

Bibliometric Analysis of Sustainable Clothing Design: A Web of Science-Based Study (2014-2023)

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Received: December 28, 2023 ▪ Reviewed: January 17, 2024

▪ Accepted: January 25, 2024 ▪ Published: February 28, 2024

Abstract:

To pinpoint the hotspots, trends, and major themes of study on this subject, the authors conducted a thorough survey of the research literature on green clothing design from 2014 to 2023 using bibliometric approaches. This study provides the academic community with a knowledge map for research on green clothing design, reveals correlations between various themes, and conducts data statistics and visualization of papers on the Web of Science using CiteSpace. Eight primary topics have been identified, including conjoint analysis, clothing design, sustainable fashion, recycling, sustainable business models, ethics, teenagers, eco-fashion design, and many other aspects. The research results indicate that the field of sustainable clothing design is experiencing an increasing trend each year. These themes serve as a roadmap for further research and represent the fundamental concerns on which academics in the field of green apparel design focus. The evolution of research hotspots in this subject is also revealed by this study. Subsequent studies eventually broadened to include a variety of elements that impact customers' purchasing decisions, whereas earlier research mostly concentrated on consumers' perceptions and behavior about green products. The authors also note that there is an interdisciplinary trend in this field of study, combining ideas and approaches from sociology, psychology, economics, and other disciplines. This study closes a research gap in the subject of green clothing design and provides the academic community a more thorough understanding of the state of the field present research. It also offers a wider viewpoint and research methodology for future studies.

Keywords: sustainable design, clothing, CiteSpace, visual analysis.

可持续服装设计的文献计量分析：基于科学的研究网络（2014–2023）

摘要:

为了明确该主题的研究热点、趋势和主要主题，作者采用文献计量学方法对 2014 年至 2023 年绿色服装设计的研究文献进行了全面调查。本研究为学术界提供了绿色服装设计研究的知识图谱，揭示了各个主题之间的相关性，并利用引用空间对科学网上的论文进行了数据统计和可视化。确定了八个主要主题，包括联合分析、服装设计、可持续时尚、回收、可持续商业模式、伦理、青少年、生态时尚设计等许多方面。研究结果表明，可持续服装设计领域正呈现逐年增长的趋势。这些主题作为进一步研究的路线图，代表了绿色服装设计领域学者关注的基本问题。本研究还揭示了该学科研究热点的演变。随后的研究最终扩大到包括影响客户购买决策的各种因素，而早期的研究主要集中在消费者对绿色产品的看法和行为上。作者还指出，该研究领域存在跨学科趋势，结合了社会学、心理学、经济学和其他学科的思想和方法。这项研究填补了绿色服装设计学科的研究空白，并使学术界对该领域当前的研究状况有了更透彻的了解。它还为未来的研究提供了更广泛的视角和研究方法。

关键词: 可持续设计、服装、引用空间、视觉分析.

1. Introduction

Sustainable clothing design is a growing discipline that covers everything from material selection to production methods to the conclusion of the product life cycle. This is due to the increased attention that sustainable development and environmental protection issues have received on a global scale in recent years. According to Cai and Choi (2020), social and environmental problems resulting from the clothing supply chain are well-known and are handled by both the apparel industry and other parties. Certain research highlights that using eco-friendly materials is essential to attaining green design, while other studies highlight the importance of design innovations, such as functional design and detachable components, in enhancing the sustainability of clothes. Scholars have, of course, also underlined the significance of entire life cycle management, from design to manufacture, usage, and ultimate disposal, to minimize resource waste and environmental effects.

According to Gazzola et al. (2020), the sector is growing because of sustainable alternatives, and many clothing manufacturers are dedicated to altering the way things are done in the industry. Still, many clothing firms seem unwilling to adapt and take too long to put sustainable solutions into practice, which leads to higher production and consumption. Companies everywhere are under pressure to adopt eco-friendly strategies and address environmental issues, but the garment sector is resistant to change. Even with government-enforced environmental restrictions, China's garment manufacturing sector continues to pose a serious environmental danger and is under tremendous pressure to implement environmentally friendly measures.

