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An Exploration of Environmentally Sustainable  
Packaging in Cosmetics: Analyzing Industry Adoptions  
and Investigating Market Potential for Innovative  
Solutions

TESI DI LAUREA MAGISTRALE IN  
MANAGEMENT ENGINEERING  
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## Abstract

The current landscape of sustainability and the increasing environmental awareness are reshaping the cosmetics industry paradigm, with a growing focus on eco-friendly packaging solutions that reflect a commitment to environmental responsibility and offer new opportunities for innovation and growth.

Against this backdrop, the aim of the thesis is to explore consumer response and preferences related to a selection of environmentally sustainable packaging innovations. The thesis seeks to identify the most promising environmentally sustainable cosmetic packaging innovations for the market, among a chosen selection. This selection was made from an analysis of twenty-four real case studies encompassing both the cosmetic industry and cross-industry sectors.

In order to reach the objective, it's been conducted a survey to collect data regarding individuals' response and preferences towards the environmentally sustainable packaging innovations for cosmetics proposed, addressing the research question. The study reached a total of 223 respondent (218 answering to the survey in Italian, 5 answering to the survey in English). The results will show that, among the six presented solutions of innovative environmentally sustainable packaging for cosmetics the most promising for the market are the "Biodegradable Jar for Skincare Cream", the "Paper Hand Soap Dispenser" and the "Jar with safety click-clack system for Skincare Cream"; where the potential market success has been measured combining the analysis of the willingness-to-pay expressed by the respondents for each packaging solution with the frequency of purchase of the respondents. Furthermore, these outcomes will result to be further corroborated by a comparative analysis of participants' preferences for the six solutions presented. Notably, these solutions, besides being those with the highest potential for market success, also emerge as the favourites among respondents.

This thesis addresses a gap in existing literature by exploring consumer preferences for environmentally sustainable cosmetics packaging innovations. Unlike prior studies concentrating on technical aspects, this research delves into understanding customer inclinations. It sheds light on consumer preferences for eco-friendly packaging solutions and offers actionable recommendations for cosmetic companies intending to implement these innovations effectively.

**Key-words:** Consumer Behaviour, Innovative Cosmetic Packaging Environmental Sustainability



## Abstract in italiano

Il panorama attuale della sostenibilità e la crescente consapevolezza ambientale stanno profondamente influenzando il paradigma dell'industria cosmetica, che sta puntando sempre più verso soluzioni di packaging eco-friendly, riflettendo un impegno per la responsabilità ambientale e aprendo nuove possibilità di innovazione e sviluppo.

In questo contesto, l'obiettivo principale della tesi è esplorare la risposta e le preferenze dei consumatori nei confronti di una selezione di innovazioni per il packaging ambientalmente sostenibile. La ricerca mira a individuare le soluzioni di packaging cosmetico sostenibile più promettenti per il mercato, selezionate a partire da ventiquattro casi reali individuati, che spaziano sia nell'industria cosmetica che in settori adiacenti.

Per raggiungere tale obiettivo, è stata condotta un'indagine volta a raccogliere dati relativi alle preferenze degli individui riguardo alle innovative soluzioni di packaging sostenibile proposte per i cosmetici. La ricerca ha coinvolto un totale di 223 partecipanti (218 che hanno risposto al sondaggio in italiano e 5 in inglese). I risultati dimostreranno che, tra le sei soluzioni presentate per un packaging innovativo e sostenibile, il "Barattolo Biodegradabile per Crema Ciso", il "Distributore di Sapone per le Mani in Carta" e il "Barattolo con Sistema di Chiusura di Sicurezza click-clack per Crema Viso" risultano essere le più promettenti per il mercato. Tale successo è stato valutato combinando l'analisi della disponibilità a pagare espressa dai partecipanti per ciascuna soluzione di packaging con la frequenza di acquisto. Inoltre, tali risultati saranno confermati da un'analisi comparativa delle preferenze dei partecipanti. Infatti, queste soluzioni, oltre a possedere un forte potenziale di successo commerciale, emergono anche come le preferite dai rispondenti.

La tesi rappresenta un contributo fondamentale alla letteratura esistente poiché esplora le preferenze dei consumatori in merito alle innovazioni nel packaging cosmetico sostenibile. Diversamente da studi precedenti focalizzati sugli aspetti tecnici, questa ricerca approfondisce la comprensione delle inclinazioni dei clienti, fornendo chiarezza sulle preferenze dei consumatori per soluzioni di packaging ecologiche e offrendo indicazioni pratiche per l'implementazione di tali innovazioni da parte delle aziende cosmetiche.

**Parole chiave:** Comportamento del consumatore, Sostenibilità Ambientale degli Imballaggi Cosmetici Innovativi



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# 1 Introduction

The chapter introduces the main theoretical topics explored in the thesis, namely the cosmetic industry and the concept of environmentally sustainable packaging. It also outlines the problem statement, research questions, and relevance of the thesis. Moreover, the chapter provides a comprehensive overview of the organization of the thesis, highlighting the structure and flow of the subsequent chapters.

## 1.1. The Cosmetic Industry

The cosmetics industry stands as a global flagship market valued at USD 262.21 billion in 2022 [1]. With products spanning skincare, haircare, make-up, perfumes, toiletries, and deodorants, it caters to a diverse consumer base, emphasizing self-care and wellness [2]. Notably, the global cosmetics market witnessed a remarkable growth of over 15 percent in 2022, underscoring its expanding influence worldwide [2].

Leading the charge are multi-national corporations like L'Oréal, Unilever, Procter & Gamble Co., The Estee Lauder Companies, Shiseido Company, and Beiersdorf [2]. In particular, L'Oréal emerged as the world's premier beauty manufacturer in 2022, boasting revenues exceeding 40 billion U.S. dollars [2]. Its flagship brand, L'Oréal Paris, achieved a staggering valuation of nearly 48 billion U.S. dollars the same year [2].

Europe serves as a central hub, accounting for a substantial portion of the global cosmetics market [1]. Noteworthy markets within Europe include Germany, France, Italy, the UK, Spain, and Poland, each contributing significantly to the industry's thriving economy [1]. This sector, valued at €88 billion in 2022, plays a pivotal role in enhancing well-being, self-esteem, and overall health for millions across the continent [1] [3]. Additionally, the cosmetics industry generates substantial economic value, contributing €29 billion annually to the European economy [1]. This impact is evident in the creation of over 3.6 million jobs, encompassing both direct and indirect employment within the cosmetics value chain [1]. Moreover, the industry's influence extends beyond its immediate workforce, generating supplementary employment opportunities in the wider economy [1] [3].

The global cosmetics market is poised for continued expansion, with skincare and personal care products driving its growth trajectory [3]. This evolution is fueled by increasing consumer awareness of natural and organic alternatives, alongside a rising

demand for anti-aging treatments and hair colour innovations [3]. Despite initial setbacks resulting from the COVID-19 pandemic, the industry is projected to rebound, buoyed by renewed activities, commerce, and manufacturing worldwide [3].

In conclusion, the cosmetics industry's profound impact on both global and European economies is evident in its substantial market valuation, job creation, and contributions to overall well-being and self-care [1] [2] [3]. This thriving sector, led by industry giants like L'Oréal, underscores the enduring relevance of cosmetics in modern consumer culture [2]. As sustainability and natural alternatives continue to shape consumer preferences, the industry is poised for further growth, solidifying its pivotal role in personal care and wellness worldwide [3].

### 1.1.1. The cosmetic industry and the “green transition”

The cosmetics industry has witnessed substantial growth, reaching a global market value of US\$500 billion in 2019. However, this growth has come at the cost of significant environmental impact due to resource consumption and unsustainable practices in supply chains. To address this, companies are shifting towards more environmentally friendly product lines, incorporating natural ingredients. The demand for safe and eco-friendly cosmetics has surged, driven in part by the Covid-19 pandemic. The global market for natural and organic cosmetic products is expected to exceed \$50 billion by 2027 [4].

While green formulations are a pivotal aspect of sustainable production, it's equally crucial to consider resource efficiency, carbon emissions, and waste management throughout the product's life cycle. Industry actors play a vital role in driving this green transformation, but they face challenges in fully integrating sustainability efforts, particularly in addressing economic and social dimensions. Legislation and regulations are essential in ensuring transparency and preventing greenwashing in product labelling and advertising [4].

Despite these efforts, many cosmetic companies, especially smaller ones, still prioritize short-term profits over environmental and social impacts. This is particularly pronounced in developing countries, where social inequalities and regulatory weaknesses pose additional challenges.

## 1.2. The definition of Environmentally Sustainable Packaging

The definition of sustainable packaging has been provided by organizations such as the Sustainable Packaging Coalition (SPC) in the USA and the Sustainable Packaging Alliance (SPA) in Australia, with the aim of articulating a common understanding of 'sustainable packaging' within the industry. Their goal is to provide guidance in decision-making and shape a vision for a more sustainable packaging system.

The SPA defines sustainable packaging based on four core principles: effectiveness, efficiency, cyclicity, and safety [5]. Effectiveness is related to the packaging's capacity to add real value to the society, by effectively containing and protecting products as they move through the supply chain and by supporting informed and responsible consumption. Efficiency means that packaging systems are designed to use materials and energy as efficiently as possible throughout the product life cycle. This should include material and energy efficiency in interactions with associated support systems such as storage, transport and handling. Cyclicity means that packaging materials are cycled continuously through natural or (industrial) technical systems, minimizing material degradation and/or the use of upgrading additives. Safety imposes that packaging components do not pose any risks to human health or ecosystems. When in doubt the precautionary principle applies [6].

The SPC's definition of sustainable packaging goes even further, particularly in its emphasis on renewable energy and materials [5] [7].

According to SPC, sustainable packaging should be beneficial, safe, and healthy for individuals and communities throughout its life cycle. It must also meet market criteria for performance and cost. Additionally, it should be sourced, manufactured, transported, and recycled using renewable energy. The packaging should maximize the use of renewable or recycled source materials and be produced using clean production technologies and best practices. Furthermore, it should be designed to optimize materials and energy, and effectively recovered and utilized in biological and/or industrial cradle to cradle cycles [5] [7].

Finally, sustainability in packaging should encompass the entire value chain, from sourcing raw materials and energy to post-consumer processing of packaging components. This is rooted in the need to manage the Earth's finite resources and apply shared value in resource management for current and future generations [7].

### 1.2.1. Underlying challenges in the development of environmentally sustainable packaging

Nowadays, the climate is undergoing unprecedented and detrimental changes.

The temperature is steadily rising, leading to the melting of ice caps and the extinction of various animal species. In tandem with these environmental concerns, the volume of non-biodegradable waste generated daily is reaching alarming levels. The world is currently facing a shortage of suitable spaces for waste disposal [8]. This escalating environmental crisis has thrust sustainability to the forefront of societal concerns. With an increasing awareness of sustainability's paramount importance and a surge in eco-friendly regulations, sustainable packaging has emerged as a critical issue for consumers [8].

Addressing these challenges in sustainable packaging adoption involves navigating a complex landscape. While there's a growing global interest in environmental

protection, the concept of green packaging plays a pivotal role in mitigating waste and pollution, and in promoting sustainable development. Companies are now urged not only by consumer demands but also by government-driven initiatives, including laws, regulations, and taxation, to embrace sustainable and environmentally friendly packaging practices [9].

However, the transition to sustainable packaging is not without hurdles. It entails overcoming barriers such as the intricacies of product marketing systems, the need to maintain competitive advantages, significant capital investments in new technologies, and the challenge of identifying and implementing transformative technologies that support packaging sustainability. Yet, one of the most overarching challenges lies in establishing a universally recognized and accepted definition of what constitutes sustainable packaging. Such a fundamental understanding is crucial for the long-term sustainability of packaging and the associated business development [6].

In essence, the adoption of green packaging practices is a multifaceted endeavor that requires concerted efforts from industries, consumers, and policymakers alike. While the challenges are formidable, the imperative to address them has never been more pressing in the face of our rapidly changing environment.

### 1.2.2. The benefits of the adoption of environmentally sustainable packaging

Packaging serves a dual role, not only as a protective enclosure for products but also as a means of effective communication between consumers and brand owners [10].

The integration of eco-friendly packaging provides to companies many advantages. Firstly, it substantiates a notable increase in sales, strengthening revenue streams, and fostering the development of a sustainable supply chain. This transition not only generates economic benefits but also actively mitigates environmental impacts. Additionally, it affords manufacturers the opportunity to cut packaging costs, enhance brand image, and curbing the global environmental footprint. This transformation further extends to revolutionizing consumer approaches, especially in the realm of fast-moving consumer goods. The palpable benefits arising from the adoption of eco-friendly packaging in a sustainable supply chain are unequivocal [10].

Furthermore, it is imperative to acknowledge the resonance of such practices in the broader context of environmental conservation. The utilization of eco-friendly packaging is intrinsically linked to a reduction in waste. By adopting sustainable packaging, businesses align themselves with a global movement towards environmental preservation and sustainable consumption patterns. This strategic alignment not only enhances corporate reputation but also positions companies as responsible stewards of the environment. The positive impact affects not only the supply chain but also environmentally conscious consumers, strengthening brand loyalty and affinity [11].

In essence, the benefits of eco-friendly packaging, as expounded in [10] and [11], extend far beyond economic considerations, permeating into the realms of environmental consciousness and ethical consumerism. Through this paradigm shift, businesses not only fortify their competitive edge but also contribute meaningfully to a more sustainable and eco-responsible future.

### 1.3. Problem statement: research questions and relevance of the thesis

The objective of the thesis is to investigate the relationship between the cosmetics industry and environmentally sustainable packaging, with a specific focus on customer behaviour. The research questions guiding the study are:

Q1: In which ways can the cosmetic product packaging be environmentally sustainable?

Q2: How are cosmetics companies currently managing environmental sustainability in packaging, and what innovative solutions from other industries show potential for adaptation in the cosmetics sector?

To address these research questions, a systematic literature review approach was adopted. The state-of-the-art research phase revealed that there is a practical gap regarding the actual use of innovative environmentally sustainable materials in the packaging of the cosmetics industry products. The search highlighted the fact that these materials have been analysed almost completely just in theory (research, prototyping, or academic discussions), they have not been practically implemented by companies in the cosmetic industry yet.

For this reason, to gain a comprehensive understanding of current industry initiatives focused on innovative environmentally sustainable packaging, various case studies have been meticulously identified and examined. This approach has been undertaken to effectively address and answer to Q2.

This research has shown a diverse number of case studies of environmentally sustainable packaging innovations adopted by companies in the cosmetics industry and in adjacent industries. What, however, neither literature nor case studies can say, is what the actual and potential customer response to these sustainable innovations in the packaging of cosmetics are.

To fill this gap, out of twenty-four case studies of environmentally sustainable packaging practices identified, six outstanding examples were selected to be submitted to customers with the aim of exploring consumer preferences and potential response related to different solutions of environmentally sustainable packaging. The various sustainable packaging solutions presented to the customer were chosen from those

identified and analysed in the case studies, selecting the ones that emerged as the most promising compared to others.

Overall, the questionnaire aimed at answering the following research question:

Q3: Among the six presented solutions of innovative environmentally sustainable packaging for cosmetics, which are the most promising for the market?

The research is relevant because it addresses the growing demand for sustainable strategies in the cosmetics packaging, analysing consumer behaviour and preferences towards environmentally sustainable packaging. The findings of the study aim to provide insights for cosmetics companies to enhance their environmentally sustainable strategies related to packaging and to meet the demands of consumers.

## 1.4. Organization of the thesis

The thesis is structured into several chapters, each with its distinct objective. This section offers a glimpse into how the work is organized and structured, outlining the main contents of the chapters.

1. Theoretical Background: review of the existing knowledge and research about the beauty product packaging environmental sustainability.
2. Case Studies Analysis: analysis of real case studies about the way beauty companies are currently managing environmental sustainability in packaging, with a look at the innovative sustainable packaging solutions of adjacent industries that show potential for adaptation in the cosmetics sector.
3. Analysis and Evaluation of current approaches and methods: evaluation of the existing practices relevant to the study with a critical analysis of the current state.
4. Research methodology: the research approach used to investigate about the theoretical background, design the survey conducted and provide a clear statement of the research questions.
5. Results: presentation of the data collected through the survey.
6. Discussion: presentation of the key findings and interpretation of them in the context of the research, with the aim of addressing the research questions.
7. Conclusion and future developments: summary of the key findings with concise answers to the research questions and future developments to explore potential further research and advancements in the field of environmental sustainability of cosmetics packaging.

The organizational structure is made to allow an easy navigation through the thesis and to represent cohesively the research journey.





## 2 Theoretical Background

The present study wants to analyse the environmentally sustainable packaging in the cosmetic industry.

### 2.1. Cosmetic Product Packaging Environmental Sustainability

This section will focus on the topic of cosmetic product packaging and environmental sustainability, exploring the strategies for reducing the environmental impact of packaging.

#### 2.1.1. Biopolymers in cosmetic packaging

In recent decades, oil-based materials have dominated various industries, especially in food packaging, due to their cost-effectiveness and favorable technological properties, including mechanical and physical performance.

However, global production of conventional plastics reached 359 million metric tons in 2018, contributing to an estimated annual waste production of more than 8 million tons from plastic packaging alone [12]. This has led to a growing consumer awareness of the environmental impact of petrochemical-based plastic packaging, coupled with a growing concern about waste management and bioeconomy regulations [13].

In response to this dramatic situation, bioplastics derived from bio-based polymers have emerged as a promising alternative [12]. This step is not limited to generic packaging, but also extends to cosmetic packaging, which is actively looking for alternatives to petroleum-based polymer packaging. The use of bio-based and biodegradable modified polymer packaging addresses the two challenges of cosmetic preservation and the broader objectives of sustainability and biodegradability. Demand for bioplastic packaging has increased significantly and continues to grow. The characteristics of bioperishability and biopolymer matrices are expected to offer distinct advantages over conventional petroleum-based polymer packaging, in particular in terms of increased recyclability and environmental sustainability [13].

By combining these perspectives, it becomes evident that the shift towards environmentally sustainable packaging materials represents a pivotal advancement in addressing the ecological challenges posed by conventional plastic packaging. This

transition not only aligns with heightened consumer awareness but also signifies a broader commitment to a more sustainable and eco-conscious future. The subsequent exploration of emerging trends and innovations in this realm will shed further light on the transformative potential of these materials [13] [12].

Table 1 summarizes the different types of Innovative Biopolymers identified in the research and also the Stage of Maturity of the Innovation.

Table 1 - Innovative Biopolymers and Stage of Maturity of the Innovation

Innovative Biopolymers	Stage of Maturity of the Innovation
<b>PolyLactic Acid</b>	Experimentation (cosmetics industry)
<b>Polyhydroxyalkanoates</b>	Experimentation (cosmetics industry)
<b>Polysaccharides</b> (Chitosan)	Experimentation (cosmetics industry)
<b>Nanocellulose</b>	Theoretical (both cosmetics and food industries)
<b>Seaweed</b> (Alginate, Carrageenan, Agar)	Experimentation (food industry)
<b>Papaya</b>	Theoretical (food industry)
<b>Pomegranate peel powder</b>	Theoretical (cosmetics industry)
<b>Aloe Vera</b>	Theoretical (food industry)

As highlighted in the Table 1, the literature shows that the innovative biopolymer materials have been analyzed almost completely just in theory (research, prototyping, or academic discussions), they have not been practically implemented by companies in the cosmetic industry yet. Just the half of the innovative biopolymer materials have been experimented on a small scale by some companies or labs. However, the use of these innovative biopolymer materials has not become a common practice in the cosmetic industry yet. Furthermore, it is worth noticing that the half of the innovative biopolymer materials have been analyzed, both in theory and experimentation, just in the food industry for the moment, but show a potential for adaptation in the cosmetics industry. This underscores the significant parallels and similarities between the two adjacent industries, offering the prospect of applying analogous approaches to both [12] [13] [14] [15] [16] [17] [18].

#### 2.1.1.1. PolyLactic Acid

Polylactic acid, commonly known as PLA, stands out as a versatile thermoplastic material suitable for both rigid and flexible packaging applications. Derived from renewable resources such as cornstarch or sugarcane, PLA boasts biodegradability and compostability, marking a significant stride towards sustainability in packaging. Its production leaves a notably lower environmental footprint in comparison to

petroleum-based plastics. Moreover, PLA's wide availability in the market renders it easily accessible to the cosmetic industry, underscoring its potential for widespread adoption [13].

One of PLA's notable advantages lies in its cost competitiveness, especially when factoring in potential long-term savings attributed to its biodegradable nature. However, it's worth noticing that PLA exhibits a tendency to hydrolyze relatively easily, potentially affecting its durability, particularly in contact with oil and water. This characteristic may have implications for the shelf life of certain cosmetic products [13].

