Research on Bibliometric Approaches: Sustainable Development, Textile Industry, and Technology

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Abstracts

This work presents a bibliometric study on the relation between technology, textile industry, and sustainable development, using Scopus as the platform. The aim of this study is to describe the scientific performance in these fields by identifying the most relevant themes from these areas, leading writers, countries, and journals. The bibliometric analysis was facilitated using tools such as R and VOS VIEWER for network visualisation and assessing scientific productivity. In these library science studies Bradford's rule is used to filter out the most influential journals, and Lotka's law is used to study the output of authors. Among the results, an annual growth of 10.58% stands out in publications on these topics between 2014 and 2024, with China leading scientific production, followed by India and Italy. Likewise, the Journal of Cleaner Production was found to be the most relevant source in this field. Keyword co-occurrence analysis revealed that terms such as “circular economy,” “natural fibers,” and “innovation” are prominent in the research. Regarding the conclusions, the growing relevance of sustainable development in the textile industry and the need to continue investigating the technological implications to promote more sustainable practices are highlighted.

Keywords: Sustainable development, Textile industry, Clothing sector, Technology, Innovation, Bibliometrics.

1. Introduction

The textile industry is one of the most polluting industries in the world, accounting for 20% of all commercial water pollution (Tyagi & Singh, 2023). Thus, in recent years, attempts have been made to establish various techniques that incorporate sustainability through technology. As a result, a recent study indicates a significant increase related to the rise of sustainability in the textile industry (Islam et al., 2014, cited in Sardar et al., 2022). Such research has focused on the search for innovative practices that aim to achieve sustainability, such as eco-design, cleaner production, and corporate innovations that investigate environmental management systems (Harsanto et al., 2023), which have relevance to each of the ecosystems in which textile activity occurs (Sardar et al., 2022).

The textile industry has been identified as one of the most polluting sectors in the world, as its operations require excessive water and chemicals, resulting in textile effluents that are not properly treated and controlled. The supply chain for the textile sector is extremely polluted, especially during the dyeing process, which produces 33% of effluents since it uses dangerous chemicals like lead, sulfur, and ammonia (Conde Miranda et al., 2024).Twenty percent of the wastewater produced worldwide is attributed to the fashion industry, according to the UN (Bailey et al., 2022). The implementation of the regenerative redox system, which has been demonstrated to be 79% efficient, has resulted in an 80% reduction in water use (Abdelileh et al., 2020). Therefore, the use of Fe-weakened TiO2 photocatalysts, which have shown remarkable efficacy in treating textile effluent, has been suggested (Mahadadalkar et al., 2023).

According to various writers, electrocoagulation, along with electrochemical oxidation, is one of the most successful strategies for pollutant removal (GilPavas et al., 2020). Even natural coagulants like cactus are recommended to help remove color and other pollutants (Azanaw et al., 2022). Given that yarn, dyeing increases the overall water footprint by 27.96% (Hossain & Khan, 2020). Furthermore, enzymes, fungi, and algae are thought to have the ability to remove dyes from wastewater; however, their efficacy is dependent on the species utilized (Al-Tohamy et al., 2022).

Given the aforementioned, it is presumed that in the current scenario, the textile sector has been acting as an entity that occupies a significant share of the primary sources of industrial pollution worldwide, while pushing environmental problems as an important issue all over the world. It should be said that sustainable fashion is defined as the act of not wasting resources in the different stages that are part of the production, sourcing, and consumption of the products derived from it (Mesjar et al., 2023). One potential strategy is to employ natural indigo as a more viable and sustainable choice for the textile supply chain because it is renewable and non-toxic (Kabish et al., 2023). Sustainably managing this chain in the fast fashion business is timely for addressing the climate issue (Wren, 2022; Hasanbeigi & Price, 2012, as quoted in Sardar et al., 2022).

However, as an ecologically friendly substitute for synthetic dyes, the use of natural dyes is becoming more and more common in the business. Fruit-derived ones, including Syzygium cumini, are currently being investigated because of their sustainability and low health risk (Periyasamy et al., 2022). To ensure their supply and continuance, additional study is necessary (Junita et al., 2024).