Presently, some researchers provide thorough theoretical support to the academic community by using cutting-edge techniques to thoroughly examine important issues and research hotspots in the field of fashion design. Nevertheless, comprehensive research on the state of sustainable clothing design from a

quantitative analytical standpoint has not yet been completed.

If you only use your own judgment to categorize and analyze the literature, significant literature can go unnoticed and the direction of the study could be lost (Zou et al., 2022). Hoover (2013) developed the quantitative method of literature, which involves the use of generally acknowledged, precise, and successful mathematical tools to quantitatively measure, classify, and evaluate literary works. It also involves representing literary components or traits through numerical means. CiteSpace collects, analyzes, delivers, and visualizes literary data by generating images, charts, or animations, supports the building of scientific knowledge maps, and pulls information from scientific literature (Chen et al., 2022).

Therefore, to gain an in-depth understanding of the research trends and academic context in the field of sustainable clothing design in academia and different countries, this study chose to use the Web of Science (WOS) database as the data collection source and introduced the CiteSpace tool for bibliometric analysis. to highlight the cutting edges and areas of interest in the study of sustainable clothes design. By assisting in understanding development trends, major themes, and scholarly relationships within the field, this creative application will provide the groundwork for future innovation and collaboration.

2. Methods

This study focuses on the design of environmentally friendly clothing and uses bibliometric research methods to conduct statistical analysis of relevant literature on the Web of Science (WOS) database. The authors used CiteSpace to conduct a comprehensive analysis of the literature on sustainable clothing design from 2014 to 2023. The operational process of the research is divided into three main modules: data collection, data analysis, and results writing (refer to Fig. 1). Initially, the author provides a precise definition of the study topic. Then, they gather and refine

documents using the WOS database, selecting those that are directly relevant to the issue. Finally, these chosen documents are exported in batches to the “full text” format. Furthermore, the author imported the previously generated files into CiteSpace to conduct data statistics and visual analysis. The specific contents encompass document co-citation relationships, clustering conditions, scientific research cooperation, and keyword co-occurrence. Finally, Excel is used to create charts, and Word is used to summarize and write the current situation and development trends in this field, revealing the knowledge evolution model in this field (Fig. 1).

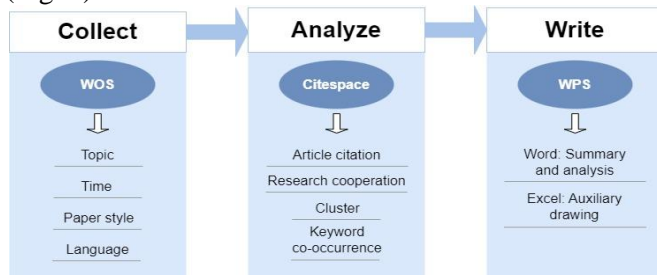


Figure 1. Flowchart of the research process (Developed by the authors)

2.1. Data Collection

In this study, to ensure a comprehensive understanding of the analysis topic, we carefully selected two keywords for the search, namely "sustainable clothing design" and "green clothing design," and confined the search scope to the "article" type. To precisely define the temporal scope of the study, we intentionally chose the time frame from 2014 to 2023 to thoroughly examine relevant literature on sustainable clothing design over the past 10 years (refer to Fig. 2). Employing this search method, we identified 498 articles related to this topic. For more precise localization, the author set the document type to “article” or “conference paper,” resulting in 470 articles, of which 466 were in English.



Figure 2. Total publications and sum of times cited from 2014 to 2023 according to the Web of Science (Data updated to December 2023)

For database selection, we used the Web of Science Core Collection as the research basis. This database encompasses various indices, including SCI, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCIS, BKCI-SSH, and ESCI, ensuring coverage across multiple subject areas. Ultimately, we collected the following number of

documents: 202 SCI articles, 130 SSCI articles, 66 CPCI-S articles, 85 ESCI articles, 35 A&HCI articles, 25 CPCI-SSH articles, 4 BKCIS articles, and 1 BKCI-SSH article. Among the 466 articles, 277 were sourced from journals.

On the Web of Science (WOS) page, we exported all 466 bibliographic entries in text format and subsequently conducted an analysis using CiteSpace software. Before importing into CiteSpace, we meticulously processed the retrieved publications, eliminating duplicates to ensure that each article was unique and non-redundant in the database. This step was crucial for maintaining the accuracy and reliability of the analysis, ensuring that each article contributed independently to the research. Through this meticulous process, we established a robust foundation for further research.

