International Journal of Mechanical and Sustainability Engineering Technology

Journal homepage:
https://uniexpertsacademy.com/index.php/IJMSET/index
ISSN: 3083-8363

A Bibliometric Review of Local Exhaust Ventilation (LEV) Culture Studies

Mohamad Farid Bin Sies [1,*], Jamiluddin Bin Jaafar [1], Norzelawati binti Asmuin [1], Winardi Sani [2]

[1] Faculty of Mechanical Engineering & Manufacturing, University Tun Hussein Onn Malaysia, 86400, Batu Pahat, Johor
[2] Universitas Sangga Buana YPKP, Bandung, Indonesia

ARTICLE INFO

Article history:
Received 09 August 2024
Received in revised form 17 September 2024
Accepted 26 September 2024
Available online 30 September 2024

Keywords:
Local Exhaust Ventilation; Bibliometric Analysis; Occupational Health and Safety; Research Trends; Co-citation Network; Author Productivity;

ABSTRACT

Local exhaust ventilation (LEV) systems are critical in maintaining air quality and ensuring safety in industrial and laboratory settings. However, a comprehensive review article needs to be published covering all aspects of local exhaust ventilation (LEV) research. This study presents a comprehensive bibliometric analysis of LEV research from 2020 to 2024, aiming to elucidate the current state, trends, and collaborative patterns in this field. Utilising the Scopus database, we employed various bibliometric techniques, including temporal analysis, author productivity assessment, subject classification, citation analysis, keyword co-occurrence, co-authorship network analysis, and co-citation network mapping. The results reveal a fluctuating publication trend, with a peak of 67 publications in 2022 and a decline in subsequent years. Engineering, Environmental Science, and Medicine emerged as the dominant subject areas, collectively accounting for 52.2% of the publications. The analysis identified key contributors, with Logachev, K.I., Averkova, O.A., and Wang, Y. as the most productive authors. Geographically, the United States, China, and the Russian Federation led in research output. Keyword analysis focused on specific industrial contexts, such as construction, welding, and occupational exposure concerns. Co-authorship network analysis revealed solid international collaborations, while co-citation mapping identified influential authors and research clusters. This study provides valuable insights into the interdisciplinary nature of LEV research, its key contributors, and collaborative networks. The findings can guide future research directions, resource allocation, and policy formulation to enhance occupational health and safety through effective LEV system implementation.

1. Introduction

Local exhaust ventilation (LEV) systems are important for keeping the air clean and ensuring everyone stays safe in industrial settings and laboratories. These systems are made to trap and get rid of bad stuff right where it starts, stopping anything harmful from spreading around. For instance, in industrial applications, LEV systems have been shown to significantly improve local air quality by capturing exhaled pollutants and enhancing the effectiveness of displacement ventilation, which can increase the regional air quality index by up to 35% near the source of contamination [1].

* *Corresponding author.*
E-mail address: norzela@uthm.edu.my

https://doi.org/10.37934/IJMSET.1.1.121

Research on local exhaust ventilation (LEV) systems has a rich history, focusing on various aspects such as contaminant capture efficiency, airflow dynamics, and practical applications in different settings. The efficacy of LEV systems in industrial applications, particularly in mitigating the spread of exhaled pollutants, has been demonstrated through experiments combining these systems with mixing and displacement ventilation, showing significant improvements in local air quality and ventilation effectiveness in the breathing zone[1]. Zdilla's study highlights the development of cost-effective and efficient local exhaust systems for gross anatomy laboratories, emphasising the removal of airborne formaldehyde and other volatile organic compounds while maintaining low noise levels and affordability [2]. Logachev et al. contribute to understanding airflow dynamics around local exhaust devices by developing a discrete mathematical model for three-dimensional airflow at the inlet of a rectangular exhaust duct. Their findings help optimise the design of exhaust hoods to reduce local resistance, improve acoustic properties, and enhance contaminant capture efficiency [3].

Bibliometric analysis is a great quantitative method that helps us map scientific information and analyse research trends, patterns, and structures within a specific field. This approach systematically examines published literature to identify influential sources, contributors, and emerging research directions [4]. A bibliometric analysis of local exhaust ventilation systems reveals a multifaceted approach to improving air quality and safety in various environments.

A review of the existing research on local exhaust ventilation (LEV) is imperative to give researchers a thorough comprehension of the present state, focal points of research, and upcoming directions in the realm of local exhaust ventilation. For example, the technical aspects of LEV systems involve several key components and considerations. Firstly, accurate data on the velocity field around local exhaust devices is essential for effective contaminant removal. This consists of developing discrete mathematical models to trace the flow separation surface and determine axial airflow velocity, as demonstrated in the study of a rectangular exhaust duct [3]. In educational environments, such as gross anatomy laboratories, LEV systems are essential for removing harmful airborne chemicals like formaldehyde. Effective systems can be built inexpensively and quickly, providing robust exhaust flow and minimal noise, thereby improving laboratory health and safety [2]. In industrial settings dealing with explosive harmful substances, LEV systems must ensure effective localisation, suction, and transportation of contaminants. Using gas ejectors in these systems can enhance the purification and recirculation of air, meeting stringent safety and environmental standards [5]. However, there is currently no comprehensive review article that covers all aspects of local exhaust ventilation.

