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Environmental Concerns in the Fashion Industry: A Twin Transition With the Digital Product Passport

Annarita Colasante¹  | Idiano D'Adamo²  | Simona Desideri³ | Martina Iannilli³ | Valeria Mangani⁴

¹Department of Law and Economics, Unitelma Sapienza—University of Rome, Rome, Italy | ²Department of Computer, Control and Management Engineering, Sapienza University of Rome, Rome, Italy | ³Independent Researcher, Rome, Italy | ⁴Sustainable Fashion Innovation Society, Rome, Italy

Correspondence: Idiano D'Adamo (idiano.dadamo@uniroma1.it)

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ABSTRACT

The fashion industry exerts a significant impact on ecosystems, prompting consumers to seek sustainable solutions and companies to adapt their production processes to minimize environmental harm. The digital product passport (DPP) may play an important role in facilitating the twin green and digital transitions. Proposed by the European Commission, the DPP aims to enhance the sustainability and traceability of products throughout their life cycle, and the recent literature reflects a growing scholarly interest in this initiative. The present paper presents the findings of an online survey conducted in Italy with a sample of 549 participants, exploring consumer perceptions regarding digital device knowledge, purchasing habits, and environmental and economic considerations. The results show a general lack of familiarity with the DPP but a strong confidence in digital labels as tools for enhancing corporate transparency. While consumer awareness of environmental issues remains somewhat ambiguous, there is growing attention to the use of raw materials. Notably, respondents expressed a willingness to pay a 17% premium for products featuring the DPP, with this tendency emerging as most pronounced among women, individuals aged 31–50 years, and those with high incomes. Additionally, 58% of respondents indicated a willingness to donate money in support of sustainability initiatives, though younger respondents (aged 18–30 years) appeared less inclined towards such altruistic contributions. The findings may inform business strategy and provide valuable insights into how the DPP may support the green and digital transition. However, its effectiveness depends on the integration of environmental protection measures with socioeconomic considerations, aligning with the objectives of Sustainable Development Goal 12.

1 | Introduction

The concepts of sustainability and the circular economy (CE) have gained increasing prominence, largely due to the growing recognition of climate change (Peçanha and Ferreira 2025; Sudusinghe and Seuring 2022). As a result, responsible production and consumption patterns—outlined in Sustainable Development Goal 12 (SDG 12)—have become critical targets

across various industries (Balsalobre-Lorente and Shah 2024; Beducci et al. 2024; D'Adamo et al. 2023). Given that climate change is driven by human activities, significant changes are required, making the transition to a CE indispensable (Di Stefano et al. 2024; Di Vaio et al. 2025).

SDG 12 calls for companies to integrate environmental concerns into their operations, transforming production processes and

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supply chains (Heeß et al. 2024; Sharma et al. 2024) in alignment with CE principles. This involves the minimization of hazardous materials, emissions reduction, and the adoption of sustainable supply chain practices (Raman et al. 2024). A core component of the CE is the emphasis on reuse and recycling, which are core ecological principles (Kirchherr et al. 2023). However, the effective implementation of these principles must be studied alongside digitization and technological innovation, as these factors are essential for achieving the SDGs (Arroyabe et al. 2024; Aziz et al. 2024).

Digital technologies offer significant resource–efficiency benefits (Sassanelli and Pacheco 2024) and play a key role in determining the resilience of firms undergoing digital transformation (Fernández-Miguel et al. 2024). Research suggests that digitalization and supply chain concentration enhance sustainable performance (Sun et al. 2024), yet further exploration is needed to assess how digital technologies can effectively address sustainability challenges (Raihan 2024). Circular strategies and digital tools compel companies to modify their operations to maintain competitiveness (Taddei et al. 2024) while integrating artificial intelligence (AI) into business management could further drive green innovation (Shaik et al. 2024). These shifts also highlight the importance of sustainability education for professionals, with the aim of enhancing both businesses competitiveness and environmental responsibility (D'Adamo et al. 2024; Podgórska and Zdonek 2024).

The textile and clothing industry has long been scrutinized for its environmental footprint, prompting commitments such as the United Nations' Fashion Industry Charter for Climate Action (FICCA), aiming for net-zero emissions by 2050 (Stridsland et al. 2023). This sector is a major contributor to environmental degradation, generating significant waste (Ahmed and Maraz 2021; Paul et al. 2023; Väisänen et al. 2016). Factors such as production location, raw material selection, and manufacturing practices all influence these impacts (Thomasset and Benayoun 2024). While recycling and increased consumer trust in circular practices represent promising solutions (Hong et al. 2024), transparency and accountability in the supply chain require digital tools (Abdelmeguid et al. 2024). Such technologies provide valuable data (Hofmann Trevisan et al. 2024; Moretto and Macchion 2022), fostering the promotion of circular products and increasing consumer willingness to pay (WTP) for sustainable alternatives (Luukkonen et al. 2024).

Supported by the dissemination of high-quality information and access to reliable data (Barletta et al. 2024), consumers are increasingly prioritizing green and circular practices in their purchasing decisions (D'Adamo et al. 2024). Indeed, recent studies have emphasized the need for further research into integrated data archives to enable access to product lifecycle information (Jensen et al. 2024). In 2024, the European Union implemented a new regulation requiring nearly all products sold within the EU to incorporate a digital product passport (DPP) under the Ecodesign for Sustainable Products Regulation (European Commission 2024). The DPP functions as a repository of information, allowing all stakeholders within a supply chain to register and access data on individual products and materials. This data, viewed through the lens of a CE, encompasses aspects such as production, transport, manufacturing, and usage

(Jensen et al. 2024). By facilitating the collection, storage, processing, and transfer of information through digital technologies, the DPP supports the implementation of both the SDGs and CE principles (Barwasser et al. 2024). Thus, the adoption of DPPs presents multiple benefits from a circular and sustainable perspective (Kebede et al. 2024; Langley et al. 2023; Lopes and Barata 2024).

The fashion industry, with its complex supply chains (Saha et al. 2024), poses challenges for the tracking of relevant data. Such challenges may be mitigated through the adoption of DPPs. However, the effectiveness of DPPs is contingent upon companies' digital orientation and associated competencies (Baawain et al. 2025). Successful circular strategies depend not only on sustainable consumer behaviors (Colasante et al. 2025) but also on the availability of robust digital infrastructures (Piedra-Muñoz et al. 2025).

