

Entrepreneurial Challenges: Transforming Eggshell Waste into Sustainable Candles

Yap Xin Yi^{1*}, Arthur Liaw Ik Han², Pradiipa Khor Pooi Hiang³

¹ Independent Researcher, Malaysia, xinyialisonyap@gmail.com

² Faculty of Design and Built Environment, First City University College, Selangor, Malaysia. arthur.liaw@firstcity.edu.my

³ Faculty of Design and Built Environment, First City University College, Selangor, Malaysia. pradiipa.khor@firstcity.edu.my

*Corresponding Author

Abstract

This paper examines the entrepreneurial challenges within the context of small-scale DIY eggshell upcycling entrepreneurship in Malaysia. Addressing the environmental concern of approximately 70,686 tons of eggshell waste generated annually in Malaysia, this research proposes upcycling as a practical approach to mitigate waste while fostering socio-economic opportunities. Employing qualitative research design, the study integrates semi-structured interviews elucidate technical and economic obstacles encountered by entrepreneurs. Thematic analysis of the interviews identifies key entrepreneurial challenges, including limited community awareness, material fragility, and scalability constraints. Nevertheless, opportunities emerge through the strategic use of social media and innovative branding to engage niche markets. By proposing a cost-effective and accessible business model, this study contributes to the advancement of sustainable waste management practices and circular economy principles, offering actionable insights for small-scale DIY entrepreneurs.

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INTRODUCTION

Food waste is a growing global issue, with millions of tons discarded annually, contributing to environmental pollution and resource depletion. Its carbon impact releases 3.3 billion tons of CO₂ into the world annually. According to the Food and Agriculture Organisation (MDPI, 2021) approximately 1.6 billion tons of food, comprising dairy, meat, fresh produce, bread, and other bakery goods, are lost along the food supply chain. Among various types of food waste, bakery waste is a significant contributor, as bakeries generate surplus goods and byproducts that are often disposed of without repurposing. While much attention has been given to reducing surplus baked goods, less focus has been placed on non-edible bakery waste, such as eggshell which are frequently discarded despite their potential value.

Eggshell waste is commonly generated in households, food services, and bakery-related operations and is often discarded despite its potential value. Although eggshells are not exclusively classified as bakery waste, bakeries and food preparation businesses represent a consistent and significant source of post-consumption eggshell waste, situating eggshells within broader food waste and circular economy discussions. According to Scientific Report (2020), the global production of eggs can increase up to 90 million tons by 2030 (Mignardi, 2020). In Malaysia, eggs that produced every year can be up to 642,600 tons while 70,686 tons of wasted eggshell is estimated to be generated annually (Sethupathi, 2017). Eggshells contain high levels of calcium carbonate, calcium phosphate and magnesium carbonate, making them useful for various applications, including agriculture, cosmetics and eco-friendly materials. Recent studies and sustainability initiatives have emphasised the need for a circular economy in food production, yet practical solutions for eggshell waste remain limited. The practical challenge lies in bridging the gap between waste management and entrepreneurship, particularly in small-scale settings. This study aims to explore the entrepreneur challenges of upcycling eggshell waste into economic opportunities.

Huge numbers of eggshell wastes are ordinarily being discarded without proper treatment that will lead to environmental and social health impact. While previous research has explored industrial applications such as fertilizers, cement additives and heavy metal adsorbents, there is little attention given to transforming eggshells into marketable consumer products for small-scale entrepreneurship (Sethupathi, 2017). One promising yet underexplored solution is the production of eggshell candles—a sustainable and innovative product that repurposes eggshell waste while addressing rising consumer demand for eco-friendly, handmade goods. Eggshell candles offer unique advantages, including low production costs, aesthetic appeal and alignment with the zero-waste movement. However, significant gaps remain regarding entrepreneurial challenges of producing and selling eggshell candles.

This study is timely due to the increasing consumer demand for eco-friendly and handmade products. The candle market, particularly in sustainable and artisanal sectors, is experiencing growth as consumers seek products that reflect their environmental values. The growing demand for cutting-edge candle products is shown by Persistence Market Research's prediction that the worldwide candle market would increase from US\$9.56 billion in 2024 to US\$14.2 billion by 2031 (Innovations in Candle Manufacturing Driving Market Growth, 2024). Eggshell candles not only offer a low-cost production model but also provide an opportunity for DIY entrepreneurship, making it an accessible business venture for individuals and communities.

