

# Sustainable Vest Development From Textile Waste Using Hand Embroidery Techniques

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## Abstract.

*This study aimed to develop sustainable vests from textile waste using hand appliqué embroidery and describe their feasibility and consumer appeal. Research and development employed the 4D model, limited to Define, Design, and Develop. Three vests were produced from cotton scraps, denim, and combinations of used clothing and kebaya scraps. Data were collected through observation, documentation, expert assessment, and questionnaires completed by 15 consumers. Two experts assessed each vest using 15 items on a five-point scale. Recalculated expert feasibility scores were 89.33%, 89.33%, and 97.33%, with an overall score of 92%. Recorded consumer totals were 961, 990, and 1,006. Consumer percentages require reconciliation because the questionnaire contains 15 items whereas the summary uses a 14-item maximum. The products demonstrate the feasibility of combining textile reuse and hand embroidery; broader consumer acceptance and environmental benefits require further testing.*

**Keywords:** sustainable fashion, textile waste, hand embroidery, vest and upcycling.

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## I. INTRODUCTION

Developing sustainable fashion requires attention to the materials used, the processing process, and the possibility of reusing the product after its initial use. In the fashion industry, fabric scraps from pattern cutting often remain in uneven sizes. Conversely, used clothing may contain parts that are still wearable even if their shape or appearance no longer meets the user's needs. Both of these material sources offer opportunities for product development through a design approach that places the characteristics of the material at the heart of creation.

The problem of textile waste relates to how materials are collected, sorted, and directed for subsequent use. Tang (2023) places collection, sorting, and processing technology as crucial components of textile waste management. In the context of small-scale fashion development, initial sorting is a step that can be taken before materials enter the production process. Fabrics that still maintain their strength and appearance can be considered for reuse, while those that do not meet requirements need to be separated.

Pre-consumer and post-consumer waste have distinct characteristics. Fabric scraps are leftovers from production activities, while used clothing has undergone previous use. These differences influence hygiene considerations, fabric size, stitching conditions, and the suitability of the material for new designs. Using these materials requires design decisions that take into account the actual conditions of each piece. Therefore, developing products from textile waste cannot simply be done by replacing new materials with used ones without considering their characteristics.

Sustainable fashion provides a framework for considering the relationship between clothing creation and resource management. Utami et al. (2025) discussed the application of environmentally friendly materials, zero-waste techniques, local production, and consumer education in the practices of a fashion brand in Indonesia. The study also revealed the challenges of cost, consumer awareness, and infrastructure. Therefore, sustainable product development requires consideration of quality and user acceptance, in addition to the initial concept of material utilization.

Upcycling is a development approach relevant to the utilization of used clothing and scrap fabric. In this approach, materials are processed into products with new functions or appearances through design decisions. Annesha and Titisari (2023) identified a series of upcycling practices that include idea development, design and production, post-production, and sales. This process demonstrates the interplay of material availability and design ideas. The design needs to adapt to available materials, while material selection is guided by the desired product concept.

The use of leftover fabric has also been applied to craft activities and fashion development. Arsanti and Sekarsih (2022) demonstrated the context of utilizing clothing to craft bags through a mini-workshop. Ari et al. (2023) discussed the use of scraps for children's clothing, focusing on concepts and color boards. Both

studies provide a basis for considering leftover materials as creative materials that require targeted processing. However, the type of product, user needs, and method of evaluating the results still need to be tailored to the objectives of each research.

The vest was chosen as the object of development because it offers a front and back area that can be explored through material composition and decorative elements. As a sleeveless outer garment, the vest allows for the development of various shapes and decorative placements in specific areas. In this research, this exploration space was used to combine textile waste with hand-embroidered appliqué. The product selection was based on the need to produce clothing that maintains its function while showcasing the character of the reused materials.

