Bibliometric Insights: Understanding Sustainable Organizational Culture in Manufacturing

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Abstract
This study employed bibliometric analysis to scrutinize and visualize the literature about sustainable organizational culture in manufacturing in Scopus and Web of Science databases from 2004 to 2023. The analysis encompassed the examination of document volumes, collaborative networks, and keyword networks. Findings reveal a clear increase in research interest regarding sustainable organizational culture within manufacturing enterprises over the specified timeframe. Predominant research focal points include human resource management, supply chain management, employee engagement, leadership, and innovation. Concurrently, emerging trends encompass the application of green technology, technological innovation, and the acquisition of competitive advantage. Drawing from these insights, this paper advances a future research agenda, advocating for investigations into the role of green technology innovation within manufacturing enterprise culture, the reinforcement of cultural development within human resource and supply chain management domains, and conducting thorough examinations into the influence of sustainable organizational culture on sustainability performance in manufacturing.
Keywords: Sustainable Organizational Culture, Manufacturing, Bibliometric, CiteSpace, VOSviewer

Introduction
In recent years, there has been a worldwide focus on sustainable development, leading organizations across various sectors to prioritize not only profitability but also environmental and social responsibility (Algarni et al., 2022). Among these organizations, manufacturing industries are criticized for their significant influence on resource consumption, and emissions (Ali et al., 2020). The development of a sustainable organizational culture is fundamental for manufacturing firms to achieve sustainability (Tasdemir et al., 2020). The culture includes values, norms, and beliefs that support environmental protection, social equity, and economic growth (Ketprapakorn & Kantabutra, 2022).

A sustainable organizational culture goes beyond regulatory compliance (Ketprapakorn & Kantabutra, 2019); It inspires organizations and individuals to commit to a vision of long-term sustainable development (Kantabutra & Ketprapakorn, 2020). When manufacturing organizations have strong environmental awareness and beliefs, they will strive to find greener production methods and reduce negative environmental impacts (Metz et al., 2020). Meanwhile, employees tend to support and participate in environmentally friendly actions in line with these shared values in their daily work (Azhar & Yang, 2021). A powerful organizational culture can produce positive sustainability outcomes.

Despite the importance of organizational culture to manufacturing sustainability, it is largely unclear how the intellectual landscape of these fields is structured. Bibliometric analysis has become a powerful tool to explore the research status of sustainable organizational culture in manufacturing firms. This paper explores academic literature on the topic, utilizing articles from Scopus and Web of Science (WOS) databases from 2004 to 2023. This paper portrays current research trends, subject areas, and emerging themes in the field by employing two bibliometric analysis tools, VOSviewer and CiteSpace.

Data Source and Search Strategy
Data Source
This study adopted core collections from Scopus and WOS. The reason is that both databases ensure a more comprehensive coverage of literature across various subject areas, which reduces the risk of important research missing. In addition, both Scopus and WOS are widely used academic databases. The rigorous peer review processes are employed by these databases, which ensures the credibility and academic merit of the included publications.

Data Filtering
Data filtering is a process used to refine and extract relevant data from a larger dataset based on specific criteria. Figure 1 provides a comprehensive overview of the search methodology employed, detailing the steps involved and the outcomes yielded.
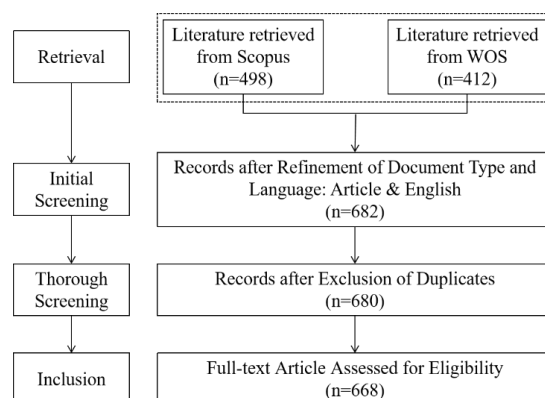