Therefore, this paper employs VOSviewer to visually analyse local exhaust ventilation research literature from 2020 to 2024, as documented in the Scopus databases. The results of this visual analysis are combined with the selection of significant literature. Based on the literature, the research question (RQ) will be answered in this review paper:

RQ1: What are the research trends in Local Exhaust Ventilation studies according to the year of publication?

RQ2: Who writes the most significant number of articles?

RQ3: What is the type of document by subject of research?

RQ4: Who writes the most-cited articles? And where do they work?

RQ5: What are the popular keywords related to the study?

RQ6: What are the collaborations of co-authorship countries?

RQ7: How about network mapping based on co-citation by authorship?

This methodology combines rigorous bibliometric analysis techniques with a systematic data collection and processing approach. This study aims to comprehensively understand LEV research's current state, trends, and collaborative patterns by addressing the seven research questions through various analytical lenses. The results of this analysis will offer valuable insights for researchers, practitioners, and policymakers in the field of Local Exhaust Ventilation.

2. Data and Method

This research utilises an extensive bibliometric analysis to investigate the present condition and patterns in Local Exhaust Ventilation (LEV) research. The approach has been devised to address seven distinct research inquiries (RQ1-RQ7) through a systematic approach for collecting, arranging, and evaluating information. The research primarily focuses on the Scopus database, which comprises peer-reviewed literature across various disciplines [6]–[8] The search was conducted in July 2024, using a carefully constructed search string to identify relevant publications, as shown in **Table 1**.

This search string was designed to capture articles related to local exhaust ventilation published between 2020 and 2024. Using the "TITLE-ABS-KEY" field code ensures that the search term is found in either the title, abstract, or keywords of the articles, maximising the relevance of the results. The language limiter restricts the search to English-language publications, while the publication stage limiter ensures that only final, peer-reviewed articles are included.

Table 1.
The search string

Scopus	TITLE-ABS-KEY ("local exhaust ventilation") AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2024)) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (PUBSTAGE, "final")) Access Date: July 2024

The selection criteria for the literature review are detailed in **Table 2**, specifying the inclusion of English articles and proceedings from journals published between 2020 and 2024, while excluding non-English documents, books, and reviews. The document does not provide the results of the analysis. Still, it sets the stage for a comprehensive review paper that will answer the posed research questions, offering insights into the state of LEV research, influential authors, document classification, collaborative networks, and the semantic landscape of the field as reflected in the literature.

These criteria ensure a focused and relevant dataset for analysing LEV research's current state and trends. The search results were exported to Microsoft Excel for further processing and analysis. This step allows for efficient data manipulation and the application of various bibliometric techniques.

Table 2.
The selection criterion is searching.

Criterion	Inclusion	Exclusion
Timeline	2020-2024	<2020
Language	English	Non-English
Document Type	Article	Non-Article
Source type	Journal (Article) and proceeding	Book, Review

To address the research questions, the following bibliometric analysis techniques were employed:

i. Temporal Analysis (RQ1): Publication frequency analysis was conducted to identify trends and patterns in LEV research over the study period (2020-2024). This involved aggregating publications by year and visualising the results to discern notable trends or fluctuations in research output [9].
ii. Author Productivity Analysis (RQ2): The dataset was analysed to identify the most prolific authors in the field. This involved calculating each author's total number of publications and ranking them accordingly [10].
iii. Subject Classification (RQ3): A subject-specific document classification was performed to categorise the publications into distinct research areas within LEV. This process involved analysing keywords, titles, and abstracts to identify predominant themes and subfields [11].
iv. Citation Analysis (RQ4): Citation analysis was conducted to identify the writers with the most impact and their affiliations. This involved ranking articles by their citation count and linking this information to the authors and their institutional affiliations [12].
v. Term Frequency Analysis (RQ5): A comprehensive analysis of frequently used terms was performed using text mining techniques. This involved extracting and analysing keywords, titles, and abstracts to identify LEV research's most common terms and concepts [13].
vi. Co-authorship Network Analysis (RQ6): A co-authorship network analysis was conducted to examine international collaboration patterns. This involved identifying articles with multiple authors from different countries and visualising these collaborative relationships using network mapping tools [14].
vii. Co-citation Network Analysis (RQ7): A co-citation network analysis was performed to map the intellectual structure of the field. This involved identifying pairs of authors frequently cited together and visualising these relationships to reveal influential clusters and research fronts within LEV research [15].

Appropriate data visualisation methods were employed for each analysis technique, including trend lines, bar charts, heat maps, and network graphs [16]. These visualisations were used to interpret the results and draw meaningful conclusions about the state of LEV research. Although this approach thoroughly examines LEV studies, it is crucial to acknowledge its restriction to the publications documented in the Scopus repository, which may only encompass some pertinent

scholarly material. The focus on English-language publications may also exclude valuable research published in other languages.

Then, the bibliometric analysis using VOSviewer has been extensively employed across various research domains to analyse and visualise data trends, relationships, and research gaps. For instance, in the field of mechanical engineering, a study utilised VOSviewer to map the development of system thinking skills, revealing a fluctuating trend in publications over the past decade, with a peak in 2019 [17].

