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Exploring the usability of peanut shells as an alternative component in manufacturing pattern paper

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Abstract

This study explored the feasibility of utilizing peanut shells as an alternative component in the production of pattern paper for clothing construction. The research specifically aimed to determine the prospective usability of peanut-shell-based pattern paper, evaluate its marking performance after trial testing, examine the relationship between usability and marking performance, and propose recommendations based on the results. The study employed a descriptive–experimental research design and was conducted at one of the state universities in Cebu City, Philippines. A total of 38 respondents, consisting of 17 garment students, 2 cutters, and 19 sewers, were selected through convenience sampling. Data were gathered using a researcher-developed survey questionnaire that underwent pilot testing to ensure its validity and reliability. The collected data were analyzed using both descriptive and inferential statistical methods, including frequency counts, percentages, mean scores, ranking, and Pearson's correlation coefficient. Findings revealed that the peanut-shell-based pattern paper demonstrated satisfactory usability and effective marking performance during pattern drafting activities. Participants described the material as flexible, durable, and capable of producing visible and clear markings using common drafting tools. Statistical analysis also indicated a positive relationship between usability and marking performance. Overall, the results suggest that peanut shells can be processed into a practical and environmentally sustainable substitute for conventional pattern paper in garment construction.

Keywords: Peanut Shell-Based Pattern Paper; Garments; Fashion; And Design; Descriptive-Experimental Research Design; Cebu City Philippines

1. Introduction

The garment and textile sector in the Philippines operates as a sophisticated ecosystem centered on the technical nuances of clothing construction. This multi-stage industrial workflow encompasses every phase of production, from the nascent creative concept and meticulous textile selection to the final realization of a complete ensemble. Within this systematic cycle, the precision of pattern drafting stands as a critical pillar, dictating the structural integrity and aesthetic success of the finished product. However, as the global fashion landscape evolves, Filipino designers and manufacturers are increasingly pivoting toward a philosophy of "slow fashion" and radical sustainability. By synthesizing ancestral artisanal techniques with avant-garde modern aesthetics, contemporary creators are striving to produce apparel that not only honors the archipelago's rich cultural heritage but also drastically minimizes the ecological footprints associated with traditional mass production [1].

In stark contrast to these green aspirations, the foundational industries supporting garment construction—specifically paper manufacturing—remain tethered to resource-heavy and ecologically damaging methodologies. Standard industrial pulping and bleaching protocols frequently discharge a cocktail of toxic substances into the environment,

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contaminating both atmospheric and aquatic ecosystems. Moreover, the massive accumulation of paper refuse in landfills triggers the anaerobic decomposition process, releasing potent methane gas and exhausting limited land space. This environmental crisis is further exacerbated by the Philippines' profound and systemic dependence on foreign paper supplies. By the close of 2024, the nation's imports of paper, paperboard, and associated pulp products reached a staggering valuation of approximately US $1.58 billion [2]. This reliance does more than just inflate localized production expenses; it significantly magnifies the carbon intensity of the fashion supply chain due to the emissions linked to international maritime trade and complex cross-border logistics.

In response to these challenges, agricultural by-products have emerged as a revolutionary alternative for raw material sourcing. On a global scale, peanut cultivation generates roughly 46.4 million metric tons of biomass annually. Approximately 22 percent of this total—exceeding 10 million metric tons—is comprised of hulls or shells, which are predominantly treated as valueless waste [3]. Chemically, these peanut husks are a goldmine of lignocellulosic material, rich in the cellulose, hemicellulose, and lignin required for high-quality paper fabrication [4]. Scientific analysis indicates that groundnut shells possess a robust composition of approximately 35.7% cellulose, 18.7% hemicellulose, and 30.2% lignin [5]. By repurposing even, a marginal fraction of this agricultural waste stream, the Philippine paper industry could substantially decrease its reliance on virgin timber pulp, thereby mitigating the deforestation and environmental degradation inherent in conventional papermaking.

Despite the burgeoning global fascination with converting agricultural residues into "bio-materials," there remains a glaring scholarly void regarding the specific application of peanut shells as a primary source for pattern paper within the apparel industry. Existing academic inquiries often prioritize the use of these shells in biodegradable packaging, construction composites, or bio-energy production. Consequently, there is little to no empirical data verifying whether peanut-based fibers can satisfy the stringent durability, tensile strength, and flexibility standards required for high-fidelity garment drafting and repetitive industrial handling.

