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CREATIVE THINKING FOR THE SUSTAINABLE DEVELOPMENT OF PACKAGING: EFFECTIVE SOLUTIONS OF ECOLOGICAL DESIGN

The purpose of this research is to develop a strategy for the creative application of thinking methods in the development of innovative packaging solutions that minimize the harmful impact on the environment and satisfy the functional, aesthetic, economic, and social requirements of modern consumption. Conceptual and literary analysis was used for further empirical verification and testing. The research framework provides a methodological tool for sustainable packaging design and evaluation.

This research culminates in developing a comprehensive and innovative method of creative thinking specifically tailored for designing sustainable packaging solutions. This method transcends conventional design approaches by integrating proven creative thinking techniques with a robust framework for assessing and ensuring ecological responsibility. The proposed strategy aims to significantly increase the creativity and efficiency of ecological packaging design, ultimately contributing to a more sustainable and circular economy.

The research presents a multi-component framework that combines creative thinking methods with sustainable packaging design, emphasizing environmental efficiency. Indicators for evaluating packaging design are listed, including its creativity, functionality, aesthetic perfection, value, meeting user needs, and environmental friendliness. In addition, innovative strategies for improving packaging sustainability, namely its circularity, biodegradability, durability, adaptability, and socio-cultural value, are proposed. The research provides packaging designers with a systematic information base and tools for creating innovative, sustainable packaging solutions. Specific, actionable strategies are presented to improve packaging design's environmental efficiency and overall sustainability.

Key words: sustainable design, packaging design, creative thinking, ecological efficiency.

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КРЕАТИВНЕ МИСЛЕННЯ ДЛЯ СТАЛОГО РОЗВИТКУ ПАКУВАННЯ: ЕФЕКТИВНІ РІШЕННЯ ЕКОЛОГІЧНОГО ДИЗАЙНУ

Мета даної роботи полягає в розробленні стратегії щодо творчого застосування методів мислення при проектуванні інноваційних пакувальних рішень, які мінімізують вплив на довкілля та відповідатимуть функціональним, естетичним, економічним і соціальним критеріям сучасного споживання. В роботі використано концептуальний та літературний аналіз для подальшої емпіричної перевірки та тестування. Структура дослідження забезпечує методологічний інструмент для сталого розвитку дизайну та оцінки пакування.

У роботі представлено комплексний метод творчого мислення для розробки сталого дизайну пакування. Цей метод виходить за рамки звичайних підходів до проектування, об'єднуючи перевірені методи креативного мислення з надійною основою для оцінювання та забезпечення екологічної відповідальності. Запропонована стратегія спрямована на суттєве підвищення креативності та ефективності екологічного дизайну пакування, що в кінцевому підсумку сприятиме більш стійкій економіці замкнутого циклу. У дослідженні представлено багатоскладову структуру, яка поєднує креативні методи мислення зі сталим дизайном пакування, акцентуючи увагу на екологічній ефективності. Перелічено показники для оцінювання дизайну пакування, зокрема, її креативності, функціональності, естетичної довершеності, вартості, забезпечення потреб користувачів та екологічності. Крім того, запропоновано інноваційні стратегії вдосконалення стійкості пакування, а саме її циклічності, здатності до біорозкладання, довговічності, адаптивності й соціокультурної цінності.

Дослідження надає дизайнерам упаковки систематизовану інформаційну базу та набір інструментів для створення інноваційних екологічних пакувальних рішень. Представлено конкретні дієві стратегії для підвищення екологічної ефективності й загальної стійкості дизайну упаковки.

Ключові слова: стійкий дизайн, екологічний дизайн, дизайн пакування, творче мислення, екологічна ефективність.

