

# **Sustainable Automated Thrifting Solution: Developing an AI-Powered Digital Wardrobe App**

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## **ABSTRACT**

In an age where technology permeates every aspect of daily life, the fashion industry is no exception. This paper introduces a digital wardrobe app designed to address key challenges in wardrobe management, including disorganization, underutilization of garments, and the growing need for sustainable practices in fashion. The app empowers users to catalogue, track, and optimize their clothing collections while promoting sustainable habits such as swapping, thrifting, and responsible purchasing. The app leverages a user-centered design (UCD) framework, ensuring functionality and aesthetics align with user needs and industry standards. Initial development incorporates iterative feedback from diverse user groups, including fashion students and professionals, to refine features such as outfit planning, inventory tracking, and sustainability insights. AI-driven technologies enable personalized outfit recommendations, sustainability ratings, and condition assessments, encouraging informed decision-making and efficient wardrobe utilization.

Future advancements include integrating garment-embedded chips for seamless digitization, real-time garment tracking, and AI-enhanced gamification features to incentivize sustainable behaviors. These features aim to foster a community-based ecosystem where users can easily exchange or donate underutilized items. The app also incorporates weather-based outfit suggestions and occasion-specific planning, ensuring practicality and user convenience.

This project's holistic approach supports circular economy principles, addressing environmental concerns such as waste reduction and resource efficiency. By combining innovative technology with sustainability-focused design, the app offers a transformative solution to modern wardrobe challenges. Expected outcomes include higher wardrobe utilization, reduced clothing waste, and improved user satisfaction. As the fashion industry undergoes significant digital transformation, this app positions itself as a pivotal tool for reshaping consumer behavior and advancing sustainability goals. With continued refinement and integration of user feedback, it promises to redefine wardrobe management, contributing to a more sustainable and innovative future for the fashion industry.

**Keywords:** wardrobe management, digitalization, sustainability, mobile app, fashion technology

## **INTRODUCTION**

The fashion industry is undergoing a digital transformation, with sustainability emerging as a key focus. However, despite its prominence in discussions, sustainability remains a distant reality in many areas of the fashion ecosystem. Challenges such as overproduction, underutilization of garments, and substantial waste generation persist, exacerbating environmental degradation and resource depletion (Daukantienė, 2023; Mukthar, 2024). While not everything can be recycled, reusability and repurposeability of garments offer practical and immediate avenues to address these issues.

This paper introduces a digital wardrobe app designed to empower users by focusing on extending the lifecycle of garments through reuse and repurposing rather than solely recycling. By digitizing personal wardrobes, users can catalog items, track inventory, and explore creative reuse options, fostering more responsible consumption habits. The app promotes practices such as thrifting, swapping, and upcycling, aligning with the principles of a circular economy (Min, 2024).

Leveraging technologies like artificial intelligence and machine learning, the app provides personalized recommendations for repurposing garments, such as styling unused clothing for new occasions. It also offers features like sustainability ratings and inventory tracking, enabling users to make informed decisions and reduce waste (Xin, 2025). Additionally, weather-based outfit suggestions and community-driven garment exchange networks enhance user engagement and promote resource efficiency.

Recognizing the limitations of a fully sustainable fashion industry, the app emphasizes practical, incremental changes over idealistic goals. By prioritizing garment reusability and repurposeability, it addresses immediate challenges while paving the way for broader adoption of sustainable practices. The developmental process includes user feedback, overcoming technical hurdles, and exploring integration with emerging technologies like garment-embedded chips for seamless digitization (Daukantienė, 2023). This approach ensures a balanced, realistic pathway towards a digital-first, more responsible fashion industry.

## **RESEARCH GAP**

While recent developments in digital fashion platforms and sustainable wardrobe management tools have aimed to reduce clothing waste and enhance consumer engagement, significant gaps remain. Current solutions often lack a seamless integration of AI-driven sustainability insights and user-centered digital wardrobes that

encourage community-based item sharing, swapping, and thrifting. Despite some advancements in inventory management and outfit planning apps, few platforms provide a comprehensive digital wardrobe solution that combines sustainability ratings with advanced features like condition tracking, predictive analytics for outfit recommendations based on personal preferences, and environmental conditions (Manzo, 2024; Gazzola et al., 2020).

Moreover, while digital wardrobes are beginning to incorporate sustainability, most existing apps do not fully leverage AI and machine learning to assess garment condition and promote sustainable decision-making within a community context (Pugh, 2024; Biliakovych, 2024). This gap in holistic sustainability features and community engagement highlights the need for a more integrated digital platform that supports automated thrifting, swapping, and a peer-driven marketplace, as proposed in this developmental paper.

Furthermore, technology adoption barriers and limited exploration of the social and behavioral impact of digital wardrobes on consumer sustainability habits remain under-researched, presenting a critical gap that this project aims to address.

## **LITERATURE REVIEW**

The development of digital wardrobe management systems aligns with a growing movement towards sustainable fashion and digital innovation. Research has highlighted that the fashion industry's rapid turnover of low-quality garments has resulted in increased environmental pollution, thus driving the need for sustainable consumer habits and technological solutions (Petänen, 2024). Digital wardrobe apps can play a significant role in reshaping consumer behavior, as they provide users with tools for cataloging, tracking, and extending the lifespan of their garments through sharing and thrifting.

Studies indicate that consumers, particularly Gen Z and Millennials, are increasingly drawn to digital platforms that promote sustainable practices, showing a preference for tools that enhance wardrobe management and decrease waste (FINESSE, 2022). These apps often feature elements such as inventory management, notifications for underused items, and community-driven marketplaces, which help consumers make informed decisions and foster sustainable habits (Shen, 2014).

