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DESIGNING FOR SUSTAINABILITY: A USER-CENTERED APPROACH TO ECO-FRIENDLY PACKAGING

The global packaging industry, fueled by population growth, urbanization, and evolving consumption patterns, faces an escalating environmental crisis marked by staggering amounts of packaging waste. This paper examines how design can act as a powerful force for positive change, fundamentally reimagining packaging to minimize its ecological footprint. Sustainable packaging design, adopting a user-centered approach, seeks to harmonize environmental considerations with aesthetics, user experience, and consumer perception to create solutions that are both ecologically responsible and commercially viable.

This paper delves into the fundamental principles of sustainable packaging design, encompassing material selection, waste reduction, energy efficiency, design optimization for recycling and reuse, and integration of social responsibility throughout the packaging lifecycle. We explore strategies such as lightweighting, material optimization, and the use of renewable, biodegradable, and recycled materials to minimize environmental impact. Life Cycle Assessment (LCA) emerges as a crucial tool for evaluating environmental performance and guiding design choices toward greater sustainability.

Recognizing the profound influence of consumer behavior, the paper examines the psychology underlying consumer perceptions of sustainable packaging. We analyze how design elements–color, shape, material choice, and messaging–impact consumer attitudes, purchase decisions, and perceptions of a brand's commitment to sustainability. The paper investigates the potential of emerging materials and technologies, including bioplastics, smart packaging, edible coatings, and active packaging, to revolutionize the industry. These innovations offer opportunities to enhance packaging functionality, reduce food waste, and minimize reliance on fossil fuels, paving the way for a more sustainable and circular packaging model.

Beyond its functional and environmental aspects, packaging plays a powerful role in shaping brand identity and consumer experiences. This paper underscores the significance of aesthetics in sustainable packaging design. By harnessing the inherent beauty of sustainable materials, employing minimalist yet visually appealing designs, and effectively communicating sustainability values, brands can enhance product desirability, foster emotional connections with consumers, and strengthen their commitment to environmental responsibility.

Finally, the paper emphasizes the critical role of user experience in driving the adoption of sustainable packaging solutions. We explore the principles of intuitive functionality, ease of use, adaptability to diverse use scenarios, and inclusive design to ensure that sustainable packaging is accessible and appealing to all consumer segments. By prioritizing user needs and preferences, designers can create packaging solutions that are not only environmentally responsible but also enhance convenience, delight users, and foster brand loyalty.

This comprehensive exploration of sustainable packaging design advocates for a holistic approach that balances environmental stewardship, aesthetic excellence, and user-centered design principles. By embracing this multifaceted perspective, stakeholders across the packaging value chain can contribute to a future where packaging solutions are seamlessly integrated into a circular economy, minimizing environmental impact while enhancing user experience and promoting a more sustainable future.

Key words: *ecological design of packaging, design, aesthetics of ecological packaging, ecologically clean packaging, consumption culture.*

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ПРОЕКТУВАННЯ ДЛЯ СТАЛОГО РОЗВИТКУ: ОРІЄНТОВАНИЙ НА КОРИСТУВАЧА ПІДХІД ДО ЕКОЛОГІЧНО ЧИСТОЇ УПАКОВКИ

Глобальна індустрія упаковки, що стимулюється зростанням населення, урбанізацією та зміною моделей споживання, стикається з дедалі більшою екологічною кризою, зумовленою великою кількістю відходів упаковки. Дана робота досліджує можливості дизайну як потужної рушійної сили принципового переосмислення упаковки у контексті позитивних змін щодо мінімізації її негативного впливу на екологію. Сталий дизайн, що спирається на орієнтований на користувача підхід, прагне гармонізувати екологічні міркування з естетикою, зручністю використання та сприйняттям споживачами, щоб створювати рішення, які є екологічно відповідальними та комерційно вигідними.

Дослідження заглиблюється у фундаментальні принципи сталого дизайну упаковки, охоплюючи вибір матеріалів, зменшення відходів, енергоефективність, оптимізацію дизайну для переробки та повторного використання, а також інтеграцію соціальної відповідальності протягом усього життєвого циклу упаковки. З метою мінімізації впливу упаковки на навколишнє середовище здійснено аналіз таких стратегій, як зменшення ваги, оптимізація матеріалів, а також використання відновлюваних, біорозкладних і перероблених матеріалів тощо. Оцінка життєвого циклу (LCA) постає як ключовий інструмент для оптимізації екологічних показників та спрямування дизайнерських рішень до більшої стабільності.

Визнаючи значний вплив культури споживання на екологію в цілому, у роботі акцентовано увагу на психологічних аспектах сприйняття сталої упаковки. Здійснено аналіз впливу таких складових дизайну як колір, форма, вибір матеріалу тощо на ставлення споживачів, прийняття рішень про покупку та сприйняття прихильності бренду до стабільності. У роботі також висвітлено інформацію про потенціал нових матеріалів і технологій, а саме біопластик, інтелектуальну упаковку, їстівні покриття та активну упаковку, для сприяння розвитку інновацій в галузі. Ці інновації відкривають можливості для вдосконалення функціональності, зменшення харчових відходів та мінімізації залежності від викопного палива, прокладаючи шлях до більш сталої та циклічної моделі упаковки.