In terms of compatibility with cosmetic formulations, PLA generally proves to be a suitable choice. Yet, it's essential to consider that its durability may be influenced by specific substances, necessitating careful formulation considerations. PLA's versatility in processing methods further enhances its appeal. Whether through techniques like injection molding, blow molding, extrusion, or thermoforming, PLA can be seamlessly integrated into existing production processes, offering a smooth transition for manufacturers [13].

The growing interest in PLA-based packaging is attributed to its impressive rigidity and mechanical resistance. When blended with complementary materials like cellulose acetate, PLA exhibits even greater promise, delivering a combination of robustness and biodegradability. While PLA presents clear advantages for sustainable packaging, its susceptibility to hydrolysis and potential impact on certain formulations must be taken into account. Overall, according to [8], with careful consideration of its unique characteristics, PLA emerges as a promising contender for eco-conscious cosmetic packaging solutions.

#### 2.1.1.2. Polyhydroxyalkanoates

Polyhydroxyalkanoates (PHAs) emerge as a significant player in the realm of packaging materials, primarily owing to their high perishability in various conditions. This versatility extends beyond packaging alone, encompassing applications in paper coating, nonwoven fabrics, molded goods, adhesives, performance additives, and films. The inherent biodegradability and natural composition of PHAs make them especially well-suited for cosmetic packaging applications [13].

Derived from bacterial sources, PHAs boast impressive biodegradability and compostability, positioning them as an environmentally responsible alternative to petrochemical-based plastics. Their production process, rooted in bacterial cultivation, may potentially limit their availability compared to more widely used materials. However, they are steadily gaining traction across diverse applications [13].

While PHAs may come at a relatively higher cost compared to materials like PLA due to their lower production rate, their unique attributes and sustainability quotient render them invaluable. Notably, their perishability and durability for cosmetic

products hinge on factors such as oil and water content, which can be optimized through proper modification [13].

PHAs exhibit a high level of safety for skin contact and demonstrate notable biocompatibility, making them an attractive choice for cosmetic packaging. Additionally, their adaptability to various production processes further enhances their appeal [13].

In conclusion, PHAs present a promising prospect for cosmetic packaging materials. Their natural composition, biodegradability, and low environmental impact position them as sustainable alternatives to conventional plastics, as reported in [13]. While considerations such as production rate and perishability exist, the unique properties of PHAs make them a compelling choice for eco-conscious cosmetic packaging solutions.

#### 2.1.1.3. Polysaccharides - Chitosan

Starch and cellulose by-products are extensively utilized in cosmetic packaging, constituting key polysaccharides in the industry. Recently, chitosan and chitin have emerged as active packaging materials, owing to their notable antimicrobial properties [13].

Chitosan, derived from natural sources such as crustacean shells, boasts biodegradability and environmentally friendly attributes, coupled with potent antimicrobial capabilities. Its ready availability in the market positions it as a viable option for cosmetic packaging, particularly due to its antimicrobial prowess [13].

While chitosan may entail a slightly higher cost compared to alternative materials, its distinct properties and benefits can often justify the investment. Notably, chitosan exhibits outstanding oxygen barrier properties and lends itself well to film formation. This translates to an extended shelf life for cosmetic products and heightened resistance to degradation [13].

Additionally, chitosan's antimicrobial and antioxidant attributes render it highly suitable for cosmetic packaging, contributing to product quality and longevity. Its versatility in production processes further underscores its potential for creating biodegradable and active packaging materials tailored to the cosmetic industry's needs [13].

Altogether, according to [13], chitosan emerges as a promising contender in cosmetic packaging, offering a range of advantages that can significantly enhance product preservation and quality.

#### 2.1.1.4. Nanocellulose

Nanocellulose, derived from renewable resources, stands out as an environmentally friendly choice for packaging materials in both food and cosmetic industries. Its

biodegradability ensures it leaves a minimal environmental footprint, aligning with the growing sustainability concerns in packaging [12]. The production process, while potentially involving chemicals, can be managed to mitigate its environmental impact. This underscores its potential as a green alternative to conventional petroleum-based materials [12].

Furthermore, nanocellulose's increasing availability in the market, coupled with its accessibility for various industries, including food and cosmetics, signals a promising trend. However, a critical consideration lies in establishing a sustainable supply chain for the raw materials, particularly cellulose sourced from plants [12]. The material's relatively low cost compared to some other nanomaterials, along with its potential for long-term cost savings through enhanced product performance and reduced environmental impact, reinforces its attractiveness [12].

In addition to its applications in food packaging, nanocellulose also demonstrates significant promise in cosmetic packaging. Its compatibility with cosmetic products is supported by its lightweight, environmentally friendly nature, and the ability to undergo chemical modification for formulation compatibility [12] [14]. The material's integration into existing production processes, including extrusion, coating, and electrospinning, presents a seamless adaptation into the manufacturing practices of the cosmetic industry [12] [10].

Moreover, nanocellulose's ability to enhance the mechanical and barrier properties of polymer matrices is a pivotal factor for packaging materials in both industries. By reinforcing polymers, nanocellulose contributes to the maintenance of product integrity over time and under external stresses [12] [14]. This quality, coupled with its biodegradability, highlights its potential for extending the shelf life of packaged goods.

In conclusion, incorporating insights from both [12] and [14], it results that the amalgamation of properties exhibited by nanocellulose - biodegradability, renewability, lightweight nature, and potential cost-effectiveness - positions it as a promising material for both food and cosmetic packaging. Its compatibility with existing production processes and demonstrated technical effectiveness further solidify its potential. However, attention must be given to sustainable sourcing practices to ensure its long-term viability. Overall, nanocellulose presents a compelling case for revolutionizing the packaging industry towards a more sustainable and environmentally conscious future.

#### 2.1.1.5. Seaweed - Alginate, Carrageenan and Agar

Alginate, carrageenan, and agar are naturally occurring polysaccharides derived from seaweeds. These materials offer a sustainable alternative for cosmetic packaging due to their low environmental impact. Seaweed farming, the primary source of these polysaccharides, is considered a renewable and eco-friendly practice. The extraction

process of alginate, carrageenan, and agar is relatively sustainable, involving minimal use of harsh chemicals or energy-intensive processes [15].

These seaweed-derived materials do not contribute to deforestation or habitat destruction, as seaweeds are abundant and can be harvested without harming natural ecosystems. However, it is crucial to ensure that the extraction process is carried out sustainably to minimize any potential environmental impact. Considering the entire lifecycle, from production to disposal, these materials exhibit a relatively low overall carbon footprint [15].

Moreover, alginate, carrageenan, and agar are readily accessible for the cosmetic industry. Brown seaweeds, the primary source of alginate, and red algae, the sources of carrageenan and agar, are widely available in various coastal regions globally. This accessibility makes them viable options for integration into cosmetic packaging materials [15].

In terms of cost-effectiveness, these seaweed-derived materials offer economic advantages. The production processes for alginate, carrageenan, and agar are relatively straightforward and do not require complex technology. This results in competitively priced materials, making them economically viable options for various applications, including packaging within the cosmetic industry [15].

When considering durability and resilience, these materials exhibit promising properties. Alginate-based films, in particular formulations, can offer good durability, especially when combined with other elements for added strength. Carrageenan-based films are known for their gelling and thickening properties, contributing to their durability, although additional measures may be needed for enhanced strength. Agar-based films, with their unique gelling capacity, also exhibit resilience, making them valuable in packaging applications. However, it is important to note that the physical properties of these films may evolve over time, especially under specific conditions like freeze-thaw cycles [15].

By incorporating extracts from these seaweed-derived materials into biofilms, active packaging can be created. These materials can interact positively with cosmetic products, providing protection against bacteria, oxidation, and UV rays. Additionally, their compatibility with existing production processes within the cosmetic industry makes their integration seamless [15].

In summary, in accordance with [15], alginate, carrageenan, and agar hold great promise for cosmetic packaging materials. Their renewable and eco-friendly origins, coupled with their accessibility, cost-effectiveness, and favorable properties, make them viable candidates for sustainable packaging solutions. However, it is crucial to ensure sustainable sourcing and production practices to fully realize their potential in reducing environmental impact.

#### 2.1.1.6. Papaya

Papaya emerges as a promising natural material for cosmetic packaging, primarily due to its low environmental impact. Unlike synthetic alternatives, the production process of papaya does not appear to involve highly resource-intensive or environmentally harmful procedures. This suggests that it could be a more sustainable choice, aligning with the growing demand for eco-friendly packaging solutions [16].

Furthermore, the widespread availability of papaya worldwide enhances its attractiveness for cosmetic companies. Its accessibility to a large number of manufacturers can potentially lead to improved availability and affordability, thus benefiting a broader market [16].

From an economic standpoint, papaya's natural origin implies cost-effectiveness compared to heavily processed or synthetic materials. The fact that it is a naturally occurring fruit suggests potential cost savings for companies, particularly if they have access to local sources. This economic advantage can contribute to its viability as a material for cosmetic packaging [16].

However, there are certain aspects that need further consideration. [16] does not provide specific information on the durability and resilience of papaya-based films. It is essential to evaluate how well these films can withstand various stresses and conditions encountered in the context of cosmetic packaging.

Additionally, the compatibility of papaya with cosmetic products is not explicitly addressed in [16]. Factors like chemical stability and safety must be thoroughly assessed to ensure that it won't react adversely with cosmetic formulations.

While [16] does not mention any challenges related to integrating papaya-based films into existing production processes, this absence suggests that it might be relatively straightforward to work with. This ease of integration could be a favorable factor in favor of papaya-based packaging.

In conclusion, in accordance with the analysis of [16], papaya exhibits several promising attributes that make it a compelling candidate for cosmetic packaging. Its natural origin, accessibility, and potential cost-effectiveness contribute to its appeal. However, a thorough evaluation of its durability, compatibility with cosmetic products, and performance in terms of product protection and usability is crucial to determine its overall effectiveness in cosmetic packaging.

#### 2.1.1.7. Pomegranate peel powder

The utilization of pomegranate peel powder as a component in biofilms for packaging represents a positive stride towards sustainability in packaging. By incorporating natural materials like pomegranate peel powder, there is potential to mitigate the environmental impact when compared to conventional plastics. This shift aligns with

the growing demand for eco-conscious packaging solutions, marking it as a favorable choice for sustainable practices [17].

One significant advantage lies in the availability and accessibility of pomegranate peel powder. It is derived as a by-product during pomegranate juice processing, signifying a readily accessible resource. This accessibility enhances its feasibility for integration into various industries, including cosmetics packaging [17].

However, [17] does not provide specific details regarding the cost implications of incorporating pomegranate peel powder into the films. Understanding the economic feasibility of this material is crucial for assessing its overall viability in cosmetic packaging.

Moreover, it is noted that the addition of pomegranate peel powder has an impact on the mechanical properties of the films. This suggests potential considerations for durability and resilience. A comprehensive evaluation of these factors will be essential in determining the material's suitability for cosmetic packaging [17].

While [17] primarily focuses on the application of these films in cosmetics packaging, specific information regarding their compatibility with cosmetic products is not provided. Assessing chemical stability and safety is imperative to ensure it won't adversely interact with various cosmetic formulations.

The described production process, involving the incorporation of pomegranate peel powder, signifies a level of compatibility with existing manufacturing processes. This compatibility facilitates a smoother transition for industries looking to adopt more sustainable practices.

In addition, the evaluation of the films' properties, including water solubility, tensile strength, and antibacterial activity, provides valuable insights into their technical effectiveness. These characteristics contribute to their potential suitability for cosmetic packaging. In summary, in accordance with the evaluation of [17], the integration of pomegranate peel powder into biofilms holds promise for sustainable packaging practices. Its natural origin, accessibility, and potential technical effectiveness are favorable attributes. However, further considerations regarding cost, mechanical properties, compatibility with cosmetic products, and detailed assessments of its environmental impact are necessary to determine its overall suitability for cosmetic packaging applications.

#### 2.1.1.8. Aloe Vera

Aloe vera emerges as a natural extract imbued with potent antioxidant and antimicrobial properties. When employed in biopolymer-based coatings, it presents an eco-friendly alternative to synthetic chemicals, potentially curtailing reliance on artificial materials and thus, mitigating environmental impact. This shift towards a more sustainable approach holds promise for a greener future in packaging [18].



The widespread availability of the aloe vera plant, renowned for its diverse applications in health and wellness, renders it readily accessible for integration into food coatings. This high accessibility not only simplifies procurement but also positions it as an attainable option for companies operating in the food industry [18].

While specific cost details are omitted from [18], aloe vera is generally recognized as a cost-effective option, particularly when juxtaposed with certain synthetic additives or preservatives. This cost efficiency could translate into tangible benefits for companies seeking economically viable solutions.

Although [18] doesn't explicitly delve into the durability and resilience of aloe vera-based coatings, it does underscore their ability to sustain fruit firmness and delay maturity. This implies a positive impact on the resilience of coated fruits, potentially leading to extended shelf life and reduced food waste. It's important to note that [18] predominantly focuses on the utilization of aloe vera in food coatings rather than cosmetics. As such, this aspect may not directly pertain to the application of aloe vera in cosmetic packaging.

However, [18] highlights that aloe vera can be seamlessly incorporated into composite films alongside various biopolymers. This indicates its compatibility with existing production processes, implying a smooth integration into the established practices of the food industry.

Furthermore, [18] underscores several instances where aloe vera is effectively employed in coating formulations to prolong the shelf life of perishable food items. This showcases its technical effectiveness in maintaining fruit quality, reducing weight loss, retarding ripening, and inhibiting enzymatic and microbial activity. Such a track record demonstrates a high level of efficacy in food coatings.

In summary, the integration of aloe vera in biopolymer-based coatings holds substantial promise for sustainable packaging solutions. Its natural origin, coupled with its demonstrated efficacy in food coatings, underscores its potential applicability in cosmetic packaging. However, further research and testing specific to cosmetic formulations would be essential to confirm its suitability for this particular industry.



## 3 Case Studies: Cosmetic Companies' Sustainability Practices in Packaging & Cross-Industry Innovations

The present section aims to analyse how beauty companies are managing the packaging environmental sustainability by proposing different case studies. Out of the twenty-four identified case studies, six standout examples have been chosen for an in-depth subsequent analysis. The selected cases not only exemplify the industry's ongoing commitment to eco-friendly practices but are also potential precursors for the adaptation of solutions from other industries in the cosmetic industry.

### 3.1. Overview of the identified case studies

An extensive search yielded a pool of twenty-four case studies spotlighting innovative and sustainable packaging solutions for cosmetic products. Notably, these case studies span not only the cosmetics sector but also encompass packaging innovations from adjacent industries, highlighting the potential for adaptation of such solutions within the cosmetics sector.

The different case studies on packaging can be arranged to be analyzed as follows.

#### 3.1.1. Refillable Aluminum Packaging

P&G Beauty is at the forefront of innovation and collaboration, championing the principles of the circular economy across its brand portfolio. The company is resolutely dedicated to ensuring that all packaging is either recyclable or reusable, with a targeted 50% reduction in the use of virgin petroleum-based plastic in packaging by 2030. Central to P&G Beauty's sustainability strategy is the pivotal role of refilling practices in shaping the future of packaging. The launch of the "good refill system" by P&G Beauty in 2020 was a groundbreaking step, enabling 200 million households across Europe to actively participate in reduction, reuse, and recycling efforts with their packaging. This pioneering initiative empowers consumers to acquire products from the company's flagship brands in aesthetically pleasing and reusable containers, complemented by fully recyclable refill pouches that utilize 60% less plastic than conventional shampoo bottles. Furthermore, these containers are constructed from

rust-resistant, recyclable aluminum, further underscoring P&G Beauty's commitment to sustainable solutions [19].



Figure 1 – P&G "good refill system"

In 2020, Unilever launched a major in-store refill trial at Asda's sustainability store in Leeds, marking a pivotal step in sustainable packaging initiatives. This trial, well-received by consumers, led to an expansion of refillable packaging trials across the UK. A notable innovation is the 'return on the go' pilot, offering convenient pre-filled stainless steel bottles that can be returned, cleaned, and refilled. These bottles feature popular brands like Persil and Simple and will be available in selected Asda and Co-op stores. Placing them strategically in-aisle aims to seamlessly integrate refillable options into regular shopping habits. Unilever's commitment to innovative and sustainable packaging solutions is further demonstrated through ongoing efforts to explore 'refill on the go' possibilities [20].



Figure 2 – Unilever in-store refill trial

Kjaer Weis has maintained an unwavering dedication to sustainability since its inception, with over 90% of their products designed to be refillable. The brand consistently seeks out cutting-edge innovations to further their environmental commitment. Notably, their Iconic Edition packaging represents the pinnacle of luxury. Crafted from a long-lasting metal alloy, it offers endless refill possibilities [21].



Figure 3 – Kjaer Weis Iconic Edition packaging

### 3.1.2. Refillable Plastic Packaging

NIVEA introduces an innovative refill station for their shower gels, advocating for a sustainable approach. The process is straightforward: consumers retrieve an empty plastic bottle from the station, select their preferred product (NIVEA Creme Soft or NIVEA Creme Sensitive shower gel), and pay via the provided label. The bottle can be refilled up to three times using a special barcode. After the third refill, customers return the bottle for recycling at the checkout, receiving a new bottle and initial filling for free. This initiative aligns with company's commitment to environmentally responsible practices and contributes to the vision of a circular economy. While refill concepts are widely discussed, NIVEA is among the few brands offering tangible solutions, particularly in Germany. Through this new refill station, the company aims to gather crucial insights from its consumers, reduce packaging waste, and champion the principles of a circular economy [22].



Figure 4 – NIVEA refill station

### 3.1.3. Refillable Biodegradable Packaging

Nendo, a Japanese design studio led by Oki Sato, has introduced an innovative solution to combat single-use plastic soap dispensers. Their creation, Carton + Pump, offers a recyclable paper carton that can be effortlessly replaced, addressing hygiene concerns associated with reusable dispensers and reducing plastic waste. The soap-filled paper pouches, designed akin to a milk carton, are compatible with a reusable dispenser pump. This inventive system allows the paper carton to be positioned upside-down within a cap, ensuring it stands upright. The dispenser pump's sharp end can then pierce through the underside, much like a straw in a portable juice pouch. This replaceable paper carton design not only prevents potential contamination but also optimizes the collection of residual soap, enhancing overall efficiency compared to standard flat-bottomed dispensers. Nendo's Carton + Pump demonstrates a commendable step towards sustainable and hygienic soap dispensing solutions [23].



Figure 5 – Nendo Carton + Pump

NEEK SKIN ORGANICS places a strong emphasis on sustainability, driving product strategy through several key considerations. These include evaluating the environmental impact of production, ensuring product effectiveness, prioritizing aesthetics and tactile experience, emphasizing product durability, and planning for the recyclability, reusability, and upcycling potential of our offerings. To actualize its commitment to waste reduction and regenerative sourcing, the company has implemented practical measures. This includes the development of versatile, multi-purpose products to minimize waste generation. Additionally, the cosmetic products feature refillable, high-quality bamboo packaging, aligning with their eco-conscious ethos. The company has also taken steps to bolster recycling rates, providing incentives for the customers who return NEEK packaging. The creamy highlighter perfectly exemplifies commitment to sustainability of the company: encased in an eco-friendly bamboo twist compact, this design guarantees the reusability of the product reducing the plastic waste [24].



Figure 6 – NEEK SKIN ORGANICS creamy highlighter

Lush, a renowned advocate for sustainable and minimal packaging practices, continues to lead the industry in eco-conscious initiatives. A recent milestone for Lush has been the introduction of their Cork Pots, priced at £7.50 each. These pots, crafted from the bark of cork oak trees in southern Portugal, signify a significant leap in Lush's sustainability efforts. Beyond their utility as a storage solution for shampoo bars, these Cork Pots have garnered distinction as Lush's inaugural carbon-positive packaging product. The Cork Pots project was conceived with a dual purpose in mind. Firstly, it directly contributes to the broader regeneration of Cork Oak Forests in Portugal. Notably, the study revealed that in the first year of production, over 20,000 native trees were planted, showcasing the tangible positive impact of this endeavor [25].



Figure 7 – Lush Cork Pots

#### 3.1.4. Single-use Biodegradable or Compostable Packaging

Axiology Beauty, based in Bend, Oregon, has garnered acclaim for its pioneering approach to sustainable beauty. The company's plastic-free, zero-waste Balmies have been recognized by various awards, including the Beacon Awards. Axiology Beauty's Balmies represent a breakthrough in sustainable makeup packaging. These crayons, formulated to be both sturdy and gentle, come wrapped in minimal post-consumer recycled paper. With no need for tubes or palettes, they exemplify a "reduce" approach

to waste management. The packaging, including an eco-friendly matchstick box, is easily recyclable or compostable. This innovation underscores the potential for producing less waste from the outset, rather than focusing solely on reuse or recycling [26].



