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THE PACKAGING IMPACT:
**EMPTY SPACE,
SUSTAINABILITY AND
CUSTOMER
SATISFACTION**



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Botta Packaging

EXECUTIVE SUMMARY

An efficient supply chain is a vital customer winning factor in today's highly competitive world. McKinsey¹ highlights "sustainability requirements increasing at every step of the value chain" as one of the five major packaging industry trends. During the 1990s due to the low cost of transportation, companies were emphasizing just-in-time delivery strategies.² The increase in transportation cost and changes in supply-demand imbalance resulted in significant changes in logistics strategies. One of the most important changes has happened in how products are produced and marketed. Before it was common to focus mainly on product marketability and production costs. Recently, however, a shift towards more efficient design and production that directly addresses the "shipability" of goods has been widely adopted. By reexamining product design to minimize weight and to improve shipment density companies can achieve better transportation cost-effectiveness.² According to the Forbes Insights and DS Smith³ research, 24% of containers shipped from Asia are empty. They result in 122 million tonnes of carbon dioxide emission which can be progressed to \$46 billion a year global savings.

This paper aims to provide a comprehensive overview of financial, environmental, and customer satisfaction factors of transporting empty, unoptimized space. The first part of the study is based on logistics-related books, academic research papers, industry surveys, and whitepapers. The second part aims to acquaint the reader with existing regulations and real world packaging optimization implementation cases.

IMPACTS OF THE PROBLEM

COSTS

After a product is manufactured it is transferred from production operations to post-production logistics operations. The packaging is important for the transportation of goods to warehouses, distribution centers, and final customers. Good packaging can enhance employee and facility productivity. Well-designed packaging protects goods, communicates a message, and ensures the lowest logistics cost possible. Packaging design impacts how a company can use available space and equipment. Package shape, strength, and materials impact the ability to use the full cubic capacity. Commonly, rectangular or square shape boxes with satisfactory strength are used for stacking purposes. Specific packaging dimensions are required to fulfill available handling requirements in warehouses, distribution centers, and final customer locations. Inadequate packaging can be dangerous and costly for handling.

The dominant concern is the balance between ease of handling and cost related to materials and transportation. Comfort handling might be of interest to production and logistics managers to increase labor productivity, but they cause later problems when products are transported. The packaging design should consider pallet and vehicle characteristics to ensure maximum possible utilization. Companies failing to do so end up paying for the costly consequence of “shipping air” which further drives up the cost of goods.⁴ In 2019, a study published in the Korean Journal of Packaging Science and Technology,⁵ measuring empty space of parcel deliveries, reported that out of 134 deliveries 64 has more than 50% free space. Packsize⁶ states that 40% of packaging materials are empty space that can be optimized. Forbes and DS Smith estimate that e-commerce parcels are shipped at least a quarter empty.³ These figures clearly represent the scale of inefficiencies related to empty space delivery.

A variety of packaging system optimization software is represented in the market to help packaging designers and logistics managers to optimize goods packaging. Usually, they are used to optimize pallets and containers. Botta Packaging has contributed to the widespread adoption of optimization techniques, releasing free to use [online pallet calculator](#).