The present study focused on the textile sector, where transparency is expected to become a legal requirement (Tolentino-Zondervan and DiVito 2024). Accordingly, the industry is increasingly exploring blockchain technologies to enhance traceability across the value chain (Alves et al. 2024). However, a critical gap remains regarding consumer perspectives, which are integral to achieving SDG 12. Although studies examining the applicability of DPPs are proliferating, the role played by consumers in the adoption of this innovation remains underexplored. To the best of our knowledge, no prior study has specifically assessed consumers' WTP for a DPP. According to economic theory (see, e.g., (Wertenbroch and Skiera 2002), the exact amount consumers are willing to pay defines the demand curve. To address this gap, the present study sought to gather insights through an online survey of Italian consumers, evaluating their opinions and WTP regarding DPPs. As DPP adoption represents a costly innovation that is likely to affect product pricing, understanding consumer attitudes is crucial for assessing the economic sustainability of firms' implementation.

The remainder of the paper is structured as follows. Section 2 presents a literature review, while Section 3 outlines the methodological framework. Section 4 discusses the results and analysis, and Section 5 provides the conclusions and implications arising from the work.

2 | Literature Analysis

There is a growing convergence between digital technologies and sustainability, with DPPs and circular innovation increasingly transforming value chains. This section proposes three thematic areas: the relationship between digital technologies and sustainability (Section 2.1), emerging trends in DPPs and circular innovation (Section 2.2), and the implications of these developments for the fashion industry (Section 2.3).

2.1 | Digital Technologies and Sustainability in the Value Chain

The SDGs provide a foundational framework for analysis, aiming to safeguard three key dimensions of sustainability

(i.e., environmental, social, and economic) while addressing the needs of as many stakeholders as possible (Ordóñez-Ponce 2023; Varriale et al. 2025). Within this framework, the integration of information and communication technologies with green technologies (Balsalobre-Lorente et al. 2025) plays a crucial role. Supply chains that successfully merge sustainability and digitalization (Fernández-Miguel et al. 2024) also emphasize the human dimension (Tavana et al. 2025) and the balance between internal and external organizational contexts (Fernández-Miguel et al. 2025). A flexible strategic approach enables firms to absorb dynamic capabilities, particularly those related to customer information (Trentin et al. 2025). Digital technologies must be embedded throughout the value chain (Frishammar et al. 2025), serving as instruments through which firms can measure and enhance performance, build resilience, and better respond to environmental uncertainties (Xie et al. 2025). In this context, sustainability reports may provide narratives that communicate a firm's progress in relation to these objectives (Gutiérrez-Ponce 2023). Supply chains are increasingly orienting towards sustainable objectives (Jamil et al. 2024; Roy et al. 2022), and the alignment between technological innovation and ecoefficiency is supported by stakeholder collaboration and data-driven decision-making (Kurrahman et al. 2025).

2.2 | DPPs: Emerging Trends in Sustainability and Circular Innovation

The DPP aims to support long-term decision-making in product management by promoting transparency and accountability (Wicaksono et al. 2025). To date, industrial applications highlight both the need for quantitative research and the potential benefits in terms of circularity (Valtanen et al. 2025). The literature analysis explored and quantified existing studies on DPPs, with the aim of assessing their implementation in production contexts and their relationship with sustainability and digitization. The search was conducted on the Scopus database on January 3, 2025, employing the keywords “Digital Product

Passport” AND “sustainability” AND “digitalisation.” No publications on the topic appeared prior to 2020, confirming its recent emergence as a research area. Interest in DPPs peaked in 2024, with 57 articles published (Figure S1). The majority of studies originated from European countries, with Germany leading (39), followed by England (30) and Italy (20) (Figure S2).

The thematic scope of DPP research was analyzed using a thematic map, which visually categorized topics based on relevance (centrality) and level of development (density) (Figure 1). The map was divided into four quadrants, identifying the key thematic drivers of research and discussion in this domain. Among these driving themes, two stood out: the CE and recycling. The CE is a highly relevant topic emphasizing waste management, waste prevention, and resource efficiency with the aim of maximizing resource value throughout a product's lifecycle (Hassan et al. 2024). However, to enhance the effectiveness of CE practices and address the challenges of an increasingly complex economy, digital innovations are needed. This has led to the emergence of the “smart CE”—a model leveraging digital technologies to improve traceability, optimize resource utilization, and incorporate innovations such as data-driven management and intelligent information sharing across the supply chain (Trevisan et al. 2023). Successful integration of the smart CE within manufacturing industries requires appropriate digital infrastructure and the allocation of significant financial resources (Khan et al. 2024).

A materials passport documenting all materials used throughout a product's lifecycle is crucial for promoting circularity in supply chain management. Thus, digitization and competitiveness must align with a sustainable vision, emphasizing resource efficiency and energy efficiency. In a highly competitive market in which resource availability is often uncertain, it is necessary to optimize production processes and adopt a holistic supply chain approach. This involves stakeholder engagement with a particular focus on end-of-life management (i.e., recycling). The thematic map suggested a shift towards integrated solutions

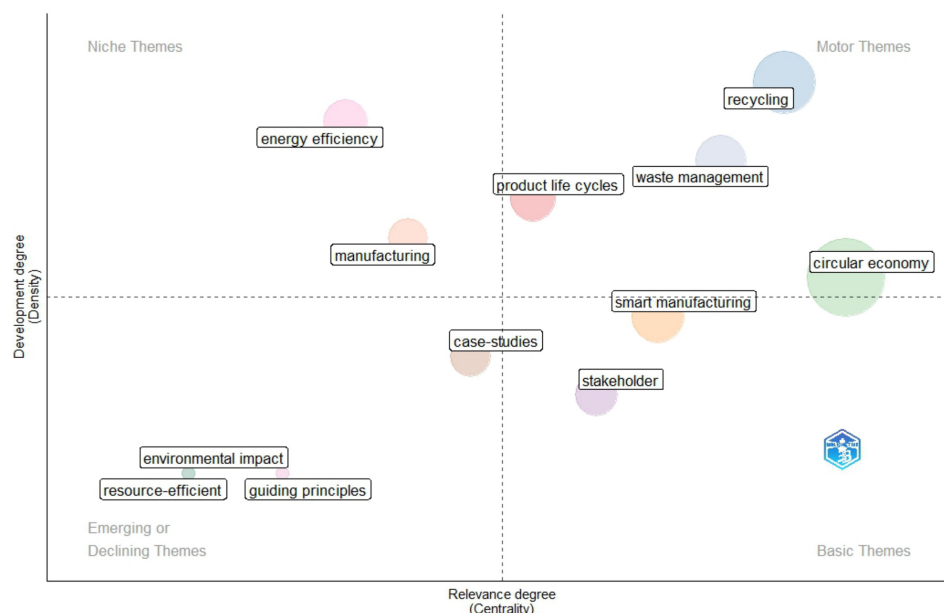


FIGURE 1 | Thematic map.

promoting innovation and environmental responsibility. In this direction, companies may leverage DPPs within digitized and integrated supply chains to collect and transmit critical data, including the origin of raw materials and information on production processes, thereby enhancing efficiency and effectiveness in supply chain management. Promoted by the European Union, this technology facilitates the transition towards more traceable, transparent, and predictable supply chains, transforming not only products and internal processes but also company interactions with customers and regulators (Tolentino-Zondervan and DiVito 2024). Despite their potential benefits, DPPs remain in the early stages of development, and the literature highlights the need for further research on their operational foundations, including the driving forces and barriers affecting their implementation and scalability (Jensen et al. 2024).