Understanding these factors is crucial for bridging the gap between waste management and economic empowerment. This study addresses these gaps by exploring the challenges faced by small-scale entrepreneurs in promoting DIY eggshell candles and identifying market strategies. In doing so, it aims to provide a sustainable business model that transforms eggshell waste into a valuable product while contributing to both environmental conservation and community wealth generation. Therefore, the main objective of this research is to identify key technical, economic and entrepreneurial challenges in producing and commercialising eggshell candles. This study is significant in its potential to create both environmental and socio-economic impact by transforming eggshell waste into viable business opportunities for small-scale entrepreneurs and communities. The study addresses the following research questions:

- What technical and economic challenges do entrepreneurs face in producing and selling eggshell candles?
- How can eggshell candles contribute to waste reduction and small-scale entrepreneurship?

LITERATURE REVIEW

Eggshell Waste: Environmental Impact and Upcycling Potential

Eggshell waste is often dumped in landfills, contributing to pollution through odours and microbial growth. As classified hazardous waste under European Union regulation, it requires proper treatment. While eggshells can be used in agriculture to raise pH, calcining CaCO_3 into CaO is energy-intensive. Though an underutilized alternative to non-renewable limestone, eggshell-derived calcium can replace it in finished products. Recovering eggshells for material production is an effective recycling method. To align with cradle-to-cradle sustainability, these products should either fully decompose and enrich soil like composites of eggshell particles and biodegradable polymers or be entirely recyclable (Vandeginste, 2021).

Research on eggshell waste utilization covers diverse applications, including cement, cosmetics, polymer and metal composites, and the removal of heavy metals from polluted water and soil (Vandeginste, 2021). Eggshells have also been upcycled into ceramic tile alternatives through cleaning, crushing, mixing with a binder and moulding (Tomlinson, 2022). For example, Mexican design firm Manufactura focuses on eco-friendly innovations, such as 3D-printed walls made from leftover eggshells (Figure 1). Using 3D printing, they transform food waste into durable blocks with bio-ceramic cement-like textures (Refash, 2024).

While industrial applications such as cement additives, calcium supplements, and adsorption materials are well documented, these processes often involve calcination or chemical treatment, making them less accessible for small-scale or DIY applications. Consequently, there is limited scholarly attention on eggshell reuse within creative, craft-based, or entrepreneurial contexts.

Sustainable Candle-Making and Upcycling Consumer Market

The demand for eco-friendly candles is growing due to rising interest in meditation, self-care, psychological well-being, carbon reduction, travel, and home décor. Consumers seek sustainable candles for both aesthetics and mindfulness, supported by manufacturers and government efforts. This trend also benefits the travel and interior design industries. From 2024 to 2025, the candle market grew from \$9.57 billion to \$10.29 billion, driven by social media, influencer culture, availability of scents and decorations, multiple use in events, and the pandemic-fuelled focus on relaxation and meditation (Hoseok, 2025).

It is anticipated that the e-commerce sector would propel the expansion of producers of environmentally friendly candles, strengthening distribution systems and meeting supply-side market demands. Production will rise in response to consumer demand for eco-friendly and sustainable products, opening up new markets for eco-friendly candles worldwide (Pandita, 2024). Despite this growth, research on sustainable candles primarily focuses on wax types, scent formulation, and consumer preferences. Limited attention has been given to candles incorporating waste-derived materials such as eggshells, highlighting a gap in understanding their entrepreneurial and sustainability potential.

Entrepreneurship and Small-Scale Business Opportunities in Upcycled Products

In 2025, the global handcrafted market has reached a value of USD 1,218 billion (B Fortune Business Insights, 2025). This growth is driven by consumer demand for unique, personalized items, increasing sustainability, ethical production methods, and online platforms and social media, which provide craftspeople with direct sales channels. The handmade market offers significant opportunities for entrepreneurs, with possibilities in product design, production, supply chain management, retail, workshops, online marketing, and consultancy. These avenues allow individuals to leverage their creativity to build successful businesses in the expanding sector.

Entrepreneurs can focus on obtaining raw materials and equipment, produce one-of-a-kind products like jewellery, clothing, accessories and home décor, set up small-scale manufacturing facilities, and sell their goods through physical storefronts, social media, online marketplaces or craft fairs. Skilled craftspeople may also provide advisory services to help budding entrepreneurs. The rise of e-commerce platforms and social media has made it easier than ever for handmade business owners to reach a global audience (Maharkhede, 2023). By encouraging entrepreneurship, supporting suppliers and creating jobs, these companies boost local economies. By maintaining the value of creative talents in the contemporary economy, craft-based business not only creates revenue but also protects artisanal crafts (Alokya, 2024).