Крім вищезгаданих функціональних та екологічних аспектів, упаковка відіграє важливу роль у формуванні ідентичності бренду та його естетичного сприйняття споживачами. Робота підкреслює значення естетики в сталому дизайні упаковки. Використовуючи природну красу екологічно чистих матеріалів, застосовуючи мінімалістичний, але візуально досконалий дизайн та ефективно розкриваючи цінності стабільності, бренди можуть підвищити привабливість продукту, сприяти емоційному зв'язку зі споживачами та зміцнити свою спрямованість до екологічної відповідальності.

Нарешті, робота підкреслює важливу роль зручності використання у стимулюванні впровадження рішень для сталої упаковки. Здійснено дослідження принципи інтуїтивно зрозумілої функціональності, простоти використання, адаптованості до різних сценаріїв використання та інклюзивного дизайну, щоб гарантувати доступність та привабливість сталої упаковки для всіх сегментів споживачів. Пріоритизуючи потреби та вподобання користувачів, дизайнери можуть створювати пакувальні рішення, які є не лише екологічно відповідальними, але й підвищують зручність, задовольняють користувачів та сприяють лояльності до бренду.

Комплексне дослідження сталого дизайну упаковки базується на цілісному підході, який збалансовує екологічну відповідальність, естетичну досконалість та принципи дизайну, орієнтовані на користувача. Застосовуючи цю багатогранну перспективу, зацікавлені сторони в усьому ланцюжку створення вартості упаковки можуть зробити свій внесок у майбутнє, де рішення для упаковки будуть органічно інтегровані в циклічну економіку, мінімізуючи вплив на навколишнє середовище, підвищуючи зручність використання та сприяючи більш сталому майбутньому.

Ключові слова: *екологічний дизайн упаковки, дизайн, естетика екологічного пакування, екологічно чиста упаковка, культура споживання.*

Problem statement. Worldwide packaging has grown tremendously in recent years, driven by population increase, urbanization, and changing consumer tastes. However, this rise has also led to an alarming increase in packaging waste, which has serious environmental effects. The United Nations Environment Programme estimates that just 9% of the nine billion tons of plastic manufactured so far has been recycled, with the remainder ending up in landfills, incinerators, or the environment. The environmental effect of packaging waste involves not only the loss of natural resources and the production of greenhouse gases but also the degradation of land and marine ecosystems, which poses substantial dangers to wildlife and human health.

In response to these environmental concerns, there has been an increasing need for sustainable packaging solutions that may decrease waste, preserve resources, and limit environmental effects. Sustainable packaging design attempts to develop packaging that is not only practical and cost-effective but also ecologically responsible and socially helpful, which means considering its impact on the environment and society. Sustainable packaging design encompasses using eco-friendly materials, optimizing package design for recycling and reuse, and reducing waste and energy consumption throughout the packaging life cycle. However, adopting sustainable packaging is not solely dependent on environmental considerations. Aesthetics, user experience, and customer perception also play key roles in boosting the need for sustainable packaging. Consumers increasingly seek items that correspond with their beliefs and lifestyle choices, including a desire for ecologically friendly and socially responsible packaging. Moreover, packaging that offers a superior user experience, such as ease of use, convenience, and functionality, can enhance customer satisfaction and brand loyalty (Steenis et al., 2017).

The relevance of design in sustainable packaging cannot be emphasized. Design bridges the technical parts of packaging, such as material selection and production procedures, and the emotional and behavioral factors, such as consumer perception and user experience. Effective, sustainable packaging design requires a holistic approach that balances environmental impact, aesthetics, user experience, and consumer perception (Magnier & Schoormans, 2015). By producing packaging that is not only ecologically sustainable but also visually appealing, operationally superior, and emotionally resonant, designers may accelerate the adoption of sustainable packaging and contribute to a more sustainable future.

This paper aims to explore the role of design in promoting sustainable packaging and driving the transition towards a circular economy. The thesis statement is: Sustainable packaging design is crucial in promoting a circular economy by balancing environmental impact, aesthetics, user experience, and consumer perception. This paper looks at the principles of sustainable package design, the psychology of consumer perception, the possibility of new materials and technologies, the significance of aesthetics and user experience, and the techniques for driving consumer adoption. The purpose is to give insights and ideas to designers, package makers, and other stakeholders so they may produce packaging solutions that are socially conscious, economically practical, and ecologically sustainable.

Review or recent research and publications. The environmental impact of packaging waste has been well-documented in the literature. Packaging waste contributes to a range of environmental problems, including greenhouse gas emissions, resource depletion, and pollution of terrestrial and marine ecosystems (Marsh & Bugusu, 2007). Most packaging waste ends up in landfills or incinerators, where it can take hundreds of years to decompose and release harmful chemicals into the environment. Moreover, the production of packaging materials, notably plastic, relies significantly on non-renewable fossil fuels and contributes to the emission of greenhouse gases.

