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Platform-Driven Sustainability in E-Commerce: Consumer Behavior Toward Recycled Fashion

Eleni Sardianou * and Maria Briana

Department of Economics and Sustainable Development, Harokopio University of Athens, 17671 Athens, Greece; mbriana@hua.gr

* Correspondence: esardianou@hua.gr; Tel.: +30-210-954-9266

Abstract

Digital platforms in fashion e-commerce are progressively shaping sustainable consumption practices. This research explores the interplay between consumer behaviors toward recycled and second-hand fashion, and the adoption of digital platform-driven innovations. The analysis is based on a structured questionnaire and an online survey of 1000 consumers conducted in 2025, employing a combination of descriptive and inferential statistical techniques, including both cluster and factor analysis. The findings suggests that demographic factors—particularly age, education, and gender—significantly shape consumer attitudes toward digital innovations in fashion e-commerce apps. The analysis also confirms that the perceived effectiveness of AI and AR tools is significantly correlated with an increased interest in circular fashion options, including second-hand marketplaces and recycled clothing. The study emphasizes the strategic importance of platform features in fostering conscious fashion choices, thereby offering practical insights for retailers aiming to harmonize technological innovation with sustainability goals.

Keywords: sustainable e-commerce; recycled fashion; digital platforms; consumer behavior

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1. Introduction

As people are buying more clothes than ever [1], the fashion industry has become a leading contributor to global pollution [2,3]. Although some progress has been made, the fashion industry remains far from achieving sustainability. Current efforts by fashion companies to implement sustainable practices are insufficient to offset the escalating environmental and social impacts driven by the sector's rapid expansion [4]. At the same time, growing concerns about environmental degradation, resource depletion, and social inequality are prompting a shift in both consumer behavior and industry operations [5–7]. Considering the rising anxieties about waste creation, resource scarcity, and climate change, the imperative to embrace circular economic frameworks in the fashion industry is unprecedentedly urgent. It is now clear that through repair, clothing can be reused, significantly reducing the need for new garments, while reducing and reusing, being the highest priority areas within the waste hierarchy, are fundamental to creating a successful circular economy system [8].

As green manufacturing seeks to integrate sustainability into industrial capitalism, the fashion industry recognizes the need for a deeper socio-political understanding of how reuse, repair, and consumption reduction can be effectively incorporated into everyday practices [9]. In this context, digital platforms in fashion e-commerce are profoundly impacting sustainable consumption practices [10,11]. These platforms are not solely facilitating

the transition towards more sustainable practices [12,13] but they are also augmenting consumer awareness and engagement with sustainable fashion [14,15]. What is more, the incorporation of digital technologies, including social media, artificial intelligence, and the metaverse, is significantly influencing this transformation [16,17]. Digital tools like blockchain for transparency, AI for personalized product recommendations, and AR for immersive virtual fitting experiences not only may improve consumer access to sustainable fashion but also strengthen trust and interaction with recycled and second-hand clothing. The pandemic-driven transition to online shopping created lasting habits that favor convenience and digital engagement [18]. The readiness of the fashion industry for transformation depends on the stage of digitalization, on innovative ecological fashion design development and on the presence of motivated coherent actions among all fashion market subjects, in addition to the establishment of a novel paradigm for garment utilization among them [19].

Considering these recent changes, it has become clear that the enhanced role of digital platforms not only promotes the adoption of sustainable fashion but also transforms consumer expectations, compelling the fashion industry to innovate in ways that are aligned with both environmental imperatives and technological developments [20]. This change in the digital landscape is highly impactful, as it increases visibility and enables consumers to make wiser purchasing decisions, consequently aiding the development of a more sustainable fashion industry. The digital platforms not only influence consumer behavior towards adopting more sustainable methodologies but also offer new opportunities for enhancing the transparency and traceability of products, thereby enabling consumers to make choices that are more aligned with their environmental values [21]. Other studies emphasize this transition towards digitalization within the second-hand fashion industry, highlighting the capacity of online platforms to not only facilitate the reuse of garments but also to foster a more extensive cultural transformation towards sustainability, thereby empowering consumers to engage in more informed and ecologically responsible purchasing choices [22].

Academic discourse highlights an array of terminologies and concepts, including “second-hand”, “circular”, “recycled”, and “sustainable fashion”. Second-hand fashion signifies previously owned apparel and accessories that are either resold or offered for reuse [23]. The rise in desirability of visibly used clothing throughout the 20th century has transformed second-hand garments from a marginalized domain to a considerable force in global fashion, with enterprises evolving from philanthropic endeavors to multimillion-dollar corporations [24]. Vintage, second-hand luxury, and eco-fashion are among the most commonly used terms that emphasize the complex interconnections and overlapping concepts within the second-hand marketplace [25]. By reusing existing products, second-hand fashion reduces the demand for new garment production, thereby conserving resources and minimizing waste [26]. Consumers often perceive second-hand clothing as a cost-effective and environmentally sustainable option, although concerns regarding quality and hygiene persist [27]. Moreover, the expansion of digital platforms has significantly enhanced the accessibility of second-hand fashion, facilitating consumers’ participation in sustainable shopping behaviors with increased convenience, while concurrently transforming the perception of second-hand goods into high-value, trend-oriented fashion choices [21].

The circular fashion concept refers to a sustainability-oriented approach in the fashion industry that applies circular economy principles to reduce the fashion industry’s environmental footprint [28]. Given the rapid pace of digital innovation and the adoption of circular business models within the fashion industry, the integration of these methodologies is pivotal for the attainment of both ecological sustainability and enduring resilience within the industry, supporting the capacity to reshape consumer perceptions regarding

sustainable fashion consumption [29]. By promoting the reuse, recycling, and upcycling of materials, circular fashion aspires to establish a closed-loop framework for products designed for longevity that can be repurposed, ultimately cultivating a more sustainable consumption paradigm among consumers [30]. This paradigm shift moves away from traditional linear models towards strategies driven by purpose, concentrating on environmental, economic, social, and cultural sustainability [31]. It encompasses strategies such as resale, repair, rental models, recycling textile waste, and designing for disassembly, facilitating the effortless deconstruction of products [32].

Recycled fashion refers to clothing made from materials that have been repurposed or recycled, thereby diminishing the ecological ramifications linked to conventional apparel manufacturing and disposal, extending their life cycle and reducing waste [33]. This includes practices like upcycling, which augments the original design and fosters a culture of reuse, and downcycling, which may undermine the original aesthetics [34]. Textile recycling, particularly of post-consumer waste, is still in its early stages, but it holds great promise for the future [35]. As technological innovations continue to evolve and consumer demand intensifies, this sector is poised for considerable expansion and creative evolution. Innovations in recycling technologies have facilitated the production of high-quality recycled textiles, though challenges remain in terms of scalability and consumer acceptance [36].

Sustainable fashion embodies initiatives aimed at minimizing the detrimental environmental and social consequences of the fashion industry throughout the entire manufacturing process, while simultaneously advancing sustainable development goals [37]. Using sustainable materials, promoting fair trade conditions, reducing waste, and encouraging responsible consumer behavior fall within this evolving approach. Although sustainable fashion was once considered something of an oxymoron [38], it is now increasingly viewed as a necessary paradigm shift within the industry. On the one hand, sustainable fashion intersects with minimalist fashion, which advocates for an apparel collection or a capsule wardrobe characterized by a restricted selection of garments that emphasizes quality, durability, and timeless design [39]. Consumers possessing capsule wardrobes indicate experiencing diminished stress levels, estrangement from fashion trends, deriving pleasure from their sartorial choices, and an increased consciousness of ethical consumption [40]. On the other hand, sustainable fashion may be perceived as an aspect of ethical fashion; nevertheless, in practice, ethical deliberations are frequently overlooked during purchasing decisions [41].