2.3 | Digitalization and Circularity in the Fashion Industry

As highlighted in Section 2.1, the value chain should be understood through the lens of balancing the green transition with technological innovation (Zoppelletto et al. 2025). This makes it essential to prioritize reuse and recycling strategies over land-fill disposal (Bonifazi et al. 2025). Entrepreneurial moral commitment and active stakeholder engagement are also critical in advancing circularity within the industry (Civera et al. 2025; Glogar et al. 2025; Orisadare et al. 2025).

Consumer-focused studies underscore the importance of education regarding circular practices in the fashion sector (Sehnm et al. 2024), particularly as skepticism persists around specific practices, such as second-hand purchasing (Colasante and D'Adamo 2021). The continued appeal of fast fashion—with its compulsive and immediate gratification dynamics—often outweighs consumers' intentions to adopt more sustainable alternatives (Colasante et al. 2025). A perceived loss of opportunity associated with the relinquishment of fast fashion persists (Bläse et al. 2024), pointing to the need to strengthen the connection between consumer knowledge and purchasing behavior in the context of slow fashion (Seock et al. 2024).

To further examine the fashion industry, an additional analysis was conducted to identify the most relevant studies. The time frame was set from 2020 onwards, focusing on articles, reviews, and editorials. The search utilized the following search string: “Digital Product Passport” AND “sustainability” AND “digitalisation” AND “textile” OR “fashion.”

Increasing awareness of environmental and social challenges is driving transformation within the textile and fashion industry, prompting companies to reconsider their business models and adopt more sustainable practices. Digitalization, representing a key element of the fourth industrial revolution, is playing a crucial role in this shift, introducing advanced technologies such as blockchain, AI, 3D modeling, and virtual reality—all of which are revolutionizing traditional processes in the fashion industry (Liu et al. 2024).

In the textile industry, one of the most complex and diverse sectors in terms of the value chain, the transition to a circular

model is particularly relevant. The textile supply chain comprises multiple industrial processes, each contributing differently to the overall environmental impact (Alves et al. 2024). In this context, digitization not only enables process optimization and operational efficiency but also supports the implementation of innovative tools such as DPPs (Neri et al. 2024).

In the textile industry, DPPs address the growing consumer demand for reliable information about the environmental and social impacts of products. Simultaneously, they enable companies to demonstrate their commitment to sustainability and social responsibility (Alves et al. 2024). The textile industry is expected to be among the first to adopt this innovation, enabling the certification of product information. This will allow consumers to verify the credibility of green claims while providing regulators with a mechanism to monitor compliance with sustainability standards (Zhang and Seuring 2024).

3 | Methodology

The online survey method is widely recognized in the literature for its effectiveness in participant recruitment, data collection, and the use of diverse measurement tools. It allows for an in-depth exploration of consumer behavior, making it a valuable approach for analyzing factors influencing the adoption of innovative, sustainability-oriented technologies in the fashion industry (Barletta et al. 2024; Brant et al. 2015; Hageman et al. 2024). This methodology has been extensively applied in studies examining sustainable consumer behavior, such as the adoption of virtual clothing-sharing platforms (Ruiz-Navarro et al. 2025) and sustainable purchasing habits, including interest in second-hand clothing (Sepe et al. 2025) and apparel made from biobased materials (Stahl et al. 2021). Additionally, online surveys have been employed to assess consumer attitudes towards sustainable fashion, particularly in relation to the bioeconomy, CE, and circular premiums (Colasante and D'Adamo 2021). This methodology has also been used to explore consumer predisposition towards new materials and awareness of popular materials, such as traditional leather and its ecological or vegan alternatives (D'Adamo et al. 2024).

The explorative nature of the present study supported the use of this tool, although responses may have been influenced by the age profile of respondents. As outlined in Section 1, the primary aim was to assess consumers' WTP for the DPP and, additionally, to evaluate the importance assigned to its various attributes and features. The questionnaire was drafted based on the literature review and expert feedback. The questionnaire (proposed in the Supporting Information) was divided into four sections, referring to (i) sociodemographic characteristics, (ii) knowledge of digital devices and purchasing habits, (iii) knowledge of DPPs, and (iv) economic aspects and WTP. It included a mix of open-ended questions, multiple-choice options, and 10-point scale responses to ensure comprehensive data collection.

Studies examining individual differences in environmental concern have consistently identified gender differences, with women more likely to make proenvironmental choices and engage in behavior aligned with such preferences (see, e.g., (Echavarren 2023; Isenhour and Ardenfors 2009 and references

therein). Understanding whether a similar gender gap exists in the context of DPP adoption is critical for the design of targeted policy interventions. Accordingly, the first research hypothesis was as follows:

Hypothesis 1. *Females would be willing to pay a higher price for information contained in the DPP that would support more sustainable choices.*

A comparable strand of research has explored generational differences in sustainable purchasing behaviors (for a meta-analysis, see, M. Wiernik, Brenton, et al. 2013). While the findings have been mixed, the evidence suggests a positive correlation between age and proenvironmental behavior.

Hypothesis 2. *Older individuals would be willing to pay a higher price for access to information contained in the DPP.*

Finally, income may also play a significant role. According to standard economic theory, individuals with higher reservation prices will be more likely to purchase products at elevated price points. Income is therefore strongly associated with WTP, particularly when it comes to paying a premium for green products (see, e.g., (Aguilar and Vlosky 2007)).

Hypothesis 3. *Higher income would be associated with a higher WTP for the DPP, in both absolute and relative terms.*

A total of 549 answers to the online questionnaire were collected between September and October 2024 using a snowball sampling method (Naderifar et al. 2017).

4 | Results

This section presents the descriptive analysis of the DPP questionnaire responses. Data from the first section of the questionnaire showed a balanced gender distribution, with 52.6% female and 47.4% male respondents (Figure S3). Average respondent age was 40 years, with 41.2% aged 18–30 years, 33.1% aged 31–50 years, and 25.7% aged over 50 years (Figure S4). In terms of annual income, 29% earned less than €20,000, 36.8% earned between €20,001 and €40,000, 17.1% earned between €40,001 and €60,000, and 17.2% earned more than €60,000 (Figure S5). The results are presented in accordance with the structure of the questionnaire: knowledge of digital devices and purchasing habits (Section 4.1), specific aspects of the DPP (Section 4.2), and economic aspects and WTP (Section 4.3).