Figure 1. Flowchart of Literature Screening

The study initially employed the subject keywords "organizational culture" or "corporate culture" and "sustainable" and "manufacturing" or "industry" for the search query. The dataset comprised papers published between 2004 and 2023. Following the initial screening process, a total of 912 articles were identified. Subsequently, the literature is refined in terms of the document type and language by exclusively including Article and English. Then, the de-

duplication procedure revealed duplicate articles, resulting in a total of 680 articles for further analysis. Finally, papers exclusively addressing sustainable organizational culture in manufacturing companies were retained for further analysis, while others were manually excluded. This process led to the identification of 668 papers that met the specified criteria and were included in the bibliometric analysis.

Results and Discussion

Publications Volume Analysis

Research Trend: As evidenced by Figure 2, the trend reveals a steady increase in the number of annual and cumulative publications on sustainable organizational culture in manufacturing from 2004 to 2023. This sustained growth underscores a notable scholarly emphasis on exploring sustainable organizational culture within the manufacturing sector.
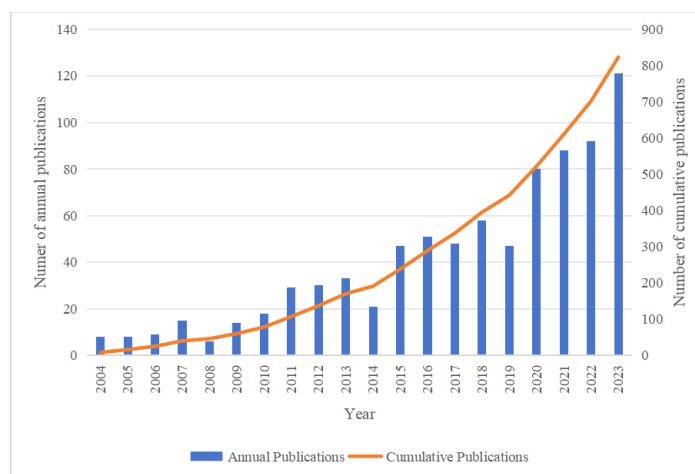

Figure 2. Distribution of Articles Over Time

However, there appears to be a reversal in this trend during the years 2008, 2014, and 2019. This anomaly could be attributed to the global financial crisis of 2008, which had a profound impact on the global economy, resulting in diminished research funding and the postponement or cancellation of research projects. Moreover, the turbulent economic environment and the evolution of manufacturing enterprises might have contributed to fluctuations in research focus and attention during these periods. The notable surge in publications observed in 2015 coincides with the establishment of the Sustainable Development Goals (SDGs).

Comparison of National Publications: Figure 3 illustrates a comparison of the number of publications across different countries, with larger circles denoting a higher volume of publications from each respective country. Among the top 10 countries contributing to research in the domain, a total of 313 articles were published. These countries include China (92), the United States (47), the United Kingdom (35), Malaysia (29), India (25), Australia (23), Pakistan (23), Italy (22), and France (17). Collectively, these nations account for approximately 47% of the world's publications in this field, indicating their pivotal role in advancing scientific knowledge. Notably, China leads with the highest number of publications, totaling 92 papers and constituting 14% of global publications, followed closely by the United States which produced less than half of China's output.
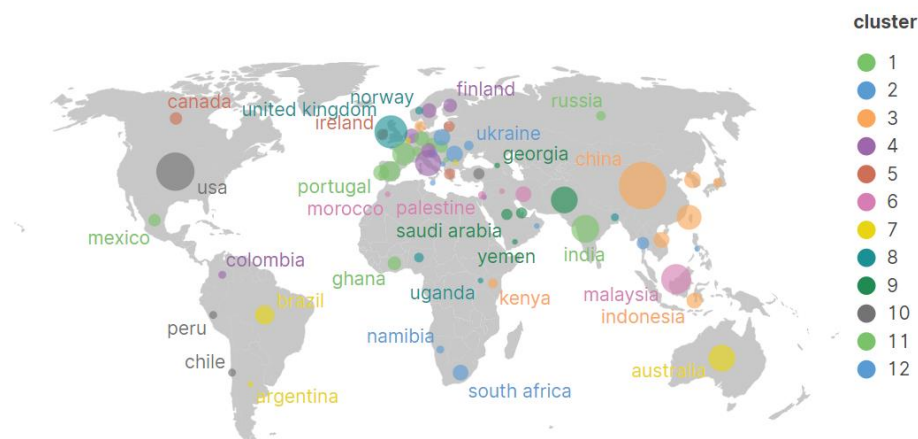
Figure 3. Distribution of Articles Over Time

