A systematic review of sustainability driven apparel supplier selection

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Abstract

In recent years, there has been growing interest in sustainable supply chain management in the textile and apparel industry, leading to an increase in research on supplier selection. The purpose of this article is to present a comprehensive review of 105 publications on sustainable apparel supplier selection (SASS) that were published between 2001 and 2021. Firstly, the paper provides a systematic analysis of the research hotspots and trends in SASS. Secondly, the paper analyzes the research themes in this field from two perspectives: the construction of standards and the use of methods using content analysis. Finally, the paper explores the future prospects of the development of SASS studies under the influence of big data and blockchain. Through a systematic analysis of the literature, the following key findings have been revealed: (1) current research on SASS predominantly employs comprehensive methods and models, with an increasing use of fuzzy mathematics; (2) investigating the impact of consumer, social, and technological factors on sustainable supplier selection is a popular direction of research; (3) future research will focus on the application of information technologies, such as big data and blockchain, in supplier selection and sustainability management. This study will be helpful for practitioners in the textile and apparel industry, and for researchers who hope to understand the current status of SASS.

Keywords: Textile and apparel, sustainability, supply chain, supplier selection
INTRODUCTION

In recent years, sustainability in the textile and apparel industry has received widespread attention from various sectors of society. The textile and apparel industry is an important livelihood industry in many countries and an important component of the national economy. The production and operation of textile and apparel enterprises not only need to provide products and services that meet customer needs but also fulfill their social responsibilities by developing green trade demonstrations that promote ecological sustainability, which is an important part of the core competitiveness of enterprises. Therefore, incorporating sustainable concepts into the development process is an essential path for the long-term development of textile and apparel enterprises\(^{(1,2)}\).

There are various methods for achieving sustainable development in textile and apparel enterprises, among which embedding sustainable concepts into supply chain management (SCM) is one of the important means of realizing sustainable development in apparel enterprises\(^{(3)}\). However, since the outbreak of COVID-19, the global supply chain has experienced significant disruptions, leading to a persistent situation of demand uncertainty and supply shortages\(^{(4)}\). As a result, there is an urgent requirement to optimize the supply chain structure and implement sustainable industrial upgrading. Supplier selection, being a crucial component of the entire supply chain, holds a position upstream. Cost savings and sustainable benefits derived from supplier selection can then be transmitted throughout the entire supply chain, ultimately benefiting all downstream links. Therefore, selecting the best supplier objectively and comprehensively can assist enterprises in establishing a positive social image, increasing corporate income, and reducing environmental pollution, among other sustainable benefits\(^{(5)}\). Consequently, research pertaining to supplier selection has consistently been highly regarded by academics and practitioners, given its pivotal role in enhancing the efficiency, competitiveness, and sustainability of core enterprises.

In research on supplier selection in the context of sustainability issues in the textile and apparel industry, Baskaran et al. (2012) established the criterion for a sustainable (social) supply chain and evaluated Indian textile and apparel suppliers and their second-tier suppliers\(^{(6)}\). Zeng and Rabenasolo (2013) proposed a fuzzy weighted system to select the most relevant materials and suppliers in the sustainable textile supply chain\(^{(7)}\). Jia et al. (2015) studied the basic concepts of the sustainable supply chain in the fashion industry by starting from social and environmental criteria\(^{(8)}\). Winter and Lasch (2016) proposed the most important and comprehensive social and environmental evaluation criteria for suppliers in the sustainable supply chain by interviewing procurement experts in the apparel and textile industry\(^{(9)}\). Amindoust and Saghafinia (2017) proposed a fuzzy reasoning system to rank the potential sources of textile suppliers based on limited economic, social, and environmental factors\(^{(10)}\). Yadlapalli et al. (2018) found that supplier selection had a significant impact on the social and environmental performance of the social responsibility supply chain in the apparel industry by applying structural equation modeling\(^{(11)}\). Kannan (2018) identified key success factors in the sustainable supplier selection (SSS) process for multinational textile companies from the perspective of multiple stakeholders and used various decision-making techniques, such as the fuzzy-Delphi analysis network process and complex proportional assessment for supplier ranking\(^{(12)}\). Guarnieri and Trojan (2019) proposed a multicriteria decision-making (MCDM) model that includes AHP (analytic hierarchy process) and ELECTRE (elimination et choice translating reality)-TRI to support managers in selecting suitable suppliers in the outsourcing process based on the triple bottom line (TBL) of sustainable development in the textile industry\(^{(13)}\). Darvishi et al. (2020) proposed a comprehensive mathematical model applied to the selection of global fabric suppliers and production planning for apparel manufacturers\(^{(14)}\).

This study will conduct a systematic review of 105 studies on SSS in the textile and apparel field from 2001 to 2021 using bibliometric analysis. Specifically, the following questions will be addressed.
1. The research progress in the past decade on the selection of sustainable apparel suppliers (SASS) will be sorted and analyzed.
2. The research topics and methods in this field will be identified.
3. The future development direction of SASS will be explored.

