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Artificial Intelligence-Based Conversational Agents Used for Sustainable Fashion: Systematic Literature Review

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ABSTRACT

In the past five years, the textile industry has undergone significant transformations in response to evolving fashion trends and increased consumer garment turnover. To address the environmental impacts of fast fashion, the industry is embracing artificial intelligence (AI) and immersive technologies, particularly leveraging conversational agents as personalized guides for sustainable fashion practices. In this research article, we conduct a systematic literature review to categorize techniques, platforms, and applications of conversational agents in promoting sustainability within the fashion industry. Additionally, the review aims to scrutinize the solutions offered, identify gaps in the existing literature, and provide insights into the effectiveness and limitations of these conversational agents. Utilizing a predefined search strategy on IEEE Xplore, Google Scholar, SCOPUS, and Web of Science, 15 relevant articles were selected through a step-by-step procedure based on the guidelines of the PRISMA framework. The findings reveal a notable global interest in AI-powered conversational agents, with Italy emerging as a significant center for research in this domain. The studies predominantly focus on consumer perceptions and intentions regarding the adoption of AI technologies, indicating a broader curiosity about how individuals incorporate such innovations into their daily lives. Moreover, a substantial proportion of the studies employ diverse methods, reflecting a comprehensive approach to understanding the functionality and performance of conversational agents in various contexts. While acknowledging the historical precedence of text-based agents, the review highlights a research gap related to embodied agents. The conclusion emphasizes the need for continued exploration, particularly in understanding the broader impact of these technologies on creating sustainable and environmentally friendly business models in the e-retail sector.

KEYWORDS

Sustainable fashion; chatbots; virtual assistants; artificial intelligence; AI-based conversational agents

1. Introduction

Over the past few years, there has been a significant transformation in the textile industry. Some of the most notable changes are an increase in the production of apparel and footwear, an increase in the number of fashion seasons, and the retailer's decision to decrease cost, design, quality, delivery, and speed to market (Peters et al., 2021). Fashion trends change rapidly, and social pressures encourage consumers to purchase new clothing that is often low in quality and cost. This fast fashion trend has resulted in one of the most significant environmental challenges, as the fashion industry has become one of the largest polluters globally. The manufacturing process requires significant amounts of resources, such as 79 trillion liters of water consumed per year, electricity, and toxic chemicals, while fabrics take a long time to decompose, leading to tons of clothes ending up in landfills, dumping 92 million tons of waste produced per year (Niinimäki et al., 2020). Fast fashion has severe consequences for the planet, the environment, and society. Therefore, more brands are starting their transition to slow fashion (equity, authenticity, functionality, localism, and exclusivity) (Jung & Jin, 2014) and opting for a more sustainable approach (Pookulangara & Shephard, 2013) in the manufacture of clothing. Slow fashion opposes the fast fashion model (Meyer & Höbermann, 2021) by avoiding the production of cheaper clothes, promoting local production, and creating durable garments that can be used for a long time, encouraging consumers to prioritize quality over quantity. To change shopping habits and initiate a shift in the fashion system, awareness of the impact on resource flows and the process behind a slow culture can help transform the fashion sector toward sustainability (Fletcher, 2010). The adoption of artificial intelligence in education across various sectors, including the growing implementation of AI for sustainability (Van Wynsberghe, 2021), has been widely embraced, yielding beneficial results, such as improved institutional quality, increased effectiveness, and enhanced efficiency in learning (Chen et al., 2020). This review aims to address the question: How have conversational agents based on artificial intelligence been utilized in promoting

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sustainable fashion? During the process of identifying relevant literature, it was discovered that systematic literature reviews published had explored the use of artificial intelligence in medical fields, such as chronic diseases (Schachner et al., 2020), drug prescription (Preininger et al., 2020), for the prevention and management of chronic and mental health conditions (Bérubé et al., 2021). More specifically, these reviews investigated the use of conversational agents (CAs) for virtual storytelling (Tarau & Figa, 2004), and AI-conversational agents in the context of sustainability education (Khosrawi-Rad et al., 2022). Other studies have reviewed chatbots in the fashion industry, specifically from an e-commerce and human–computer interaction (HCI) approach (Landim et al., 2022). However, the purpose of these studies has been to explore different strategies of chatbot design to enhance the online user experience, rather than to inform the consumer about sustainable fashion practices. In another article (Deng & Yu, 2023), the investigation focused on the impact of using chatbots for sustainable education, addressing various environmental challenges but not specifically within the fashion industry. Bolesnikov et al. (2022) delved into customer perceptions (benefits and risks) with a particular focus on sustainability. However, their coverage was limited to the role of artificial intelligence (AI) (Ju et al., 2022) in improving purchasing experiences or communicating trends (Vashisht & Mittar, 2019) in sustainable fashion, not specifically addressing the concept of conversational agents, which includes different types of AI-conversational agents. Moreover, existing studies have proposed a conversational agent that examines the use of chatbots in education (Wollny et al., 2021), encompassing sustainable fashion and the use of virtual influencers (VI) to promote climate change (Yang et al., 2022). Nevertheless, these studies only covered limited research on the applications of AI-bots to pursue sustainable fashion, or climate change in general, highlighting the need for further research in this area. In conclusion, a specific literature review focused on AI-based conversational agents (chatbots, virtual agents, AI systems using NLP, etc.) and their potential impact on promoting sustainable fashion has not yet been conducted.

2. Methodology

This systematic literature review adheres to the reporting guideline for systematic reviews, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework (Page et al., 2021). The PRISMA approach was chosen to ensure a transparent and standardized methodology, enhancing the reliability and reproducibility of our systematic review process. PRISMA provides a structured framework for conducting and reporting systematic reviews, guiding each step from the initial search strategy to the final synthesis of results. This choice aligns with established best practices and contributes to the overall quality and credibility of our review.

2.1. Information sources

The sources used to identify studies for this literature review were three main research databases: SCOPUS, Web of Science (WoS), IEEE Xplore, and the research engine Google Scholar (GS). The selection of these databases was based on the research *What is the best database for computer science journal articles?* Cavacini (2015) and their use in other systematic literature reviews covering similar topics. Upon comparison of GS, WoS, and SCOPUS, the latter two were found to offer superior quality indexing and bibliographic records in terms of precision, uniformity, management, pertinence, and level of detail. However, GS proved valuable in identifying and rectifying inadequate citation issues within WoS and SCOPUS. Moreover, the study revealed that GS retrieved more items and citations in the field of computer science compared to other disciplines. Therefore, these four databases complement each other.