Statement of the problem. Packaging is vital in modern life, offering convenience and affordability while safeguarding products from damage and minimizing food waste. These benefits are often achieved through advanced design features that enhance usability and preservation (Marsh & Bugusu, 2007). However, the convenience of modern packaging, particularly the prevalence of single-use containers, has created a substantial environmental burden (Hopewell et al., 2009). Effectively managing packaging waste presents two significant challenges: enhancing the inherent recyclability of packaging materials and improving the processes of waste collection and recycling, thus preventing leakage into the environment (Jambeck et al., 2015).

A major obstacle to achieving high recycling rates is the complex composition of much of today's packaging. Multi-material packaging, which combines various materials like plastics, paper, and metals to achieve specific performance characteristics, is particularly problematic. The difficulty in separating these materials after use poses a significant and largely unresolved challenge to effective recycling (Ögmundarson et al., 2022). Furthermore, even when packaging is theoretically recyclable, the actual recycling rates remain disappointingly low. For instance, plastic packaging, despite its widespread use, has a particularly low recycling rate compared to materials like cardboard, metal, and glass. This is underscored by the fact that globally, an estimated 19 percent of all plastic ends up in unmanaged landfills or polluting our environment, including oceans and other sensitive ecosystems (Antonopoulos et al., 2021).

These challenges have led to increased public interest and concern about the environmental impact of packaging waste. Many consumer goods companies have committed to making packaging more sustainable, for example, by increasing the use of recycled content, reducing unnecessary packaging, and switching to recyclable or compostable materials (Franz & Welle, 2022). In navigating these evolving trends and multifaceted challenges, designers are tasked with developing packaging solutions that strike a delicate balance between functional requirements, aesthetic appeal, economic viability, and environmental responsibility. Employing creative thinking methods to address these complex and dynamic problems is crucial for generating innovative and effective ideas that advance sustainable packaging design (Crilly et al., 2004).

Creative thinking methods encompass a suite of systematic techniques and tools strategically designed to enhance the cognitive processes that underpin problem-solving and idea generation. These methods

provide designers with frameworks to break free from conventional thinking, overcome ingrained biases, and explore a wider range of perspectives and alternatives. This, in turn, facilitates the development of novel solutions and the enhancement of existing ones (Antonopoulos et al., 2021).

Research analysis. Modern research and design practices aim to find ways to reduce the environmental and social impact of packaging systems throughout their life cycle and improve their functional and aesthetic qualities (Costa-Pierce, 2010). According to Pigosso et al. (2015), sustainable packaging design can be understood as a process that includes four main dimensions: material selection, design optimization, end-of-life management, and communication. Nowadays, the choice of materials for production is characterized by low harmful effects and a high ability for secondary processing or biological decomposition (Zari & Storey, 2007). Design optimization refers to minimizing the amount of material used, maximizing transportation and distribution efficiency, and improving the usability and durability of packaging (Smith et al., 2010). End-of-life means promoting packaging recovery, reuse, or recycling after usage (Dewulf, 2010). Communication means informing and educating consumers and stakeholders about the environmental and social aspects of packaging.

Sustainable Packaging Coalition (SPC) is an industry organization that provides resources and tools for the sustainable development of packaging design, namely «Design for recovery guidelines», «Essentials of sustainable packaging course» and «How to recycle label» (Moreno et al., 2016).

Despite the growing interest in sustainable packaging, several challenges persist. A primary obstacle is the absence of a universally accepted definition of sustainability and its corresponding metrics for this field (Boz et al., 2020). Disparate stakeholders often hold divergent views and expectations regarding what constitutes sustainable packaging and how its performance should be measured or evaluated (Oloyede & Lignou, 2021). Another problem is the trade-off or conflict between different dimensions or criteria of sustainability, such as environmental efficiency, economic viability, social acceptability or aesthetic appeal (Munda, 2016). For example, choosing a biodegradable material can reduce the impact of packaging on the environment, but at the same time increase its cost or reduce its shelf life (Oloyede & Lignou, 2021). In addition, there is the complexity and uncertainty of the packaging system and its life cycle, which makes it difficult to predict and assess the impact or consequences (Leggett, 2022).

