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## THE ROLE OF PACKAGING IN LOGISTICS PROCESSES - IMPACT ON SUSTAINABLE LOGISTICS IN THE FOOD SECTOR

**Abstract:** *Packaging is one of the main factors of logistics. Its primary roles are protection, preservation, traceability, profitability, convenience / practicality and presentation, while its secondary roles are handling, containment (safety containers), identification, labelling and suitability. A wide range of regulatory measures, high standards and the correct handling of food in logistics processes ensure that food is delivered safely from the producer to the consumer. The essential role of packaging in logistics is to provide products with the necessary protection during storage and transport and to reduce costs.*

*Packaging has a positive impact on product distribution and safety, particularly in the food industry, where it increases shelf life, facilitates transportation and helps to save costs. By carefully arranging and packaging the products in suitable packaging, the available space can be used optimally. This article presents the role of packaging in logistics processes such as transport, storage, loading and packaging of food with an explicit focus on sustainability. A case study shows the example of the overseas logistics chain of the avocado, a type of food with very high CO<sub>2</sub> release and high water consumption. The status of the green logistics and further requirements for companies and consumers is demonstrated.*

**Keywords:** *Packaging, Logistics, Sustainability, Food Sector, Green Logistics, Shelf Life, CO<sub>2</sub> Release*

### 1. Primary, secondary and tertiary roles of food packaging

The chief function of packaging is to protect its contents along the entire length of the logistics chain, be it from mechanical impacts during transport and handling or from environmental effects such as humidity, contaminants or microorganisms (BMEL, 2010). At times packaging may also protect the environment from its contents in the case of hazardous goods. "Packaging

needs to be more than its contents". The food industry is one of the largest business sectors and the development and implementation of the right packaging is an area of great importance (Forbes, 2007). New developments in materials and techniques can greatly increase shelf life and save costs, a factor that should not be underestimated in the food industry, which deals in significant quantities of packaging. The packaging, on average, accounts for six percent of the total value of the product, a figure, which is more

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than double that of the next product category (ESU-services Ltd., 2018). Packaging has primary, secondary and tertiary roles (Querblicke, 2018).

### 1.1. Primary roles

Primary roles mostly refer to the technical properties of the packaging in terms of its protective, storage, handling and transport functions (Querblicke, 2018). In the context of the food industry the packing needs to reach the following requirements with regard to its primary roles:

- **Shelf Life / Protection:** Increasing the shelf life of food products is of the utmost importance. By utilizing the right kind of packaging, even biochemically active products may be kept longer without necessitating refrigeration. Often these kinds of products could otherwise not be exported. Adverse environmental effects that can be diffused through packaging may include light, oxygen, bacteria, parasites, physical damage and contaminants in general, for which “a large number of regulations exist, affecting all businesses in the food industry, ranging from the producer to the shop keeper” (BMEL, 2010).
- **Traceability:** “Any type of food and its ingredients has to be traceable back through all stages of production, processing and distribution. Securing complete traceability represents an important tool to authorities when it comes to ensuring food safety, particularly with regard to recalls of unsafe food (Lebensmittel-info.eu, 2016).”
- **Strains of transportation:** Packaging aims to protect from the strains of transportation, particularly the dynamic kind, encountered on the journey via sea, land and air. A lot of food is sensitive to pressure and

needs to be packed accordingly. Up to 70 percent of transport damages could be avoided with better packaging. Packaging makes it easier to form loading units, which can be safely handled and stored.

- **Machine compatibility:** Food pack-ging needs to be suited for machine processing.
- **Space utilization and stackability:** Storage space is a major cost factor, particularly during transport. Packaging can help utilize the available cargo space efficiently, which is particularly important for refrigerated goods.
- **Material Flow/ Storage Function:** The material flow includes the delivery, handling and transport of goods as well as their storage in designated packaging. Packaging enables a secure and efficient material flow.
- **Resource consumption:** Producers continuously strive to reduce the quantities of resources and energy needed for the production of packaging. Thinner materials of higher quality are employed. This also means that the share of plastics continues to rise.

Certain packaging materials are able to keep food fresh without refrigeration; one example for this is aseptic packaging (Tetra-Pak-System), which can keep unrefrigerated food fresh for up to six months and is used for liquids such as milk, juices and wine as well as a variety of different foods, vegetables, tomatoes, ready meals, soups and pet food. The water-, steam-, gas- and light barrier properties of the polymers used in packaging are crucial for upholding the quality of agricultural products, which themselves are highly complex matters of varying degrees of biological activity. Synthetics with barrier properties has allowed the food industry to shift from

energy intensive materials such as metal and glass to co-extruded packaging materials. Plastics have many advantages: lower transport costs, high durability and minimal loss of produce. This type of packaging has also enabled producers to export shelf-ready products rather than the raw product.