2.2. Search method

For this systematic literature review, an alternative method was employed to formulate queries using the 2DSearch tool. This tool is designed for data exploration and visualization. It allows users to search and analyze information in a visual, two-dimensional space. The tool enables users to input various queries and parameters, generating interactive graphs and plots that represent the relationships and patterns within the data (Russell-Rose & Shokraneh, 2019).

2.3. Search criterion

The initial search involved an unstructured review of literature reviews that covered synonyms related to the title of this research. The aim was to gather commonly used synonyms for the terms" artificial intelligence," "conversational agent," and" sustainable fashion." To implement the literature search, pre-selected synonyms were required for query construction. To align with the objective of the proposed project, the selection of synonyms needed to be closely related to artificial intelligence-based conversational agents for sustainable fashion. The various combinations of synonyms are shown in Table 1.

2.4. Search string

A search string was constructed using the automated method and adapted to each database, conducting several searches with the automated tool. The query string for the different search engines and databases ended with the following search query:

- Google Scholar: ("conversational AI"—"virtual agent"—"Conversational agent"—chatbot—"virtual assistant"—"digital assistant"—"smart assistant"—"natural language processing agent") ("sustainable fashion"—

Table 1. Search criteria table.

Keyword	Artificial intelligence	Sustainable fashion	Conversational agent
Synonyms	AI	Eco-fashion	Virtual agent
	Natural Language processing	Ethical fashion	Chatbot
	Intelligent agents	Conscious fashion	Conversational ai
	Machine learning	Green fashion	Virtual assistant
	Computational intelligence	Sustainable apparel	Intelligent agent
	Intelligent systems	Slow fashion	Dialogue system
	Cognitive computing	Responsible fashion	Voice assistant
	Neural networks	Upcycling fashion	Digital assistant
	Intelligent analytics	Zero waste fashion	Smart assistant
	Machine intelligence	Socially responsible fashion	Personal digital assistant
		Environmental fashion	Automated conversational agent
		Sustainable textiles	Interactive agent
			Text-based assistant
			Chatting robot
			Messaging bot

Table 2. Overview of search results and study selection.

Source	After automated search	After selection criteria (title and abstract)	After selection criteria (full text)
SCOPUS	26	12	2
Web of Science	20	7	5
Google Scholar	141	39	5
IEEE Xplore	13	7	3

"Environmental Fashion"—"slow fashion"—"sustainable textiles"—ecofashion—"Zero Waste Fashion")

- SCOPUS: all fields: "conversational AI" OR "virtual agent" OR "Conversational agent" OR chatbot OR "virtual assistant" OR "digital assistant" OR "smart assistant" OR "natural language processing agent" AND all fields: "sustainable fashion" OR "Environmental Fashion" OR "slow fashion" OR "sustainable textiles" OR "eco-fashion" OR "Zero Waste Fashion"
- IEEE Xplore: ("All Metadata": "conversational AI" OR "virtual agent" OR "Conversational agent" OR chatbot OR "virtual assistant" OR "digital assistant" OR "smart assistant" OR "natural language processing agent") search within results: fashion
- Web of Science: (ALL = (conversational AI OR virtual agent OR Conversational agent OR chatbot OR virtual assistant OR digital assistant OR smart assistant OR natural language processing agent)) AND ALL = (sustainable fashion OR Environmental Fashion OR slow fashion OR sustainable textiles OR eco-fashion OR Zero Waste Fashion)

It combines sustainable fashion related keywords with various types of artificial intelligence based conversational agents. The following Table 2 lists the results of the search query.

2.5. Inclusion and exclusion criteria

2.5.1. Inclusion criteria

The search was limited to journal articles and conference articles from the past 5 years (2019–2023). All included documents were available and written in English.

Table 3. Study selection criteria.

Criterion
Articles without full text available
Articles not accessible in English
Articles out of scope
Non-scientific articles
Non last 5 years articles

2.5.2. Exclusion criteria

Irrelevant topics and non-scientific studies were excluded. Additionally, editorials, literature reviews, books, and book chapters were also excluded. Table 3 specifies more conditions to delineate the criteria.

2.6. Selection process

The searches were completed in March 2023. Initially, there were a total of 200 studies resulting from the database searches. The metadata of the studies, including document, title, authors, publication details, abstract, reference count, author keywords, etc., was exported and downloaded. Subsequently, it was imported into an open-source machine learning tool called AsReview Lab. This tool facilitated the reviewing, including, and excluding of studies by filtering through the title and abstract screening process. The process of selecting the articles was carried out in the following stages:

1. Reading the article's metadata and applying the inclusion and exclusion criteria. Additionally, duplicated studies were eliminated.
2. Filtering process by reading the title and abstract using AsReview Lab. In this step, articles that were out of scope or irrelevant were excluded. As a result, the number of studies included was reduced to 65.
3. The 65 studies were downloaded in full text and read carefully. Studies that had little information about artificial intelligence-based conversational agents in the context of sustainable fashion were excluded.
4. Finally, after applying the selection criteria to read the full text the number of studies was reduced to 15.

For PRISMA compliance, Figure 1 shows the flow diagram outlining the identification process.