Purpose of the article. The main goal of this work is to define a strategy for increasing the creativity and

durability of packaging design, namely its ability to be processed or reused, durability, adaptability, aesthetic, and socio-cultural value.

Considering today's global problems, it is necessary to find ways to effectively apply creative thinking methods in developing environmentally effective packaging design solutions. At the same time, it is worth noting that modern environmentally friendly packaging must satisfy the functional, aesthetic, economic, and social criteria for its evaluation.

Presenting main material. The main result of this research is the development of a comprehensive framework for evaluating and improving the creativity and effectiveness of green packaging design solutions. Based on the previous content, a framework was formed consisting of four main steps, which are sequentially listed below.

Idea generation for sustainable packaging design solutions using creative thinking techniques such as brainstorming, mind mapping and such modern popular tools for generating and improving ideas as SCAMPER (Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse), TIPS (Theory of Inventive Problem Solving) etc. These methods stimulate divergent and convergent thinking in developing new ideas in the context of the challenges and opportunities of the packaging system. For example, a designer can use brainstorming to generate ideas for sustainable packaging design of coffee products, including using edible or biodegradable materials for its production, reducing size or weight, increasing functionality and optimizing cost etc.

Evaluation and improvement of the creativity and effectiveness of the created ideas of ecological packaging design using various indicators that quantitatively and qualitatively reflect the preservation or restoration of natural capital and compliance with the packaging system's functional, aesthetic, economic, and social criteria. Among the above indicators (or metrics) are material efficiency, energy efficiency, water efficiency, carbon footprint, waste reduction, biodegradability, compostability, recyclability, renewability, toxicity reduction, increased biodiversity, provision

of ecosystem services, social well-being, functionality, aesthetic perfection, cost, and user satisfaction (Jagoda et al., 2023). For example, a designer can use a feasibility analysis to evaluate the technical and economic viability of the generated green packaging design ideas for coffee products, such as evaluating the availability and quality of the materials and processes used, the efficiency and durability of the packaging solutions, the environmental impact and the benefits of the packaging solutions, market demand and acceptance of packaging solutions, as well as profitability and competitiveness of packaging solutions. The developer can also use cost-benefit analysis to compare different alternatives and choose the most optimal one.

Implementing eco-efficient design samples and testing them for compliance with the packaging system's functional, aesthetic, economic, and social criteria involves developing and manufacturing a prototype or final product. The creativity and effectiveness of the design solution is validated through user testing, peer review, life cycle assessment (LCA) and ecological footprint analysis (EFA). For example, a designer aims to implement and test an eco-friendly packaging solution for coffee products that uses biodegradable and compostable biological materials. Therefore, it is worth testing to get feedback from potential consumers about their satisfaction with the packaging solution's functionality, aesthetics, usability and sustainability. A developer can also use LCA to quantify the environmental impact of a packaging solution throughout the product's life cycle. In addition, using EFA to determine the resources needed to ensure the production and consumption of a packaging solution is advisable.

Applying one or more strategies increases the creativity and efficiency of the green packaging design solution based on the feedback and results obtained in the third step. Applying such strategies (Fig. 1) as design for the cyclical cycle, modularity and adaptability, strength and durability, and social and cultural impact contributes to the productivity and quality of the packaging solution in terms of its environmental performance, functional, aesthetic, economic and social criteria.

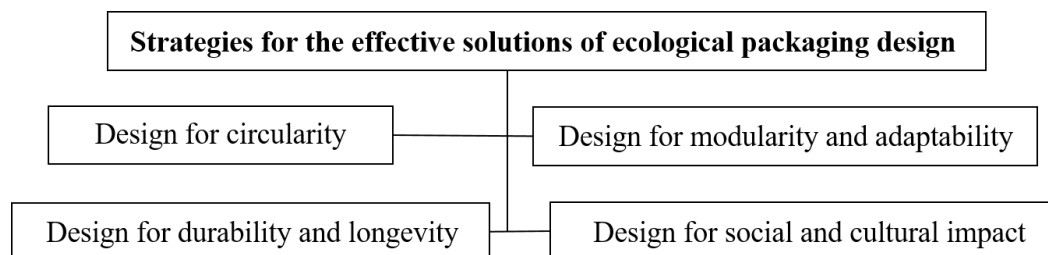


Fig. 1. Systematic four-step framework for enhancing the creativity and eco-efficiency of sustainable packaging design