The careful selection of sustainable clothing providers is growing together with the application of fuzzy mathematics and integral approaches. Thus, electro-Fenton removal of textile colors is more than 97% efficient at removing organic pollutants (Afanga et al., 2020). This demonstrates that Keggin complexes and aided ultrafiltration are an effective approach for removing heavy metals from industrial effluents (Kahloul et al., 2022).

Furthermore, fast fashion has led to a rise in apparel consumption, which has had a huge impact on the worldwide economy. As a result, it is critical to prioritize efforts to establish a circular economy in textile waste management. The disposal of synthetic dyes presents a significant challenge (Fobiri, 2022). However, immobilization is a novel technique for removing reactive

dyes and Cu2+ ions from wastewater (Ahmed et al., 2023). New best practice procedures would be required to decrease pollutants in the textile industry (Kim et al., 2022).

Meanwhile, although articles combining Big Data approaches with unstructured data, such as online reviews from users of specific platforms are scarce (Serrano et al. (2020), it has been proposed to carry out the application of Industry 4.0 technologies, specifically Big Data, to improve decision making and operational efficiency in textile manufacturing (Araque González et al., 2022), as the circular economy approach has most likely been suggested to mitigate high textile waste through reuse, recycling, incineration and safe disposal (Shirvanimoghaddam et al., 2020). Moreover, the present sustainable textile manufacturing has been confronted with the facility that cutting-edge technologies such as nanotechnology, enzymatic processing, ultrasonic treatments, ozone bleaching for cotton fabrics, and electrochemical dyeing have provided (Tyagi & Singh, 2023).

In turn, the technologies adopted during the fourth industrial revolution for use in the fashion industry, for example, were intended to solve three major problems: increasing sector productivity, establishing a sustainable environment, and increasing hyper-personalization (Jin & Shin, 2021). Adopting technology has helped the textile and jewelry sectors meet various market demands while also sustaining the fashion industry. Online marketing methods have gained traction in businesses to help sustain the fashion sector as a result of digitization (Kwame Fobiri et al., 2024).

Furthermore, it is noted that people perceive the benefits of Industry 4.0 through its implementation; for example, energy consumption has been reduced by 15%, work efficiency has increased by up to 25%, and decision-making has become more assertive (Hoque et al., 2021). The country's adaptability to new technology has been modest, whereas other areas of industrialization have seen rapid progress (CNI - Confederação Nacional do Indústria, 2020). In different countries, certain strategic actions have been developed, since the adoption rate represents 29% for this sector, which shows that it is an environment that urgently needs studies on the subject (Hoque et al., 2021).

Finally, it should be highlighted that the key components of Industry 4.0 recognized in the textile industry are mostly concerned with computerization and automation, implying that the goal is to boost productivity while drastically lowering operational costs (Dal Forno, 2021).

2. MATERIALS AND METHODS

The frequency and applicability of publications on technology, the textile sector, and sustainable development are investigated using the empirical model for this bibliometric study. Because of its wide coverage and comprehensive indexing of high-quality scientific articles, the Scopus database was the main source of information for the research, which was conducted utilizing a systematic literature analysis (Borre et al., 2023). The search was conducted in September 2024, utilizing key terms relevant to the study themes.

The bibliometric data taken from Scopus was managed and analyzed using the R and VOS VIEWER tools, which are recognized for their network visualization and analysis capabilities

(Ramírez et al., 2023). Researchers were able to describe the scientific output in this discipline by identifying key trends, well-known authors, production by nation, and the most influential institutions thanks to the descriptive documentary research approach. This method made it possible to assess measures including author collaboration trends, document categories, and publishing growth rates (Wang, 2024).

Additionally, Bradford's law was utilized to identify the most significant journals in the field of research, Lotka's rule was utilized to evaluate author productivity, and trends in scientific contribution were identified (Tunga, 2021). To ascertain the influence and visibility of research in the fields of sustainable development, textiles, and technology, important variables including source relevance, author affiliations, and citation patterns were also investigated (Aria et al., 2020).

