Application of Upcycling in Repurposing Discarded Denim: Integration of Design Experiments and Analysis of Consumer Attitudes

Primjena upcyclinga u prenamjeni odbačenog trapera: integracija dizajnerskog eksperimenta i analize potrošačkih stavova

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Abstract
The fashion industry is a major contributor to textile waste and environmental degradation, with fast fashion driving excessive consumption and shortening garment lifespans. Although upcycling has gained attention as a sustainable strategy for textile waste management, research that integrates its practical application in fashion design with consumer perceptions remains limited. This study therefore aimed to explore the potential of transforming discarded denim jeans into contemporary garments through upcycling and patchwork techniques, and to analyse consumer attitudes towards sustainable fashion and products made from repurposed materials. A mixed-methods approach combining a design experiment and a survey was employed. In the experimental phase, a mini collection of garments was created from 33 pairs of discarded denim jeans. The survey was conducted with a sample of 213 respondents. Data were analysed using descriptive and inferential statistical methods. The findings indicate that respondents perceive positively the aesthetic and functional value of upcycled products and show interest in purchasing them. A statistically significant association was found between awareness of sustainable fashion and upcycling and the importance attached to sustainability when purchasing clothing ($\chi^2 = 21.42$; $p = 0.002$). However, no statistically significant relationship was identified between the importance attached to sustainability and the intention to purchase upcycled products ($\rho = 0.080$; $p = 0.317$), suggesting the presence of an attitude–behaviour gap. The results confirm the potential of upcycling to extend textile lifecycles and highlight the importance of design quality and consumer awareness in the acceptance of sustainable fashion products.

Keywords: sustainable fashion; upcycling; patchwork; denim; circular economy; textile waste

Sažetak
Modna industrija jedan je od značajnih izvora tekstilnog otpada i opterećenja okoliša, pri čemu brza moda potiče prekomjernu potrošnju i skraćivanje životnog vijeka odjeće. Iako se upcycling sve češće ističe kao održiva strategija upravljanja tekstilnim otpadom, ograničen je broj istraživanja koja istodobno ispituju njegovu primjenu u modnom dizajnu i percepciju takvih proizvoda među potrošačima. Cilj ovog rada bio je ispitati mogućnosti prenamjene odbačenih traperica u suvremene odjevne predmete primjenom upcycling i patchwork tehnika te analizirati stavove potrošača prema održivoj modi i

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proizvodima izrađenima od prenamijenjenih materijala. Istraživanje je provedeno primjenom mješovitog metodološkog pristupa koji objedinjuje dizajnerski eksperiment i anketno istraživanje. U eksperimentalnom dijelu izrađena je mini kolekcija odjevnih predmeta od 33 para rabljenih traperica, dok je anketno istraživanje provedeno na uzorku od 213 ispitanika. Podaci su analizirani primjenom deskriptivne i inferencijalne statistike. Rezultati pokazuju da ispitanici pozitivno percipiraju estetsku i funkcionalnu vrijednost upcycling proizvoda te iskazuju interes za njihovu kupnju. Utvrđena je statistički značajna povezanost između poznavanja održive mode i upcyclinga te važnosti koju ispitanici pridaju održivosti pri kupnji odjeće (χ^2 = 21,42; p = 0,002). Istodobno, nije utvrđena statistički značajna povezanost između važnosti održivosti i namjere kupnje upcycling proizvoda (ρ = 0,080; p = 0,317), što upućuje na postojanje nesklada između stavova i kupovnih namjera potrošača. Rezultati potvrđuju potencijal upcyclinga u produljenju životnog ciklusa tekstila te naglašavaju važnost dizajna i informiranosti potrošača u prihvaćanju održivih modnih proizvoda.