Compared with previous studies, this study has the following innovations. First, this study collects a targeted literature dataset on SSS in the apparel industry through a query-based search method, which is more focused. Second, the use of bibliometric software for a systematic review and the combination of traditional literature review methods can help us obtain more objective research topics and track the development trends and evolution of knowledge structures. Finally, bibliometric software can assist scholars in quickly identifying key information and recognizing knowledge structures and evolution in a certain field of knowledge. This study is the first systematic review of supplier selection strategies in the apparel industry.

The contributions of this article are as follows. First, the research hotspots in the field of SASS were analyzed by co-occurrence keyword network analysis using CiteSpace and Vosviewer, and the development trends of this field were analyzed by time zone views in CiteSpace. Second, the research topics in the field of SASS were analyzed using content analysis. Finally, the future applications of big data and blockchain technology in SASS were predicted.

The remainder of this article is organized as follows. The second section introduces the research framework and methodology. The third section analyzes the research hotspots and trends. The fourth section provides a detailed analysis of the research topics, while the fifth section summarizes the main findings of the article and explores the development changes of SASS in the future under the influence of big data and blockchain technology. Finally, the article is concluded. This study will provide assistance to practitioners in the textile and apparel industry and researchers who are interested in understanding SASS.

RESEARCH FRAMEWORK AND METHODOLOGY

Research framework
The research framework of this paper is shown in Figure 1. First, the literature retrieval process is conducted by searching relevant literature in the field of SSS from the WoS (Web of Science) database based on the search formula and conducting a certain degree of screening. With a reasonable quantity and quality of literature obtained, a bibliometric analysis is conducted to understand the research trends and hotspots in the field of SASS. Then, the research topic is introduced in detail from two aspects: the construction of criteria and the use of methods. Finally, based on existing research, the development trends in the field of SASS are predicted.

Research methodology

Literature review
The sources of information for bibliometric analysis typically come from three channels: WoS, Scopus, and Google Scholar. In this study, WoS was selected as the database for literature retrieval, as it covers high-quality journals, is more comprehensive, and contains literature that is more representative of research.

The search for keywords in this study was conducted using a combination of three types of words. Each search used a mixture of the first type of words related to supply, such as supplier selection methods and supplier selection criteria; the second type of words related to green issues, such as green and sustainable; and the third type of words related to apparel, such as textiles, clothing, and fashion. By combining these three types of words, the research scope was limited to the field of SASS, making the research more targeted.
In terms of language, only English-language journals were considered. All data were obtained from the latest core collection of scientific.net. The search formula used in this article is as follows:

\[ \text{TS} = (\text{“supplier select* OR supply chain selection method* OR supply chain selection criteria*”}) \text{ AND } (\text{“apparel OR garment* OR cloth* OR textile* OR fashion OR fabric OR yarn”}) \text{ AND } (\text{“sustain* OR green OR environment OR econom* OR society OR ecological”}) \]

Among them,
\[ \text{TS/TITLE – ABS – KET} = \text{Title, Abstract, and Keywords} \]
\[ \text{AND/OR} = \text{Boolean operators to connect different keywords} \]
\[ * = \text{used for loose/approximate phrase} \]
\[ “” = \text{used for exact phrase} \]

**Literature screening**
To ensure that all relevant articles on the topic could be searched, a total of 112 relevant studies were retrieved through the search formula mentioned above in WoS, without any time limitation. However, in consideration of the validity and academic rigor of the retrieved literature, conference papers, editorial materials, letters, notes, sections, and book reviews were excluded. Therefore, four conference records and three review papers were deleted, resulting in a final set of 105 relevant studies. When we set the time span as “2001-2021”, no literature was excluded, indicating that all relevant literature in this field has been published in the past 20 years under the search conditions we set. Consequently, this article ultimately set the time span as 2001-2021 and the number of studies at 105. **Figure 2** illustrates the process of literature collection and screening.

**RESEARCH HOTSPOT ANALYSIS**
**Literature publication status**
By analyzing the literature publication status of the research topic of SSS in the textile and apparel industry from 2001 to 2021, the overall development process of research in this field can be grasped. Additionally, by conducting keyword clustering analysis and temporal keyword view analysis, the research hotspots and their changes in this field can be identified.

The annual publication output in a particular field of knowledge is an important indicator for assessing the development of scientific research. To some extent, it reflects the increase in the amount of knowledge and the research progress of researchers in that field\[15\]. The reviewed database includes 105 peer-reviewed papers published in journals in the past 21 years (2001-2021). The publication trends over the years are shown in **Figure 3**. The first paper was published in the JOURNAL OF THE AIR & WASTE MANAGEMENT ASSOCIATION in 2001, and until 2014, the number of papers published each year was less than three. From 2012, the publication output began to steadily increase, with approximately 62% of publications concentrated between 2019 and 2021.
Research hotspots of SASS

This study employs the method of co-word analysis to reveal the research hotspots in the area of SASS. To identify the key themes, this study selected keywords that appeared at least three times among the 105 articles and retained the relevant keywords while removing the irrelevant ones. The resulting keywords were divided into three major clusters, as shown in Figure 4. The lines connecting two keywords in the figure represent their co-occurrence, with thicker lines indicating a higher frequency of co-occurrence and shorter lines indicating a closer relationship between the keywords. The following is an analysis of these three clusters.