Despite growing research on sustainable fashion, the analysis of how emerging high-tech digital innovations integrated into e-commerce formats are shaping consumer behaviors toward recycled fashion remains underexplored. This study aims to address this gap by examining how platform-driven innovations affect consumer behavior towards recycled and second-hand fashion. Specifically, the paper seeks to:

- offer a data-driven understanding of key behavioral consumers' attitudes toward fashion e-commerce.
- investigate the impact of digital innovations on consumers' decision making toward recycled retail.
- provide valuable insights into consumers' e-commerce preferences in respect to sustainable and recycled fashion.
- understand how platform-driven innovations can boost consumers' e-commerce preferences in respect to recycled fashion.

This research draws on the Theory of Planned Behavior (TPB) as proposed by Ajzen [42], according to which behavioral intentions express positive attitudes and are a powerful predictor of actual behavior. This theoretical viewpoint establishes the basis for understanding consumers' willingness to use technology-oriented sustainable fashion solutions. The survey design incorporates constructs aligned with TPB, including attitudes toward digital tools and sustainability, intention to use second-hand fashion platforms, and perceived barriers.

The primary contribution of this analysis lies in its exploration of the intersection between e-commerce and recycling in the fashion industry, shedding light on understudied areas such as the role of emerging technologies in promoting recycled fashion, while highlighting the need for further research. By synthesizing interdisciplinary knowledge derived from digital marketing and cloth recycling, this study introduces a novel approach by highlighting the particular significance of IoT innovations in advancing and transforming an intelligent, sustainable fashion industry. This interdisciplinary approach underscores the revolutionary capacity of digital tools in promoting the evolution of sustainable consumption within fashion e-commerce and aspires to offer valuable insights for all stakeholders, including enterprises, scholars, and policymakers, seeking to contribute to the development of a sustainable digital economy, focusing on cloth recycling.

The remainder of this study is structured as follows. Section 2 details the research methodology. Sections 3 and 4 present the analysis and discussion of the study's findings. Finally, Section 5 summarizes the main insights and offers implications for retailers, digital managers, and marketers seeking to implement innovative strategies that can enhance recycling and sustainability in the fashion industry.

2. Materials and Methods

2.1. Quantitative Research Design

This study employs a quantitative research design to explore how attitudes, behaviors, and future intentions concerning sustainable fashion are supported by digital technologies. A sample of 1000 Greek consumers was obtained, in line with established recommendations for statistically robust sample sizes in survey research [43]. To foster innovation and draw knowledge from the fields of recycling management and behavioral science, sustainability, and platform-driven sustainability commerce, this study addresses the following three research questions using a qualitative analysis:

RQ1: What factors influence consumers' engagement with recycled fashion e-commerce platforms?

RQ2: How do digital innovations affect consumers' decision-making processes regarding recycled and sustainable fashion?

RQ3: What preferences do consumers exhibit toward e-commerce offerings of recycled and second-hand fashion, and how do these preferences relate to their sustainability attitudes?

RQ4: How can platform-driven innovations enhance consumers' preferences to choose recycled fashion products in online retail environments?

To address the proposed research questions, a structured questionnaire was developed based on constructs and items adapted from previous consumer behavior studies [3,6,10,18,21,22,27], with appropriate modification to suit the context of recycled fashion e-commerce. To the best of our knowledge, no prior study has employed a composite research instrument incorporating the interaction between digital engagement recycled fashion behaviors in the context of e-commerce. Thus, the questionnaire developed for this research represents a novel adaptation of previous related studies, tailored to the context of

recycled fashion behaviors via digital platforms. The questionnaire used in the analysis is presented in Appendix A.

The questionnaire was organized into six distinct sections designed to comprehensively address the study's research questions. The first section gathers sociodemographic data—including age, gender, education, occupation, and income—to analyze how these variables influence online fashion shopping preferences [8,17]. The second section explored online shopping habits, including purchase frequency, use of fashion apps, factors affecting purchasing decisions related to recycled fashion items (e.g., price, reviews, delivery speed). It also explored preferred platforms and perceived barriers to buying online recycled clothing online, like product fit, delivery delays, or environmental impact, and identifying what would increase consumer confidence, which are essential for understanding key behavioral aspects of consumers in fashion e-commerce [3,6,18,30,37]. The third section examined the impact of digital apps on buying recycled fashion, focusing on which features (e.g., AI recommendations, AR try-on) they value most—directly informing the study's investigation of digital innovations. These indicators reflect the relevance of platform innovation in shaping decision-making and consumer experience [10,12,14] adopted, in our case, for recycled fashion items. The fourth section of the questionnaire included items on sustainability preferences, such as the importance of sustainability practices and experience with second-hand platforms, providing direct insights into how platform-driven technologies could boost consumer interest in recycled and sustainable fashion [13,28,30,32]. Finally, the fifth section assessed attitudes toward digital marketing, shedding light on factors driving engagement with recycled or sustainable retail. These items follow dimensions found in previous consumer behavior studies [22,27,28].

2.2. Data Collection and Sampling Strategy

Data were gathered through an online structured questionnaire distributed via email invitations and social media platforms, taking advantage of the broad reach and cost-efficiency of online surveys [44]. The database for our study, collected during March–May 2025 and analyzed using STATA version 19, was analyzed employing a combination of descriptive and inferential statistical techniques. Specifically, frequency analysis was used for descriptive insights; *t*-tests, ANOVA, and chi-square tests supported group comparisons and hypothesis testing; while cluster analysis and factor analysis, employing tetrachoric PCA, facilitated pattern recognition and dimensionality reduction. A non-probability sampling method was used to ensure that responses proportionally reflected key sociodemographic characteristics—such as age, gender, education level, and income—thus enabling a sample that represents the general population more effectively than purely random sampling approaches [45]. Snowball sampling further supported participant recruitment by encouraging respondents to forward the survey to others in their network. The questionnaire was pilot-tested with 30 participants in person to assess clarity and consistency. To increase response rates and adhere to ethical standards, informed consent was obtained by providing participants with comprehensive information about the study, ensuring voluntary participation and confidentiality in accordance with the guidelines by Dillman et al. [46]. While online surveys offer clear advantages, including low cost, scalability, and rapid data collection [47], they may be affected by limitations such as self-selection bias and the exclusion of individuals lacking internet access, which can constrain the generalizability of the findings [48]. Future research could benefit from mixed-method approaches to cross-validate quantitative results with qualitative insights.

3. Results

The following section presents the empirical results of our study, which are organized according to each research question and based on a combination of frequency analyses, cluster analysis, *t*-tests, ANOVA, chi-square tests, and factor analysis. It offers a detailed examination of Greek consumers' attitudes and behaviors regarding platform-driven innovations, sustainable fashion preferences, and the influence of digital features on engagement with recycled and second-hand fashion.

3.1. Sample's Socioeconomic Profile

Demographic results revealed that the majority of respondents were women (66.6%), while men accounted for 32.8%, and 0.6% identified as another gender. Most participants had a high school or vocational education (48.6%), followed by university graduates (35.2%), master's degree holders (13.6%), and only 1.2% with a PhD. Private-sector employees represented 47.2% of the sample, with 21.6% public-sector employees, 18.8% self-employed, and 12.4% unemployed.

3.2. Key Consumer Behavioral Aspects Toward Recycled Fashion E-Commerce (RQ1)

3.2.1. Frequency Statistics

Regarding online shopping frequency, as shown in Figure 1, 28.8% shopped fashion items three times a year, 27.6% twice, 18.8% once, and only 11.2% five times a year, indicating moderate engagement. Consumers mainly used official brand websites (83.8%), followed by major platforms like Amazon/Zalando (26%). Social media shops (12.2%) and second-hand platforms (6.2%) had limited reach. About 47.2% used fashion apps, with SHEIN the most popular (50.4%), while Zalando (1.6%) and ASOS (9.4%) lagged behind.