Barriers to market access, scalability concerns, material prices and internet competition are some of the difficulties facing in handmade crafts sector. Entrepreneurs may overcome obstacles by using restricted manufacturing runs, streamlining procedures, creating dependable supply networks and educating consumers about workmanship, materials and ethical advantages. Businesses may also stand out in the e-commerce sector by tackling the high cost of sustainable materials and developing a strong brand identity (Maharkhede, 2023). Besides that, upcycling-based businesses also face challenges such as complex pricing strategies, customer distrust, and difficulty scaling production due to inconsistent raw material supply. Entrepreneurs overcome these obstacles through creative design, clear communication, and partnerships with local businesses. By utilizing online marketing and direct sales platforms, craftspeople can reach niche customers who value sustainability and craftsmanship. Upcycling

businesses can thrive by addressing these challenges, contributing to the circular economy, and emphasizing the artisanal and economic value of handcrafted products within local communities (Alokya, 2024). These challenges are particularly relevant to eggshell-based products, which involve unfamiliar materials and unconventional aesthetics.

Despite its challenges, the handmade sector provides business owners with special benefits including community involvement, sustainability, personalized products, specialized markets for environmentally concerned consumers and creative expression. It stresses eco-friendly techniques, serves certain audiences and enables artists to realize original ideas. Businesses may accommodate individual tastes with customization possibilities, which builds loyalty and solid partnerships (Maharkhede, 2023).

CONCEPTUAL FRAMEWORK

This study is guided by a conceptual framework that links entrepreneurial challenges, adaptive strategies, and resulting impacts in small-scale eggshell upcycling ventures. The framework identifies four key challenges: market access barriers, scalability issues, high material and production costs, and consumer scepticism. In response, entrepreneurs adopt strategies such as controlling production runs, developing efficient supply chain partnerships, consumer education, and strong branding and digital marketing. These strategies contribute to broader impacts, including market expansion, sustainability outcomes through waste reduction, cultural and economic benefits, and the growth of consumer demand. This framework is informed by prior studies on upcycling entrepreneurship and DIY business practices (Alokya, 2024; Maharkhede, 2023) and guides the analysis and discussion of the findings.

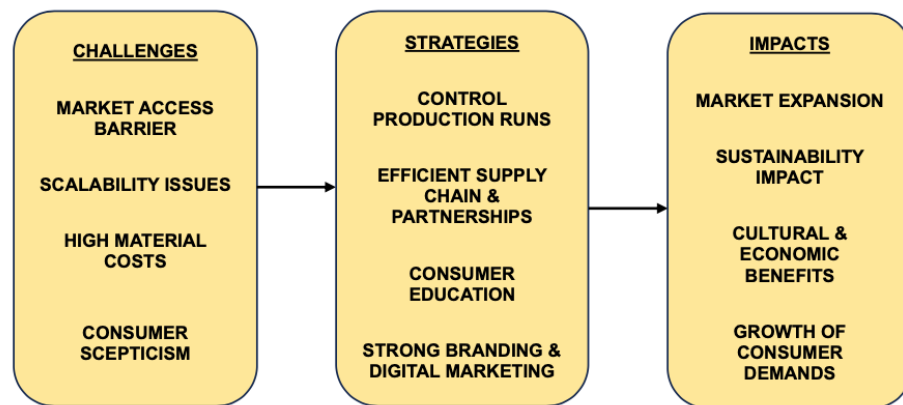


Figure 1: Conceptual Framework Illustrating the Relationship between Entrepreneurial Challenges, Adaptive Strategies, and Impacts in Eggshell Upcycling Entrepreneurship

Source: Adapted from Alokya (2024) and Maharkhede (2023).

RESEARCH METHODOLOGY

This study adopted a qualitative research design centred on semi-structured interviews to explore the experiences, challenges, and strategies of entrepreneurs and small business owners involved in DIY and upcycling ventures, with particular attention to upcycled eggshell products. Semi-structured interviews were selected to capture rich, contextualised insights into entrepreneurial practices, product innovation, market access, consumer perceptions, and sustainability considerations, while allowing flexibility to pursue emerging themes.

A purposive sampling strategy was employed to recruit participants with relevant expertise, including eco-conscious entrepreneurs, sustainability advocates and home-based DIY entrepreneurs. Ethical considerations were observed throughout the study, with informed consent obtained from all participants. The study involved three interview

participants: one participant from Sangetsu Pottery, one from Hea Corner, and one from Ecoser. Participants were selected based on their direct involvement in sustainable craft production, upcycling practices, and eco-oriented product innovation.