Advanced technologies like AI and machine learning have shown potential in providing personalized recommendations and sustainability ratings, enabling users to assess garment conditions and make responsible fashion choices (Sustainable AI-Driven Fashion Tech, 2024). Furthermore, the concept of wardrobe digitization, with embedded digital features such as garment scanning, represents a futuristic approach that could streamline sustainable wardrobe management by offering real-time

inventory insights and personalized outfit suggestions (Virtual vs Sustainable Fashion, 2023).

However, gaps remain in the application of these technologies to foster a truly community-based sharing and thrifting culture within digital wardrobes. This paper will address these gaps, proposing an automated, sustainable thrifting solution that encourages efficient and responsible wardrobe management while promoting user engagement in a digital, community-centered ecosystem.

## **METHODOLOGY**

To achieve the research aims and objectives, a User-Centered Design (UCD) framework will be implemented, focusing on the aesthetic, functional, and practical needs of users in the fashion industry. This approach will ensure the app meets user requirements while aligning with modern fashion trends and sustainability goals.

### **1. Research Phase**

This phase involves collecting qualitative and quantitative data through a structured process. In the first stage, surveys and focus group interviews are conducted with graduate and postgraduate fashion students, as well as professionals from the fashion industry and academia. A detailed questionnaire explores users' wardrobe habits, seasonal usage patterns, fashion preferences, and challenges in incorporating sustainability into wardrobe management. With approximately 25 questionnaires already completed, ongoing research is gathering additional insights into user needs.

### **2. Analysis and Development Phase**

- Once the research phase concludes, the collected data will undergo thorough analysis to identify recurring themes and specific user pain points, such as:
  - Lack of visibility into wardrobe inventory.
  - Challenges in remembering underutilized garments.
  - Preferences for features like garment swapping and outfit planning.
- The insights will guide the development of the app's features and functionalities.
- Prototyping will commence with wireframes reflecting the identified needs. Iterative testing and user feedback will refine the app's design, focusing on seamless navigation, visual appeal, and practical usability.

### **3. Development and AI Integration**

- a. **Initial Development:** The app will be built with foundational features such as:

- i. Manual and automated garment entry.
  - ii. Inventory organization.
  - iii. Community engagement tools for swapping and thrifting.
- b. **AI Integration (Next Steps):**  
AI and machine learning will be implemented in later phases to provide advanced capabilities, including:
- i. **Sustainability Ratings:** Analyzing garment data to generate eco-scores based on production impacts and usage patterns.
  - ii. **Personalized Recommendations:** Suggesting outfits based on user preferences, weather conditions, and occasion types.
  - iii. **Condition Tracking:** Using AI to assess garment wear and suggest potential actions like repair or donation.

#### 4. Future Roadmap

##### a. Short-Term Goals (0-1 Year Post-Launch)

###### 1. Enhanced Gamification Features:

- Introduce a points-based system where users earn rewards for sustainable actions like swapping, donating, or using underutilized items.
- Implement leaderboards and badges to promote engagement and incentivize sustainable behavior.
- Collaborate with fashion brands to provide tangible rewards (e.g., discounts or coupons) for high-performing users.

###### 2. Improved Data Analytics:

- Utilize user interaction data to refine app features and identify new opportunities for engagement.
- Focus on immediate user feedback to enhance the app's usability and address initial challenges effectively.

##### b. Mid-Term Goals (1-2 Years Post-Launch)

###### 1. Real-Time Garment Scanning Pilot:

- Begin testing garment scanning using QR codes or RFID tags for real-time inventory updates instead of embedded chips, which may require significant industry collaboration and cost.
- Collaborate with select fashion brands to roll out pilot programs for garment tagging.

###### 2. AI and ML Integration:

- Develop algorithms for sustainability ratings based on garment material, usage frequency, and disposal practices.
- Introduce predictive analytics for personalized outfit recommendations, leveraging user preferences and weather data.

##### c. Long-Term Goals (3+ Years Post-Launch)

###### 1. Community Ecosystem Expansion:

- Create localized groups within the app to foster a sense of community and encourage peer-to-peer exchanges of garments.
- Add virtual closet-sharing features to allow users to plan outfits collaboratively or borrow garments.

## **2. Advanced Technology Integration:**

- Explore partnerships with fashion manufacturers to incorporate garment-embedded chips for automated inventory management once the technology becomes more feasible and affordable.
- Implement augmented reality (AR) tools for virtual try-ons, enhancing the digital wardrobe experience.

### **d. Iterative Development Approach**

- Conduct semi-annual updates based on evolving user needs and technological advancements.
- Continuously engage users through surveys and beta testing to ensure the app remains relevant and impactful.

## **CONCLUSION**

The development of a digital wardrobe management system signifies a transformative leap in tackling the environmental and consumer challenges prevalent in today's fashion industry. Grounded in user-centered design principles and augmented by AI-powered analytics, the system is poised to redefine how users manage their wardrobes. By integrating features such as sustainability ratings, predictive outfit recommendations, and intuitive garment tracking, the platform encourages sustainable practices like swapping, thrifting, and informed consumption.

Moreover, the system's community-focused modules foster collaborative fashion practices, creating a shared ecosystem that promotes resource efficiency and collective responsibility. The iterative design methodology ensures continuous refinement, with user feedback at the core, enabling the app to evolve dynamically and address emerging user needs.

While challenges remain in fully embedding advanced technologies such as garment-embedded chips and establishing widespread community adoption, the project's phased approach ensures realistic implementation. As pilot testing progresses and AI integration matures, this digital wardrobe platform has the potential to revolutionize fashion sustainability, making it accessible, actionable, and impactful for individual users and the industry at large. Ultimately, this innovation aligns with the principles of a circular economy and supports the transition to a more sustainable and digitally advanced fashion ecosystem.

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