3. Results and Discussion

3.1 Research Trends in Local Exhaust Ventilation (LEV)

The bibliometric analysis of Local Exhaust Ventilation (LEV) publications from 2020 to 2024 reveals a dynamic landscape in this field of research. This comprehensive examination of publication trends offers valuable insights into the evolving focus and intensity of scholarly activity in LEV studies over five years. **Fig. 1** and **Table 3**. This paper presents a quantitative overview of publication trends, illustrating a non-linear progression in research output. The data demonstrates notable fluctuations in scholarly productivity, with distinct growth phases, peaks, and subsequent declines.

The initial years of the study period, 2020 and 2021, show a steady increase in research output. In 2020, 46 publications (19.2%) were recorded as the total publications over the five years. It was followed by a moderate uptick in 2021, with 53 publications representing 22.2%. This upward trajectory suggests a growing interest in LEV research, driven by increased awareness of indoor air quality issues, occupational health concerns, or advancements in ventilation technologies. Year 2022 emerges as a significant inflexion point in the analysis, marking the apex of research productivity. With 67 publications, accounting for 28.0% of the total output, 2022 represents a period of intensified scholarly focus on LEV. This surge may indicate several factors, including potential breakthroughs in LEV technology, heightened regulatory attention to workplace safety standards, increased funding allocation for LEV research and a possible response to global health concerns emphasising the importance of air quality [18].

However, the subsequent years witnessed a notable decline in publication numbers. In 2023, the output decreased to 42 publications (17.6%), followed by a further reduction to 31 publications (13.0%) in 2024. This downward trend in the latter part of the study period warrants careful interpretation. Several hypotheses could explain this phenomenon, such as a natural ebb in research activity following intense focus, shifts in funding priorities or resource allocation within the field and changes in academic or industry priorities affecting LEV research [19]. It is crucial to note that the 2024 data may need to be completed, depending on when the analysis was conducted within that year. This factor should be considered when concluding the most recent trends.

The observed fluctuations in publication output over these five years provide valuable insights for various stakeholders in the field of LEV research. Researchers can use these trends to guide future study directions and identify potential gaps in the current body of knowledge. Policymakers and funding bodies can utilise this data to assess the efficacy of past initiatives and inform future budgetary allocations. Industry professionals may find these trends indicative of shifting focus areas within LEV technology and application. The citation analysis, co-authorship networks, and keyword trends are critical to making this bibliometric analysis even more complete. Such a multi-faceted approach would provide a more comprehensive understanding of the qualitative aspects of LEV research, including its impact, collaborative patterns, and evolving thematic focus [20].

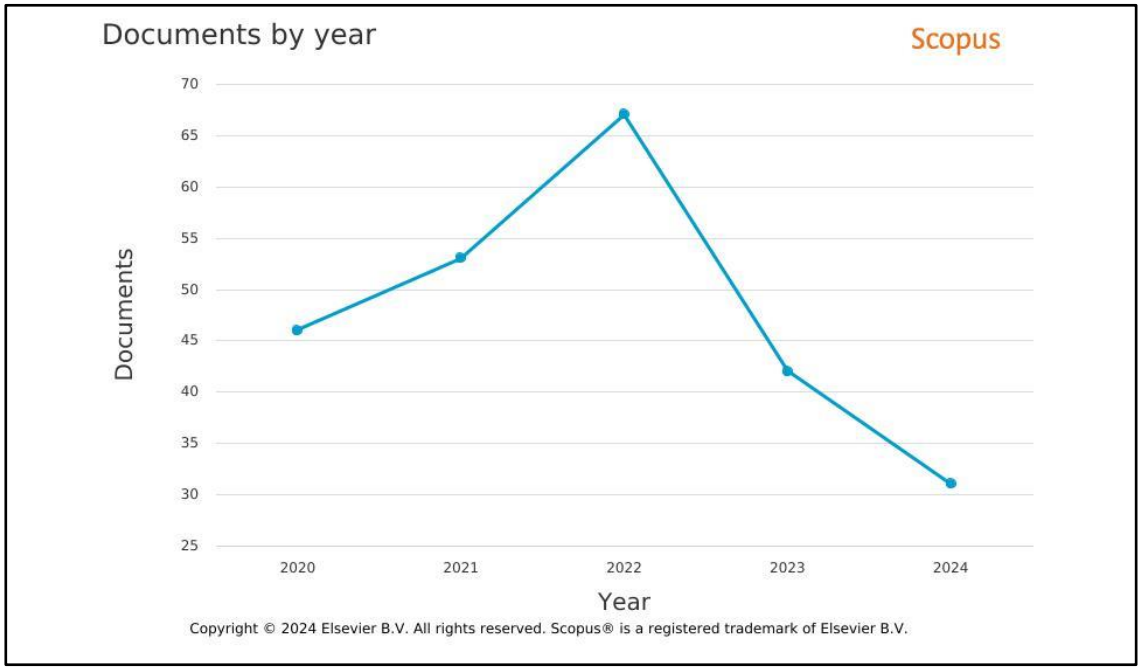

Fig. 1. Publication trend of Local Exhaust Ventilation for 2020-2024.

Table 3.
Number of publications by year from 2020 until 2024.