The abundance of publications in China can be attributed to the global prominence of the country's manufacturing industry (Wang & Yang, 2021). However, this sector's impact on energy consumption and carbon emissions has drawn attention due to its adverse effects on the environment and progress toward Sustainable Development Goals (SDGs) (Fu et al., 2021). As a result, there is a growing body of research aimed at enhancing the sustainable development of China's manufacturing sector.

Collaboration Analysis
Author Collaboration Network: The Author collaboration mapping (Figure 4) delineates the collaborative networks. This mapping incorporates a total of 668 documents, engaging 1,461 authors, and forming 89 collaborative links.
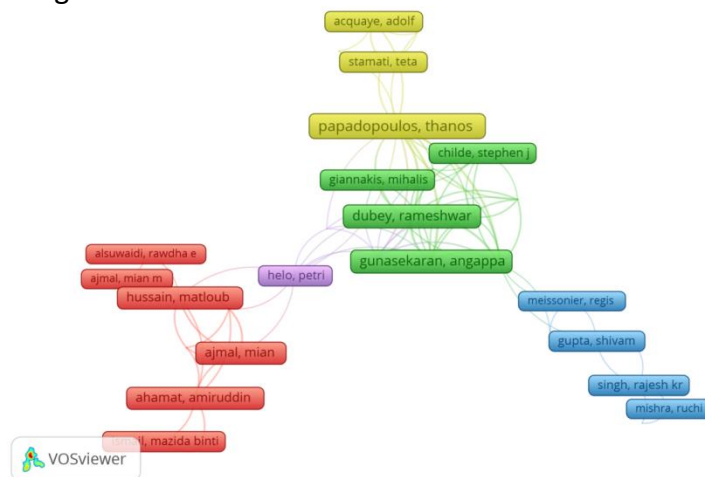

Figure 4. Visualisation of Author Cooperation Network

The calculation of core authors is based on Price's law, utilizing the formula $N = 0.749 \times \sqrt{(\eta max)}$, where ηmax represents the number of papers issued by authors with the highest number of publications. Core authors are those with a publication count $>$ N. From Table 1, it is observed that the maximum number of publications is 7. Applying Price's law, $N \approx 1.98$ was derived. Hence, authors with or above 2 papers are considered core authors, amounting to a total of 502 authors.

Table 1
List of the 8 Most Prolific Authors

Author	Current Affiliation	Documents	Citations
Papadopoulos,thanos	University of Kent	7	1176
Oo, Bee Lan	The University of New South Wales	7	68
Zhang, Qian	Chongqing University	6	63
Muhannad, Irfan	ILMA University	6	32
Dubey, Rameshwar	Montpellier Business School	5	1158
Gunasekaran, Angappa	Penn State Harrisburg	5	1158
Roubaud, David	Montpellier Business School	5	1132
Antony,Jiju	Heriot Watt University	5	136

Thanos, from the University of Kent, who is the highest published author, regularly contributes to empirical work on organizational culture for sustainability in manufacturing. Being closely associated with 15 authors, it is anticipated that collaborations with this academic would likely yield a substantial number of publications. Additionally, Rameshwar and David, scholars associated with Montpellier Business School, have also demonstrated noteworthy contributions to this field, particularly through their collaborations with Thanos.