Design for the circularity (Fig. 2) represents a forward-thinking approach in the packaging industry, emphasizing the creation of packaging solutions that can be seamlessly reintegrated into the production cycle – either through reuse, recycling, or composting – thus establishing a closed-loop system that substantially reduces waste and resource consumption. This approach necessitates a comprehensive analysis of the packaging's entire lifecycle, encompassing sourcing of materials, production processes, consumer usage, and eventual disposal. Additionally, it requires ensuring that the packaging is compatible with existing or future recovery and recycling systems, thereby facilitating the circular journey of materials.

A key aspect of circular design is the prioritization of monomaterials or using components that can be easily separated after use. This simplifies the recycling process, as materials that are homogeneous in nature or easily separable do not require complex sorting and processing, thereby increasing the efficiency of recycling operations and the quality of recycled materials. By minimizing the variety of materials used in packaging, designers can significantly enhance the recyclability of packaging components, aligning with the principles of circular economy.

Moreover, circular design advocates for the reduction of unnecessary or excessive packaging. This not only reduces the volume of waste generated but also reduces the environmental impact associated with the production and disposal of packaging materials. By eliminating superfluous elements and focusing on essential functionality, designers can achieve a balance between product protection and sustainability, leading to more resource-efficient packaging solutions.

Incorporating recycled or renewable materials into packaging design is another cornerstone of circularity. Utilizing recycled materials reduces the demand for virgin resources, lowers carbon emissions, and supports the development of a market for recycled content. Concurrently, renewable materials – sourced from sustainably managed resources – offer a replen-

ishable option that minimizes environmental depletion, further contributing to the sustainability of packaging solutions.

Standardized or modular designs represent an innovative strategy within the realm of circular packaging. Standardization facilitates the reuse and recycling of packaging by creating designs that can be easily adapted or repurposed for multiple uses or products, thereby extending the lifecycle of packaging materials. Modular designs, however, allow for the easy replacement or addition of components, enhancing the functionality and longevity of packaging solutions. Such approaches not only contribute to waste reduction but also offer consumers and businesses greater flexibility and efficiency in the use of packaging.

In conclusion, designing for circularity encompasses a multi-faceted strategy that requires thoughtful consideration of the entire packaging lifecycle, from material sourcing through to end-of-life management. By focusing on the use of monomaterials, minimizing unnecessary packaging, incorporating recycled or renewable materials, and adopting standardized or modular designs, packaging designers and manufacturers can significantly contribute to the creation of a more sustainable and circular packaging industry (MacArthur, 2019). This not only addresses the pressing environmental challenges of waste and resource depletion but also aligns with the growing consumer demand for sustainable and responsible packaging solutions.

Design for modularity and adaptability (Fig. 3). Designing for modularity and adaptability in packaging is a forward-thinking approach that emphasizes the creation of versatile packaging systems capable of being easily modified, adapted, or repurposed to suit varying functions, contexts, or consumer preferences. This design philosophy advocates for the development of interchangeable components that can be combined or customized innovatively, thereby enhancing the utility and lifespan of the packaging. Furthermore, it entails designing inherently flexible systems, allow-



Fig. 2. Design for circularity (MacArthur, 2019)

ing for variations or changes without compromising on functionality or aesthetic appeal. Such an approach not only caters to the dynamic needs of the market but also significantly contributes to sustainability by reducing the need for single-use packaging.