4.1 | Knowledge of Digital Devices and Purchasing Habits

The second section of the questionnaire was analyzed in relation to demographic variables such as age group, income group, and gender, with further subdivision within these categories. In terms of familiarity with QR codes and digital devices, respondents reported an average score of 7.78. When considering the three age clusters (Figure S6), familiarity was highest among younger respondents and decreased with age (8.81 for those aged 18–30 years, 7.65 for those aged 31–50 years, and 6.29 for

those aged > 50 years). Gender differences were minimal, with average scores of 7.69 for women and 7.87 for men.

For interest in following fashion trends, the average score was 6.20, with the middle age group (31–50 years) showing the highest levels of interest across both genders (Figure S7). In general, women across all age groups exhibited greater interest in fashion trends than men. The lowest score was observed among men aged over 50 years (4.96), while the highest was recorded among women aged 31–50 years (7.32).

Regarding the frequency of purchasing clothes and accessories, the overall average score was 5.31, with a positive correlation between income and shopping frequency (Figure S8). As income increased, so did the frequency of purchases reported by respondents (ranging from 4.81 for those earning less than €20,000 to 5.90 for those earning > €60,000).

Considering gender, the data revealed a link between interest in fashion trends and the frequency of purchasing clothing and accessories (Figure 2). In terms of interest, women consistently reported higher average scores across all age groups compared to men, with a peak among those aged 31–50 years (7.32). Conversely, men showed declining interest with age, with the highest score observed among those aged 18–30 years (5.6). A similar pattern emerged for purchase frequency, as women demonstrated more active purchasing behavior across all age groups, with consistently higher average scores than men and a peak among those aged 31–50 years (6.01). In contrast, men showed a declining trend in both fashion interest and purchase frequency, with purchases decreasing progressively with age.

These results suggest a positive correlation between fashion interest and purchase frequency, especially among women and young adults, reflecting age- and gender-related consumption dynamics. The groups showed statistically significant differences, as confirmed by the Kruskal–Wallis test, for both interest and purchase frequency among women ($\chi^2(5) = 68.71, p < 0.001$) and men ($\chi^2(5) = 35.08, p < 0.001$), across all age groups.

Following the analysis of purchase frequency, respondents were asked to identify the factors they considered most relevant when purchasing a product. The results were as follows:

- Product price: 7.53
- Product aesthetics: 7.3
- Product origin: 6.45
- Raw materials used in the production process: 6.35
- Durability and repairability of the product: 6.35
- Protection of workers' rights: 6.03
- Environmental impact: 5.45

The highest scores were associated with price and aesthetics, while the lowest score was attributed to the environmental impact of the product. However, when considering other factors that directly contribute to a product's environmental footprint (e.g., raw materials, durability, and workers' rights), scores were high and above the midpoint. This suggests that consumers may

struggle to prioritize environmental impact as a decisive factor, possibly due to limited information at the point of purchase.

Figure 3 illustrates respondents' purchasing priorities by age group, revealing several significant differences. In particular, for factors contributing to product sustainability (e.g., environmental impact, raw material selection, workers' rights protection, product origin, and durability), those aged 31–50 years demonstrated greater awareness compared to other groups. This suggests a more mature perspective, likely influenced by more active roles in society and family responsibilities. At the same time, this group also placed the highest emphasis on price, indicating a need to balance multiple factors during the point of purchase. Product aesthetics received high scores across all age groups, emphasizing its central importance in consumer decisions. Meanwhile, price sensitivity was particularly pronounced among younger (18–30 years) and older (> 50 years) consumers, likely reflecting budget constraints. According to the Kruskal–Wallis test, statistically significant differences were observed

in purchasing priorities across all age groups: 18–30 years ($\chi^2(6)=221.51$, $p<0.001$), 31–50 years ($\chi^2(6)=88.83$, $p<0.001$), and > 50 years ($\chi^2(6)=22.51$, $p<0.001$).

Next, the questionnaire introduced respondents to the central topic of the study, assessing the perceived importance of digital product labels. This factor received an overall average score of 7.71. When analyzed by age group, the middle group (31–50 years) assigned the highest importance to this technology (7.99) compared to those aged 18–30 years (7.62) and those aged > 50 years (7.51). This result aligns with those obtained previously, showing that those aged 31–50 years placed the greatest emphasis on sustainability-related factors when making purchasing decisions.

However, the importance assigned to digital labels did not necessarily reflect respondents' level of knowledge, as only 25.9% of respondents reported prior awareness of this concept (Figure 4). This discrepancy—between the high interest in digital labels

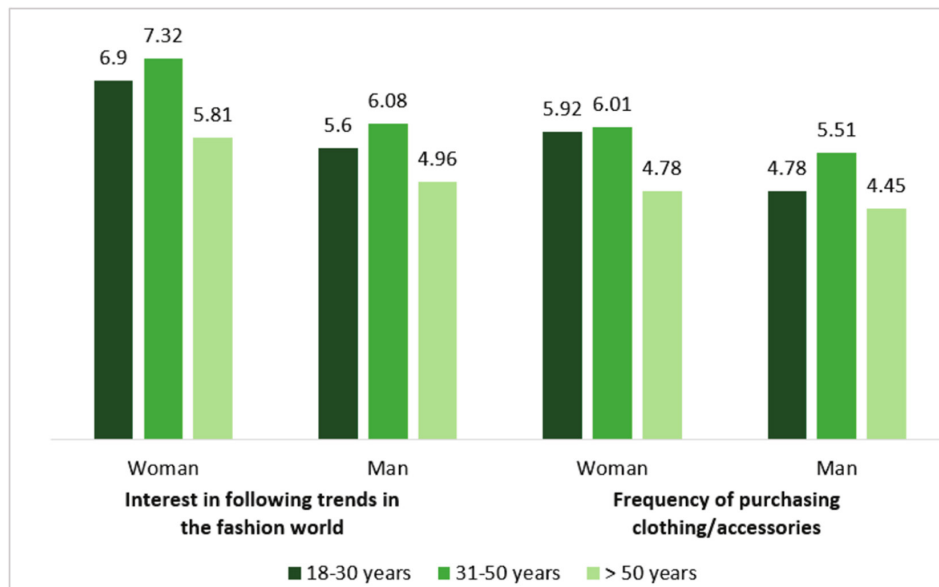


FIGURE 2 | Interest in fashion trends and purchase frequency by age and gender.