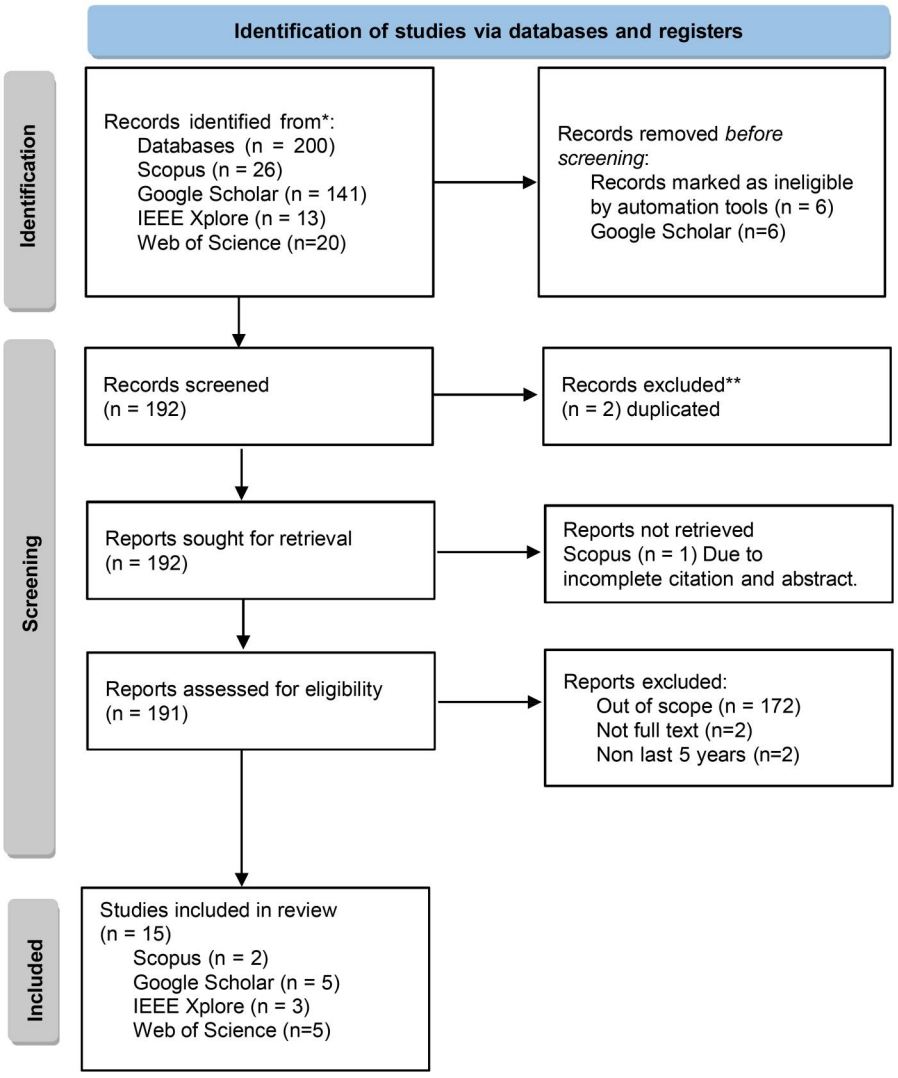

Figure 1. Flow diagram of PRISMA process.

3. Results

First, this section presents the main statistics for the 15 primary studies included in this review. Table 5 enumerates the studies, providing information about the authors, publication year, and title. As shown in Table 2, Web of Science and Google Scholar were the databases that yielded the most results according to the inclusion criteria, each contributing five studies. The most notable publication journal is the Journal of Retailing and Consumer Services, with an Impact Factor of 10.972 according to ScienceDirect (Akhtar et al., 2021).

In terms of the type of studies reviewed, only a small fraction (6.6%) consisted of symposiums or thesis studies, while a significant proportion (13.33%) were conference papers. The majority (over 73%) were classified as journal articles, suggesting that the studies included in this systematic review underwent a peer-review process.

Afterwards, the studies were classified based on:

- Purpose of the research study or objectives for implementing chatbots.
- Type of AI-chatbots identified in publications
- The roles of the chatbots in the selected articles.
- Evaluation methods used in the research to prove the effectiveness of the proposed chatbots.
- Technology used to develop the chatbot and/or the platforms the chatbots operate on.
- The measurements used in the studies related to the research.

The articles encompass a diverse range of fields, spanning disciplines, such as management, sustainability, production economics, retailing and consumer services, business research, and human–computer interaction. This broad spectrum of journals reflects the multidisciplinary nature of the studies included in this review, contributing insights from various academic perspectives.

To assess the international collaboration in co-authored articles, we examined the affiliations of authors listed in the publications related to AI-powered conversational agents for sustainable fashion, as shown in Figure 2. Co-authored articles involving contributors from multiple countries suggest a collaborative effort across diverse geographic

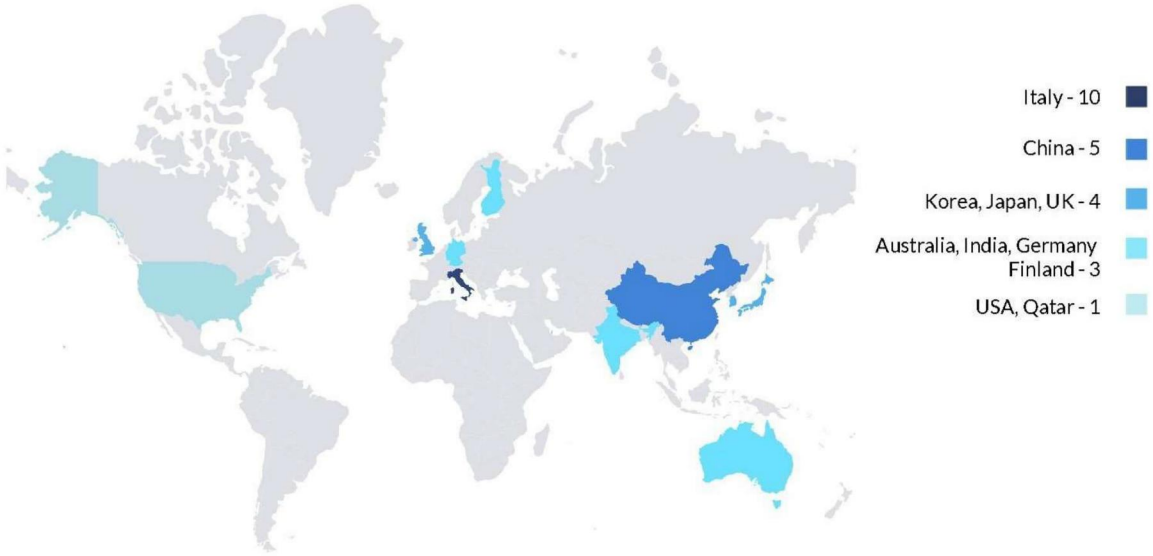

Figure 2. Geographic mapping of the included studies.