Data were collected through in-person and virtual interviews, complemented by observational engagement at selected pop-up markets in Klang Valley, where entrepreneurs interacted with eggshell-based prototypes and provided real-time feedback on usability, design, and market readiness. This multi-method approach enabled triangulation between reported experiences and observed practices. The data were analysed using thematic analysis, involving systematic familiarisation, coding, theme development, refinement, and interpretation. The thematic analysis was conducted using NVivo 14 qualitative data analysis software to support data organisation and coding. Coding was carried out collaboratively, with the researchers analysing the data together and engaging in iterative discussions to deliberate and agree upon codes and themes, rather than coding independently. This process facilitated the identification of key patterns related to business challenges, consumer acceptance, and innovation strategies within the upcycling sector. The findings were synthesised to generate practical recommendations aimed at enhancing the sustainability, accessibility, and commercial viability of eggshell-based entrepreneurial initiatives.

A limitation of this study is the small sample size and the use of purposive sampling, which may introduce selection bias and limit generalisability. However, this approach is appropriate for exploratory qualitative research aiming to generate in-depth insights within an under-researched context.

DATA ANALYSIS AND FINDINGS

Entrepreneurial Journey and Motivation

Theme	Theme Description	Example Quotes
Personal Inspiration and Career Transition	This theme illustrates how DIY entrepreneurship often emerges from personal life transitions and value-driven motivations, bringing both purpose and challenge. Career disruptions, emotional needs, and formative experiences with nature or craft inspire entrepreneurs to create meaningful, experience-based offerings rather than purely commercial products. While this strengthens authenticity, community connection, and differentiation, it also limits scalability and complicates income generation. As a result, DIY entrepreneurs must navigate the challenge of translating deeply personal narratives and social intentions into sustainable business models that remain financially viable while preserving their original creative and ethical values.	"Before I start on this artistic journey, my main was a chef in Singapore for almost 10 years... What trigger me was the MCO of covid-19... we pay a visit to a pottery workshop... and we got interested in these ceramic arts... my friend was mentioning about creating our own studio." – JT "Our studio is actually more on letting people to experience the process of making their own candles, and let them come to 'hea'... they have some pressure and need for heal by doing something satisfying" – EF "When I was small, I was living with my grandparents at Kulim from Kedah... surrounded with natural elements... I noticed that the huge difference of city and 'kampung'... I am intended to bring this nature elements back to the city... I think nature has got a power to unify the community " – CH
Community and Social Good	This theme reflects how DIY entrepreneurs position their practices as platforms for environmental concern and emotional engagement rather than purely skill-based or commercial offerings. By prioritising sustainability intentions, enjoyable handmaking experiences, and building up knowledges over professional instruction or mass production, entrepreneurs seek to nurture appreciation for nature, craft, and mindful consumption. However, this approach also presents entrepreneurial challenges that	"As long as they are all trying to protect the natural environment, I think the intentions are good to create the consciousness" – JT "We are not offering professional candle making classes, we just want our customers to 'hea' and have fun through DIY and crafting process" – EF "I realised that the awareness of people to this kind of products are very low. Therefore, I created this

	requires continuous education, outreach, and storytelling, demanding time and effort that may not immediately translate into financial returns while remaining central to their mission-driven values.	account as a starting point of creating a consciousness" – CH
Target Audience and Expectation	This theme examines how entrepreneurs conceptualise their target audiences, uncovering assumptions about consumer lifestyles and environmental concern that often diverge from market realities. The theme questions whether audience targeting is grounded in evidence or intuition, suggesting that passion-led assumptions may constrain market reach and hinder scalability.	"Our target audience is all women, they have some pressure and need for heal by doing something satisfying." – EF "People living in city has more demands and consciousness about upcycling... people in 'kampung' they desire for city lifestyle; while people living in city, they desire for natural lifestyle." – CH

These insights reveal that entrepreneurs often see their journey as a personal quest for fulfilment, highlighting the tension between individual drive and broader systemic realities. Their focus on transformative moments—such as career shifts or rediscovering purpose—reflects a belief in self-directed change, which aligns with literature on values-driven and lifestyle entrepreneurship within sustainable craft practices. However, this perspective may overlook external factors, like economic challenges or the rural-urban divide, which unevenly shape opportunities. The emphasis on therapeutic and further suggests a latent orientation toward sustainability, aligning with entrepreneurs who intermittently adopt eco-friendly practices rather than fully embedded circular economy models. While these motivations support waste reduction and cultural value creation, the transition from personal inspiration to sustained societal or environmental impact remains uncertain. This gap reflects a key framework tension between entrepreneurial intention and actual market impact, particularly in a crowded and sceptical consumer landscape (Maharkhede, 2023). These insights reveal a fragmented view of consumers, relying more on anecdotal than evidence-based targeting. This highlights a core issue: entrepreneurs may project their values onto consumers, assuming shared priorities where scepticism or apathy exists—a disconnect that could hinder growth without market validation. Therefore, market research is needed to understand the consumers.