Table 1 Keywords standardization

Variable	Descriptor
Sustainable development	"sustainable development" "sustainable growth" "green development"
Textile industry	"textile industry" "textile production" "fabric industry" "clothing sector"
Technology	"Technology" "technological development" "Innovation"

Source: Authors (2024).

Based on identifying these elements, the following search equation is provided in the Scopus database: (TITLE (sustainable AND development) OR TITLE-ABS-KEY (sustainable AND growth) OR TITLE-ABS-KEY (green AND development) OR TITLE-ABS-KEY (sustainable AND growth) AND TITLE-ABS-KEY (textile AND industry) OR TITLE-ABS-KEY (textile AND production) OR TITLE-ABS-KEY (fabric AND industry) OR TITLE-ABS-KEY (clothing AND sector) AND TITLE-ABS-KEY (technology) OR TITLE-ABS-KEY (technological AND development) OR TITLE-ABS-KEY (innovation)) AND PUBYEAR > 2013 AND PUBYEAR < 2025

3. RESULTS

Table 2. Main information of the data obtained from Scopus

MAIN INFORMATION ABOUT DATA	
Timespan	2014:2024
Sources (Journals, Books, etc)	338
Documents	549
Annual Growth Rate %	10.58
Document Average Age	3.36
Average citations per doc	17.41
References	33198

DOCUMENT CONTENTS	
Keywords Plus (ID)	3868
Author's Keywords (DE)	1834
AUTHORS	
Authors	1760
Authors of single-authored docs	66
AUTHORS COLLABORATION	
Single-authored docs	68
Co-Authors per Doc	3.73
International co-authorships %	18.03
DOCUMENT TYPES	
article	264
book	13
book chapter	83
conference paper	72
conference review	24
erratum	1
letter	1
note	1
review	90

Source: Authors (2024)

The preceding table (table 2) identifies the general aspects linked with the scientific production of the field of knowledge, where there has been a 10.58% increase in recent years, in a total of 549 sources with 1760 authors participating in these publications. Figure 1 shows the growth of scientific production more clearly; the years 2024 (82), 2023 (119), and 2022 (86) stand out as having the highest yearly production.

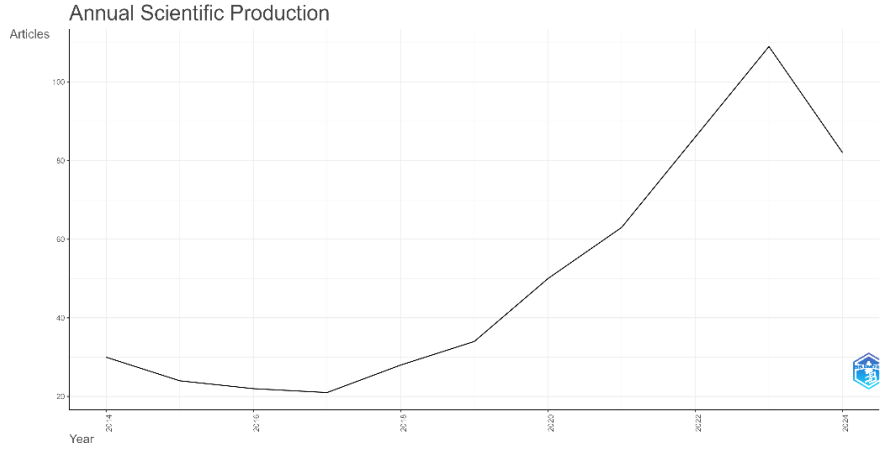

Figure 1. Annual scientific production, Source: Authors (2024).

Laws of bibliometric productivity

Lotka's law allows us to map the production curve on the number of authors to more clearly understand their impact in the field of knowledge (Junior et al., 2023). Table 3 reveals that 90% of the authors have made a single contribution, 7.1% have provided a minimum of two, and 1.3% have contributed at least three publications.

Table 3:Lotka's Law

Documents written	N. of Authors	Proportion of Authors
1	1585	0.901
2	125	0.071
3	23	0.013
4	12	0.007
5	8	0.005
6	1	0.001
7	2	0.001
8	2	0.001
9	1	0.001
10	1	0.001

Source: Authors (2024).

