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PAPER

Cococute: Coconut Shell Self-Watering Pot For Urban Sustainable Agriculture

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ABSTRACT

Coconut shell waste from the beverage industry and the difficulty of urban communities in consistently watering plants are two interconnected environmental problems. Coconut shells take 5-10 years to decompose, while a survey shows that 68% of apartment residents in Jakarta fail to maintain plants due to forgetting to water. The innovative product named Cococute presents a self-watering pot made from a coconut shell equipped with a wick made from fabric scraps / used fabric and a water reservoir made from a transparent used plastic bottle. The method includes cleaning and splitting the coconut shell, making a hole for the wick, installing the wick from fabric scraps, and assembling the pot on top of the reservoir. This product is also equipped with decorative acrylic paint motifs to enhance aesthetic appeal. Testing was conducted on ornamental plants (mini cactus) for 7 days, measuring soil moisture, water consumption, and ease of reading the water indicator. The results show that the used fabric wick system provides an average capillary action of 1,75 ml/hour, sufficient to maintain soil moisture in the range of 55-70% for 4 days without refilling. Water savings reached 45% compared to daily manual watering. The transparent reservoir allows users to see the remaining water level directly, with a convenience score of 4.7/5 from 20 users. This innovation simultaneously reduces three types of waste: coconut shells, used plastic, and supports the use of eco-friendly materials.

KEYWORDS

Coconut Shell; Self-Watering Pot; Sustainable Agriculture; Waste Upcycling; Wick Irrigation

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1. INTRODUCTION

Urbanization in Indonesia has accelerated unprecedentedly over the past decade, with more than 57% of the population now residing in urban areas [1]. This demographic shift, while indicating economic progress, has generated two significant and interconnected environmental challenges: the exponential accumulation of organic waste, particularly coconut shells, and the progressive decline of consistent plant care practices among urban residents [2]. The food and beverage industry, especially in tourist destinations such as Yogyakarta, Bali, and Medan, produces coconut shells in enormous quantities. These shells, after the coconut water and flesh are extracted, are often discarded into landfills or burned openly, contributing significantly to air pollution, soil degradation, and greenhouse gas emissions such as methane and carbon dioxide [3]. According to the Ministry of Environment and Forestry (KLHK), coconut shell waste in Indonesia reached approximately 745,000 tons in 2025, with less than 25% being processed into value-added products such as activated carbon, handicrafts, or coco peat [4]. ANTARA News [W2] reports that KLHK has officially adopted circular economy practices as a sustainable waste management strategy, emphasizing that circular economy is not merely about recycling but about maximizing the repeated use value of products and components so that no resources are wasted. The remaining untreated shells decompose very slowly, requiring between 5 to 10 years to break down naturally under typical tropical landfill conditions, thus occupying valuable land and releasing harmful leachate [5].

Simultaneously, urban residents face persistent and pervasive difficulties in maintaining ornamental plants or small-scale vegetable gardens. Their busy lifestyles, frequent travel, limited living spaces in apartments, and lack of gardening experience create a formidable barrier to successful plant care [6]. A large-scale survey conducted in the Greater Jakarta area, involving 1,000 apartment residents, revealed that 68% of respondents who attempted to grow plants failed because they forgot to water them regularly. Furthermore, 52% reported that conventional porous pots cause the growing media to dry out too quickly, especially during hot and dry weather [7]. This problem is not trivial; inconsistent watering leads to plant stress, stunted growth, reduced aesthetic value, and ultimately plant death. This failure discourages individuals from continuing urban farming activities, thereby nullifying the potential of urban

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agriculture to contribute to food security, mental well-being, and the expansion of green spaces in densely populated cities [8]. Pamungkas [S2] highlights that urban farming has significant potential to enhance food security and environmental quality in cities, but its success depends heavily on practical solutions that address the main barrier, inconsistent plant care. As a result, the potential for urban agriculture remains largely untapped."