Overall, from 2014 to 2023, the number of articles published on the theme of sustainable clothing design has demonstrated an increasing trend, except a decline in 2019. Particularly noteworthy is the significant increase in the number of articles published since 2021, rising from 43 articles in 2020 to 64 articles in 2021, and further to 87 articles in 2023. This upward trajectory may be attributed to the increased attention given to sustainable design within academic circles following the global outbreak.

The observed trend underscores the growing significance and interest in sustainable clothing design, reflecting a proactive response from the academic community to the emerging importance of sustainability in design practices. This increasing scholarly output suggests a robust and expanding research landscape in the field, further highlighting the relevance and urgency of sustainable design considerations in academic discourse.

2.2. Data Analysis

Using CiteSpace to construct a network diagram, one can visually represent co-authors, co-cited documents, co-occurring keywords, and other pertinent elements within the domain of sustainable clothing design. This study places particular emphasis on the analysis of the following facets: co-citation of articles, clustering networks, keyword co-occurrence, and the knowledge evolution model of documents. To begin, the exploration of article co-citation serves as a valuable tool for identifying influential research outcomes in sustainable clothing design. Scrutinizing the frequency and manner in which articles are cited enables a nuanced understanding of hotspots and crucial research directions within the field.

Furthermore, the examination of cluster network dynamics unveils research groups and thematic focuses within the discipline. Establishing a network that delineates relationships between authors and documents facilitates the identification of closely cooperating research groups and concentrated areas of research

exploration. The scrutiny of keyword co-occurrence contributes to unraveling the interconnections between keywords in sustainable clothing design. This analysis unveils key themes and research hotspots, offering insights that guide further research endeavors.

3. Results and Analysis

3.1. Article Citation Analysis

CiteSpace was used for visual analysis of 466 documents in the core database, resulting in a co-citation network with 292 nodes and 901 links (Chen & Chen, 2005). Nodes represent the citation status of documents, with larger nodes indicating higher citation frequencies, highlighting significant influence in the green building discipline. The timeline from 2014 to 2023 was divided into two-year intervals, facilitating a detailed examination of the co-citation networks.

The top 10 frequently co-cited documents were selected for further exploration, covering the period from 2014 to 2023. The most cited document is “The Environmental Price of Fast Fashion” by Niinimäki et al. (2020), emphasizing the need for fundamental changes in the fashion industry, advocating for a slowdown in manufacturing speed, and promoting sustainable practices throughout the supply chain, including changes in consumer behavior.

The second most cited work is “Environmental Impact of Textile Reuse and Recycling – A Review” by Sandin and Peters (2018), published in the Journal of Cleaner Production. This review assesses the environmental impact of textile reuse and recycling, highlighting their environmental superiority over incineration and landfilling.

The third most cited article is “Sustainable Product-Service Systems for Clothing: Exploring Consumer Perceptions of Consumption Alternatives in Finland” by Armstrong et al. (2015), which was also published in the Journal of Cleaner Production. This study explores opportunities and challenges in adopting innovative business models such as product-service systems (PSS) in the apparel industry. It reveals that young consumers favor experiential and social PSS, linking positive perceptions of apparel PSS to environmental benefits and emotional experiences. Challenges include negative perceptions of service provider trust and ease of use (refer to Table 1).

Using CiteSpace software, we identified the seven documents exhibiting the most substantial citation bursts (refer to Table 2). Notably, over the past decade, the zenith of citation bursts has predominantly occurred between 2014 and 2017, underscoring a noteworthy surge in attention to the field during this specific timeframe.