Cluster 1 (in red) is the largest cluster, consisting of 87 keywords, and its theme is SSS factors and influences. By analyzing the keywords, current research hotspots on SSS include (1) environmental protection, the impact of enterprise environmental management and environmental practices on supplier selection; (2) social responsibility, the relationship between enterprise social responsibility practices and
consumer demands and their impact on supplier selection; and (3) sustainability trends, the impact of market trends and globalization on supplier selection. In the apparel industry, companies need to enhance their image and meet consumer demands through environmental and social responsibility practices while also adjusting their strategies in a timely manner according to market trends to seek competitive supplier cooperation and achieve sustainable development\textsuperscript{[16-18]}. Cluster 2 (in green) consists of 86 keywords and mainly includes methods and tools for SSS. The main hotspots in this cluster include green supplier selection, MCDM methods and tools, consideration of social and environmental factors, and supply chain sustainability. In terms of green supplier selection, researchers focus on how to evaluate and select sustainable suppliers to reduce the negative impact of the supply chain on the environment. Commonly used MCDM methods and tools, such as the fuzzy AHP and VIKOR (VIseKriterijumska Optimizacija I Kompromisno Resenje), can help decision-makers consider multiple factors comprehensively and select the best supplier. In addition, social and environmental factors are also included in the scope of consideration, such as worker rights and environmental protection. Moreover, resource utilization, waste management, and carbon emissions are also studied. These research hotspots provide useful insights and practical significance for the sustainable development of the apparel industry\textsuperscript{[4,19-22]}. Cluster 3 (in blue) consists of 50 keywords and mainly discusses the key considerations for SSS. The research hotspots in this cluster include but are not limited to (1) assessing the environmental impact of potential suppliers, considering their impact on the environment during the manufacturing and transportation process, and selecting suppliers
with minimal environmental impact; (2) sustainability criteria and certifications: developing and applying sustainability criteria and certifications to ensure that potential suppliers meet sustainability requirements; and (3) sustainable supply chain collaboration: establishing long-term collaborative relationships, working closely with potential suppliers, achieving sustainable supply chain goals, jointly addressing supply chain challenges, and improving overall performance. In practice, we can combine government policies, market trends, and technological innovations to develop relevant strategies to improve the sustainability of supplier selection and promote sustainable development.

Dynamic evolution of research hotspots
This section will conduct a dynamic evolution analysis of hot research topics. The dynamic evolution of keywords is shown in Figure 5. The horizontal axis in Figure 5 represents the timeline, with each time period divided into one year, and the keywords that appeared in each year are displayed within each time period. The larger the keyword, the higher its frequency of appearance. Based on Figure 5, the research on the SASS can be roughly divided into four stages. The first phase, from 2001 to 2009, was the starting stage of SASS research. The emerging keywords at this time were only basic supply chain terms such as cost, industry, construction, etc., and the emphasis was on cost performance. There was relatively little research on the supply chain environment or society during this period. The second phase, from 2010 to 2013, was the peak period for supplier selection research. During this period, keywords related to SSS research such as environment management, environment criteria, analytical hierarchy process, corporate social responsibility (CSR), etc., emerged one after another. This indicates that with the development of society, people are increasingly aware of the importance of sustainable development for human beings. During this period, scholars focused on SASS by analyzing the behavior criteria of suppliers through the analytical hierarchy process and then evaluating supplier selection. The third phase, from 2014 to 2017, was a period of steady development for SASS research. The main keywords during this period included group decision-making, SCM practices, environmental performance, and institutional pressure. Overall, the research during this period expanded the scope of the previous research, from the study of the green supply chain to the sustainable supply chain. The research focus continued to be on carbon emissions, mainly in the automotive industry. New keywords emerged, such as environmental performance and SCM practices. The research methods also became more standardized, considering sustainability issues from the perspective of the supply chain system and framework. The fourth phase, from 2018 to 2021, was another peak period for SASS research. The related keywords during this period included MCDM, AHP model, BWM (Best-Worst Method), CO₂ emission, etc. Due to the risks and uncertainties brought by external pressures to companies, research has begun to focus on the coordination of the supply chain. Companies began to voluntarily engage in sustainable development while also paying attention to service quality. The research mainly focused on establishing model frameworks and solving MCDM problems through mathematical models such as AHP models and BWM.