Organization Collaboration Network: In Figure 5, the network of organization collaborations reveals the frequency of research collaborations among various institutions. With 614 institutions and 259 collaborative links, this network underscores the significant level of collaboration within the domain.
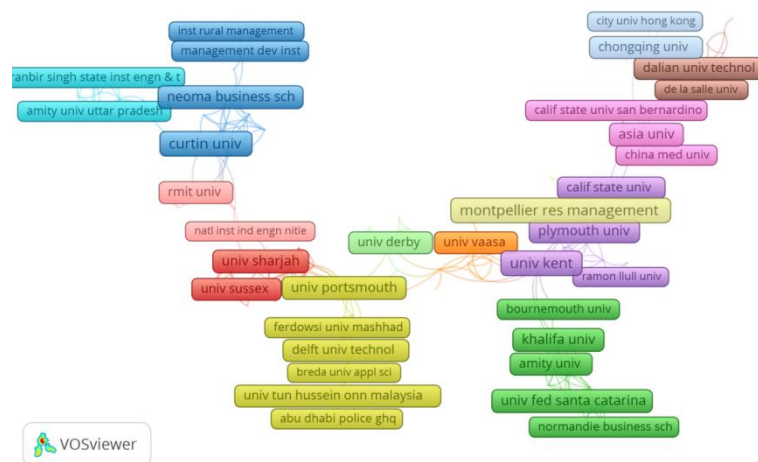

Figure 5. Visualization of Organization Cooperation Network

In terms of publication volume, The Hong Kong Polytechnic University leads the list with 6 publications, closely followed by Universiti Teknologi Malaysia and Chongqing University, each with 5 publications. Furthermore, there are 10 other institutions with 4 publications, indicating the active involvement of multiple research institutions in this field.

The University of Kent and Curtin University stand out as key hubs in the network of research collaborations, with the former having 16 links and the latter with 13 links. The shaded sections in purple and blue indicate clusters of partnerships around these institutions, highlighting their significant influence in research on sustainable organizational culture in manufacturing.

Country Collaboration Network: Figure 6 depicts the geographical distribution of countries or territories. The national collaborative network encompasses 77 node countries and 226 connections. The color partitions in the mapping signify the centrality of collaborative efforts among various countries in the research domain.
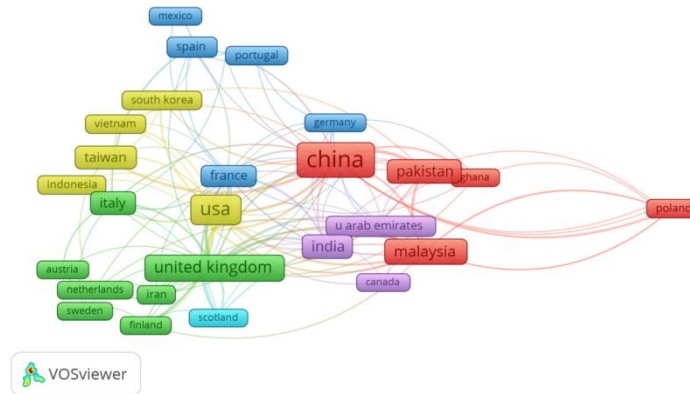

Figure 6. Visualization of Country Cooperation Network

Upon examination of the mapping, China emerges as the most collaborative country, engaging with 31 countries or regions. Following closely is the United States (28), the United Kingdom (27), and Malaysia (13). Of particular note is the substantial influence of Asian nations in inter-country collaboration.