This research, therefore, seeks to fill this critical gap by evaluating the practical feasibility of utilizing peanut shell waste as a sustainable substitute for traditional pattern paper. By embracing this bio-based alternative, the study bolsters the transition toward a circular fashion economy and aligns directly with the United Nations Sustainable Development Goals (SDGs). Specifically, the project advances SDG 12 (Responsible Consumption and Production) and SDG 15 (Life on Land) by championing innovative resource management and the aggressive reduction of industrial waste. Ultimately, by bridging the divide between agricultural waste valorization and textile engineering, this study proposes a transformative model that supports both environmental preservation and the economic resilience of the local Filipino fashion industry.

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To achieve these objectives, the subsequent sections of this article are organized as follows: The next section details the experimental methodology, focusing on the chemical extraction of fibers from peanut shells and the papermaking process. This is followed by a presentation of the findings regarding the paper's usability and durability. The discussion then evaluates these results against industry standards for garment drafting, and finally, the paper concludes with a summary of the study's implications for the Philippine circular economy.

2. Materials and Methods

The research was conducted using a descriptive–experimental approach that utilized the Input–Process–Output (IPO) model as its foundational framework. In the Input phase, the study established the baseline for assessing the usability of peanut shell-based pattern paper by identifying key variables such as texture, thickness, durability, and marking performance across various media like pencils and permanent markers. The Process phase involved securing institutional approval from the Dean of College of Education from one of the state universities in Cebu City, Philippines and implementing the research design through controlled trials and data collection. Finally, the Output phase resulted in the production of a prototype peanut shell-based pattern paper, which demonstrated the material's potential as a sustainable industrial component. This entire sequence was carried out at Garments, Fashion, and Design department and a garments shop in Cebu City, Philippines providing a dual-environment perspective that bridged academic innovation with real-world garment production needs.

The participant pool consisted of 38 individuals selected through universal convenience sampling, primarily comprising BTVTEd garment students, professional cutters, and sewers. To ensure the integrity of the data, the researchers

prioritized ethical considerations and data privacy throughout the engagement. All participants were required to sign an informed consent form that detailed the study's purpose and their right to withdraw at any time. Furthermore, strict data privacy protocols were maintained; all survey responses were anonymized and stored securely in Microsoft Excel, ensuring that no personal identification was linked to the statistical results. This professional cohort provided a specialized feedback loop, with sewers representing the largest demographic at 50%, followed by students and cutters, all of whom possessed the technical expertise to evaluate the paper's performance in a high-stakes industrial setting.

The technical procedure followed a rigorous multi-stage papermaking process that involved cleaning, soaking, and boiling peanut shells for one hour to extract the necessary fibers. Once a smooth pulp was formed using a blender, the researchers conducted three distinct experimental trials to optimize the material's composition. Trial 1 and Trial 2 focused on varying ratios of peanut shell powder, cassava starch, and glue, but it was Trial 3 that proved most successful by incorporating 150 grams of powder with 360 milliliters of glue and 30% recycled paper bag to enhance the sheet's structural integrity. The resulting pulp was transferred to a papermaking mold, couched onto muslin cloth, and pressed with a sponge to remove excess moisture before being air-dried. This systematic refinement ensured that the final sheets achieved the necessary smoothness and stability required for professional garment drafting.

Data were gathered using a researcher-developed survey instrument that was pilot-tested for validity and reliability. This questionnaire utilized a 4-point Likert scale to quantify participant feedback on usability and marking performance, with scores ranging from 1.00 (Strongly Disagree) to 4.00 (Strongly Agree). The statistical treatment of the data involved frequency counts, mean calculations, and Pearson's r correlation to examine the relationship between the paper's physical usability and its functional marking ability. By converting qualitative observations from industry professionals and students into numerical data, the researchers were able to identify significant trends and correlations. This comprehensive analysis allowed the study to conclude that the peanut shell-based material could indeed serve as a functional, eco-friendly alternative to traditional timber-based pattern paper in the clothing construction industry.

3. Results and Discussion

The following section presents the results and a comprehensive discussion of the data gathered during the assessment of usability of peanut shell as an alternative component for manufacturing pattern paper.