Figure 8 – Axiology Beauty zero-waste Balmies

Blue Ocean Closures, along with Stora Enso and AISA, has introduced a pioneering paperboard tube with a fiber-based closure, prioritizing recyclability. The cap, comprising over 85% fibers, stands as a breakthrough in tube design. Advanced techniques like pyrolysis and solvolysis enable the extraction and reuse of fibers from this packaging. This innovation addresses the challenge of finding sustainable alternatives to plastic tubes and underscores the significance of heightened fiber content for enhanced recyclability and reduced carbon footprint, meeting consumer expectations. CEO Lars Sandberg believes this development marks a pivotal stride towards a more sustainable packaging future [27].



Figure 9 – Blue Ocean Closures x Stora Enso x AISA paperboard tube

L'Oréal is at the forefront of sustainability in the beauty industry, showcasing a groundbreaking innovation - the paper bottle. This achievement, resulting from collaboration with packaging partners, marks a significant stride in minimizing environmental impact. The company's dedication to sustainable packaging solutions led to a notable project with Billerudkorsnäs, aimed at crafting cosmetics bottles from



paper. L'Oréal now stands as a prominent member of the Paper Bottle Community, a venture initiated by the Paper Bottle Company, comprising leading packaging experts. This endeavor prioritizes eco-friendly alternatives to plastic packaging, primarily utilizing paper from sustainable sources in bottle production. This underlines L'Oréal's commitment to driving positive industry change and underscores their dedication to a more sustainable future [28].



Figure 10 – L'Oréal paper bottle

Elate Beauty, a North American brand, is dedicated to promoting beauty that is compassionate towards people, animals, and the environment. Their cosmetic range stands as a testament to this ethos, being entirely vegan and cruelty-free. Notably, over 95% of their packaging is not only beautifully adorned with sustainable wood but is also designed to be reusable, recyclable, or even plantable. In collaboration with Quadpack, Elate Beauty has introduced innovative packaging solutions for its Prep Priming Serum and Refresh Foundation. These packs not only exude elegance but also uphold the brand's commitment to sustainability. Crafted at the Quadpack Wood factory in Spain, both components feature caps and elements made from ash wood sourced from meticulously managed forests. What's particularly commendable is their refillable and recyclable nature, perfectly mirroring Elate's message of kindness towards both people and the planet [29].



Figure 11 – Elate Beauty Refresh Foundation

Virospack introduces a cutting-edge eco-friendly packaging solution: a fully plant-based dropper cap made from FOREWOOD® material in collaboration with the Rezemo GmbH brand. This marks a significant leap towards sustainability in cosmetics packaging. The cap is derived entirely from sustainable forestry, certified by PEFC, and is 100% plant-based compostable with zero fossil resources, thereby substantially reducing the carbon footprint. Additionally, the kit includes a bulb with over 50% bio-based content and a pipette featuring a biobased plastic with over 40% bio-based content. This innovative approach not only prioritizes environmental responsibility but also showcases Virospack's commitment to providing cutting-edge, sustainable packaging solutions for the cosmetics industry [30].



Figure 12– Virospack plant-based dropper cap

Shellworks has introduced Vivomer, a groundbreaking compostable material that is entirely free from petroleum. This innovative solution offers a fully bio-based and home-compostable alternative to single-use plastics. What sets Vivomer apart is its unique process of creation and decomposition, orchestrated by natural microorganisms. Vivomer's development is a significant stride towards reducing reliance on traditional plastics and embracing eco-conscious alternatives, aligning with the global shift towards sustainable practices in packaging [31].



Figure 13 – Shellworks Vivomer

Sulapac, founded in 2016 in Helsinki, Finland, has garnered acclaim for its pioneering approach to sustainable beauty. The company has developed Sulapac: an innovative, bio-based and biodegradable material that can replace conventional plastics in endless applications. Sulapac material can be used to realize biodegradable cosmetic jars. These particular containers have the same resistance of plastic: they are resistant to oil, water and prevent the penetration of oxygen. Once they have finished their function, they can be thrown into the compost and take three weeks to fully degrade [32].



Figure 14 – Sulapac jars

Chanel's collaboration with Knoll Packaging resulted in a groundbreaking 100% Knoll Ecoform pulp clamshell, winning the esteemed Formes de Luxe Award. Crafted to commemorate N°5 perfume's centenary, this innovative packaging showcases sustainable attributes and meticulous design, faithfully reproducing the iconic N°5 bottle. Jeremy Cohen, President & CEO, lauds it as a pioneering advancement in luxury packaging, setting a new standard for sustainability in the industry. The clamshell, made from FSC-certified bamboo and sugarcane waste, is both biodegradable and easily recyclable within paper and board systems. This achievement reflects a remarkable fusion of engineering expertise and creative vision, propelling the industry towards a more sustainable future [33].



Figure 15 – Chanel x Knoll Packaging, Knoll Ecoform pulp clamshell

Ecovative, a pioneering company in sustainable packaging solutions, has introduced a groundbreaking product known as MycoComposite™. Harnessing the power of mushroom roots, or 'mycelium', Ecovative's compostable packaging aligns with the principles of a circular economy. This innovative approach allows products to decompose naturally, mirroring the processes of the natural world. Notably, Ecovative's eco-friendly packaging boasts the protective qualities of polystyrene packaging (EPS), yet it doesn't contribute to the staggering 8 million tonnes of plastic pollution that enters our oceans each year. Furthermore, it can be safely disposed of in a home composting setting, marking a significant stride toward more responsible and environmentally-conscious packaging solutions [34].



Figure 16 – Ecovative MycoComposite™

Plus is an eco-conscious personal care brand introducing an innovative zero-waste body wash. This groundbreaking product dissolves completely in the shower, leaving no trace behind. By eliminating bottles, Plus significantly reduces plastic waste and water consumption, as traditional body washes are mainly composed of water. The product arrives in the form of dehydrated paper sheets, made from wood pulp sourced from FSC forests. The ink used is non-toxic and derived from renewable resources. Plus's approach marks a significant stride towards a more sustainable and responsible future in personal care, challenging the status quo of conventional packaging [35].



Figure 17 – Plus zero-waste body wash

Mi Zhou, a post-graduate student from Central Saint Martins, has introduced Soapack, a unique solution to traditional toiletry packaging. These bottles, crafted entirely from soap, dissolve as they're used up. Each Soapack is created by dyeing vegetable oil-based soap with natural pigments and casting it in a mold. A fine layer of beeswax provides waterproofing, ensuring the bottle holds its form until it comes into contact with water. This innovative approach challenges the wasteful nature of conventional plastic packaging and advocates for a more sustainable future in personal care products [36].



Figure 18 – Soapack

Notpla, a sustainable startup, has unveiled an innovative packaging made from seaweed and plants, aimed at replacing conventional plastic. Developed by branding agency Superunion, the packaging offers an eco-friendly alternative, striving to combat the alarming levels of plastic pollution in oceans. Notpla's material is both biodegradable and edible, decomposing naturally in four to six weeks. It has already been employed in various applications, including thin films, coatings for takeaway boxes, and condiment sachets. Notpla's use of seaweed is considered sustainable, as it doesn't compete with food crops for land and aids in carbon sequestration. The startup's portfolio also includes Ooho, edible sachets designed for consumption during sporting events, further contributing to a reduction in plastic waste [37].



Figure 19 – Notpla edible seaweed packaging

### 3.1.5. Recycled Material for Packaging

Beiersdorf's latest offering, NIVEA Fresh Blends (Nature Fresh in Germany), represents a significant stride in sustainability within its product line. These shower products stand out as the most environmentally conscious NIVEA offering to date, with a formulation comprised of 90% naturally derived and 98% biodegradable ingredients. The sustainability focus extends beyond the formulation to the packaging itself. The bottles are crafted from recycled PET, presenting an innovative approach to materials use. While the transition to recycled PET presented some challenges, including ensuring consistent quality and addressing color variations, the growing acceptance and advancing technology in this area motivated the company to forge ahead. This initiative is a part of the broader company-wide objective to achieve 30% recycled content across all plastic packaging by 2025, demonstrating a commitment to a more sustainable future [38].



Figure 20 – NIVEA Fresh Blends

### 3.1.6. Material and Weight Reduction of Packaging

The latest innovation from NIVEA, the Naturally Good Body Lotion, introduces a groundbreaking packaging solution. This new design utilizes 50% less plastic compared to previous body lotion bottles, significantly enhancing its sustainability. The reduction in plastic not only makes the packaging more environmentally friendly but also results in a thinner and more flexible bottle, improving user convenience. Rigorous testing, including transportation and labeling assessments, was conducted to guarantee the durability of the thinner bottle. The roll-up and squeeze function further optimizes product usage, allowing for easy extraction of the last portions of lotion. This innovative approach not only reduces plastic waste but also minimizes product formula wastage, exemplifying NIVEA's commitment to sustainable packaging solutions [39].



Figure 21 – NIVEA Naturally Good Body Lotion

Albéa's pioneering EcoFusion Top redefines responsible packaging. This cutting-edge two-in-one solution achieves an astounding 80% reduction in weight compared to standard head+cap configurations, resulting in an impressive 55% overall weight reduction for the entire tube. By streamlining the design to incorporate only two components and implementing a single open-and-close system, Albéa sets a new industry standard with EcoFusion Top. Crafted from HDPE, this ensures mono-materiality and recyclability, aligning with sustainable practices. Additionally, EcoFusion Top caters to the demands of the e-commerce sector while adhering to Ista-6 standards, making it a comprehensive and innovative packaging solution [40].



Figure 22 – Albéa EcoFusion Top

### 3.1.7. Eliminate the Packaging

While Lush has long been a pioneer in naked products, the company is pushing boundaries further amid the escalating plastic pollution crisis. Approximately 60% of their year-round products are now naked, including solid shampoos, which offer a sustainable and travel-friendly alternative to their liquid counterparts. This shift to naked products not only contributes to environmental sustainability but also allows customers to invest in high-quality ingredients instead of packaging. Lush's





## 3.2. Selection of the cases for in-depth analysis

Out of the twenty-four case studies carefully analyzed in the previous paragraph, six standout examples have been chosen for an in-depth subsequent analysis. It's essential to underscore that the solutions presented here reflect their current state and implementation. It's imperative to emphasize that this analysis does not entail hypothetical renderings or propose entirely new concepts.

The packaging solution choices have been guided by three core principles: innovation, sustainability, and profitability. It's important to note that initially, some solutions may require a higher investment due to the need for the development and use of advanced materials and innovative production processes. However, it's crucial to consider that in the long run, the adoption of these more sustainable materials and designs may not only lead to tangible savings but also significant business benefits. These may include an enhanced corporate reputation, the attraction of a more environmentally conscious customer base, and potential reductions in production and waste management costs. Each of the selections stands out for its positive impact on the environment and its innovation in the use of advanced materials and technologies. Furthermore, all choices have been made with a careful balance between sustainability and commercial practicality, ensuring an excellent user experience without compromising product effectiveness.

The aim here is to analyze and highlight the existing solutions within the scope of their current implementation, rather than proposing entirely new innovations.

### 3.2.1. Dissolvable Shower Sachet



Figure 25 - Dissolvable Shower Sachet

The shower gel comes in sheets wrapped in dissolvable sachets, made of wood pulp from responsibly managed FSC forests, that vanish down the drain. The ink is bio-renewable and FDA approved. The Dissolvable sachet disappears when exposed to water, while the sheets themselves turn into a silky foam.

This choice reflects the commitment to sustainability since it uses cellulose from responsibly managed forests according to FSC standards. Soluble sachet significantly reduces waste compared to traditional alternatives, effectively combining innovation and sustainability. Furthermore, using materials from responsibly managed forests, the expectations of an increasingly sensitive customer to environmental issues are accomplished [35].

### 3.2.2. Paper Hand Soap Dispenser



Figure 26 - Paper Hand Soap Dispenser

This innovative solution consists of a recyclable paper carton and a reusable dispenser pump, providing an eco-friendly alternative to single-use plastic soap dispensers.

Once finished the product inside, the carton can be switched out and replaced. The soap-filled paper pouches resemble a milk carton and are compatible with the reusable pump. The carton's design allows it to stand upright when placed in a cap, and the dispenser pump pierces through the underside, ensuring stability and preventing deformation or moisture accumulation in a washroom setting.

This option represents a brilliant solution to reduce plastic waste. The carton is easily replaceable, allowing the service life of the packaging to be extended without compromising pump functionality. This balance between sustainability and commercial practicality was decisive in the choice [23].

### 3.2.3. Biodegradable Clamshell for Perfume



Figure 27 - Biodegradable Clamshell for Perfume

The perfume bottle is packed in a sustainable outer packaging, made of bamboo and bagasse (sugar cane waste) certified FSC. The package is also biodegradable and recyclable in the paper & board recycling stream. Instead, in the traditional solutions the perfume bottle is packed in a cardboard box wrapped in a plastic film.

The use of bamboo fibers and bagasse from sugar cane waste demonstrates a tangible commitment to the use of renewable resources. These materials, in addition to being rapidly renewable, have a significantly reduced ecological impact compared to traditional plastic alternatives [33].

### 3.2.4. Biodegradable Jar for Skincare Cream



Figure 28 - Biodegradable Jar for Skincare Cream

The skincare cream is contained in a jar, which is crafted from a special compostable polymer (Vivomer), made with the assistance of friendly microbes. The jar, once disposed of, they break down completely in soil or marine environments, leaving no microplastics behind. This regenerative material enriches the environment when composted, providing a sustainable solution for packaging.

This choice has been guided by the groundbreaking step towards sustainable packaging it represents. Its composition allows it to be fully digested by natural microbes, leaving no harmful residues. This innovative material is not only biodegradable but also supports the regenerative capacity of our ecosystems [31].

### 3.2.5. Jar with safety click-clack system for Skincare Cream



Figure 29 - Jar with safety Click-Clack system for Skincare Cream

The skincare cream jar features the 'Click Clack' system that certifies product integrity. This eliminates the need for extra packaging, making it both eco-friendly and convenient. All necessary instructions and legal information are conveniently located on the jar. The cream jar is placed on the shelf and sold without additional boxes/packaging.

The 'Click Clack' system works in a similar way to the common jam packs that we probably all know. When the package is properly closed and not tampered with, pressing the finger on the cap, you will not hear any noise ('Click Clack'). This indicates that the package has been hermetically sealed and that the air has not entered. In case of incorrect opening or closing, you would hear a 'Click Clack' instead. This principle guarantees the freshness and integrity of the product and offers tangible confirmation of the correct closure of the package.

This choice combines the durability of glass with the recyclability of aluminum, providing a robust and sustainable packaging solution. The 'Click Clack' system adds an extra layer of safety, allowing for the removal of unnecessary secondary packaging and providing comprehensive product information directly on the jar.

### 3.2.6. Biodegradable Seaweed Capsules for Face Serum



Figure 30 - Biodegradable seaweed capsules for Face serum

The face serum is contained in biodegradable seaweed capsules which are biodegradable and home compostable for an eco-friendly skincare routine. Dispose of as a banana peel, apple core or other piece of fruit.

The use of seaweed-based materials for the pipette demonstrates a forward-thinking approach. It leverages natural resources in a way that is both biodegradable and compostable, aligning with the goal of reducing plastic dependency [37].

To conclude, out of the twenty-four case studies of environmentally sustainable cosmetic packaging innovations carefully analyzed, six standout examples have been chosen according to three core principles: innovation, sustainability, and profitability. In the following chapter, a summary table of these solutions will be presented.

## 4 Analysis and Evaluation of Current Approach and Methods

The present chapter aims to provide an analysis and evaluation of current approach and methods of each section of literature review.

### 4.1. Cosmetic Product Packaging Environmental Sustainability

The section discusses the packaging innovations in sustainability fostered by the cosmetic industry. The literature unequivocally underscores the prevailing emphasis on seeking innovations to maximize the biodegradability of packaging materials, with the ultimate aim of reducing reliance on and pollution from plastic.

In recent decades, oil-based materials have been dominant in various industries, including food packaging, due to their cost-effectiveness and favorable properties. However, the production of conventional plastics has led to a significant waste problem. This has raised awareness about the environmental impact of petrochemical-based plastic packaging, leading to a growing interest in bioplastics derived from bio-based polymers.

These bioplastics offer potential solutions not only for generic packaging but also for cosmetic packaging. They address challenges related to cosmetic preservation and align with sustainability goals. The demand for bioplastic packaging is increasing, driven by their potential for increased recyclability and environmental sustainability.

Despite their promise, innovative biopolymer materials have mostly been studied in theory, with limited practical implementation in the cosmetic industry. Only a fraction of these materials have been experimented with on a small scale. However, there is potential for their adaptation in the cosmetics industry, given the similarities with the food industry.

Several specific biopolymer materials have been discussed:

1. PolyLactic Acid (PLA): PLA is a versatile thermoplastic derived from renewable resources like cornstarch or sugarcane. It offers biodegradability and

compostability, making it a sustainable option for cosmetic packaging. However, its susceptibility to hydrolysis may affect its durability.

2. Polyhydroxyalkanoates (PHAs): PHAs are biodegradable polymers derived from bacterial sources. They offer biodegradability and compostability, making them suitable for cosmetic packaging. Their production process may limit availability, but they are gaining traction.
3. Polysaccharides (Chitosan): Chitosan, derived from crustacean shells, is biodegradable and has antimicrobial properties. It offers potential for cosmetic packaging, especially due to its antimicrobial capabilities. While it may be slightly more expensive, its oxygen barrier properties and film formation make it valuable.
4. Nanocellulose: Derived from renewable resources, nanocellulose is environmentally friendly and biodegradable. It enhances the mechanical and barrier properties of polymer matrices, making it promising for both food and cosmetic packaging.
5. Seaweed-Derived Polysaccharides (Alginate, Carrageenan, Agar): These naturally occurring polysaccharides offer sustainable alternatives for cosmetic packaging. They are renewable and eco-friendly, with accessible sources. Their gelling and thickening properties contribute to durability.
6. Papaya: Utilizing papaya in packaging materials is a sustainable choice, as it involves minimal resource-intensive processes. Its availability and accessibility enhance its feasibility. Further assessment of its durability and compatibility with cosmetic products is needed.
7. Pomegranate Peel Powder: Incorporating pomegranate peel powder into biofilms holds promise for sustainable packaging. It is derived as a by-product, making it readily accessible. However, more evaluation is needed regarding cost, mechanical properties, and compatibility with cosmetic products.
8. Aloe Vera: Aloe vera's antioxidant and antimicrobial properties make it a potential eco-friendly component in biopolymer-based coatings. It is accessible and cost-effective, with potential benefits in extending shelf life. Further research on its durability and compatibility with cosmetic products is warranted.

In summary, these natural and biodegradable materials offer promising alternatives for cosmetic packaging, aligning with the growing demand for sustainable and environmentally conscious solutions. However, further research and testing are needed to confirm their suitability for widespread use in the cosmetic industry.

## 4.2. Case Studies: Cosmetic Companies' Sustainability Practices in Packaging & Cross-Industry Innovations

This section provides an in-depth analysis of various case studies showcasing innovative and sustainable packaging solutions within the cosmetic industry. Out of the twenty-four identified case studies, six standout solutions have been selected for detailed examination. The selected cases demonstrate a commitment to eco-friendly practices and offer potential solutions for the broader cosmetic industry.

Table 2 summarizes the case studies identified in the analysis, grouping them to exemplify the analysis by macro categories and distinguishing them by:

- Case study to which the innovation belongs;
- Material used for the innovative environmentally sustainable packaging;
- Industry of origin of the innovation (cosmetics industry or food industry);
- Type of application of the innovation (shower, toiletry, perfume, skincare, make up).

Finally, the six selected solutions are visually represented by the highlighted cells.


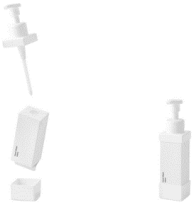




Table 2 – Identified Case Studies on Innovative Sustainable Packaging for Cosmetics

ENVIRONMENTALLY SUSTAINABLE PACKAGING	CASE STUDY	MATERIAL	COSMETICS INDUSTRY					FOOD INDUSTRY
			SHOWER	TOILETRY	PERFUME	SKINCARE	MAKE-UP	
Refillable Aluminum Packaging	P&G, Unilever, Kjaer Weis	Aluminum	X					X
Refillable Plastic Packaging	Beiersdorf	Plastic	X					
Refillable Biodegradable Packaging	Nendo, Neek Skin Organics, Lush	Cardboard, cork, wood	X					X
Single-use Biodegradable or Compostable Packaging	Axiology Beauty, Blue Ocean Closures x Stora Enso x AISA, L'Oréal, Elate beauty, Virospace, TheShellworks, Sulapac, Chanel x Knoll Packaging, Ecovative, Plus, Soapack, Notpla	Carton, Vivomer material, Sulapac material, wood, plant-based material, bamboo and bagasse fibres, mushroom, soap, seaweed, wood pulp	X	X	X	X	X	X
Recycled material	Beiersdorf	PET	X					
Material and Weight Reduction of Packaging	Beiersdorf, Albéa	Plastic	X					
Eliminate the packaging	Lush		X					
Reduce Overpackaging (tamper-evident seal)	"click clack" system from jam jars							X



The selected solutions perfectly embody the integration of the principles of innovation, sustainability and commercial feasibility. These selections prioritize environmental impact and utilize advanced materials and technologies. Each choice strikes a balance between sustainability and practicality, ensuring a positive user experience. The selected solutions are reported in Table 3.