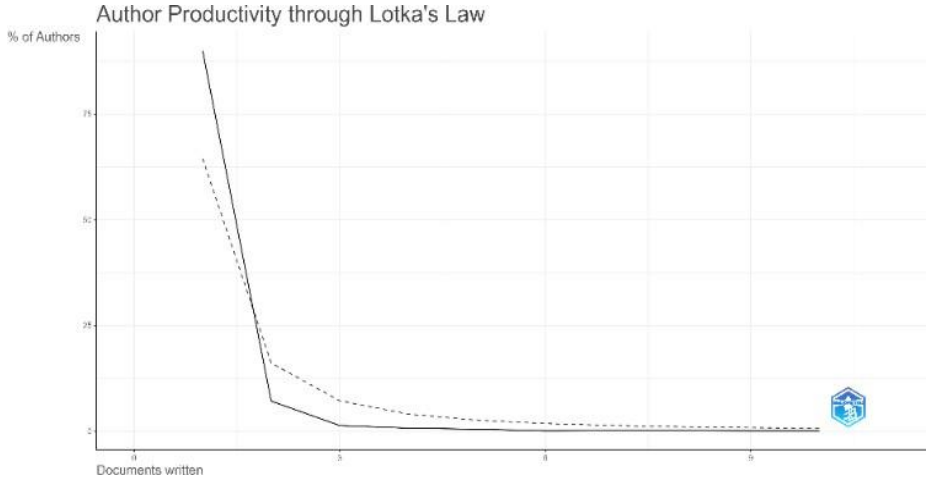

Figure 2: Lotka's Law, Source: Authors (2024).

The most relevant sources are displayed based on the frequency of publishing on the topic and the percentiles determined by Bradford's Law; this law divides journals into three performance zones, each with a growing number of journals plus a corresponding proportion of articles (Sudhier, 2020). Table 4 provides the percentages for each Bradford's Law Zone. Zones 1 and 2 had the same percentage of publications (33.51%), with 184 titles in 25 and 132 journals, respectively. Figure 3 depicts the most representative journals based on this law.

Table 4: Bradford's Law.

Zone	No. Magazines	No. Titles	Percentages
Zone 1	25	184	33,51%
Zone 2	132	184	33,51%
Zone 3	181	181	32,97%

Source: Authors (2024).

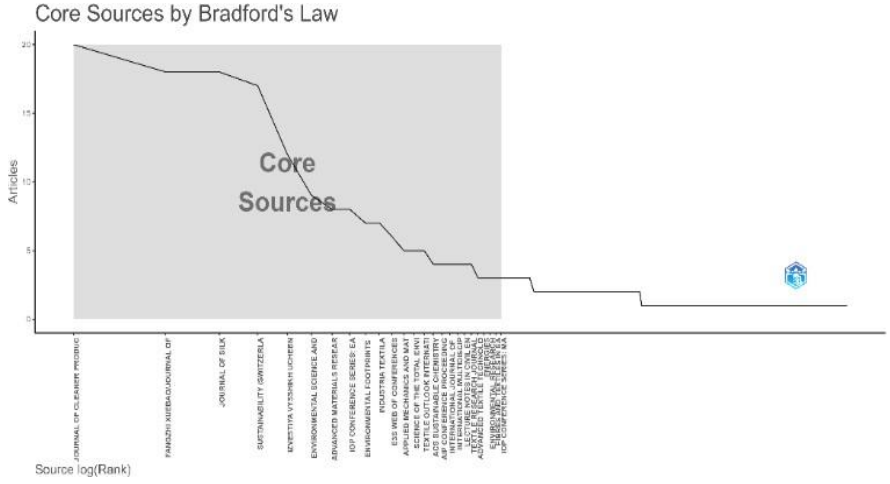

Figure 3: Bradford's Law, Source: Authors (2024).

Bibliometric indicators

Table 5 reveals that the Journal of Cleaner Production leads the region with 20 publications, followed by Fangzhi Xuebao with 18 publications, and finally the Journal of Silk with 18 publications, as previously stated.