From the evolution of research hotspots over time, it can be seen that there is relatively little research in the academic community on the issue of SASS. Most studies solve common supplier selection problems across various industries by establishing general mathematical models, which lack specificity. In terms of research progress, the focus has shifted from green supply chain research to sustainable supply chain research, with greater emphasis on the coordination and risk-bearing capacity of the supply chain. The research methods have evolved from establishing a single mathematical model to establishing a stable mathematical framework. Overall, research on SASS is still in its early stages, and apparel companies need to establish sustainability awareness and embed sustainable SCM (SSCM) and SSS issues into their development plans.
TOPIC ANALYSIS ON SASS FIELD

As can be inferred from the analysis in Section 3, the present study will proceed to conduct a theme analysis with respect to two aspects, namely, the establishment of criterion systems and the determination of selection methods, both based on the characteristics of the apparel industry.

Establishment of a criterion system

This section focuses on the construction of a criterion system from two perspectives: sustainable development criteria for apparel suppliers in the selection process and relevant criteria for apparel supplier selection.

Sustainable development criteria

Based on the three dimensions of the TBL framework, criteria that have influenced supplier selection for the past 20 years are typically classified into three categories: economic, environmental, and social. Traditional supplier evaluation research usually involves only economic performance. Common criteria in the economic dimension include cost/price\textsuperscript{[12,24]}, quality\textsuperscript{[24,25]}, technological capability\textsuperscript{[26,27]}, production capacity\textsuperscript{[28,29]}, financial condition\textsuperscript{[30,31]}, logistics\textsuperscript{[32,33]}, service\textsuperscript{[34,35]}, relationship\textsuperscript{[36]}, flexibility\textsuperscript{[37,38]}, etc. These criteria often only reflect the economic benefits that suppliers bring to companies. However, with increasing attention to global environmental issues and the enhancement of ecological awareness, environmental performance has become an important evaluation criterion for supplier selection systems. Widely recognized and used criteria in the environmental dimension include green image\textsuperscript{[39,40]}, environmental management system\textsuperscript{[41,42]}, environmental capability\textsuperscript{[43,44]}, pollution control\textsuperscript{[45,46]}, resource consumption\textsuperscript{[47,48]}, green design\textsuperscript{[49,50]}, green products\textsuperscript{[51]}, green SCM\textsuperscript{[52]}, green technology innovation\textsuperscript{[53]}, etc. Although research on CSR is not a new topic and has already made some achievements, research combining CSR with supplier selection has only emerged in recent years. Social dimension supplier selection criteria include employee rights\textsuperscript{[54]}, stakeholder rights\textsuperscript{[55,56]}, labor safety and health\textsuperscript{[57]}, impact on local communities\textsuperscript{[58]}, compliance with laws and policies\textsuperscript{[59]}, employee training\textsuperscript{[60]}, information disclosure\textsuperscript{[24]}, child labor or forced labor\textsuperscript{[59]}, etc.
Figure 6 summarizes some commonly used criteria in the field of SSS in recent years. Overall, the criteria for each dimension are currently quite comprehensive. However, there is a lack of research on the application of criteria that unify the three dimensions in the context of SSS in the apparel industry.

**SASS criteria**
When considering sustainability factors, there are currently only a few studies that have addressed SSS in the apparel industry and developed corresponding criterion systems. Shaw *et al.* considered criteria such as cost, quality compliance rate, delivery delay rate, greenhouse gas emissions, and demand and integrated the weights of these criteria into a fuzzy multiobjective linear programming problem for supplier selection\(^\text{[60]}\). Luthra *et al.* determined 22 SSS criteria based on TBL through literature screening and expert opinions\(^\text{[61]}\). The results showed that environmental cost, product quality, product price, occupational health and safety system, and environmental capability were the top five SSS criteria. In the research of Awasthi *et al.*, in the selection of multilevel sustainable global suppliers, the results showed that the economic criterion had the highest weight among the five sustainable criteria (economic, quality, environmental, social, and global risk), while global risk had the lowest weight\(^\text{[62]}\). In the construction of sustainable criterion systems for the textile and apparel industry, Baskaran *et al.* conducted a sample survey of 63 apparel suppliers based on six criteria, including discrimination, human rights violations, child labor, long working hours, unfair competition, and pollution\(^\text{[6]}\). The results showed that long working hours were a key criterion for both apparel manufacturers and auxiliary suppliers. Pollution and unfair competition were the most important criteria for apparel manufacturers. Winter *et al.* studied how apparel companies apply environmental and social criteria in supplier evaluation\(^\text{[6]}\).

Overall, as time goes on, the criteria for selecting sustainable apparel suppliers are becoming more comprehensive and diverse, and they consider more fuzzy factors in the supplier selection process. This is strongly related to the development of MCDM methods.

**Analysis of research methods**
This section will first introduce the research methods used in the area of supplier selection and provide a macrolevel understanding of the current hot research methods used in this field. Then, a detailed analysis of the methods applied in the sustainable apparel supplier field will be conducted.

