported by the increased use of recycled material and the use of mono materials. The latter two facilitate a transition towards CE sharing the "4R" (Reduce, Reuse, Recycle, Recover) discussed by Kirchherr et al. [Kirchherr et al., 2017; Potting et al., 2017; Reike et al., 2018]. CE has the goal to establish a closed loop supported by the economic system.

Kirchherr et al. defined CE by analysing and combining 114 definitions derived from the linear economic model [Kirchherr et al., 2017]. Linear economy suggests recovery. The

energy will be recovered once having fulfilled the primary purpose [Kirchherr et al., 2017; Potting et al., 2017]. This is the case for 60% of plastics in Germany. Extending the lifespan of products and/ or their parts increases circularity. Recycling is the next step towards the circular economy. It is defined by the processing of material to obtain a comparable product quality [Kirchherr et al., 2017; Potting et al., 2017]. This goal can be reached through the incorporation of new materials. Reusing materials and products by other consumers supports the extension of the life span [Kirchherr et al., 2017; Potting et al., 2017]. Continuous innovation, reduced use of materials and higher efficiency reduction of materials should be sought in a CE system [Kirchherr et al., 2017; Potting et al., 2017; Wolf et al., 2021].

Korhonen et al. conclude that circular systems have three elements in common. Such systems are (i) closed cycles, use (ii) renewable energy and follow a (iii) system thinking approach [Korhonen et al., 2018a]. This definition is close to other researchers arguing that (iv) social inclusiveness is also a key element of circular economy [Korhonen et al., 2018a, 2018b].

Closed cycles are defined through zero waste, as all residual streams, including both materials or energy, are the feedstock of new products. To reach this goal high material quality needs to be maintained and the life cycle conceptualized [Geissdoerfer et al., 2020; Korhonen et al., 2018b].

The required energy in circular systems is also subject to a waste-free generation minimizing the impact on external systems such as but not limited to the environment using renewable sources [Korhonen et al., 2018a]. However, following the laws of thermodynamics energy cannot be recycled and closed loops established.

The circular economy is based on a full life cycle analysis of materials. Thus, connecting and requiring a high level of collaboration across all levels. This includes packaging design, production, use, reuse, recycling and recovery [Kirchherr et al., 2017; Korhonen et al., 2018a; Reike et al., 2018].

Social inclusiveness can be seen as an intrinsic factor of circular systems. In contrast to linear systems circular systems facilitate a transition towards a shared economy increasing interdependencies among all actors [Geissdoerfer et al., 2020; Korhonen et al., 2018a]. This empowers self-organized social systems fostering the importance of social value rather than personal gains.

The implementation of CE systems in the food or beauty industry is challenging. On the one hand, these industry faces strong regulations associated with product safety. Additionally, there is only limited recycled HD/ LD PE or PP are available [Blass and Feeß, 2021]. On the other hand, the economic cost benefits of new "virgin" plastic materials often outweigh the sustainable benefit of recycling [Blass and Feeß, 2021].

This is often the case as complex composite Packaging Materials are used and desegregated waste collection is in place significantly decreasing recycling efficiency thus increasing costs. Moreover, international product standards need to be established to provoke sustainability and circularity across the entire value chain throughout country borders [Blass and Feeß, 2021; Coelho et al., 2020]. This has to be analysed and reviewed for each material individually. The case of fully recycled PET clearly demonstrated the feasibility.

PACKAGING DESIGN

Packaging Design is an important area having a direct influence on used materials, logistics and lifespan, translating to sustainability. In the light of recent years especially e-commerce, optimized Packaging Design and brand experience developed in the industry.

E-commerce is a key area of influence and the main driver within Packaging Design. The positive development and the significant increase of B2C packages between pre covid 2019 and 2020 support this [Esser and Kurte, 2021]. Unboxing videos and other publicity through various channels are used to increase the audience and reach. E-commerce is antimonic to sustainability. Research into the

environmental impact compared to traditional in-store shopping revealed, that GHG emissions can be up by the factor of 3 - 6 [Carling et al., 2015; Escursell et al., 2021; van Loon et al., 2015].