The influence of packaging waste on marine habitats has garnered considerable attention in recent years. It is estimated that 8 million metric tons of plastic waste enter the oceans yearly, causing significant harm to marine life through ingestion, entanglement, and habitat destruction (Jambeck et al., 2015). The breakdown of plastic waste into microplastics, which can be ingested by marine organisms and enter the food chain, poses additional risks to wildlife and human health.

Sustainable packaging design seeks to build packaging that reduces environmental impact while preserving functionality and cost-effectiveness. Various organizations and researchers, such as Gronman et al. (2013), have articulated key principles of sustainable packaging design. These principles typically include material selection, emphasizing using renewable, recycled, or biodegradable materials to minimize waste and conserve resources. Waste reduction is another critical principle, optimizing packaging design to reduce material usage, minimize product damage, and facilitate recycling or composting. Energy efficiency involves reducing energy consumption throughout the packaging life cycle, from production to transportation and storage. Design for recycling ensures that packaging is easily recyclable or compostable, with clear labeling and instructions for proper dis-

posal. Additionally, design for reuse promotes the creation of durable, refillable, or reusable packaging to extend its useful life and reduce waste. Lastly, social responsibility involves considering social impacts, such as fair labor practices and community well-being, throughout the packaging life cycle.

Applying these principles requires a comprehensive strategy addressing the full package life cycle, from raw material extraction to end-of-life disposal. Life Cycle Assessment (LCA) is a commonly used tool for evaluating the environmental impact of packaging and identifying opportunities for improvement (Curran, 2012). LCA involves quantifying resource use, energy consumption, and emissions throughout the packaging life cycle and assessing potential impacts on human health and the environment.

Consumer perception and behavior play a crucial role in adopting sustainable packaging. Research has shown that consumers are increasingly aware of the environmental impact of packaging and are willing to pay more for environmentally friendly options (Martinho et al., 2015). However, the extent to which sustainability influences purchasing decisions varies depending on factors such as the product category, the perceived trade-offs between sustainability and other attributes (e.g., price, quality), and the individual's environmental values and beliefs.

The visual appearance of the packaging, including its color, form, and substance, can considerably impact customer opinion of sustainability. For example, packaging made from natural or recycled materials like paper or bioplastics is often perceived as more sustainable than conventional plastic packaging. Similarly, packaging with a minimalist or "eco-friendly" design, such as a green color scheme or nature-inspired graphics, can evoke positive associations with sustainability (Pancer et al., 2017).

However, the perception of sustainability only sometimes translates into sustainable behavior. Research has identified several barriers to sustainable packaging consumption, including lack of knowledge, inconvenience, and perceived costs (Gleim et al., 2013). Moreover, consumers may engage in "greenwashing" behavior, where they purchase products with sustainable packaging but fail to recycle or dispose of them properly).

Researchers have identified various strategies to overcome these barriers and encourage sustainable behavior, including consumer education, incentives, and nudges (White et al., 2019). For example, offering clear and straightforward information on the sustainability advantages of packaging, such as its recycled content or carbon footprint, may help customers make better-educated choices. Similarly, including sustainability information in product labelings or package design, such as eco-labels or recycling instructions, maybe a visual reminder and promote sustainable behavior.

Materials science and technology advances have brought up new opportunities for sustainable package design. Bioplastics, created from renewable resources such as maize starch or sugarcane, have emerged as a possible alternative to conventional petroleum-based plastics. Bioplastics can be biodegradable or compostable, reducing the environmental impact of packaging waste. However, the sustainability of bioplastics depends on factors such as the specific material composition, the production process, and the end-of-life management.

Other innovative materials for sustainable packaging include mushroom-based composites, seaweed-based bioplastics, and edible coatings. These materials offer unique qualities and advantages, including biodegradability, thermal insulation, and antibacterial activity, that can increase the sustainability and performance of packaging. However, the scalability and cost-effectiveness of these materials remain challenging

In addition to materials innovation, technological advances have enabled the development of smart and active packaging solutions. Smart packaging comprises sensors, indicators, or other devices that may monitor and transmit the status of the packaged goods, such as their freshness, temperature, or integrity. Active packaging, conversely, comprises the introduction of chemicals or compounds that can lengthen shelf life, improve safety, or enhance quality. While these technologies offer potential benefits for sustainability, such as reducing food waste and improving resource efficiency, their environmental impact and safety require further investigation (Muncke et al., 2020).

The aesthetics and user experience of packaging play a crucial role in consumer perception and behavior. Packaging design features like color, form, and material can impact consumer emotions, attitudes, and buying intentions. Moreover, packaging with a pleasant user experience, such as ease of opening, handling, and storage, can boost consumer satisfaction and brand loyalty (Galchynska et al., 2023).