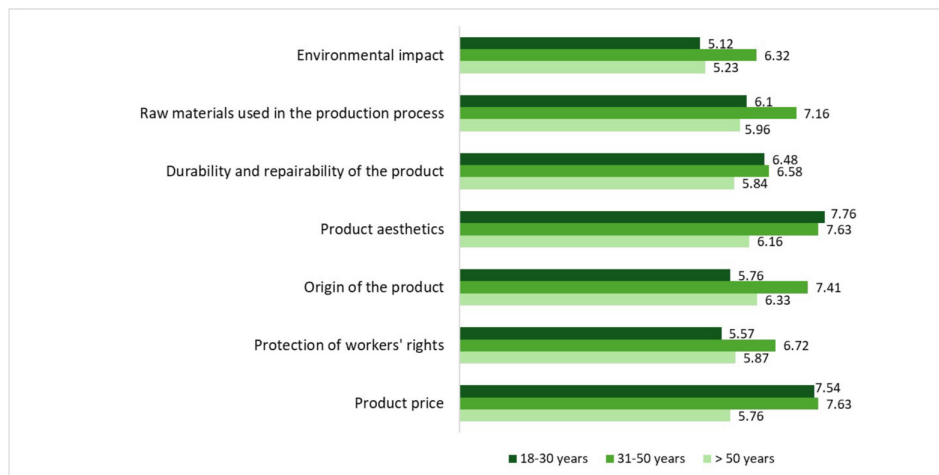


FIGURE 3 | Factors considered at the point of purchase by age.

and the limited familiarity with DPPs—may stem from an intuitive perception of its benefits. Despite their lack of familiarity with the specific initiative, respondents appeared to recognize its potential advantages and express openness towards innovative solutions addressing the growing demand for informed and responsible consumption.

Respondents aged 31–50 years demonstrated the greatest awareness of DPPs (28.6%), followed by those aged 18–30 years (26.5%) and those aged > 50 years (21.3%). This pattern mirrors previous findings, reinforcing a positive correlation between awareness of DPPs and interest in their implementation. With regard to gender, men demonstrated greater knowledge of the DPP than women (28.5% vs. 23.5%).

4.2 | DPP

The third section of the questionnaire examined respondents' propensity to purchase from a company providing greater transparency through a DPP. On a scale of 1 to 10, respondents assigned an average score of 8.24, indicating a strong appreciation for corporate transparency as a guiding factor in their purchasing decisions (Figure 5).

The analysis by age group indicated that older individuals placed greater value on transparency, with those aged 31–50 years expressing the highest average score (8.61) (Figure S11). This trend may be attributed to greater awareness and sensitivity towards

sustainability and social responsibility, which tend to develop with age, experience, and involvement in complex economic decisions. While those aged 18–30 years also recognized the importance of transparency, they appeared less likely to prioritize it over more immediate and practical considerations in their purchasing choices, as reflected in their lower average score (7.97). The figure for respondents aged > 50 years was slightly higher (8.18). No statistically significant differences were observed between genders.

In the questionnaire, respondents were asked to rate the importance of various types of information contained in DPPs on a score from 1 to 10 (Figure S10). Average scores were as follows:

- Raw materials used: 7.59
- Certifications (workers' rights, occupational safety, etc.): 7.44
- Energy consumption and emissions: 7.20
- Waste disposal: 7.18
- Social commitment: 7.13
- Production process: 7.01
- Logistics and transport: 6.42

Among these factors, raw materials used in garment production were rated most important, reflecting growing consumer interest in sustainability. This suggests that consumers are

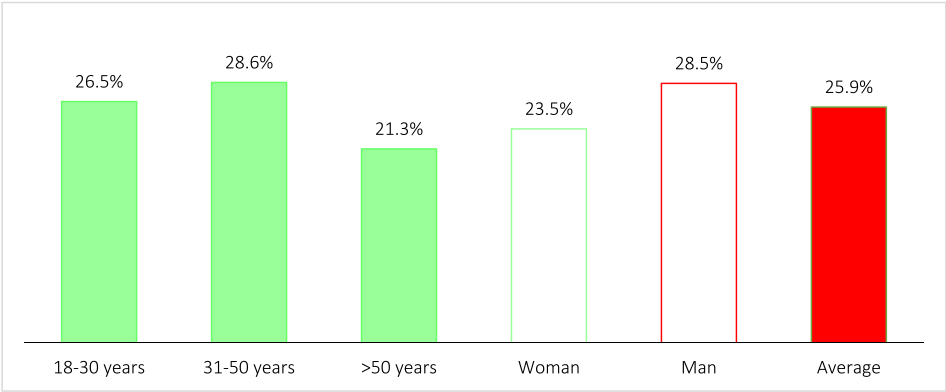


FIGURE 4 | Respondents who have heard of the DPP.

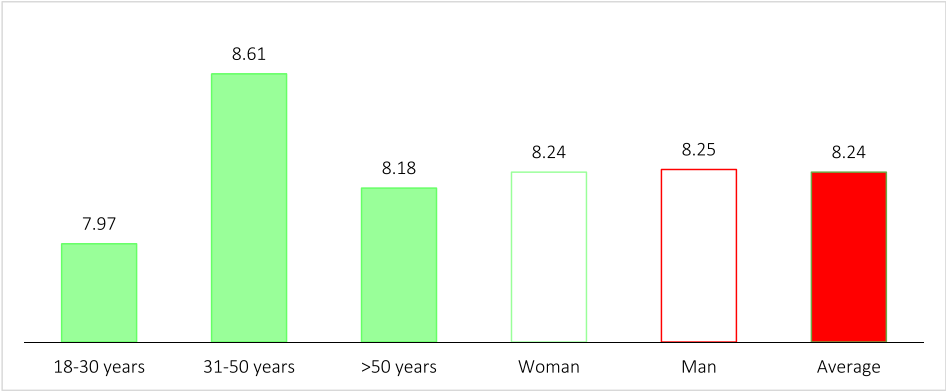


FIGURE 5 | Predisposition to greater purchasing due to the DPP.

increasingly seeking clear and detailed information on product materials to make more environmentally conscious purchasing decisions. Following raw materials, certifications related to workers' rights and occupational safety were also considered highly relevant. This reflects heightened consumer awareness of ethical business practices, particularly with regard to working conditions and human rights. By contrast, logistics and transport received the lowest score. While these factors are crucial in managing environmental impact, they appear less understood by consumers, who tend to prioritize aspects more directly related to product quality and ethical considerations.

Consumers aged 31–50 years demonstrated the greatest level of attention to corporate transparency, with scores often reaching or exceeding the threshold of 8 across several categories (Figure 6). This trend may be attributed to their life stage, as respondents in this group—often parents or professionals with family and work responsibilities—tended to be more conscious of the social and environmental impact of their purchasing decisions. Their strong preference for raw materials (8.15) and certifications (8.06) likely reflects a desire to ensure quality, safety, and sustainability, which are essential for family well-being and a stable future. Younger consumers (18–30 years) exhibited growing sensitivity to environmental sustainability, with a particular emphasis on raw materials (7.64) and waste disposal (7.20). This heightened awareness may have been influenced by increased exposure to environmental issues through social media and educational initiatives. By contrast, consumers aged > 50 years reported lower scores across most categories, indicating reduced overall interest in corporate transparency. This may stem from less familiarity with modern corporate communication strategies or a more traditional purchasing approach, emphasizing the product itself over its ethical or sustainable production context. With regard to gender, both male and female respondents identified raw materials as the most relevant information, although men assigned a higher value than women (8.03 vs. 7.19).