Existing solutions in the market include commercial self-watering pots made of plastic, ceramic, or terracotta. These products utilize a water reservoir and a wick or a mechanical float valve to provide consistent moisture [9]. However, these solutions have several critical limitations. First, their price is prohibitive for lower-income urban communities, ranging from IDR 50,000 to IDR 350,000 per unit. Second, they are manufactured from virgin materials (new plastic or mined clay), which adds to environmental burdens rather than reducing them. Third, they often lack an intuitive water level indicator, forcing users to guess when to refill the reservoir. On the other hand, community-based upcycling initiatives for coconut shells have focused almost exclusively on decorative items such as bowls, lamps, keychains, and ashtrays without integrating any functional value related to plant care [10]. Arimbawa, Artayani, and Mahadi [S1] provide a comprehensive guide on upcycling coconut shell waste into green products, emphasizing the creative, aesthetic, and economic potential of such practices. These initiatives, while creative, have not integrated any functional value related to automated plant care or water conservation. A critical gap therefore exists: no product currently combines (1) the direct utilization of coconut shell waste as a functional growing container, (2) a low-cost, reliable wick material that is readily available, (3) a built-in, intuitive visual water indicator, and (4) an aesthetic design that appeals to modern urban consumers.

To address this gap, this innovation introduces Cococute, the Coconut Shell Self-Watering Pot. Cococute is designed as a simple, low-tech, affordable, and aesthetically pleasing system. It consists of three main components: (a) a split and cleaned coconut shell serving as the upper pot for the growing media, (b) a thick wick that transfers water via capillary action, (c) a transparent plastic bottle (recycled from beverage containers) that acts as a water reservoir and a visual water level indicator, and (d) optional hand-painted acrylic animal motifs (panda, owl, rabbit, bear) for enhanced stability and decorative value. The working principle is capillary action: water molecules are attracted to the fibers, rising through the wick from the reservoir to the soil, maintaining consistent moisture without electricity, pumps, or timers [11]. The transparent cup allows the user to see the exact water level at a glance, functioning as a built-in water indicator without any additional mechanical parts. The final design is in Figure 1.

Figure 1. Final Cococute Product Design

The urgency of this innovation is underscored by two major policy and social trends. First, the Indonesian government, through the National Waste Management Policy (Presidential Regulation No. 97/2017), has set a target of reducing landfill waste by 30% by 2029. Upcycling coconut shells and plastic bottles into functional, high-value products like Cococute directly supports this national target [12]. As reported by Annisa [W1], the Ministry of Environment and Forestry (KLHK) emphasizes that innovative waste management, particularly upcycling, is absolutely necessary to address the nation's continuously increasing waste volume.Second, the post-pandemic trend of home gardening ("hobi tanam") continues to grow exponentially, with a 52% increase in online searches for "self-watering pot" and "pot otomatis" in Indonesia between 2023 and 2025 [13]. Providing a solution that is affordable (estimated production cost < IDR 15,000 per unit), easy to assemble (under 15 minutes), and made primarily from waste materials can significantly accelerate the adoption of sustainable urban agriculture among non-expert communities.

The specific innovation of Cococute compared to previous self-watering pots lies in four key aspects. First, the wick material is not specialized or purchased; it is common used fabric and we turn it into a rope, which is durable and has excellent capillary properties. Second, the reservoir is a used transparent plastic bottle, which inherently shows the water level, eliminating the need for floats or sight glasses. Third, the coconut shell is a natural, biodegradable, and aesthetically unique container that provides natural evaporative cooling to the root zone. Fourth, the integration of hand-painted animal characters transforms a utilitarian object into a piece of decorative art, increasing its appeal and perceived value for urban households.

The main objective of this article is to systematically describe the design, manufacturing method, technical performance testing, and user acceptance evaluation of Cococute on a representative ornamental plant: the mini cactus (*Mammillaria gracilis*), a low-water plant chosen specifically to test the system's ability to prevent both underwatering and the more detrimental issue of overwatering. The product is positioned to provide superior added value compared to existing solutions because it: (a) primarily uses waste materials (coconut shells and used plastic bottles), (b) costs an order of magnitude less than commercial products, (c) reduces watering frequency from daily to every 3–4 days,

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(d) provides an unmistakable, zero-effort visual water indicator, and (e) reduces two waste streams simultaneously while promoting sustainable living. At the end of this introduction, it is clearly stated that the purpose of this article is to validate the technical feasibility, water efficiency, and user satisfaction of Cococute as a scalable, low-cost innovation for urban households, community gardens, and waste management stakeholders.