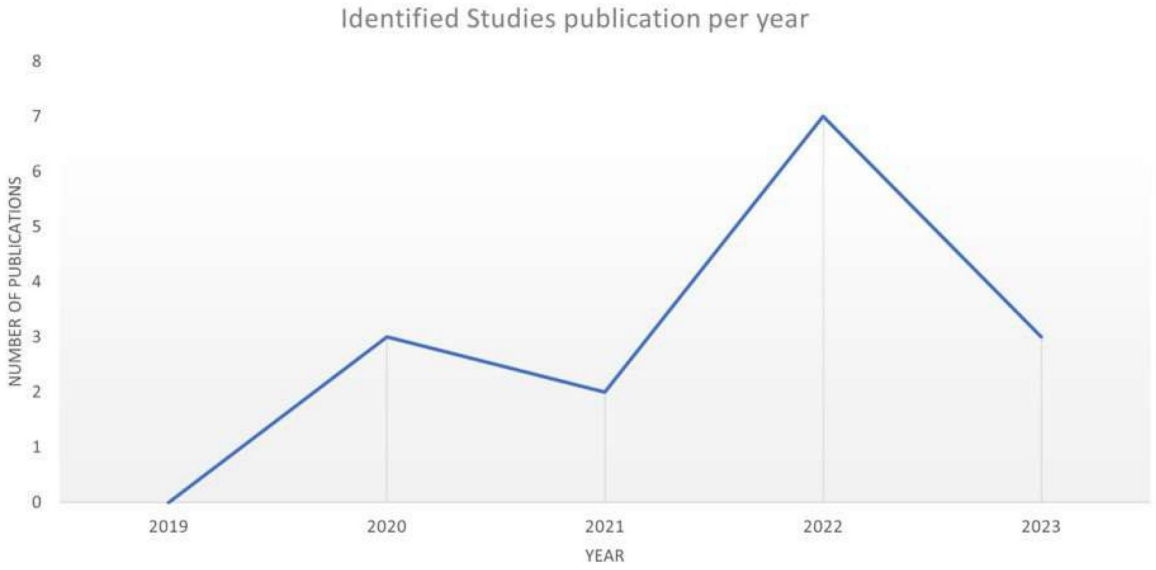

Figure 3. Identified publications per year.

locations. This collaborative trend is common in academic research, reflecting the global nature of scholarly pursuits. The diverse backgrounds of co-authors from different countries indicate a broad exchange of ideas, expertise, and perspectives, contributing to the richness and global relevance of the research. International collaboration is a common and positive aspect of academic endeavors, fostering a more comprehensive understanding of complex topics and promoting a diverse range of insights within the field.

The study's geographical analysis indicates that the majority of the articles were published in Italy, signaling a pronounced interest and research activity in this field within the country. Furthermore, the geographical mapping reveals a broader international distribution of studies, with additional significant contributions originating from China, Korea, Japan, and the UK. Noteworthy is the diverse global participation, including countries, such as Australia, India, Germany, Finland, Brazil, the USA, and Qatar, showcasing a widespread engagement in exploring the intersection of AI and sustainable fashion practices. Despite the diverse international contributions, Italy emerges as a prominent hub for research on AI-powered conversational agents in the context of sustainable fashion.

Organizing the pertinent publications based on their publication date reveals a notable surge of interest in artificial intelligence-powered conversational agents focused on sustainable fashion. As shown in Figure 3, the trend line indicates a rapid increase in the number of studies in recent years. This underscores the importance of acknowledging that research in this domain is continuously progressing and evolving rapidly (Table 4).

Table 4. Studies included in the systematic review.

ID	Title	Authors	Year	Published in
1	Fostering fashion retail experiences through virtual reality and voice assistants	Morotti, Elena; Donatiello, Lorenzo; Marfia, Gustavo	2020	IEEE Conference on Virtual Reality and 3D User Interfaces, VRW 2020
2	Chatbot e-service and customer satisfaction regarding luxury brands.	Chung, Minjee; Ko, Eunju; Joung, Heerim; Kim, Sang Jin	2020	Journal of Business Research
3	Chatbots in retailers' customer communication How to measure their acceptance?	Rese, Alexandra; Ganster, Lena; Baier, Daniel	2020	Journal of Retailing and Consumer Services
4	Digital humans in fashion: Will consumers interact?	Silva, E. Sirimal; Bonetti, Francesca	2021	Journal of Retailing and Consumer Services
5	Exploring the impact of chatbots on consumer sentiment and expectations in retail.	Tran, Anh D.; Pallant, Jason I.; Johnson, Lester W.	2021	Journal of Retailing and Consumer Services
6	Investigating the impact of artificial intelligence on consumer's purchase intention in e-retailing.	Bhagat, Rohit; Chauhan, Vinay; Bhagat, Pallavi	2022	Foresight
7	How should chatbots be designed to support attachment to unused wardrobe?	Yi, Simeng	2022	UCL Interaction Center
8	A new perspective on the textile and apparel industry in the digital transformation era.	Akhtar, Waleed Hassan; Watanabe, Chihiro; Tou, Yuji; Neittaanmaki, Pekka	2022	Textiles
9	Mindful sustainable consumption and sustainability chatbots in fast fashion retailing during and after the COVID-19 pandemic.	Prete, Marzia Del	2022	Journal of Management and Sustainability
10	Fashion meets bot: What should the bot wear?	Wang, Ziqi; Guo, Bin; Cui, Helei; Ding, Yasan; Yu, Zhiwen	2022	2022 IEEE 25th International Conference on Computer Supported Cooperative Work in Design, CSCWD 2022
11	A chatbot to search for similar fashion photos and reference fashion coordinators via body part and fashion item segmentations.	Sawada, Yusuke; Tanabe, Akari; Nakada, Yohei	2022	IEEE Symposium Series on Computational Intelligence (SSCI)
12	"Hi! How can I help you today?": Investigating the quality of chatbots-millennials relationship within the fashion industry.	Murtarelli, Grazia; Collina, Carolina; Romenti, Stefania	2022	TQM Journal
13	Social presence and imagery processing as predictors of chatbot continuance intention in human–AI-interaction.	Jin, S. Venus; Youn, Seounmi	2022	International Journal of Human–Computer Interaction
14	Future of textile: Sustainable manufacturing & prediction via ChatGPT.	Rathore, Bharati	2023	International Peer Reviewed/Refereed Multidisciplinary Journal (EIPRMJ)
15	From fast to slow: An exploratory analysis of circular business models in the Italian apparel industry.	Abbate, Stefano; Centobelli, Piera; Cerchione, Roberto	2023	International Journal of Production Economics