Year	Number of publications	Percentages
2024	31	13.0%
2023	42	17.6%
2022	67	28.0%
2021	53	22.2%
2020	46	19.2%

3.2 Authors and their number of articles

The bibliometric analysis of author productivity in local exhaust ventilation research reveals significant patterns and implications for the field. This quantitative assessment provides valuable insights into the intellectual leadership, collaborative structures, and geographic distribution of research efforts in this critical occupational health and safety domain based on **Fig. 2**. The data presents a clear hierarchical structure in research productivity, with a small group of authors contributing disproportionately to the literature.

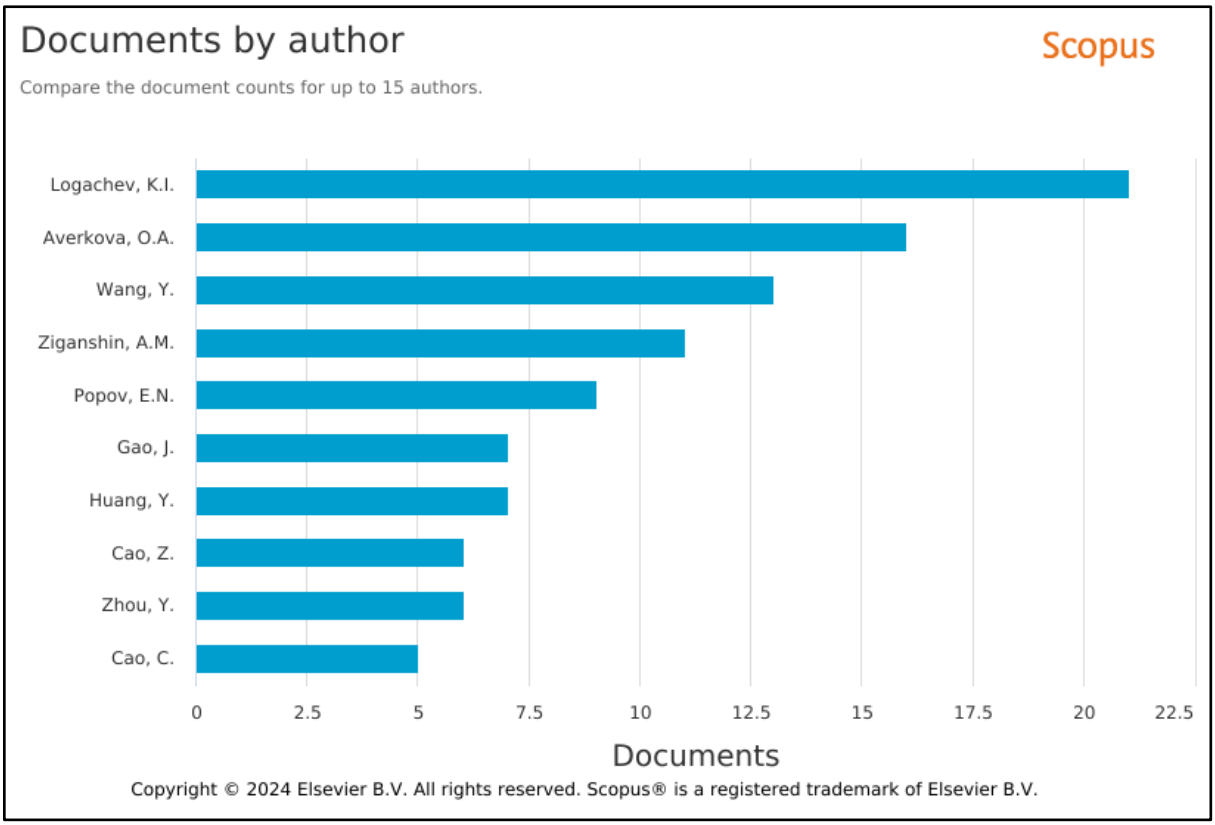

Fig. 2. Top 10 Authors of Local Exhaust Ventilation from 2020 until 2024.

Logachev, K.I., Averkova, O.A., and Wang, Y. are identified as the leading three authors, together representing 13% of the total publications, as seen in **Table 4**. This output concentration suggests that these individuals may be pivotal in shaping research agendas and driving innovation in local exhaust ventilation studies. Their substantial contributions (6%, 4%, and 3% of total articles, respectively) underscore their sustained engagement and commitment to advancing knowledge in this field.

Table 4.
The top 10 most productive authors were published on local exhaust ventilation.

Author Name	Number of Articles	Percentages
Logachev, K.I.	21	6%
Averkova, O.A.	16	4%
Wang, Y.	13	3%
Ziganshin, A.M.	11	3%
Popov, E.N.	9	2%
Gao, J.	7	2%
Huang, Y.	7	2%
Cao, Z.	6	2%
Zhou, Y.	6	2%
Cao, C.	5	1%

Additional analysis of co-authorship patterns could yield a more profound understanding of the social organisation of the research community and its influence on the spread of information. The diversity of surnames among the top contributors indicates a global research effort, with significant input from Western and Eastern researchers. This international engagement is crucial for addressing the universal occupational health and safety challenges that local exhaust ventilation seeks to mitigate. The global nature of contributions suggests that the field benefits from diverse perspectives and potentially varied methodological approaches, which can enhance the robustness and applicability of research findings across different contexts [21].