In sustainable packaging, aesthetics and user experience can be powerful tools for communicating sustainability values and motivating sustainable behavior. Research has shown that consumers are more likely to purchase products with sustainable packaging when the packaging design is visually appealing and aligns with their values. Moreover, packaging that integrates

sustainability information into its design, such as eco-labels or recycling instructions, can educate consumers and encourage sustainable behavior.

However, balancing sustainability with aesthetics and user experience can be challenging. Sustainable packaging materials, such as bioplastics or recycled paper, may have different visual and tactile properties than conventional materials, affecting consumer perception and acceptance (Lindh et al., 2018). Moreover, sustainable package designs, such as minimalist or reusable packaging, may necessitate changes in consumer behavior or habits, which might be greeted with opposition.

Therefore, there are numerous techniques for integrating sustainability into package design to tackle these issues. These include using biomimicry or nature-inspired design, which may create visually appealing and useful packaging while minimizing environmental effects. Another technique is co-creation, or incorporating customers in the design process, to ensure sustainable packaging matches their requirements and preferences. Finally, using narrative and branding helps explain the environmental benefits of packaging and build an emotional connection with customers.

The aim of this article is to investigate the multifaceted role of design in fostering the adoption of sustainable packaging solutions. Through a comprehensive analysis of eco-design principles, consumer psychology, innovative materials and technologies, and the interrelationship between aesthetics and user experience, this study seeks to evaluate their combined influence on the development of environmentally responsible, user-centered, and commercially viable packaging.

The main body. The eco-design principles are fundamental to developing sustainable packaging solutions (Figure 1). Eco-design involves considering the environmental impact of a product throughout its entire life cycle, from raw material extraction to end-of-life disposal. In the context of packaging design, this means minimizing material usage, designing for reuse and recycling, and considering the entire packaging life cycle.

One of the key strategies for minimizing material usage in packaging design is lightweight, which involves reducing the amount of material used without compromising the packaging's functionality or protection (Gronman et al., 2013). Minimizing material usage in packaging design can be achieved using thinner or lighter materials, such as flexible packaging or biod packaging's form and size to limit the amount of vacant space and lessen the total volume of the package. For example, the Coca-Cola Company's redesigned “PlantBottle” packaging uses up to 30% plant-based materials, reducing the use of fossil fuels and the overall carbon footprint.

Designing for reuse and recycling is another crucial component of sustainable packaging design. Designing for reuse and recycling involves choosing materials that can be quickly recycled or repurposed, such as glass, metal, or paper. It also entails developing packaging that can be readily dismantled and split into its component pieces for recycling. In addition, designers may integrate elements that encourage reuse, such as refillable containers or packaging that can be recycled for new applications. For instance, TerraCycle's “Loop” initiative provides reusable packaging for products, from ice cream to shampoo, which is collected, cleaned, and refilled after use (Fig. 1).

Considering the entire packaging life cycle is essential for creating truly sustainable solutions. Considering the entire packaging life cycle involves assessing the environmental impact of the packaging at every stage, from raw material extraction to manufacturing, distribution, use, and disposal. Life Cycle Assessment (LCA) is a valuable tool for evaluating the environmental impact of packaging and identifying areas for improvement (Muncke et al., 2020). By conducting an LCA, designers can make informed decisions about material selection, production processes, and end-of-life scenarios, ultimately reducing the environmental footprint of the packaging.

Balancing sustainability, aesthetics, and user experience is a key challenge in sustainable packaging design. While eco-friendly materials and minimalist designs can contribute to sustainability, they may only sometimes be the most visually appealing or user-friendly. However, there are strategies for incorporating sustainable elements into packaging design without compromising aesthetics or functionality. For example, using attractive colors and graphics can make eco-friendly packaging more visually appealing, while clear labeling and intuitive opening mechanisms can enhance user experience (Steenis et al., 2017). For instance, the “Seed Phytonutrients” brand uses post-consumer recycled paper and plastic in their packaging, with a unique design allows the bottles to be easily separated for recycling.

Case studies of successful sustainable packaging designs demonstrate the potential for creating environmentally friendly and commercially viable solutions. For example, the “Ecologic” brand uses a molded fiber shell made from recycled cardboard and newspaper, which can be easily separated from the plastic liner for recycling. This innovative design reduces waste and provides a distinctive and