Ključne riječi: održiva moda; upcycling; patchwork; traper; kružno gospodarstvo; tekstilni otpad

1. Introduction and literature review

The fashion industry is widely regarded as one of the economic sectors with the greatest negative environmental impact, due to its intensive consumption of natural resources, substantial waste generation, and emissions associated with the production and consumption of clothing [1-4]. The dominant fast-fashion model is characterised by rapid production and frequent turnover of collections, encouraging excessive clothing consumption and shortening garment lifespans [3, 4]. As a result, textile waste generation continues to increase, placing growing pressure on natural resources [5]. In response to the challenges posed by fast fashion, the concepts of sustainable fashion and the circular economy have gained increasing attention, emphasising waste reduction, the extension of product life cycles, and more efficient use of material resources [6-8]. One approach that has received particular attention in recent years is upcycling, defined as the creative transformation of discarded materials into products of higher added value [9]. Unlike recycling, upcycling preserves the existing structure of the material, thereby reducing the consumption of energy and raw materials while simultaneously extending the useful life of textiles [9]. Denim is particularly well suited to upcycling techniques due to its mechanical durability, long service life, and potential for repeated repurposing without significant deterioration of its functional properties [10]. As denim production requires substantial amounts of water, energy, and chemicals, extending its life cycle through reuse and creative repurposing represents an important strategy for reducing the environmental impact of the textile industry [10, 11].

In fashion design, upcycling is frequently associated with patchwork techniques, which involve combining smaller textile pieces into a new functional and aesthetically coherent product [12, 13]. This approach enables the creative reuse of textile waste while facilitating the development of unique products that possess both environmental and aesthetic value. In addition to the technological and design-related aspects of sustainability, consumers play a crucial role in the transition towards more sustainable fashion. Previous studies indicate that awareness of the environmental and social impacts of the fashion industry is increasing; however, purchasing decisions continue to be largely influenced by factors such as price, design, quality, and comfort [14, 15]. Numerous authors have highlighted the existence of the so-called *attitude–behaviour gap*, referring to the discrepancy between positive attitudes towards sustainability and actual purchasing behaviour [15]. This phenomenon can also be explained by the Theory of Planned Behaviour (TPB), which states that behavioural intention is determined by an individual's attitudes, subjective norms, and perceived behavioural control [16]. In the context of sustainable fashion, positive attitudes towards sustainability do not necessarily lead to the purchase of sustainable products, as consumers' decisions are simultaneously influenced by economic, aesthetic, and social factors [16, 17]. Consequently, research on sustainable consumption has increasingly focused on examining the

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relationships among consumer awareness, attitudes, and actual purchase intentions [15, 17]. Previous research has shown that consumers generally perceive upcycled products positively, particularly because of their creativity, uniqueness, and aesthetic appeal [15]. According to Paras and Curteza [18], the successful acceptance of upcycled fashion products depends not only on their sustainability attributes but also on consumers' perceptions of their aesthetic value, craftsmanship, and functionality. This finding highlights the importance of aligning sustainability principles with the demands of the contemporary fashion market. Furthermore, studies indicate that consumer awareness, environmental consciousness, and perceived product quality are important determinants of the willingness to purchase sustainable clothing and to pay a premium for such products [19]. Despite the growing body of research on sustainable fashion, there are still relatively few studies that empirically combine the development of upcycled products through a design experiment with an evaluation of their acceptance among consumers. In particular, there is a lack of research simultaneously examining the practical application of upcycling techniques and the relationships among consumer awareness of sustainable fashion, the importance attributed to sustainability when purchasing clothing, and the acceptance of upcycled products. This research gap provides the foundation for the present study. Accordingly, the aim of this study was to investigate the potential of applying upcycling and patchwork techniques to transform discarded denim jeans into contemporary fashion products, while also analysing consumers' attitudes towards sustainable fashion and their perceptions of the aesthetic, functional, and market acceptability of garments produced using upcycling techniques. Based on the literature review and theoretical framework, the following hypotheses were formulated: H1: Awareness of sustainable fashion and upcycling is positively associated with the importance consumers attach to sustainability when purchasing clothing. H2: Greater importance attributed to sustainability when purchasing clothing is associated with a stronger intention to purchase upcycled products. H3: Consumers positively evaluate the aesthetic and functional value of garments made from repurposed denim. Testing these hypotheses provides a better understanding of the relationships among sustainable design, consumer awareness, and the acceptance of upcycled products. Furthermore, the findings contribute to advancing knowledge on the application of circular economy principles in contemporary fashion design.