Regardless of age, respondents were particularly concerned with the raw materials used in production and the presence of certifications for socially relevant information, such as workers' rights. Waste disposal also emerged as a significant area of interest. These findings may serve as a valuable foundation for identifying the types of information that should be prioritized by producers within the DPP framework.

Respondents were then asked about their willingness to provide feedback on purchased products (through, e.g., evaluation questionnaires or ratings left on manufacturers' websites) to improve the information captured by DPPs. Overall average willingness was 6.9, indicating moderate consumer interest in actively contributing to the improvement of DPP-related information. Respondents aged 31–50 years exhibited the highest average willingness to provide feedback (7.13), followed by those aged 18–30 years (6.98). In contrast, those aged > 50 years demonstrated less inclination towards this activity, with a lower average score of 6.47.

While younger individuals are generally more digitally adept, they may have less experience in providing structured feedback, whereas older consumers may be less familiar with online review mechanisms and surveys.

Significant differences also emerged across income brackets (Figure S11). Respondents earning up to €20,000 annually showed the highest willingness to provide feedback (7.18), followed by those in the €20,001–€40,000 (6.93) and €40,001–€60,000 (6.94) income ranges. Conversely, respondents earning > €60,000 exhibited the lowest willingness (6.33). This suggests that lower income consumers, who may have fewer financial means to support sustainability efforts, might perceive the provision of feedback as an alternative way of contributing to product improvement and corporate transparency. Conversely, higher income consumers, who may be less emotionally involved or

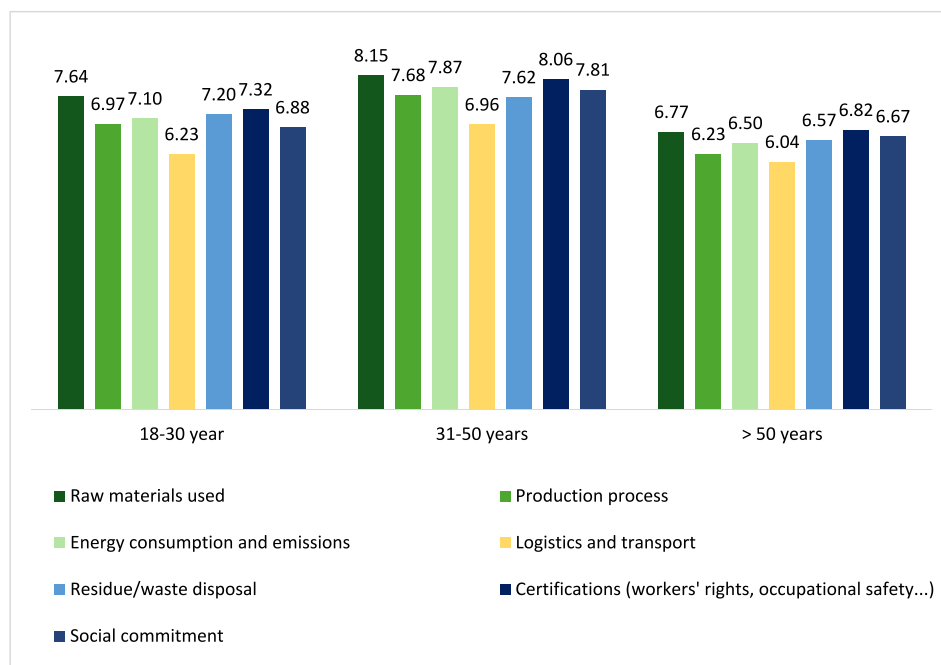


FIGURE 6 | Importance of DPP information by age.

less inclined to dedicate time to such activities, may be less motivated to participate.

Respondents were then asked to indicate their preferred method for accessing DPP information (Figure S12). The QR code emerged as the most preferred option across all age groups, with an overall selection rate of 71.4%, likely due to its practicality and ease of access. However, preference for QR codes decreased significantly among respondents aged > 50s (56.7%), while remaining high among those aged 18–30 years (75.2%) and 31–50 years (78.0%). In contrast, the paper label, preferred by 20.2% of respondents, was most valued by older respondents. While only 16.4% of young respondents (aged 18–30 years) opted for this format, preference dropped further among respondents aged 31–51 years (12.6%) while rising sharply among those aged >50 years (36.2%). Other options, such as chatbots and producer website URLs, maintained similar levels of preference across all age groups. The declining preference for QR codes with increasing age may be attributed to lower technological familiarity among older consumers, who may favor more tangible and traditional formats, such as paper labels.

4.3 | Economic Aspects and WTP

The fourth section of the questionnaire explored economic considerations and specifically respondents' WTP for products with and without a DPP. The results indicated that the average price attributed to a product without a DPP was €48.0, while the price for the same product with a DPP increased to €56.1, representing an average increase of 17%. This finding suggests that DPPs were perceived as an added value, justifying a greater WTP (Figure 7).

Women assigned a higher value to DPP products than men, with their WTP increasing from €44.8 to €54.6 (+22%). In contrast, men exhibited a smaller increase, with prices rising from €51.5 to €57.7 (+12%). These results confirmed Hypothesis 1 and aligned with the literature, highlighting greater female sensitivity to issues of transparency and sustainability. Age also influenced price assessments. Respondents aged 31–50 years demonstrated the greatest WTP for both products, valuing products without a DPP at €52.1 and products with a DPP at €59.5. This trend was likely driven by a combination of higher economic capacity and

increased attention to the values of sustainability and transparency. These results confirmed Hypothesis 2. Notably, the majority of respondents over the age of 30 selected the option that included both the DPP and a donation, indicating a broader interest in both the environmental and social dimensions of sustainability. Interestingly, while the 31–50 age group showed the highest absolute WTP, they recorded the smallest price increase between products with and without a DPP—just €7.40. In contrast, respondents aged 18–30 and over 50 reported increases of €8.20 (from €43.80 to €52.00) and €8.90 (from €49.40 to €58.30), respectively.

From an income perspective, WTP generally increased with income, both for products with and products without a DPP. However, the impact of a DPP was particularly pronounced in lower income brackets. Without a DPP, respondents earning less than €20,000 annually were willing to pay €41.4, while this amount rose to €51.0 for products with a DPP, representing an increase of €9.6. While the effect of a DPP was less pronounced in higher income groups, it remained significant across all brackets. The introduction of a DPP resulted in an increase in the perceived product value across all income groups: +23% for the €0–€20,000 bracket, +15% for the €20,001–€40,000 and €40,001–€60,000 brackets, and +14% for the > €60,000 bracket. The lower income bracket was predominantly comprised of younger individuals, who may have had less experience managing personal spending decisions.