Hand-applique embroidery combines fabric pieces with a base material through a decorative stitching and sewing process. This technique offers the opportunity to utilize patchwork of varying shapes, colors, and textures as part of a fashion composition. Butar-Butar et al. (2025) explain that the development of embroidery techniques involves the exploration of basic stitches, materials, and complementary techniques. This understanding supports the development of embellishments tailored to the characteristics of textile waste, without compromising the precision of the workmanship and the cohesiveness of the product's appearance.

The value of hand embroidery can also be understood through the context of craftwork. Prihatin (2022) discusses traditional embroidery in economic, social, and cultural dimensions. Its relevance to this study lies in its emphasis on manual craftsmanship as part of the product's character. However, this vest study did not measure cultural preservation or the social impact of embroidery activities. Embroidery is operationally positioned as a decorative technique whose assessment is related to neatness, motif suitability, and integration with the clothing design.

Research related to decorative techniques provides an example that development outcomes need to be assessed based on the resulting product. Apriliasari et al. (2022) examined the application of painting and embroidery to daytime party wear through expert testing. Putri and Prihatina (2025) developed a denim jacket through an exploration of slashing combined with patchwork. Meanwhile, Zakiyah et al. (2023) processed post-consumer denim waste using water-soluble embroidery. The differences in techniques in these studies suggest multiple material utilization pathways, but the results cannot be directly translated to the feasibility of hand-embroidered vests.

Product attractiveness is another consideration after assessing technical quality. Kim et al. (2021) differentiated consumer perceived value and risk for secondhand, upcycled, and recycled clothing. This framework demonstrates the importance of distinguishing product perceptions from their material properties. In this study, consumer responses were examined through attitudes toward the product, uniqueness, perceived environmental value, emotional responses, and ownership interest. These assessments were based on product displays, not actual purchase transactions.

Based on this background, this study focuses on the development of three vests through the utilization of textile waste and hand-applique embroidery. The intended contributions include documentation of the development process, expert feasibility assessment, and a description of initial consumer responses to the three product variations. The study is not intended to prove that one decoration technique is superior to all others. The differences in material, shape, and composition of the three vests are treated as characteristics of the products being developed, not as controlled experimental variables.

The purpose of this research is to describe the process of developing a sustainable vest from scrap fabric and used clothing, determine product feasibility based on expert assessment, and describe product appeal based on consumer responses. The term "sustainable" in this research is limited to material reuse strategies. The extent of waste reduction, energy use, water requirements, and economic benefits have not been measured and therefore cannot be used as a basis for claiming quantitative success of the research.

## II. METHOD

The research used a research and development (R&D) method. This approach was chosen because the research objectives encompass product creation and evaluation of its development results. Sugiyono (2019)

serves as a general reference for research methods, while Okpatrioka (2023) emphasizes a systematic development process to produce a reliable product. In its implementation, quantitative data is obtained from assessment scores, while process documentation and expert input are used to explain product characteristics and directions for improvement.

The development model used is the 4D model, with implementation limited to Define, Design, and Develop. The Disseminate stage was not implemented as a widespread testing stage. This limitation is in accordance with the focus on the creation of three products, feasibility assessment, and initial consumer response testing. Siregar (2023) discusses the stages of the research and development model, while Waruwu (2024) outlines the concepts and stages of R&D. In this study, the model is used as a framework for fashion product development, with activities at each stage tailored to the object, the vest.

The research activities are within the context of the Fashion Design Vocational Education Study Program and the fashion practice environment in Medan City. Materials were obtained from leftover production of fashion businesses, used clothing that is still usable, and the researcher's collection of used clothing. The research documentation in the source text is dated 2026. The detailed implementation date range is not stated precisely, so this article does not include months or dates that are not available in the research records.

The research subjects were three vests developed with different material characteristics. The first vest used cotton scraps, the second used denim, and the third used a combination of used clothing and kebaya scraps. These descriptions follow the product descriptions in the research report. Visual documentation was used to support the description of shape and appearance, while the product numbering followed the sequence in the assessment table. All three vests were developed and assessed separately.