Materials, Processes and Pricing

Theme	Theme Description	Example Quotes
Use of Natural and Recycled Materials	This theme highlights how DIY entrepreneurs leverage the inherent recyclability and natural qualities of materials as both a creative advantage and an operational challenge. By working with reusable clay, natural waxes, plant-based elements, and raw textures, entrepreneurs align their practices with sustainability values and material authenticity. However, relying on natural and upcycled materials also requires deeper material knowledge, experimentation, and careful handling to maintain quality and consistency. This highlights a key DIY entrepreneurial challenge: balancing eco-conscious material choices with the technical demands, limitations, and uncertainties of small-scale, hands-on production.	"Soil. It can be continuously recycled, reused and remould... it can be broken, mix into a new clay and undergo the same process for another desired product" – JT "We use Bee Wax... while those in glasses we will use Soy Wax... Essential oils are more natural because they are extracted from real flowers or fruits" – EF "Like the Betel leaves, I used that to make the bowl... It is actually cheap and lightweight. I try to remain the natural texture of the products" – CH
Upcycling and Recycling Practices	This theme reflects how DIY entrepreneurs adopt flexible reuse and circular practices to minimise waste while navigating the limitations of small-scale production. By remelting flawed items, encouraging customer return-and-remake systems, and continuously exploring new upcycling materials, entrepreneurs demonstrate adaptive problem-solving and resourcefulness. However, these	"Sometimes we do reuse the leftover or flawed products, remelting, remoulding and repurposing into another new products" – JT "If the customer uses it, they can return the cup back and make one by themselves" – EF

	practices also introduce challenges, including additional labour, time, skill requirements, and inconsistent outcomes, which can affect efficiency and scalability. The theme highlights a core DIY entrepreneurial challenge: turning material constraints and imperfections into sustainable opportunities without overburdening limited resources or compromising product consistency.	"Besides eggshell there are many more potential resources and materials that can be upcycled" – CH1 "Continue to explore new sustainable innovation and upcycling materials, also building up my social media" – CH2
Impact on Product Quality	This theme explores how the use of upcycled materials influences perceptions of product quality, a critical factor for consumer trust and market competitiveness. While entrepreneurs often assume sustainability itself adds value, the findings suggest that quality must be clearly demonstrated to counter scepticism towards unfamiliar upcycled products. The theme questions whether such products can overcome perceptions of inferiority, emphasising the need to balance environmental intentions with consistent performance and durability in a price-conscious market.	"No. Ceramic clay is very durable and tough, they take times to be weathered so is good to reuse" – JT "We have some skills, and we have to keep it a distance, also if the flower rinsed in the wax it wont burn easily" – EF "Upcycle products can't always compete with artificial or processed products like plastic, those can last forever" – CH
Packaging and Presentation	This theme examines packaging as both an opportunity and a challenge for DIY entrepreneurs, where visual appeal is used to enhance perceived value and justify higher prices, yet often requires additional cost, skills, and resources. While attractive packaging can differentiate handmade products in competitive markets, it also intensifies pressure on small-scale entrepreneurs to balance creativity, affordability, and operational feasibility.	"Packaging is also one of the important elements of your products... There might also be some customers they will say like they pay expensive just for your packaging." – JT "People nowadays like to see beautiful things... The packaging can also increase its price, add LED lights and other embellishment." – EF

The findings indicate that DIY upcycling practices reflect an experimental approach to sustainability, often struggling with consistency and adoption. The irregular reuse of materials suggests a casual or occasional commitment to sustainable practices, reflecting early-stage circular economy engagement rather than fully embedded systems, which can conflict with the expectations of price-sensitive consumers, as additional effort may drive costs beyond what buyers are willing to pay. This observation aligns with the conceptual framework's identification of high production costs and consumer scepticism as interlinked challenges, reinforcing earlier observations that upcycling's appeal remains largely conceptual; innovative ideas can inspire, but without reliable execution and effective market education, their capacity to generate broader market and sustainability impact remains limited.

Quality emerges as a persistent challenge, with entrepreneurs adopting a defensive stance to meet mass-market standards. Skill-based limitations and the superior performance of synthetic materials create doubts about durability, further constrained by competition, scalability issues, and pricing pressures (Maharkhede, 2023). These constraints directly reflect the framework's scalability and market access barriers. Consequently, the ethical appeal of upcycled products competes with practical scepticism, increasing the risk of long-term niche confinement unless quality perceptions are strengthened through validation, testing, or targeted consumer re-education.