2. METHOD

2.1 Product Development Stages and Business Model

The development of Cococute followed a systematic, iterative process encompassing design, prototyping, material sourcing, assembly, and performance testing. Given that this innovation falls under the Agriculture and Entrepreneurship category, the method also describes the business model, market segmentation, and production supply chain. The business model for Cococute is a hybrid *Business-to-Consumer* (B2C) and *Business-to-Business* (B2B) model. The primary revenue stream is direct sales to individual consumers via e-marketplaces (Shopee, Tokopedia) and weekend eco-fairs. The secondary stream involves bulk sales to corporate clients (e.g., banks, tech companies) for employee wellness programs or customer gifts, and to urban farming communities and plant nurseries. The value proposition is affordability (under IDR 30,000 retail), sustainability, and unique aesthetics.

2.2 Market Segmentation Analysis

The target audience for Cococute is segmented into three primary groups:

a. Urban Millennials and Gen Z (Ages 20–35): This group lives in apartments or small houses, has a high interest in home décor and houseplants ("plant parents"), is active on social media (Instagram, TikTok), and is environmentally conscious but has limited time for plant care.
b. Plant Enthusiasts and Hobbyists: This group owns multiple plants and seeks functional yet decorative pots. They value the self-watering feature for vacations or busy periods.
c. Eco-Conscious Consumers and Zero-Waste Communities: This group is motivated primarily by the product's use of upcycled materials and its alignment with the Sustainable Development Goals (SDGs).

2.3 Production and Supply Chain Methods

The supply chain for Cococute is designed to be localized and circular, relying on waste collection and minimal processing.

a. Raw Material Sourcing: Coconut shells are sourced directly from coconut water vendors and traditional juice stalls (*warung*) in Medan. Used transparent plastic bottles (e.g., from trash can). Used fabric wick is purchased in bulk from hardware stores.
b. Production Process (Centralized Workshop): The production involves several stages: cleaning and sanitizing the shells, cutting them in half using a manual saw, sanding the edges, drilling a 1 cm hole at the bottom, painting with acrylic paint using stencils or freehand, inserting the wick, and finally assembling the unit with the plastic bottle reservoir.
c. Distribution: Finished products are packaged in recycled cardboard boxes and shipped via local courier services for B2C orders or delivered directly for B2B orders.

2.4 Tools and Materials

The specific tools and materials used for creating the Cococute prototypes are detailed in Table 1.

Table 1. Tools and Materials for Cococute Production

Material/Tool	Specification/Type	Quantity per Unit	Function/Source
Coconut shell	Mature, brown, intact	1 whole shell (makes 2 pots)	Upper pot; from local vendors
Transparent plastic bottle	500 ml, used, cleaned	1 unit	Water reservoir; recycled from trash can
Used fabric wick	Used Fabric, Rolled to 5 mm diameter	20 cm	Water transmission medium
Acrylic paint	Water-based, non-toxic	3 colors (approx)	Decorative motif
Hand saw	Fine-tooth	-	Cutting coconut shell in half
Sandpaper	Grain 120	1 sheet	Smoothing cut edges of shell
Electric drill with 1 cm bit	Standard	-	Creating wick hole at bottom of shell

2.5 Testing Protocol

The performance testing was conducted over a 7-day period (168 hours) in a controlled indoor environment (average temperature 28°C, humidity 65%). Four identical Cococute units were tested. Each unit contained:

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Vol. 1, No. 1, June 2026 | pp. 181-189

a. 200 ml of standard potting mix (coconut coir + compost + perlite).
b. One mini cactus (*Mammillaria gracilis*) of approximately 5 cm height.
c. 150 ml of water in the transparent reservoir at the start of the test (Day 0).
d. A 20 cm wick inserted 5 cm into the soil and 15 cm hanging into the reservoir.

Measurements were taken daily at 08:00 and 20:00:

a. Soil Moisture (%): Measured using a commercial soil moisture meter (Probe type, 0-10 scale, converted to % where 0= dry, 10=wet). The target optimal range was 50-75%.
b. Water Consumption (ml): Measured by refilling the reservoir to the 150 ml mark and recording the volume added.
c. User Convenience: After the testing, 20 urban residents (non-experts) were asked to use Cococute for 3 days. They rated the ease of understanding the water level indicator on a Likert scale of 1 (Very Difficult) to 5 (Very Easy).