*Primary methods utilized for supplier selection*
There are differences in supplier selection processes across various industries. Currently, AHP, TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution), VIKOR, and their variants are commonly used methods in the supplier selection process. Scholars have explored different SSS methods, with most studies using a combination of multiple methods to improve decision quality. The following is a partial summary of these studies.

Gupta and Barua proposed a BWM-fuzzy TOPSIS model to address the green supplier selection problem for small and medium-sized enterprises\(^\text{[63]}\). Banaeian *et al.* combined fuzzy set theory with VIKOR, TOPSIS, and GRA (Grey Relation Analysis) to help the agriculture and food industries select green suppliers\(^\text{[64]}\). Babbar and Amin proposed a two-stage Quality Function Deployment (QFD) and stochastic multiobjective mathematical model to address the green supplier selection and order allocation problem in the beverage industry\(^\text{[65]}\). Gupta *et al.* proposed a FAHP-MABAC-WASPAS-TOPSIS model to evaluate green suppliers in the automotive industry\(^\text{[66]}\). Moheb-Alizadeh and Handfield proposed a multiobjective mixed integer linear programming model to address the SSS and order allocation quantity problem in the automotive industry, considering sustainability, stockout, and discount situations\(^\text{[67]}\). Memari *et al.* proposed an intuitive fuzzy
TOPSIS method to select reliable suppliers for automotive component companies[68]. Stević et al. developed a new compromise solution (MARCOS) for SSS in the healthcare industry[69]. Mahmoudi et al. combined the gray system theory (GST) and the ordered priority approach (OPA) method to address SSS in large investment projects[70]. Amiri et al. proposed combining FBWM and α-cut to address SSS in the automotive industry[71]. Li et al. developed a two-stage integrated mathematical model to select sustainable suppliers in the new energy automotive industry and allocate orders to each supplier[72].

The researchers in this field have employed various methods, including fuzzy set theory, VIKOR, TOPSIS, GRA, QFD, multiobjective mathematical models, intuitionistic fuzzy TOPSIS, compromise solution, gray theory, sequential priority, and α-cut. Each of these methods possesses its own characteristics and advantages. However, as time progresses, new methods are developed to overcome the limitations of the old ones, gradually enhancing the research on MCDM. For example, in the past, most of the methods used to determine the weight of criteria were AHP. However, due to the challenges associated with consistency testing and complex hierarchy structures, AHP has certain limitations. The introduction of the BWM method proposed by Rezaei in 2014 has gradually replaced AHP in the field of MCDM[73]. The BWM method offers advantages such as fewer comparison times and high result consistency. Another noteworthy method is MULTIMOORA[74] (Multiobjective Optimization on the Basis of a Ratio Analysis plus the full MULTIplicative). It is a comprehensive approach that combines several MCDM methods and fulfills all six robust conditions through three or more methods. Since its introduction, MULTIMOORA has found widespread application in various industries, including supplier selection, risk assessment, logistics partner selection, project management, and more.
The selection of these methods depends on the specific environment and problem of the SSS. Most researchers also combine multiple methods to improve decision quality. Table 1 summarizes the methods and their extensions currently used in the supplier selection process.

Methods used in SASS
As emphasized by de Boer et al., not all methods are equally applicable to every industry. For the fashion industry, the particularity of the industry must be taken into account when selecting suppliers. The fashion industry is seasonal, so delivery time must be considered; product quality is related to brand image; trends are strong, requiring a certain degree of flexibility and market sensitivity; other factors such as price, design, stability, and social responsibility are also important considerations for companies in supplier selection. Moreover, with the increasing sustainability awareness of consumers, product sustainability has become a necessary consideration. The selection of fashion suppliers is a very obvious multicriteria decision problem. The following are the mainstream research methods for SSS in the textile and apparel industry.

Of all 105 literature reviewed, the first to research SSS in the fashion industry was Wang et al., who in 2012 combined fuzzy logic (a popular method for incorporating uncertain parameters into the decision-making process) with an analytical hierarchy process to form a model for selecting (decision-making) different green initiatives in the fashion industry. Additionally, in 2012, Baskaran et al. classified suppliers into “good performance”, “noncompliant”, and “underperforming” categories by analyzing a sample of 63 suppliers and six sustainable development criteria (i.e., discrimination, human rights abuses, child labor, long working hours, unfair competition, and pollution) using gray methods and found that pollution and unfair competition were the most important criteria. In recent years, Nasr et al. have used the fuzzy BWM to select the most suitable suppliers based on economic, environmental, social, and circular criteria and designed a multiproduct, multiperiod, closed-loop supply chain (CLSC) network, inventory location routing, vehicle scheduling, and quantity discount considerations using a multiobjective mixed integer linear programming (MOMILP) model. Celik et al. used the Interval Type-2 Fuzzy Best Worst Method (IT2F-BWM) to determine evaluation criteria for selecting green suppliers and applied the Interval Type-2 Fuzzy TODIM (IT2F-TODIM) method for the selection of green suppliers. A case study on the Turkish textile industry demonstrated the applicability of the method. Kusi-Sarpong et al. first used the BWM method to determine the relative importance weight and then applied VIKOR to rank the suppliers, helping a Pakistani textile manufacturing company find the best supplier. Majumdar et al. captured opinions on each criterion and alternative using linguistic terms from experts, modeled them using fuzzy mathematics, and then introduced and demonstrated a solution algorithm for flexible supplier selection based on a trapezoidal intuitionistic fuzzy technique for order preference by similarity to ideal solution (TrIFTOPSIS).