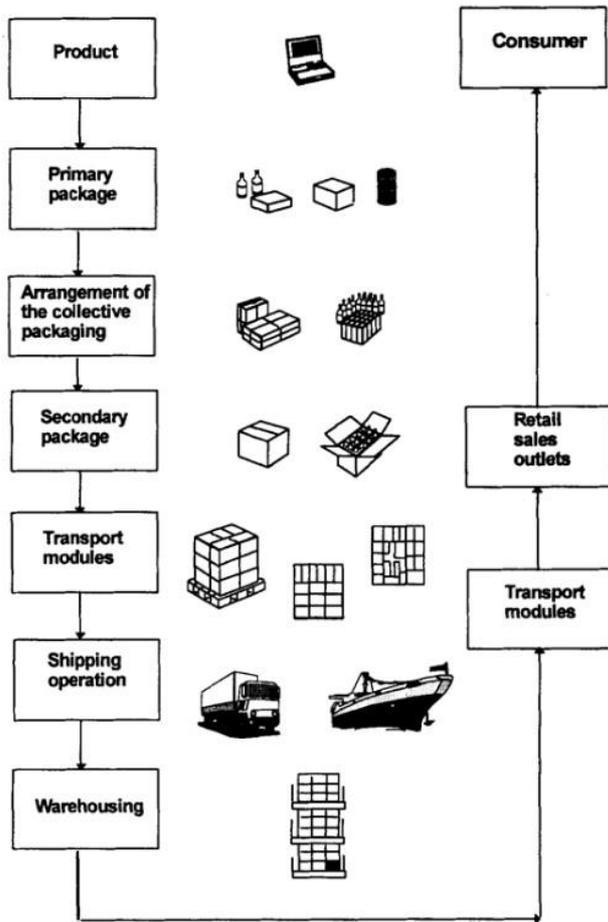


Figure 1: Packaging in a typical logistics system⁷

As indicated by Figure 1 a typical logistics system consists of primary, secondary, and transport module packaging. Cost optimization requires a holistic view of all materials and manufacturing stages involved. Total packaging costs are an aggregate of material, equipment, operations, and labor costs. Primary packaging can be reduced by decreasing the amount of material used. For example, material innovations have recently allowed decreasing glass and metal thickness used in primary packaging, thus decreasing weight transported. Using the empirical model presented in the study⁸ one can optimize required secondary packaging. The last approach is to optimize pallet space and

container space. An inefficient package can occupy more space for the same number of shipping boxes that could have otherwise been packed into fewer containers. Palletizing boxes also decreases efficiency becoming a pseudo-container itself. An ill-considered box leads to inefficiency at the pallet level which subsequently escalates at the container level. Cost optimization can be grouped into two aspects: material and transportation.⁷

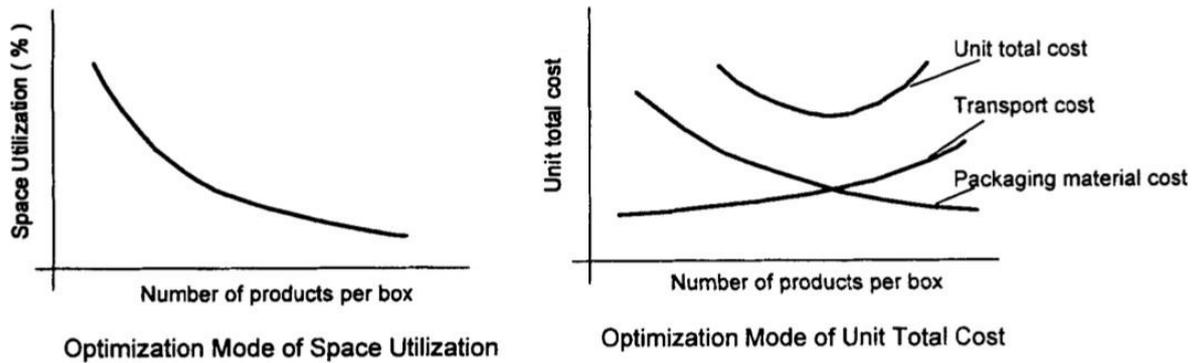


Figure 2: Comparison between space utilization and cost optimization⁷

It is important to highlight the differences between space utilization and total cost optimization. Smaller boxes can ensure higher space utilization. The total unit cost is calculated by adding transport and packaging material costs. As the number of products per box increases, empty space increase too, resulting in higher transportation costs. But inversely it decreases packaging material required. Thus, it is very important to identify transport cost to packaging material cost ratio to effectively optimize your utilization ratio.⁷

In 2015 small parcel delivery operators started dimensional pricing which is based on the relative space the package occupies in relation to its weight. Retailers are now incentivized to optimize shipped packages to reduce “empty air” to curtail total cost.⁹

Recent University of Padova “Packaging Design: General Framework and Research Agenda” paper ¹⁰ shows that both internal and external logistic activities have to be considered to ensure logistic efficiency. The analysis concludes that logistic-oriented packaging design can improve 10 factors:

- Handling, lifting, and loading/unloading activities
- Material handling devices
- Warehousing, stocking, and stacking
- Filling, order picking, sorting, packing, and unpacking
- Shipping, transportation, and delivery
- Traceability
- Reuse and recycle
- Easiness of inventory controlling and

- Availability and transparency of information

Each year \$46 billion can be saved by eliminating empty space.³ Recent Trivium Packaging¹¹ report highlights that 74% of consumers say that they would pay more for sustainable packaging, among which 25% are willing to pay 10% or more. A sustainable approach to packaging drives sales up with sustainably-marketed products growing 5.6 times faster than conventionally marketed products.¹¹ And in over 90% of individual product categories, sustainability-marketed products outpaced the growth of their categories.¹¹ 48% of the US and 56% of European businesses state that their logistics is not scaled to support online business acceleration.¹²