Table 1. Top 10 frequently co-cited documents in the “sustainable clothing design” discipline (Developed by the authors)

Ranking	Author	Year	Freq.	Source	Cluster ID
1	Niinimäki K	2020	25	NAT REV EARTH ENV	2
2	Sandin G	2018	11	J CLEAN PROD	7
3	Armstrong CM	2015	10	J CLEAN PROD	4
4	Gazzola P	2020	6	SUSTAINABILITY-BASEL	2
5	Jacobs K	2018	6	J CLEAN PROD	0
6	Liang JF	2018	6	INT J CONSUM STUD	2
7	Khare A	2017	6	INT J CONSUM STUD	5
8	Geissdoerfer M	2017	6	J CLEAN PROD	2
9	Legere A	2020	6	J CLEAN PROD	2
10	Fletcher Kate	2016	6	CRAFT OF USE: POST-GROWTH FASHION	4

Table 2. Top 7 documents with the strongest citation bursts in “sustainable clothing design” area (Developed by the authors)

Bursts	Author	Year	Source
3.33	Armstrong CM	2015	J CLEAN PROD FASHION SUSTAINABILITY: DESIGN
3.16	Fletcher Kate	2012	FOR CHANGE
2.66	Todeschini BV	2017	BUS HORIZONS
2.66	Ellen MacArthur Foundation	2017	A NEW TEXTILES ECONOMY: REDESIGNING FASHIONS FUTURE
2.53	Ertekin ZO	2015	J MACROMARKETING
2.53	McNeill L	2015	INT J CONSUM STUD
2.52	Harris F	2016	INT J CONSUM STUD

Armstrong claimed the top spot in terms of citation burst value, registering an impressive burst value of 3.33 (Armstrong et al., 2015). Next, Fletcher Kate is ranked second with a notable burst value of 3.16 (Fletcher, 2012). Todeschini secured the third position with a commendable burst value of 3.15 (Todeschini et al., 2017). It is noteworthy that Armstrong boasts the highest citation burst value among these documents, underscoring its significant impact within the research field.

3.2. Scientific Research Cooperation Analysis

One of the primary strategies for engaging in interdisciplinary research involves fostering scientific research partnerships, which form the bedrock for overcoming challenges in science and achieving significant advancements in the field. Collaboration among researchers for the creation of novel scientific knowledge aligns with the definition of scientific research collaboration provided by Katz and Martin (1997). As articulated by Liang et al. (2017), knowledge graphs derived from publication references, particularly those showcasing cited authors, can provide valuable insights into notable research groups and potential collaborators.

To facilitate the identification of prominent research groups and potential collaborators, the co-authorship analysis feature in CiteSpace is instrumental. This tool allows exploration of knowledge graphs to discern key individuals and groups contributing to specific fields. By leveraging CiteSpace, it becomes possible to pinpoint the most productive authors in particular areas

of study, thereby enhancing the understanding of collaborative networks and potential partners in interdisciplinary research (refer to Fig. 3).



Figure 3. Co-author network of sustainable clothing design between 2014 and 2023 (Developed by the authors)

Arpita Khare from the Indian Institute of Management Rohtak, a pivotal figure advancing academic research and practice in green clothing, is at the forefront. Khare’s extensive work explores the psychology and behavior of Indian consumers in purchasing green clothing, offering a comprehensive understanding of facets such as environmental awareness, sustainable fashion perceptions, shopping decisions, and consumer attitudes. Her theses on market trends, consumer preferences, and the impact of eco-friendly brands provide invaluable insights for steering Indian apparel design toward greater environmental sustainability.

Securing the second position is Siti Shukhaila Shaharuddin from Malaysia, who delves into various aspects of environmentally friendly children’s clothing. His research explores parent decision-making, ecological fashion based on clothing life cycles, design strategies, mechanical properties of sustainable fibers, and the behavior of fashion designers in eco-fashion design. Shaharuddin’s comprehensive studies contribute critical insights to drive the eco-friendly children’s clothing market, spanning from understanding consumer demand to fostering design innovation and sustainable material application.

Cosette M. Armstrong dedicated research in sustainable fashion spans design strategy impact, consumer decision-making, product service systems, and fashion leadership in sustainable retail. Armstrong significantly contributes to sustainable development by introducing innovative design methodologies. That research investigates the intricate relationship between creative thinking and sustainable apparel consumption, explores consumer perceptions of sustainable alternatives, and examines the role of fashion leadership in shifting the retail paradigm. Her studies offer profound insights, providing strategic recommendations for steering the fashion industry toward greater sustainability, emphasizing the critical roles of creativity and leadership. The outcomes contribute valuable research findings to both industry and academia, enriching the discourse on sustainable practices in the fashion world (refer to Table 3).

