SHADE: Empowering Consumer Choice for Sustainable Fashion with AI and Digital Tooling

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ABSTRACT

We present SHADE, a real-world application of using digital tooling to nudge consumer behavior toward sustainable, conscious fashion. In this paper, we outline how digital tools and platforms play an important role in the shifting paradigm of the fashion industry towards conscious fashion, which herein, refers to sustainably-made apparel and accessories produced with minimal environmental and social impact. This includes, but is not limited to, ethical sourcing and responsible resource management. Specifically, we discuss how SHADE leverages extensive data, publicly available information, and AI to guide consumers towards conscious fashion choices by empowering them to make well-informed decisions at the point of online shopping. This contribution explores the fundamental principles, research conducted, and potential impact of using SHADE within the broader context of how digital tools and platforms influence the fashion industry as a whole.

CCS CONCEPTS

• **Applied computing** → **Online shopping**; • **Human-centered computing** → *Interactive systems and tools.*

KEYWORDS

Digital, Artificial Intelligence (AI), Web Extension, Sustainability, Fashion, E-commerce, End-user

ACM Reference Format:
Jenny Hu, Fatimah El-Rashid, and Sille Eva Bertelsen. 2024. SHADE: Empowering Consumer Choice for Sustainable Fashion with AI and Digital Tooling. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '24), May 11–16, 2024, Honolulu, HI, USA.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3613905.3651025

1 INTRODUCTION

Fashion as a canvas for identity and culture is synonymous with large-scale consumerism and unsustainable practices, imposing an immense toll on the environment and society [39]. The fashion sector is responsible for approximately 5% of global greenhouse gas emissions [5], 4% of global freshwater extraction [35], and 92 million tonnes of waste annually [34], often subjecting garment workers to dangerous conditions and low wages [8].

In recent years, there has been a notable increase in consumer awareness regarding the negative environmental and societal impacts of the fashion industry. As a result, the sustainable fashion community has expanded to include not only those with pre-existing sustainability interests, but also everyday consumers who actively seek to make sustainable fashion choices [33]. Multiple consumer-oriented strategies have risen to popularity: shopping less, shopping secondhand, and shopping with consideration for longevity, environmental impact, and labor [21, 42]. For this paper, we will refer to the latter as *conscious consumption* and the fashion that incorporates improved manufacturing and production processes to environment and societal benefit as *conscious fashion.*

Conscious consumption presents multiple challenges for everyday consumers: navigating multiple channels of (often contrary) information, and the limited availability and accessibility of opportunities to make sustainable fashion choices. Despite the abundance of online information promoting sustainable behavior among consumers, there still exists a disconnect between intention and action [7, 31].

As a result, we developed SHADE: a browser extension that presents third-party brand sustainability ratings to consumers while they browse the web and utilizes artificial intelligence (AI) to enable visual search to find sustainable alternatives from verified eco-friendly and ethical brands. This paper explores SHADE's core principles, its approach to consumer behavior change through digital tooling, initial research, and an open discussion on its role in promoting sustainable fashion practices in e-commerce.

2 RELATED WORK

The intersection of sustainable fashion e-commerce and Human-Computer Interaction (HCI) has garnered attention as digital tools play an increasingly pivotal role in shaping consumer behavior and promoting ethical consumption. Existing research in sustainable fashion emphasizes the importance of digital nudging in fostering positive environmental and social impact [14]. A number of digital platforms and tools have emerged, addressing challenges related to sustainability in e-commerce such as [9, 10, 24], and environmentally conscious tags in online marketplaces [4]. These tools exist to support consumers in buying products according to specific values such as supporting Black-owned businesses, LGBTQIA+ businesses, and eco-friendly products. Specifically in the fashion industry, direct-to-consumer marketplaces [1, 17, 18, 29, 38, 40, 44] and web extensions with a focus on secondhand products [6, 19, 41] have been published. Researchers have explored how publicized information, recommendation systems, and interactive tools can enable sustainable consumer behavior in the fashion industry [14, 48, 49].

CHI EA '24, May 11–16, 2024, Honolulu, HI, USA

ACM ISBN 979-8-4007-0331-7/24/05
https://doi.org/10.1145/3613905.3651025

Two critical elements in SHADE's design are its integration of sustainability rating systems and its use of visual search to discover relevant products. Various rating systems and sustainability metrics are employed in the fashion industry including examples such as [3, 13, 27, 36, 45]. Each of these metrics brings a nuanced perspective to evaluating a brand's sustainability practices, contributing to the evolving landscape of informed consumer choices.

Visual search technologies in e-commerce have been a subject of considerable research, potentially enhancing the user experience by allowing consumers to discover products through images rather than text [16, 28]. Existing research in this domain has predominantly focused on applications in generalized search like that by [15, 26, 47], e-commerce search such as [20, 22, 46], and geospatial, like the work of [23]. While visual search is not a novel concept, SHADE's application of this feature, tied together with information accessibility, to sustainable fashion is noteworthy.