Packaging highlights a tension between sustainability and consumer-driven aesthetics. While visually appealing packaging can increase perceived value, and supports branding strategies identified within the conceptual framework, decorative enhancements often raise costs, potentially alienating price-conscious buyers and echoing broader financial constraints. This focus on aesthetics aligns with a creative, niche-oriented audience but may limit appeal to a wider market, particularly given low familiarity with upcycled products like eggshell candles. Overall, eco-entrepreneurs may rely on surface-level appeal to differentiate their offerings, which can act as a

short-term response to market entry barriers but risks diluting sustainability messaging and restricting long-term market reach.

Market Dynamics and Consumer Behaviour

Theme	Theme Description	Example Quotes
Market Channels and Sales Platforms	This theme highlights how DIY entrepreneurs' experiment with multiple sales channels—pop-up markets, personal networks, and online platforms—to increase visibility and reach. Entrepreneurs often begin with in-person interactions to test products and gain exposure, gradually expanding to digital channels as confidence, capacity, and market understanding grow. The approach reflects a learning process in balancing direct engagement, audience building, and the operational challenges of managing different sales platforms while establishing brand presence in a niche market.	"More in the market. Then there are coffee shop friends, and personal friends... cooperate with teahouses and coffee shops. Let's assume that we drink tea and coffee, and we all study the taste and shape" – JT1 "We are still building up our own channel for online sales... We already have that Artisix account just that haven't had time to implement on it." – JT2 "We will have our own candles and brand, do a marketing campaign... The purpose that we coming to this market is just to get exposure." – EF1 "We don't have products, but this is our first time selling products here at the booth... Yes, yes, we have plans next [for online sales]" – EF2 "I started to build up the awareness through social media... I might consider it next time for my Ecoser [pop-up market]" – CH
Customer Preferences and Feedback	This theme explores the diverse motivations and preferences of consumers engaging with DIY and upcycled products. Some consumers prioritise aesthetic appeal, favouring vibrant colours, unique shapes, textures, and artistic designs, seeking novelty and creative expression. Others value experiential enjoyment, such as social interaction and the fun of the making process, rather than functional outcomes. A separate segment focuses on product durability and quality, reflecting practical considerations alongside willingness to invest in higher-value, eco-friendly items. Overall, consumer engagement is shaped by a combination of creativity, lifestyle, affordability, and risk tolerance, highlighting the challenge for entrepreneurs to balance innovation, usability, and market positioning.	"So far they like more fancy products, more vibrant colours because is more artistic and unique" – JT1 "They require distinctive items that is rarely seen in markets, in terms of colours, shapes, materials, surface textures." – JT2 "They will prioritise enjoying the process... Is more on they want to have fun with friends, there is no special purpose" – EF "The most comments from them were the durability and if the products is long-lasting" – CH1 "When people start caring about their health and lifestyle and they have more incomes than just to spent for basic requirements... most of the consumers that interested in this kind of eco-friendly and upcycle products are those that manage to afford higher value of products." – CH2 "The first group are those they prioritise creativity and innovative ideas... they would likely to take the risk... so their main intention would not be the price and quality, they are managed to spend for the risk and idea." – CH3
Concept and Brand Story Development	This theme highlights how DIY entrepreneurs rely on brand identity and storytelling to differentiate their upcycled products and engage consumers. While the story about sustainability, craftsmanship, and personal inspiration can justify higher prices and foster community, developing a compelling brand demands significant time, skill, and creative effort.	"That's why brand concept is very important, you will create consciousness and your own community base, also adding in some elements like recycle, upcycle and such." – JT1 "... you manage to persuade them with your craftsmanship, concept and idea, they are also willing to pay you more." – JT2

	Packaging, design, and consistent messaging become operational challenges, particularly for small-scale entrepreneurs balancing limited resources with the need to communicate value effectively. Thus, branding and storytelling are both powerful tools and ongoing challenges in establishing market credibility and consumer connection in the DIY upcycling sector.	"Like some they will ask, "What is your product story?" "What is the origin of your concept?" "What inspire you to do that?" You can always add the values by your skills, techniques, messages, many many more elements to strengthen your brand and products... have an amazing story behind to support it, the process, inspiration, ideas." – JT3 "... packaging design also take place in delivering the concept and idea of your upcycling products, like brand message and stories... most consumer they buy your products are mainly because of your concept... need to look for a way to promote your products, what makes it so special and distinctive? Also, they see your passions and effort paid on the products, they able to resonate with it and connect with people." – CH
Pricing and Perceptions	This theme explores the tension DIY entrepreneurs face in pricing upcycled products, balancing the cost of materials, labour, skills, and time against market willingness to pay. High prices risk limiting consumer accessibility, while low prices may undermine profitability and fail to reflect the investment in craftsmanship and self-manufacturing. This highlights a core challenge for small-scale upcycling ventures: establishing pricing strategies that fairly value their work while remaining competitive and appealing to target customers.	"If you set up a high price for your raw products, at the end you will find there is no one can afford your products." – JT1 "Sometimes in the end it ends up selling too cheap, because all our manpower and time are used on the materials" – JT2 "Is pricier because of the investment on self-manufacturing, skills, time, tools and such" – CH