However, the concentration of publications among a relatively small group of authors (25% of articles from the top 10 contributors) raises important questions about the field's development. While this concentration ensures consistent output from experienced researchers, it may also limit the diversity of perspectives and approaches. A small group of researchers may significantly affect field direction. This situation calls for strategies to encourage broader participation and support emerging researchers, which could foster innovation and ensure the long-term vitality of local exhaust ventilation research [20].

The observed drop in productivity between the third and fourth-ranked authors suggests a possible threshold effect, where a select few researchers have achieved a level of expertise and resources that allows for significantly higher output. This pattern may reflect contributors' differences in research infrastructure, funding access, or career stage. Understanding the factors that enable such high productivity could inform policies aimed at supporting researchers and enhancing overall research output in the field. It is crucial to acknowledge the constraints of this analysis. While informative, the focus on publication counts does not account for other crucial factors such as citation impact, journal prestige, or the specific subdomains within local exhaust ventilation research. Future studies should incorporate these elements to provide a more nuanced understanding of research influence and specialisation. Additionally, investigating temporal trends in publication patterns with co-authorship networks, and institutional affiliations could provide further perspectives on the development and cooperative aspects of the field.

The concentration of publications among a small group of authors (with the top 10 contributors accounting for 25% of articles) suggests a potential "Matthew effect" in local exhaust ventilation research. The "Matthew effect," a term coined by Robert K. Merton and Harriet Zuckerman, describes the phenomenon where well-known researchers or institutions receive disproportionate recognition and credit compared to lesser-known counterparts, even for similar work [22]. This bias can significantly impact local exhaust ventilation (LEV) research, where the contributions of prominent researchers or institutions might overshadow equally valuable findings from less renowned sources. For instance, the study by Matthew J. Zdilla highlights the development of cost-effective and efficient LEV systems for gross anatomy laboratories, significantly improving air quality and reducing noise levels [2]. This sociological phenomenon, first described by Robert K. Merton in Science in 1968, refers to the accrual of more tremendous advantages to those already established in a field [23]. Established researchers such as Logachev, K.I., Averkova, O.A., and Wang, Y. might potentially gain advantages from enhanced access to resources, collaborations, and funding opportunities, which would enable them to generate a greater number of publications. As noted in the document, this concentration "ensures consistent output from experienced researchers" but may also "limit the diversity of perspectives and approaches.

3.3 Types of documents by subject of research

The data in **Fig. 3** and Table 5.3 provide crucial insights into the current research landscape, highlighting the diverse academic disciplines contributing to advancing LEV technology and practices. The engineering field is predominantly a subject area, representing 20.9% of the total publications. This predominance underscores the fundamental role of engineering principles in the design, implementation, and optimisation of LEV systems. The high volume of engineering-focused research suggests a sustained effort to enhance the efficiency and effectiveness of LEV through technological innovation and refinement. This emphasis aligns with the practical challenges of developing and improving LEV systems to meet evolving industrial needs and regulatory standards.

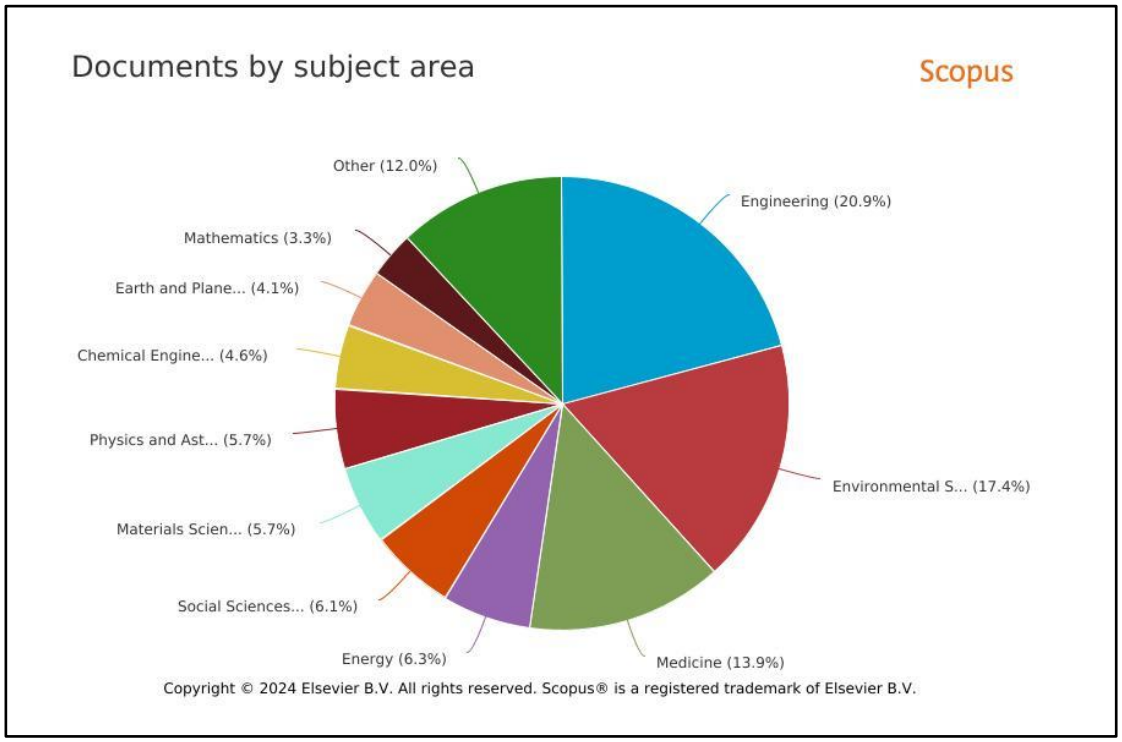

Fig. 3. The pie chart reveals the subject areas that were researched on local exhaust ventilation.