Table 2 summarizes the commonly used methods of supplier selection by some apparel suppliers in recent years, as well as the corresponding supplier selection criteria. Based on the table and the above content, it can be concluded that the research logic in this field is basically to formulate a framework for selecting suppliers for textile and apparel enterprises, calculate criterion weights, establish mathematical models, rank suppliers, obtain the best supplier, and finally verify the effectiveness of the established model through enterprise cases. The methods for calculating criterion weights include BWM and AHPANP. Mathematical methods for ranking suppliers include TOPSIS, VIKOR, TODIM, DEA, PROMETHEE, and so on.

DISCUSSION AND IMPLICATIONS
Findings
In the field of SCM, an increasing number of enterprises and scholars have become aware of the importance
Table 1. Supplier selection methods and related studies

<table>
<thead>
<tr>
<th>Methods</th>
<th>Extension</th>
<th>Ref.</th>
</tr>
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<tbody>
<tr>
<td>AHP</td>
<td>Fuzzy AHP</td>
<td>Shaw et al. [60], Kilincici and Onal [75]</td>
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<tr>
<td></td>
<td>AHP and DEA</td>
<td>Ramanathan [76]</td>
</tr>
<tr>
<td></td>
<td>AHP and VIKOR</td>
<td>Luthra et al. [83]</td>
</tr>
<tr>
<td></td>
<td>AHP and Fuzzy TOPSIS</td>
<td>Lima Junior et al. [77], Beikkhakhian et al. [78]</td>
</tr>
<tr>
<td>TOPSIS</td>
<td>Fuzzy TOPSIS</td>
<td>Kannan et al. [79], Awasthi et al. [80]</td>
</tr>
<tr>
<td></td>
<td>VIKOR-TOPSIS-GRA</td>
<td>Banaeian et al. [64]</td>
</tr>
<tr>
<td></td>
<td>DEMATEL-ANP-TOPSIS</td>
<td>Büyüközkan and Çifçi [81]</td>
</tr>
<tr>
<td>BWM</td>
<td>Fuzzy BWM</td>
<td>Gupta and Barua [63]</td>
</tr>
<tr>
<td></td>
<td>BWM-Fuzzy TOPSIS</td>
<td>Kumar et al. [83]</td>
</tr>
<tr>
<td></td>
<td>BWM and VIKOR</td>
<td></td>
</tr>
<tr>
<td>GRA</td>
<td>Fuzzy GRA</td>
<td>Chen et al. [51]</td>
</tr>
<tr>
<td></td>
<td>GRA and AHP</td>
<td>Li and Zhao [84]</td>
</tr>
<tr>
<td></td>
<td>GRA and DEMATEL</td>
<td>Fu et al. [85]</td>
</tr>
<tr>
<td>VIKOR</td>
<td>Fuzzy VIKOR</td>
<td>Sanayei et al. [86]</td>
</tr>
<tr>
<td></td>
<td>VIKOR and NGT</td>
<td>Awasthi and Kannan [55]</td>
</tr>
<tr>
<td></td>
<td>VIKOR and Fuzzy ELECTRE</td>
<td>Zandi and Roghanian [87]</td>
</tr>
<tr>
<td>DEA</td>
<td>Fuzzy DEA</td>
<td>Mahdiloo et al. [43], Azadi et al. [88]</td>
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<td></td>
<td>DEA and ANN</td>
<td>Azadi et al. [88]</td>
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<tr>
<td></td>
<td>DEA and RST</td>
<td>Bai and Sarkis [89]</td>
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</tbody>
</table>


of sustainable development and actively practice it to achieve their social, environmental, and economic goals. In enterprise SCM, procurement plays a critical role and has a significant impact on downstream activities. Consequently, an increasing number of empirical and conceptual papers are exploring the issue of SSS. Particularly in the fashion industry, choosing sustainable suppliers is crucial, but currently, there are relatively few quantitative and literature reviews on SASS. This limitation restricts our in-depth understanding and summary of the development in this field.

This article presents a visual and systematic analysis of 105 literature pieces published in the past 20 years in the field of SSS in the fashion industry. Based on this literature analysis, this paper identifies several research hotspots and starting points regarding the process of SSS in the fashion industry.

This article reveals that the majority of current research on SSS in the fashion industry employs integrated approaches and models, such as hybrid decision-making models and data collection and mining, to evaluate the suitability, environmental factors, complexity, and performance of suppliers to achieve the goal of selecting sustainable suppliers. The research also finds that an increasing number of studies apply fuzzy mathematics and MCDM methods to SSS, fully considering the subjective fuzziness of decision-makers, to address the applications of complex problems, environmental pollution, and resource conservation.