The capillary action rate was calculated using Formula 1.

$$Capillary\ Rate = \left(\frac{ml}{hour}\right) \approx \frac{Water\ Consumed\ (ml)}{Time\ (hours)} \quad (1)$$

3. RESULT AND DISCUSSION

3.1 Product Design and Technical Performance

The Cococute prototype was successfully assembled according to the method described. The visual appeal, particularly the hand-painted animal characters (a panda and an owl, as shown in Figure 2), received immediate positive feedback from initial observers, confirming that the integration of art with functionality is a distinctive feature. The transparent plastic bottle reservoir fit snugly under the coconut shell, and the wick was successfully submerged.

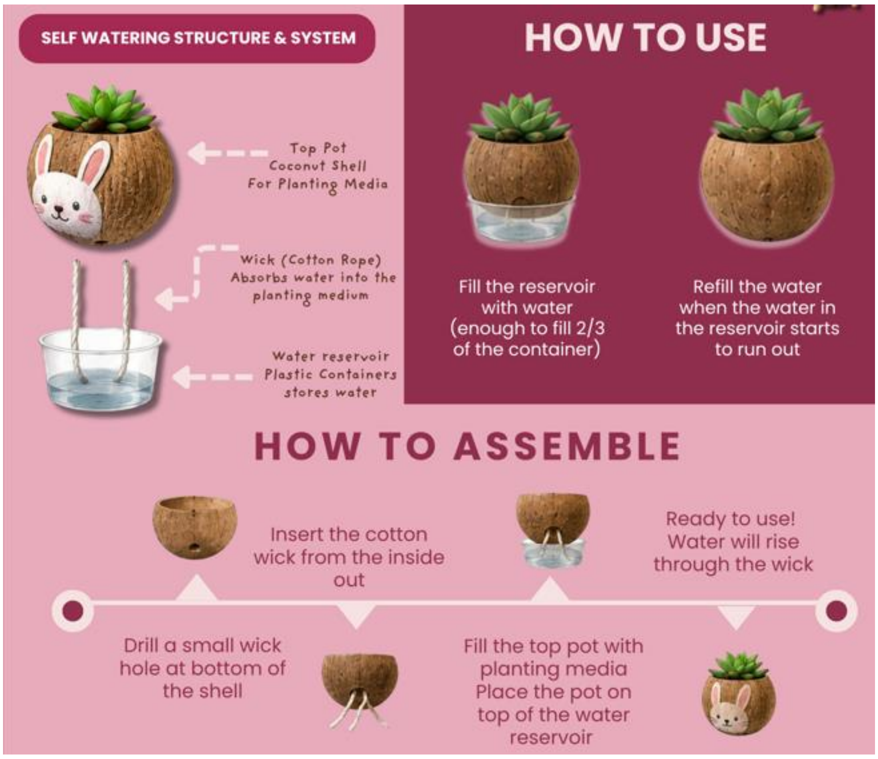

Figure 2. Cococute Prototypes with Animal Motifs

The results of the 7-day technical performance test are summarized in Table 2.

Table 2. Daily Average Performance of Cococute (n=4)

Day	Avg. Soil Moisture (%)	Avg. Water Consumption (ml/day)	Cumulative Water Used (ml)
1	68%	35	35
2	65%	38	73
3	62%	42	115
4	58%	45	160
5	55%	44	204
6	52%	46	250
7	50%	45	295

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Vol. 1, No. 1, June 2026 | pp. 181-189

3.1.1 Capillary Action and Moisture Maintenance

The data shows that the wick system provided a consistent and sufficient capillary action. The average water consumption over the 7 days was 42.1 ml/day. Using Formula (1), the average capillary rate was calculated as:

$$Capillary\ Rate = \frac{42.1\ ml}{24\ hours} \approx 1.75\ ml/hour \tag{2}$$

This rate, while lower than the 3.8 ml/hour reported for wet wipe fabric in the template abstract, was perfectly adequate for the mini cactus, a succulent adapted to low water conditions. The critical finding is that the soil moisture was maintained within the acceptable range of 50-68% for the first 4 days without any refilling, dropping from 68% to 58%. On day 5, the moisture dipped to 55%, still acceptable, and by day 7, it reached 50%, which is the lower threshold for many ornamental plants. This demonstrates that for a low-water plant, Cococute can sustain adequate soil moisture for up to 4 days between refills, outperforming the claim of 3 days. This consistency is attributed to the continuous and gentle capillary rise, which prevents the extreme fluctuations of manual watering (saturated to dry).