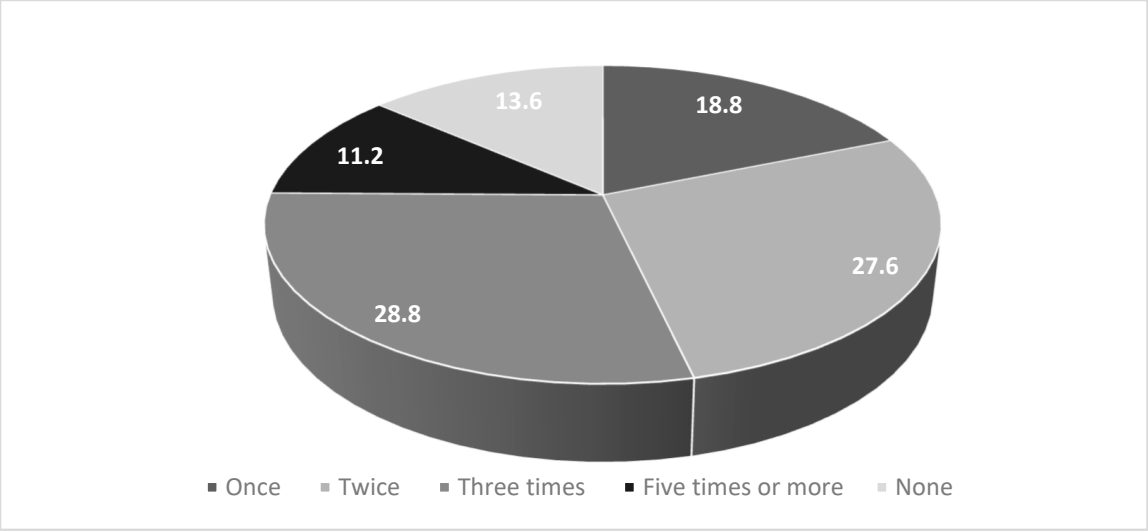


Figure 1. Online shopping for fashion items per year (%).

As shown in Figure 2, price and discounts (82.4%) were the most influential factors for purchasing recycled fashion items online, followed by quality and materials (43%), reviews and ratings (39%), brand reliability (34.8%), clear size guides (20.2%), product presentation (25.8%), and delivery speed (17.6%). Meanwhile, only 7.6% considered sustainability and ethical production.

Major concerns in relation to purchasing online recycled fashion included the inability to try on clothes (85.6%), differences in fit or quality (54%), difficulties or costs in returns/exchanges (29.8%), delayed delivery (19.8%), high shipping costs (25%), worries

about unreliable stores (37.2%), payment/data security (38.2%), and potentially defective or wrong orders (100% agreement on possibility of sizing issues).

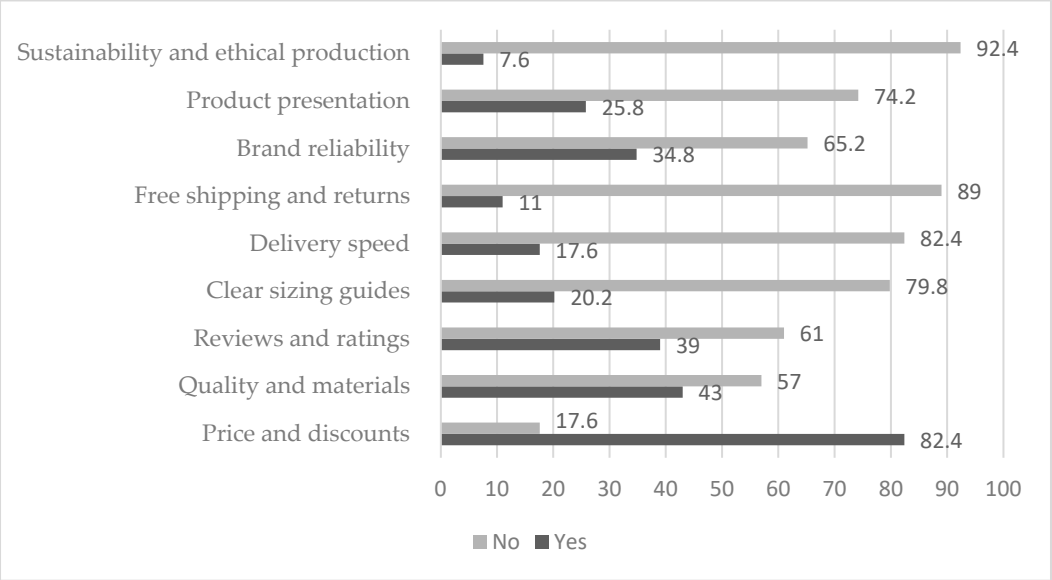


Figure 2. Factors influencing consumers' purchasing attitudes for recycled online fashion (%).

3.2.2. Cluster Analysis

Next, the study used K-means clustering to uncover distinct consumer profiles based on behavioral aspects influencing online recycled fashion purchases. More precisely, to identify consumer behavioral profiles in relation to key decision-making factors in online fashion shopping, a K-means cluster analysis was conducted. The analysis utilized 10 key behavioral variables: frequency of online fashion shopping, and nine purchase decision factors (price and discounts, quality and materials, reviews and ratings, clear sizing guides, delivery speed, free shipping and returns, brand reliability, product presentation, and sustainability and ethical production). Prior to clustering, the variables were standardized using z-scores. The optimal number of clusters (k = 9) was determined based on the highest silhouette score (0.212), indicating an acceptable level of internal cohesion and separation among clusters for social science research. Table 1 presents the results of cluster profile characteristics based on behavioral aspects influencing online fashion purchases.

Table 1. Clusters analysis results regarding factors influencing consumers' decisions to purchase recycled fashion items.

Cluster	*n*	E-Shop Fashion	Price and Discounts	Quality and Materials	Reviews	Sizing and Fit	Delivery Speed	Free Shipping	Brand Reliability	Image and Product Presentation	Sustainability
0	92	2.7	0.98	0.46	0.61	0	1	0.3	0.5	0.39	0
1	108	2.35	1	1	0.35	0	0	0.09	0.37	0	0
2	138	3.12	1	0.72	0.54	1	0.26	0.48	0.48	0.39	0
3	76	2.87	0.87	0.79	0.5	0.5	0.32	0.47	0.55	0.34	1
4	92	3.37	1	0.28	0.72	0	0	0.65	0.72	0	0
5	104	2.96	1	0.31	0.52	0.02	0	0.29	0.27	1	0
6	226	2.46	1	0	0.1	0.03	0	0.06	0.04	0	0
7	76	3.34	0	0.16	0.13	0.21	0.26	0.03	0.34	0.47	0
8	88	1.48	0	0.57	0.36	0.02	0.05	0.07	0.27	0.02	0

The results per cluster are analyzed below:

Consumers in Cluster 0 (n = 92)—"Value-Driven Speed Seekers"—exhibit a moderate average shopping frequency and place the highest importance on price, with moderate interest in quality and reviews. They show no concern for sizing guides or sustainability but value delivery speed highly and free returns to a lesser extent. Brand reliability and product presentation have a moderate influence. Cluster 1 (n = 108)—"Classic Bargain Hunters"—has a lower average shopping frequency and demonstrates very high importance for both price and quality, but low concern for reviews, delivery speed, and sustainability. They show minimal interest in free returns, brand reliability, and product presentation. Cluster 2 (n = 138)—"Fit-Conscious Deal Seekers"—displays the highest shopping frequency across the clusters. It shows maximal emphasis on price and considerable interest in quality and brand reliability. Participants are highly sensitive to clear sizing guides and demonstrate moderate concern for reviews and free returns, with no attention to sustainability.