The findings illustrate the multifaceted challenges DIY entrepreneurs face in developing, marketing, and sustaining upcycled products. These challenges closely reflect the conceptual framework's emphasis on market access barriers, scalability constraints, and consumer scepticism. Market Channels and Sales Platforms reveal that entrepreneurs adopt a phased, experimental approach, beginning with in-person sales at pop-up markets and leveraging personal networks before expanding to online platforms. This approach reflects adaptive strategies used to manage limited resources and mitigate market risk, while also indicating a learning curve in audience engagement and the operational demands of managing multiple sales channels while establishing visibility and brand presence. Such phased expansion aligns with literature on small-scale sustainable entrepreneurship, where gradual market entry is often necessary due to capacity and financial constraints.

Customer Preferences and Feedback highlight the complexity of meeting diverse consumer motivations. Some buyers prioritise aesthetic novelty and creative expression, others seek experiential enjoyment, while a segment values durability and quality. This diversity reinforces the framework's identification of consumer scepticism and fragmented demand as key challenges, as entrepreneurs must balance these varying demands alongside considerations of affordability and consumer risk tolerance. As a result, product design and positioning become strategic responses rather than purely creative decisions, shaped by both market uncertainty and sustainability goals.

Concept and Brand Story Development highlight the strategic role of branding and storytelling in differentiating DIY upcycled products. Entrepreneurs rely on narratives around sustainability, craftsmanship, and personal inspiration to foster community engagement and justify pricing. These practices correspond to the framework's adaptive strategies of consumer education and branding as mechanisms to overcome low awareness and perceived value gaps. However, developing and communicating a cohesive brand demands time, skill, and resource investment, introducing further operational strain that can limit scalability for small-scale ventures.

Finally, Pricing Challenges and Perceptions reveal the tension between fair valuation and market acceptance. Entrepreneurs must reconcile the costs of materials, labour, and skill with what consumers are willing to pay, balancing affordability with profitability. This tension reflects the framework's emphasis on high production costs and pricing pressure as structural constraints. Misalignment in pricing risks limiting market reach or undervaluing craftsmanship, ultimately affecting long-term sustainability and the ability of DIY upcycling ventures to transition from niche initiatives to viable circular economy enterprises.

Balancing Profitability and Creative Integrity in DIY Upcycling

Theme	Theme Description	Example Quotes
Sustaining Creativity Under Commercial and Cost Pressures	This theme explores the tension DIY entrepreneurs face between generating income and maintaining the integrity of their creative and sustainable practices. Entrepreneurs acknowledge the need to earn revenue, but emphasise that commercialisation must not compromise craftsmanship, ethical values, or the artisanal nature of their products. High production costs—driven by skilled labour, specialised materials, and small-scale, non-mass-produced processes—further complicate pricing, highlighting the ongoing challenge of sustaining a viable business while preserving the principles of creativity and sustainability.	"We don't focus on making money. We want to make money, but we can't be too commercial... Artists can't make a lot of money because you can't be too ruthless to acquire money." – JT1 "Money is for sure... The time cost is higher... every process has a skill and knowledge. You have to understand that if you make a mistake in one part, your thing will be ruined." – JT2 "We want to make money, but we can't be too commercial because that's why we always say that we can't make money" – JT3 "The cost of making a candle is higher. Because there are essential oils and eternal flowers" – EF1 "We don't mainly sell products; our product is experience" – EF2 "The main thing is that the products haven't been mass produced yet. So is pricier" – CH1 "I think the main focus is my passion and interest, the profit comes to the second priorities" – CH2
Community Awareness and Adoption	This theme highlights the difficulties DIY entrepreneurs face in shifting consumer perceptions and building market awareness for upcycled products. Entrepreneurs note that many consumers associate commercial products with higher quality and affordability, making it challenging for small-scale, artisanal offerings to gain credibility. Limited demand and low community consciousness about sustainability further constrain market acceptance, prompting entrepreneurs to actively engage in awareness-building through channels like social media. Overall, success depends not only on product quality but also on educating consumers and fostering recognition of the value and impact of upcycled products.	"Not really. Because most people think that commercial products have higher quality and good appearance, and cheap" – JT1 "There are also this kind of saying that natural elements are precious so they try to avoid wasting the natural resources" – JT2 "We are not like that, we are completely different from them [professional candle makers]" – EF1 "Bee Wax and Soil Wax are more natural things. So it's better to use natural ones" – EF2 "The main challenge was the consciousness of community... people now is still like that, they still can't feel the impact" – CH1 "The biggest challenges of upcycle products is the less demands and lack of consciousness of community... I started to build up the awareness through social media." – CH2 "I tried to implement it fully eco-friendly in terms of manufacturing way, materials and finishing" – CH3