Table 3. Top 10 most effective authors in sustainable clothing design (Developed by the authors)

Ranking	Count	Author	Year	Institution or nations of Author
1	5	Khare, Arpita	2020	Indian Institute of Management Rohtak, India
2	4	Shaharuddin, Siti Shukhaila	2020	University Malaysia Sarawak, Malaysia
3	3	Armstrong, Cosette M	2015	Oklahoma State University, USA
4	2	Goworek, H, 2017	2017	Nottingham Trent Univ, Nottingham, England
4	2	Sato duarte, Adriana Yumi	2015	Centro Universitário Nossa Senhora do Patrocínio, Itui, Brazil
4	2	Mclaren, A	2017	Nottingham Trent Univ, Nottingham, England
4	2	Alonso, Raquel Seawright	2015	Univ Sao Paulo, Brazil
4	2	Hill, H	2017	Nottingham Trent Univ, Nottingham, England
4	2	Pereira marcicano, Joao Paulo	2015	Univ Sao Paulo, Brazil
4	2	Dedini, Franco Giuseppe	2015	State Univ Campinas UNICAMP, Brazil

To delve deeper into collaboration patterns among institutions, this study conducted thorough and extensive research, culminating in the findings presented in Figure 4. The figure illustrates that Donghua University in China leads in terms of the number of published papers; however, its collaborative efforts with other institutions appear relatively limited. Although Chinese institutions have made significant contributions to research outcomes, notably authors with a higher volume of individual papers and elevated citation rates predominantly hail from other countries. This observation suggests that Chinese scholars, within the realm of sustainable clothing design, face challenges in achieving research depth.

Furthermore, the figure reveals that nine out of the top ten contributing institutions are universities, underscoring the dominant role of academic institutions in sustainable clothing research. Notably, there is a scarcity of representation from companies or social organizations among the top contributors. Given the inherent connection between the sustainability of clothing and the market, this underscores the need for universities to strengthen collaborations with diverse institutions and leverage their respective professional strengths. This collaborative approach can facilitate a more comprehensive exploration of sustainable clothing design by incorporating expertise from various sectors and fostering a holistic understanding of market dynamics.

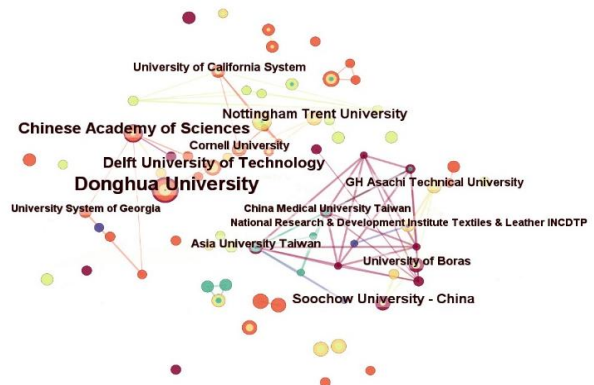


Figure 4. Cooperation pattern among research institutions in the field of sustainable clothing design (Developed by the authors)

3.3. Cluster Analysis

Co-citation cluster analysis, a widely used method in bibliometric research, has proven effective across various fields, as demonstrated in studies on scientific measurements of climate change and tourism (Fang et al., 2017). In the analysis graph generated by CiteSpace through keyword clustering, this study identified eight main topic clusters (refer to Fig. 5): conjoint analysis, clothing design, sustainable fashion, recycling, sustainable business models, ethics, teenagers, and eco-fashion design. Modularity Q, reaching 0.711 and surpassing the standard of 0.3, indicates a highly reasonable structure (Newman, 2004). Within these eight clusters, “0” comprises 44 articles, “1” has 43 articles, “2” contains 42 articles, and the smallest cluster, “7”, consists of only 12 articles.