Cluster 3 (n = 76)—"Ethical Quality Advocates"—demonstrates elevated importance on delivery speed, quality, and brand reliability. Notably, it is the only cluster expressing interest in sustainability and ethical production, combined with a moderate consideration for reviews and free returns. Cluster 4 (n = 92)—"Frequent Brand-Loyal Shoppers"—shows the highest average shopping frequency but focuses almost exclusively on price while assigning low importance to quality and moderate importance to reviews. They express no interest in sizing guides, delivery speed, or sustainability but demonstrate a moderate preference for free returns and high brand reliability, with negligible interest in product presentation.

Consumers in Cluster 5 (n = 104)—"Image-Oriented Price Shoppers"—display a relatively high average shopping frequency and place maximum importance on price but with a low emphasis on quality. They show moderate concern for reviews, minimal interest in sizing guides, and assign negligible importance to delivery speed or sustainability. Free returns hold low relevance, while they place a distinct emphasis on product presentation and have moderate consideration for brand reliability. In the largest group, Cluster 6 (n = 226)—"Pure Price-Driven Consumers"—consumers shop with an average frequency, assign maximum importance to price, but give virtually no importance to quality or reviews. They show minimal concern for sizing guides, delivery speed, free returns, and product presentation. Brand reliability scores extremely low, and sustainability is not a priority, indicating a purely price-driven segment with little interest in other product attributes.

Cluster 7 (n = 76)—"Impulsive Feature-Balanced Buyers"—shows a high average shopping frequency, but, strikingly, does not prioritize price or quality. Reviews and sizing guides register low scores, while moderate importance is attached to delivery speed and brand reliability. Product presentation holds moderate weight, but sustainability remains absent. This cluster may represent impulsive shoppers or those motivated by other unmeasured factors. Cluster 8 (n = 88)—"Selective Occasional Shoppers"—records the lowest shopping frequency among all, assigning low importance to price but moderate consideration to quality and reviews. Consumers in this group show almost no interest in sizing guides, delivery speed, free returns, product presentation, or sustainability, and only moderate concern for brand reliability, indicating cautious but selective shoppers.

Overall, the findings of the cluster analysis indicate that price and discounts constitute the primary decision driver across almost all clusters, confirming their universal appeal in online fashion shopping. While quality, reviews, and brand reliability differentiate consumer profiles to some extent, sustainability emerges as a decisive factor for only a small segment—"Ethical Quality Advocates"—highlighting limited integration of environmental considerations into purchasing behavior. The diversity across clusters in preferences for factors such as sizing guides, free returns, and delivery speed underscores the existence of distinct consumer profiles with varying needs and expectations, offering actionable insights

for online fashion platforms aiming to personalize marketing strategies and enhance customer engagement.

3.3. Impact of Digital App Features on Decision-Making Toward Recycled Retail (RQ2)

3.3.1. Frequency Statistics

As shown in Figure 3, useful app features that impact decision-making toward recycled clothing retail included easy navigation (78.6%), personalized AI recommendations (34.4%), barcode scanning for similar products (30.4%), virtual fitting rooms (31.4%), and real-time interaction with 3D models (31%). Features with lower acceptance included scanning clothes to find similar items (22.2%), chatting with stylists (17.6%), AR try-on features (16.4%), and recognizing trends and fashion advice (12.8%).

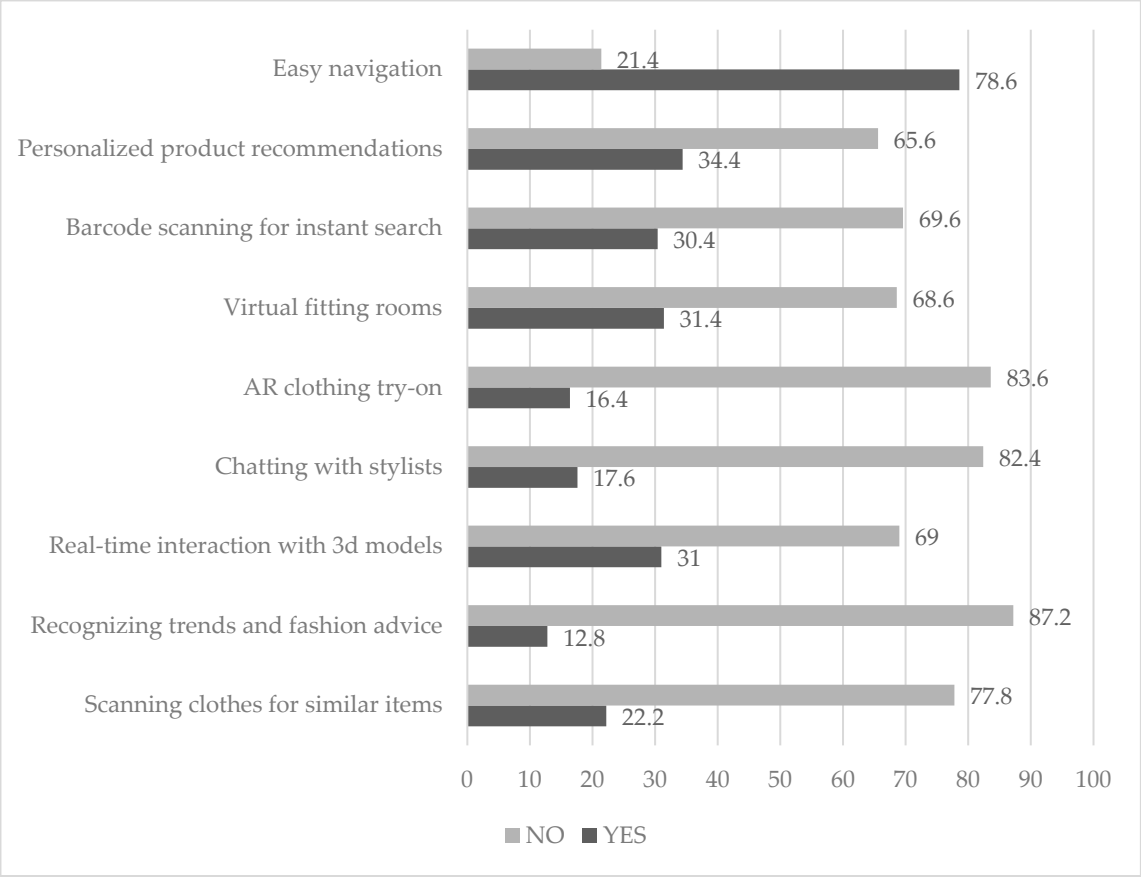


Figure 3. The impact of apps' features on purchasing decision-making toward recycled fashion (%).

3.3.2. *t*-Test and ANOVA Results

The results of the *t*-test and ANOVA analyses examining whether consumers' demographic characteristics are associated with differences in their attitudes toward digital innovations in fashion e-commerce are presented in Table 2. First, by conducting independent sample *t*-tests and one-way ANOVAs, we aimed to determine whether consumers' openness to personalized AI-based product recommendations (AI Attitude) and augmented reality try-on features (AR Attitude) varied significantly across demographic groups. Understanding these differences provides valuable insights into which consumer segments are more receptive to platform-driven technological innovations, enabling fashion retailers to tailor their digital strategies more effectively.

Table 2. *t*-test and ANOVA results for demographic differences in consumer purchasing attitudes toward digital innovations in recycled fashion.