Table 5: Most relevant sources.

Sources	Articles
JOURNAL OF CLEANER PRODUCTION	20
FANGZHI XUEBAO/JOURNAL OF TEXTILE RESEARCH	18
JOURNAL OF SILK	18
SUSTAINABILITY (SWITZERLAND)	17
IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENII, SERIYA TEKNOLOGIYA TEKSTIL'NOI PROMYSHLENNOSTI	12
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH	9
ADVANCED MATERIALS RESEARCH	8
IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE	8
ENVIRONMENTAL FOOTPRINTS AND ECO-DESIGN OF PRODUCTS AND PROCESSES	7
INDUSTRIA TEXTILA	7

Source: Authors (2024).

On the other hand, the bibliometric analysis results, depicted in Figure 4, indicate a comparison of scientific paper production across countries with the most publications. China dominates this production with 634 documents, followed by India with 332 and Italy with 84. Some countries, such as Pakistan and Romania, the United States, the United Kingdom, Portugal, Brazil, and Spain, produce significantly less than the former.

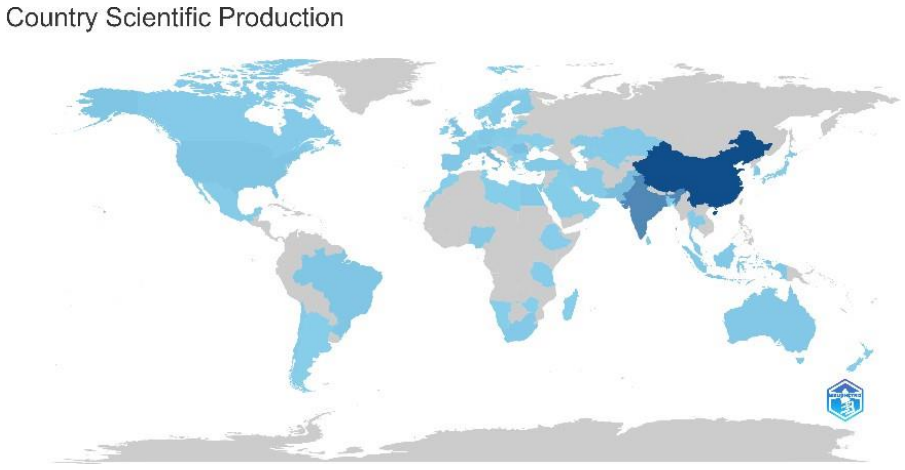

Figure 4: Scientific Production By Country, Source: Authors (2024).

Following this order of ideas, Figure 5 depicts the institutions that have made the most contributions to the subject of study: Donghua University (78 contributions), Wuhan Textile University (45 contributions), and Jiangnan University (26 contributions); these institutions account for 27.14% of the total number of articles.

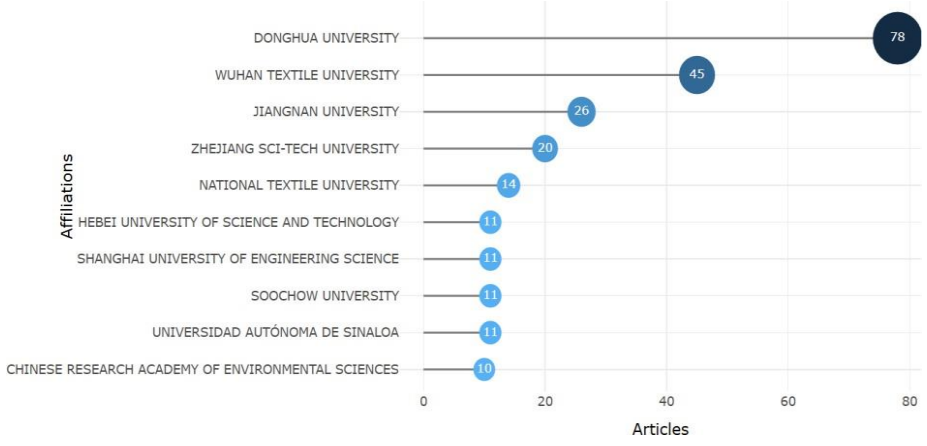

Figure 5: Most Relevant Affiliations, Source: Authors (2024).