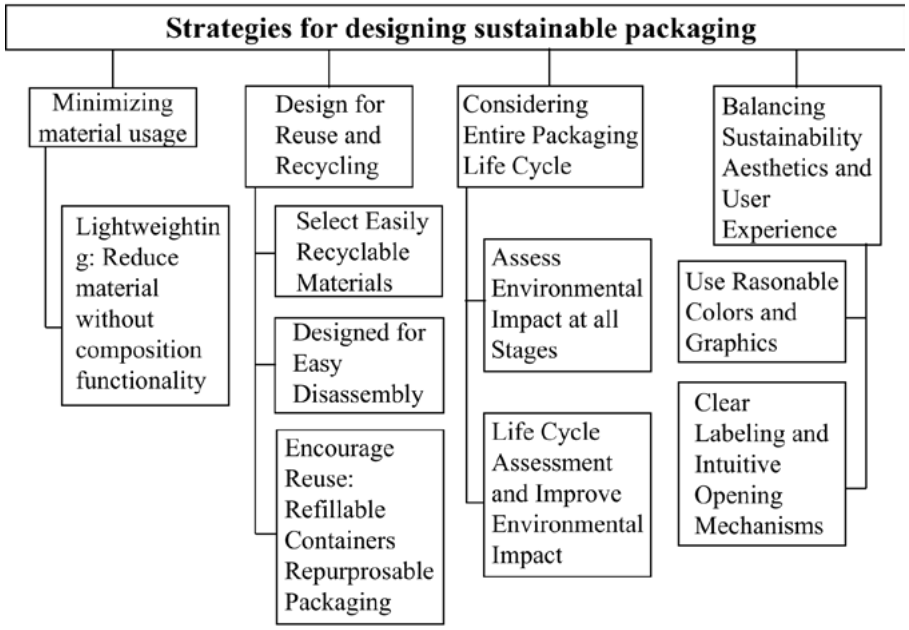

Fig. 1. Strategies for designing sustainable packaging

appealing aesthetic. Another example is the "Saltwater Brewery" six-pack rings, made from barley and wheat ribbons, making them biodegradable and safe for marine life if they end up in the ocean. These case studies illustrate how sustainable packaging design can be both environmentally responsible and visually striking, appealing to consumers' growing demand for eco-friendly products.

The psychology of sustainable packaging design plays a crucial role in shaping consumer perception and behavior. Research has shown that various design elements, such as color, shape, and material choice, can significantly influence consumers' perceptions of sustainability.

Color is a particularly important design element in sustainable packaging. Studies have indicated that customers prefer to link specific hues, such as green and brown, with sustainability and environmental friendliness. However, using more than these colors is insufficient to convey sustainability and must be combined with other design elements and clear messaging. For example, the "Seventh Generation" brand uses a predominantly white packaging design with accents of green and nature-inspired imagery to convey its commitment to sustainability.

The shape and structure of packaging can also influence consumer perception of sustainability. Packaging that is minimalist in design and avoids excess material usage is often perceived as more sustainable than oversized or over-designed packaging. Similarly, packaging that is easy to disassemble and recycle is viewed more favorably than packaging that is difficult to separate into its parts. For instance, the "Kellogg's" company has redesigned its cereal boxes to use 14% less material and be more easily flattened for recycling.

Material choice is another key factor in the psychology of sustainable packaging design. Consumers tend to view packaging made from natural or recycled materials, such as paper or bioplastics, as more sustainable than conventional plastics (Mykhailiuk & Hu, 2023). However, the perceived sustainability of a material can also be influenced by factors such as its texture, weight, and transparency. The "Aveda" brand, known for its commitment to sustainability, uses 100% post-consumer recycled PET in its packaging, which egradable polymers. Another technique is to optimize the is also recyclable.

The influence of sustainable package design on customer behavior and purchase decisions has been the topic of many studies. Research has shown buyers are more interested in sustainable packaging and are prepared to pay extra for things that are packed sustainably. However, the extent to which sustainable packaging influences purchasing decisions varies depending on factors such as the product category, the consumer's environmental attitudes, and the perceived trade-offs between sustainability and other attributes such as price and quality. Designers can employ various strategies to encourage consumers to choose eco-friendly packaging options. One approach is to make sustainable packaging more visually appealing and distinctive, using attractive colors, graphics, and shapes to stand out on the shelf (Magnier & Schoormans, 2015).

Another option is to give clear and straightforward information regarding the sustainability benefits of the packaging, such as its recycled content or biodegradability. To promote sustainable behavior, designers can also employ nudges and hints, such as eco-labels or recycling instructions. For example, the "How2Recycle" label gives clear and standardized directions for recycling package materials, making it easier for customers to dispose of packaging ethically.

Consumer attitudes and preferences towards sustainable packaging are complex and multifaceted. While many consumers express concern about the environmental impact of packaging and a desire for more sustainable options, their actual purchasing behavior may sometimes align with these attitudes.

Factors such as convenience, affordability, and brand loyalty can all impact customers' packaging choices. Additionally, consumers may have different preferences for sustainable packaging depending on the product category or environmental values (Rokka & Uusitalo, 2008). For instance, consumers may be more willing to pay a premium for sustainable packaging for products they perceive as healthy or environmentally friendly, such as organic food or natural cosmetics.

To better understand customer attitudes and preferences regarding sustainable packaging, designers might apply several research approaches, including surveys, focus groups, and eye-tracking studies. By gathering insights into customers' perceptions, wants, and habits, designers may build sustainable packaging solutions more likely to be accepted and adopted by consumers. For example, a study by Magnier and Crie (2015) used eye-tracking technology to investigate how consumers visually process sustainable packaging elements, finding that eco-labels and recycling symbols attracted more attention than other design elements.