Digital App Features	Gender (t, *p*) *t*-Test	Education (F, *p*) ANOVA	Age (F, *p*) ANOVA	Significant Demographics
Easy Navigation	t = 0.81, $p = 0.416$	F = 2.78, $p = 0.026$	F = 4.51, $p = 0.011$	Education, Age
Personalized AI Recommendations	t = −1.89, $p = 0.060$	F = 2.59, $p = 0.036$	F = 0.21, $p = 0.814$	Education
Barcode Scanning	t = 3.79, $p < 0.001$	F = 2.84, $p = 0.023$	F = 12.79, $p < 0.001$	Gender, Education, Age
Virtual Fitting Rooms	t = −0.79, $p = 0.430$	F = 7.25, $p < 0.001$	F = 1.82, $p = 0.162$	Education
AR Try-On Features	t = 1.38, $p = 0.168$	F = 6.37, $p < 0.001$	F = 2.18, $p = 0.114$	Education
Chatting with Stylists	t = 2.47, $p = 0.014$	F = 0.70, $p = 0.593$	F = 0.62, $p = 0.536$	Gender
Real-Time 3D Interaction	t = −0.50, $p = 0.617$	F = 2.20, $p = 0.067$	F = 0.56, $p = 0.573$	—
Trends and Fashion Advice	t = 2.15, $p = 0.032$	F = 0.56, $p = 0.690$	F = 2.13, $p = 0.119$	Gender
Scanning Clothes for Similar Items	t = 3.04, $p = 0.002$	F = 2.53, $p = 0.039$	F = 11.03, $p < 0.001$	Gender, Education, Age

For "Easy Navigation", there was no significant gender difference (t = 0.81, $p = 0.416$), but significant differences were found across education levels (F = 2.78, $p = 0.026$) and age groups (F = 4.51, $p = 0.011$). Regarding Personalized AI Recommendations, gender differences approached significance (t = −1.89, $p = 0.060$), with significant effects of education (F = 2.59, $p = 0.036$), but no significant differences across age groups (F = 0.21, $p = 0.814$). For "Barcode Scanning", significant gender differences (t = 3.79, $p < 0.001$) and significant differences were found both by education (F = 2.84, $p = 0.023$) and age (F = 12.79, $p < 0.001$). Virtual Fitting Rooms showed no significant gender differences (t = −0.79, $p = 0.430$) but had highly significant effects of education (F = 7.25, $p < 0.001$) without age differences (F = 1.82, $p = 0.162$).

"AR Try-On Features" revealed no gender difference (t = 1.38, $p = 0.168$) but significant effects of education (F = 6.37, $p < 0.001$) and no significant age differences (F = 2.18, $p = 0.114$). For "Chatting with Stylists", there was a significant gender difference (t = 2.47, $p = 0.014$), with no significant education (F = 0.70, $p = 0.593$) or age effects (F = 0.62, $p = 0.536$). For "Real-Time 3D Interaction", no significant differences emerged across gender (t = −0.50, $p = 0.617$), education (F = 2.20, $p = 0.067$), or age groups (F = 0.56, $p = 0.573$). Recognizing "Trends and Fashion Advice" showed significant gender differences (t = 2.15, $p = 0.032$) but no significant effects for education (F = 0.56, $p = 0.690$) or age (F = 2.13, $p = 0.119$). Finally, "Scanning Clothes for Similar Items" demonstrated significant gender differences (t = 3.04, $p = 0.002$), with significant education effects (F = 2.53, $p = 0.039$) and age effects (F = 11.03, $p < 0.001$).

These results suggest that attitudes toward several app features vary significantly with education level, particularly for features such as barcode scanning, virtual fitting rooms, and AR try-on. Gender differences emerged for features including barcode scanning, chatting with stylists, recognizing trends, and scanning clothes, indicating that men and women may have different preferences or openness toward specific digital shopping functionalities. Age differences were observed primarily for barcode scanning and scanning clothes for similar items, suggesting that younger and older consumers may diverge in their interest in certain innovative features.

3.4. Consumers' E-Commerce Preferences for Sustainable and Second-Hand Fashion (RQ3)

3.4.1. Frequency Statistics

Despite 52% of participants stating that sustainability affects their online fashion shopping, only 15.8% reported using second-hand platforms like Vinted or Depop, suggesting a disconnect between stated interest and actual behavior. As shown in Figure 4, features such as product sustainability information (19.8%) and filters for sustainable products (6%)

received limited preference. Moreover, 80.2% showed no interest in sustainability labels or sourcing details, underlining a challenge in translating concern into action.

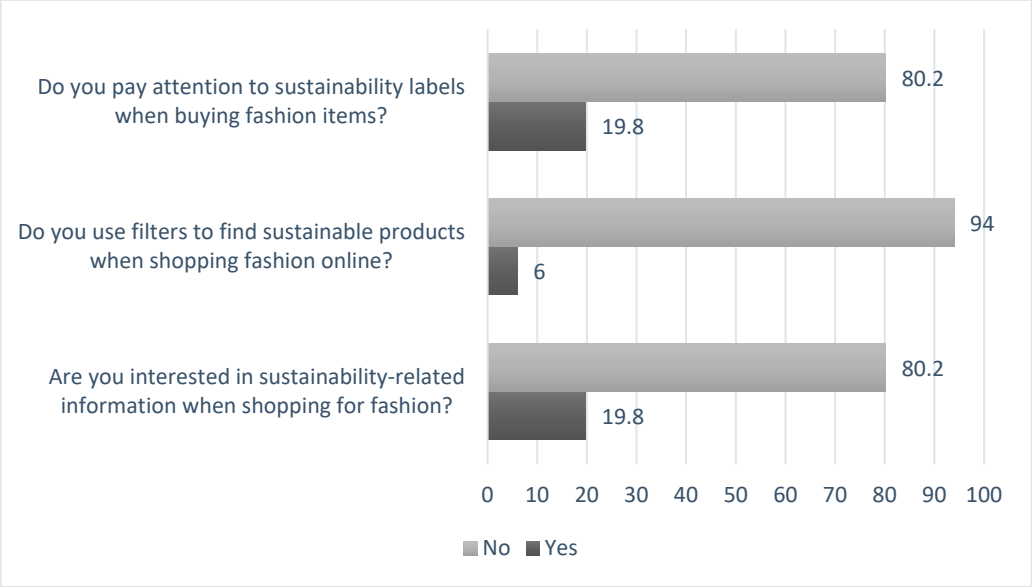


Figure 4. Consumers' sustainability fashion preferences (%).

3.4.2. Chi-Square Tests

This analysis aimed to explore how key demographic factors—gender, age, and education level—relate to consumer behaviors concerning sustainable and second-hand fashion in online shopping. Specifically, it examined whether participants' self-reported influence of sustainability on their purchases, actual use of second-hand platforms, and interest in features such as sustainability information, filters for sustainable products, and sourcing details varied significantly across demographic groups. By conducting chi-square tests, the analysis sought to identify which segments of the population are more engaged with sustainability-related practices in fashion e-commerce, providing insights that can inform targeted strategies for promoting sustainable consumption. Table 3 presents the chi-square tests results. The results suggest that, as regards sustainability affecting purchases, there were significant differences across gender ($\chi^2 = 22.30$, $p < 0.001$) and age groups ($\chi^2 = 6.09$, $p = 0.048$) but no significant differences across education levels ($\chi^2 = 0.91$, $p = 0.923$). This indicates that gender and age are associated with whether consumers report sustainability influencing their online fashion purchases, while education is not.