Packaging the product in a modified and controlled atmosphere extends the longevity of fresh fruit and vegetables, thus allowing consumers to enjoy green grapes from South Africa and red grapes from Chile, sold together in Dutch supermarkets. These techniques are by no means new territory, as they have been used to store large quantities of fruit since decades, expanding their window of availability. And once that closes, carbon-dioxide heavy imports from the Southern hemisphere are there to fill the gap.

## 1.2. Secondary roles

Communication, the secondary role of packaging is of great importance in the food industry and encompasses sales, services, advertisement and warranty functionalities. (Querblicke, 2018).

- **Sales:** Packaging facilitates and streamlines sales and extends the shelf life of food from producers all the way to consumers.
- **Services:** Food packaging contains valuable information such as price, weight, quantity, expiration dates, nutritional values, possible uses, and the EAN barcode as well as additional information on the type of product.
- **Advertisement:** Customers are able to recognize the product based on its packaging, which is aimed at consumers and hopes to make a positive impression and influence sales decisions. Test results often show that identical food items are rated higher if presented in colourful and aesthetically pleasing packaging.

- **Warranty:** Producers guarantee that the product is as stated, if the packaging is intact. This is the basis for product liability and consumer protection.

The packaging will sometimes add significant value to the product and in some cases almost become the product itself. (Schmidt, 2016).

## 1.3. Tertiary roles

The tertiary role of packaging comes in after its contents have been consumed, extending its life span beyond its original purpose (Querblicke, 2018):

- **Reuse and repurpose:** Most people will be familiar with returnable bottles as an example for the continued use of food packaging. Outer or secondary packaging such as palettes, pallet cages, trolleys or plastic containers are also examples of reusable food packaging. Utilizing reusable packaging should be further encouraged due to its environmental benefits.
- **Recycling:** A significant percent of food packaging can be recycled. Tinplate, glass, plastics as well as paper and cardboard packaging are all valuable resources, reducing residual waste.
- **Environmental protection:** Protecting the environment is becoming an increasingly greater concern. The share of packaging relative to all waste (household and industrial) produced in Germany accounts for half in terms of volume and for one third in terms of weight (Relay Group, 2016). As people become more conscious of the environment, they begin to prefer recyclable packaging. Bio-degradable plastics made from renewable resources (or at least to a significant degree) are used to create compostable

packaging. Waste separation further facilitates the reduction of waste.

## 2. Expensive packaging, expansive logistics and a large CO<sub>2</sub>-footprint: A case study of the avocado

The avocado is a good example of a type of food that is very demanding in terms of the logistics involved, the quantity and quality of packaging needed as well as the amount of carbon dioxide produced. Dietary trends and thus the demand for different foods change over time. The avocado is currently highly sought after, especially as it can be used as a substitute for eggs and butter in vegan households, another recent dietary trend.

Both discounters and supermarkets stock avocados all year round, importing them from Spain, Israel, Morocco, Mexico, Peru, Chile, Brazil, Kenya or South Africa, depending on the time of year. German avocado imports have increased more than threefold between 2008 and 2017, rising from less than 20,000 tonnes to over 71,000 tonnes per year (Brandt, 2018). Like Chia, Quinoa, Acai- and Goji-berries, the avocado is attributed with significant health benefits despite a general lack of conclusive evidence from scientific studies. It does, however, contain a number of vitamins, minerals and unsaturated fats, although most types of fruit and vegetables, such as domestic apple varieties, possess many similar benefits.

However, not everyone is enthused by the current avocado fad as a quick google search will reveal. The criticism chiefly stems from the high demands of the avocado in terms of labour and energy during its production and distribution. One of Europe's biggest avocado suppliers is the South African farm ZZ2, which employs 10,000 people on an area the size of Hamburg and possesses its own school, hospital and airport:

- Saplings are raised in a fully

darkened room.

- Selection of saplings in preparation for the next step.
- Application of special hormones in a room filled with green light.
- Maturation of saplings in a pathogen-free greenhouse.
- Saplings are then grafted on plants of different species such as apple trees due to the fragility of the roots of the avocado.
- Soil ought to not contain any stones and is thus sieved through with heavy machinery.
- Bark is coated with a layer of paint, which acts as sun blocker.