The product evaluation subjects consisted of two experts and 15 consumers. This number follows the implementation reported in the results section, not the sample size outlined in the initial section of the thesis. Subjects were selected using purposive sampling, based on their expertise or interest in fashion products. Experts assessed product quality, while consumers provided feedback on each vest. Consumer demographic characteristics were not detailed in the source text, so the results cannot be generalized to the entire fashion market.

In the Define stage, activities focused on identifying textile waste utilization issues and determining product needs. Observations included material availability, fabric condition, and opportunities for reuse in clothing. This information served as the basis for selecting the vest and applique embroidery technique. The output of this stage was the determination of the development scope: three products combining waste materials with decorative elements, which were then assessed based on their feasibility and potential user feedback.

The design phase encompasses the vest's shape, material composition, color scheme, and embroidery placement. Materials are selected based on their condition, pattern, texture, and suitability to the design. The relationship between material and design is crucial because textile waste is not readily available as a uniform surface. Design and material documentation helps explain the rationale for combining fabric pieces into the product. This phase provides visual and technical guidelines for the manufacturing process.

The Develop stage includes material preparation, cleaning, processing necessary materials, pattern making, cutting, assembling parts, sewing, embroidery, and finishing. After three products are completed, an expert assessment is conducted, followed by a consumer appeal test. Expert input is positioned as the basis for improvement. However, the source manuscript does not provide details of changes before and after revisions and reassessments, so this study does not report score increases resulting from specific revisions.

Data collection was conducted through observation, documentation, and questionnaires. Observations were used to record the material processing and product manufacturing processes. Documentation included photographs of the materials, processing stages, the final product, and the assessment process. Questionnaires were used to obtain eligibility scores and consumer feedback. These three techniques serve different purposes: photographs support process traceability, while assessment scores serve as the basis for describing the product evaluation results.

The expert feasibility questionnaire consists of 15 items grouped into five aspects. Each aspect contains three items: design or aesthetics, engineering, innovation, product quality, and usability. The assessment scale is 1–5, ranging from very poor to excellent. The maximum score for one expert for a product is 75. With two experts, the maximum score for each vest is 150, while the maximum combined score for three vests is 450.

Table 1. Scope of expert assessment

| Aspect              | Focus of assessment                                  |
|---------------------|------------------------------------------------------|
| Design              | Color, proportion, uniqueness                        |
| Technique           | Embroidery, motifs, use of materials                 |
| Innovation          | Waste utilization, creativity, potential sales value |
| Product quality     | Stitching, finishing, strength                       |
| Eligibility for use | Comfort, function, appeal                            |

The consumer questionnaire in the appendix contains 15 statements with the options strongly agree, agree, neutral, disagree, and strongly disagree, scored on a 5-to-1 scale. The grid groups the statements into four product attitude items, three epistemic value items, four environmental value items, three emotional value items, and one purchase intention item. The consumer value framework refers to Kim et al. (2021), with editorial adjustments to the developed framework. These adjustments do not necessarily mean the instrument has the same psychometric properties as the original instrument.

The content validity of the instrument in this thesis was assessed through expert judgment by a single validator, who considered the appropriateness of the indicators, language, and assessment objectives. This article maintains this procedure as reported. Although reliability testing is mentioned in the methods section of this thesis, coefficient values and test results are not presented. Therefore, the instrument cannot be considered statistically reliable. This reporting limitation is taken into consideration when interpreting the assessment scores.

Quantitative analysis uses descriptive statistics in the form of summed scores and percentages of the maximum score. The percentage is calculated using the following equation.

$$P = (S / N) \times 100\%$$

In this equation, P is the percentage of assessments, S is the total score obtained, and N is the maximum score corresponding to the number of assessors, the number of items, and the highest score for each item. The same formula is used for each product and the combined summary as long as the denominator is consistent. The use of percentages is intended to summarize the assessment results, not to transform the data into evidence of effectiveness or cause-and-effect relationships.