The ecologically optimized design tries to reduce environmental impact by light-weighting, using mono materials, simplifying recyclability and extending the life span. According to the Ellen MacArthur Foundation, 80% of the environmental impact of packaging are defined within its design phase ["Ellen MacArthur Foundation," 2021]. Optimized Packaging Design has become a value for consumers. Blass and Feeß demonstrated the consumers' willingness to pay for sustainable design [Blass and Feeß, 2021].

Nowadays, Packaging Materials have become a multipurpose product being integrated into the customer journey and brand experience. The package has developed towards a marketing instrument.

SMART PACKAGING

Product digitalization is one innovation area in the packaging industry. In the context of this article Smart Packaging refers to active and intelligent functionalized packaging systems. Active packaging systems interact with transported goods by releasing or absorbing substances [Chen et al., 2020; Drago et al., 2020; Kuswandi and Jumina, 2020]. Intelligent packages are able to monitor conditions of the good, providing information without interaction [Chen et al., 2020; Drago et al., 2020; Kuswandi and Jumina, 2020]. Smart packages interact with the good based on the provided information, extending product life span and maintaining quality standards [Chen et al., 2020; Drago et al., 2020; Kuswandi and Jumina, 2020].

Such smart packages are of significant benefit in the food or pharmaceutical industry. These systems do not only extend shelf life, therefore increasing product life span, minimizing waste and the environmental impact, but also support product safety [Chen et al., 2020; Drago et al., 2020; Kuswandi and Jumina, 2020]. In the pharmaceutical industry, intelligent packages allow tracking of storage and transportation as well as medical regimes. This is accelerated based on consumer needs and as technology becomes more available and affordable [Dobrucka, 2013].

Product security goes beyond the above-mentioned quality control and regulating systems. The pharmaceutical and food industry is highly sensible against counterfeit. Micro text, debossing, customized varnishes and the latest RFID allowing track & trace [Pareek and Khunteta, 2014]. It is currently believed, that by 2023 90% of pharmaceutical deliveries will be using track & trace systems [Blass and Feeß, 2021].

Focus on the environmental impact and efforts towards increased sustainability can be supported by Smart Packaging. One important pillar in CE is efficient recycling. Segregated processing of individual materials is key and leads to better sorting of post-consumer waste while increasing yield quality. A digital watermark - the holy grail promotes the development and unifies recycling efforts.

CONCLUSION

The aim of this present research was to examine current trends in the plastic and packaging industry.

Within Europe, Germany is driving the plastic and packaging industry. In 2019 more than 24% (12Mt p.a.) of plastics in Europe have been used in Germany, primarily for packaging materials and construction. Most commonly polyethylene and polypropylene can be found. At the end of its lifetime, Germany uses almost 60% of its plastics for energy recovery (vs. 43% of the European average).

Yet climate change, environmental action and public concerns led to industry changes provoking innovation and product development. Despite the inhomogeneous nature of its products and customers similarities in form of trends became evident. These trends can be summarized to the trends Packaging Materials, Packaging Design and Smart Packaging.

Packaging Materials are driven by sustainability. The most obvious finding to emerge from this study is that there is a strong focus on shifting the currently linear industry into a circular economy. The overall goal is to increase sustainability across the packaging's life span. Key areas of concern are simplified Packaging Materials, facilitating recycling with an extended design life span.

Packaging Design partially supports the above-mentioned sustainability efforts. Packages are ecologically designed using methods such as but not limited to light-weighting. In contradiction to this e-commerce and increased shipping show negative effects on the environment.

Smart Packaging shows the added value of packaging systems across various industries throughout functionalization within logistics or quality control. The development of affordable technologies is key to further promoting these trends. Smart Packaging is expected to grow in the food and pharmaceutical sector.

Considering these developments, the packaging industry is in the process of revolution. Established linear systems accelerating consumption are being replaced by circular processes and an increased social valuation. Sustainability and increased functionality of packaging materials and enhanced life cycle assessments add value to packaging design.

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