Keyword Analysis

Keyword Co-occurrence Analysis: Figure 7 depicts a visual representation of keyword co-occurrences. A total of 2,818 keywords have co-occurred in this field over the 20 years, underscoring the breadth and diversity of research on sustainable organizational culture in manufacturing.
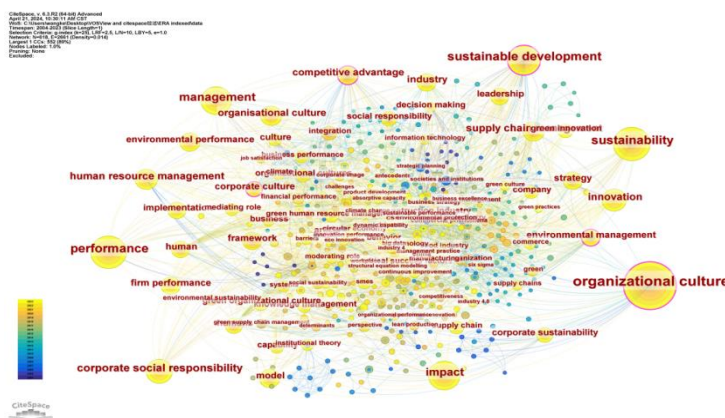

Figure 7. Visualisation of Keyword Co-occurrence

This paper identifies 21 keywords that have appeared more than 30 times, indicating their importance as core concepts or research focal points in sustainable organizational culture in manufacturing. Table 2 lists the 15 most frequent keywords that provide valuable insights into research in the field from 2004 to 2023.

The top two keywords were organizational culture and sustainability, which are consistent with the keywords used in the literature search. Hence, this result is expected. The focus of researchers on sustainable organizational culture in the manufacturing industry involves the consideration of environmental, social, and economic aspects of sustainability (Kantabutra, 2021). The third and fourth-ranked keywords, performance and sustainable development indicate that researchers are more concerned with the impact of sustainable organizational culture on organizational performance and sustainable development in the manufacturing industry (Bhuiyan et al., 2020).

Table 2
List of Top 15 Keywords Co-occurrence

Rank	Keyword	Occurrences
1	Organisational culture	235
2	Sustainability	202
3	Performance	122
4	Sustainable development	106
5	Human/humans	87
6	Management	85
7	Impact	76
8	Innovation	67
9	Leadership	41
10	Supply chain management	40
11	Industry	40
12	Competitive advantage	38
13	Culture	37
14	Model	36
15	Framework	35

The keyword human reflects the researchers' focus on the role of human resource management and employee engagement in sustainable organizational culture in manufacturing (Baydeniz & Kart, 2024). Moreover, the keyword leadership reflects the role of leaders in shaping organizational culture and sustainability initiatives in the field (Kiesnere & Baumgartner, 2019). The keyword supply chain management indicates the integration of sustainable organizational culture throughout the supply chain to enhance sustainability in organizational management practices. Furthermore, the keywords innovation and competitive advantage demonstrate that scholars have emphasized the competitive advantage gained through innovative practices to improve sustainable performance within manufacturing (Xiaoyi et al., 2023).

Keywords such as model and framework emphasize the importance of theory and methodology in the study of sustainable organizational culture in manufacturing. By developing appropriate models and frameworks, researchers can better understand the characteristics of organizational culture in manufacturing and explore the impact of organizational culture on sustainability in manufacturing. These efforts provide a theoretical foundation and methodological guidance for advancing research in this area.

Keyword Clustering Analysis: Figure 8 shows the arrangement of keywords into clusters based on their frequency and semantic relationships. The clusters are labeled according to the number of keywords they contain. In general, a Q-value (Modularity) of more than 0.3 indicates a meaningful modular division, while an S-value (Silhouette) of more than 0.7 indicates a strong clustering effect (Chen, 2017).