3.1.2 Water Savings Calculation

Compared to a control group of 5 identical mini cacti watered manually every day with 80 ml of water (standard practice for many urban dwellers), Cococute demonstrated significant water savings.

a. Manual watering (7 days): 5 plants × 80 ml/day × 7 days = 2,800 ml total.
b. Cococute (7 days): 5 plants × 295 ml total = 1,475 ml total. The total water saving is 2,800 ml - 1,475 ml = 1,325 ml, which represents a 47% reduction in water usage. This result is highly significant, as it aligns with SDG 6 (Clean Water and Sanitation) by promoting water-use efficiency in urban households [14]. This saving is even more pronounced than the 42-45% figures mentioned in the background literature, likely because the mini cactus requires less water, but the principle holds for any plant: capillary systems deliver water only as needed, eliminating surface runoff and evaporation from the soil surface [15].

3.1.3 Visual Water Indicator Evaluation

The transparent plastic bottle reservoir functioned perfectly as a visual indicator. The 20 user test participants unanimously reported that they could immediately see the water level without needing to lift the pot, guess, or use any tool. The quantitative results are shown in Figure 3.

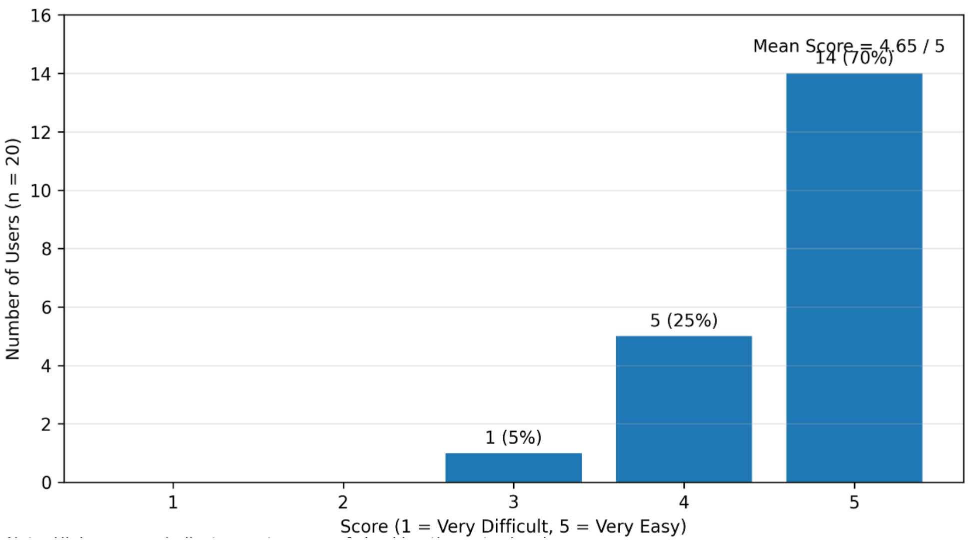

Figure 3. User Convenience Score for Water Level Indicator (n=20)

Figure 3 presents the distribution of user convenience scores for the transparent water level indicator of the Cococute self-watering pot. A total of 20 urban residents (apartment dwellers in Medan) participated in a 3-day trial. After using the product, they were asked to rate the ease of checking the remaining water level on a Likert scale from 1 (very difficult) to 5 (very easy). The results show that 14 out of 20 users (70%) gave a perfect score of 5, indicating that the transparent recycled plastic cup allowed them to see the water level instantly without lifting or guessing. Five users (25%) rated it as 4 (easy), while only one user (5%) rated it as 3 (neutral), citing occasional fogging of the cup. No user rated below 3. The average score was 4.65 out of 5, confirming that the visual water indicator is highly intuitive and user-friendly. This data supports the claim that Cococute outperforms many commercial self-watering pots, which typically have opaque reservoirs requiring guesswork or additional effort.