When it comes to the use of second-hand platforms, no significant differences were found by gender ($\chi^2 = 2.34$, $p = 0.311$) or education ($\chi^2 = 5.92$, $p = 0.205$) but highly significant differences emerged across age groups ($\chi^2 = 45.70$, $p < 0.001$), suggesting second-hand platform adoption varies strongly by age. Regarding interest in product sustainability information, significant differences were observed across gender ($\chi^2 = 43.08$, $p < 0.001$) and education levels ($\chi^2 = 26.60$, $p < 0.001$), while no significant age differences were found ($\chi^2 = 3.43$, $p = 0.180$). As for the use of filters for sustainable products, significant differences were present across gender ($\chi^2 = 12.00$, $p = 0.002$) and education levels ($\chi^2 = 24.98$, $p < 0.001$) but not age groups ($\chi^2 = 4.23$, $p = 0.121$). Finally, as regards sustainability labels or sourcing information, there were significant differences by gender ($\chi^2 = 16.90$, $p < 0.001$) and age groups ($\chi^2 = 7.50$, $p = 0.024$), with no significant effect of education ($\chi^2 = 7.86$, $p = 0.097$).

These findings indicate that gender is a consistent factor associated with differences in sustainability-related attitudes and behaviors, significantly affecting all variables tested, except second-hand platform use. Age differences also emerged, particularly in second-hand

platform adoption and the perceived impact of sustainability on purchases, highlighting younger consumers' greater engagement with sustainable fashion options. Education had significant effects primarily on preferences for specific sustainability features (e.g., information, filters) but not on broader behaviors like second-hand shopping or sustainability's overall influence. These insights suggest that marketing strategies aiming to promote sustainable and second-hand fashion should be tailored by demographic segment, especially considering gender and age-based preferences.

Table 3. Chi-square test results of demographics and in consumer behavior for sustainable and second-hand fashion.

Consumer Behavior	Gender (χ^2, p)	Age Group (χ^2, p)	Education Level (χ^2, p)	Statistically Significant Demographics
Sustainability influences purchases	22.30, $p < 0.001$	6.09, $p = 0.048$	0.91, $p = 0.923$	Gender, Age
Use of second-hand platforms	2.34, $p = 0.311$	45.70, $p < 0.001$	5.92, $p = 0.205$	Age
Interest in sustainability information	43.08, $p < 0.001$	3.43, $p = 0.180$	26.60, $p < 0.001$	Gender, Education
Use of filters for sustainable products	12.00, $p = 0.002$	4.23, $p = 0.121$	24.98, $p < 0.001$	Gender, Education
Interest in sourcing sustainability labels	16.90, $p < 0.001$	7.50, $p = 0.024$	7.86, $p = 0.097$	Gender, Age

3.5. How Platform-Driven Innovations Could Boost Preferences for Recycled Fashion (RQ4)

3.5.1. Frequency Statistics

As shown in Figure 5, digital marketing innovations that could enhance consumer engagement with sustainable and recycled fashion included easy-to-understand sustainability information (19.8%), barcode scanning for instant searches (30.4%), and virtual fitting rooms (31.4%). More advanced ideas, such as using drones or autonomous vehicles for eco-friendly deliveries (11.4%) or integrating AR try-ons directly into e-shops (7.6%), had limited appeal. Additionally, features like digital authenticity certificates (23.4%), 3D product interactions (31%), custom-made clothing options based on body measurements (33.2%), or combining online and offline shopping experiences (38.4%) showed varying levels of interest, highlighting that practical and interactive features are more promising for engaging consumers than futuristic concepts.

3.5.2. Factor Analysis

To address (RQ4) and explore how consumer preferences for platform-driven innovations are organized, a factor analysis using tetrachoric Principal Components Analysis (PCA) was conducted on the nine variables representing key digital features offered in fashion e-commerce apps. The selected features were derived from questionnaire items that measured participants' interest in various app features related to purchasing recycled fashion items, including easy navigation, personalized AI-based product suggestions, barcode scanning for similar products, virtual fitting rooms, AR try-on capabilities, chatting with stylists, real-time interaction with 3D models, recognizing trends and receiving fashion advice, and scanning clothes to find similar items.

Before performing PCA, the data for these nine items were screened for missing values, and cases with incomplete responses were excluded. PCA was then applied to the standardized data matrix, and component loadings and explained variance were extracted to determine the underlying dimensions of consumer preferences. The suitability of the

dataset for factor analysis was assessed by examining the total variance explained and the component loadings. Components with eigenvalues greater than 1 were considered in line with Kaiser's criterion, while the scree plot and the cumulative explained variance guided the decision on the optimal number of components to retain. Finally, interpretation of the components was based on the magnitude and pattern of the variable loadings, allowing the identification of conceptual clusters such as usability and personalization, social and interactive features, and trend and knowledge-seeking dimensions.

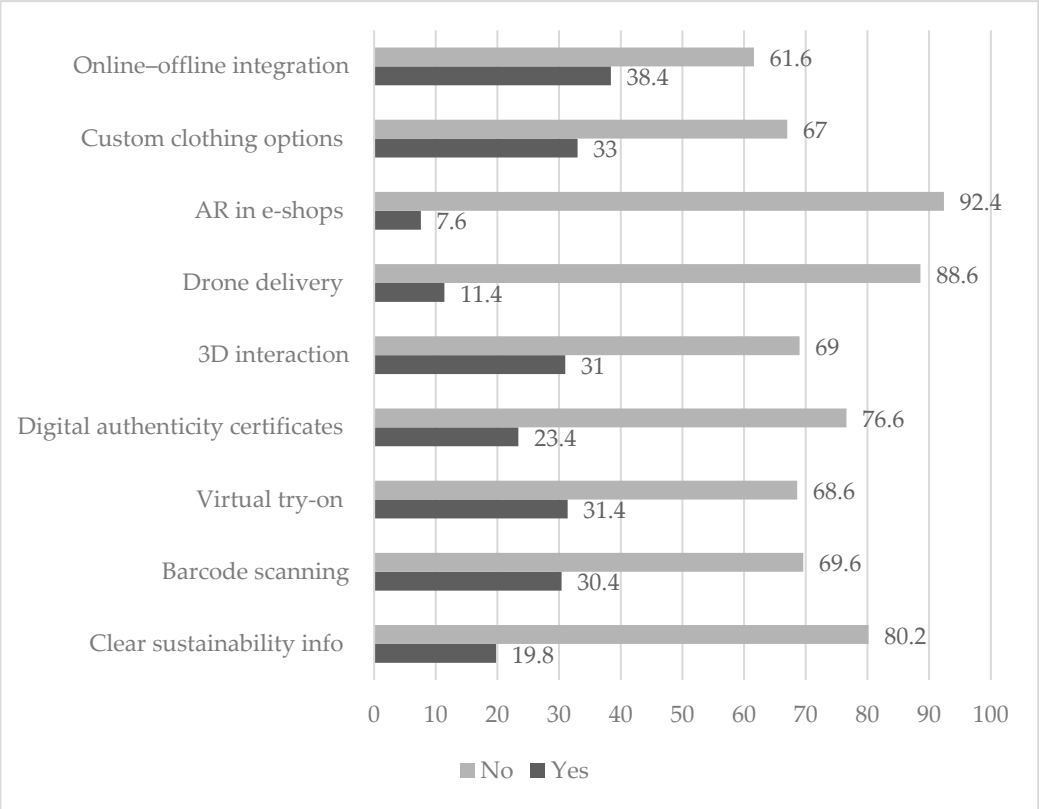


Figure 5. Digital innovations that would motivate consumers to buy recycled or sustainable fashion (%).

Findings from the PCA are presented in Tables 4 and 5, explained variance and component loadings, respectively. The PCA revealed that the first three principal components explain a total of 46.1% of the variance (PC1: 19.3%, PC2: 14.0%, PC3: 12.8%), while the remaining six components contribute less to the total of 53.9%. This indicates that a two- or three-factor structure sufficiently summarizes consumer preferences for app features.

Table 4. PCA explained variance per component.