Table 1 Usability

NO	INDICATORS	Mn	SD	VD
1	The fiber structure of the material makes it possible to draw neat and defined lines without bleeding or feathering when using a pencil or fine-tip pen.	3.5	0.6	SA
2	The material can be marked easily with different tools such as pencils, chalk, or tracing wheels, without needing too much pressure or risking damage to the tools.	3.34	0.67	SA
3	Markings made on the surface stay clear during normal handling yet can be erased cleanly when needed without leaving residue or shadow marks.	3.47	0.5	SA
4	When using a tracing wheel, the material shows a visible and lasting impression on the fabric without requiring extra force.	3.39	0.61	SA
5	Permanent marker lines remain sharp and intact on the material, with no bleeding or smudging even after some time.	3.34	0.6	SA
	Overall	3.41		SA

Legend: 3.25-4.00 Strongly Agree (SA); 2.50-3.24 Agree (A); 1.75-2.49 Strongly Disagree (SD); 1.00-1.74 Disagree (D)

The peanut shell-based material achieved an overall mean score of 3.41 ("Strongly Agree"), confirming its high usability for pattern-making. The highest-rated attribute was the material's fiber structure (M = 3.50, SD = 0.60), which allowed for precise, bleed-free markings—a finding that aligns [4] regarding the benefits of cellulose-rich residues for surface quality. While items concerning permanent markers and tool versatility received the lowest scores (M = 3.34, SD = 0.60–0.67), they remained within the "Strongly Agree" category, proving the material's functional effectiveness.

The results are consistent with the findings [4], particularly the highest mean score for neat line formation without bleeding (M = 3.50), which supports the claim that cellulose-rich agricultural residues can improve paper strength and print quality. Even the lowest-rated indicators (M = 3.34) still demonstrate that the material remains practically

functional for its intended use. From a sustainability perspective [3] in emphasizing the value of repurposing peanut shells instead of discarding them as waste. Reinforcing previous research that agricultural by-products can achieve performance levels comparable to those of conventional materials when appropriately processed [6].

Table 2 Marking Ability

NO	Indicators	Mn	SD	VD
1	The surface of the material supports drawing lines that stay crisp and consistent, with no feathering or ink spread.	3.42	0.61	SA
2	The material works well with common pattern-making tools like pencils, markers, and tracing wheels, without demanding extra pressure.	3.42	0.65	SA
3	Lines made on the material resist smudging from handling and stay visible over time.	3.26	0.59	SA
4	Pencil marks on the material can be erased fully and neatly without leaving stains or harming the surface.	3.26	0.63	SA
5	The material responds well to tracing wheels, producing clear and accurate impressions that transfer smoothly onto fabric.	3.42	0.65	SA
	Overall	3.36	0.66	

Legend: 3.25-4.00 Strongly Agree (SA); 2.50-3.24 Agree (A); 1.75-2.49 Strongly Disagree (SD); 1.00-1.74 Disagree (D)

As shown in Table 2, the peanut shell material achieved an overall mean score of 3.36 (SD = 0.66), falling under the "Strongly Agree" category and confirming its effectiveness in maintaining markings. The highest-rated items (M = 3.42) highlighted the material's compatibility with common fashion design tools, allowing for clear, consistent lines without excessive pressure. Conversely, smudge resistance and erasability received the lowest scores (M = 3.26) but remained within the "Strongly Agree" range, indicating the material is reliable for repeated use and easy corrections.

The high ratings for tool compatibility (M = 3.42) can be attributed to the material's lignocellulosic composition, containing 37–45% cellulose and 12–18% hemicellulose, which facilitates good ink adhesion and clear impressions [7]. Even the lower scores for smudge resistance and erasability (M = 3.26) fall within the "Strongly Agree" range, indicating that the material can still accommodate corrections, an important aspect of pattern-making processes. These findings support the conclusions of [8], demonstrating that peanut shells are suitable for paper products requiring precise marking, while also contributing to circular economy objectives by offering an alternative to virgin pulp through the use of agricultural waste [9].

Table 3 Correlation Between the Usability and Marking Performance

Variable	r	Strength of Correlation	p-value	Decision	Interpretation
Usability vs Marking Ability	0.748	Strong Positive	< 0.001	Significant	Strong Positive Correlation

Legend: Strength of Correlation (r): 0.91-1.00 Very Strong; 0.71-0.90 Strong; 0.51-0.70 Moderate; 0.31-0.50 Weak; 0.00-0.30 Negligible Level of Significance (p): $p < 0.05$ Significant (S); $p > 0.05$ Not Significant (NS)

As shown in Table 3, the correlation analysis revealed a strong positive relationship between usability and marking performance ($r = 0.748$, $p < 0.001$). This statistically significant result indicates that as the material's ease of use improves, its performance during marking tasks increases proportionally.