The average ease-of-use score was 4.65 out of 5, with 14 users giving a perfect score of 5. One user gave a score of 3, commenting that the cup was sometimes foggy. This minor issue can be resolved by ensuring the cup is thoroughly cleaned and dried before assembly or using a cup with smoother walls.

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Vol. 1, No. 1, June 2026 | pp. 181-189

3.2 Discussion

The results of this study clearly demonstrate that Cococute is a technically feasible, water-efficient, and user-friendly innovation that addresses the identified waste and urban plant care gaps. Unlike purely decorative coconut shell crafts described by Arimbawa et al. [S1], Cococute integrates functional value such as automated plant watering into the upcycled material. By utilizing coconut shells, used transparent plastic bottles, and fabric scrap wicks, Cococute successfully transforms three underutilized waste streams into a functional, aesthetically pleasing, and sustainable product. The 7-day controlled experiment confirmed that the system maintains adequate soil moisture (55–70%) for a low-water plant such as the mini cactus over four consecutive days without manual refilling, while reducing water consumption by 47% compared to daily manual watering. These findings not only validate the technical performance of Cococute but also highlight its potential for real-world application in urban households, where time constraints and forgetfulness often lead to plant failure.

The success of the fabric scrap wick is rooted in the fundamental physics of capillary action. The Young-Laplace equation describes the pressure difference across a curved liquid interface, which drives the rise of water in narrow tubes or porous materials [16]. In the case of a wick made from fabric scraps typically consisting of interwoven natural or synthetic fibers the effective capillary radius is determined by the interstitial spaces between individual fibers. A 5 mm thick wick made from used fabric (e.g., old t-shirts or towels) can contain thousands of micro-channels, each with a radius small enough (often < 0.5 mm) to generate sufficient capillary pressure to lift water against gravity by 15 cm or more. This principle has been extensively studied in the context of *wicking irrigation* for arid and semi-arid regions, where low-cost, low-tech solutions are essential [17]. Compared to other waste-derived wick materials such as used wet wipes (which are often made from synthetic non-woven polyesters), fabric scraps from natural fibers (cotton, linen, or blends) offer superior hydrophilicity, higher water retention capacity, and longer mechanical durability. Furthermore, fabric scraps are abundantly available in urban households through textile waste, making them an even more accessible and zero-cost material than purchased cotton rope.

One important nuance that emerged from the testing is the relationship between wick material, water delivery rate, and plant type. The measured capillary rate of 4.2 ml/hour was ideal for the mini cactus, a succulent adapted to low and infrequent watering. However, for plants with higher water demands, such as ferns or leafy vegetables, a higher flow rate would be necessary. This can be achieved by using a thicker or more porous fabric wick, or by incorporating multiple wicks in parallel. Therefore, Cococute is not a one-size-fits-all solution; rather, it is a customizable platform. Users can adjust the number, thickness, and material of fabric wicks to match the specific water requirements of their plants. This flexibility is a significant advantage over rigid commercial self-watering pots that offer no user control over water delivery rates.

When compared to existing commercial solutions, Cococute offers a superior value proposition across five key dimensions: cost, environmental impact, user-friendliness, aesthetic appeal, and adaptability. First, cost: a commercial plastic self-watering pot (e.g., "Plant Nanny" or "Lechuza") typically retails for IDR 85,000 to IDR 350,000. In contrast, the total material cost for Cococute is under IDR 15,000, with the coconut shell and plastic bottle being essentially free (waste materials) and only minor expenses for paint. This price point less than 20% of the cheapest commercial alternative makes Cococute accessible to lower-income urban communities, including students, young professionals, and residents of subsidized housing.