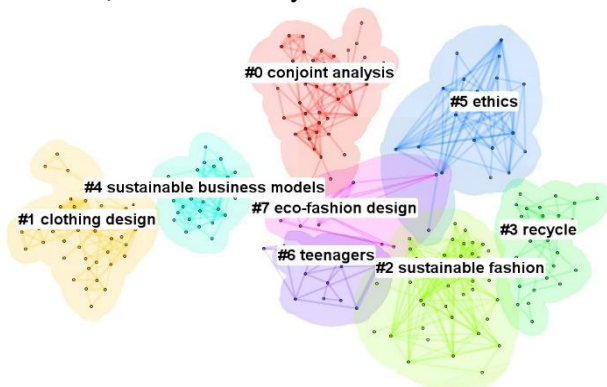


Figure 5. Clustering atlas of 466 references (Developed by the authors)

This analysis underscores that within the domain of sustainable apparel, academic research spans several crucial topics, including consumer analysis, apparel design, sustainable fashion, recycling, sustainable business models, ethics, youth consumers, and ecological apparel design. It reflects the academic community’s comprehensive focus on multiple facets of sustainable clothing, highlighting research hotspots and preferences for specific topics. This nuanced understanding of the field will contribute to shaping future research trajectories and guiding scholarly endeavors in sustainable apparel.

The cluster analysis provides insights into the current state of scholarship in sustainable apparel design. Notably, upon closer examination of each cluster, it becomes apparent that papers in clusters 2 and 3 are relatively recent, indicating that scholars are placing increased emphasis on cutting-edge issues within domains such as sustainable fashion and recycling. This observation underscores sustained academic attention and heightened research activity in emerging fields, showcasing a commitment to exploring and addressing contemporary challenges.

Conversely, articles in cluster 1 tend to be older, suggesting that notable research in the past focused on the application of “conjoint analysis” in market research.

However, it may indicate a relative conservatism in research within this field, with fewer new theories or methods emerging or limited exploration of newer topics. The overall trend suggests a gradual shift in academic research from traditional to more forward-looking topics, with a heightened emphasis on sustainability and environmental protection issues within the apparel industry. This shift may reflect the growing concern among scholars about the sustainability challenges inherent in current and future developments in the fashion industry. The evolving academic focus underscores the need for ongoing exploration and innovation to address pressing issues in the pursuit of sustainable apparel design.

In these cluster studies, scholars conducted in-depth research on the relationship between sustainable fashion, environmentally friendly consumption, green product purchasing behavior, organic clothing, and consumer attitudes and behaviors. Evans and Peirson-Smith (2018) pointed out that there is a lack of understanding of green language terms among fashion brand marketers and suggested that brand messages should aim to stimulate sustainable behaviors to enhance brand trust and responsible business behavior. Wiederhold and Martinez (2018) revealed the barriers that influence consumers to purchase green clothing and proposed that companies should adopt strategies to encourage the purchase of eco-conscious clothing. Dhir et al. (2021) emphasized that consumers’ increased awareness of environmental issues does not necessarily translate into the purchase of green clothing, and that green trust and environmental protection attitudes have a positive impact on purchasing behavior. Chaturvedi et al. (2020) highlighted willingness to pay, environmental concern, and perceived value as the main predictors of Generation Z’s purchase intention for recycled clothing. Rahman and Koszewska (2020) pointed out that Polish consumers pay attention to esthetics functionality, and economic benefits when purchasing sustainable products. Nguyen et al. (2019) conducted an in-depth study of Vietnamese young people’s purchase intentions for green clothing by combining the theory of planned behavior and materialism values. Khare and Varshneya (2017) found that past environmentally friendly behaviors impacted the organic clothing purchasing behavior of young people in India. These studies provide key information for understanding consumer behavior and driving markets for sustainable fashion and green products.

These studies not only provide insights into advancing the sustainable fashion industry but also highlight the critical role of brands, designers, and consumers in achieving environmental goals.

3.4. Keyword Co-Occurrence Analysis

Analyzing the rapid growth of keyword citations serves as a valuable tool for reconstructing the core

content of a research topic and understanding how research trends evolve over time. This method aids in tracking and identifying emerging trends, offering scholars insights into changes in research hotspots within their professional fields. By using tools such as CiteSpace for synthesizing and evaluating keywords with rapidly growing citations, researchers gain access to information about research fronts, including emerging theoretical trends and topics (Li & Wang, 2018). This approach not only informs scholars about the dynamic nature of their research landscape but also provides relevant inspiration and information crucial for navigating and contributing to the ongoing discourse in their respective fields.