3.1. Purpose/aim of the research study

These studies focus on exploring the practical implementation of artificial intelligence, particularly in the context of retail and consumer services. They aim to understand consumer behavior and intention to use chatbots (Bhagat et al., 2023; Chung et al., 2020; Murtarelli et al., 2023; Rese et al., 2020; Silva & Bonetti, 2021; Tran et al., 2021) and measure user experience in human–computer interaction (Jin & Youn, 2023). Additionally, the studies assess the use of verbal-based interactions in a VR-based fashion e-commerce environment (Morotti et al., 2020), and design a personalized appearance transformation framework for the next generation of intelligent bots (Wang et al., 2022). Moreover, these studies seek to investigate how fashion companies are redesigning their value chain to meet growing stakeholder demands for sustainability and the circular economy (Abbate et al., 2023). They explore different ways to mitigate waste generation (Yi, 2022), improve product quality, and achieve sustainability in the textile industry (Akhtar et al., 2022) through the use of AI and chatbots (Rathore, 2023). The studies included in this review can be categorized into three different objectives:

- Objective 1: Studying the impact of artificial intelligence by measuring consumer intention, expectations, and/or sentiments.
- Objective 2: Understanding consumer interaction with artificial intelligence.
- Objective 3: Examining sustainability and circular economy with the use of artificial intelligence.

The findings of our study reveal noteworthy trends in the distribution of research objectives among the selected articles. A significant portion, specifically 6 out of 15 studies, concentrated on assessing the impact of artificial intelligence by delving into consumer intention, expectations, and sentiments. This focus holds particular significance as it provides comprehensive insights into how consumers perceive and anticipate the integration of AI into their daily lives. Understanding these aspects is crucial for businesses and policymakers aiming to enhance user experiences and facilitate the seamless adoption of AI technologies.

Furthermore, four out of 15 studies centered their attention on comprehending consumer interactions with artificial intelligence. This aspect is pivotal for refining the design and functionality of AI systems, ensuring they align effectively with user needs and preferences. By exploring the dynamics of consumer-AI interactions, these studies contribute valuable knowledge that can inform the development of user-friendly and responsive AI applications.

Additionally, five out of 15 studies undertook the examination of sustainability and circular economy aspects in conjunction with the use of artificial intelligence. This

signifies a growing awareness of the potential of AI technologies to contribute to sustainable practices. These studies play a crucial role in uncovering how AI can be leveraged to address environmental concerns and promote circular economy principles, fostering a more environmentally conscious approach in technological applications.

In conclusion, the diversification of research objectives in the selected studies reflects the multidimensional impact of artificial intelligence. The focus on consumer perception, interaction dynamics, and sustainability aspects collectively contributes to a holistic understanding of AI's role in various domains, providing valuable insights for future developments and implementations.

Figure 4 displays the studies that have been categorized into the three discussed objectives.

3.2. Types and roles of AI chatbots identified in publications

Chatbots, digital assistants, virtual assistants, or chatting robots are conversational agents that can be categorized based on various factors, such as their functionality, platform, user interface, or the application areas they cater to. These areas can range from education, games, customer support, health, banking, marketing, and entertainment, to general assistance like virtual couches. The primary classification of conversational agents can be divided into three distinct categories:

- Text-based agents, commonly referred to as chatbots, are software programs that interact with users through messaging platforms or SMS. These agents require users to type their queries and may take longer to respond.
- Voice-based virtual agents, also known as voice assistants or voice conversational agents (VCAs), utilize speech recognition technology to communicate with humans. These agents have the potential to respond with synthesized speech and allow for hands-free interactions.
- Embodied agents are computer-generated virtual characters, either human or non-human, that interact with users by imitating human behavior. These agents are typically used in technologies or applications that require a more engaging experience with the user.

The chatbots studied in this review are primarily classified considering the three categories mentioned earlier. Furthermore, the studies are categorized based on the application areas in which these chatbots are employed, encompassing e-retail, sustainable fashion, retail and consumer services, online shopping, e-services, and e-commerce. Table 5 provides detailed information for each research, including the type of AI, role, and the specific application area the study was focused on.

As shown in Figure 5, the results of the study reveal that the majority of the studies have primarily researched text-based conversational agents. This preference for text-based interaction, as exemplified by platforms like ChatGPT mentioned by Rathore (2023), suggests a prevalent choice for bot-user communication through messaging platforms. Notably, Wang et al. (2022) implemented an embodied agent to personalize a virtual bot, changing its clothes according to the region. In contrast, two publications explored the use of voice assistants, specifically Alexa from EchoDot, as smart speakers for hands-free services, as detailed by Akhtar et al. (2022) and Rathore (2023).

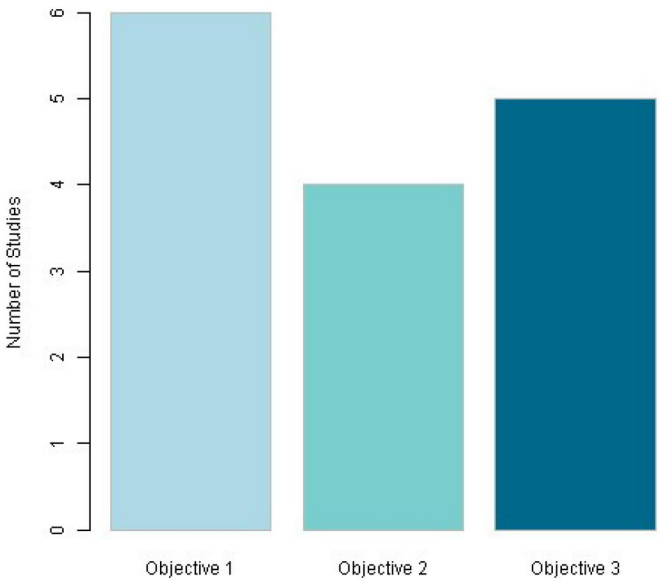

Figure 4. Studies categorized into objectives.

Table 5. AI classified by type and roles.