Component	Explained Variance	Cumulative Variance
PC1	0.193	0.193
PC2	0.140	0.334
PC3	0.128	0.461
PC4	0.112	0.573
PC5	0.102	0.675
PC6	0.095	0.770
PC7	0.089	0.859
PC8	0.082	0.941
PC9	0.059	1.000

Table 5. PCA component loadings.

Features	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
Easy Navigation	0.12	−0.07	−0.43	−0.76	0.24	0.28	0.13	0.21	0.15
Personalized Product Recommendations	0.43	−0.10	0.17	−0.38	−0.27	−0.12	−0.64	−0.22	−0.31
Barcode Scanning for Instant Search	0.07	0.423	−0.60	0.23	−0.06	0.34	−0.07	−0.46	−0.25
Virtual Fitting Rooms	0.54	−0.22	0.12	0.10	−0.10	0.16	0.26	−0.45	0.58
AR Clothing Try-On	0.50	−0.33	−0.05	0.22	0.10	0.10	0.38	0.27	−0.59
Chatting with Stylists	0.17	0.53	0.23	−0.28	0.24	−0.47	0.42	−0.26	−0.17
Real-Time Interaction with 3D Models	0.37	0.12	−0.30	0.29	0.49	−0.39	−0.38	0.26	0.27
Recognizing Trends and Fashion Advice	0.11	0.34	0.52	0.05	0.41	0.61	−0.19	0.13	−0.01
Scanning Clothes for Similar Items	0.28	0.48	−0.02	0.03	−0.62	0.04	0.09	0.52	0.17

Key component loadings are characterized as follows:

- PC1 (Usability and Personalization): Characterized by high loadings on "Virtual fitting rooms" (0.54), "AR try-on features" (0.50), and "Personalized AI recommendations" (0.43), suggesting that consumers associate these advanced features with overall app usability. The first component (Usability and Personalization) reflects how consumers link AR, virtual fitting rooms, and AI-powered suggestions with overall app ease of use. These results support that consumers share a focus on providing an efficient, tailored, and immersive shopping experience. The strong associations among them indicate that consumers view these technologically advanced tools as part of a cohesive effort to improve app usability and relevance, likely interpreting them collectively as indicators of a modern, customer-centered platform. Conceptually, it implies that adoption of or interest in one of these innovations predicts a similar attitude toward the others, forming a unified construct of perceived technological convenience and personalization.
- PC2 (Social and Interactive Features): Features strong loadings on "Chatting with stylists" (0.53), "Scanning clothes for similar items" (0.48), and "Barcode scanning" (0.43), emphasizing interactive and socially engaging elements of the app experience. The second component (Social and Interactive Features) captures a preference for features facilitating interaction and social engagement, such as chatting with stylists and scanning items. These results highlight a consumer segment motivated by enhanced engagement, feedback, and a more personalized, consultative shopping experience rather than passive browsing.
- PC3 (Trend and Knowledge Seeking): Dominated by high loadings on "Recognizing trends and fashion advice" (0.52) and negative loadings on "Barcode scanning" (−0.60), indicating a distinct dimension related to trend awareness and fashion guidance. The third component (Trend and Knowledge Seeking) highlights interest in receiving trend information and fashion advice.

Overall, these results imply that consumer preferences for innovative platform-driven features are multi-faceted and should not be treated as a single scale. Features like AR, AI personalization, social interactivity, and trend information are not universally valued together but instead appeal differently depending on individual priorities.

4. Discussion

The cluster analysis conducted in this study provides critical insights into the heterogeneity of online fashion consumers' decision-making processes (RQ1). The findings reveal nine distinct consumer segments with markedly different behavioral profiles, underscoring the importance of moving beyond average consumer analyses when designing digital strategies for fashion e-commerce.

Across nearly all clusters, price and discounts consistently emerged as the dominant factors for purchasing attitudes toward recycled clothing. This result aligns with prior research indicating that monetary incentives remain the most powerful driver in online shopping behavior [49]. This universal emphasis suggests that competitive pricing strategies are essential for attracting a broad spectrum of consumers, irrespective of demographic differences. Quality and reviews were moderately important in several consumer clusters, a result that is consistent with previous studies highlighting the role of perceived product quality and social proof in building consumer trust [50,51]. Notably, brand reliability and product presentation showed varied levels of importance across clusters, indicating that while some consumers prioritize established, trustworthy brands, others may be more price-driven and less concerned about reputation or aesthetic presentation.

A particularly noteworthy finding is that sustainability considerations were salient only in the "Ethical Quality Advocates" cluster, the smallest group, with a clear focus on ethical production and environmental impact. This result confirms previous studies by the authors of [52,53] related to the limited integration of sustainable practices into mainstream consumer priorities for online fashion. Furthermore, differences between clusters regarding the importance of delivery speed, free returns, and clear sizing guides highlight diverse logistical expectations. These differences signal an opportunity for e-commerce platforms to personalize the shopping experience by segmenting their audiences and tailoring services—for example, emphasizing fast delivery and hassle-free returns for clusters valuing convenience, while promoting detailed sizing information for accuracy-focused segments.

The overall low prioritization of features such as augmented reality, advanced recommendations, or innovative delivery methods across most clusters suggests that, although technological innovations attract some consumers, these elements alone are insufficient to motivate the majority to change their shopping habits. This finding supports literature by the authors of [54] emphasizing that technology adoption in online fashion requires clear, perceivable benefits tied to consumers' existing priorities—particularly price and trust. Taken together, these results illustrate the need for multi-layered marketing strategies. Fashion e-commerce platforms should maintain competitive pricing to appeal to the mass market, invest in quality control and transparent reviews to build credibility, and selectively promote sustainability features to niche segments that show clear interest. Additionally, segment-specific communication and services can better align with distinct consumer profiles, increasing engagement and satisfaction, and potentially fostering loyalty.

The analysis revealed important demographic variations in consumers' attitudes toward a range of digital innovations in fashion e-commerce apps (RQ2). Education level emerged as a key differentiator, with significant differences across educational groups for several features including ease of navigation, personalized AI recommendations, barcode scanning, virtual fitting rooms, AR try-on, and scanning clothes for similar items. These findings suggest that consumers with higher educational attainment may have greater digital literacy or openness to advanced shopping technologies, aligning with prior research that indicates that education is a driver of technology adoption [55]. Gender differences were significant for features such as barcode scanning, chatting with stylists, recognizing trends, and scanning clothes, reflecting potential differences in shopping habits or comfort

with digital tools between male and female consumers. For example, women may value personal interactions like chatting with stylists more, while men might show more interest in fast, functional features like barcode scanning. However, no gender differences were found for widely appreciated features like ease of navigation or virtual fitting rooms, indicating some innovations may have universal appeal regardless of gender.

Age showed significant differences primarily for barcode scanning and scanning clothes for similar items, with younger consumers possibly more inclined to adopt these interactive, mobile-oriented features. This result is in line with previous studies highlighting age-related differences in mobile technology use [56]. Notably, for most features, age did not significantly affect attitudes, suggesting that interest in many app functionalities may transcend generational boundaries when it comes to online fashion shopping. Together, these results underscore that while some digital innovations hold broad appeal across demographic segments, others are more niche, resonating strongly with specific groups. This differentiation has crucial implications for fashion e-commerce platforms seeking to tailor digital experiences, since understanding which features attract which consumer segments can support the design of more effective, personalized app interfaces and marketing strategies.