Innovative design solutions for smart and multifunctional packaging offer significant potential for promoting sustainable consumption and reducing packaging waste. Smart packaging, which incorporates technologies such as sensors, indicators, and RFID tags, can provide information about the condition and freshness of products, helping to reduce food waste and extend shelf life (Yam et al., 2005). For example, the "Bumble Bee Foods" company uses a smart packaging solution called "ThermoSensor" that changes color to indicate when a can of tuna has reached the optimal temperature for consumption (Table 1).

Multifunctional packaging, which serves multiple purposes beyond simply containing and protecting products, can also contribute to sustainability by reducing the need for additional packaging materials. For example, packaging that doubles as a serving dish or storage container can eliminate the need for separate dishes or containers. In contrast, packaging that can be easily repurposed for other uses, such as planters or toy containers, can extend the life of the packaging and reduce waste. The "Puma" brand's "Clever Little Bag" is an example of multifunctional packaging,

Table 1

Key ideas about innovative Design Solutions for Smart and Multifunctional Packaging

Aspect	Image	Discussion
Multifunctional packaging		Multifunctional packaging serves multiple purposes, reducing the need for additional packaging materials. Examples include packaging that doubles as a serving dish, storage container, or can be repurposed for other uses.
Innovative materials and technologies		Sustainable packaging design can incorporate innovative materials and technologies, such as biodegradable plastics, plant-based inks, and edible packaging.
Smart packaging and user experience		Smart packaging can provide consumers with valuable information about product quality, safety, and environmental impact, empowering them to make more informed and sustainable choices.

as it eliminates the need for a separate shoebox and can be reused as a shopping bag or storage container.

Sustainable packaging design can incorporate innovative materials and technologies, such as biodegradable plastics, plant-based inks, and edible packaging (Muncke et al., 2020). These materials can assist in lessening the environmental effect of packaging by lowering dependency on fossil fuels, minimizing waste, and enhancing recyclability or compostability. For instance, the "Evoware" brand uses seaweed-based packaging that is biodegradable and edible, providing a sustainable alternative to conventional plastic packaging.

Examples of innovative sustainable packaging designs include the "WikiPearl" edible packaging, which encapsulates food and beverages in a biodegradable, edible skin made from natural ingredients, and the "Ecovative" mushroom-based packaging, which uses mycelium (the root structure of mushrooms) as a biodegradable and compostable alternative to styrofoam. These examples demonstrate the potential for innovative materials and technologies to revolutionize sustainable packaging design.

The role of smart packaging in enhancing user experience and promoting sustainable consumption is another area of innovation. Smart packaging can provide consumers with valuable information about product quality, safety, and environmental impact, empowering them to make more informed and sustainable choices (Vanderroost et al., 2014). For example, the "Insignia Technologies" company has developed a smart label that uses color-changing technology to indicate when a product is nearing its expiration date, helping to reduce food waste.

However, implementing innovative sustainable packaging solutions can also present challenges and opportunities. One challenge is the higher cost of some sustainable materials and technologies compared to conventional packaging options (Muncke et al., 2020). Another challenge is the need for infrastructure and systems to support the recycling or composting new packaging materials. Additionally, customers may need more time to accept unusual package styles or materials, particularly if they see them as less convenient or dependable than traditional choices. To overcome these difficulties, designers, manufacturers, and retailers must work together to develop cost-effective and scalable solutions, educate customers on the benefits of sustainable packaging, and offer a supporting infrastructure for recycling and composting.

The prospects for creative, sustainable package design are large and exciting. Package designers may build ecologically friendly, operationally superior, and emotionally captivating solutions by utilizing innovative materials, technologies, and design concepts. Moreover, sustainable packaging innovation can assist in promoting the shift towards a circular economy, where resources are maintained in use for as long as feasible and waste is avoided. As customers become increasingly conscious of the environmental effects of packaging and demand more sustainable choices, firms that invest in creative, sustainable packaging solutions may gain a competitive edge and contribute to a more sustainable future.

The Aesthetics of Sustainable Packaging.

The aesthetics of sustainable packaging play a key part in designing ecologically beneficial, beautiful, and desirable solutions for customers. While sustainability is an increasingly important factor in consumer purchasing decisions, packaging aesthetics remain a key driver of product choice and brand perception.

One challenge in designing sustainable packaging is balancing eco-friendly materials and minimalist designs with the need for visual appeal and brand differentiation. However, there are strategies for incorporating sustainable elements into packaging design without compromising aesthetics. For example, natural or recycled materials can create a unique and authentic look, while minimalist designs can convey simplicity and purity. Additionally, judicious application of colors, graphics, and typography can make packaging more visually appealing and memorable (Galchynska O. et al., 2023).