Modular boxes or pallets are quintessential examples of this strategy, where packaging components are designed to fit together in multiple configurations (Yesta, 2012). This modularity not only facilitates efficient storage and transportation but also offers end-users the flexibility to reconfigure packaging according to their specific needs, thereby extending usability and reducing the environmental impact associated with producing new packaging.



Fig. 3. Design for modularity and adaptability.
Base Design (Yesta, 2012)

Adjustable or flexible shapes and sizes are another hallmark of this approach, where packaging can be resized or reshaped based on the product it contains or the space available. This adaptability reduces the need for a wide range of packaging sizes, simplifying business inventory management and reducing waste. Packaging that can expand or contract to fit its contents precisely not only improves material efficiency but also enhances the protection of the product, thereby reducing the risk of damage during transportation and storage.

Interactive or smart features represent a more technologically advanced modular and adaptable design aspect. Incorporating elements such as QR codes, NFC (Near Field Communication) tags, or sensors allows the packaging to engage with consumers innovatively, providing information, verifying authenticity, or even monitoring the condition of the contents. Smart packaging can adapt its functionality based on user interaction or environmental conditions, offering a personalized experience and extending the utility beyond traditional packaging.

Moreover, designing for modularity and adaptability encourages end-users involvement in the packaging lifecycle, promoting a sense of ownership

and responsibility towards sustainable practices. For instance, packaging that can be repurposed or reassembled for secondary uses not only adds value for the consumer but also encourages the diversion of waste from landfills.

In essence, the design for modularity and adaptability in packaging is a multifaceted approach that requires innovative thinking and a deep understanding of the needs of both the market and the environment. By creating flexible, customizable, and interactive packaging, designers can meet consumers' evolving demands while simultaneously addressing the critical challenges of sustainability. This approach not only enhances the functionality and appeal of packaging but also significantly contributes to reducing waste and promoting a circular economy.

Design for strength and durability (Fig. 4) is a crucial strategy in extending the packaging lifespan and, by extension, the products they contain. This approach is centered on developing packaging solutions that can endure multiple uses without significant deterioration, thereby contributing to waste reduction and promoting sustainability. Achieving this level of durability necessitates carefully selecting materials known for their robustness and resistance to wear and tear, alongside the thoughtful incorporation of design features that support easy maintenance, repair, or replacement of components.



Fig. 4. Design for durability and longevity
(Castillo, 2024)

The choice of materials plays a pivotal role in this strategy. Metals and glass are often favored for their durability and ability to withstand repeated use without losing functionality or aesthetic appeal (Jagoda et al., 2023). Metal containers, for example, offer exceptional strength, making them suitable for long-term storage and transportation of goods. They are resistant to crushing and can be designed to be corrosion-resistant, ensuring that they maintain their integrity over time. While heavier and more fragile, glass containers offer unparalleled purity and inertness, making them ideal for storing food, beverages, and pharmaceuticals over extended periods. Both materials are highly recyclable, which adds another layer of sustainability to packaging solutions designed for durability.

In addition to selecting resilient materials, incorporating protective coatings or layers is another

effective way to enhance the durability of packaging. These coatings can provide additional resistance against environmental factors such as moisture, UV radiation, and physical abrasions, thereby extending the lifespan of the packaging. For instance, a protective coating on a metal container can prevent rust and corrosion, while a UV-resistant layer on plastic packaging can prevent degradation caused by sunlight.

Furthermore, reusable lids and closures are a testament to the emphasis on durability in packaging design. Reusable lids not only ensure the contents of the container are protected over time but also contribute to the overall sustainability of the packaging by allowing for multiple uses. This can be particularly effective in consumer products, such as food and beverage containers, where the packaging needs to be opened and closed frequently. Designing these components to be durable and easy to use enhances the user experience and encourages the repeated use of the packaging, reducing the need for disposable alternatives.

To facilitate maintenance and extend the usability of packaging, designers also focus on features that allow for the easy repair or replacement of elements. This could involve designing packaging with modular components that can be individually replaced if damaged or creating systems that allow for easy disassembly and reassembly. Such design considerations not only contribute to the longevity of the packaging but also support a circular economy by promoting repair and reuse over disposal.