The study of the influence of consumer, social, and technological factors on SSS is a relatively popular research direction. Understanding consumer awareness and attitudes toward sustainability issues is the foundation for achieving sustainability. In addition, sustainability and environmental protection training and the awareness of supply chain partners are also crucial. The application of information technology in
Table 2. SASS criteria and methods

<table>
<thead>
<tr>
<th>Relevant scholars</th>
<th>Year</th>
<th>TBL</th>
<th>Research methods</th>
<th>Relevant criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallahpour et al. [95]</td>
<td>2017</td>
<td>YES</td>
<td>FPP; FTOPSIS</td>
<td>Cost; quality; delivery and service; flexibility; workers' rights; health and safety at work; supportive activities; environmental management system; green products; green warehousing; ecological design; green transportation; green logistics.</td>
</tr>
<tr>
<td>Ulutas et al. [96]</td>
<td>2019</td>
<td>NO</td>
<td>FROV; FPSI</td>
<td>Cost; defective rate; late delivery rate; technical capability; technical assistance; pollution control; environmental management; green transportation; green warehousing.</td>
</tr>
<tr>
<td>Guanleria and Trojani [10]</td>
<td>2019</td>
<td>YES</td>
<td>AHP; ELECTRE-TRI</td>
<td>Geographical location; cost; quality; delivery date; human rights; charitable activities; certification; environmental impact; reverse logistics; environmentally friendly packaging; emission control.</td>
</tr>
<tr>
<td>Wang et al. [87]</td>
<td>2019</td>
<td>YES</td>
<td>FAHP; TOPSIS</td>
<td>Cost; delivery reliability; quality; technical ability; employment practice; health and safety; impact on local communities; impact on contractual stakeholders; pollution production; resource consumption; ecological design; environmental management system.</td>
</tr>
<tr>
<td>Wang et al. [20]</td>
<td>2020</td>
<td>NO</td>
<td>ANP; FAHP; PROMETHEE II</td>
<td>Reliability; responsiveness; flexibility; cost; assets.</td>
</tr>
<tr>
<td>Nasr et al. [92]</td>
<td>2021</td>
<td>YES</td>
<td>FBWM; MOMILP</td>
<td>Quality; reputation; lead time; flexibility; technical capabilities; service and after-sales; use of environmentally friendly and recyclable raw materials; design of reusable products; environmental management; management of air pollution caused by production; hazardous waste management; job creation; information disclosure; transparency.</td>
</tr>
<tr>
<td>Wang et al. [99]</td>
<td>2021</td>
<td>NO</td>
<td>FAHP; FTOPSIS; DEA</td>
<td>Financial capability; quality assurance; service commitment; technological advantage.</td>
</tr>
<tr>
<td>Karami et al. [19]</td>
<td>2021</td>
<td>YES</td>
<td>DEA; PCA; VIKOR</td>
<td>Reliability; responsiveness; flexibility; assets; employee benefits and rights; occupational safety and health; compliance with policies; information disclosure; environmental management system; environmental competitiveness.</td>
</tr>
</tbody>
</table>


Supplier selection and sustainability management is also a future research hotspot. In conducting research on SSCM, the focus should be on environmental and sustainability issues, optimization of order allocation strategies, limiting factors and constraints in SCM, and data-driven decision support systems for SCM. The research findings require scholars to pay more attention to stakeholder and regulatory issues in sustainable supply chains, such as CSR, globalization, policy makers, manufacturers, and consumers. It is necessary to apply the research results to practice and encourage suppliers to adopt environmental and sustainable measures to achieve the goal of sustainable development.

Future prospects

The application of information technology in supplier selection and sustainability management is a hot research topic[24]. Future research can explore how to use technologies such as artificial intelligence[24], the Internet of Things[100], and blockchain[101] to improve the visibility and transparency of the supply chain, enhance the efficiency and accuracy of supplier selection, and reduce environmental and social risks. The following discussion will delve into the future development prospects of the clothing industry, focusing on big data utilization and the selection process of clothing suppliers as examples.
Analysis of apparel supply chain partner selection in the big data environment

With the advent of the big data era and acceleration of economic globalization, supplier selection in the apparel industry has become more important than ever before. Apparel companies need to keep up with the development of the big data economy and adjust their supply chain partners in a timely manner to adapt to changing environments, which is crucial for their sustainable development.