“Packaging Design: General Framework and Research Agenda” literature review ¹⁰ on packaging costs found that:

- Approximately 9% of the cost of any product is likely to be the cost of its packaging
- Approximately 90% of packaging costs may be attributed to factors other than the packaging material itself
- Hidden costs associated with overpackaging, in Europe alone, seem to be 20 times higher than the cost of excessive packaging materials, and they have been valued at an estimated €130 billion/year.
- Packaging materials constitute as much as 65% of the global solidwaste

ENVIRONMENT

With the increasing concern on environmental issues an assumption that going green would lead to increased cost has prevailed. Governmental regulation and social pressure demand to adopt a green supply chain, reduce pollution, and carbon emissions. As a result of this shift, organizations were able to reduce their carbon footprint and still lower their costs.

High oil prices in 2008 increased logistics actors' interest in fuel consumption reduction. One of the improvements born at that time was increasing fuel efficiency which reduced carbon footprint. Other ones are brand reputation, corporate responsibility, competitive pressures, and regulatory actions. With the invention of the fracking technique in 2014, oil prices reduced significantly generating concern that it may slow sustainability issues.¹³

Also, packaging facilities and waste management influence sustainability issues. Transportation economics axioms as “don't ship air” and “don't ship water” are fundamental. Empty backhauls and less-than-capacity shipments are wasted and never recovered. Truck utilization has to be maximized both for volume and weight simultaneously. It requires the consolidation and division of goods to improve shipment density. Such consolidation surely impacts on lead-time but is compensated by fuel and carbon emission reduction. The perception of getting more with a larger package is an existing marketing trick, but with increasing civil pressures, this tendency is changing. In the second part of the paper, we will analyze how Walmart has addressed this issue.¹³

New materials, optimization techniques, configurations are sought under continuous improvement processes. To produce packaging, renewable and non-renewable energy resources are used, waste is created and greenhouse gas is emitted. Attempt to reduce waste, reuse, and recycle is widely promoted and demanded by societies.¹⁰ The environmental impact of a particular packaging solution can be evaluated by ISO 14040 Life Cycle Assessment (LCA). LCA is “a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributed to the functioning of a product or service system throughout its life cycle”.

According to DS Smith research ³ every year 122 million tonnes of carbon dioxide are emitted as a result of empty space shipping. That is equal to the emission by countries such as Belgium or the Czech Republic.

CUSTOMER EXPERIENCE

Packaging influences customer experience and satisfaction. A survey organized by DS Smith³ highlights that 51% of customers see packaging waste as an important environmental issue, also underlining the fact that the sustainability issue is today of much-increased importance than five years ago. 2020 Global Buying Green Report results show that 67% of consumers now identify themselves as environmentally aware.¹¹ Unilever survey spot that one-third of customers choose brands according to their social and environmental impact. Millennials became spenders who relate brand views with packaging experience and used materials.

Geodis and Accenture whitepaper shed light on expectancies of businesses in the COVID-19 pandemic situation. E-commerce channels share have doubled during lockdowns moving from 34% of sales to 65%.¹² Online webshops share increased fivefold in Europe.¹² In the next three years, 76% of the US and 56% of European brands expect their direct online sales to exceed 20% of the business.¹²

72% of consumers prefer receiving parcels wrapped in cardboard rather than plastic.¹⁴ Among 7000 respondents 61% prefer delivery of parcels to be carbon-neutral and 66% are willing to receive packages a few days later to reduce environmental impact.¹⁴

The research¹⁵ to understand customer attitudes to packaging sustainability revealed that more than two-thirds (68%) of European respondents say that being environmentally-friendly is more, or very important to them. 80% of younger shoppers between 19-29 emphasize the environmental aspect importance. 74% of Europeans say that the media focus on the issue has influenced them to change their purchasing habits.¹⁵