Table 3 – Selected Solutions of Innovative Sustainable Packaging for Cosmetics

Image	Innovative Sustainable Packaging Solution	Key features	Environmental Benefits
	<b>Dissolvable Shower Sachet</b>	Wood pulp from responsibly managed forests (FSC) for dissolvable sachets.	It significantly reduces waste compared to traditional alternatives.
	<b>Paper Hand Soap Dispenser</b>	Recyclable paper carton and reusable dispenser pump.	It provides an eco-friendly alternative to single-use plastic soap dispensers.
	<b>Biodegradable Clamshell for Perfume</b>	Bamboo and bagasse (sugar cane waste) certified by FSC.	It offers a biodegradable and recyclable solution for outer packaging.
	<b>Biodegradable Jar for Skincare Cream</b>	Crafted from a compostable polymer (Vivomer) with the assistance of friendly microbes.	It breaks down completely in soil or marine environments, leaving no microplastics.
	<b>Jar with safety click-clack system for Skincare Cream</b>	'Click Clack' system certifying product integrity.	It eliminates the need for extra packaging, combining durability with recyclability.
	<b>Biodegradable seaweed capsules for Face serum</b>	Biodegradable and home compostable for an eco-friendly skincare routine.	It utilizes seaweed-based materials for capsules, reducing plastic dependency.



## 5 Research Methodology

This chapter outlines the research methodology employed for the theoretical background and for the survey.

### 5.1. Theoretical background

This study adopted a systematic literature review approach to define the theoretical background and answer the following research questions:

Q1: In which ways can the cosmetic product packaging be environmentally sustainable?

Q2: How are cosmetics companies currently managing environmental sustainability in packaging, and what innovative solutions from other industries show potential for adaptation in the cosmetics sector?

The search engine utilized to conduct the literature review is Scopus.

The query searched for articles that have "plastic-free", "refill", "green packaging", "sustainable packaging", "refill packaging", "eco-friendly packaging" in the title, or in the abstract or as keywords, in order to filter the literature regarding sustainable packaging. Furthermore, the query searched for articles that have "beauty", "cosmetic\*", "make-up" in the title, or in the abstract or as keywords, in order to filter the literature limited to the cosmetic industry. Finally, the search was limited to the literature published after 2009, to catch the growing trend from 2010, as highlighted in Figure 31. This search aimed to answer Q1. From this initial screening, 44 articles resulted.

```
( TITLE-ABS-KEY ( "plastic free" OR "refill" OR "green packaging" OR
"sustainable packaging" OR "refill packaging" OR "eco-friendly packaging" )
AND TITLE-ABS-KEY ( beauty OR cosmetic* OR make-up ) ) AND
PUBYEAR > 2009
```

The abstracts of the papers were carefully read and only the articles that could provide any insight into the research question Q1, were selected. At the same time, the literature whose access is blocked by a paywall was excluded from the selection. From this final screening, 13 papers resulted as highlighted in Figure 32.

Finally, to gain a comprehensive understanding of the current cosmetic industry initiatives focused on environmentally sustainable packaging innovations, various

case studies have been meticulously identified and examined. This approach has been undertaken to effectively address and respond to Q2.

Figure 31 - Documents by year. Source: Scopus

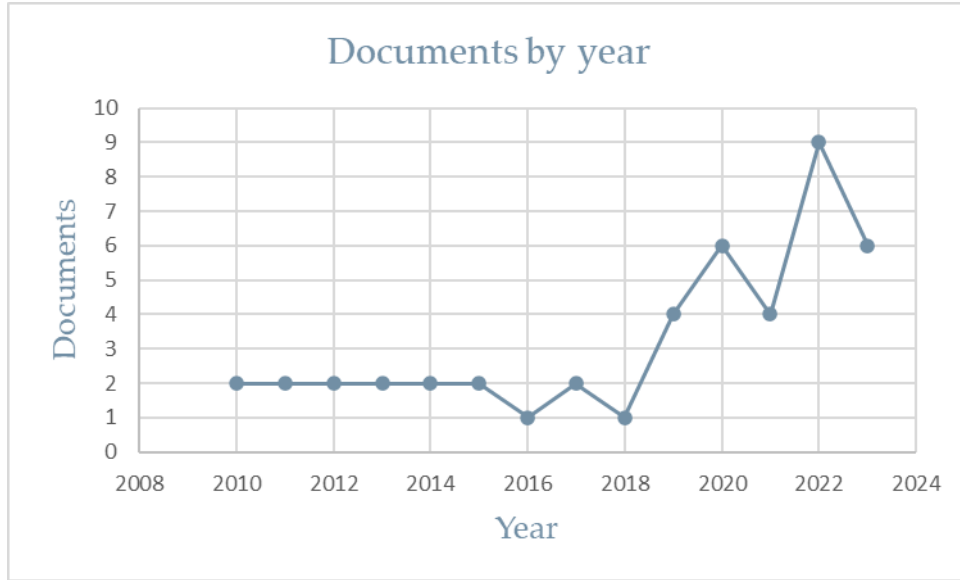
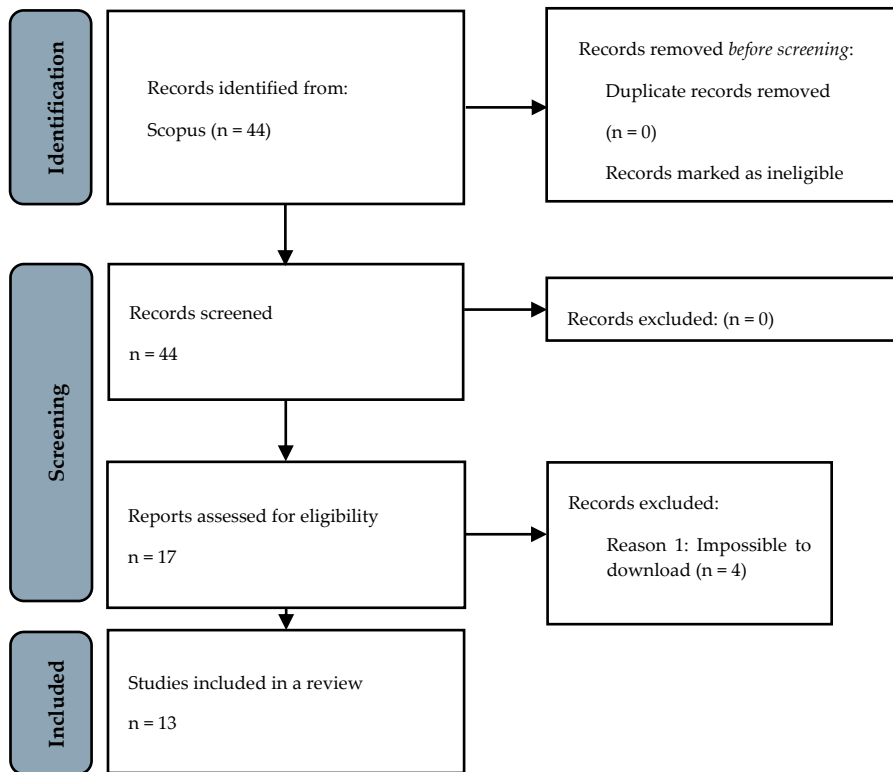


Figure 32 - Prisma Diagram. Source: The PRISMA 2020 statement - An updated guideline for reporting systematic reviews



The state-of-the-art research phase revealed that there is a theoretical gap regarding the actual and potential customer response and customer preferences towards environmentally sustainable packaging in cosmetics.

Hence, out of twenty-four case studies of environmentally sustainable packaging practices identified, six outstanding examples were selected to be submitted to customers through a survey, in order to fill the gap and answer the following research question:

Q3: Among the six presented solutions of innovative environmentally sustainable packaging for cosmetics, which are the most promising for the market?

In the following chapter, this analysis will be explained in detail.

## 5.2. Survey

A survey was conducted to collect both qualitative and quantitative data regarding individuals' response and preferences towards the environmentally sustainable packaging innovations for cosmetics proposed, addressing the research question Q3. The survey was developed both in Italian and English to target as many people as possible, then the results have been converged to be analysed. The survey was launched in November 2023 and concluded after a two-week period.

Following the collection of responses, the analysis phase involved the exclusion of invalid questionnaires, which included incomplete or inaccurate submissions.

The survey was designed using Google Forms and shared through three distinct channels:

1. WhatsApp: to capture data from individuals across various generations.
2. Instagram: primarily used to gather data from the Z and Y generations.
3. LinkedIn: mainly utilized for data collection from the Z, Y, and X generations.

### 5.2.1. Structure of the survey

The survey is composed by four sections: demographics, respondent clustering, importance and knowledge of sustainability in cosmetics packaging for the customer and evaluation of each environmentally sustainable packaging innovation proposal.

The first section aims at gathering all the demographic data necessary to learn more about respondents, including information about:

- Gender
- Range of age: to distinguish between respondents of different generations
- Country of residence: Italy, other European countries, non-European countries.

The second section aims at clustering respondents:

- In four different spending profiles (luxury, entry-level luxury, premium and mass), before for each product category and then overall;
- According to the frequency of purchase of cosmetic products.

The respondents are clustered for each product category asking how much money they would be willing to spend for each one of the five different product typologies. On the basis of their response, they are assigned to a specific spending profile for each product category. The results are shown in Table 4.

Table 4 – Type of buyers

PRODUCT	WILLINGNESS TO PAY	TYPE OF BUYER
<b>Liquid hand soap with sink dispenser (300 ml)</b>	< 5 €	Mass
	5 € - 10 €	Premium
	10 € - 20 €	Entry-level luxury
	> 20 €	Luxury
<b>Tube/bottle shower gel (500 ml)</b>	< 5 €	Mass
	5 € - 10 €	Premium
	10 € - 20 €	Entry-level luxury
	> 20 €	Luxury
<b>Perfume (50 ml)</b>	< 50 €	Mass
	50 € - 100 €	Premium
	100 € - 200 €	Entry-level luxury
	> 200 €	Luxury
<b>Face cream in jar (50 ml)</b>	< 30 €	Mass
	30 € - 60 €	Premium
	60 - 100 €	Entry-level luxury
	> 100 €	Luxury
<b>Face serum in capsules (60 pcs)</b>	< 30 €	Mass
	30 € - 50 €	Premium
	50 € - 100 €	Entry-level luxury
	> 100 €	Luxury

Furthermore, to cluster respondents based on their overall spending behaviour rather than by product category, several steps have been taken:

1. Weighting: firstly, the most representative products for each spending profile (luxury, entry-level luxury, premium and mass) have been identified. This was done to assign to each product weights that reflected their relative importance for that spending profile.
2. Assigning a numerical value to each price range: the respondent's willingness to pay for each product is expressed in intervals. For this reason, to simplify the analysis, a representative numerical value has been assigned to each interval. In this case, an average value was assigned to the range to calculate the weighted total expenditure.

3. Calculation of the total weighted expenditure: The weighted expenditure was calculated for each respondent and for each spending profile (luxury, entry-level luxury, premium and mass) using the weights assigned to the products and multiplying them by the willingness to pay expressed by the respondent for each product category. The results were then summed up to obtain the total weighted expense for each spending profile and for each respondent.
4. Clustering: the total weighted expenses, for each spending profile, have been used in order to execute the clustering in the four spending profiles (luxury, entry-level luxury, premium, mass). Finally, after performing the clustering, the results were analyzed and buyers were assigned to each cluster based on their spending characteristics.

To resume, the calculation of the total weighted expense, has been used like key metric in the process of clustering the respondents based on their overall spending behaviour rather than by product category.

Additionally, the second section also aims at clustering respondents on the basis of the frequency of purchase of cosmetic products, asking:

- How often they buy cosmetic products;

The respondent frequency of purchase of cosmetic products has been investigated giving four distinct response alternatives:

1. Weekly
2. A couple of times a month
3. Once every two months
4. Two or three times a year

The third section aims at collecting information about the importance and knowledge of sustainability in cosmetics packaging for respondents.

This has been done asking:

- Their familiarity with the concept of sustainable packaging in the cosmetic sector;
- The importance they give to sustainable packaging when buying cosmetic products.

The respondent's familiarity with the concept of sustainable packaging in the cosmetic sector has been investigated giving three distinct response alternatives:

1. Yes, I know it well
2. Yes, I have heard of
3. No, I don't have any knowledge

The importance the respondent gives to sustainable packaging when buying cosmetic products has been investigated giving three distinct response alternatives:

1. Very important
2. Important
3. Neutral
4. Unimportant
5. Unimportant at all

The last section aims at investigating the respondent's response to six environmentally sustainable packaging innovation proposals: Dissolvable Shower Sachet, Paper Hand Soap Dispenser, Biodegradable Clamshell for Perfume, Biodegradable Jar for Skincare Cream, Jar with safety click-clack system for Skincare Cream, Biodegradable seaweed capsules for Face serum.

The "Dissolvable Shower Sachet" offers a unique approach to packaging shower gel, presented in sheets enclosed within dissolvable sachets. These sachets dissolve upon contact with water, ultimately reducing waste substantially compared to traditional alternatives. The "Paper Hand Soap Dispenser" combines a recyclable paper carton with a reusable dispenser pump, effectively replacing single-use plastic soap dispensers. The "Biodegradable Clamshell for Perfume" consists in a biodegradable outer packaging, which represents a notable departure from traditional solutions that involve cardboard boxes wrapped in plastic film. In the realm of skincare, the "Biodegradable Jar for Skincare Cream" is a significant advancement. Crafted from a special compostable polymer called Vivomer, this jar decomposes entirely without leaving any harmful residues. This innovative material contributes to ecosystem enrichment when composted, marking a substantial stride in sustainable packaging solutions. The "Jar with safety click-clack system for Skincare Cream" ensures product integrity without requiring additional packaging, enhancing convenience and eco-friendliness. Comprehensive product information is conveniently located directly on the jar, eliminating the need for extra packaging. Lastly, the "Biodegradable Seaweed Capsules for Face Serum" consists in biodegradable capsules, made from seaweed which align with efforts to reduce plastic dependency.

Specifically, for each proposal, is investigated:

- Respondent inclination to adopt the new solution over the traditional one;
- Respondent willingness-to-pay for the new proposal, with respect to the traditional solution;
- Respondent price expectation for the new proposal, with respect to the traditional solution;
- Respondent concerns about the use of the new proposal;
- Respondent overall impression on the new proposal.

The respondent inclination to adopt the new solution over the traditional one has been investigated giving four distinct response alternatives:

1. Strongly Affirmative
2. Likely Affirmative



3. Likely Negative
4. Strongly Negative

The respondent willingness-to-pay for the new proposal, with respect to the traditional solution, has been investigated giving four distinct response alternatives:

1. Only if it costs less than the traditional
2. Even if it costs the same as the traditional
3. Although it costs more than the traditional, but at most 10% more
4. In any case, regardless of price

The respondent price expectation for the new proposal, with respect to the traditional solution, has been analysed asking whether he/she expects to pay:

1. More
2. Less
3. The same

Respondent's concerns about the use of the new proposal has been investigated asking whether he/she thought that the new proposal might have some contraindication, giving four distinct response alternatives:

1. No
2. Yes, Durability
3. Yes, Resistance
4. Yes, Safety
5. Yes, Hygiene
6. Yes, Practical functionality

Finally, the overall impression on the new proposal has been investigated using a Likert scale with range from 1 to 5.



## 6 Results of the study

This chapter presents the results of the survey and gives a general overview of the most important data used for answering to the research questions.

### 6.1. Results of the survey

The answers of the survey are presented in four different sections of analysis and the total number of answers collected was 223 (218 answering to the survey in Italian, 5 answering to the survey in English).

#### 6.1.1. Demographics

The respondents have been classified based on their gender, age and country of residence. The results are presented in the charts below.

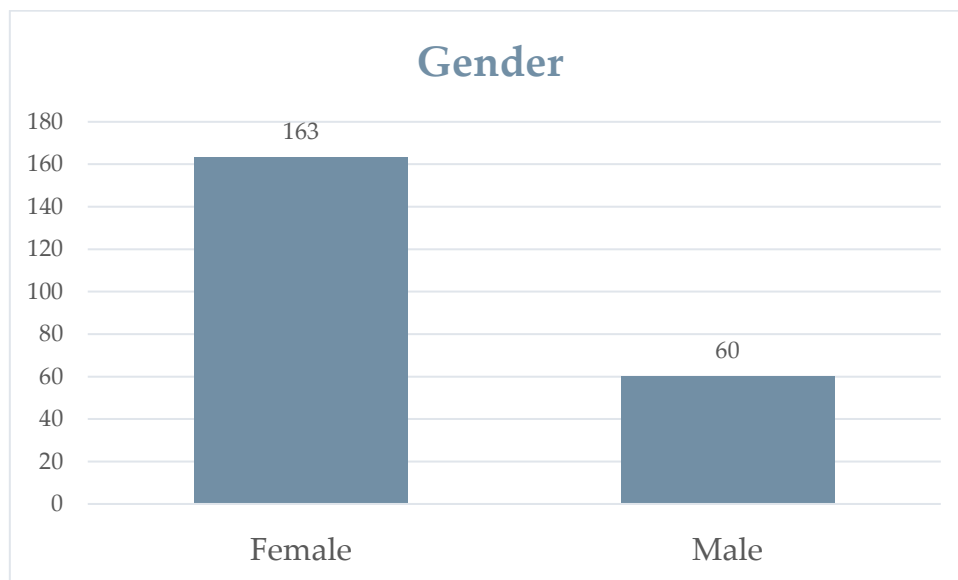


Figure 33 - Gender classification of respondents

The 73% of respondents is represented by female people, while the 27% by males.

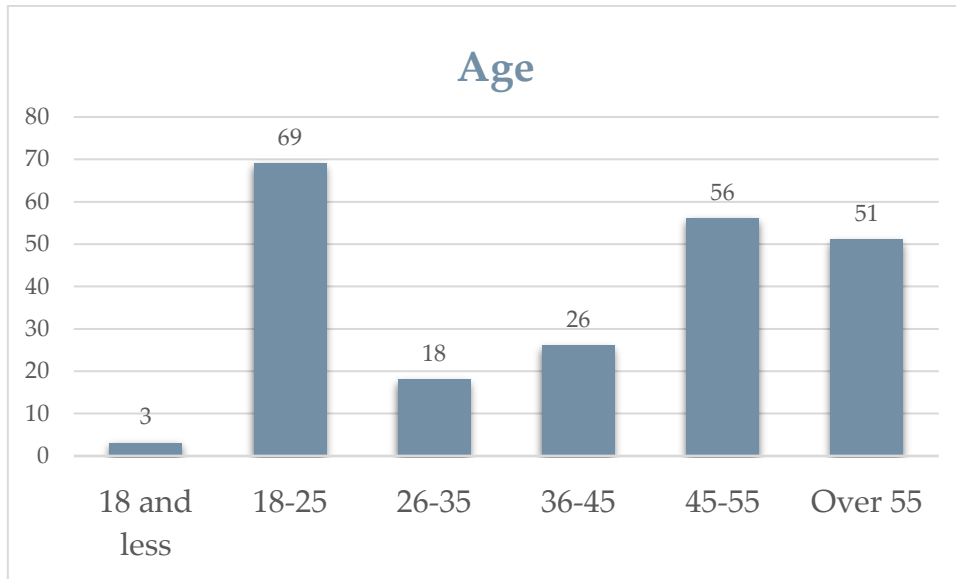


Figure 34 - Age classification of respondents

The 1% of respondents belongs to the range of “18 and less”, the 31% of respondents belongs to the range of age 18 - 25, the 8% of respondents belongs to the range of age 26 – 35, the 12% of respondents belongs to the range 36- 45, the 25% belongs to the range of age 45 - 55, the 23% belongs to the range of age “Over 55”. The results show a large variety of respondents in terms of the different age groups they belong to.