2. Experimental part

2.1. Materials and methods

This study employed a mixed-methods research design, integrating a qualitative design experiment with a quantitative survey. This approach enabled the simultaneous examination of the technical and aesthetic potential of repurposing textile waste and the analysis of consumers' perceptions of sustainable fashion and garments produced using upcycling techniques. The study pursued two primary objectives: (1) to investigate the potential of applying upcycling and patchwork techniques to transform discarded denim jeans into contemporary fashion products, and (2) to analyse consumers' attitudes towards sustainable fashion and evaluate the aesthetic, functional, and market acceptability of the developed products.

2.2. Design experiment

The qualitative component of the study was conducted through a design experiment focusing on the repurposing of used denim. A total of 33 pairs of discarded denim jeans were collected through donations for the purposes of the study. The jeans were washed, disassembled, and carefully cut into square pieces, which were then sorted according to fabric thickness, colour intensity, and fibre composition to ensure uniform material properties during the construction of the textile panels and to achieve dimensional stability in the finished garments. Using the patchwork technique, three textile panels were produced. Two panels were created using a random arrangement of denim pieces, while the third was designed using a planned tonal gradation. This enabled the investigation of two different approaches to patchwork composition: a spontaneous approach and a controlled approach. Three garments – a skirt, trousers, and a coat – were subsequently constructed from the textile panels. Their functionality and technical feasibility were evaluated throughout the production process by assessing the practicality of garment

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construction and the usability of the finished products.

2.3. Survey

The quantitative component of the study was conducted using an online questionnaire administered through the Google Forms platform. A convenience sampling method was employed, and the questionnaire was distributed via social media, student groups, and communication channels associated with the Shika brand. A total of 213 respondents participated in the study, including 187 women (87.8%) and 26 men (12.2%). The inclusion criteria were being at least 18 years of age and providing informed consent to participate voluntarily. The questionnaire was developed based on a review of the relevant literature on sustainable fashion, upcycling, and consumer behaviour. It consisted of four sections:
1. Respondents' demographic characteristics;
2. Purchasing habits and attitudes towards fast fashion and sustainable fashion;
3. Awareness of sustainable fashion practices;
4. Evaluation of garments produced using upcycling techniques.
In the final section of the questionnaire, respondents were presented with photographs of the garments developed during the design experiment. For each garment, respondents evaluated its aesthetic appeal, perceived wearability, purchase intention, and willingness to pay.

2.4. Statistical analysis

The data were analysed using both descriptive and inferential statistical methods. Descriptive statistics included the calculation of frequencies, percentages and graphical representations of the response distributions. The chi-square (χ^2) test of independence was used to examine associations between categorical variables. Specifically, the relationships between respondents' awareness of sustainable fashion and upcycling, the importance they attributed to sustainability when purchasing clothing, and their demographic characteristics (gender and age) were analysed. The relationship between the importance attributed to sustainability when purchasing clothing and the intention to purchase upcycled products was assessed using Spearman's rank correlation coefficient, as the variables were measured on an ordinal scale. Statistical significance was set at $*p* < 0.05$. The application of inferential statistical methods enabled the testing of the research hypotheses and the identification of statistically significant patterns in consumers' attitudes towards sustainable fashion and upcycled products.

3. Results and discussion

The results of the design experiment demonstrated the feasibility of transforming discarded denim into contemporary garments through the application of upcycling and patchwork techniques. Three garments – a skirt, trousers and a coat – were developed using different approaches to the arrangement of patchwork elements and were styled according to three distinct aesthetic concepts. Additional functional and decorative elements, including buttons and jewellery, were produced from defective staples and epoxy resin, thereby extending the application of material repurposing principles (Figure 1).

a)

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b)

c)

Figure 1. Models from the collection created using the patchwork technique include: a) a skirt, b) trousers and c) a coat. Model: Klara Ergović. Photographer: Stjepan Mirković [20]