Environmental Science follows closely, representing 17.4% of the research output. The substantial focus on environmental aspects reflects LEV critical role in mitigating industrial pollution and protecting ecosystems. This synergy between LEV and ecological science is pivotal in addressing global challenges related to industrial emissions and their environmental impact. The significant contribution from this field indicates a growing recognition of LEV as a key strategy in sustainable industrial practices and environmental protection efforts [24].

The strong presence of Medicine (13.9%) in LEV research highlights the vital link between ventilation systems and occupational health. This substantial body of medical research emphasises the critical role of LEV in preventing occupational diseases and protecting worker well-being. Integrating medical perspectives with engineering and environmental considerations demonstrates a holistic approach to LEV research, considering the technical aspects of ventilation systems and their direct impact on human health [25].

Table 5.
The top ten subject areas with the publication number and percentages.

Subject Area	Number of Publication	Percentages %
Engineering	96	20.9%
Environmental Science	80	17.4%
Medicine	64	13.9%
Energy	29	6.3%
Social Sciences	28	6.1%
Materials Science	26	5.7%
Physics and Astronomy	26	5.7%
Chemical Engineering	21	4.6%
Earth and Planetary Sciences	19	4.1%
Mathematics	15	3.3%

The collective dominance of Engineering, Environmental Science, and Medicine, accounting for 52.2% of the publications, establishes a robust interdisciplinary core for LEV research. This tripartite focus ensures that advancements in LEV technology are grounded in technical innovation, environmental consciousness, and health-centric design principles. The presence of Energy (6.3%) and Social Sciences (6.1%) in the top subject areas is noteworthy. Energy-related research likely focuses on optimising the energy efficiency of LEV systems, an increasingly important consideration in sustainable industrial practices. The significant contribution from Social Sciences suggests a growing recognition of the broader societal implications of LEV systems, potentially encompassing studies on workplace policies, economic impacts, and behavioural aspects of LEV implementation and usage [26].

Materials Science, Physics and Astronomy (both at 5.7%) contribute to the fundamental understanding of LEV principles. Materials Science research likely explores novel materials for LEV components to enhance system performance and durability. At the same time, Physics and Astronomy studies may focus on the physical principles underlying airflow dynamics and particulate behaviour within LEV systems. The inclusion of Chemical Engineering (4.6%), Earth and Planetary Sciences (4.1%), and Mathematics (3.3%) among the leading subject areas highlights the intricate and interdisciplinary characteristics of research on LEV. These fields contribute essential perspectives on chemical processes in pollutant control, broader environmental impacts, and mathematical modelling for system optimisation. The diverse range of disciplines represented reflects the complex challenges LEV systems address and underscores the importance of collaborative, cross-disciplinary research in advancing the field. This multi-faceted approach is crucial for developing comprehensive solutions considering technical efficiency, environmental impact, health outcomes, and practical implementation.

3.4 Top ten countries of this document

The geographic distribution of research output in local exhaust ventilation (LEV) provides valuable insights into the global landscape of scientific contributions in this critical field of occupational health and environmental protection. Analysis of the data presented in **Fig. 4** and **Table 6** reveals several significant trends and implications for the development and focus of LEV research worldwide. China

is the dominant contributor, accounting for 20% of the total research output, 61 articles. This preeminence reflects China's growing emphasis on occupational health and environmental protection, likely driven by its rapid industrialisation and the accompanying challenges in workplace safety and air quality management. The substantial contribution of China suggests a strategic national focus on addressing these issues through research and innovation in LEV technologies.