52% of all Europeans believe that cardboard is the most environmentally-friendly packaging.¹⁵ 75% of consumers from across Europe say the environmental impact of a product's packaging affects their purchasing decision.¹⁵ Four out of five consumers (81%) said they would choose cardboard packaging over plastic packaging.¹⁵ A resounding 91% of European consumers say they'd choose to spend their money with a supermarket or shop that was proactively encouraging suppliers to adopt more

environmentally-friendly forms of packaging and policies.¹⁵ A very high percentage of respondents (77% ,over 5000 out of 7000 respondents) say they are willing to pay extra for packaging that has less impact on the environment.¹⁵

2 out of 3 consumers believe that we're heading towards environmental disaster unless we change our daily habits.¹⁶ Environmental issues are at the top of the global concerns list (63%) with more (86%) believing that the situation will get worse.¹⁶

Stora Enso reports¹⁷ that 50% of customers are disappointed by the quality of product packaging, but damaged boxes are not only a problem. The material used is also playing an important role as 59% of millennials prefer secondary packaging made from sustainable materials and 89% this it is important for primary packaging too.¹⁷

According to the 2020 Smurfit Kappa¹⁸ report, 83% of businesses describe sustainability as a business opportunity to be exploited and 72% say it is a lasting trend.

“One-size fits all” packaging is not providing the best efficiency for e-commerce. Packages in online retail have almost 3-time distribution touches compared to brick-and-mortar stores.¹⁹ As online sales are expected to increase to \$900 billion by 2023 and it is 3 times of traditional commerce growth rate²⁰, packaging will play a growing role in establishing a competitive advantage. Packaging failures are proved to be costly with 7 out 10 customers experiencing packaging issues, 1 out of 10 stopped shopping at an online retailer because of a bad packaging experience, 20% of consumers will not buy certain products due to packaging concerns and 35% of customers are more likely to post about a negative experience on social media.²¹

Amazon's success and further requirements are to fulfill customer expectations without using unnecessary space, overprotecting, or generating excess waste. Empty space in a carton uses more material and space than needed. Companies often use more than one type of filler of different materials, which sometimes are also not recyclable. In 2008 Amazon launched the Frustration-Free Packaging (FFP) initiative to change the way goods are packaged and reduce environmental damage. Since it started, more than 244 thousand tons of packaging materials have been eliminated, avoiding usage of 500 million boxes, and reducing overall packaging waste by 16%.²²

Now, companies that do not fulfill FFP requirements are charged an extra fee by Amazon. Such incentive “helps to re-examine entire packaging process to find new cost-saving opportunities for your business and deliver a more sustainable packaging experience for your customers”.²³ FFP guidelines were formulated as a result of customer demand which aims to reduce waste, protect against damage, ensure ease to open and to be made with 100% recyclable material. Amazon is trying to drive the industry toward protective, cost-effective, easy-to-open, low-waste packaging.²³ Empty space is a compounding factor in the e-commerce field. One third of online orders are returned, resulting in forward and reverse travel of these packages. Often customer returns are free allowing customers to order multiple sizes and return those that are not fit.

ACTIONS TO SOLVE THE PROBLEM

REGULATION

An increasing number of governments around the world are adopting policies and regulations to address environmental concerns. Eco-taxes, deposit return, obligatory rules to recover packaging, allocation, distribution of waste management, and responsibility shifted to manufacturers are examples of possible actions. The European market directive 94/62/CE and its updated version 2004/12/CE regulate material rationalization and packaging waste reduction. The directive includes a set of important rules to source material reduction, recovery standards, reuse, heavy metal content, and minimization of hazardous substances in packaging.

Life Cycle Assessment (LCA) is a methodology used to evaluate the environmental impact of a packaging system. It is represented under International Standard Organization ISO 14040 with updates ISO 14041-14044. Environmental impact directly attributed to the functioning of a product is examined by inputs and outputs of materials and energy following systematic procedures. This way of assessment is widely used in empirical studies of the sustainability of a particular packaging. Several additional designs and support tools were developed by Sustainable Packaging Alliance, Australia, and Sustainable Packaging Coalition, USA. They give visual aid to a designer and supply a set of environmental indicators. Different packaging alternatives, package details life cycle analysis and material health can be examined using this way of estimation.¹⁰