The feasibility categories follow the ranges used in the report: 81–100% highly feasible, 61–80% feasible, 41–60% moderately feasible, 21–40% less feasible, and 0–20% not feasible. The values within the study range fall far enough between the categories that groupings do not rely on rounding around these boundaries. Percentages are presented consistently rounded to two decimal places. The categories are used for interpretation based on the instrument, not as certification of product quality.

Prior to drafting the article, the summary scores were compared with the sum of the components presented in the thesis. In expert assessments, the total scores could be reconciled from the tables for each product. In consumer assessments, discrepancies were found between the number of items in the grid and the number of items in the summary. Because the item-by-item answer sheets could not yet be established as a basis for a complete recalculation, the article presents the available aggregate scores and explains the limitations of the denominator. The percentage of consumers from the summary is treated as a provisional figure that requires checking against the original questionnaire.

### III. RESULTS AND DISCUSSION

The development resulted in three vests utilizing leftover textile materials and used clothing through hand-embroidered applications. The primary research outcomes include physical products, workmanship

documentation, expert feasibility scores, and initial consumer feedback. These results demonstrate the process of transforming materials into assessable products. The discussion is limited to available findings and excludes material testing results, production costs, or environmental measurements not conducted in the report.

The definition phase resulted in the decision to utilize two groups of materials: fabric scraps from production activities and used clothing that still has wearable parts. In the context of this development, leftover materials are not treated as materials that can be directly compared in quality. The initial condition, size, color, pattern, and texture are all considerations in the selection. This process is crucial for connecting the upcycling idea with the construction needs of the clothing to be created.

Documentation shows the collection and sorting of materials prior to the manufacturing process. This activity resulted in the selection of materials that were then used in the vest design. Sorting provided an opportunity to determine which fabrics could serve as the main material and which were more suitable for decoration. At this stage, the characteristics of the material both limit and open up design possibilities. Not all of the patchwork had to be placed on the same surface; decisions about its use depended on the design and the material's characteristics.



**Fig. 1.** Collected textile materials Source: Research documentation (2026)

The design phase yielded three alternative vests with varying material compositions and embellishment placement. These differences demonstrate the design's response to the source material, not simply the repetition of a single decorative pattern. The first product used cotton patchwork, the second used denim, and the third used a combination of secondhand clothing and kebaya patchwork. All three remained within the same development direction: material reuse and the addition of hand-embroidered elements.

The design considers the balance of color relationships, fabric surfaces, and decorative details. This aligns with the attention to color concepts and composition in the use of patchwork in Ari et al.'s (2023) research. In this study, design results were not measured using objective aesthetic indicators such as surface area or color proportions. The available evidence was the product's physical appearance and expert judgment, so the quality of the composition was interpreted based on the product's evaluation.

During the manufacturing stage, documentation shows the cleaning of materials, pattern making, piece assembly, and sewing and embroidery. Cleaning is performed before the materials are used further. The dyeing process also appears in the documentation for used clothing processing. However, the dye types, dosages, temperatures, and water usage are not detailed, so the documentation cannot be used to certify that the entire process meets specific environmental standards.



**Fig. 2.** Preparation for cleaning materials Source: Research documentation (2026)

Patternmaking and cutting the material connect the vest's shape to the available material. After the pieces are assembled, sewing is performed to create the product's construction. Hand embroidery is then placed according to the design so that the decorative pieces blend with the base material. The final finishing is focused on a neat appearance. These stages demonstrate that development goes beyond simply attaching ornaments to the garment, but also encompasses assembling the material into a garment that has both form and function.

Process documentation also indicates that manual skills are involved in assembly, sewing, and decoration. For products made from diverse materials, technical decisions need to be made considering the joining points and the thickness of the seams. This explanation represents an interpretation of the construction requirements of the products; the study does not present experimental tests on the best joining types or thicknesses. Therefore, the article does not establish a single technical procedure as a standard for all types of textile waste.