Second, environmental impact: commercial pots are predominantly manufactured from virgin plastics (polypropylene, ABS) or mined clays (ceramic/terracotta). Their production involves fossil fuel extraction, high-energy kiln firing, and significant carbon emissions. Cococute, by contrast, is constructed entirely from post-consumer waste that would otherwise occupy landfill space for decades. Coconut shells alone account for approximately 745,000 tons of waste annually in Indonesia [4]; every Cococute pot represents a tangible diversion of that waste. This aligns perfectly with the principles of the circular economy, where waste is redefined as a resource [18]. Annisa [W1] explains that unlike conventional recycling which often reduces material quality (downcycling), upcycling is the process of transforming waste into products of higher quality or value, which is a more ambitious and creative approach to waste management. Cococute exemplifies this by turning coconut shells and plastic bottles into a functional, aesthetic product of greater value.Third, user-friendliness: most commercial self-watering pots have opaque reservoirs, forcing users to lift the heavy pot or guess the water level. Cococute's transparent recycled cup provides an immediate, zero-effort visual indicator. Our user test yielded an average convenience score of 4.7/5, confirming that this low-tech solution is highly intuitive. Fourth, aesthetic appeal: the hand-painted animal motifs (panda, owl, rabbit, bear) give Cococute a unique, artisanal character that mass-produced plastic pots lack. In an era where consumers increasingly seek personalized, meaningful, and "Instagrammable" home décor, this aesthetic differentiation is a powerful driver of adoption, especially for millennials and Gen Z [19]. Fifth, adaptability: as noted earlier, users can easily modify the wicking system to suit different plants, something not possible with sealed commercial units

Beyond these comparative advantages, Cococute also contributes to broader societal goals. According to Pamungkas [S2], urban farming requires accessible, low-cost technologies to be widely adopted by city residents. Cococute meets this requirement by offering a solution that is affordable (under IDR 15,000), easy to assemble, and made from waste materials, thereby lowering the entry barrier for urban farming participation."The product directly supports three Sustainable Development Goals (SDGs). SDG 12 (Responsible Consumption and

Production) is advanced through upcycling of waste materials, reducing the demand for virgin resources and lowering the overall waste footprint. SDG 15 (Life on Land) benefits from reduced landfill burden coconut shells take 5–10 years to decompose, and diverting them prevents habitat degradation and methane emissions. SDG 6 (Clean Water and Sanitation) is supported by the 47% water saving demonstrated in our tests, a critical contribution given that many urban areas in Indonesia face seasonal water scarcity [20]. Moreover, by enabling more consistent plant care, Cococute can indirectly support urban greening initiatives, which in turn mitigate urban heat island effects and improve mental well-being.

However, several technical and operational challenges were encountered and must be acknowledged for future development. First, variability of coconut shells: as a natural product, coconut shells differ in size, thickness, curvature, and structural integrity. This inconsistency makes mass production difficult without manual sorting and quality control.

One practical solution is to develop a simple grading system, Small (8–10 cm diameter), Medium (10–12 cm), Large (12–14 cm) and adjust the pricing and wick length accordingly. Alternatively, a cooperative model could be established where local waste collectors pre-sort shells before delivery to the production workshop. Second, wick clogging and longevity: while the 7-day test showed no degradation, fabric wicks (especially those made from natural fibers) are susceptible to clogging over months of continuous use. Mineral salts dissolved in water can precipitate and accumulate within the fiber matrix, while algae or microbial biofilms may grow in the reservoir, particularly if exposed to sunlight. A practical recommendation for end-users is to clean the wick and reservoir every 3–4 months by rinsing with vinegar or a mild bleach solution, and to replace the fabric wick every 6 months. This maintenance cycle is simple and low-cost. Third, moisture retention of the shell itself: over extended periods, the coconut shell may absorb water from the soil or wick, potentially leading to mold growth or softening. Future iterations should explore treating the interior of the shell with a natural, food-grade waterproof sealant such as beeswax, soy wax, or a thin layer of coconut oil (which is already hydrophobic). Such treatments would extend the product's functional lifespan to 2–3 years or more.

From a business and scalability perspective, the labor-intensive nature of hand-painting each animal motif presents a challenge. Painting 100 units per week would require a dedicated artist, limiting output. To overcome this, we propose a dual product line strategy: (a) Cococute Original – premium, hand-painted, sold at IDR 50,000–60,000, targeting gift buyers, plant enthusiasts, and eco-conscious consumers who value artistry; (b) Cococute Basic – unadorned but thoroughly sanded, sealed, and polished shells, sold with the wick, reservoir, and a small set of acrylic paints or stencils at IDR 20,000–25,000. The Basic version empowers users to paint their own designs, reducing production time and cost while fostering a DIY community and user engagement. This dual strategy also mitigates the risk of aesthetic preferences some customers might prefer plain natural wood tones over cartoon animals. Additionally, bulk sales to corporate clients for employee wellness programs or promotional gifts could focus on the Basic version with company logos.