Another key criticism centres on the large quantities of water needed, approximately 1,000 litres will yield a kilogram or two and a half avocados. The following table shows the water consumption of different fruits and vegetables (per kilogram) (Hoekstra, 2017):

• Tomato	200
• Salad	250
• Potato	300
• Cucumber	350
• Orange	560
• Apple	800
• <b>Avocado</b>	<b>1000</b>
• Dates	2200

Avocados are a product of industrial-scale farms with the means to construct their own pipelines to secure their water supply. Yet growing and harvesting the avocados is just the beginning, as they often face a long and (logistically) taxing journey before they reach their final destination:

- Lorries transport the avocados to the port in Durban, a 1000 kilometres journey from the ZZ2 farm.
- 26-day sea passage to Rotterdam.
- Energy intense storage in electrically powered containers at six degrees Celsius, controlled humidity and CO<sub>2</sub> concentration levels throughout the entire journey.

- Avocados also require additional packaging material on an individual level due to their shock sensitivity.
- Storage space needs to be kept clean at all times as avocados are vulnerable to any oils or pollution.
- Avocados cannot be transported or stored together with odorous goods due to their high sensitivity to odours.

An Avocado is as hard as a rock at the moment of harvest. To ensure that they reach the right level of ripeness (neither too hard nor too soft) at just the right time, they are later placed in ripening chambers. This process increases revenue significantly since the product can be tailored to consumer preferences:

- Having reached the port of Rotterdam, the (still hardened) avocados are once again loaded onto lorries and taken to Maasdijk (30 km) where they are placed in ripening chambers, after first having been inspected to determine the correct duration.
- The gas ethylene, which is emitted during the ripening process of bananas and is harmless in small doses, is added.
- Avocados spend six days on average in the ripening chamber at temperatures of between six and 25 degrees.

Once ripened a few more steps follow before the avocado is ready to be distributed to retailers:

- Ultrasound is used to detect dark spots within the fruit and affected avocados are sorted out.
- Mechanical touch test for ripeness.
- Green and dark-brown avocados are automatically sorted out due to consumer preference for aesthetically pleasing fruits.
- Manual collection from the belt conveyor and sorting into boxes.

- Manual application of a sticker on the avocados.

The avocado is representative of a life style with a large foot print in terms of packaging, logistics, water and carbon dioxide. While people are generally becoming increasingly aware of the need to protect the environment and preserve the planet for future generations, their consumption habits are often in opposition to these goals. Everyone wants society as a whole to become greener, yet few are willing to make the necessary personal sacrifices. This contradiction is readily apparent in the context of the food people consume, as generally environmentally conscious people will continue to buy food, which consumes large quantities of water during production, yet is grown in arid countries, which uses significant amounts of energy while they drive their energy-saving hybrid cars, and whose cultivation changes large swathes of land as they spend their holidays in national parks.

A majority of Germans support a shift towards regionally grown, seasonal products yet their own shopping lists rarely reflect this. The results of a survey conducted by Forsa shows this inconsistency (Ehrenstein, 2016):

- 94 percent of Germans believe that protecting the environment has a significant positive influence on their quality of life.
- 79 percent believe that everyone is able to personally contribute to protecting the environment.

Yet there remains a huge discrepancy between personal expectations and reality:

- 68 percent experience difficulty in making their household more environmentally friendly.
- Only twelve percent of consumers use environmentally friendly cleaning agents.
- 38 percent of Germans perceive it to be an arduous process to pay



attention to whether a product is marked as environmentally friendly or biodegradable while shopping.

- 46 percent just buy what they always have bought out of habit.
- One out of three do not separate organic waste and just throw it away with their residual waste.

These results should not be surprising given that Germany, with its 618 kilograms of household waste per person, comes in second place among European Union member states (the Danish take the crown with 759 kilograms per capita per annum). Protecting the environment works best, if it presents a financial savings to the consumer. Being conscious of the need to protect the environment is only the first step and ultimately means little if it doesn't lead to a change in behaviour.

### 3. Green logistics

While peoples' willingness to make personal sacrifices for the environment often leaves a lot to be desired, the tide is definitely turning as both government and consumers as a whole have become markedly more conscious of the environment. This, in turn, is often reflected in changes to the regulatory framework as well as increased public pressure directed at businesses. Green products are thus becoming one of, if not the most significant driver of competitive differentiation, as an ever-greater variety of products, which themselves come in different revisions, continue to hit the market. They often consist of numerous, highly specialized components and are manufactured in highly integrated manufacturing chains across country borders. All these components as well as the partially manufactured goods need to be transported and are thus stowed in containers tailored to the exact needs of their contents, as a "one size fits all" approach would result in higher transport and storage costs. Cross Dock processes, which can consolidate

transports and reduce the complexity of transport networks, will become increasingly important.