In conclusion, designing for strength and durability is integral to creating sustainable packaging solutions. By selecting materials known for their durability, incorporating protective features, and designing for maintenance and repairability, packaging can be developed to withstand multiple uses, thereby reducing waste and supporting environmental sustainability. This approach not only benefits the environment by minimizing resource consumption and waste generation but also offers economic advantages by extending the packaging lifecycle and reducing the need for frequent replacements. Through such thoughtful design strategies, it is possible to create packaging that supports the principles of sustainability while meeting the demands of both manufacturers and consumers.

Design for social and cultural impact (Fig. 5) is a profound strategy in the realm of packaging, aiming to imbue products with values and meanings that resonate deeply with users and communities. This approach transcends the conventional packaging objectives, venturing into creating a packaging experience that fosters positive social and cultural value.

Achieving this requires a nuanced understanding of the target audience's needs, expectations, and values and thoughtful incorporation of elements that mirror their identity, culture, or historical context.



Fig. 5. Design for social and cultural impact (Jilin Yee, 2018)

The essence of designing for social and cultural impact lies in the ability to connect on a personal level with the audience. This can be accomplished through the use of specific local materials or crafts, which not only celebrates traditional craftsmanship but also supports local economies and sustainability (Jilin Yee, 2018). For instance, employing handwoven textiles or naturally dyed materials from a particular region for packaging can highlight and preserve artisanal practices, making the packaging itself a bearer of cultural heritage and a story of communal effort and environmental stewardship.

Symbols or stories that convey meaning and emotion play a crucial role in this design strategy. Packaging that incorporates cultural symbols or motifs can serve as a bridge between the product and the consumer's cultural background or personal identity, fostering a deeper emotional connection with the product. Similarly, integrating narratives into the packaging design – whether through imagery, text, or augmented reality experiences – can engage users in a way that transcends the physical product, embedding it within a tapestry of cultural or historical significance.

Colors and patterns that evoke associations or memories are other powerful tools in the designer's arsenal. The strategic use of color schemes or patterns emblematic of a community's culture or history can trigger emotional responses and create a sense of belonging or nostalgia. This can be particularly effective in markets where diaspora or cultural preservation is significant, offering a tactile and visual link to heritage and identity.

Moreover, this design strategy extends to fostering social inclusivity and awareness. Packaging designed with inclusivity in mind – considering various physical abilities, age groups, and cultural backgrounds – can make products more accessible and appreciated by a wider audience. Additionally, packaging that conveys social awareness messages or supports social

causes can elevate the product experience, aligning the brand and its consumers with broader societal values and initiatives.

In conclusion, designing for social and cultural impact is a holistic approach that integrates the tangible aspects of packaging design with its audience's intangible needs and values. By deeply understanding the cultural and social context of the target market and employing elements that reflect this understanding, designers can create packaging solutions that do more than protect and sell a product. They can build bridges of empathy, celebrate diversity, and foster a sense of community and belonging. This not only enhances the consumer experience but also positions brands as socially and culturally conscious entities, contributing positively to the fabric of society and the preservation of cultural heritage.

Conclusions. This research presents a systematic multi-component framework for increasing the crea-

tivity and environmental performance of sustainable packaging design, which consists of idea generation, sustainability assessment, solution implementation and strategy application. The study enriches the theoretical base of design by integrating creative thinking into the process of forming a culture of sustainable consumption. By highlighting the impact of packaging on the environment through valuing natural capital, designers are given tools and strategies to improve their practices. However, further validation through empirical research is needed to refine the framework, expand indicators, explore trade-offs, develop software tools, and address implementation challenges. Overall, by catalyzing creative systems approaches, this research supports the transition to design where human activity restores natural ecosystems. The proposed frameworks and innovation strategies can be adapted in different areas to shape the culture of smart consumption.

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