With the help of big data, apparel companies can easily establish a scientific, systematic, informational and diversified evaluation index system\textsuperscript{[102]}. The new system not only needs to consider various elements involved in the traditional supplier selection process but also needs to address two aspects of system element construction and system structure construction. System element construction involves establishing a clear index system based on evaluation criteria, including criterion concepts, calculation scope, and benchmark content. System structure construction refers to the interrelationships between criteria and the construction of hierarchical structures, which can improve evaluation efficiency and effectiveness. For the apparel industry, sustainable development is of great importance. Therefore, when selecting suppliers, their performance in environmental, social, and economic aspects needs to be taken into consideration. At the same time, factors such as product quality, service, and credibility of the supplier also need to be considered. By establishing a comprehensive, scientific, and applicable evaluation index system, each optional object can be carefully and scientifically evaluated to select partners that meet the requirements of sustainable development. In this process, big data can provide data support\textsuperscript{[103]}, analyze a large amount of supplier data, provide decision-making reference, and help enterprises choose more suitable partners to improve the efficiency and sustainability of the supply chain.

Characteristics of managing partner relationships in the apparel supply chain under the big data environment

With the advent of the big data era, significant changes have occurred in the management of the fashion supply chain, and the following are some characteristics of managing fashion supply chain partnerships in the big data environment based on literature analysis.

First, the SCM concept in the big data environment has achieved precision\textsuperscript{[104]}. By collecting and feeding back consumer demand information to the production end and redesigning and producing products again, it meets the more precise needs of end consumers at a deeper level. Second, the synergy effect in the big data environment is amplified\textsuperscript{[105]}. Through data processing of intelligent hardware and software technology, information processing, collection, analysis, and application in various links of the supply chain can be optimized in a timely and effective manner. This not only achieves academic rigor and operational agility at the execution level of each link but also realizes the synergistic effect of the whole chain. Third, the customization of consumer demand is propelled with in the big data environment\textsuperscript{[106]}. Through the analysis of consumer demand, production customization is achieved, transforming the existing problem of batch production on the supply side into customized production that satisfies individualized needs. This model can satisfy the individual needs of consumers, improve the efficiency and reduce the production cost of enterprises. Fourth, supply-side structure management optimization is achieved in the big data environment\textsuperscript{[107]}. By improving the quality of supply-side products, achieving industrial transformation and upgrading, optimizing the structure, improving the efficiency of production and manufacturing, and focusing on sustainable development strategies such as environmental protection, it can achieve competitive products that are suitable for sales and truly meet consumer needs. Finally, small- and medium-sized fashion enterprises use big data applications to enhance competitiveness\textsuperscript{[108]}. With the sensitivity and flexibility of big data in the market, small and medium-sized fashion enterprises can maintain a certain living space in the fiercely competitive market. Big data provides strategic flexibility for small and medium-sized enterprises to better adapt to market demand and improve competitiveness.
In summary, in the big data environment, the management of partner relationships in the apparel supply chain has the characteristics of precision, collaborative effects, driving consumer demand customization, optimizing supply-side structural management, and enhancing the competitiveness of small and medium-sized enterprises through the use of big data applications.

**CONCLUSION**

This article conducts a comprehensive and systematic analysis of 105 relevant scholarly studies about the SASS published between 2001 and 2021. Using a methodology based on keyword co-occurrence, this investigation identifies the main research focal points and predicts future directions of progress in this field. Additionally, by scrutinizing the shared citations within the body of literature, this study identifies the predominant subject matters and principal methodological approaches that are prevalent in this sphere. Drawing upon the existing scholarship, this article offers predictions about possible directions for future research in this field. The principal empirical discoveries can be encapsulated as follows: (1) The study of SSS predominantly focuses on incorporating complex methodologies and models, utilizing fuzzy mathematics and MCDM approaches to effectively tackle the growing complexities that come with supplier selection concerns; (2) The main concerns within the field of SSCM include systematically addressing environmental and sustainability challenges, optimizing order allocation strategies, improving challenges and constraints within SCM, and creating data-centric decision support systems tailored to the SCM domain; (3) The exploration of merging information technology with supplier selection and sustainability management processes emerges as a significant research frontier. Cutting-edge technologies, such as artificial intelligence, the Internet of Things, big data, and blockchain can enhance the visibility of supply chains and data transparency. This, in turn, improves the effectiveness and precision of supplier selection while also reducing environmental and social risks.

This systematic and comprehensive review provides valuable insights and guidance for readers, encompassing researchers and practitioners in the sustainable clothing supplier selection field. For instance, this paper presents the most popular supplier selection methods in the garment industry, enabling researchers to establish the foundation for their own supplier selection systems. Simultaneously, it facilitates relevant scholars in identifying regions and institutions worldwide that have conducted in-depth research on supplier selection within the supply chain in the garment industry. This aids in discovering more suitable research methods and innovative ideas.

To sum up, this article provides readers with a better understanding of sustainable development in the garment industry. It focuses on the supplier selection, relevant scholars, and institutions concerned with this field, as well as the main research concepts, their evolution, and emerging trends.

**DECLARATIONS**

**Authors’ contributions**

General framework proposition and funding arrangement: Xue Z  
Literature analysis and paper writing: Zhu Z, Li Q  
Data acquisition and analysis: Wang T, Du T

**Availability of data and materials**

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All authors declared that there are no conflicts of interest.

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