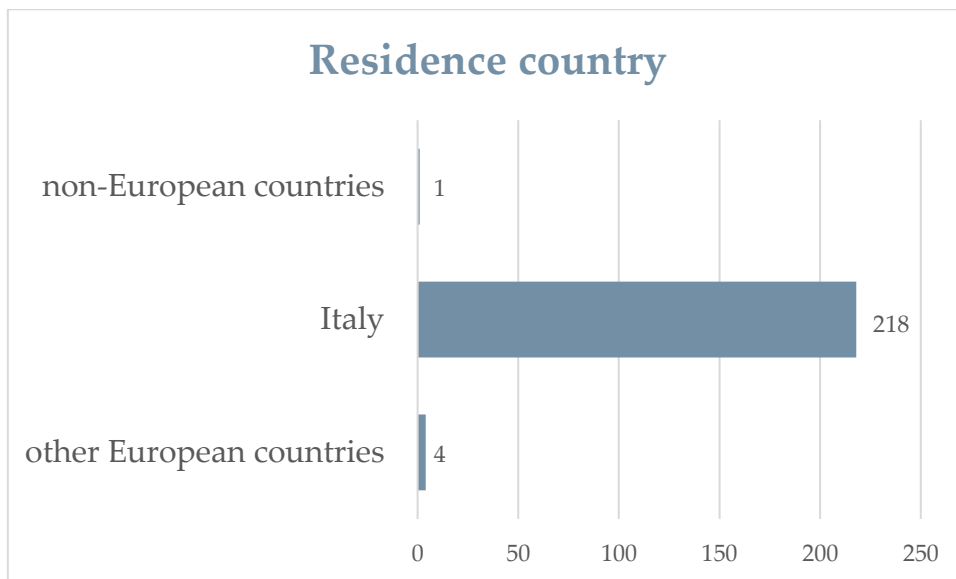


Figure 35 - Residence classification of respondents

The 97,8% of respondents live in Italy, while the 1,8% lives in other European and the 0,4% lives in non-European countries.

### 6.1.2. Clustering of respondents

The respondents have been classified according to:

- Their spending behavior;

- The frequency of purchase of cosmetic products.

6.1.2.1. Clustering of respondents on spending behavior

Firstly, the respondents are clustered for each product category asking how much money they would be willing to spend for each one of the five different product typologies. On the basis of their response, they are assigned to a specific spending profile for each product category. The results are shown in Table 5.

Table 5 – Spending profiles

PRODUCT	WILLINGNESS TO PAY	SPENDING PROFILE
Liquid hand soap with sink dispenser (300 ml)	< 5 €	Mass
	5 € - 10 €	Premium
	10 € - 20 €	Entry-level luxury
	> 20 €	Luxury
Tube/bottle shower gel (500 ml)	< 5 €	Mass
	5 € - 10 €	Premium
	10 € - 20 €	Entry-level luxury
	> 20 €	Luxury
Perfume (50 ml)	< 50 €	Mass
	50 € - 100 €	Premium
	100 € - 200 €	Entry-level luxury
	> 200 €	Luxury
Face cream in jar (50 ml)	< 30 €	Mass
	30 € - 60 €	Premium
	60 - 100 €	Entry-level luxury
	> 100 €	Luxury
Face serum in capsules (60 pcs)	< 30 €	Mass
	30 € - 50 €	Premium
	50 € - 100 €	Entry-level luxury
	> 100 €	Luxury

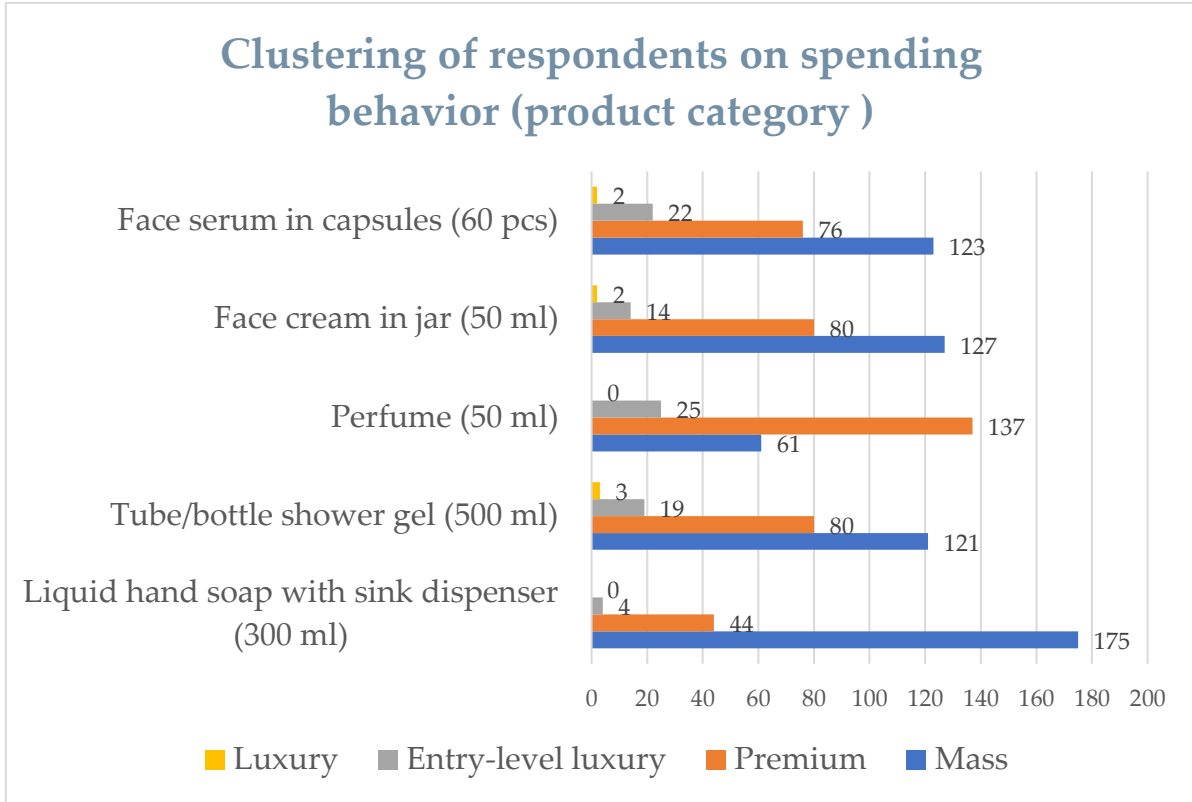


Figure 36 - Clustering of respondents on their spending behavior, for each product category

The results are different for each product category:

- Liquid hand soap with sink dispenser (300 ml): the 78% of respondents is classified as “Mass buyer”, the 20% is classified as “Premium buyer”, the 2% of respondents is classified as “Entry-level luxury buyer”, the 0% of respondents is classified as “Luxury buyer”. Results show a variety of different types of buyers.
- Tube/bottle shower gel (500 ml): The 54% of respondents is classified as “Mass buyer”, the 36% is classified as “Premium buyer”, the 9% of respondents is classified as “Entry-level luxury buyer”, the 1% of respondents is classified as “Luxury buyer”. Results show a variety of different types of buyers.
- Perfume (50 ml): The 27% of respondents is classified as “Mass buyer”, the 61% is classified as “Premium buyer”, the 11% of respondents is classified as “Entry-level luxury buyer”, the 0% of respondents is classified as “Luxury buyer”. Results show a variety of different types of buyers.
- Face cream in jar (50 ml): The 57% of respondents is classified as “Mass buyer”, the 36% is classified as “Premium buyer”, the 6% of respondents is classified as “Entry-level luxury buyer”, the 1% of respondents is classified as “Luxury buyer”. Results show a variety of different types of buyers.
- Face serum in capsules (60 pcs): The 55% of respondents is classified as “Mass buyer”, the 34% is classified as “Premium buyer”, the 10% of respondents is

classified as “Entry-level luxury buyer”, the 1% of respondents is classified as “Luxury buyer”. Results show a variety of different types of buyers.

Furthermore, to cluster respondents based on their overall spending behaviour rather than by product category, several steps have been taken:

1. **Weighting:** firstly, the most representative products for each spending profile (luxury, entry-level luxury, premium and mass) have been identified. This was done to assign to each product weights that reflected their relative importance for that spending profile.
2. **Assigning a numerical value to each price range:** the respondent’s willingness to pay for each product is expressed in intervals. For this reason, to simplify the analysis, a representative numerical value has been assigned to each interval. In this case, an average value was assigned to the range to calculate the weighted total expenditure.
3. **Calculation of the total weighted expenditure:** The weighted expenditure was calculated for each respondent and for each spending profile (luxury, entry-level luxury, premium and mass), multiplying the respondent’s willingness to pay for each product by the weight assigned to the product, for that particular spending profile. The results were then summed up to obtain the total weighted expense for each spending profile and for each respondent.
4. **Clustering:** the total weighted expenses, for each spending profile, have been used in order to execute the clustering in the four spending profiles (luxury, entry-level luxury, premium, mass). Finally, after performing the clustering, the results were analyzed and buyers were assigned to each cluster based on their spending characteristics.

### Weighting

Each product has been assigned a weight that reflects its relative importance to that spending profile (luxury, entry-level luxury, premium, mass), as it follows.

Luxury Class:

- Perfume (50 ml): weight 0.3
- Facial Serum in Capsules (60 pcs): weight 0.25
- Face Cream in Jar (50 ml): weight 0.2
- Shower Gel Tube/Bottle (500 ml): weight 0.15
- Liquid Hand Soap with Sink Dispenser (300 ml): weight 0.1

For the luxury class, products that are generally more expensive, such as perfume and face serum have a higher weight, followed by face cream. Shower gel and liquid hand soap are considered less important in this class.

Entry-Level Luxury Class:

- Face Cream in Jar (50 ml): weight 0.3

- Facial Serum in Capsules (60 pcs): weight 0.25
- Perfume (50 ml): weight 0.2
- Shower Gel Tube/Bottle (500 ml): weight 0.15
- Liquid Hand Soap with Sink Dispenser (300 ml): weight 0.1

In the Entry-Level Luxury class, the face cream is still considered essential, followed by the face serum and perfume. Shower gel and liquid hand soap remain less relevant than the other products for this spending profile.

Premium Class:

- Shower Gel Tube/Bottle (500 ml): weight 0.3
- Face Cream in Jar (50 ml): weight 0.25
- Facial Serum in Capsules (60 pcs): weight 0.2
- Perfume (50 ml): weight 0.15
- Liquid Hand Soap with Sink Dispenser (300 ml): weight 0.1

In the Premium class, the shower gel takes on a predominant role, followed by the face cream and facial serum. The perfume, although important, is less relevant than the other products in this category. Liquid soap for the hands remains the least important.

Mass Class:

- Liquid Hand Soap with Sink Dispenser (300 ml): weight 0.3
- Shower Gel Tube/Bottle (500 ml): weight 0.25
- Face Cream in Jar (50 ml): weight 0.2
- Facial Serum in Capsules (60 pcs): weight 0.15
- Perfume (50 ml): weight 0.1

In the Mass class, liquid hand soap is of utmost importance due to daily use, followed by shower gel. Skincare products such as face cream and face serum have a lower priority in this category, while perfume has the lowest weight.

#### Assignment of a numerical value to each price range

To assign a representative numerical value to each price range, it has been used the midpoint of each range as a rough representation of the price, as shown in Table 6.



Assignment of a numerical value to each price range	Price range	Price equivalent value
Liquid hand soap with sink dispenser (300 ml)	< di 5 €	2.5 €
	5 -10 €	7.5 €
	10 - 20€	15 €
	> 20 €	25 €
Tube/bottle shower gel (500 ml)	< di 5 €	2.5 €
	5 -10 €	7.5 €
	10 - 20€	15 €
	> 20 €	25 €
Perfume (50 ml)	< di 50 €	25 €
	50 -100 €	75 €
	100 - 200 €	150 €
	> 200 €	250 €
Face cream in jar (50 ml)	< di 30 €	15 €
	30 - 60 €	45 €
	60 - 100 €	80 €
	> 100 €	150 €
Face serum in capsules (60 pcs)	< di 30 €	15 €
	30 - 50 €	40 €
	50 -100 €	75 €
	> 100 €	150 €

Table 6: Assignment of a numerical value to each price range

### Calculation of the total weighted expenditure

The weighted expenditure was calculated for each respondent and for each spending profile (luxury, entry-level luxury, premium and mass), multiplying the respondent's willingness to pay for each product by the weight assigned to the product, for that particular spending profile. The results were then summed up to obtain the total weighted expense for each spending profile and for each respondent.

### Clustering

The total weighted expenses, for each spending profile and for each respondent, have been used in order to execute the clustering in the four spending profiles (luxury, entry-level luxury, premium, mass). It's been used the K-Means method. Finally, after performing the clustering, the results were analyzed and respondents were assigned to each cluster based on their spending characteristics. In Table 7 and Figure 37 are reported the results of the K-Means clustering.

Cluster	Luxury	Entry-level luxury	Premium	Mass
1 (Respondent 116)	1307,500	1117,500	862,500	395,000
2 (Respondent 73)	560,000	470,000	382,500	160,000
3 (Respondent 16)	847,500	697,500	547,500	225,000
4 (Respondent 41)	287,500	247,500	202,500	95,000

Table 7 – Central Objects K-Means

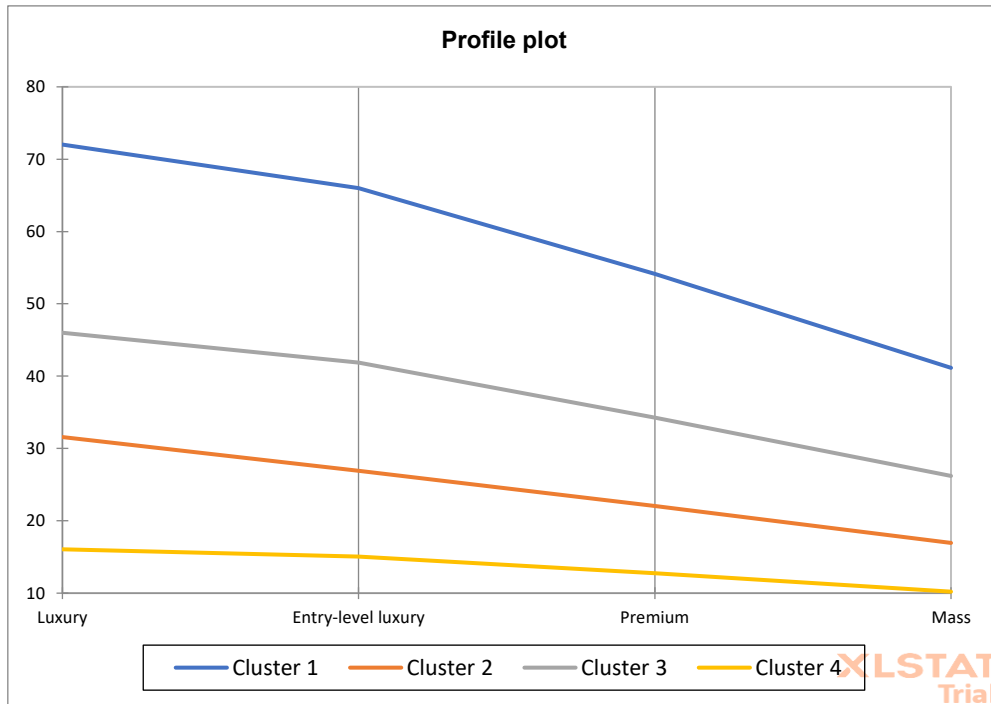


Figure 37 – Cluster means

Both the table and the graph show that:

- Cluster 1 can be associated with the buyer category of “Luxury”, since it has a higher spending value for this category than all other clusters;
- Cluster 3 can be associated with the buyer category of “Entry-level luxury” buyers, since, after cluster 1, it has a higher spending value for this category than all other clusters;
- Cluster 2 can be associated with the buyer category of “Premium” , since, after cluster 1 and cluster 2, it is the one with a higher spending value for this category;
- Cluster 4 can be associated with the category of “Mass” buyers.

Finally, the graph below shows the results of this classification, clustering respondents based on their overall spending behaviour.

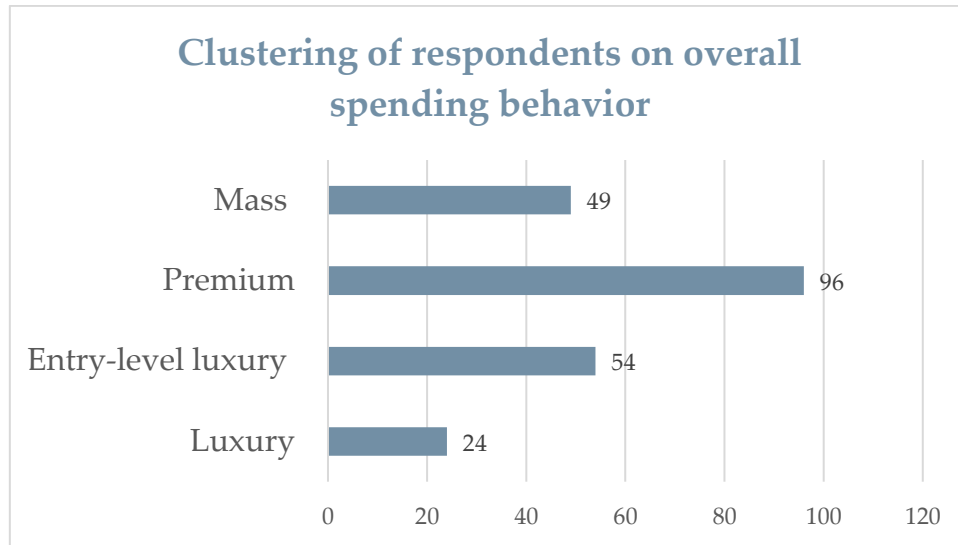


Figure 38 - Clustering of respondents on overall spending behavior

The 22% of respondents is classified as “Mass buyer”, the 43% is classified as “Premium buyer”, the 24% of respondents is classified as “Entry-level luxury buyer”, the 11% of respondents is classified as “Luxury buyer”. Results show a variety of different types of buyers.

#### 6.1.2.2. Clustering of respondents on the frequency of purchase of cosmetic products

The respondents have been classified according to their frequency of purchase of cosmetic products and the graph below shows the results.

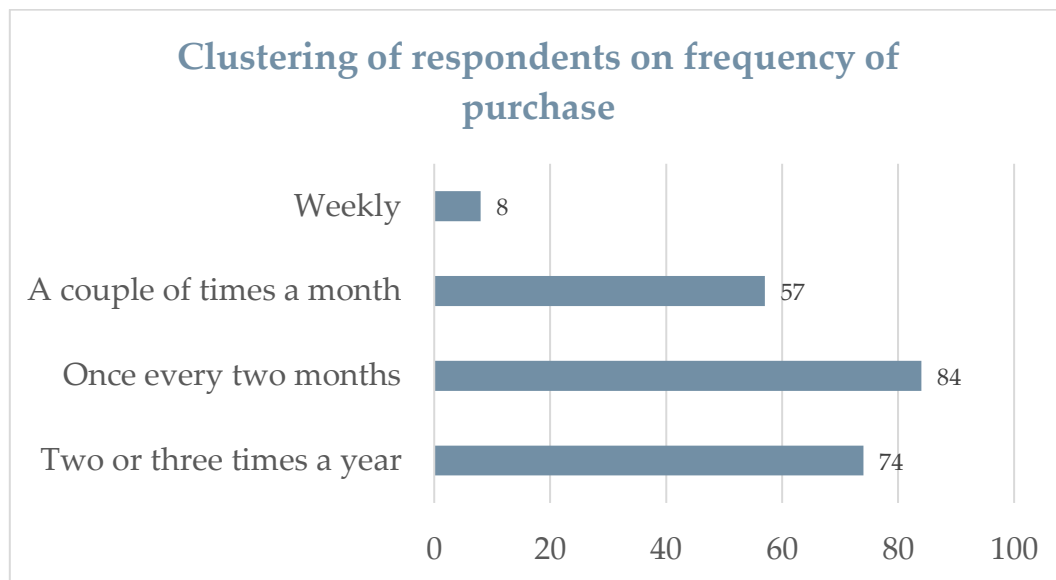


Figure 39 – Clustering of respondents on their frequency of purchase of cosmetic products

The 33% of respondents buys cosmetic products two or three times a year, the 38% of respondents buys cosmetic products once every two months, the 26% of respondents

buys cosmetic products a couple of times a month, the 4% of respondents buys cosmetic products weekly.

### 6.1.3. Knowledge and Importance of Sustainable Packaging

The respondents have been classified according to their knowledge in sustainable packaging in the cosmetic sector and the importance they give to it. The graphs below show the results.