In another order of ideas, the frequency index is used to assess productivity per researcher, as shown in Figure 6, where Zhang Y S leads with ten (10) contributions, followed by Wang Y and Liu Y with nine (9) and eight (8) contributions, respectively.

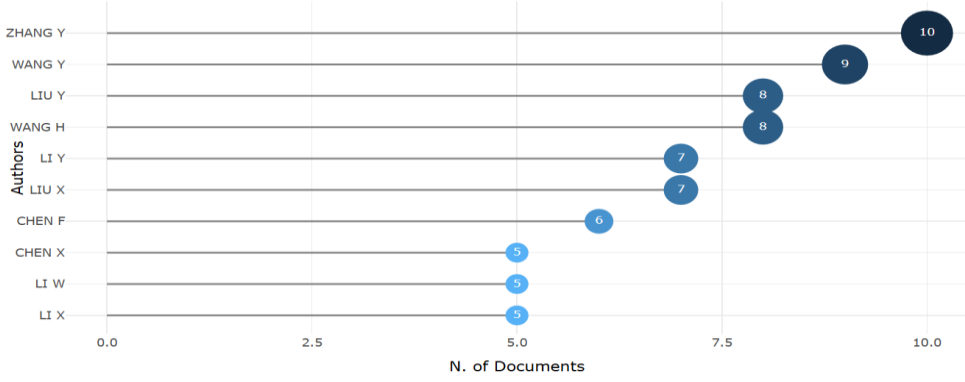

Figure 6: Most Relevant Authors, Source: Authors (2024).

To conclude, Table 6 shows the twenty articles related to the topic of study with the most citations; the three most representatives are RAFIQ A, 2021, J IND ENG CHEM, with 631 citations in total, in second place, SARAVANAN A, 2021, CHEMOSPHERE, with 525 citations and lastly FRANCO MA, 2017, J CLEAN PROD with a total of 294 citations.

Table 6: Most cited articles.

Articles	DOI	Total Citations	TC per Year	Normalized TC
RAFIQ A, 2021, J IND ENG CHEM	10.1016/j.jiec.2021.02.017	631	157.75	14.59
SARAVANAN A, 2021, CHEMOSPHERE	10.1016/j.chemosphere.2021.130595	525	131.25	12.14
FRANCO MA, 2017, J CLEAN PROD	10.1016/j.jclepro.2017.09.056	294	36.75	9.20
DE CAROLIS A, 2017, IFIP ADVANCES IN INFORMATION AND COMMUNICATION TECHNOLOGY	10.1007/978-3-319-66923-6_2	232	29.00	7.26
FANG Y, 2021, CHEM SOC REV	10.1039/d1cs00003a	213	53.25	4.93
D'AMATO D, 2020, FOR POLICY ECON	10.1016/j.forpol.2018.12.004	210	42.00	5.89
SHEN B, 2014, SUSTAINABILITY	10.3390/su6096236	200	18.18	10.51
BEHERA M, 2021, J ENVIRON CHEM ENG	10.1016/j.jece.2021.105277	175	43.75	4.05
DE OLIVEIRA NETO GC, 2019, J CLEAN PROD	10.1016/j.jclepro.2019.04.334	175	29.17	6.52
LU Z, 2015, J COLLOID INTERFACE SCI	10.1016/j.jcis.2015.04.015	168	16.80	6.17