Another strategy for creating visually appealing sustainable packaging is to focus on the inherent beauty and functionality of the materials themselves. For example, using transparent or translucent materials can showcase the product inside, while using recycled paper or cardboard's natural texture or color can create a rustic or artisanal look. By celebrating sustainable materials' unique properties and characteristics, designers can create eco-friendly and visually striking packaging.

Case studies of successful sustainable packaging designs demonstrate the potential for creating aesthetically pleasing and environmentally responsible solutions. For example, the "Lush" cosmetics brand uses 100% post-consumer recycled plastic packaging, with vibrant colors and playful designs that reflect the brand's fun and quirky personality. Similarly, the "Pangea Organics" brand uses compostable paperboard packaging with embedded seed paper that can be planted after use, creating a unique and engaging unboxing experience for consumers (Table 2).

The aesthetics of sustainable packaging also play a vital part in developing brand identification and distinction in the marketplace. By creating visually distinct and memorable packaging, sustain-

Table 2

Key ideas about designing the aesthetics of Sustainable Packaging

Aspect	Image	Discussion
Importance of aesthetics in sustainable packaging design		Packaging aesthetics play a key role in designing environmentally beneficial, attractive, and desirable solutions for consumers. Sustainability and aesthetics should be balanced to create appealing and eco-friendly packaging.
Celebrating the inherent beauty of sustainable materials		Designers can create visually striking and eco-friendly packaging by focusing on the unique properties and characteristics of sustainable materials, such as transparency, texture, or natural color.
Role of aesthetics in brand identity and differentiation		Sustainable packaging with visually distinct and memorable designs can help brands stand out on the shelf, attract eco-conscious consumers, and reinforce their commitment to environmental responsibility.

able brands can stand out on the shelf and attract consumers looking for eco-friendly options (Magnier & Schoormans, 2015). Moreover, sustainable packaging may reaffirm a brand's values and dedication to environmental responsibility, generating a deeper emotional connection with consumers. For instance, the "Nohbo" brand employs water-soluble pod packaging for its personal care products, which matches its objective to decrease plastic waste and encourage a more sustainable lifestyle.

To make sustainable packaging that is visually appealing and successful, designers need to consider a variety of components, including material selection, color and graphics, shape and structure, and messaging and branding. By employing a comprehensive approach that combines sustainability, functionality, and aesthetics, designers may build packaging solutions that suit the demands of both customers and the environment. For example, the "Bulldog Skincare" brand uses sugarcane-based plastic packaging that is renewable and recyclable, with a sleek and modern design that appeals to their target male audience.

The relevance of aesthetics in sustainable package design is not confined to product packaging but extends to shipping and transit packaging. With the development of e-commerce, the need for sustainable shipping packaging has expanded substantially, giving new potential for inventive and visually appealing solutions. For instance, the "Ecoenclose" brand offers sustainable shipping packaging solutions, such as recycled paper mailers and biodegradable packing peanuts, with custom printing and branding options that allow businesses to create a unified and memorable unpacking experience for their clients.

Ultimately, the aesthetics of sustainable packaging are not only about designing a lovely box but about conveying a brand's beliefs and commitment to sustainability in a way that connects with customers. By utilizing the power of design to produce attractive and sustainable packaging, businesses can differentiate themselves in the marketplace, generate consumer loyalty, and contribute to a more sustainable future. Designing for user experience is essential to creating sustainable packaging solutions that are environmentally friendly, convenient, easy to use, and enjoyable for consumers. By focusing on the needs and preferences of users, designers can create packaging that enhances the overall product experience and encourages sustainable behavior.

Creating easy and intuitive solutions is a key aspect of designing for user experience in sustainable packaging and can involve designing easy-to-open and close packaging with clear instructions and labeling. It can also involve creating easy-to-handle and store packaging with features like resealable closures or stackable designs (Gronman et al., 2013). For example, the "Snapseal" packaging by "Snapple" uses a resealable cap that allows consumers to easily open and close the bottle with one hand, enhancing convenience and reducing the risk of spills (Table 3).

Table 3

Key ideas about designing for User Experience in Sustainable Packaging

Aspect	Image	Discussion
Importance of designing for user experience		Designing for user experience is crucial in creating sustainable packaging solutions that are environmentally friendly, convenient, easy to use, and enjoyable for consumers.
Adaptability to different use scenarios and lifestyles		Packaging should be designed to be adaptable to various use scenarios and lifestyles, such as on-the-go or travel-friendly options, and easy to store and dispose of in different contexts.
Driving consumer satisfaction and loyalty		Sustainable packaging design that prioritizes user experience can lead to increased consumer satisfaction, loyalty, and brand trust, as consumers increasingly demand environmentally responsible products.

Another important consideration in designing for user experience is creating packaging adaptable to different use scenarios and lifestyles. Creating packaging adaptable to different use scenarios and lifestyles can involve designing portable and easy packaging, such as single-serve or travel-sized options. It can also involve designing packaging suitable for different storage and disposal contexts, such as packaging that is easy to flatten or collapse for recycling. For instance, the "Stasher" company provides a selection of reusable silicone bags that may be used for food storage, cooking, and even as a toiletry bag for travel, giving a flexible and sustainable alternative to single-use plastic bags.