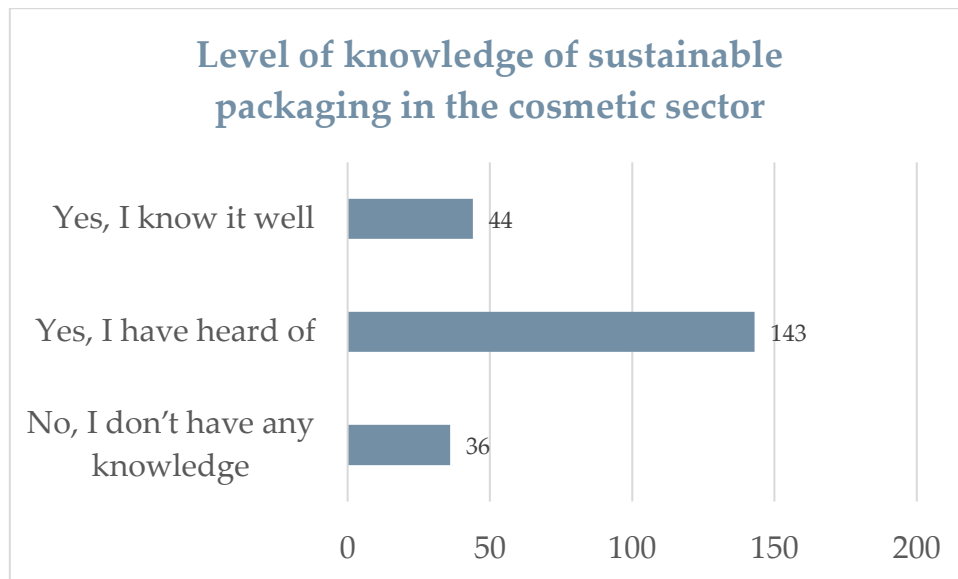


Figure 40 – Level of knowledge of respondents of sustainable packaging in the cosmetic sector

The 16% of respondents claims to have no knowledge of the concept of sustainable packaging in the cosmetic sector; the 64% of respondents claims to have some familiarity with the concept of sustainable packaging in the cosmetic sector; the 20% of respondents claims to know well the concept of sustainable packaging in the cosmetic sector.

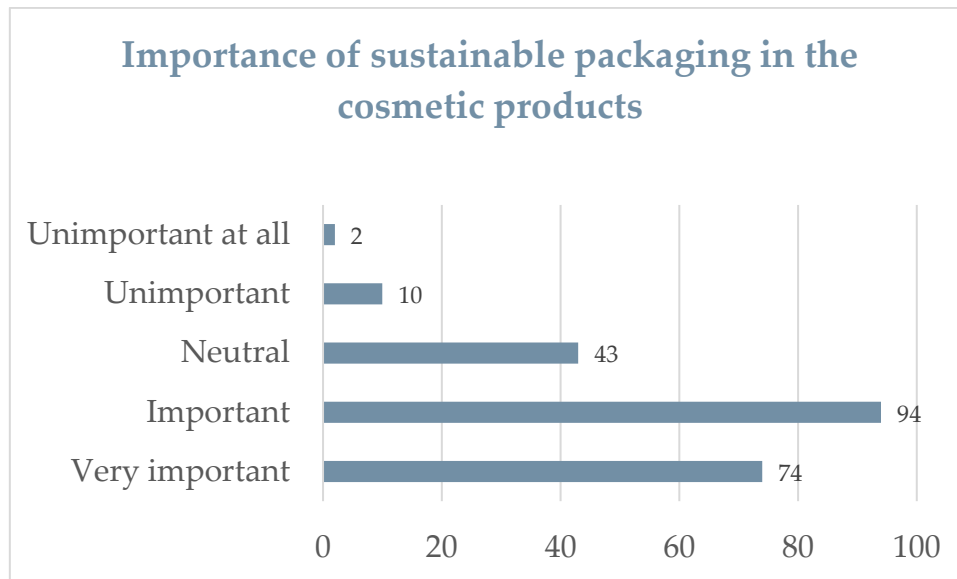


Figure 41 – Importance for respondents of sustainable packaging in the cosmetic products

The 33% of respondents consider sustainable packaging in the cosmetic products very important, the 42% of respondents consider sustainable packaging in the cosmetic products important, the 19% of respondents is neutral to sustainable packaging in the cosmetic products important, the 4% of respondents consider sustainable packaging in the cosmetic products unimportant, the 1% of respondents consider sustainable packaging in the cosmetic products unimportant at all.

#### 6.1.4. Evaluation of the environmentally sustainable packaging innovations

Respondent's feedback to the six environmentally sustainable packaging innovation proposals have been investigated. The six proposals are: the "Dissolvable Shower Sachet", the "Paper Hand Soap Dispenser", the "Biodegradable Clamshell for Perfume", the "Biodegradable Jar for Skincare Cream", the "Jar with safety click-clack system for Skincare Cream" and the "Biodegradable seaweed capsules for Face serum".

Proposals have been compared in each of these areas:

- Respondent inclination to adopt the new solution over the traditional one;
- Respondent price expectation for the new proposal, with respect to the traditional solution;
- Respondent concerns about the use of the new proposal;
- Respondent overall impression on the new proposal.

Then, it's been evaluated respondents' inclination towards sustainable packaging solutions across various demographic segments, considering age groups, spending profiles, and purchase frequency profiles.

Finally, the six proposed innovative environmentally sustainable packaging solutions have been compared according to:

- The preferences expressed by the respondents (measured analyzing the willingness-to-pay expressed by the respondent for each solution);
- The potential market success of each solution (measured combining the analysis of the willingness-to-pay expressed by the respondent for each solution with the purchase frequency profile of the respondent)

#### 6.1.4.1. Comparative Analysis of Proposed Sustainable Packaging Solutions: User Reception and Perception

Proposals have been compared in each of these areas:

- Respondent inclination to adopt the new solution over the traditional one;
- Respondent price expectation for the new proposal, with respect to the traditional solution;
- Respondent concerns about the use of the new proposal;
- Respondent overall impression on the new proposal.

The graphs below show the results.

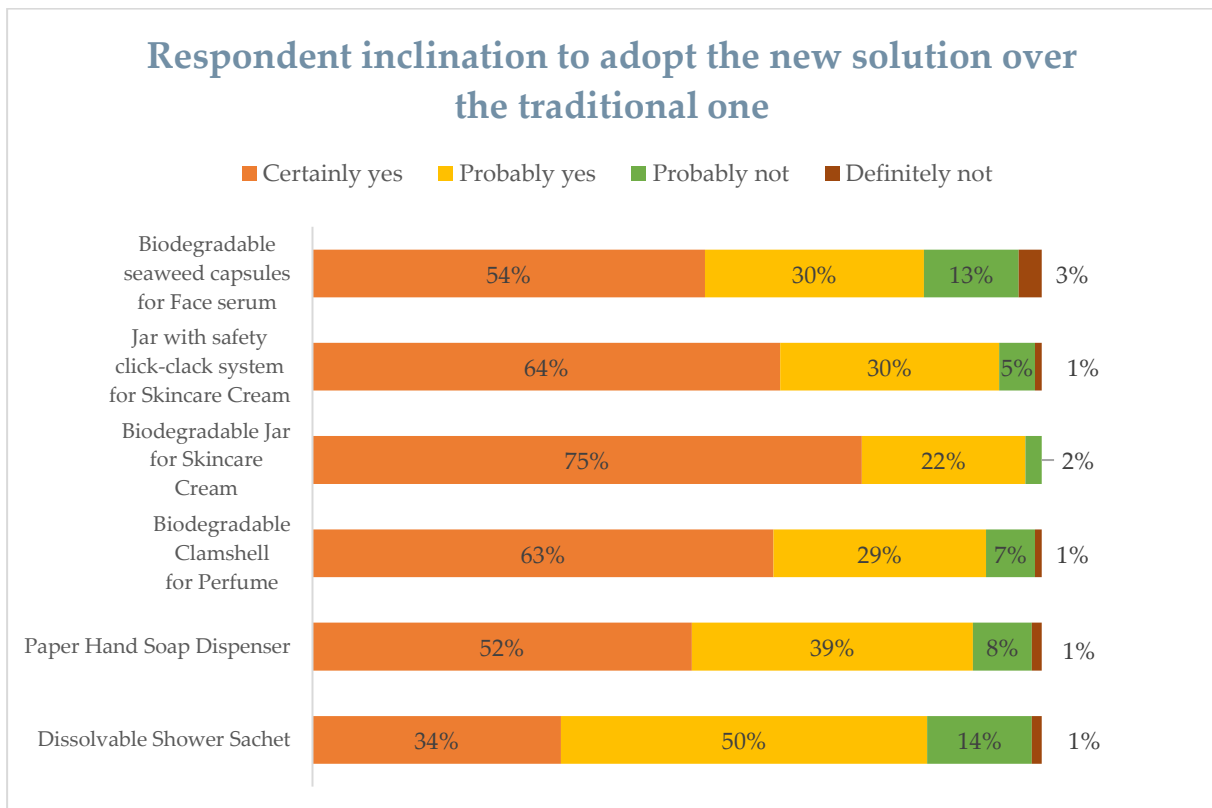


Figure 42 – Respondent inclination to adopt the new solution over the traditional one

The innovations that have garnered the highest level of respondent enthusiasm for adopting the new solution are: Biodegradable Clamshell for Perfume, Biodegradable Jar for Skincare Cream, and Jar with a safety click-clack system for Skincare Cream.

For the Biodegradable Clamshell for Perfume, 63% of respondents would definitely adopt the new solution instead of the original one. For the Biodegradable Jar for Skincare Cream, 75% of respondents would definitely adopt the new solution instead of the original one. For the Jar with safety click-clack system for Skincare Cream, 64% of respondents would definitely adopt the new solution instead of the original one.

These solutions are then followed by the Paper Hand Soap Dispenser and Biodegradable seaweed capsules for Face serum, for which not less than 50% of respondents would definitely adopt the new solution. For the Paper Hand Soap Dispenser, 52% of respondents would definitely adopt the new solution instead of the original one. For Biodegradable seaweed capsules for Face serum, 54% of respondents would definitely adopt the new solution instead of the original one.

Finally, the solution that respondents are least inclined to adopt is the Dissolvable Shower Sachet. For this solution, only 34% of respondents would definitely adopt the new solution instead of the original one.

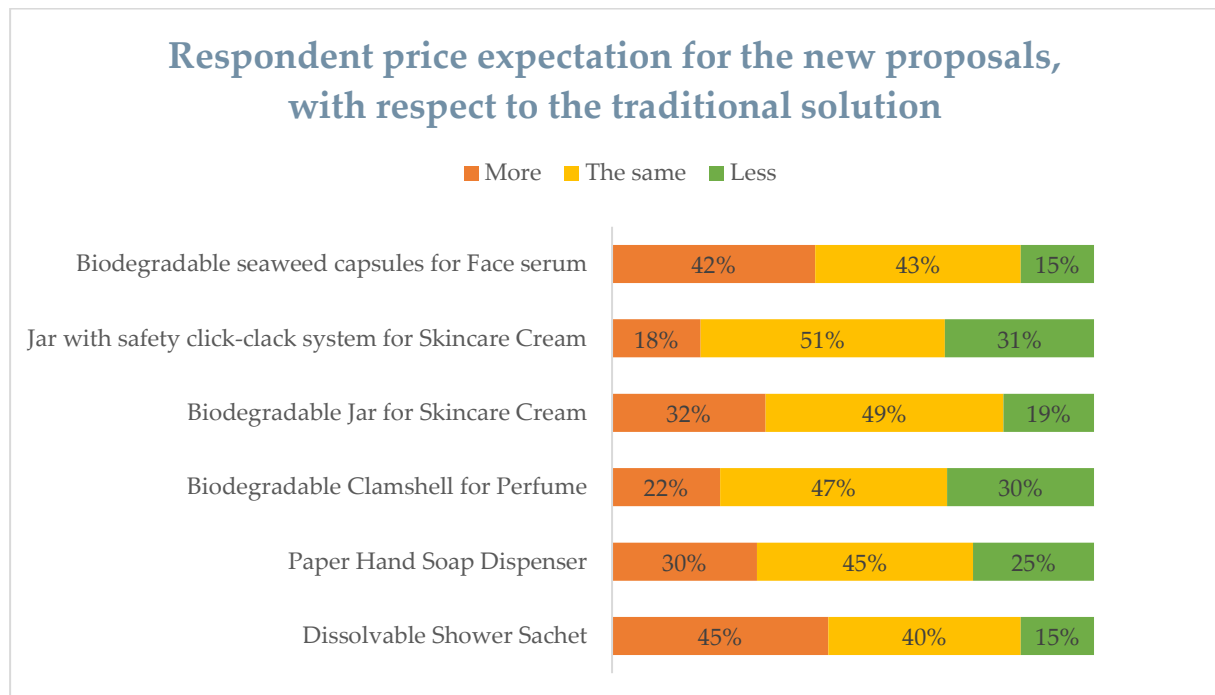


Figure 43 – Respondent price expectation for the new proposals, with respect to the traditional solution

For the Dissolvable Shower Sachet, the 45% of respondents expect to pay more for the new solution, with respect to the traditional one; the 40% of respondents expect to pay the same price for the new solution as the traditional one; the 15% of respondents expect to pay less for the new solution, with respect to the traditional one.

For the Paper Hand Soap Dispenser, the 30% of respondents expect to pay more for the new solution, with respect to the traditional one; the 45% of respondents expect to pay the same price for the new solution as the traditional one; the 25% of respondents expect to pay less for the new solution, with respect to the traditional one.

For the Biodegradable Clamshell for Perfume, the 22% of respondents expect to pay more for the new solution, with respect to the traditional one; the 47% of respondents expect to pay the same price for the new solution as the traditional one; the 30% of respondents expect to pay less for the new solution, with respect to the traditional one.

For the Biodegradable Jar for Skincare Cream, the 32% of respondents expect to pay more for the new solution, with respect to the traditional one; the 49% of respondents expect to pay the same price for the new solution as the traditional one; the 19% of respondents expect to pay less for the new solution, with respect to the traditional one.

For the Jar with safety click-clack system for Skincare Cream, the 18% of respondents expect to pay more for the new solution, with respect to the traditional one; the 51% of respondents expect to pay the same price for the new solution as the traditional one; the 31% of respondents expect to pay less for the new solution, with respect to the traditional one.

For the Biodegradable seaweed capsules for Face serum, the 42% of respondents expect to pay more for the new solution, with respect to the traditional one; the 43% of respondents expect to pay the same price for the new solution as the traditional one; the 15% of respondents expect to pay less for the new solution, with respect to the traditional one.

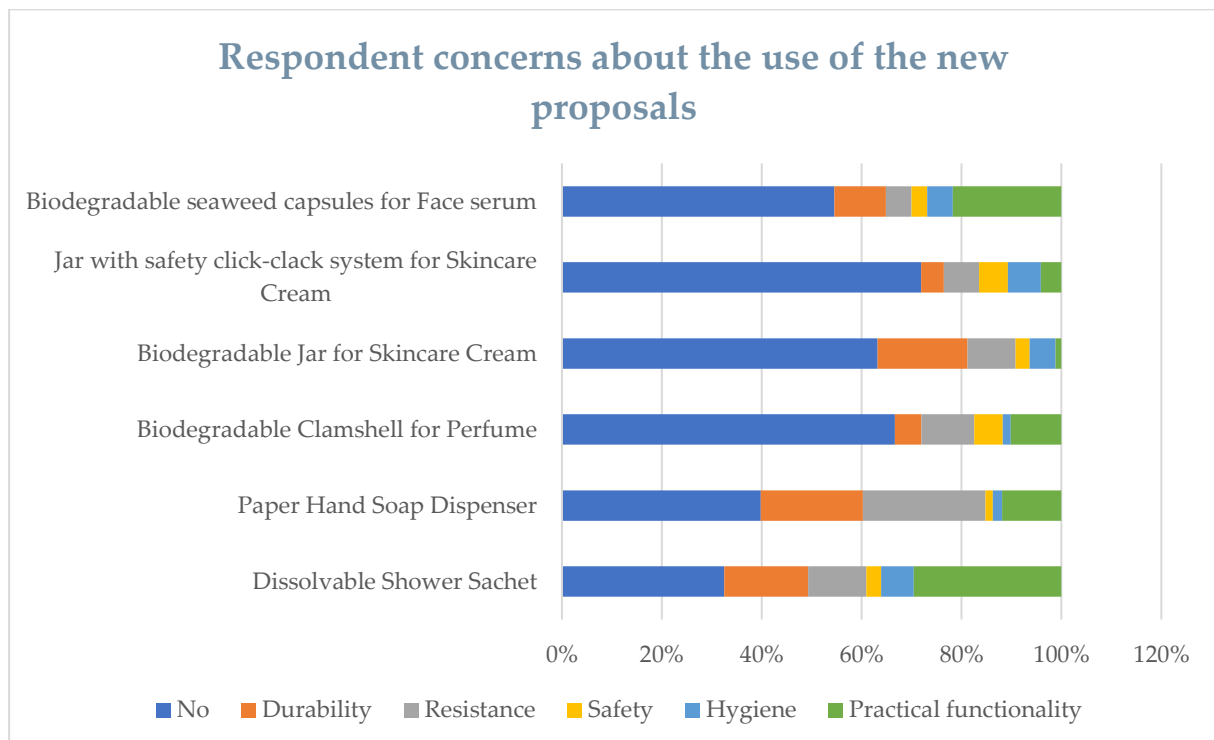


Figure 44 – Respondent concerns about the use of the new proposals

For each proposal submitted, the percentages of the individual variables (No, Durability, Resistance, Safety, Hygiene, Practical functionality) do not represent the percentage of respondents who provided that specific response. Rather, they indicate



how many times that variable appeared in the responses, compared to the total number of times that all variables appeared, for each type of product.

The solutions respondents are most concerned about are: the Dissolvable Shower Sachet and the Paper Hand Soap Dispenser. For the Dissolvable Shower Sachet, the most worrying aspect for respondents, with respect to the others, is the Practical functionality (30%), followed by Durability (17%). For the Paper Hand Soap Dispenser, the most worrying aspect for respondents, with respect to the others, is the Resistance (25%), followed by Durability (20%).

Then, there are products of whom respondents are less worried by and have a higher percentage of “No” than the other answers, but that still show not negligible percentages of concerns. These products are: the Biodegradable Jar for Skincare Cream and the Biodegradable Seaweed capsules for Face serum. For the Biodegradable Jar for Skincare Cream, the most worrying aspect for respondents, with respect to the others, is the Durability (18%). For the Biodegradable Seaweed capsules for Face serum, the most worrying aspect for respondents, with respect to the others, is the Practical functionality (22%).

Finally, the products of whom respondents are less worried and with a higher percentage of "No" with respect to the other answers are the Biodegradable Clamshell for Perfume (67%) and the Jar with safety click-clack system for Skincare Cream (72%).

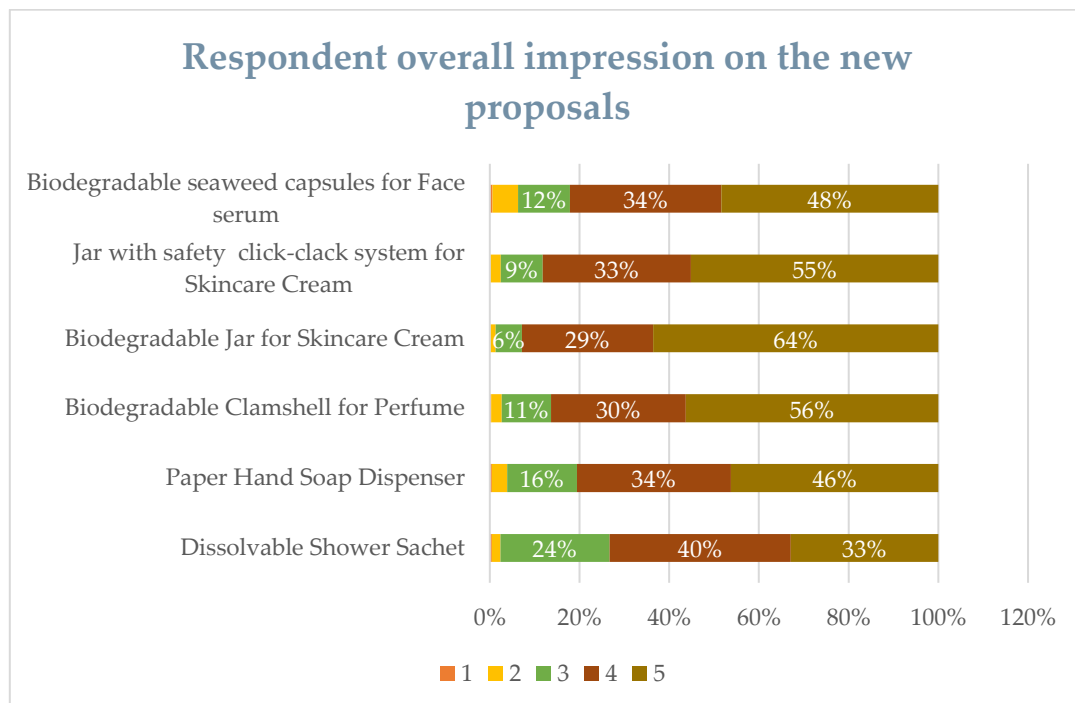


Figure 45 – Respondent overall impression on the new proposals

In general, respondents tend to have a generally positive opinion of the new packaging solutions. For each solution, at least 70% of respondents rated it 4 or higher. In fact,

only a very small percentage of respondents (less than 6%) gave a rating of 2 or lower for any proposed solution.