**Fig. 3.** Sewing and embroidery process Source: Research documentation (2026)

The final results demonstrate the visual character differences of the three vests. Product documentation displays variations in surface finishes, plane composition, and decoration on both the front and back. These differences form the basis for assessing each product separately. The combined photographs are maintained as a single document because the same image is used repeatedly in the source text. The material identity of each vest is based on the research description, so the positional order in the photographs is not used to re-assign product numbering.



**Fig. 4.** Documentation of three vests resulting from development. Source: Research documentation (2026)

The first vest is described as a product made from cotton patchwork. In this product, leftover fabric is used as part of the garment's surface structure and is combined with hand embroidery. The second vest uses denim with adjustments to the composition and embellishments to suit the material's characteristics. The third vest combines secondhand clothing and kebaya patchwork. These variations demonstrate several

development possibilities within a single garment, although research has not yet compared the results to vests made from new materials.

Hand-applique embroidery provides a decorative role through the placement of fabric pieces and thread work on the surface of the material. The combination of these elements can be interpreted as an effort to create a visual identity from available materials. This relates to Butar-Butar et al.'s (2025) description of the exploration of materials and stitches in the development of embroidery. In this study, the success of the technique's application is primarily seen through expert assessment of neatness, motifs, and the appropriateness of the materials used.

Expert assessments were conducted on three products using 15 items on each vest. A detailed table in the thesis records identical scores from both experts: 67 for the first vest, 67 for the second vest, and 73 for the third vest. The score agreement is reported based on available data. Aggregate agreement is not interpreted as evidence of inter-rater agreement on each item because agreement statistics and score pairs per item are not presented.

Table 2. Recap of feasibility by two experts

| Product | Expert 1 | Expert 2 | Score | P (%) |
|---------|----------|----------|-------|-------|
| Vest 1  | 67       | 67       | 134   | 89.33 |
| Vest 2  | 67       | 67       | 134   | 89.33 |
| Vest 3  | 73       | 73       | 146   | 97.33 |
| Total   | 207      | 207      | 414   | 92.00 |

Maximum score: 150 per product and 450 for three products. All products are categorized as very suitable. Source: Recalculated from the thesis' detailed table.

The sum of the scores for each product yields  $134 + 134 + 146 = 414$ . With a maximum score of 450, the overall percentage is 92%. This figure corresponds to the calculation results described elsewhere in the thesis, but differs from the total of 404 and the percentage of 89.77% listed in the source summary table. The article uses 414 and 92% based on verifiable components. This correction is an arithmetic correction to the summary, not a change to the scores assigned by the experts.

The first and second vests received the same percentage, 89.33%, while the third vest received 97.33%. All three were categorized as very suitable based on research guidelines. This difference indicates that the third vest received a higher aggregate rating than the other two products. However, this descriptive assessment does not prove that the kebaya patchwork material alone contributed to the increased score. The products also differ in design, material composition, and decoration, so the contribution of each element cannot be separated.

Aspect-by-aspect analysis provides more specific information than the overall score. In the two assessment tables, design and engineering each received the maximum scores across all vests. The innovation aspect received a 14 for the first vest and a 15 for the next two. For product quality, the scores were 12, 11, and 13, respectively. The usability aspect received 11, 11, and 15. These values indicate that the overall score is very good, but there are still areas requiring technical attention.

Table 3. Scores per aspect for each expert

| Aspect      | V1 | V2 | V3 |
|-------------|----|----|----|
| Design      | 15 | 15 | 15 |
| Technique   | 15 | 15 | 15 |
| Innovation  | 14 | 15 | 15 |
| Quality     | 12 | 11 | 13 |
| Eligibility | 11 | 11 | 15 |
| Amount      | 67 | 67 | 73 |

The maximum for each aspect is 15. The detailed tables for expert 1 and expert 2 in the source contain identical values. Source: research data (2026).

In the second vest, the product quality aspect received 11 out of 15, or 73.33%. This score is lower than the design and engineering aspects. Quality aspects include stitching, finishing, and material strength or construction. Therefore, subsequent improvements will require reviewing these components on the detailed

assessment sheet. Aggregate data does not yet indicate the weakest item, so it is insufficient to conclude the presence of a specific defect or determine the type of revision without further product inspection.