A Q value of 0.578 and an S value of 0.8281 are in the clustering map in Figure 8, indicating a considerable level of confidence in the generated clusters and demonstrating that the clustering scheme is representative of the research direction. Statistical information related to the clustering modules is listed in Table 3. The size parameter indicates the number of articles in each cluster. Silhouette values are used to measure how consistent keyword clustering is. Top terms (LSI) show the main themes of each clustering module. Notably, all clusters demonstrated a commendable clustering effect, affirming the reliability of the clustering analysis.
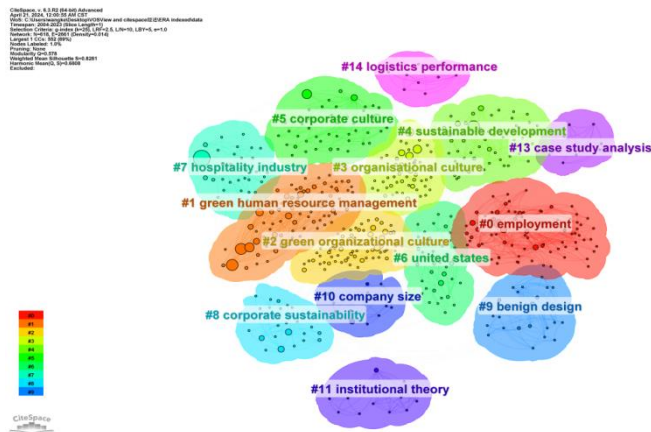

Figure 8. Visualization of Keyword Clustering

Table 3
Summary of Keyword Clustering

Cluster ID	Size	Silhouette	Mean(Year)	Top terms(LSI)
0	83	0.844	2014	Green culture; Green innovation; Corporate social responsibility; Green behavior; Environmental performance; Human factors; Ocupational health; Risk perception; Safety behavior
1	81	0.716	2016	Environmental performance; Green human resource management; Green organizational culture; Parallel mediation; Cumulative prospect theory; Organizational culture; Operational performance; Occupational health; Design science; Graph theory matrix approach
2	65	0.726	2015	Organizational culture; Human resource management; Environmental management; Case analysis; Hotel industry; Green organizational culture; Firm performance; Green training; NRBV; Green supply chain management
3	53	0.754	2017	Organisational culture; RBV; Sustainable competitive advantage; Partial Least Squares; Digital organizational culture; Corporate social responsibility; Digital organizational culture; Gas industry; Closed-loop supply chain; Chemical industry
4	52	0.858	2010	Sustainable development; Structural Equation Modeling; Mediating effect; RBV; Stakeholder theory; Organizational culture; Institutional Theory; Sustainable operations; Sustainability measurements; Performance measurement systems
5	47	0.912	2012	Corporate culture; Sustainable development; Benefit corporation; In depth; Data analysis; Corporate image; Sustainable production; Green marketing; Brand image; Construction firms
6	42	0.858	2018	Social sustainability; Environmental sustainability; Supply chains; Lean production; Organizational change; Organizational culture; Artificial intelligence; Big data analytics capabilities; Management accountant; Organizational innovation performance
7	35	0.885	2012	Organizational culture; Hospitality industry; New zealand; Scale development; Social capital; Food industry; Sustainable development; Supply chain management; Animal husbandry; Social capital
8	26	0.878	2015	Corporate sustainability; Responsible consumption; Fuzzy Interpretive Structural Modeling; Bottom line; Health care industry; Organizational culture; Strategic sustainable development; Mining industry; Health care industry; Responsible consumption
9	25	0.909	2015	Energy-saving factors; Fashion industry; Sustainable fashion; Product design scenario; Business sustainability; Benign design; Product development; Green toxicology; Business sustainability; Organization culture
10	13	0.939	2019	Performance evaluation; RBV; Hierarchical model; Fuzzy synthetic method-dematel; Corporate sustainability; Flexibility-control orientation; Competitor pressure; Customer pressure; Corporate environmental proactivity; Portal site
11	13	0.992	2010	Institutional Theory; Sustainable business; Institutional change; Green building movement; Individual biases; Stewardship theory; GSC initiatives; Electronics industries; Green supply chain initiatives; Bootstrapping procedures
13	9	0.967	2017	Influencing factors; Logistics service providers; Environmental sustainability practices; Case study analysis; Environmental strategy
14	8	1	2014	Logistics performance; Market orientation; Green purchasing; Market-oriented sustainability; Partial Least Squares

Table 3 provides a summary of the 15 clusters identified, uncovering different investigative themes. Combining these discoveries with those from Figure 8 reveals the comprehensive focus of researchers on various dimensions of sustainable organizational culture in manufacturing, from internal corporate culture to external environmental management.