The solutions for which respondents seem to have a better opinion compared to others are the Biodegradable Clamshell for Perfume, the Biodegradable Jar for Skincare Cream, and the Jar with safety click-clack system for Skincare Cream. For the Biodegradable Clamshell for Perfume, 86% of respondents gave a rating of 4 or higher. For the Biodegradable Jar for Skincare Cream, 93% of respondents gave a rating of 4 or higher. For the Jar with safety click-clack system for Skincare Cream, 88% of respondents gave a rating of 4 or higher.

Following these, less popular but still with a percentage of ratings 4 or higher not less than 80%, are the Biodegradable seaweed capsules for Face serum and the Paper Hand Soap Dispenser.

Finally, the solution that seems to have garnered less success among respondents is the Dissolvable Shower Sachet, with a percentage of ratings 4 or higher lower than the other solutions and equal to 73%.

#### 6.1.4.2. Respondents Inclination Towards Sustainable Packaging

The analysis aimed to evaluate respondents' inclination towards sustainable packaging solutions across various segments, considering age groups, spending profiles, and purchase frequency profiles, based on their declared willingness to pay for such solutions. Response options related to the the question asking to respondents their willingness to pay for more sustainable packaging solutions included: 'Only if it costs less than the traditional'; 'Even if it costs more than the traditional, but at most 10% more'; 'Even if it costs the same as the traditional' and 'In any case, regardless of price'. The objective was to assess different segments' propensity towards sustainable packaging solutions, which has been measured, for each respondent, calculating a score that considered the responses regarding the willingness-to-pay for the new solution, with respect to the traditional one, weighing the score of each respondent across the total of the six proposed sustainable packaging solutions.

For each participant, the score was calculated among the responses given, assigning specific weights to the different types of responses, based on their willingness to pay. The weighs have been assigned as it follows:

- 'In any case, regardless of price' = 1
- 'Although it costs more than the traditional, but at most 10% more' = 0,5
- 'Even if it costs the same as the traditional' = 0,25
- 'Only if it costs less than the traditional' = 0

The highest level of willingness to pay is indicated by "In any case, regardless of price," to this answer has been assigned the highest weight equal to "1". The other response typology which indicated that respondents are willing to accept a slightly higher cost

with respect to the traditional solution ("Although it costs more than the traditional, but at most 10% more"), has been given a weight of "0,5". The lowest weights have been assigned to "Even if it costs the same as the traditional" and "Only if it costs less than the traditional".

Following this, these weighted evaluations were summed within each demographic segment, including age groups, spending profiles, and purchase frequency profiles, to obtain an overall assessment of the propensity towards sustainable packaging solutions across these varied segments. Finally, to calculate the medium assessment for respondent of the class, the overall assessment of the class has been divided by the number of people belonging to that class.

The final scores will vary within a range from 0 to 1, where:

- 0 is the minimum value and indicates that the average respondent within a specific age group/spending profile/purchase frequency profile has indicated, for each proposed eco-friendly packaging solution, that he/she is unwilling to pay either an equal or higher price compared to traditional solutions. Therefore, overall, he/she can be considered entirely disinclined to adopt sustainable solutions.
- 1 is the maximum value and indicates that the average respondent within a specific age group/spending profile/purchase frequency profile has indicated, for each proposed eco-friendly packaging solution, that he/she would be willing to pay any price. Consequently, overall, he/she can be considered totally inclined to adopt sustainable solutions.

This comprehensive approach allowed for the identification and evaluation of respondents' inclination towards sustainable packaging across different segments: age group, spending profile, purchase frequency profile.

The results are shown in the following graphs.

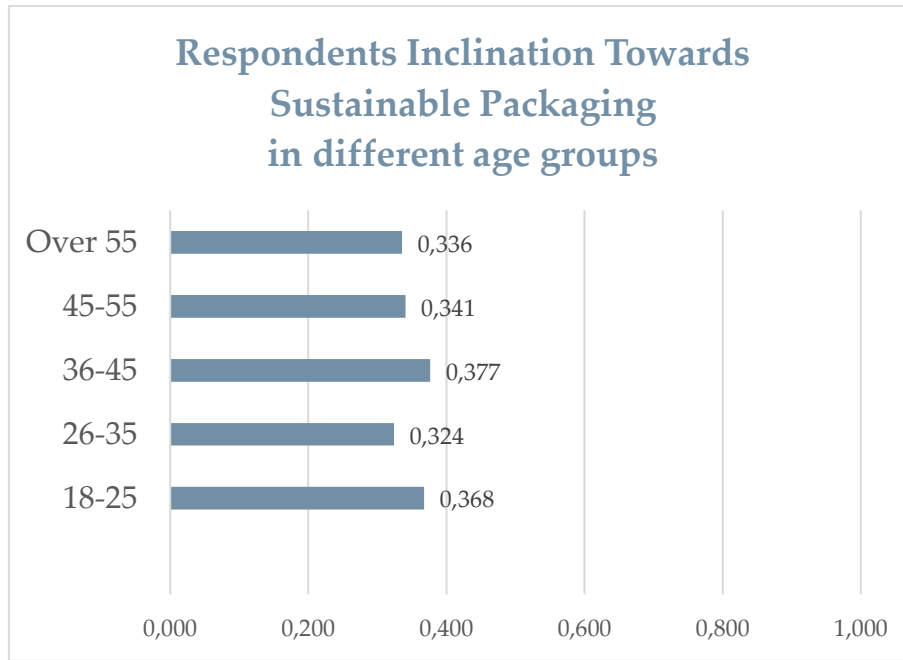


Figure 46 – Respondents Inclination Towards Sustainable Packaging in different age groups

Since the "18 and less" age group consists of only 3 respondents and therefore the sample cannot be considered representative, this age group was excluded from the analysis.

The scores among the different age groups are quite homogeneous. The age group "36-45" demonstrates the highest inclination with a score of 0.377, indicating a substantial willingness among participants within this demographic to invest in sustainable packaging solutions. Following closely, the age group "18-25" recorded a score of 0.368, suggesting a notable willingness among younger participants to pay more for sustainable packaging solutions. Participants aged "45-55" and "Over 55" displayed moderately similar levels of interest, with scores of 0.341 and 0.336 respectively. Although they express a significant willingness to pay for sustainable packaging, it appears slightly lower compared to the aforementioned age groups. The age group 26-35 demonstrated a comparatively lower inclination, recording a score of 0.324. This group seems to have a relatively lesser willingness to incur additional costs for sustainable packaging solutions, compared to other age brackets.

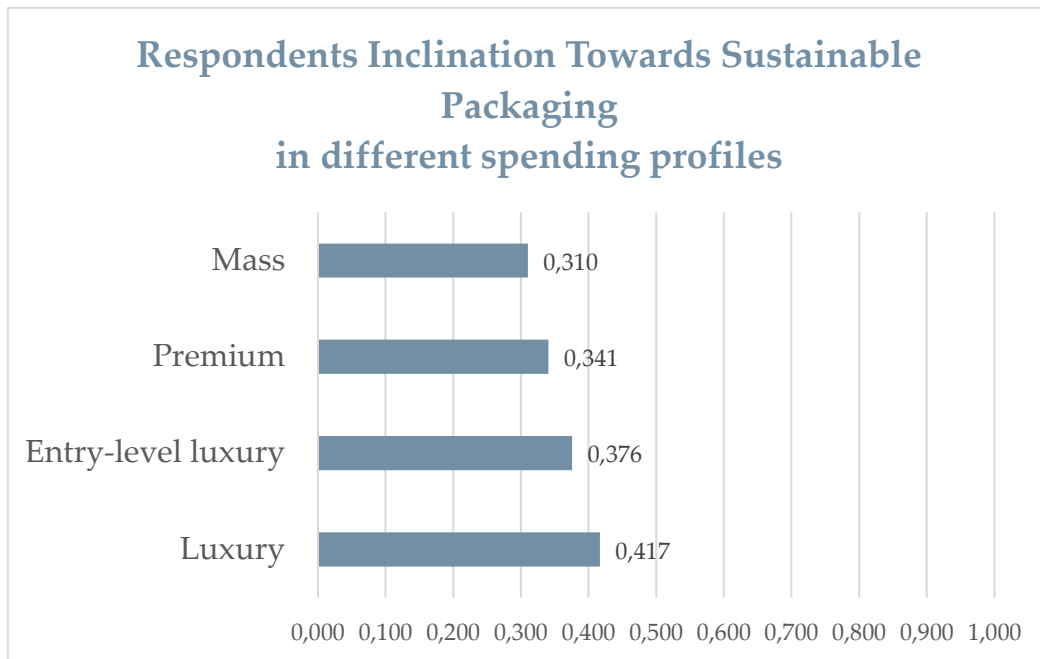


Figure 47 – Respondents Inclination Towards Sustainable Packaging in different spending profiles

The “Luxury” spending profile stands out with the highest score of 0.417, indicating a substantial willingness among participants within this category to invest in sustainable packaging solutions.

Following, the “Entry-level luxury” and “Premium” spending profiles both achieved scores of 0.376 and 0.341, respectively. Both groups demonstrate a considerable propensity to pay for sustainable packaging solutions, although slightly lower than the Premium group.

The “Mass” spending profile obtained a score of 0.310, indicating the lowest inclination towards sustainable packaging solutions compared to the other spending profiles analyzed.

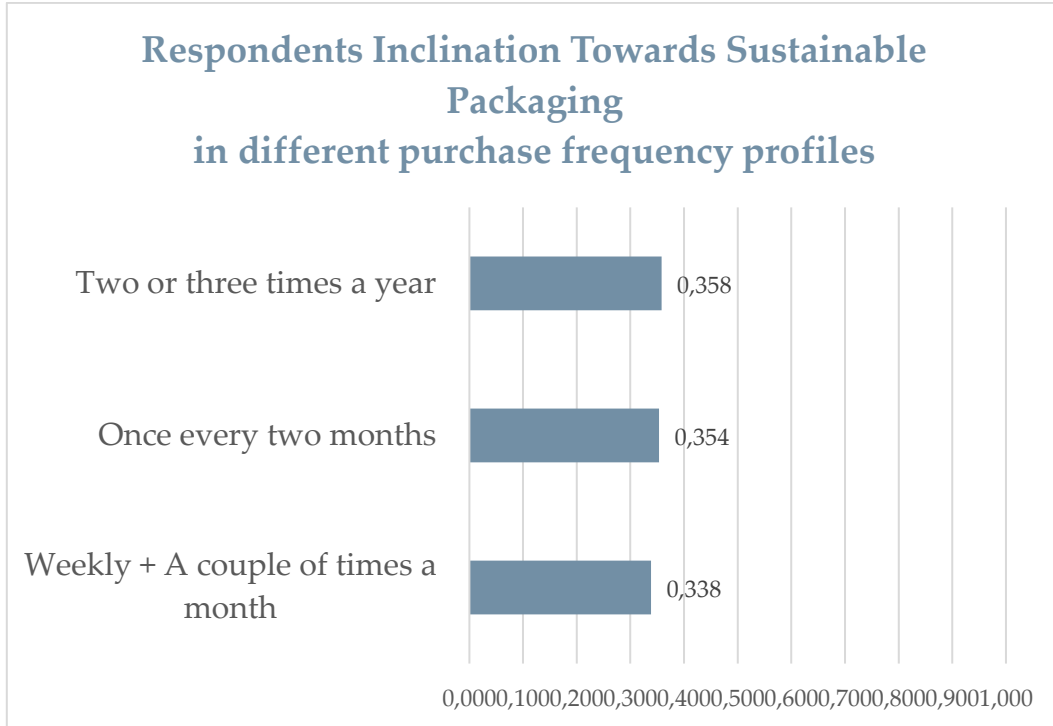


Figure 48 – Respondents Inclination Towards Sustainable Packaging in different purchase frequency profiles

Since the "Weekly" purchase frequency cluster consists of only 8 respondents and the purchasing habits of that cluster are similar to those of the "A couple of times a month" purchase frequency cluster, the two clusters can be merged for the further considerations.

The scores among the different purchase frequency profiles are quite homogeneous. The group labeled as "Two or three times a year" displays the highest score of 0.358, indicating a substantial willingness among participants in this category to invest in sustainable packaging solutions. Following closely, the "Once every two months" obtained scores of 0.354. Finally, "Weekly + A couple of times a month" obtained a score of 0.338, indicating the lowest inclination towards sustainable packaging solutions compared to the other spending profiles analyzed.

#### 6.1.4.3. Innovative Packaging Solutions in Comparison: Respondent Preferences and Market Potential

The six proposed innovative environmentally sustainable packaging solutions have been compared according to:

- The preferences expressed by the respondents (measured analyzing the willingness-to-pay expressed by the respondent for each solution);
- The potential market success of each solution (measured combining the analysis of the willingness-to-pay expressed by the respondent for each solution with the purchase frequency profile of the respondent)

### Innovative Packaging Solutions in Comparison: Respondents Preferences

The innovative environmentally sustainable packaging solutions have been compared according to respondents preferences, which have been assessed analyzing respondents willingness-to-pay for these solutions. The scores attributed to the responses are the same as those used in the previous analysis regarding "Respondents Inclination Towards Sustainable Packaging" ("In any case, regardless of price" = 1; "Although it costs more than the traditional, but at most 10% more" = 0,5; "Even if it costs the same as the traditional" = 0,25; "Only if it costs less than the traditional" = 0).

The choice of these specific scores is coherent with the aim of emphasizing the responses where the respondent declared to be willing to spend more on the new solution, with respect to the traditional one, in order to establish the solutions preferred by the respondents.

Then, for each solution, scores have been summed.

The final scores of each solution will vary within a range from 0 to 223, where:

- 0 is the minimum value and indicates that, for that specific eco-friendly packaging solution, every respondent has indicated to be unwilling to pay either an equal or higher price compared to the respective traditional solution.
- 223 is the maximum value and indicates that, for that specific eco-friendly packaging solution, every respondent has indicated to be willing to pay any price, compared to the respective traditional solution.

This comprehensive approach allowed for the identification and evaluation of the preferences of the respondents on the six environmentally sustainable cosmetic packaging innovations.

The graph below shows the comparison of the six solutions and the results.

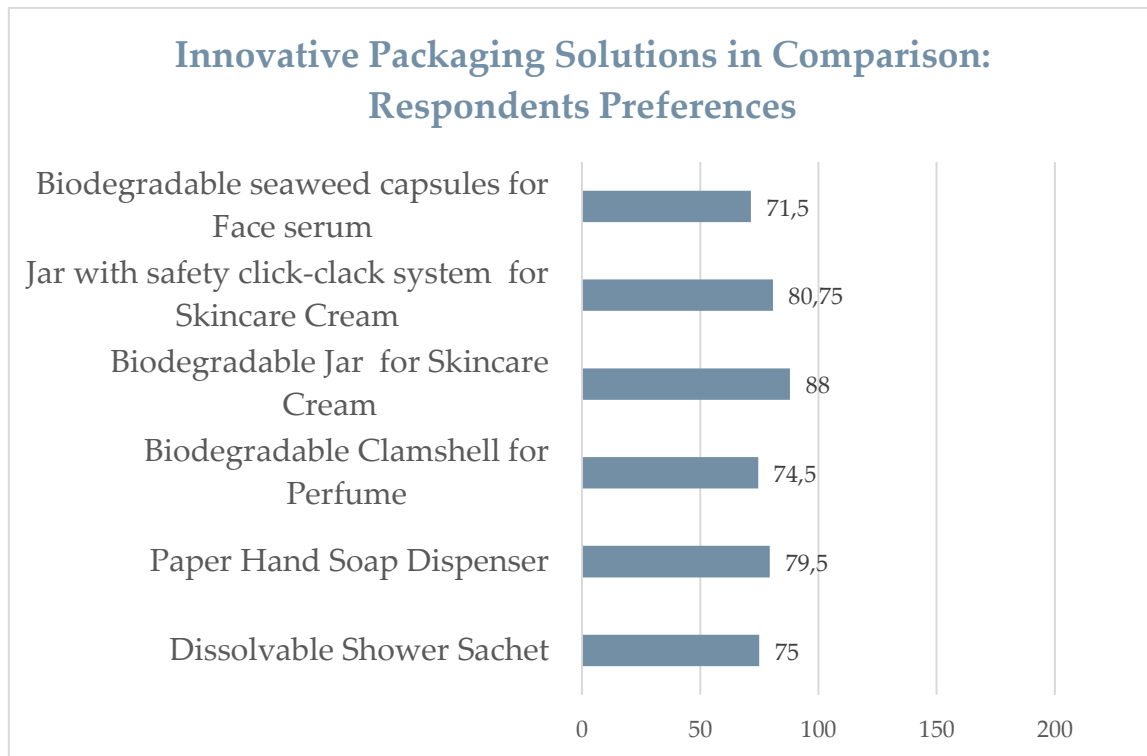


Figure 49 – Innovative Packaging Solutions in Comparison: Respondents Preferences

The "Biodegradable Jar for Skincare Cream" obtained the highest score, equal to 88.

The "Jar with safety click-clack system for Skincare Cream" and the "Paper Hand Soap Dispenser" achieved a score of 80.75 and 79.5 respectively, indicating a similar level of interest among participants in these two solutions. Finally, the solutions with the lowest score are the "Dissolvable Shower Sachet", the "Biodegradable Clamshell for Perfume" and the "Biodegradable seaweed capsules for Face serum", with scores of 75, 74.5 and 71.5 respectively.

#### Innovative Packaging Solutions in Comparison: Potential Market Success

The innovative environmentally sustainable packaging solutions have been compared to identify the most promising for the market, according to respondents preferences and purchase frequency profiles.

The potential market success of the six innovative environmentally sustainable packaging solutions for cosmetic products have been assessed analyzing respondents willingness-to-pay for these solutions combined with respondents purchase frequency profile.

The scores attributed to the responses relative to the willingness-to-pay are the same as those used in the previous analysis ("In any case, regardless of price" = 1; "Although it costs more than the traditional, but at most 10% more" = 0,5; "Even if it costs the same as the traditional" = 0,25; "Only if it costs less than the traditional" = 0).



Furthermore, the respondent's "purchase frequency profile" was also considered as a relevant indicator for the comparison of the six solutions and was therefore included in the analysis. In fact, the willingness to pay declared by the respondent allows to understand the preferences of the respondent, and combined with the respondent's purchase frequency profile, allows to understand the potential success in sales of the specific solution.

Response options related to the question asking to respondents their purchase frequency of cosmetic products included "Weekly + A couple of times a month", "Once every two months" and "Two or three times a year".

To attribute scores to the responses, the following scoring system was utilized:

- "Weekly/A couple of times a month" = 4
- "Once every two months" = 2
- "Two or three times a year" = 1

The highest purchase frequency is indicated by "Weekly/A couple of times a month", to this answer has been assigned the highest score equal to "4". This high purchase frequency indicates that consumers are highly engaged in purchasing cosmetics. If they are willing to pay more for a specific sustainable packaging solution and buy regularly, it suggests a strong potential for market success for that solution. The high purchase frequency increases the likelihood that sales for a solution will be sustained over time. Another purchase frequency is indicated by "Once every two months" and to this answer has been assigned a score equal to 2. Although less frequent than the first group, this category still indicates some interest in cosmetics. Willingness to pay more for sustainable solutions might be a positive sign, but the lower frequency could limit the impact on overall sales compared to more frequent consumers. The last purchase frequency is indicated by "Two or three times a year" and to this answer has been assigned a score equal to 1. These consumers purchase cosmetics very rarely, which could negatively affect the commercial success of sustainable packaging solutions. Although some might be willing to pay more, the extremely low frequency might limit the effectiveness in generating substantial sales for sustainable packaging solutions.

In summary, these scores aim to highlight the solutions for which not only consumers are willing to pay more but also those that could have a greater impact on the market. Higher purchase frequency, combined with a willingness to pay more, indicates a higher likelihood of market success for sustainable packaging solutions.

To evaluate the potential success in sales of the specific solution, the score corresponding to the frequency of purchase of each respondent has been multiplied with the score relative to its willingness to pay for each proposed solution. Subsequently, for each solution a final score was calculated by summing the score calculated previously (with the multiplication) for each respondent.

The final scores of each solution will vary within a range from 0 to 892, where:

- 0 is the minimum value and indicates that, for that specific eco-friendly packaging solution, every respondent has indicated to be unwilling to pay either an equal or higher price compared to the respective traditional solution.
- 892 is the maximum value and indicates that, for that specific eco-friendly packaging solution, every respondent has indicated to be willing to pay any price, compared to the respective traditional solution and every respondent purchases cosmetic products "Weekly/A couple of times a month".

The graph below shows the comparison of the six solutions and the results.