The first vest also scored 11 out of 15 for usability, while the third vest achieved 15. These aspects encompass comfort, functional suitability, and visual appeal. These assessments provide insights into expert perceptions of product functionality. However, the study did not provide comfort measurements during repeated wear or testing on various body sizes. The reported usability therefore refers to expert judgment in the context of this development.

These results can be compared with the research of Apriliasari et al. (2022), which used expert assessment to evaluate clothing with decorative techniques. Both demonstrate the need for post-production evaluation. Comparisons were not made by ranking the percentages between publications because the types of clothing, instruments, assessors, and production contexts differed. The relevant similarity lies in the assessment's function as a basis for product quality considerations and a basis for improvement.

The attractiveness test was conducted after expert assessment, with 15 consumers evaluating the three vests using separate sheets. The summary showed a score of 961 for the first vest, 990 for the second, and 1,006 for the third. The combined score for the three vests was 2,957. Based on the recorded scores, the third vest ranked highest, followed by the second and first vests. This ranking is descriptive and has not been tested for significance.

There are differences in the calculation basis for consumer data processing. The grid and attached questionnaire contain 15 items arranged in a 4 + 3 + 4 + 3 + 1 format. Meanwhile, the aspect summary table uses a 4 + 3 + 3 + 3 + 1 format, resulting in a total of 14 items. With 15 assessors and a maximum score of five, the 14 items yield a maximum score of 1,050 per product. If all 15 items are assessed, the maximum score is 1,125 per product. This difference is particularly evident in the environmental value group.

Table 4. Consumer scores and percentage recap

| Product  | Score | P recap (%) |
|----------|-------|-------------|
| Vest 1   | 961   | 91.52       |
| Vest 2   | 990   | 94.29       |
| Vest 3   | 1,006 | 95.81       |
| Combined | 2,957 | 93.87       |

The recapitulation was calculated using a denominator of 1,050 per product and a combined 3,150, following the 14-item recapitulation. The figures are preliminary and not the final results of the 15-item questionnaire.

The percentages in Table 4 represent calculations based on the denominators used in the source summary, rounded to two decimal places. Due to the discrepancy in the number of items, these values cannot be confirmed as the final percentages for the attached instrument. Simply changing the denominator to 1.125 does not resolve the issue, as it is unknown whether the scores for items not included in the summary are included in the numerator. The necessary solution is to re-match the responses per item, not to select a denominator that yields a specific percentage.

Rounding differences also appear in the source reports. A score of 990 divided by 1,050 yields 94.29% after rounding, and 1,006 divided by 1,050 yields 95.81%. The 94.28% and 95.80% figures in the thesis appear to be decimal truncations. The article standardizes the rounding to allow for traceability of the calculation procedure. This standardization does not address the issue of item count; the two are distinct issues and need to be understood separately.

Given these limitations, consumer results are used primarily to illustrate initial responses and aggregate score rankings. It is not possible to assert that all products have been widely accepted by the market. In addition to the limited number of respondents, the sample selection was not random, and detailed information about respondents' backgrounds was not collected. The aggregate score data also does not reflect the distribution of ratings, so it is unclear whether consumer ratings are relatively uniform or whether there are significant differences between individuals.

The purchase intention scores in the summary were 66, 64, and 69 out of a maximum of 75 for the three vests. This item has a maximum score consistent with one statement, 15 consumers, and a five-point scale. The percentages were 88%, 85.33%, and 92%, respectively. Interest in owning a product still needs to be

distinguished from purchasing behavior. The study did not set an offering price or record transactions, so the results cannot be considered evidence of commercial success.

The distinction between interest, perceived value, and purchase intention aligns with Kim et al.'s (2021) study of consumer responses to various types of circular fashion. In this study, products that scored high on appearance or uniqueness did not necessarily lead to purchase decisions in real-world situations. This is relevant for future development, as factors such as price, size, comfort, and usage needs can influence decisions after consumers examine the product more closely.