Design requirements to control empty space ratios are implemented in Taiwan, South Korea, and China. Maximum layers of packaging and ceiling of allowed empty space ratio are regulated. In South Korea, the allowed empty space is 10-35%, Japan allows up to 40% free space for cosmetics products while in Australia, it is 25-40%.²⁴ Australia, Belgium, the Netherlands, Greece, Slovakia, Spain require producers to submit a detailed packaging reduction plan.²⁴ Another important regulation is Extended Producer Responsibility in which the manufacturer bears responsibility for “post-consumer” waste. Packaging fees are used to fund recycling systems. These fees are calculated depending on the weight and type of packaging material used. Fees are adopted by Japan, Korea, Turkey, Canada, Australia, Singapore, and the Netherlands. Non-regulatory standard ISO/TC 122 addresses “characteristics, performance requirements and tests, and utilization of related technologies on packaging”.²⁵ The European Organization for Packaging and the Environment (EUROPEN)³¹ and Global Packaging Project (GPP) are worth mentioning for commitment to developing and using sustainable packaging.

IMPLEMENTATION CASES

Volvo has attempted to evaluate packaging alternatives according to its sustainability perspective. Packaging fill rate, material, transport, handling, and waste handling criteria have been adopted. The case study concludes that a one-way packaging solution resulted in fewer costs and negative environmental impact. The same model

can be applied by managers to evaluate their sustainability and economic perspectives of existing supply chains. Rarely, these dimensions are considered simultaneously. Packaging size affects warehousing and transportation space used; the packaging design may reduce disposal costs, lighter packaging may reduce transportation costs and the more protective packaging may reduce damage.²⁶ Two existing methodologies implemented by Volvo are Life Cycle Analysis (LCA) and packaging scorecard. LCA is a widespread approach used to gauge the total environmental impact of results from used energy, consumed materials, and released waste. Often LCA is criticized for the difficulty of collecting necessary data. A packaging scorecard is a tool used to calculate packaging performance at each stage of the supply chain. Balanced scorecards, which are practically calculated by multiplying the level of fulfillment by the relevance percentage quotient. The drawback of this method is a subjective evaluation. Other evaluation models such as concurrent packaging and product design, sustainable packaging design, economic and environmental framework, and design of reusable packaging can be used. **Volvo Car Corporation** and **Volvo Logistic Corporation's** returnable packaging are selected for analytical investigation. A comparative quantitative model was divided into five parts: packaging manufacturing, transport, filling, storage, and waste management. Packaging fill rate, material type, weight, energy use, mode of transport, shipping distance, empty running, handling, sorting, packing, recycling, and many other important criteria were selected for calculations. As a result, research reports that returnable packaging was 208 g CO₂/component and 0.37 €/component higher than the one-way packaging solution. This fact highlights the importance of careful evaluation of existing packaging solutions. Decisions as an implementation of returnable packaging that look more sustainable at first sight may be harmful both in economic and environmental dimensions.²⁶

IKEA has been recognized as one of the world's best retailers in terms of sales volume, the number of stores, and the number of countries. The company is famous for recognizing packaging and logistics as important factors for success.²⁷

Distribution and the packaging solution have been set from the beginning for the European distribution on euro pallets. Back in 1996 **IKEA** decided to address packaging issues. A packaging support function was set up later in 1999. Packaging technicians were located closer to the product and product development process. Since then, **IKEA** has been in a continuous search of empty space solutions in

packaging and vehicles. In 2002 they found that “GLIMMA” tea candle products had more air than any other products. Initially, products were packed in a plastic bag, and bags were transported on standard pallets. Collaboration with a German company resulted in a system that can hold 360 packs instead of the original 252 packs. Euro pallets used reduced from 59,524 to 41,667 which allowed cutting the number of trucks needed for the distribution. Optimization contributed to environmental perseverance by producing 21% less CO₂ emissions. Lowered costs meant increased profit margins. With easier handling, packaging, and better display opportunities it was calculated that the new design saves 186-day of work-time each year.²⁷ Also, **IKEA** is among global leaders in sustainable resource usage with 91% of the wood from sustainable sources or recycled wood. 59% of the polyester used in textile products is also recycled, with the goal to reach 100% in 2020.²⁸

“Project Gigaton” is a **Walmart** project aimed to decrease greenhouse gas emissions in the retail giant supply chain. The goal of this project is to eliminate 1 gigaton - 1 billion tons of emissions from its supply chain by 2030. An important role in achieving this is played by suppliers who are communicated via the “sustainability platform”. The environmental toolkit that was developed by contributions from non-governmental organizations such as the **World Wildlife Fund** and **Environmental Defence Fund** is expected to bring an impact by taking 211 million vehicles off the roads. “Through the years, we’ve seen that integrating sustainable practices into our operations improves business performance, spurs technological innovation, inspires brand loyalty, and boosts employee engagement,” said Laura Phillips, senior vice president of sustainability for **Walmart**.¹³