The chi-square analysis revealed significant demographic differences in consumer engagement with sustainable and second-hand fashion (RQ3). Gender emerged as a consistent predictor across most variables, with significant differences found in attitudes toward sustainability's influence on purchases, interest in sustainability information, use of filters for sustainable products, and interest in sustainability labels. These findings align with previous research that pointed out that women often exhibit greater environmental concern and pro-environmental behaviors than men in consumer contexts [57]. Age was another key factor, and significant differences were observed in whether sustainability affects purchases and in second-hand platform use, suggesting that younger consumers are more likely to translate sustainability concerns into concrete behaviors. These results corroborate recent studies that indicated younger generations (e.g., Gen Z) are more willing to adopt sustainable consumption patterns and experiment with circular economy options like second-hand platforms [1]. Education, however, demonstrated mixed effects. While it did not significantly influence overall sustainable purchasing attitudes or second-hand platform use, it was significantly associated with preferences for detailed sustainability information and use of filters for sustainable products. This pattern suggests that higher educational attainment may enhance consumers' interest in product-level sustainability features but may not directly drive sustainable shopping behaviors, highlighting a potential knowledge–action gap.

Collectively, these results indicate that while concern for sustainability is present among many consumers, translating that concern into actual behavior, such as using second-hand platforms or actively seeking sustainability information, varies substantially by demographic factors. These findings underscore the complexity of promoting sustainable fashion consumption and the necessity for demographic-specific strategies.

Finally, the factor analysis results indicate that preferences for innovative digital app features cluster around combined factors related to usability and innovation, the social dimension of the shopping experience, and the desire for trend-related information. The association of AR and AI with a single component underscores the centrality of technological innovation as a key element in enhancing the online shopping experience. In contrast, the separation of social interaction into a distinct factor indicates that consumers seeking personal support or communication with experts form a unique profile. This grouping of preferences provides valuable insight into how fashion platforms can design and promote different app features to meet specific consumer needs.

5. Conclusions

This study analyzed the role of digital platform features on consumer behavior toward recycled fashion in the context of sustainable e-commerce. The statistical analysis revealed the following key findings:

- Price and discounts remain the most influential factors for online recycled fashion shoppers.
- Only a small consumer segment demonstrates strong interest in sustainability, underscoring the gap between growing environmental awareness and actual purchasing behavior in the online recycled fashion context.
- Fashion e-commerce platforms should adopt differentiated marketing strategies that go beyond one-size-fits-all approaches to address the diverse expectations and priorities identified in the consumer clusters.
- Demographic factors, particularly education and gender, significantly shape consumer attitudes toward digital innovations in fashion e-commerce apps. Younger consumers show more openness to second-hand fashion platforms. Gender and age significantly influence consumers' sustainable fashion behaviors and preferences, while education plays a nuanced role, primarily affecting interest in specific sustainability-related features.
- Developing engaging educational content and promoting accessible, easy-to-understand sustainability information could bridge the gap between awareness and action, fostering broader adoption of sustainable and second-hand fashion practices.

6. Policy Implications

The results of this study suggest policy implications that directly encourage consumer adoption of recycled and second-hand fashion as outlined below:

- Introduction of financial incentives such as targeted subsidies or discount schemes for purchases of recycled garments, as well as tax benefits for retailers who prioritize circular fashion practices.
- Launch of public campaigns promoting the environmental and economic benefits of second-hand shopping to help normalize recycled fashion and reduce social stigma associated with used clothing, particularly in cultures where second-hand products may be perceived negatively.
- Establishment of clear, standardized labels indicating when a product is made from recycled materials to improve transparency and consumer confidence, empowering shoppers to make sustainable choices.
- Integration of second-hand platforms into mainstream retail environments through partnerships or digital marketplaces to increase the accessibility of recycled fashion and encourage more consumers to consider second-hand options as part of their regular shopping habits.

Such measures would directly address the disconnect identified in the study between consumer interest in sustainability and their low engagement with second-hand fashion, ultimately contributing to waste reduction and advancing circular economy goals in the clothing industry.

7. Limitations and Further Research

While the current study provides valuable insights into consumer attitudes toward platform-driven innovations and sustainable fashion, it has several limitations, which are summarized below, along with areas that offer opportunities for further research:

- Given the online sampling methodology of the research, future in-person research would strengthen the representativeness of findings across different population segments, including those with limited internet access or lower digital literacy.
- Given the country-specific sample used, conducting cross-cultural studies in various countries would expand understanding of how cultural contexts shape consumer attitudes and behaviors, ensuring the results are applicable beyond the Greek market.
- The reliance on self-reported measures offers rich, subjective insights into consumer preferences, yet incorporating observational or behavioral data in future studies would complement self-reports and provide a more comprehensive picture of actual consumer actions.
- The cross-sectional design effectively captures a snapshot of consumer opinions; however, adopting longitudinal or experimental research designs would enable the exploration of changes in attitudes over time and help identify causal relationships between digital innovations and sustainable purchasing behaviors.
- Integrating qualitative approaches such as interviews or focus groups could deepen understanding of the motivations, barriers, and social dynamics influencing engagement with recycled and second-hand fashion, further enriching quantitative results and guiding more effective policy and marketing strategies.

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Appendix A

Table A1. Questionnaire on Platform-Driven Sustainability and Recycled Fashion Consumption.

Section	Question	Response Scale
A. Demographics	What is your gender?	Male ☐ Female ☐ Other☐
	What is your age group?	18–24 ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55+ ☐
	What is your highest level of education?	High school / Vocational ☐ University Degree ☐ Master's Degree ☐ PhD holder ☐
	What is your current employment status?	Private sector ☐ Public sector ☐ Self-employed ☐ Unemployed☐
B. Online shopping	How often do you purchase fashion items online per year?	Once ☐ Twice ☐ Three times ☐ Five times or more ☐ none ☐
	Which platforms do you use most frequently to purchase fashion items? (Multiple selection possible)	Official brand websites ☐ Amazon/Zalando ☐ Social media shops ☐ Second-hand platforms ☐
	Which fashion apps do you use? (Select all that apply)	SHEIN ☐ ASOS ☐ Zalando ☐ Other ☐ None ☐

Table A1. *Cont.*

Section	Question	Response Scale
B. Online shopping	Which of the following factors influence your decision to purchase recycled fashion items from online stores? (Select all that apply)	Price and discounts ☐ Quality and materials ☐ Reviews and ratings ☐ Clear sizing guides ☐ Delivery speed ☐ Free shipping and returns ☐ Brand reliability ☐ Product presentation (images, etc.) ☐ Sustainability and ethical production ☐ Inability to try on clothes ☐ Fit or quality issues ☐
	What are your biggest concerns when shopping recycled clothing online? (Select all that apply)	High shipping costs ☐ Delayed delivery ☐ Returns complexity/cost ☐ Store reliability ☐ Payment/data security ☐ Wrong or defective orders ☐
C. Impact of Digital App Features	Which of the following app features do you find useful for buying recycled fashion items? (Select all that apply)	Easy navigation ☐ Personalized AI recommendations ☐ Barcode scanning for similar items ☐ Virtual fitting room ☐ Augmented reality (AR) try-on ☐ Chat with stylists ☐ Real-time 3D interaction ☐ Trend recognition and fashion advice ☐ Scanning clothes to find similar products ☐
D. Sustainability Preferences	Does sustainability influence your fashion purchases?	Yes ☐ No☐
	Do you use second-hand platforms to purchase fashion items like (Vinted or Depop)?	Yes ☐ No☐
	Are you interested in sustainability-related information when shopping for fashion?	Yes ☐ No☐
	Do you use filters to find sustainable products when shopping fashion online?	Yes ☐ No☐
	Do you pay attention to sustainability labels when buying fashion items?	Yes ☐ No☐
E. Digital marketing Innovations	Which of the following innovations would motive you to purchase recycled or sustainable fashion? (Select all that apply)	Clear sustainability info ☐ Barcode scanning ☐ Virtual try-on ☐ Digital authenticity certificates ☐ 3D interaction ☐ Drone delivery ☐ AR in e-shops ☐ Custom clothing options ☐ Online–offline integration ☐

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