A total of 213 respondents participated in the survey, of which 87.8% were women. The largest age group comprised respondents aged 21-30 years (48%). Most respondents reported purchasing clothing at least once every few months, while 82.7% indicated that they occasionally or regularly purchase fast fashion products (Figures 2 and 3). The term fast fashion is known to 73.2% of respondents, while 51.6% of participants are familiar with the terms sustainable fashion and upcycling. Environmental sustainability when buying clothes is considered very important by 19.7% of respondents and somewhat important by 54% (Figure 4). The criteria most frequently cited as most important when buying clothes are comfort, design and price, while sustainability is cited as the primary criterion by 8% of respondents.

After viewing photos of the collection, respondents rated the products' aesthetic appeal, wearability and their willingness to purchase them. The trousers received the highest ratings, with 64.8% of respondents stating that they would purchase such a product. More than 40% of respondents indicated that they would purchase or give away the skirt, while the coat was rated as the most visually striking item of clothing, with approximately half of respondents stating that they would wear it.

Most respondents were willing to spend between 20 and 100 euros on sustainable fashion products, while a greater willingness to pay higher amounts was recorded for the coat (Figure 5).

The results of the χ^2 test of independence showed a statistically significant relationship between knowledge of the concepts of sustainable fashion and upcycling and the importance respondents attach to sustainability when buying clothes (χ^2 = 21.42; df = 6; p = 0.002). There were no statistically significant associations between age and the importance of sustainability when purchasing (χ^2 = 17.61; df = 12; p = 0.128), nor between gender and the importance of sustainability (χ^2 = 12.32; df = 6; p = 0.055) (Table 1).

Spearman correlation analysis showed a weak positive association between the importance of sustainability in clothing purchases and the intention to purchase upcycled products (ρ = 0.080), but this association was not statistically significant (p = 0.317) (Table 2).

The findings of this study confirm the feasibility of applying upcycling and patchwork techniques in the development of sustainable fashion products from discarded denim. The garments produced in the design experiment demonstrated that textile waste can be transformed into functional, aesthetically appealing clothing, thereby supporting the principles of the circular economy and extending the life cycle of textiles [10, 21].

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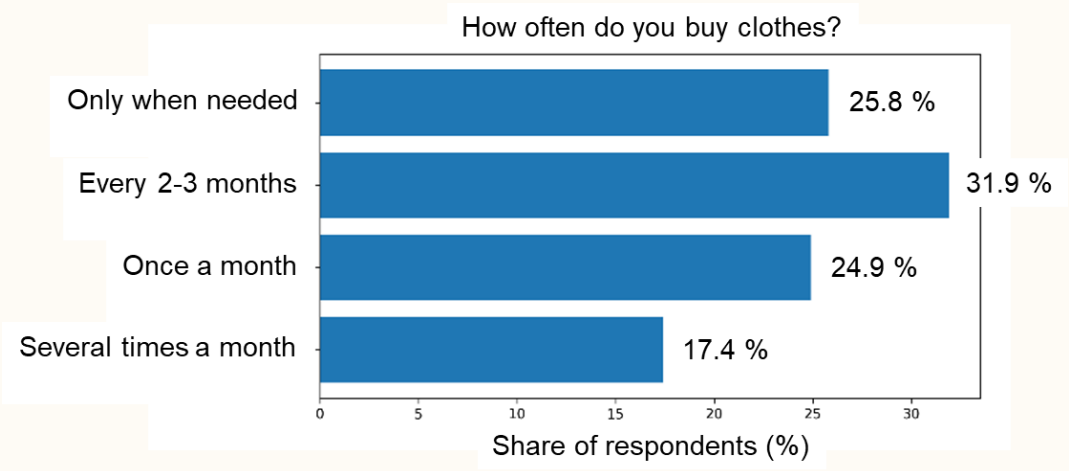

Figure 2. Distribution of answers to the question: how often do you buy clothes?