An international survey on procurement decisions showed that their environmental impacts have become an area of concern. While quantitative factors such as labour costs or raw material prices and qualitative factors such as a flexible production and logistic remain at the forefront, ecological and ethical considerations are given increasingly greater importance. One of the biggest obstacles when buying from China are its lower environmental standards (BrainNet, 2009). „Green Logistics is the holistic transformation of logistic strategies, structures, processes and systems in businesses or business networks with the goal of creating ecological and economical logistics processes. “Green logistics strives to create sustainable value for the company by balancing both economic and environmental efficiency” (Cetinkaya, 2011, p. 14). Green logistics or climate-friendly logistics is expected to become a major competitive advantage in the logistics sector, as such services have the potential to lessen the costs accrued by purchasing CO<sub>2</sub> certificates.

While a lot of companies have begun to implement sustainable logistics at a concept level, putting these plans into action has proved more difficult. This is partly due to the difficulty of quantifying its success. What can be done to elicit greater commitment by businesses? As with consumers, increased awareness on its own does not suffice without a willingness to shoulder the associated increase in costs and effort. German online retailing is an example for a business sector, which leaves a lot to be desired, as green logistics is yet to really play any significant role (Internet World, 2010):

- Two thirds (or 61 %) of merchants are unfamiliar with the concept.

- One out five (21 %) doesn't consider green logistics as an area of significant potential benefit.
- Only eight percent of merchants have already shifted or plan to shift their online retailing business towards utilizing more sustainable logistics solutions.
- Ten percent are at least keeping up with the discussions.

A survey conducted by Forsa and commissioned by Steria Mummert Consulting (2010) in March 2010 polled 100 decision makers employed at the 68 largest producers of consumer goods as well as the 32 largest retailers in Germany with regard to their strategies and concrete measures to be undertaken over the next two years to combat climate change and protect the environment (Steria Mummert Consulting and F.A.Z. Institut, 2010):

- 32 stated that there was a willingness to shoulder the costs of green logistics.
- 60 admitted that any additional costs would be seen as prohibitive.
- 8 chose not to comment.

While customers consider green logistics a desirable good, few are willing to pay for it. Though there are signs that are promising, as the number of people in Germany willing to pay more for a product, if it were environmentally friendly, rose from 17.1 to 22.19 million between 2013 and 2017 (Statista, 2018). While these figures are encouraging, there is still a long way to go until the idea that economy and ecology belong together will be universally accepted as

the sceptical taglines of many seminars and conferences on the topic illustrates:

- "Green Logistics – An oxymoron or a silver bullet".
- „Marketing Green. Logistics – Promotion or Deception?"
- „Certifying Green Logistics: Complementary or confusing:
- The many awards and certificates

#### 4. Upcoming challenges facing businesses and consumer

It is in their own long-term interests that companies shoulder their share of the responsibility for the environment and society and not merely act in the name of profit: Resources are to be used efficiently and economically, while risks are to be identified and minimized. Running a sustainable business is increasingly seen as a desirable good by consumers. The latter yield considerable influence on the behaviour of businesses. Thus one would be wrong to dismiss prepacked food products as a costly hobby of overzealous packaging engineers, as they allow for more efficient logistic processes, extend the shelf life of the products and are ultimately what the costumers want. The food sector has grown into a complex, global business while cutting back on storage and labour costs as much as possible (DIE ZEIT Archiv, 1955). On average, packaging will account for 5.9 percent of the value of food sold in Germany, this figure rises to seven percent, if the additional packaging used during transport is taken into account (Buchner, 1999).

18 million tonnes of food are lost every year in Germany at some point during its lifespan from the producer to the consumer. This accounts for almost a third of all food consumed in Germany (54.5 million tonnes). 10 million tonnes or more than half of those

losses could be easily avoided: 2 million tonnes of cereals or cereal products, 1.5 million tonnes of fruit and a similar amount of vegetables as well as over a million tonnes of potato and milk products. The remaining eight million tonnes were unavoidable: losses during refrigeration, cooking, cleaning and cutting as well as respiratory losses (Noleppa and Cartburg, 2015). It is one thing to call for a reduction of packaging, but the other side of the story is that 54.5 million tonnes of all the food transported to and sold in Germany is ultimately thrown away. Yet the quantity of discarded food is expected to continue to rise on an international level, as a new middle class in emerging economies and the purchase sensibilities accompanying them begins to import this particular disease of civilization. 2.1 billion tonnes of food are expected to be thrown away by 2030, a rise of more than a third compared to current levels, which already account for a third of all food produced worldwide (1.6 billion tonnes, valued at 1.2 billion US dollars) (Hengsholt et al., 2018).