ID	Type of AI	AI Role	Focused on
1	VR voice assistant (Alexa)	Virtual shopping assistant	E-retail service
2	Text-based chatbot	Personal shopping assistant	E-services
3	Text-based chatbot	Personal shopping assistant	Online fashion retailing
4	Digital human	Brand ambassador or personal stylist	Sustainable fashion
5	Text-based chatbot	Personal shopping assistant	Retail and consumer services
6	All types of chatbot	N/A	E-retail
7	Text-based chatbot	Educative	Sustainable fashion
8	Voice assistant, GAN, AR	Fashion advisor	E-commerce
9	Text-based chatbot	Educative	E-retail
10	Virtual bot	Service providers	Personalize the user experience
11	Text, LINE stamp and image function	Fashion coordinator	E-commerce
12	All types of chatbot	Personal shopping assistant	Online-shopping
13	Text-based chatbot	Personal shopping assistant	E-services
14	Text-based chatbot	Educative	Sustainable fashion
15	All types of chatbot	E-commerce	Online-shopping

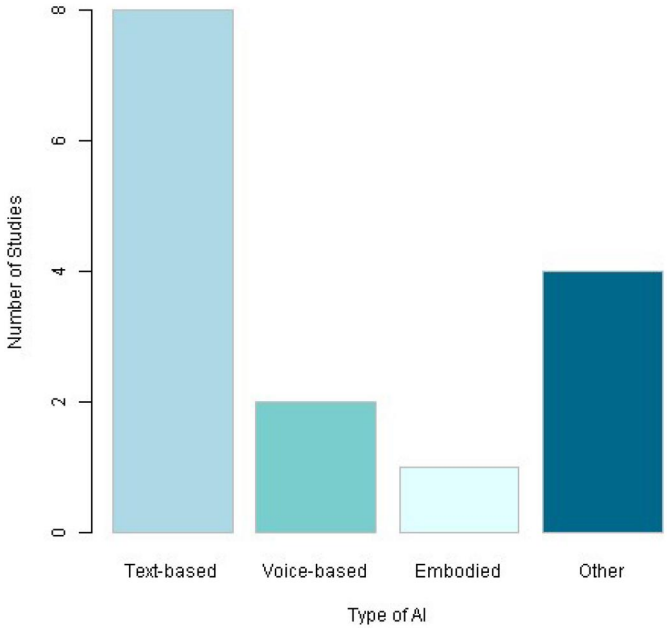

Figure 5. Conversational agents classification by type.

The inclination toward text-based conversational agents in the majority of studies can be attributed to their historical precedence as the initial type of bots. Text-based bots were among the first iterations of conversational agents, dating back to the early stages of AI development. This early adoption laid the foundation for subsequent research and applications, creating a familiarity and established base for text-based interactions.

Moreover, text-based bots offer several advantages. They are platform-agnostic, functioning effectively on various messaging platforms, websites, and applications. Additionally, they are resource-efficient and compatible with a wide range of devices, making them accessible to a broader user base.

The maturity and stability of text-based bot technology, coupled with its versatility and widespread user acceptance, make it a natural choice for researchers and developers. As a result, the majority of studies have centered around text-based conversational agents, leveraging the established foundation and acknowledging their historical significance in the evolution of conversational AI.

While text-based bots have seen extensive exploration, the emergence of other modalities, such as voice assistants and embodied agents, indicates a growing diversification in the field. Understanding the reasons behind the predominant focus on text-based bots provides valuable context for future research to explore the potential benefits and drawbacks of different conversational agent modalities.

3.3. Evaluation methods

When evaluating the functionality and performance of different applications for conversational agents, it was found in the included studies that there are various methods that can be used to gather data and insights from users. Table 6 provides a summary of the findings from each of these methods for functional evaluation and performance assessment, including the measurements taken for every study. These methods include surveys using the Technology Acceptance Model (TAM), collecting tweets, questionnaires with seven-point Likert scales and open/closed questions, semi-structured interviews, and image/text mining. Additionally, online surveys based on Likert scales, Amazon Mturk online panels, and multiple case study analyses with semi-structured interviews can also provide valuable data on user satisfaction, usability, and performance.

Table 6. Evaluation methods used in the studies.

Methods used	Number of articles
Likert scale	5
Semi-structured interviews	2
Multiple case study analysis	1
TAM	1
Collecting tweets	1
Amazon Mturk online panel	1
Five-level semantic differential method	1
N/A	3

Each method has its own advantages and limitations, and the choice of method will depend on the research question and the context of the artificial intelligence application being evaluated. For example, the use of the Technology Acceptance Model (TAM) method can help evaluate the acceptance of new technology and identify factors that influence its adoption. The use of multiple-choice questions and the Likert scale can provide valuable quantitative data. However, the five-level semantic differential method (Questionnaire form with Google Forms) can offer more nuanced data than a Likert scale.

On the other hand, the use of open-ended questions can provide detailed qualitative data. Another method that can offer such data on users' experiences, perceptions, and behaviors is the semi-structured interview. However, both interviews and questionnaires demand significant time investments, not only for the researchers but also for the general users. The use of an online survey can reach a large audience but may be subject to response bias. A multiple case study analysis along with semi-structured interviews gives detailed qualitative data on users and can identify common themes and patterns. However, it requires multiple cases to draw meaningful conclusions. Additionally, collecting tweets can provide real-time feedback and insights into how users perceive a product or system.

As shown in Table 6, the results indicate that the Likert scale method was the most commonly employed method, Semi-structured interviews were implemented in two studies, Multiple case study analysis in one study, TAM in one study, collecting tweets in one study, Amazon Mturk online panel in one study, and the five-level semantic differential method in one study.

It's noteworthy that 42% of the studies adopted a multi-method approach, emphasizing the desire for a comprehensive understanding of user interactions with conversational agents. This trend reflects researchers' recognition that both quantitative and qualitative information is vital for gaining a holistic perspective on user experiences. By embracing a diverse range of methodologies, researchers aim to capture a more nuanced spectrum of insights. This approach allows for the amalgamation of quantitative metrics and qualitative

Table 7. Methods for functional evaluation including the measurements and platform/technology used.