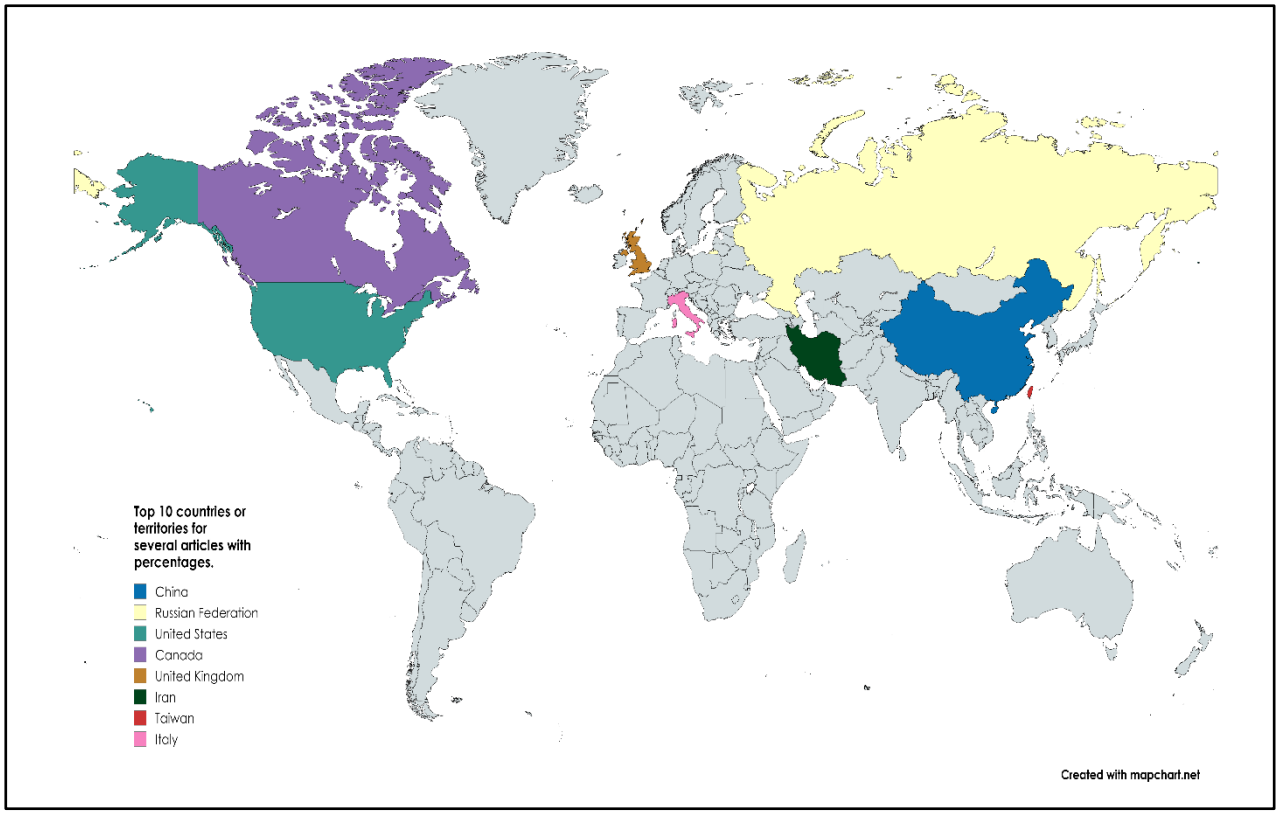

Fig. 4. Top 10 of most productive countries or territories publishing on Local Exhaust Ventilation research (Map created with mapchart.net).

The Russian Federation's strong showing, ranking second with 43 articles (14%), is particularly noteworthy. This significant contribution may be attributed to Russia's historical focus on industrial hygiene and the ongoing need to address occupational health issues across its diverse industrial sectors. The high output from Russia indicates a continued prioritisation of LEV research, possibly reflecting a legacy of industrial safety concerns and current efforts to modernise workplace practices. The United States, ranking third with 32 articles (10%), aligns with its traditionally strong research infrastructure and long-standing focus on occupational safety and health. The presence of the United States in the top three underscores the country's continued commitment to advancing LEV technologies and practices, likely driven by stringent regulatory requirements and a robust workplace safety culture [18].

Table 6.
Top 10 countries or territories for several articles with percentages.

Country/Territory	Number of Articles	Percentages
China	61	20%
Russian Federation	43	14%
United States	32	10%
Canada	13	4%
United Kingdom	12	4%

The three leading nations collectively contribute to 44% of all publications, suggesting a notable focus on research production. This concentration suggests that these nations may set the global LEV research and innovation agenda, potentially influencing international standards and best practices. The remaining seven countries in the top 10 contribute between 2% and 4% each, demonstrating a more distributed research effort among these nations. This distribution includes a mix of developed economies (Canada, United Kingdom, Italy, Japan, Finland) and emerging industrial powers (Iran, Taiwan), reflecting the global relevance of LEV research across different stages of economic development.

The strong representation from East Asia, including China, Taiwan, and Japan, highlights the region's focus on industrial efficiency and worker protection. This emphasis may be driven by the high concentration of manufacturing activities in these countries and the need to address associated environmental and health challenges. European participation, represented by the Russian Federation, United Kingdom, Italy, and Finland, underscores the continent's ongoing engagement with occupational health and safety issues. This involvement is likely influenced by stringent EU regulations and a strong tradition of workplace protection, driving continued research and innovation in LEV technologies. It demonstrates the global nature of LEV research and the emerging contributions from countries with growing industrial bases, including Iran and Taiwan. This diversification of research sources enriches the field with potentially varied perspectives and approaches to LEV challenges, reflecting different industrial contexts and regulatory environments [26].

The 66% concentration of research output among the top 10 countries suggests that while LEV research is a global endeavour, there are clear expertise centres. This concentration could facilitate focused collaborations and knowledge exchange but may also raise questions about the worldwide applicability of research findings and the need for more diverse international participation.

However, it is important to note the limitations of this analysis. The data is based on publication counts alone and does not account for factors such as citation impact, research quality, or specific areas of focus within LEV studies. Future research could incorporate these elements to provide a more nuanced understanding of each country's influence and specialisation within the field. Additionally, investigating temporal trends in country contributions could reveal how the global landscape of LEV research has evolved, potentially highlighting emerging research hubs or shifting priorities among nations.