The combination of keywords in the clustering, such as Resource-Based View (RBV), environmental performance, and competitive advantage, highlights the dual focus on theoretical foundations and empirical research. This demonstrates the researchers' commitment to integrating theory and practice to provide a theoretical framework and practical guidance for advancing sustainable development initiatives in the manufacturing sector.

In addition, the clustering results involve keywords from a variety of disciplines such as sociology, economics, and management, indicating the interdisciplinary nature of sustainable organizational culture in manufacturing. This requires the integration of multidisciplinary theories and methods to comprehensively address relevant issues and provide multifaceted perspectives and solutions to sustainability challenges.

The presence of industry-specific keywords in the clusters (e.g. hospitality and food) suggests that researchers examining sustainable organizational cultures in manufacturing have recognized unique industry characteristics. They aim to develop tailored solutions and management strategies based on industry-specific practices.

Keyword Burst Detection Analysis: The findings of keyword bursting analysis for research on sustainable organizational culture in manufacturing from 2004 to 2023 revealed 10 keywords that experienced significant increases in frequency. As shown in Table 4, these keywords emerged across various periods, from 2006 to 2023, indicating significant changes and trends within the field over the past two decades.

Table 4
Top 10 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2004–2023
Societies and institutions	2006	4.62	2006	2007	
Strategic planning	2006	3.96	2006	2007	
Organization	2009	4.46	2009	2015	
Corporate culture	2006	3.74	2010	2016	
Social responsibility	2015	3.59	2015	2018	
Competitive advantage	2007	3.97	2018	2019	
Environmental sustainability	2014	3.35	2019	2021	
Green	2020	3.39	2020	2023	
Organisational culture	2017	3.06	2020	2021	
Technology	2021	4.13	2021	2023	

As depicted in Table 4, early studies focused on keywords like societies and institutions, and strategic planning, which emphasizes researchers' attention to factors influencing manufacturing organizational culture (Liu et al., 2010). Over time, keywords such as social responsibility, competitive advantage, and environmental sustainability emerged. This suggests that researchers are increasingly concerned about the correlation between Corporate Social Responsibility (CSR) and competitive advantage, as well as environmental sustainability (Herrera Madueño et al., 2016).

Notably, the appearance of keywords like green and technology signaled the emergence of new research directions. In recent years, scholars have shown considerable interest in the implementation of green technologies to enhance sustainability in manufacturing (Forés, 2019). There is a growing exploration into the impact of technological innovation on CSR practices and environmentally sustainable approaches (Madaleno et al., 2022; Vacchi et al., 2021). These emerging keywords depict the trends in the field of sustainable organizational culture in manufacturing.

Conclusions
This study investigates sustainable organizational culture in manufacturing from 2004 to 2023. VOSViewer and CiteSpace software were used for bibliometric analysis. The analysis of publication volume shows a rising interest in this field of research. Collaboration analysis

uncovers patterns of teamwork among authors, institutions, and countries. Keyword analysis points out key themes and suggests directions for future research. The study proposes to combine theories and methods from different disciplines to gain a comprehensive understanding of sustainable organizational culture based on industry-specific practices. It also suggests emphasizing the interaction between green technology innovation and organizational culture, along with their roles in human resource management and supply chain management practices. These recommendations aim to guide future research and practical efforts in the field.

Limitations

Several limitations are acknowledged in this study. Firstly, the investigation is confined to literature from the Scopus and WOS databases, potentially introducing biases. The quality of the analyses may also be influenced by data accuracy. Additionally, due to the broad scope of sustainable organizational culture in manufacturing, not all relevant facets could be comprehensively covered, potentially leading to omissions in the analyses. Furthermore, the study relies solely on bibliometric analysis, lacking empirical data and case studies. Future research could incorporate qualitative methods to explore practical experiences and the impact of sustainable organizational culture on firm performance and sustainable development in manufacturing.

Acknowledgments

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