From a design practice perspective, the research demonstrates that heterogeneous materials can be combined into a single fashion concept. This process aligns with Annesha and Titisari's (2023) framework, which places material sourcing as part of the upcycling practice. The findings of this study provide an example of its application in vests, specifically through hand-embroidered appliqués. Its contribution lies in product documentation and initial evaluation, and therefore should not be interpreted as a business model or production system that has been tested on an industrial scale.

The technique used also differs from Putri and Prihatina's (2025) exploration of slashing on denim jackets and Zakiyah et al.'s (2023) water-soluble embroidery. The first study developed surface effects through slashing techniques, while the second produced alternative fabrics from recycled denim waste. The vest development utilized material cuts and hand embroidery as part of the final garment. The differences in object and technique clarify the research's position without necessarily claiming that the results are superior to those of the previous study.

Material reuse provides a relevant development direction for vocational fashion design education. The processes of sorting, designing, sewing, and evaluating can be used as examples of activities that connect technical skills with considerations of material use. However, the study did not measure student learning outcomes or changes in environmental awareness. The educational implications are the potential use of the results, not findings about the effectiveness of a learning model.

The meaning of sustainability in products must also be placed within the scope of the evidence. Three vests used materials that were previously leftover from production or used clothing. This demonstrates reuse practices, but does not provide figures on waste reduction. There are no records of material weights before and after production, new scraps, energy requirements, or product lifespan. As discussed in Tang (2023) regarding textile management, environmental assessment requires attention to the entire process, not just the source of the material.

Similarly, the economic value increase could not be calculated because labor, additional materials, processing, and selling price costs were not reported. Utami et al. (2025) showed that costs and consumer awareness can be challenges to sustainable fashion practices. In this context, the attractiveness score provides initial guidance for product exploration, but business feasibility requires cost recording and price testing. This limitation on claims ensures that product assessment results do not go beyond the data collected.

Limitations of the study include three products that do not represent the full range of textile waste, two experts, and 15 consumers selected purposively. Respondent demographics, detailed research timeframes, reliability coefficients, and individual data are not yet fully available in the report. Furthermore, inconsistencies in consumer summaries require the percentage results to be interpreted tentatively. Further testing is needed, starting with reorganizing the baseline data to provide a consistent basis for product interpretation.

Overall, the strongest evidence in the report is the successful implementation of the three vests and the expert assessments traceable through the score components. This evidence supports the product's initial feasibility in the research context. Consumer data complements the picture with responses to the three variations, but does not yet support marketing conclusions or broad environmental claims. Both sets of data remain useful if their functions and limitations are clearly explained.

#### **IV. CONCLUSION AND SUGGESTIONS**

The development of a vest from textile waste through hand-embroidered applications can be implemented using the Define, Design, and Develop stages. The process yielded three product variations

utilizing cotton scraps, denim, and a combination of used clothing and kebaya scraps. These results provide an example of processing waste materials into clothing with distinct visual characteristics. Two expert assessments supported the initial feasibility of all three products within the scope of the research instrument, with particular attention paid to improvements in construction quality and usability, which received lower scores.

The responses from 15 consumers showed the highest aggregate score in the third vest. However, the appeal percentage cannot be determined as a final result due to inconsistent item counts in the questionnaire and summary. Therefore, the research supports the potential for product development and provides an overview of initial consumer response, but has not yet demonstrated measurable market acceptance, economic benefits, or reduced environmental impact.

Before the manuscript is submitted for publication, the consumer summary should be compared with all original answer sheets, particularly the number of environmental rating items and the maximum score for each product. Further research is recommended using more detailed respondent reporting, instrument consistency checks, and documentation of revisions and reassessments. Wear tests, washing tests, connection strength tests, and cost calculations can complement the expert assessment. Recording material weights and resource usage is also necessary to more quantify sustainability contributions.

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