Of the global losses of food during its production and distribution:

- 32 percent happens as early as the field or barn.
- 46 percent is lost during storage, processing or at the retailer.
- 22 percent is thrown away by consumers.

While the last figure isn't exactly a badge of honour, it also shows that consumers cannot solve this problem alone, as most losses are caused by inefficiency and poor planning during production and distribution. More efficient transportation methods with more reliable refrigeration systems, better storage solutions and faster processing methods are required (Hengsholt et al., 2018; Lieberich, 2018, p. 23). The FAO estimates that 815 million people were suffering from chronic malnourishment in 2016 (of a total global population of 7.6 billion), while 8 percent of all greenhouse gas emissions were related to

food waste and loss (Ratcliffe, 2018). The quantities of plastic packaging used continue to rise despite already having done potentially irreparable damage to the oceans and natural habitats. Yet the US oil and gas industry continues to heavily invest in new cracking facilities and plants producing a wide range of plastic products, including bottles and inlays: a number of familiar names are involved in the construction of these new facilities, among them Exxon Mobile Chemical and Shell Chemical. This shouldn't come as a surprise; fossil fuels do after all account for 99 percent of the raw materials used in creating plastics. The global production of plastics could rise up to 40 percent over the coming decade, putting further strain on the planet (Taylor, 2017).

While food packaging does allow for more effective logistic processes and is convenient for the consumer, it also reveals that peoples' self-perception as environmentally conscious consumers and the reality presented in their actions is at odds. Something has to give and while not everyone can be expected to follow zero waste's inverted pyramid of waste management and its 5 R's to the letter, most should be able to make one or two changes in their daily lives to help alleviate the problem (Zero Waste Switzerland, 2018; Zerowaste-home.com 2018; Su, 2015):

- Refuse: Only acquire what is needed and refuse what is not: outer packaging, promotional leaflets and gifts.
- Reduce: Avoid unnecessary purchases, generally stick to a predetermined list of goods and avoid overstocking perishable goods.
- Reuse: Give reusable products preference and consider if something can be repaired before throwing it away.
- Recycle: as big a share of one's overall waste as possible; products in recyclable packaging should be given preference when shopping.



- Rot: Compostable waste should be added to a local compost system.
- Landfill: What cannot be processed according to the five R's should be thermally processed if possible and deposited on a landfill if not.

Schörner (2019) showed an unusual case of reduce /reuse: his regular supermarket plastic bag served as a template for a Chinese seamstress making carrier bags with fabric remnants. Daniel Webb, the co-author of the Everyday Plastic report, collected his plastic waste (4490 plastic parts) for a full year while also discovering the truth about recycling: “We have been indoctrinated by a system that actually achieves little. It’s our throwaway culture that needs to change. We need to massively improve and invest in recycling infrastructure, but also significantly reduce what we produce and use. Learning to connect with and reduce what we consume not only confronts the plastic problem, but can also improve our society and culture as a whole” (Webb, 2018). His report is available online (Webb and Schneider, 2018). The world’s deepest ocean trenches are becoming “the ultimate sink” for plastic waste, according to a study that reveals contamination of animals even in these dark, remote regions of the planet (Watts, 2019). According to Monbiot, the Earth is in a death spiral and it will take radical action to save us. Climate breakdown could be rapid and unpredictable. We can no longer tinker around the edges and hope minor changes will avert a collapse of our ecosystem. What is needed is a change in our disposable culture (Monbiot, 2018).

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Conscience ought to beat Convenience and this is far too seldom the case.

## 5. Conclusion

The primary functions of packaging, such as protection, preservation, economy, convenience / practicality and presentation / demonstration, and, especially for food, food safety and extension of shelf life, are uncontested. Yet the incredible amount of packaging being thrown away on a daily basis has very much come into the focus of public discussions. Packaging is a short-lived commodity. Crucial is not the packaging itself, but the treatment of packaging in a sustainable logistics chain: reduce, reuse and recycle. For reasons of sustainability, economic viability, society and the environment, it is important for companies to focus their attention on reducing all types of resource consumption. On average, packaging accounts for up to two percent of product costs and up to about six percent in the case of food products. Developing an environmentally compatible mindset is crucial. The handling of packaging is an introduction to this way of thinking, which is absolutely essential for a resource-saving consumption of the remainder of the goods (i.e., the 94 to 98 percent which isn’t packaging). Sustainable procurement makes a contribution to this. All stakeholders, i.e. both businesses and consumers, must progress from environmental awareness to concrete environmental activities.

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