ID	Methods for evaluation	Technology/platform	Measurements
1	Survey using Technology Acceptance Model (TAM)	Amazon Alexa (voice assistant)	Perceived Usefulness Perceived Ease of Use
2	5 point Likert scale	Screenshot of a conversation between a customer and Chatbot	Chatbot's marketing efforts, communication quality, and satisfaction.
3	7 point Likert scale (questions)	Website via Facebook messenger	Convenience authenticity of conversation, enjoyment, pass time, privacy concerns, immature technology,
4	Quantitative methodology survey of 14 questions 7 point Likert scale (multiple choice, and open-questions)	Survey posted in social media (Facebook, twitter, LinkedIn & Instagram)	Demographics, forms of interaction with technologies and devices used
5	Collecting Tweets	N/A	Negative and positive tweets
6	7 point Likert scale (open and closed questions)	N/A	Subjective norms, faith, consciousness, purchase intention
7	Semi-structured interview	Google DialogFlow	Emotional attachment
8	N/A	N/A	N/A
9	N/A	N/A	Mindful Sustainable Consumption (MSC) Approach
10	Image, text and image-text mining from the test set to compare with the outputs	VTON	Appearance analysis system
11	Questionnaire form with google forms using five-level semantic differential method	Recruit Talk API and LINE	Subjective assessment of similarities
12	Online survey based on Likert-scale	N/A	Perceived trust perceived risk
13	Amazon Mturk online panel, online surveys	Photoshop to create the fictional chatbot	Human likeness, animacy, perceived intelligence
14	N/A	N/A	N/A
15	Multiple case study analysis, semi-structured interviews	N/A	Institutional theory, business model literature, green supply chain innovation research

nuances, facilitating a comprehensive exploration of various dimensions related to user satisfaction, usability, and the identification of common themes and patterns.

The combined use of these methods enables researchers to triangulate findings, leveraging the strengths of both quantitative and qualitative approaches. This triangulation not only enhances the robustness and reliability of study conclusions but also provides a holistic view of conversational agent performance.

Essentially, the significance of employing multiple methods lies in achieving an enriched and well-rounded evaluation of conversational agents. This comprehensive approach adheres to best practices in research methodology, ensuring a reliable foundation for drawing meaningful conclusions and informing future advancements in conversational agent technology.

3.4. Technology/platforms

It was found in the included studies that only one study (Morotti et al., 2020), created an immersive experience of a virtual store in Unity, and three studies created chatbots using Google DialogFlow (Yi, 2022), VTON (Wang et al., 2022), and Recruit Talk API and LINE. The majority of the studies did not create a bot, did not engage in real-time interactions with the chatbots, and did not use augmented visuals like 3D animations or VR in the Human-AI interaction. Moreover, to create the text-based agent, they took examples from industries to craft the conversations or used Photoshop (Jin & Youn, 2023) to create a fictional chatbot.

3.5. Measurements

The measurements used in the studies were diverse, including perceived usefulness, perceived ease of use, satisfaction, convenience, authenticity, emotional attachment, and trust. Some studies also focused on specific approaches, such as the Mindful Sustainable Consumption approach, subjective assessment of similarities, and human likeness. Additionally, some studies used institutional theory, business model literature, and green supply chain and innovation research as frameworks for their analysis (Table 7).

4. Discussion and future research directions

This section presents the research gaps and needs discovered through the findings after examining the included studies and categorizing them into the different techniques, platforms, and methodologies used. The research directions for AI-based conversational agents focused on sustainable fashion are presented in accordance with this classification.

4.1. Purpose/aim of the research study

The distribution of research objectives in the selected studies underscores the multifaceted impact of artificial intelligence (AI), with a significant focus on consumer perception, interaction dynamics, and sustainability. Notably, six out of 15 studies delve into consumer intention, providing crucial insights for businesses and policymakers navigating the integration of AI into daily life. The examination of consumer interactions in four out of 15 studies contributes to refining user experiences with AI applications. Additionally, five out of 15 studies explore sustainability and circular economy aspects, signaling a positive trend toward environmentally conscious AI applications.

Despite these valuable contributions, a notable research gap emerges in the lack of studies exploring the implementation of chatbots in the education sector. No research has investigated how chatbots can effectively enhance the learning experience for students, specifically focusing on raising awareness of sustainable fashion. This identified gap presents a

compelling opportunity for future research to delve into the potential benefits and challenges of implementing chatbots in non-traditional education settings. Bridging this gap would not only contribute to a more comprehensive understanding of AI's impact across diverse domains but also open the way for innovative applications in sustainable education.

4.2. Discussion of AI chatbot types identified in publications

The findings of the study highlight a predominant focus on text-based conversational agents, particularly exemplified by platforms like ChatGPT, indicating a prevalent choice for bot-user communication through messaging platforms. This preference aligns with the historical precedence of text-based bots, which were among the initial types of conversational agents during the early stages of AI development. However, there is a notable gap in the literature when it comes to embodied conversational agents (ECAs) or virtual humans. Only one study mentioned implementing an embodied agent, the lack of exploration into the implementation of conversational agents as embodied agents and the existing focus on text-based interactions underscores an opportunity for future research to delve into the integration and impact of embodied agents, addressing a noteworthy gap in the current conversational agent literature.

Furthermore, while two studies explored the benefits of using voice assistants like Alexa from EchoDot, these studies focused on the benefits of hands-free services and did not delve deeply into the design and implementation of the voice assistants themselves. Future research could explore the potential of voice assistants as embodied conversational agents and how they can be personalized to better meet users' needs or focus on removing meta-education barriers.

4.3. Discussion of roles of AI chatbots identified in publications

Based on the findings, it appears that most AI-based conversational agents implemented in different technologies for sustainable fashion have primarily focused on serving as personal shopping assistants and fashion advisers. These conversational agents are used to help customers find sustainable fashion options and provide personalized recommendations based on their preferences and past purchases. However, several limitations and gaps were identified in the literature review. For example, there is a lack of standardization in the design and implementation of conversational agents, which can lead to inconsistencies in their effectiveness and usability. Additionally, there is a need for more research to understand the ethical implications of using conversational agents in a sustainable fashion, including issues related to privacy, data security, and bias.

4.4. Evaluation methods

In the discussion of the study's findings, the significance of using multiple methods for both quantitative and qualitative analysis in 42% of the studies emphasizes the comprehensive approach taken to evaluate conversational agent performance. This multifaceted evaluation strategy aligns with the diverse nature of conversational agents and acknowledges the need for a nuanced understanding of their functionality and user interactions.