3 SHADE

3.1 Concept and Objective

The core concept behind SHADE is to empower users to easily find sustainable fashion from anywhere across the web. Through the desktop browser extension, users can seamlessly discover new information on brands while browsing the internet, and its AI capabilities enable them to find visually similar items to those they come across. SHADE bridges the gap between consumers' values and their shopping habits.

The objective of SHADE is to promote sustainable consumer behavior in fashion e-commerce. What sets SHADE's overall design apart from current solutions is its hybrid approach to digital nudging, combining two commonly used behavior change interventions: *education* and *enablement* [32]. The educational intervention, 'Ratings' (Section 3.2), increases users' knowledge and understanding of sustainable purchases by integrating sustainability ratings, while the enablement intervention facilitates sustainable choices through 'Recommendations' (Section 3.3). This approach not only empowers users to make sustainable purchases, but also creates a positive impact on the fashion industry by creating demand for environmentally-friendly and ethically-made products.

3.2 Ratings

Understanding the sustainability impact of fashion brands is integral to promoting conscious consumerism. Existing rating systems such as [27] or [45] are key examples of resources consumers use to learn about brands, but exist online for users to reference as they see fit. This makes consumer intention to shop sustainably reliant on their ability to pause their current shopping experience, recall or search any given brand's impact, and decide whether to continue shopping.

In response to this challenge, SHADE focuses on enhancing consumer access to existing rating data while they browse. It integrates data from Good On You (GOY), a leading third-party source for fashion brand sustainability ratings, including overall performance rating, as well as a detailed breakdown of the overall rating into People, Planet, and Animals dimensions addressing labor rights, environmental impact, and animal welfare respectively [37]. Notably, due to the complexity of assessing sustainability at the product level, most rating systems, including GOY, operate at the brand level. However, as more brands shift their practices to be more sustainable, efforts are increasing to provide product-specific ratings. Subsequently, we hope to integrate product ratings in the future.

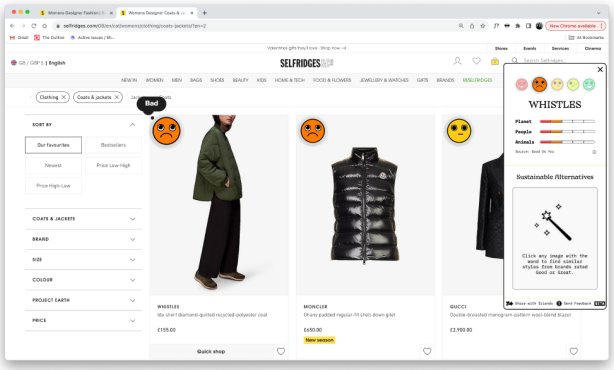

Figure 1: An example of SHADE working on an online marketplace, displaying ratings on top of products and with an open panel of detailed information in the People, Planet, and Animal dimensions.

The aggregated information takes the form of intuitive emoji stickers. These stickers display the overall GOY rating on products as they are viewed, providing users with a quick snapshot of a brand's sustainability standing. For more in-depth insights, users can click any sticker for additional information under the categories of People, Planet, and Animals (Figure 1). Each rating is supplemented with direct links to the Good on You source, facilitating a seamless transition from intuitive visual cues to more detailed sustainability metrics.

3.3 Recommendations

Discovering clothing that aligns with both personal values and stylistic preferences is an ongoing challenge for any consumer. In cases where stylistic preferences and personal values do not align, consumer reactions are dependent on immediate shopping needs and the importance of aligning to personal values. SHADE addresses this challenge by curating products from conscious brands and implementing them through visual search using freely available neural networks. Using the magic wand tool, users can click on any image, fashion product or otherwise, and surface visually similar products within a regularly updated directory of positively rated sustainable fashion brands' products (Figure 2). When users click on any recommended product, they are forwarded to the original listing on the recommended brand's website.

In addition to visual search, SHADE offers practical filters to enhance the user experience. Users can tailor their searches based on various factors, including price range and sorting low to high prices. This inclusion enhances the versatility of SHADE's recommendation engine, allowing users to refine their search results according to specific criteria. We believe SHADE's application of this feature to sustainable fashion is pioneering, differentiating it from

more common applications in mainstream platforms mentioned in Related Work.

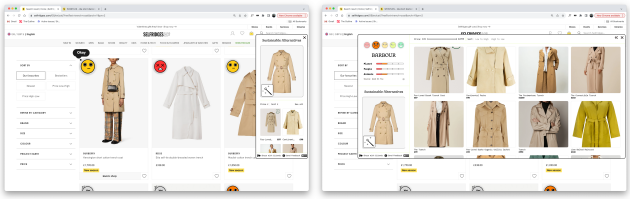

Figure 2: To the left, an example of SHADE after the magic wand tool has clicked on an image, with recommendations from sustainable brands in the panel. To the right, an expanded view of recommendations from the same query.

3.3.1 Implementation of Recommendations. SHADE's recommendation engine utilizes handmade heuristics combined with vector search. We use multimodal image embedding models to compute embeddings of sustainable products. The embeddings are combined with other data sources such as tags and prices, and used by our vector search engine to surface similar products.