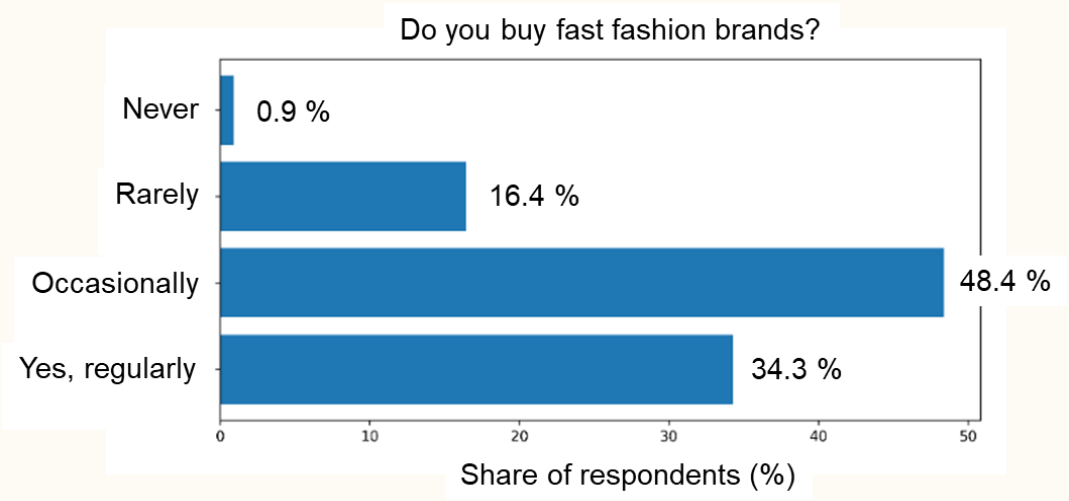

Figure 3. Distribution of answers to the question: how often do you buy clothes from fast fashion brands (e.g. Zara, H&M, Bershka, Sinsay, Primark…)

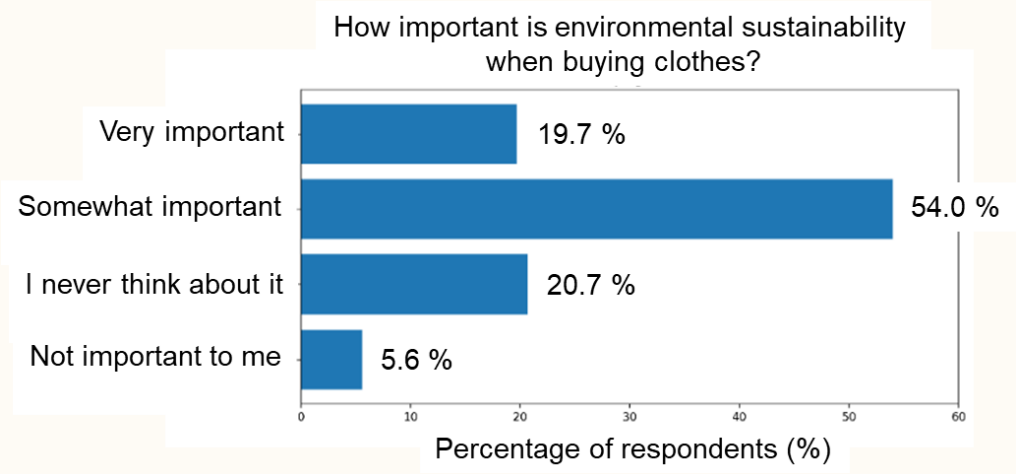

Figure 4. Distribution of answers to the question: How important is environmental sustainability to you when buying clothes?