The co-occurrence frequency analysis presented in Figure 6 highlights the most frequently used keywords in the field of sustainable clothing design, shedding light on the primary concerns of researchers. The top keywords include “design” (47 times), “circular economy” (37 times), “consumption” (34 times), “sustainable fashion” (27 times), “behavior/fashion” (25 times), “impact” (24 times), “green” (23 times), and “performance/sustainable consumption” (21 times). This analysis reveals key thematic areas and research foci within the field. The prominence of the keyword “design” underscores the significant emphasis on various aspects of design within the fashion industry, encompassing product design, production processes, and other related facets. “Circular economy” emerges as a crucial keyword, indicating a strong focus on resource recycling. For instance, Vehmas et al. explored Finnish consumers’ perceptions of circular clothing, emphasizing effective communication strategies for the remanufacturing process and marketing circular fashion (Vehmas et al., 2018). This research highlighted the potential of environmental information, digital services, and circular clothing to create additional value.

The keyword “consumer behavior” underscores the pivotal role of consumers in sustainable fashion, reflecting the research interest in understanding the key factors influencing consumers’ choices in this domain. Studies such as those by Kaur et al. (2023) reveal that consumers’ attitudes and subjective norms positively influence their intentions to purchase environmentally sustainable products. This underscores the crucial role that consumers play in decision-making within the field of sustainable fashion, offering valuable guidance for companies and brands to align with consumer demands for sustainability. Against this backdrop, a profound understanding of consumers’ values and shopping behaviors emerges as a critical factor in the development of effective sustainable fashion strategies. The identified keywords collectively contribute to shaping the research landscape and strategic considerations within the realm of sustainable clothing design.

The overarching concepts of “sustainable fashion” and its related counterpart, “green fashion”, stand out as

central concerns for researchers, underscoring the pressing need for the fashion industry to pivot toward a more sustainable trajectory. Within the framework of sustainability, scholars are exploring theories aimed at mitigating the environmental impact of the fashion system by scrutinizing the resource cycle of emerging business models, as demonstrated in the work of Pal and Gander (2018). Contrary to the assumption that the high cost of sustainable clothing is the primary obstacle to consumers adopting sustainable consumption, relevant research suggests that the main hindrance lies in consumers’ lack of awareness regarding the environmental impact of fast fashion (2023). This insight illuminates a crucial barrier to achieving sustainability in the fashion industry, emphasizing the need for increased consumer education and awareness initiatives to foster a more significant shift toward sustainable practices.

Keywords such as “impact,” “performance,” and “sustainable consumption” underscore researchers’ careful consideration of the environmental and social repercussions of sustainable clothing design, as well as consumers’ concerns regarding the performance of sustainable products. These high-frequency keywords offer a profound understanding of the principal research directions and hotspots in sustainable clothing design.

Furthermore, the prevalent keywords depicted in the figure provide a comprehensive view that spans various dimensions, aiming to propel the fashion industry toward a more sustainable trajectory. First, through keywords such as circular fashion and sustainable production, researchers focus on circular economy principles and sustainable production methods, aiming to minimize resource waste and environmental impact. Concerning the understanding of consumer behavior in sustainable clothing design, the keyword “behavior gap” highlights the disparity between consumer intentions and actual behavior, a critical aspect for developing more effective strategies in sustainable clothing design. Simultaneously, collaborative and sustainable consumption underscore the significance of cooperative and sustainable consumption models, encouraging practices such as sharing and recycling to reduce the overall demand for resources. These keywords collectively encapsulate the multifaceted dimensions of sustainable clothing design, providing a roadmap for holistic development within the fashion industry.

Attention to corporate responsibility in the realm of sustainable clothing design is evident through keywords such as “corporate social responsibility” and “ethical fashion”. These terms underscore the responsibility of businesses to positively impact society and the environment in their operations, reflecting a growing trend to incorporate ethical values into design practices. This emphasis on corporate responsibility aligns with the broader objective of fostering sustainability within the fashion industry. Additionally, concerning the management and decision-making facets of the fashion

industry, the keywords “supply chain management” and “decision-making” underscore the pivotal role of decision-making processes at supply chain, corporate, and policy levels in driving the development of sustainable clothing design. Moreover, the term “business models” signifies researchers’ interest in exploring innovative business models that contribute to sustainable development within economic operations.