Designing for user experience in sustainable packaging also requires addressing the sensory characteristics of packaging, such as touch, sound, and scent. The tactile properties of packing materials, such as the feel or weight, can impact consumers' perceptions of product quality and value. Similarly, the sound of packaging, such as the crunch of a chip bag or the burst of a cork, may create a memorable and delightful user experience. For example, the "Tipa" brand employs a biodegradable packaging material that has a similar look and feel to standard plastic, delivering a familiar and enjoyable user experience while being ecologically friendly.

Inclusive design is another important principle in designing for user experience in sustainable packaging. To ensure sustainable packaging is accessible to all, designers should create packaging usable by people with different abilities and needs, such as older adults or people with disabilities. For instance, the “Arthritis Foundation" has developed design guidelines for easy-to-open packaging, including features such as large grip tabs, clear labeling, and minimal twisting or grasping motions. By developing packaging that is inclusive and accessible, businesses may not only improve the user experience for all consumers but also demonstrate their commitment to social responsibility and sustainability.

To build sustainable packaging that successfully fits the requirements and preferences of consumers, designers need to engage in user research and testing throughout the design process. By conducting surveys, focus groups, or usability testing, designers can gain valuable information about customer attitudes and preferences. Surveys, focus groups, or usability testing are valuable research tools that can help designers understand how customers interact with packaging and what they value regarding convenience, usefulness, and sustainability. By involving users in the design process and iterating based on their feedback, designers can create packaging solutions that are both sustainable and user-friendly.

Another important consideration is the potential for sustainable packaging design to drive consumer satisfaction and loyalty. Research has shown that consumers are more likely to purchase and recommend sustainable products, particularly if the packaging

is convenient and easy to use (Prakash & Pathak, 2017). Moreover, sustainable packaging may assist in creating brand trust and credibility, as customers increasingly demand firms to take responsibility for their environmental effects. By investing in sustainable package design that prioritizes user experience, businesses may minimize their environmental impact, build a competitive edge, and establish long-term customer connections.

Analysis of user feedback and insights on sustainable packaging design and performance is a helpful tool to assess the success of sustainable packaging solutions and find areas for improvement. By gathering and analyzing data on consumer perceptions, behaviors, and preferences, businesses can make informed decisions about packaging design and optimization. For example, the "Loop" reusable packaging platform uses customer feedback and data to continuously improve the design and performance of its packaging, such as by adjusting the size and shape of containers based on user needs and preferences. By leveraging user feedback and insights, businesses can create sustainable packaging solutions that are environmentally responsible, commercially successful, and socially impactful.

Designing for user experience is a vital component of sustainable package design that may assist in boosting customer adoption, happiness, and loyalty. By concentrating on the requirements and preferences of consumers, businesses may offer packaging solutions that are simple, functional, and joyful to use while also lowering their environmental effects and promoting a more sustainable future. As the need for sustainable packaging continues to rise, user-centered design will become increasingly vital in producing packaging that satisfies the shifting expectations of customers and contributes to a more circular and sustainable economy.

Conclusion. The impact of design on promoting ecological packaging and promoting the transition of modern society to conscious consumption has been determined. Research findings are provided on how sustainable packaging design can contribute to a greener future by balancing environmental impact, aesthetics, user experience and customer perception.

The article highlights the critical need for sustainable packaging solutions, highlighting the environmental consequences of packaging waste and the need to move to a circular paradigm. The basic concept of green packaging design is defined, including material selection, waste reduction, energy efficiency, design for recycling and reuse, and social responsibility. Attention is focused on the psychology of consumer perception, in particular, the features of packaging design, namely color, shape and material, which influence customers' impressions of environmental friendliness and purchase decisions, are listed.

In addition, the potential of new materials and technologies, such as bioplastics and smart packaging, is explored. Systematized improvements that increase the sustainability and utility of packaging, and address challenges related to cost, scalability, and customer acceptance. The study also highlighted the importance of aesthetics and user experience in sustainable packaging design, exploring how visually appealing and user-friendly packaging can communicate the principle of sustainable development and encourage green behaviour.

Drawing on case studies of already existing successful sustainable packaging designs, the article outlines the practical application of these principles and strategies, demonstrating how innovative design combined with a focus on user experience and aesthetic excellence can create packaging solutions that are environmentally sound and commercially viable.

In conclusion, this work proposes an integrated approach to sustainable packaging design to address environmental and social issues. It has been proven that by combining the concept of eco-design, understanding the psychology of designers, using breakthrough materials and technologies and emphasizing the experience of users, manufacturers, producers and other stakeholders, it is possible to accelerate the movement towards the rooting of a culture of sustainable consumption. This transformation will require ongoing collaboration, research and innovation to create packaging solutions that are not only environmentally sound, but also aesthetically perfect, functionally sound and socially responsible.

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