Furthermore, this observation leads to important considerations for future research directions. Researchers in the field of conversational agents should continue to embrace a mixed-methods approach, combining quantitative metrics with qualitative insights to gain a holistic perspective. Future studies can explore innovative methodologies or refine existing ones to enhance the depth and breadth of evaluation.

Additionally, the identified preference for the Likert scale method in 42% of the studies suggests a commonality in quantitative assessment. Future research could delve into refining and standardizing Likert scale methodologies for consistent and comparable evaluations. Simultaneously, there is an opportunity to explore emerging qualitative methods that may offer more nuanced data and insights.

Moreover, the integration of user feedback from various sources, such as tweets and online panels, underscores the importance of real-time and diverse data collection. Future research directions may involve exploring advanced techniques for sentiment analysis and natural language processing to extract valuable insights from user-generated content on social media platforms.

As conversational agents evolve and find applications in diverse domains, future research should also consider adapting evaluation methodologies to specific contexts. For instance, studying the impact of conversational agents in educational settings may require tailored evaluation methods that capture learning outcomes and student engagement effectively.

In conclusion, the significance of employing a variety of evaluation methods provides valuable insights for shaping the future trajectory of conversational agent research. Future studies can build upon this foundation by refining existing methodologies, exploring innovative approaches, and adapting evaluation strategies to the evolving landscape of conversational agent applications toward fashion.

4.5. Technology implemented

In terms of the platforms and applications used, the literature review identified a wide range of technologies being employed for these conversational agents, including web-based chatbots, mobile apps, and voice assistants like Alexa and Google Assistant. Some of the techniques used for these conversational agents include natural language processing (NLP), machine learning, and sentiment analysis, among others. However, several future research directions could be explored to address the limitations and gaps identified:

- Developing more immersive experiences: Given that only one study created an immersive experience of a virtual store using Unity, there is a need for more research to explore the potential of using augmented visuals like 3D

animations or VR in Human–AI interaction. This could help create more engaging and interactive experiences for customers, improving their satisfaction with the conversational agents.

- Exploring new platforms and technologies: While some studies used Google DialogFlow, VTON, Recruit Talk API, and LINE to create their chatbots, there is a need to explore other platforms and technologies that could be used to develop conversational agents. For example, researchers could investigate the potential of using emerging technologies like WebVR or Amazon Sumerian to make it more accessible to the public.
- Leveraging natural language generation (NLG): Some studies used examples from industries or Photoshop to craft the conversations for their conversational agents. Future research could explore the potential of using natural language generation (NLG) to create more realistic and engaging conversations that can adapt to different users and contexts.

By addressing these future research directions, researchers can create more effective and engaging conversational agents that can help to promote sustainable fashion and improve the user experience.

4.6. Measurements

One potential gap in the literature is the lack of focus on the environmental impact of the use of AI-based conversational agents in a sustainable fashion. While the use of chatbots and virtual assistants can contribute to reducing waste and improving efficiency in the fashion industry, there may be unintended consequences, such as increased energy consumption or carbon emissions from the use of servers and data centers. Another direction for future research could be the exploration of the potential for AI-based conversational agents to promote behavior change and encourage sustainable consumption habits among users. This could involve the integration of persuasive technology techniques, such as social influence and gamification, to motivate users to adopt more sustainable fashion choices. Finally, there is a lack of research on the effectiveness of using augmented visuals like 3D animations or VR in Human–AI interaction in sustainable fashion contexts. Future studies could investigate the impact of these technologies on user engagement, satisfaction, and behavior change.

5. Conclusions

This scientific contribution aimed to comprehensively examine existing literature on AI-based conversational agents in the context of sustainable fashion, focusing on identifying utilized technologies and offered solutions. Employing a well-formulated query with relevant synonyms, searches spanned various search engines and databases, such as Google Scholar, SCOPUS, IEEE Xplore, and Web of Science. A meticulous selection process based on defined criteria, aligned with the PRISMA approach, led to the identification and assessment of 15 relevant articles.

The review identified a noteworthy surge in interest in AI-powered conversational agents for sustainable fashion. Specifically, studies implementing artificial intelligence in the fashion industry predominantly delved into understanding its impact on users' intention to use it, particularly in online shopping or e-retail, emphasizing its benefits for sustainable fashion.

Significantly, 40% of the studies, comprising six out of 15, aimed to measure consumer intention to use AI in daily life. This emphasis on understanding individuals' perceptions and anticipations regarding incorporating artificial intelligence into their daily activities contributes valuable insights into factors influencing AI technology adoption. The findings underscore a substantial global focus on AI-powered conversational agents for sustainable fashion research, with Italy prominently leading in published articles. Noteworthy contributions also emerged from China, Korea, Japan, the UK, Australia, India, Germany, Finland, Brazil, the USA, and Qatar. Italy, in particular, stands out as a pivotal center for studying AI-powered conversational agents in a sustainable fashion.

While the study highlights a prevailing focus on text-based conversational agents, indicating historical precedence, it also reveals a notable gap in the literature regarding the limited exploration of embodied agents, emphasized by only one study mentioning their implementation. This underscores the need for future research to delve into this unexplored area.

Furthermore, 42% of the studies employed multiple methods for quantitative and qualitative analysis of user interaction. This reflects researchers' commitment to comprehensively understanding the nuances of conversational agent functionality and performance in diverse contexts, thereby enhancing the robustness of study conclusions through a combined quantitative and qualitative approach.

In conclusion, this review offers valuable insights, identifies research gaps, and lays the groundwork for further exploration at the dynamic intersection of AI, conversational agents, and sustainable fashion. Recommendations for future research include a focused exploration of embodied agents' implementation to enhance sustainable fashion education and the investigation of innovative methodologies for a deeper understanding of conversational agent functionality across diverse contexts.

5.1. Study limitations

Some limitations were identified that may affect this study. First, the search was conducted using four databases: SCOPUS, Web of Science, IEEE, and Google Scholar as research engines. It's acknowledged that other relevant articles, the criteria for relevance include providing substantial information about the application and impact of these conversational agents within the context of sustainable fashion could be found in different databases. Second, the search was restricted to be completed in March 2023, including

only the most recent articles from the last 5 years. Third, the screening process was conducted in two phases with the selection criteria of Title, Abstract, and Full-Text. This decision might have introduced bias, and some relevant articles may have been missed due to the different synonyms that can be used for a conversational agent.

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