DIY upcycling entrepreneurship is shaped by a complex interplay of internal constraints and external market challenges. These dynamics closely align with the conceptual framework, which links entrepreneurial challenges, adaptive strategies, and resulting market and sustainability impacts. Entrepreneurs face significant financial and resource pressures, as high production costs, skilled labour requirements, and small-batch, non-mass-produced processes make pricing and profitability difficult to balance. These internal constraints reflect the framework's emphasis on high material and production costs and scalability limitations. At the same time, commercialisation must not compromise the artisanal quality, sustainability principles, or creative integrity that define their products, creating a tension between generating income and preserving value. This tension illustrates the challenge of translating sustainability-driven intent into commercially viable practice. These internal challenges are compounded by external barriers: low community awareness, limited consumer understanding of sustainability, and a perception that mass-produced products offer superior quality and affordability. Such perceptions directly correspond to the framework's identification of consumer scepticism and market access barriers as critical obstacles. As a result, market adoption is slow, requiring proactive efforts in brand storytelling, consumer education, and strategic engagement through both physical and digital channels. These responses reflect adaptive strategies identified within the framework, aimed at mitigating scepticism and building perceived value. The success of DIY upcycled ventures therefore depends not only on managing production and resource constraints but also on cultivating consumer consciousness, communicating environmental and creative value, and fostering trust in a niche yet growing sustainable market. Ultimately, these efforts determine whether small-scale upcycling initiatives can contribute meaningfully to circular economy practices and long-term sustainability outcomes.

CONCLUSION

This study provides a comprehensive examination of the challenges faced by small-scale DIY entrepreneurs in producing and commercialising upcycling crafts such as eggshell candles, highlighting the complex interplay of creative, operational, and market factors. Entrepreneurs navigate tensions between artistic integrity, sustainability, and profitability, striving to maintain eco-friendly practices while contending with high production costs, limited resources, and skill-intensive processes. Market adoption remains slow due to low consumer awareness, scepticism about product quality, and the perceived superiority of mass-produced alternatives. Entrepreneurs respond by leveraging storytelling, branding, and experiential offerings to communicate value, foster community engagement, and differentiate their products in a niche market. Continuous innovation through new product designs, upcycling practices, and digital marketing emerges as a critical strategy to remain relevant and build sustainable ventures despite operational constraints. Importantly, these findings reinforce the role of small-scale eggshell upcycling within the circular economy, where food waste is redirected from landfill into value-added products that extend material lifecycles and reduce environmental impact. By transforming eggshell waste into functional and aesthetic objects, DIY entrepreneurs contribute to waste reduction, resource efficiency, and sustainable consumption, demonstrating how micro-enterprises can act as grassroots drivers of circular and sustainable economic practices.

Based on the findings, three practical recommendations are proposed for entrepreneurs and policymakers. First, DIY entrepreneurs should prioritise strategic storytelling and transparent sustainability communication to educate consumers about the environmental value, craftsmanship, and quality of upcycled products, helping to overcome scepticism and reposition waste-based crafts as premium, meaningful goods. Second, policymakers and local authorities should support small-scale upcycling ventures through micro-grants, shared production facilities, training programmes, or waste-collection partnerships, enabling entrepreneurs to reduce costs while strengthening local circular economy ecosystems. Third, collaboration platforms between households, cafés, bakeries, and DIY makers should be encouraged to ensure consistent eggshell supply chains, improve material efficiency, and formalise community-based waste-to-value systems.

While these findings illuminate key technical, economic, and entrepreneurial challenges, the study's scope is limited to small-scale, home-based, and community-driven ventures in urban and suburban contexts where eggshell waste is accessible. Insights may not fully apply to rural areas or industrial-scale enterprises, and advanced scientific or large-

scale upcycling techniques were beyond the study's focus. Future research could expand to examine industrial applications, regional variations in consumer behaviour, and strategies for scaling DIY upcycled products while maintaining sustainability and creative integrity. Overall, the study highlights the potential of small-scale eggshell upcycling as both an environmental and socio-economic opportunity, offering practical guidance for DIY entrepreneurs seeking to transform household waste into viable and sustainable business ventures.

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