Walmart has adopted scoring calculations for each product according to packaging efficiency and sustainability. It considers selling packages, transporting packaging, packaging materials. Specific scores worth to mention are greenhouse gas emissions from packaging production, material sustainability, package to product ratio, cube utilization, and recycled material.²⁹

Mercadona is the Spanish largest retailer with more than 1400 supermarkets. Packaging optimization implemented by the company can be summarized in the words of its CEO and founder Juan Roig: “The truck is full, the pallet is full, the box is full, the shelves are full and the product is full”. **Mercadona** collaborates with

suppliers on packaging design issues, encouraging improvements along the supply chain. “Shelf ready packaging” are displayable boxes or pallets that reduce packing material, optimize handling and storage. The substitution of rigid reusable plastic boxes with foldable ones resulted in 80% space reduction when these boxes are returned. This measure freed around 38,000 trucks reducing CO2 reduction to 10,000 tonnes. “Sustainable packaging logistics improvement deployed in one of the food suppliers who supplied frozen fish products achieved an increase in palletization of 12.6%. Packaging waste decreased by more than 2.5 tonnes of plastic, 36 tonnes of paperboard, and 90 tonnes of cardboard with combined 400,000 €/year savings. **Mercadona** sees achieved results as a benchmark and would suggest a “sustainable packaging approach” to the rest of its supply chain.³⁰

Marks & Spencer, a UK supermarket chain, is developing packaging machines that make customized packaging for the size of each order. Pre-cut cartons are identified as a source of inefficiency and, according to the machine manufacturer, it is a matter of time before they move from standard-sized boxes to custom made ones. The machine company representative said the retailer had saved \$2.1 million in logistics, handling, and packaging costs.³

SmartWay Transport Partnership is a governmental program initiated by the Environmental Protection Agency to match targeted carriers and shippers. The program intended to reduce environmental damage by doing things efficiently at less cost. Members are widely known companies such as Best Buy, Target, Coca-Cola, Johnson & Johnson, Procter and Gamble, and Walmart. Recommendations on fuel-economy saved thousands of dollars per year. In total, the SmartWay program has contributed to 196.5 million barrels of oil save and 94 million tons of carbon dioxide emission reduction.¹³

McCormick & Co. have revealed a plan to reduce carbon footprint by 25% by 2025.

Unilever, whose packaging acquisition has reached 2 million tonnes per year highlights the urgency to be efficient and find a solution for generated waste.

Bed Bath and Beyond, the retail company, initiated a program to “ship the most efficient number of cartons, saving corrugated packaging”. They were able to reduce the number of trucks used to transport goods and overall fuel consumption.³

CONCLUSION

Packaging plays an important role in logistics cost and environmental impact from the transportation of goods. Scientific models to calculate packaging-related costs include not only primary packaging but must also include secondary and tertiary packaging costs. E-commerce is growing and sustainable products are showing notable sales increases. From associated surveys, it was concluded that customer environmental awareness increased significantly in recent times and carbon footprint is an important customer satisfaction point. Government regulation to control empty space, waste management and material usage is an important trend that will increase in the immediate future. Life Cycle Analysis (LCA) and Balanced Scorecard are common tools used to evaluate the environmental impact produced by existing packaging systems. The paper presented an extensive number of implementation cases from the biggest industry players such as Amazon, IKEA, Volvo, Walmart to reduce logistics costs and address sustainability issues.

BOTTA PACKAGING

BOTTA Packaging is a corrugated cardboard box and industrial packaging company since 1947, representing the right mix of manufacturing tradition and innovation.

The company has also become specialized in Innovative and Sustainable packaging solutions, in line with its commitment to environmental protection and social responsibility, which earned it the recognition of Italian Eco-Pack by the Turin Polytechnic University, Eco-Packaging Award for Interpreting Circular Economy Through Innovation, and the selection as Sustainable Packaging Experts by Comieco. Instapack.me, the advanced e-commerce portal, was created adopting cutting edge and pioneering technologies in the packaging sector, using an Open Innovation approach.

BOTTA Packaging is one of only 11 Italian companies listed as Europe's 100 Digital Champions by the Financial Times.

For more information, visit www.botta.it

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