Finally, since sustainability is closely linked to the concept of altruism, respondents were asked to choose between the following purchasing options:

- Jeans priced at €50 (P1).
- Jeans with a DPP priced at €55 (P2).
- Jeans with a DPP priced at €55, plus a €3 donation to families in need (P3).

The results revealed several key insights. Younger respondents (18–30 years) primarily opted for jeans with a DPP (44.2%), though the option including a donation (P3) also received strong support (42.9%) (Figure 8). As age increased, the preference for the DPP plus donation option (P3) grew significantly, surpassing 60% among respondents aged 31–50 years (68.1%) and > 50 years (67.4%).

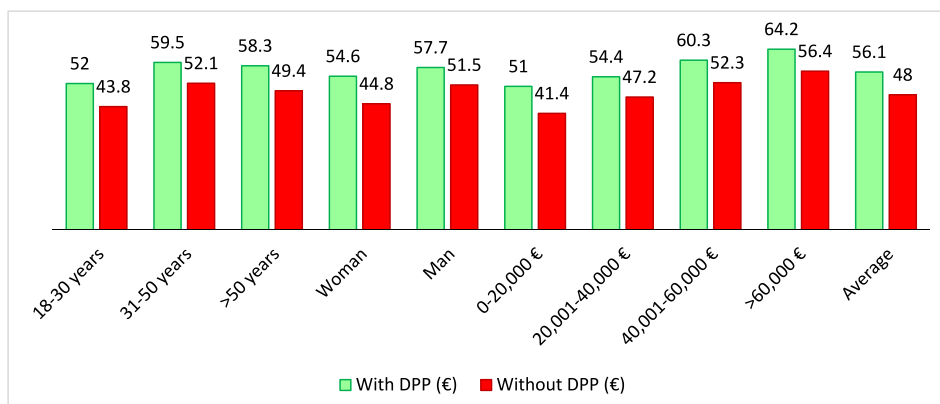


FIGURE 7 | Willingness to pay for products without and with a DPP by income bracket.

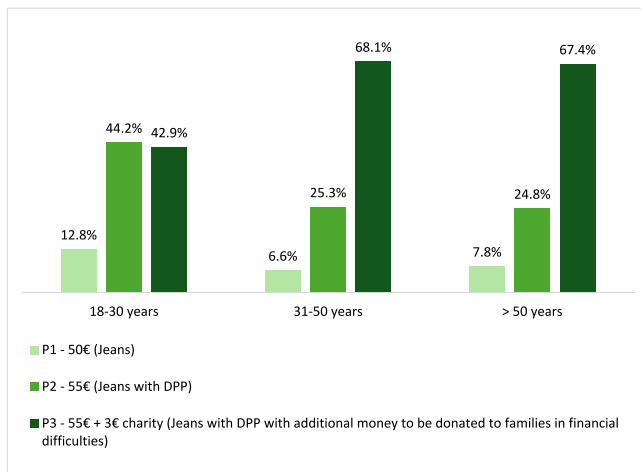


FIGURE 8 | Product choice without a DPP, with a DPP, and with a DPP plus donation by age.

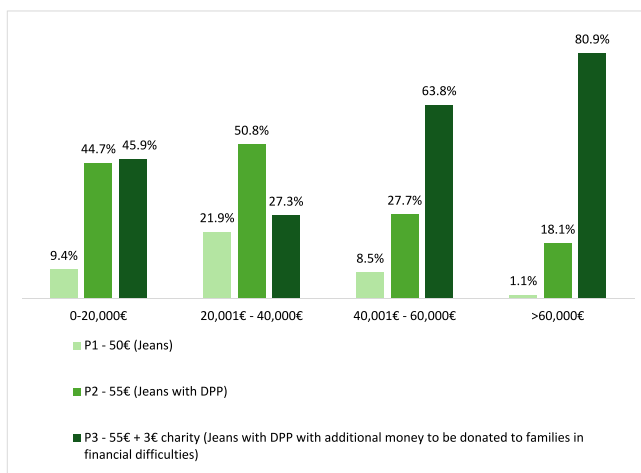


FIGURE 9 | Product choice without a DPP, with a DPP, and with a DPP plus benefit by income bracket.

Regarding income, respondents in the lowest income bracket (€0–€20,000) showed a nearly equal preference for jeans with a DPP (P2) and jeans with a DPP plus donation (P3). This trend may be attributed to the minimal price difference between the two options and the added appeal of contributing to a charitable cause (Figure 9). As income increased, preference for P3 also rose, reaching 80.9% among respondents earning >€60,000. This suggests that higher income consumers were particularly receptive to the social and charitable component of the product. Conversely, preference for jeans without a DPP (P1) was significantly lower (9.5%), reinforcing the notion that, while price remained a consideration, the availability of a DPP or a charitable contribution played a more decisive role in consumer purchasing decisions. The evidence of a higher average WTP in absolute terms (Figure 7), along with the strong preference for option P3 among respondents in the highest income bracket, confirmed Hypothesis 3.

Finally, in terms of gender, women exhibited a slightly stronger preference for option P3 compared to men (58.8% vs. 56.2%) (Table S1).

4.4 | Discussion

The twin green and digital transition presents a complex challenge requiring a comprehensive set of initiatives. The intersection of digitalization, the CE, and technological innovation is essential for achieving the SDGs (Aziz et al. 2024; Mishra et al. 2024). However, certain limitations must be addressed (Raihan 2024). To be truly beneficial, digital technologies must be efficient (Sassanelli and Pacheco 2024) and drive transformation in business processes to maintain competitiveness (Taddei et al. 2024). The present findings align with the literature by confirming the importance of digital tools in enhancing transparency (Abdelmeguid et al. 2024) and providing relevant product information (Hofmann Trevisan et al. 2024; Moretto and Macchion 2022). Additionally, the application of digital tools within industrial contexts could stimulate further reflection among stakeholders (Valtanen et al. 2025; Wicaksono et al. 2025). The results suggest that consumers expect a wide range of information to be included in DPPs, reinforcing previous findings highlighting the importance of evaluating the entire product lifecycle (Jensen et al. 2024) and the imperative for companies to effectively communicate such information (Baawain et al. 2025). However, it should be noted that supply chains—particularly in the fashion sector—are often too complex to manage with ease (Saha et al. 2024), and the implementation of DPPs demands a robust digital infrastructure (Piedra-Muñoz et al. 2025), potentially increasing operational costs.