This finding suggests that enhancements in usability directly contribute to improved marking performance, which is essential for maintaining consistent quality in pattern-making tasks. Consistent with [10], the result supports human-centered design principles that emphasize the relationship between material properties and user efficiency. Practically, this indicates that the material is likely to be both manageable and effective for key pattern-making activities. Moreover, in line with [11], the outcome demonstrates that sustainable material innovations can uphold or even enhance technical performance, reinforcing previous evidence linking the composition of agricultural residues to paper functionality.

4. Conclusion

This study successfully confirms that exploring the usability of peanut shells as an alternative component for manufacturing pattern paper yields a functional, eco-friendly, and durable material suitable for professional clothing construction. Participants provided positive feedback on its structural integrity, yet further research is recommended to enhance smudge resistance and large-scale manufacturing potential. Based on these findings, it is recommended that this peanut-shell and recycled paper composite be adopted by educators and dressmakers as a practical substitute for traditional paper. Future studies should focus on optimizing the material's refined quality and evaluating production costs to fully integrate this sustainable innovation into the global fashion industry's circular economy.

Compliance with ethical standards

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Disclosure of conflict of interest

There was no conflict of interest.

Statement of ethical approval

This study did not undergo formal ethical review, as it exclusively involved the voluntary participation of student respondents and presented no foreseeable risk or use of sensitive or intrusive procedures. Nonetheless, the researchers ensured that all aspects of the study were conducted in full compliance with the established research standards and institutional guidelines of a state university in Cebu, Philippines.

Statement of informed consent

Prior to participation, all respondents were fully informed about the nature and purpose of the study, as well as the procedures involved. Their voluntary agreement to take part was obtained before any data collection began. Participants were also made aware of their right to refuse or withdraw from the study at any point without penalty. The researchers ensured that all information gathered remained confidential and was handled with strict privacy throughout the research process.

References

[1] United Nations Global Compact, "UN Global Compact strategy 2024–2025: Accelerating collective impact for the SDGs," 2024. [Online]. Available: https://unglobalcompact.org/library/6200

[2] Trading Economics, "Philippines imports of paper and paperboard, articles of pulp, paper and board," *Trading Economics*, 2025. [Online]. Available: https://rb.gy/isiafk

[3] S. Gerber and S. B. Roberts, "Peanut hulls, an underutilized nutritious culinary ingredient: Valorizing food waste for global food, health, and farm economies—a narrative review," *Front. Nutr.*, vol. 11, Art. no. 1453315, 2024. [Online]. Available: https://sl1nk.com/6lTbV

[4] R. Mandala, G. Hegde, D. Kodali, and V. R. Kode, "From waste to strength: Unveiling the mechanical properties of peanut-shell-based polymer composites," *J. Compos. Sci.*, vol. 7, no. 8, p. 307, 2023. doi: 10.3390/jcs7080307

[5] M. Y. Y. Abduh, C. R. Ramadhan, A. P. Fadhlilah, S. D. F. Abdul, and K. H. Burhan, "Solid-state fermentation of groundnut (*Arachis hypogaea*) shell using *Trichoderma sp.*, tape yeast, and tempeh yeast to produce cellulase," *J. Appl. Biol. Biotechnol.*, vol. 10, no. 4, pp. 153–160, 2022. doi: 10.7324/JABB.2022.100421

[6] L. J. A. Angat et al., "From nuts to bag: Peanuts (*Arachis hypogea*) shells as sustainable alternative source in making eco-friendly paper bags," *Multi-Discip. Res. J.*, 2024. [Online]. Available: https://l1nq.com/iTzZg

[7] A. H. Tayeb, M. Tajvidi, and D. Bousfield, "Alkaline hydrolysis of biomass as an alternative green method for bioplastics preparation: In situ cellulose nanofibrillation," *Chem. Eng. J.*, vol. 454, Art. no. 140171, 2022. doi: 10.1016/j.cej.2022.140171

[8] Tyohemba et al., "Agricultural waste utilization for the production of paper-bags: A potential substitute for plastics bags in food packaging," 2025. [Online]. Available: https://www.researchgate.net/publication/386724562

[9] TAL-L Materials, "Sustainable production guidelines," 2024. [Online]. Available: https://www.tallmaterials.com/

[10] I. Lykourentzou, A. Antoniou, Y. Naudet, and S. P. Dow, "Self-organization in online collaborative work settings," *Collect. Intell.*, vol. 1, no. 1, 2022. [Online]. Available: https://sl1nk.com/gEqyy

[11] L. A. Worku et al., "Agricultural residues as raw materials for pulp and paper production: Overview and applications on membrane fabrication," *Membranes*, vol. 13, no. 2, p. 228, 2023. [Online]. Available: https://sl1nk.com/AQS9G