Collectively, these keywords construct a comprehensive framework that addresses crucial topics in sustainable clothing design. They provide researchers with a robust foundation for delving deeply into how the fashion industry can achieve sustainable development, emphasizing the interconnectedness of environmental responsibility, ethical considerations, and strategic decision-making processes.

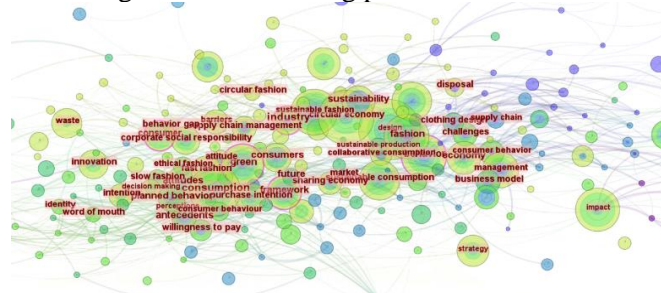


Figure 6. Keyword clustering atlas of 466 references (Developed by the authors)

4. Conclusion

In recent years, there has been a notable increase in the volume of articles published within the realm of sustainable clothing design. This heightened interest among researchers in sustainable fashion is evident in the proliferation of new research articles that encompass various facets of the field. These encompass, but are not limited to, environmentally friendly materials, design innovation, and consumer behavior. The central themes revolve around different dimensions of sustainable fashion, including the use of eco-friendly materials, the advancement of design innovation, and an exploration of consumers’ awareness and attitudes toward sustainable fashion. The interconnections between these topics have produced a comprehensive and diverse research framework.

It is noteworthy that international collaboration among researchers in sustainable clothing design has been progressively increasing, forming a network of transnational and transretinal cooperation. This international collaboration serves to advance global research endeavors in a sustainable fashion, fostering the exchange and sharing of knowledge. Within this collaborative network, certain high-quality and influential core papers have emerged, demonstrating outstanding performance in terms of citations and impact, thus attaining classic status in the field.

CiteSpace analysis has also unveiled some emerging trends, including the integration of digital technology in

sustainable fashion design and the fusion of social innovation with sustainable fashion. These emerging trends indicate potential future directions in sustainable clothing design. Notably, research in the field has evolved into an interdisciplinary endeavor, spanning disciplines such as design, material science, and consumer behavior. This interdisciplinary approach contributes significantly to a more holistic understanding of the intricacies of sustainable fashion and fosters collaborative innovation across diverse fields.

In conclusion, the quantity and quality of articles within the domain of sustainable clothing design are steadily on the rise. The diversity of topics and emerging trends provides researchers with an expansive scope for exploration. As the concept of sustainable fashion deepens, one can anticipate the emergence of more innovative and profound research endeavors that will further propel sustainable development in the field of sustainable clothing design.

5. Limitations and Further Study

Existing academic research on sustainable clothing design has the following shortcomings:

Relative scarcity of highly productive authors and highly cited articles: The number of highly productive authors is limited, and there are relatively few articles whose works are widely cited. Prolific authors may specialize in in-depth research on a specific topic but lack broad coverage of multiple fields. This focus allows for in-depth research, but it also limits the breadth of research. Conversely, highly cited articles may require more time for in-depth research, whereas productive authors focus more on frequent output than on in-depth research.

Lack of cross-regional and cross-institutional cooperation: There are relatively few articles on cross-regional and cross-institutional cooperation. Researchers prefer to conduct research within their own areas of expertise rather than collaborate across disciplines. Limited resources and different research focuses and concerns are the reasons for this phenomenon, making most people choose to conduct research locally.

Authors with limited influence: There are relatively few authors with great influence, most of whom are authors from Western countries. This may reflect the greater academic prestige and influence of researchers from Western countries in the field of sustainable clothing design. Therefore, when promoting international cooperation, it is necessary to pay more attention to promoting exchanges and cooperation among researchers from various regions and cultural backgrounds to establish a more comprehensive and diverse research landscape.

Authors' Contributions

The main author contributed 60% of the idea and the completion of the paper. The second and third authors performed the data analysis, 40% equally.

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