Given the significant environmental impact of the textile sector, prior research (see Sections 1 and 2) and institutional reports emphasize the urgent need for a paradigm shift. The present findings confirm that consumers are increasingly prioritizing raw material choices (D'Adamo et al. 2024) and expressing growing interest in specific aspects of sustainability within the fashion industry (Colasante et al. 2025). Nonetheless, a cognitive bias in consumer decision-making is also evident (Colasante and D'Adamo 2021). Future research could explore whether increased consumer knowledge through feedback mechanisms might enhance decision-making. In this regard, the collection and transfer of information may play a crucial role (Barwasser et al. 2024). However, as the transition progresses, both the availability and the accuracy of information become critical. If companies engage in greenwashing, they may undermine the credibility and effectiveness of sustainability initiatives. To counter this phenomenon, transparency is needed (Tolentino-Zondervan and DiVito 2024), ensuring traceability across the value chain and promoting corporate social responsibility (Alves et al. 2024). Thus, the integration of DPPs with CE principles is considered a key strategy for companies (Hassan et al. 2024), offering a challenge and an opportunity for consumers (Zhang and Seuring 2024) to assess whether the textile sector is truly ready to embrace sustainability (D'Adamo et al. 2024).

The implications of this work should be interpreted across seven key points of interest. First, the relationship between technological familiarity and age reveals that younger consumers possess an innate ease with digital technologies. This underscores the need for targeted educational strategies aimed at older consumers to ensure inclusivity and equitable

access to relevant information. Second, consumption dynamics appear to be influenced by both age and gender. In particular, women aged 31–50 tend to exhibit greater attentiveness to purchasing behaviors and a higher WTP for a DPP. While such observations fall beyond the central scope of this study, they suggest avenues for future marketing analyses aimed at distinct consumer segments.

Third, the factors driving purchasing decisions merit further consideration. Many consumers struggle to translate environmental values into concrete purchasing behavior, potentially due to limited information available at the point of sale. That said, a sustainability discourse overly centered on the environmental dimension may alienate some consumers. Similarly, sustainability is not always the decisive criterion in product selection, especially when competing against price and aesthetics (traditionally dominant influences in consumer decision-making).

Fourth, the perception and acceptance of DPPs reveal that these tools are widely viewed as adding value, thereby justifying a greater WTP. This reflects a strong potential for DPPs to drive more informed and responsible consumer choices. From a business perspective, such investments could be implemented in the short to medium term, with the expectation that related costs will diminish over time. Indeed, the DPP may evolve from being a voluntary enhancement to a mandatory requirement. The gap observed between high interest in digital labeling and low actual awareness of DPPs further suggests promising opportunities for targeted awareness campaigns.

Fifth, attention must be paid to the type of information included within DPPs. There is a growing consumer interest in the ethical and sustainable origin of products, particularly in relation to raw materials and certifications concerning workers' rights and occupational safety. Sixth, willingness to engage and methods of information access are also relevant. While there is moderate consumer interest in the provision of feedback on purchased products to improve DPP content, this willingness appears more pronounced among lower income groups, potentially as an alternative means of contributing to sustainability efforts. However, difficulties reported by older consumers in accessing QR codes highlight the need for alternative, more inclusive access options.

Finally, seventh, the relationship between sustainability and altruism is evident in the finding that WTP for products with a DPP increased further when accompanied by a charitable donation—especially among older consumers and those with higher incomes. Such findings suggest that sustainability may be closely linked to altruistic values, with consumers willing to support initiatives generating tangible social benefits.

5 | Conclusions

Strategy serves as the critical link between companies and their sectoral environment. In the twin green and digital transition, static solutions are insufficient for navigating ongoing change. The thematic map generated in the present study emphasizes the central role played by circular models (particularly recycling) in promoting a corporate transition with economic and environmental benefits. However, achieving SDG 12 requires

both responsible production models and consumer choices recognizing the value of ecosystem preservation.

The present findings underlined significant generational differences in digital literacy, with younger consumers exhibiting greater familiarity with QR codes. Women emerged as highly attentive to fashion trends, while purchase frequency increased with income. Moreover, in purchasing decisions, price and aesthetics were the most influential factors, while environmental considerations (despite being acknowledged) held less weight. This has important policy implications: information and awareness campaigns must emphasize environmental management as an integrated concept linked to both economic and social dimensions in order for a pragmatic sustainability model to be developed.

The questionnaire results indicated that respondents aged 31–50 years exhibited more virtuous behavior, while those aged 18–30 years appeared to require greater alignment between their intentions and actions to support a sustainability model rooted in altruism. Despite limited familiarity with DPPs, there was strong confidence in digital labeling systems. Notably, the present findings suggest a clear propensity to buy from companies ensuring greater transparency through DPPs. Among the most sought-after information, raw material characteristics were most prioritized. This leads to a second policy implication: emphasizing local resources adhering to green and circular principles may enhance a country's competitiveness. However, true sustainability can only be achieved through global collaboration. While certifications relating to workers' rights and workplace safety were regarded as important, these factors should be better integrated into consumer decision-making to reward businesses upholding responsible practices. Additionally, while the COVID-19 pandemic intensified reliance on transportation, its environmental impact remains largely overlooked. This requires more than a mere transition to green fuels; it also necessitates optimization strategies ensuring environmental sustainability across the product life cycle.

The third key implication of the present findings relates to consumer reluctance to provide feedback, underscoring the need to identify incentives encouraging participation. Such incentives need not be economic. Notably, consumers demonstrated a WTP 17% more for products with a DPP, with this willingness most pronounced among women, respondents aged 31–50 years, and those with higher incomes. The social dimension of sustainability and the need to move beyond self-interest were strongly reflected in the study findings: 91% of respondents opted for higher priced jeans with a DPP, and 58% were also willing to make a donation. No significant gender differences emerged in donation preferences, while respondents earning over €40,000 annually showed a greater willingness to contribute to charitable causes. Additionally, with the exception of respondents aged 18–30 years, all other age groups chose the donation-inclusive option.

Several limitations are evident in the present study. First, it did not differentiate DPP implementation across specific product categories. Second, it lacked a socioeconomic analysis to identify the most effective allocation of funds from donations. Third, no life cycle analyses of the digital technologies involved

were explored, preventing a full evaluation of their environmental impacts. Fourth, the findings may not be generalizable to other populations beyond the sampled group. Finally, while this study lacked a formal theoretical framework, the empirical results provide valuable insights into the factors consumers consider important—providing a foundation for future efforts to model consumer decision-making. The questionnaire is easily replicated, allowing for further validation in future research. Moreover, pragmatic sustainability models require life cycle analyses to quantify the benefits of digital solutions. Ultimately, “Made in Italy” branding, the fashion industry and the twin green and digital transition are interconnected factors positioning transparency as a key enabler in achieving SDG 12. The DPP has the potential to support this goal by enhancing traceability across the product life cycle, reducing waste and promoting recycling and reuse in line with CE principles. In doing so, it may assist businesses in becoming more sustainable, improving the communication of their practices, and empowering consumers to make environmentally responsible and circular choices.

Author Contributions

All authors equally participated in the definition and writing of this paper.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.