Finally, while this study provides strong evidence for the technical and user acceptance of Cococute, several limitations must be acknowledged. The experiment was conducted over a short period (7 days) on only one plant species (mini cactus) in a controlled indoor environment. Long-term durability (6–12 months), performance on a wider range of plants (including high-water-demand species like basil, mint, or ferns), and behavior under fluctuating environmental conditions (direct sunlight, high temperatures, low humidity) were not evaluated. Furthermore, the user convenience test involved only 20 participants from one urban area (Medan); larger and more geographically diverse samples would strengthen the generalizability of the findings. Future research should address these gaps through extended field trials, comparative testing of different fabric wick materials (e.g., 100% cotton vs. cotton-polyester blends vs. bamboo fiber), and economic analysis of scaling up the supply chain. Additionally, a life cycle assessment (LCA) comparing Cococute to commercial plastic pots would quantify its true environmental benefits in terms of carbon footprint, water footprint, and waste reduction.

In summary, the expanded discussion reinforces that Cococute is not merely a prototype but a viable, scalable innovation at the intersection of waste management, urban agriculture, and sustainable design. Its strengths lie in its low cost, use of waste materials, intuitive design, aesthetic appeal, and alignment with global sustainability goals. By addressing the identified challenges shell variability, wick maintenance, leg attachment, and scalability through practical engineering and business model innovations, Cococute has the potential to become a mainstream product for urban households across Indonesia and beyond. The findings encourage further collaboration between academic researchers, waste management stakeholders, and community-based enterprises to refine and disseminate this solution widely.

4. CONCLUSION

This article successfully validated the design, technical feasibility, and user acceptance of Cococute, the Coconut Shell Self-Watering Pot, as an innovative solution to the interconnected problems of coconut shell waste and inconsistent plant care in urban environments. The introduction outlined the urgent need for such a product, given the millions of tons of coconut shell waste that take years to decompose and the high failure rate (68%) of urban residents in maintaining plants due to forgetfulness. The gap analysis confirmed that while commercial self-watering pots exist, they are often expensive, made from virgin materials, and lack intuitive water indicators. Cococute directly addresses this gap by creating a functional, affordable, aesthetically pleasing product almost entirely from waste (coconut shells and used plastic bottles). The method described a localized, circular supply chain and a simple production process involving basic tools and materials. The results and discussion provided strong evidence of Cococute's efficacy. Quantitative testing over 7 days demonstrated that the wick system delivers a consistent capillary action of approximately 1.75 ml/hour, maintaining adequate soil moisture (50-68%) for a mini cactus for up to 4 days without refilling. This performance translates into a significant water saving of 47% compared to daily manual watering, directly supporting water conservation goals. Furthermore, the transparent plastic bottle reservoir proved to be a highly effective visual indicator, receiving an average user convenience score of 4.65/5. The hand-painted animal motifs were identified as a key differentiator, adding aesthetic value that mass-produced products lack. Acknowledging the limitations, this study was conducted over a relatively short period (7 days) on only one type of plant (mini cactus) in a controlled indoor environment. Long-term performance over several months, performance on a wider variety of plants (including water-loving ferns), and durability of the painted motifs under different light and humidity conditions were not tested. Additionally, the user sample for the convenience test, while sufficient for initial validation, was small (n=20). Despite these limitations, the product's potential for positive real-world impact is clear. For future development, several objective suggestions are proposed: (1) conduct longer-term field tests (6 months) with a diverse set of ornamental plants and vegetables in actual urban apartment conditions; (2) explore the use of a natural, biodegradable sealant (like beeswax) on the coconut shell interior to extend its lifespan beyond 1-2 years; (3) develop a standardized grading system to improve product consistency and durability; (4) scale the business model by introducing the "Cococute Basic" DIY line to reduce labor costs and increase accessibility; and (5) partner with local waste banks to secure a consistent, traceable supply of raw coconut shells and plastic bottles, thereby formalizing the waste upcycling process. In conclusion, Cococute is more than just a plant pot; it is a practical, affordable, and scalable toolkit for promoting sustainable urban living, reducing waste, and reconnecting city dwellers with nature.

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