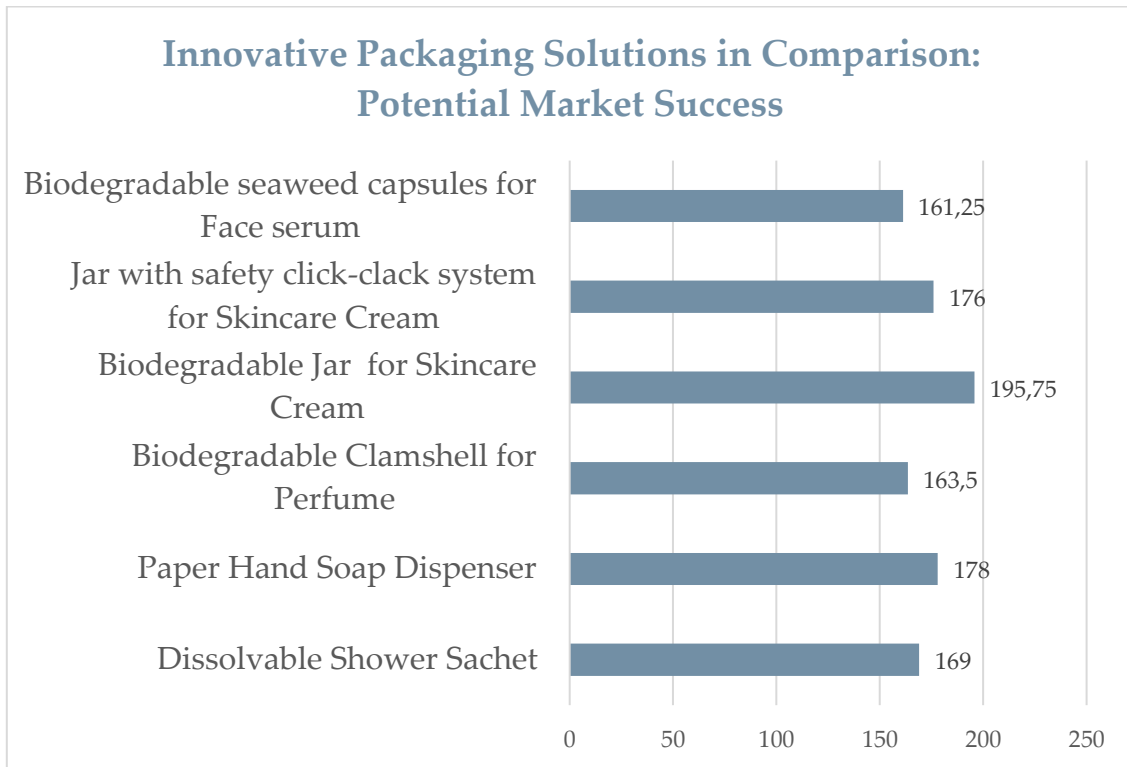


Figure 50 – Innovative Packaging Solutions in Comparison: Potential Market Success

The “Biodegradable Jar for Skincare Cream” scored the highest with a score equal to 195.75, indicating the highest potential of success on the market with respect to the other packaging solutions. To follow there are the “Paper Hand Soap Dispenser” and the the “Jar with safety click-clack system for Skincare Cream” both scored at 178 and 176 respectively. Finally, the solutions scored the lowest are the “Dissolvable Shower Sachet”, the “Biodegradable Clamshell for Perfume” and the “Biodegradable seaweed capsules for Face serum” that scored at 169, 163.5 and 161.25 respectively, showing the lowest potential of success on the market with respect to the other packaging solutions.

## 7 Discussion

The chapter presents a comprehensive overview of the survey findings concerning respondents' attitudes toward environmentally sustainable packaging solutions in the cosmetic sector, with the objective of answering to the research question, according to the objectives of the thesis. Reasonable awareness and considerable importance towards cosmetic packaging sustainability were evident among the respondents. While a significant proportion of participants expect prices for innovative packaging solutions to be equal to or higher than traditional ones, some expect lower costs instead. Concerns and preferences vary among the different solutions, with the "Biodegradable Jar for Skincare Cream" emerging as the most favoured option with greater potential for success in the market, closely followed by the "Paper Hand Soap Dispenser" and the "Jar with safety click-clack system for Skincare Cream". Variations tied to age, spending profiles, and purchase frequency showcase nuanced inclinations toward sustainable packaging. Overall, the analysis provides crucial insights aligned with the thesis objectives, shedding light on preferences, concerns, and the potential market success of various eco-friendly cosmetic packaging solutions.

### 7.1. Discussion of the results

To present the key findings of the research, an enumerated list is utilized, encapsulating the primary discoveries derived from an in-depth analysis of the survey data.

The main findings obtained from the results of the survey are:

1. The majority of the respondents displayed at least some familiarity with the concept of environmentally sustainable packaging in the cosmetic sector, showcasing a reasonable awareness of sustainable packaging. Furthermore, there is an important percentage of people who consider packaging sustainability as an important variable when buying cosmetic products.
2. Overall, for all the proposed solutions, a significant percentage of participants (between 40% and 50%) expect to pay a price equal to that of traditional solutions. However, in some cases, a considerable percentage of respondents (ranging from 30% to 45%) expect paying more for the new solution compared to the traditional one. This trend is observed in the "Dissolvable Shower Sachet" (45%), the "Biodegradable seaweed capsules for Face serum" (42%), the

“Biodegradable Jar for Skincare Cream” (32%), and the “Paper Hand Soap Dispenser” (39%). Conversely, a minority of respondents (around 30%) expect to pay less for the new solutions compared to the traditional ones. This attitude is more evident in products like the “Jar with safety click-clack system for Skincare Cream” (31%) and the “Biodegradable Clamshell for Perfume” (30%), where a significant percentage of participants expect to pay less.

3. Regarding the concerns of the respondents related to the innovative packaging solutions proposed, two solutions, in particular, garnered considerable concern among respondents: the “Dissolvable Shower Sachet” and the “Paper Hand Soap Dispenser”. For the “Dissolvable Shower Sachet”, respondents expressed the highest level of concern regarding Practical functionality (30%), followed by Durability (17%). In the case of the “Paper Hand Soap Dispenser”, respondents showed significant worry about Resistance (25%), followed by Durability (20%). On the other hand, there are products that elicited less worry from respondents. These products include the “Biodegradable Jar for Skincare Cream” and the “Biodegradable Seaweed capsules for Face serum”. For the “Biodegradable Jar for Skincare Cream”, Durability emerged as the most concerning aspect (18%). As for the “Biodegradable Seaweed capsules for Face serum”, respondents exhibited higher concerns about Practical functionality (22%) compared to other factors. Lastly, the products that seem to evoke the lowest levels of concerns among respondents are the “Biodegradable Clamshell for Perfume” (67% of “No concerns”) and the “Jar with safety click-clack system for Skincare Cream” (72% of “No concerns”).
4. In general, the respondents have shown a predominantly positive inclination towards the various proposed packaging solutions. Across all solutions, a noteworthy trend emerges: a significant majority, at least 70% of the respondents, rated each solution with a score of 4 or higher. Among these solutions, certain options have received more favorable opinions from respondents compared to the others. The “Biodegradable Clamshell for Perfume”, the “Biodegradable Jar for Skincare Cream” and the “Jar with safety click-clack system for Skincare Cream” stand out as the solutions with the highest ratings. Impressively, 93% of respondents rated the “Biodegradable Jar for Skincare Cream” with a score of 4 or higher. Similarly, the “Jar with safety click-clack system for Skincare Cream” received a high positive rating from 88% of respondents, while the “Biodegradable Clamshell for Perfume” earned an 86% of respondents rating it with a high positive rating. Succeeding these highly favored solutions are the “Biodegradable seaweed capsules for Face serum” and the “Paper Hand Soap Dispenser”, both receiving positive ratings of 4 or higher from a significant portion of respondents, not below the 80%.

Conversely, the “Dissolvable Shower Sachet” appears to have garnered relatively less success among respondents, obtaining a positive rating (4 or higher) from a lower number of respondents, with respect to the other solutions, but still respectable and equal to 73%.

5. In general, the different age groups analyzed showed a more or less homogeneous interest in investing in eco-sustainable packaging solutions. However, the 36-45 age group exhibited the highest inclination with a score equal to 0.377, followed closely by the 18-25 group, scored at 0.368. Participants aged 45-55 and Over 55 showed moderately similar interest, with scores equal to 0.341 and 0.336 respectively, while the 26-35 group displayed a comparatively lower inclination with a score equal to 0.324.
6. Distinct inclinations toward sustainable packaging were observed across spending profiles: “Luxury” displayed the highest inclination with a score equal to 0.417, followed by “Entry-level luxury” and “Premium” scored at 0.376 and 0.341, respectively. Conversely, “Mass” showed a slightly lower inclination with a score equal to 0.310.
7. In general, the different purchase frequency profiles analyzed showed a more or less homogeneous interest in investing in eco-sustainable packaging solutions. “Two or three times a year” scored highest at 0.358, followed closely by “Once every two months” at 0.354. “Weekly + A couple of times a month” displayed the lowest inclination at 0.338. These results highlight the fact that frequent buyers seem slightly less interested in environmentally sustainable packaging solutions.
8. The comparative analysis of participants' preferences regarding the six innovative environmentally sustainable packaging solutions clearly reveals the hierarchy of the solutions. The “Biodegradable Jar for Skincare Cream” ranks first, obtaining the highest score of 88. This result suggests significant interest and a strong inclination among participants towards this specific solution. Following closely are the “Jar with safety click-clack system for Skincare Cream,” and the “Paper Hand Soap Dispenser”, with scores equal to 80.75 and 79.5 respectively. These two solutions exhibit a comparable level of interest among participants. The solutions that received the lowest scores are the “Dissolvable Shower Sachet”, the “Biodegradable Clamshell for Perfume” and the “Biodegradable seaweed capsules for Face serum”, with scores equal to 75, 74.5 and 71.5 respectively, indicating a relatively lower level of interest among participants compared to the other analyzed solutions. In summary, based on the preferences expressed by the participants, the “Biodegradable Jar for Skincare Cream” emerges as the most appealing and positively received

solution, followed by two other solutions with a similar level of interest, while the remaining three have shown relatively lower interest.

9. The comparative analysis aiming to evaluate potential market success for each solution clearly reveals the hierarchy of the solutions. The "Biodegradable Jar for Skincare Cream" emerged as the most promising solution for the market, scoring the highest at 195.75. This indicates its potential for substantial success in the market compared to the other packaging solutions analyzed. Following closely behind are the "Paper Hand Soap Dispenser" and the "Jar with safety click-clack system for Skincare Cream", scored at 178 and 176 respectively, suggesting a similar level of potential market success. Finally, the solutions with the lowest score are the "Dissolvable Shower Sachet", the "Biodegradable Clamshell for Perfume" and the "Biodegradable seaweed capsules for Face serum", which obtained a score of 169, 163.5 and 161.25 respectively. This outcome suggests the least potential for market success among the analyzed packaging solutions.

Therefore, the findings allow to provide a comprehensive response to the research question **Q3: Among the six presented solutions of innovative environmentally sustainable packaging for cosmetics, which are the most promising for the market?**, where the potential market success has been measured combining the analysis of the willingness-to-pay expressed by the respondents for each packaging solution with the frequency of purchase of the respondents. Indeed, the analysis highlights the **"Biodegradable Jar for Skincare Cream"** as the most promising solution in terms of potential market success, followed closely by the **"Paper Hand Soap Dispenser"** and the **"Jar with safety click-clack system for Skincare Cream"**. These outcomes are further corroborated by a comparative analysis of participants' preferences for the six solutions presented. Notably, these solutions, besides being those with the highest potential for market success, also emerge as the favourites among respondents: the Biodegradable Jar for Skincare Cream stands out as the favourite among the others, followed closely by the "Jar with safety click-clack system for Skincare Cream" and the "Paper Hand Soap Dispenser".

The findings of this study are in line with the literature, in particular they are consistent with the industries' global shift towards environmentally sustainable packaging materials, caused by the escalating concerns about the environmental impact of conventional plastic packaging. As highlighted in previous research [12] [13], the escalating production and waste generation from petroleum-based plastic packaging have also catalyzed a critical awareness among consumers about environmental repercussions and waste management issues. This growing consciousness has accelerated the demand for alternatives, propelling the emergence of bioplastics derived from bio-based polymers as a promising solution.

The evaluation of innovative environmentally sustainable packaging solutions echoes the trends observed in the industry's inclination toward biodegradable and bio-based materials. The identified top-ranking solutions – the “Biodegradable Jar for Skincare Cream”, the “Paper Hand Soap Dispenser” and the “Jar with safety click-clack system for Skincare Cream” - align with the industry's pivot towards more sustainable options. The findings affirm that these innovative packaging solutions are not only promising in terms of market viability, as corroborated by their combined willingness-to-pay and purchase frequency scores, but also resonate with consumers' preferences. Such alignment is further validated through the survey findings. A significant proportion of respondents consider sustainable packaging as an important variable when buying cosmetic products. Moreover, it also emerged that in general, the respondents have shown a predominantly positive inclination towards the various sustainable packaging solutions, in fact, over 70% of the participants rated each solution favourably, consistently awarding them high scores (4 or higher, based on a scale with a maximum score of 5).

In summary, the research results validate the ongoing industry movement towards environmentally sustainable packaging materials, exemplifying the potential and preference for innovative solutions that address environmental concerns associated with conventional plastic packaging.

Moreover, this study makes a significant contribution to the existing literature by addressing the knowledge gap regarding actual and potential customer responses to sustainable innovations in cosmetic packaging. Existing literature primarily focuses on analyzing the technical and environmental properties of innovative substitute materials, leaving a void in understanding consumer preferences toward such innovations. By contrast, this study employed a survey involving respondents to evaluate six environmentally sustainable packaging solutions. This approach allowed for a clear and effective understanding of their preferences.

In essence, this methodological shift from a technical focus to a consumer-centric viewpoint serves as an invaluable contribution to the literature on sustainable packaging.

## 7.2. Recommendations for companies

Considering the findings, several recommendations can be provided to cosmetic companies regarding the introduction in the market of the environmentally sustainable packaging innovations that resulted in the previous analysis as the most promising in terms of market potential, namely the “Biodegradable Jar for Skincare Cream”, the “Paper Hand Soap Dispenser ” and the “Jar with safety click-clack system for Skincare Cream”.

For the three proposed solutions, respondents show different price expectations. Regarding both the "Biodegradable Jar for Skincare Cream" and the "Jar with safety click-clack system for Skincare Cream" the highest percentage of participants (around 50%) expect to pay a price equal to that of traditional solutions. While, although for the "Paper Hand Soap Dispenser" a high percentage of respondents expect to pay a price equal to that of traditional solutions (40%), a larger number of people (45%) expect to pay more for that solution. Therefore, to develop more effective pricing strategies for these innovative solutions, companies should take these outcomes into account to match customer expectations.

Regarding the analysis of consumer concerns for the innovative solutions, the innovation that garnered considerable concern among respondents is resulted to be the "Paper Hand Soap Dispenser", for which respondents showed significant worry about the resistance and the durability of the packaging solution. However, it results that despite eliciting the highest level of concern among respondents, this solution has also emerged as one of the favorites. The "Biodegradable Jar for Skincare Cream" elicited less worry from respondents, the only relevant concern expressed by respondents is relative to the durability of the packaging. Finally, the "Jar with safety click-clack system for Skincare Cream" emerges as the product that evokes the lowest level of concerns among respondents showing a greater number of people, compared to other solutions, stating they have no concerns regarding the solution. Hence, it is advisable for companies to pay attention to consumers' preemptive concerns (expressed before product usage) so that they can tailor their development and marketing strategies to mitigate these worries and fully exploit the market potential of those innovations.

Moreover, companies should customize their marketing strategies for innovative solutions by considering the preferences articulated across various generations, distinct spending profiles, and diverse purchase frequency patterns among respondents. Notably, even though the different age groups analyzed showed a more or less homogenous interest in investing in eco-sustainable packaging solutions, the 36-45 age group and the 18-25 age group exhibited a more pronounced interest in investing in sustainable packaging solutions compared to other age brackets. This highlights the importance of tailoring marketing and product strategies to align with the preferences of these specific age groups, capitalizing on their keen interest in environmentally friendly packaging. The Luxury spending profiles emerged as the segments demonstrating heightened interest in sustainable packaging solutions, with respect to the other spending profiles. Therefore, companies could benefit from focusing on precise product positioning strategies targeting these specific market segment, catering to their preference for eco-conscious products. Finally, even though



the different purchase frequency profiles analyzed showed a more or less homogenous interest in investing in eco-sustainable packaging solutions, the consumers who make purchases "Two or three times a year" and "Once every two months" displayed a slightly greater inclination toward sustainable packaging solutions, while consumers who make purchases "Weekly + A couple of times a month" displayed the lowest inclination toward sustainable packaging solutions. These results highlight the fact that frequent buyers seem slightly less interested in environmentally sustainable packaging solutions. In response, companies aiming to broaden their customer base could engage in raising awareness on the benefits of packaging sustainability among consumer categories that make more frequent purchases of cosmetic products.

In conclusion, the comprehensive analysis highlights multiple considerations essential for cosmetic companies venturing into environmentally sustainable packaging solutions. The identified innovations, particularly the "Biodegradable Jar for Skincare Cream", the "Paper Hand Soap Dispenser", and the "Jar with safety click-clack system for Skincare Cream", present a dynamic blend of consumer expectations, concerns, and preferences that need to be managed properly. The study underscores the pivotal role of understanding consumer behavior in devising effective marketing strategies, encompassing pricing, alleviating apprehensions, and capitalizing on diverse consumer profiles.

By acknowledging the expectations concerning pricing structures, companies can strategically align the price of innovative solutions with consumer expectations. Addressing prevalent concerns, particularly regarding resistance and durability, becomes paramount in product development and communication strategies. Simultaneously, the resonance of certain solutions with specific age groups, spending profiles, and purchase frequencies highlights the need for tailored marketing approaches.

Therefore, an adaptive and targeted marketing strategy, sensitive to diverse consumer segments' preferences, emerges as a key driver in maximizing market penetration and consumer satisfaction.

## 8 Conclusion and future developments

This thesis contributes to research in both the cosmetic industry and environmental sustainability domains. It explores consumer responses to six environmentally sustainable packaging solutions selected out of twenty-four real case studies identified, offering valuable insights for cosmetic companies seeking to market these innovative solutions effectively. Moreover, the study offers targeted recommendations tailored for cosmetic companies regarding their marketing strategies.

The research question aimed to identify, among the six solutions of innovative environmentally sustainable packaging presented to the respondents through the survey, which are the most promising for the market, where the potential market success has been measured combining the analysis of the willingness-to-pay for each solution with the frequency of purchase of the respondents. The analysis conducted highlights the "Biodegradable Jar for Skincare Cream" as the most promising solution in terms of market potential, followed closely by the "Paper Hand Soap Dispenser" and the "Jar with safety click-clack system for Skincare Cream". These outcomes are further corroborated by a comparative analysis of participants' preferences for the six solutions presented. Notably, these solutions, besides being those with the highest potential for market success, also emerge as the favourites among respondents: the Biodegradable Jar for Skincare Cream stands out as the favourite among the others, followed closely by the "Jar with safety click-clack system for Skincare Cream" and the "Paper Hand Soap Dispenser".

However, despite the acknowledged market success potential of these solutions, it's crucial to emphasize significant considerations. In the conducted analysis, it was observed that most respondents expect to pay either an equal or higher price for the new solutions compared to traditional ones. Beyond pricing, the analysis of consumers' preemptive concerns for innovative solutions revealed that the "Paper Hand Soap Dispenser" raised considerable worries among participants regarding the resistance and the durability of the packaging. Clearly, although this solution has emerged as one of the favorites, it has also elicited consumer considerable concerns. Hence, it's advisable for companies to consider these expectations and apprehensions expressed by consumers to fully harness the market potential of these innovations. Lastly, companies should tailor their marketing strategies for innovative solutions by

considering preferences across various generations, distinct spending profiles, and diverse purchase frequency patterns among participants.

Through the analysis of the findings, significant insights have been acquired, leading to the identification of future developments and the recognition of certain limitations.

Given that the survey predominantly garnered responses from Italian participants (with only 2.2% being non-Italian), the findings might not directly apply to consumers in other nations. Subsequent research endeavors could concentrate on conducting analogous studies in different countries to explore commonalities or discrepancies, aiming for a more holistic comprehension of the subject matter.

Another limitation of the study concerns the analysis of case studies aimed at identifying innovations in sustainable packaging evaluated by the participants. While this analysis provides a current snapshot of the situation, it's crucial to consider that the landscape of innovations is in constant evolution. Future research could focus on emerging new solutions, thereby providing an updated and in-depth picture of progress in the realm of sustainable packaging.

Finally, considering that the solutions presented to the respondents reflect their current state without any rendering done to make these solutions visually appealing, respondents might have been negatively influenced in their responses. Future research endeavors could also delve into rendering to elicit more accurate consumer responses.

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