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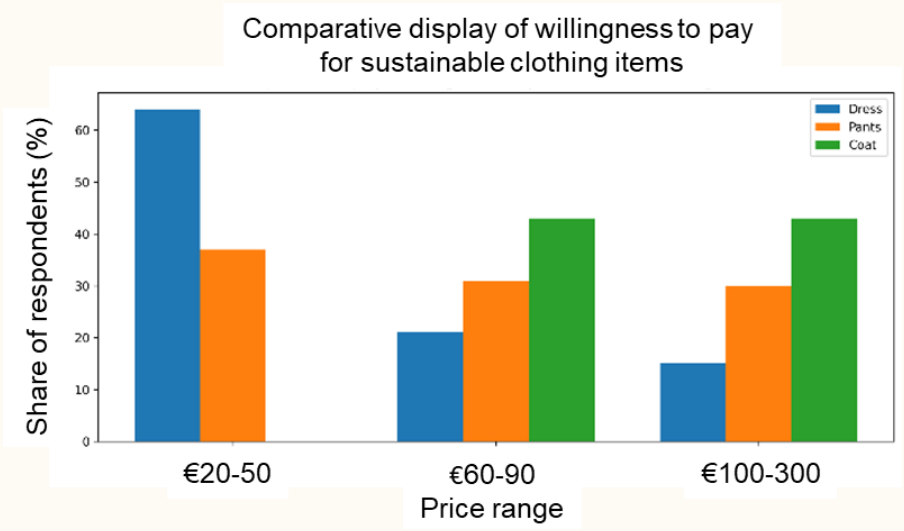

Figure 5. Comparative presentation of responses on willingness to pay, self-assessment

Table 1. Results of the χ^2 test of independence

Compared variables	χ^2	df	p-value
Knowledge of sustainable fashion and upcycling × importance of sustainability when purchasing clothing	21.42	6	0.002*
Age × importance of sustainability when purchasing clothing	17.67	12	0.128
Gender × importance of sustainability when purchasing clothing	12.32	6	0.55

Note *Statistically significant at the $p < 0.05$ level.

Table 2. Spearman correlation between the importance of sustainability and the intention to purchase upcycled products.

Variables	Spearman's ρ	p-value
Importance of sustainability when purchasing clothing × intention to purchase upcycled products	0.080	0.317*

These findings further confirm the suitability of denim for upcycling applications due to its durability, mechanical strength, and potential for repeated repurposing [10, 11]. Accordingly, Hypothesis H3 was supported, indicating that consumers positively evaluate the aesthetic and functional value of garments made from repurposed denim. The survey results indicate that consumers do not evaluate sustainable fashion products solely on the basis of their environmental benefits but also according to their aesthetic and functional characteristics. Among the three garments, the trousers achieved the highest level of acceptance, being perceived as the most wearable and commercially viable product. This finding is consistent with the study by Paras and Curteza [19], which reported that consumer acceptance of upcycled fashion products depends not only on their sustainability attributes but also on perceptions of their aesthetic value, craftsmanship, and functionality. These results therefore suggest that sustainability alone is insufficient to stimulate purchase intentions and should be complemented by design solutions that meet consumers' expectations and preferences. Although more than half of the respondents were familiar with the concepts of sustainable fashion and upcycling, sustainability was not among the primary criteria influencing clothing purchase decisions. Instead, greater importance was attributed to comfort, design and price, which is consistent with previous studies showing that positive attitudes towards sustainability do not necessarily translate into sustainable purchasing