4 USER FEEDBACK AND IMPACT ASSESSMENT

At the time of writing, SHADE has garnered over 243 unique users with roughly 52% monthly active users (MAU). User research was also conducted with a total of 68 users. The user analytics demonstrate SHADE's impact on users' fashion shopping behavior.

- **Learning about brands:** Approximately 30% of SHADE users actively engaged over the last 90 days with the information provided through the platform, specifically by clicking on ratings displayed to learn more. In user research, participants were also instructed to independently research and assess the sustainability effectiveness of a specific brand, halting their research when they felt they had obtained sufficient information. It was found that, on average, users spent approximately 465 seconds to comprehensively investigate a brand using traditional methods like searching for articles and analyzing public brand information. In contrast, the same users were able to gather equivalent information using SHADE in as little as 6 seconds.
- **Choosing Sustainable Fashion:** Over the last 30 days, 80% of SHADE users searched for sustainable alternatives using SHADE's AI search tool, with 37.5% of those searches leading to a click for more information on a recommended product, and 1.1% resulting in a successful purchase. In its beta phase, the outcome shows promise when compared to the fashion e-commerce benchmark of 1.6% [12].

These statistics demonstrate SHADE's effectiveness in making crucial information accessible to consumers and finding comparable alternatives in real time, providing users with valuable insights into the ethical and environmental credentials of the brands they encounter during their shopping journeys.

5 DISCUSSION

SHADE demonstrates how digital tools can be leveraged to bridge the gap between consumer intention and action in the realm of sustainable fashion. Our user research showed that sustainability information is not enough to get a consumer to go from the intent to make a conscious purchase to making the purchase, and it alone cannot create long-term behavior change. This is validated by wider research in the field [25]. The design of SHADE, drawing on principles of choice architecture, simplifies complex information and influences users toward sustainable decisions [30].

In its deployment of *education* and *enablement* interventions for nudging behavior change SHADE enables users to learn sustainability information and increases the opportunity to make a sustainable purchase via enabling visual search for sustainable products using multimodal AI. Visual search significantly simplifies the process of finding visually similar sustainable alternatives for users, reducing the need to use detailed text descriptions in queries. This enriches the user experience, exemplifying the potential of AI to enhance discoverability and steer the fashion industry towards more sustainable practices. SHADE's use of AI reflects the evolving landscape of AI applications in promoting sustainable consumption.

6 FUTURE WORK

SHADE represents a strong opportunity for digital platforms to bridge the information gap between consumers, brand data, and their fashion goals. The statistics gathered from user analytics and user research support the notion that SHADE can be an effective tool. Notably, there are a few topics of consideration for the further development of SHADE and digital tools to support conscious consumerism at large.

- **Improving User Experience:** Enabling an even richer shopping experience comparable to that of fashion marketplaces, such as additional filters for material or country of manufacture, is likely to improve the competitiveness of discovering sustainable fashion. In addition, improving recommendation accuracy through participatory design practices like user feedback, combined with preference tuning of the embedding model, promises to improve user experience.
- **Mobile shopping:** Our team recognizes consumer shopping habits are ever-changing. Despite significant growth in mobile shopping, desktop conversion rates in 2023 are reported to be 4.8% compared to mobile at 2.9% [11]. In our user research, it was revealed that 59% of participants reported making final purchases on desktop browsers. For this reason, the early development of SHADE focused on desktop behavioral change for the greatest impact, however, as mobile browsing and purchasing behavior increases, it will be favorable to consider how similar interactions can be adapted to a mobile environment.
- **Text first search:** Two paradigms of shoppers can be colloquially identified: 1. *Netcasters:* shoppers who browse, and 2. *Spearfishers*: shoppers who have a specific mission and goal [2, 43]. For example, consumers who google "sustainable high-waisted jeans" to find jeans that match their values, as well as their style needs, can be considered *spear-fishing*.

SHADE's user interface targets users' native browsing experience, the visual search covering the 'difficult to articulate' visual qualities of fashion pieces like aesthetics and cut. Our team acknowledges that direct text search development could more directly address the Spearfishers who have clear search missions and goals.

7 CONCLUSION

In conclusion, this paper has delved into the symbiotic relationship between HCI and sustainable fashion practices, exemplified by the application of SHADE. Through its intuitive ratings system and recommendation engine, SHADE represents a novel approach to empowering consumers to make informed and sustainable choices during their online shopping experiences. The incorporation of Good on You's sustainability metrics in the form of emoji stickers and the implementation of visual search powered by AI showcase the potential of HCI to reshape consumer behavior towards more ethical and eco-conscious fashion decisions.

The user feedback and impact assessment affirm that SHADE effectively bridges the information gap, providing users with real-time insights and alternatives, thereby contributing to a paradigm shift in conscious consumption in the fashion industry. As SHADE evolves, it not only highlights the challenges inherent in sustainable fashion practices but also underscores the dynamic role of digital platforms in steering the fashion industry towards a more sustainable and conscious future.

ACKNOWLEDGMENTS

We kindly thank the developers Aman Tiwari, Mikhail Koviazin, Tobias Kappeler, Emil Lauritsen, Emir Kurtovic, Samurai L., and Andrey Galko for their support in building SHADE.

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