PAKDEL E, 2021, RESOUR CONSERV RECYCLE	10.1016/j.resconrec.2020.105340	166	41.50	3.84
KUMAR R, 2020, SCI TOTAL ENVIRON	10.1016/j.scitotenv.2019.134169	144	28.80	4.04
AHMAD A, 2020, ENVIRON TECHNOL INNOVATE	10.1016/j.eti.2020.101138	140	28.00	3.92
JIANG X, 2020, J BIORES BIOPROD	10.1016/j.jobab.2020.03.002	131	26.20	3.67
DAS P, 2020, ACS APPL NANO MAT	10.1021/acsanm.0c02305	130	26.00	3.64
NWANYA AC, 2019, J HAZARD MATER	10.1016/j.jhazmat.2019.05.004	122	20.33	4.55
KOUHI M, 2020, TRENDS FOOD SCI TECHNOL	10.1016/j.tifs.2020.05.025	118	23.60	3.31
DISSANAYAKE G, 2015, RESOUR CONSERV RECYCLE	10.1016/j.resconrec.2015.09.008	110	11.00	4.04
SHARMA S, 2021, J CLEAN PROD	10.1016/j.jclepro.2021.127039	108	27.00	2.50
ISLAM S-U, 2015, ACS SUSTAINABLE CHEM ENG	10.1021/acssuschemeng.5b00537	106	10.60	3.90

Source: Authors (2024)

Relationship and co-occurrence analysis

Finally, the cluster analysis through VOS VIEWER, figure 7, reveals the terms with the highest impact grouped by co-occurrence, where keywords such as 'Textiles', 'Textile industry', 'Circular economy', 'Natural fibers', 'Innovation', and 'Economic and social effects' are several of the key terms associated with the knowledge area of 'Sustainable development, textile industry, and technology'.

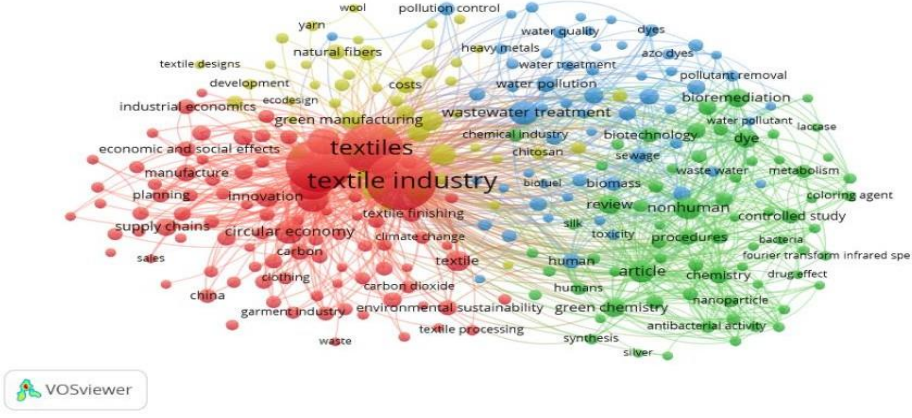

Figure 7: Co-occurrence of Keywords, Source: Authors (2024).

4. CONCLUSIONS

Scientific production is critical in many fields of research; yet, it is well known that in the area of sustainable development, the textile industry and technology remain limited. The extensive bibliometric research revealed that the authors who have so far undertaken the work of publishing on these themes have not contributed more than once. This is concerning, given that research has shown that it is critical to conduct studies that set the groundwork for the conscious exercise that arises from global textile production. This is because the textile sector has a significant role in the release of vast quantities of greenhouse gases, hazardous chemicals, and other pollutants into the environment, with obvious environmental and health repercussions.

In turn, the Journal of Cleaner Production leads the thematic axis with the most publications. This is significant because it demonstrates a greater interest in conducting a series of studies that stem from the need to share new and improved experiences that promote the sustainable use of resources in textile industry activities in various countries around the world. It should be noted that environmental sustainability includes measures such as material conservation, methods for their efficient use, recycling, and the preference for those with lower toxicity.

As a result, the number of citations for this form of material has increased significantly beginning in 2021. Thus, there is a need to continue working to demonstrate that energy efficiency evaluations and textile industry technologies are an ideal combination for improving sustainability and reducing energy consumption. This could lead to the development of initiatives that address the fashion industry's failures to date.

Finally, this sector can reduce its environmental impact by investing in more sustainable materials and production methods, such as using renewable energy sources, ecologically friendly fabrics, and byproducts of the manufacturing process. However, for this to happen, fresh research must be released that demonstrates highly impressive efforts, which will inspire others to continue the task of discovering creative strategies that are satisfying for the textile sector, including sustainable development and technology.

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