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behaviour [4, 15, 17]. This pattern highlights the complexity of consumer decision-making in the fashion industry, where environmental concerns represent only one of several factors influencing purchasing behaviour. The results of the chi-square (χ^2) test revealed a statistically significant association between respondents' awareness of sustainable fashion and upcycling and the importance they attributed to sustainability when purchasing clothing. Hypothesis H1 was therefore supported, further emphasising the importance of consumer awareness and education in promoting more sustainable consumption patterns. This finding is consistent with previous research indicating that greater knowledge of environmental issues and sustainable practices increases the likelihood of positive attitudes towards sustainable consumption [19]. In contrast, Spearman's rank correlation analysis did not reveal a statistically significant relationship between the importance attributed to sustainability when purchasing clothing and the intention to purchase upcycled products. Consequently, Hypothesis H2 was not supported. This finding may be explained by the well-documented „attitude–behaviour gap", which is frequently observed in studies of sustainable consumption [15]. In other words, individuals may express positive attitudes towards sustainability, but these attitudes do not necessarily translate into actual purchasing decisions. The findings can also be interpreted within the framework of the Theory of Planned Behaviour (TPB) [16]. According to this theory, behavioural intention is determined not only by an individual's attitudes but also by subjective norms and perceived behavioural control. In the context of sustainable fashion, this suggests that positive attitudes towards sustainability alone are insufficient to motivate the purchase of sustainable products, as consumers' decisions are also influenced by factors such as price, product availability, personal fashion preferences and social influences. This interpretation further explains why no significant relationship was identified in the present study between the importance attributed to sustainability and the intention to purchase upcycled products. Qualitative comments provided by the respondents further highlighted the creativity, originality, and uniqueness of the collection, while also revealing differences in aesthetic preferences among participants. These findings emphasize the importance of product individualization and the emotional value of clothing as potential factors influencing the acceptance of sustainable fashion products. This study contributes by integrating a design experiment with an empirical analysis of consumer attitudes, supported by inferential statistical methods. Unlike studies that focus exclusively on the environmental aspects of sustainable fashion or solely on consumer attitudes, this research simultaneously examines the practical application of upcycling techniques and the factors that influence consumer acceptance of upcycled products. The findings should be interpreted in light of several limitations. First, the study employed a convenience sample predominantly composed of younger women, which limits the generalisability of the results to the broader consumer population. Second, product evaluation was based on photographs rather than direct interaction with or use of the garments, which may have influenced respondents' perceptions of their functionality and quality. Furthermore, the study assessed stated purchase intentions rather than actual purchasing behaviour; therefore, the findings cannot be directly linked to the market success of the developed products. Future research should employ more representative samples, experimental evaluations of upcycled garments under real-life conditions, and investigations of consumers' actual purchasing behaviour.

4. Conclusion

The aim of this study was to investigate the potential of applying upcycling and patchwork techniques to transform discarded denim jeans into contemporary fashion products and to analyse consumers' attitudes towards sustainable fashion and products made from repurposed materials. The results of the design experiment showed that discarded denim can be successfully transformed into functional and aesthetically appealing garments, confirming the potential of upcycling as a sustainable design approach that extends the life cycle of textiles and supports the application of circular economy principles within the fashion industry. The survey findings indicated that consumers perceive upcycled products positively, with aesthetic appeal and functionality playing a more important role in product acceptance than the sustainability attributes of the products themselves. The highest level of acceptance was observed for garments perceived as both wearable and visually appealing, confirming that the success of sustainable fashion products largely depends on their ability to meet consumers' aesthetic expectations and functional requirements. The statistical analysis confirmed a significant association between awareness of sustainable fashion and upcycling and the importance consumers attach to sustainability when purchasing clothing, highlighting the importance of education and consumer awareness in fostering more sustainable consumption

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attitudes. At the same time, no statistically significant relationship was found between the importance attributed to sustainability and the intention to purchase upcycled products, supporting previous findings regarding the existence of the *attitude–behaviour gap*. These results suggest that positive attitudes towards sustainability alone are insufficient to stimulate purchase intentions, as consumers' decisions are simultaneously influenced by aesthetic, functional, economic, and social factors. The scientific contribution of this study lies in the integration of a design experiment and an empirical investigation of consumer attitudes within a unified research framework. This approach enabled the simultaneous evaluation of the practical potential of upcycling and a better understanding of the factors influencing consumer acceptance of sustainable fashion products. The findings expand current knowledge of the relationships among sustainable design, consumer awareness, and purchase intentions, thereby contributing to the advancement of interdisciplinary research in sustainable fashion and the circular economy. Despite the limitations of using a convenience sample and evaluating products solely based on photographs, the findings indicate the market potential of garments produced using upcycling techniques and confirm the importance of developing design solutions that simultaneously meet sustainability objectives and consumer expectations. Future research should use more representative samples, examine actual purchasing behaviour, and investigate additional factors such as perceived product quality, willingness to pay, and social norms to provide a more comprehensive understanding of the mechanisms underlying consumer acceptance of sustainable fashion products.

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