3.5 The common keywords connected to the research

The study uses a network visualisation map and corresponding **Fig. 5** and **Table 7** to illustrate and quantify the relationship between keywords. These tools serve as vital components in

bibliometric examination, painting a vivid picture of the connections between research themes by showcasing the simultaneous appearance of key terms in scholarly publications. This effectively showcases the degree of connection between different areas of research.

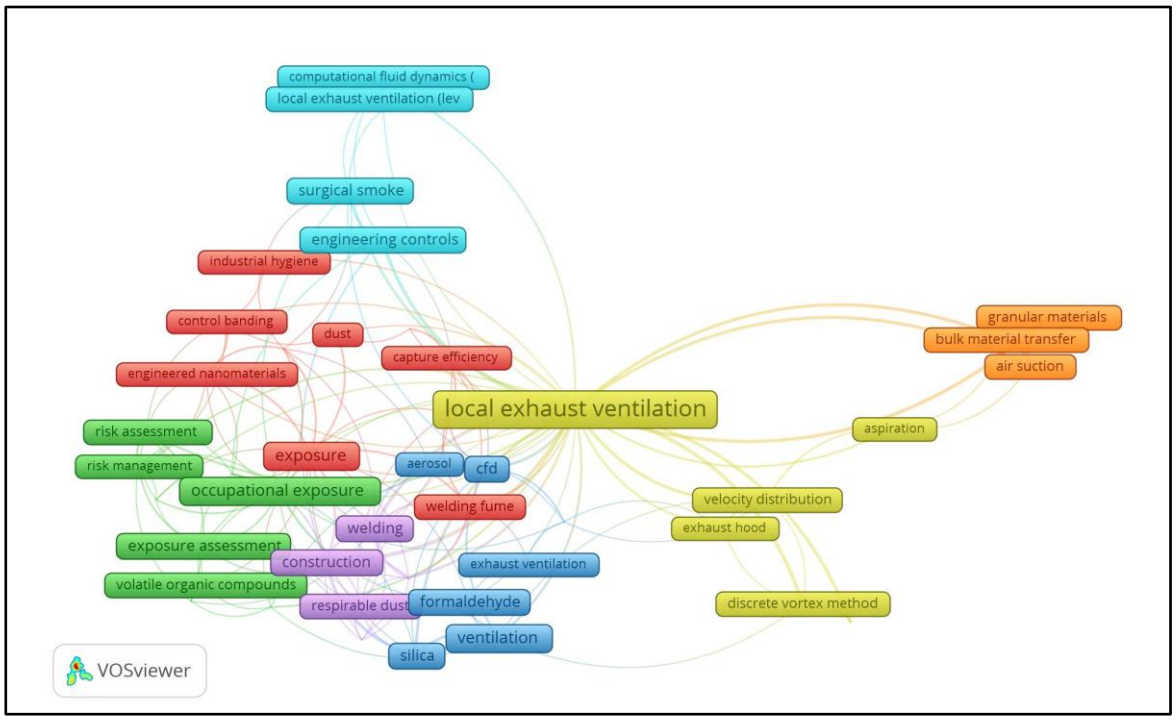

Fig. 5. Network visualisation map of keywords' co-occurrence.

Central to this analysis is the keyword "Local Exhaust Ventilation," which emerges as the dominant topic with 96 occurrences and a total link strength of 116. This high frequency and link strength suggest that local exhaust ventilation is a significant area of interest and serves as a central node in the network of research topics. Its prominence indicates its critical role in controlling occupational exposures to hazardous substances across various industrial contexts.

The analysis reveals several key industrial contexts where local exhaust ventilation is particularly relevant. "Construction" (16 occurrences, 29 link strength) and "Welding" (14 occurrences, 26 link strength) stand out as substantial areas of application. This emphasis suggests that the research extensively examines the implementation of local exhaust ventilation systems in construction settings and welding processes, where workers are exposed to various harmful materials, dust, fumes, and gases.

The keywords "Exposure" (19 occurrences, 20 link strength) and "Occupational Exposure" (22 occurrences, 20 link strength) underscore the study's focus on understanding and potentially mitigating occupational exposures to hazardous substances. Their frequent occurrence highlights the paramount importance of occupational health and safety in the research landscape. Specific contaminants and materials of concern are also identified in the keyword analysis. "Silica" (13 occurrences, 19 link strength) and "Manganese" (7 occurrences, 17 link strength) are mentioned, indicating that the research addresses industries where exposure to silica dust and manganese particles is a significant concern. Silica exposure is often associated with construction and mining

activities, while manganese exposure can be related to welding processes, aligning with the other industrial contexts mentioned.

Table 7.
Network visualisation map of keywords' co-occurrence

Keyword	Occurrences	Total Link Strength
Local Exhaust Ventilation	96	116
Construction	16	29
Welding	14	26
Exposure	19	20
Occupational Exposure	22	20
Air Suction	7	19
Bulk Material Transfer	7	19
Silica	13	19
Granular Materials	7	17
Manganese	7	17

The presence of keywords such as "Air Suction" (7 occurrences, 19 link strength), "Bulk Material Transfer" (7 occurrences, 19 link strength), and "Granular Materials" (7 occurrences, 17 link strength) suggests that the study examines specific materials and processes that may be sources of occupational exposure and the mechanisms by which local exhaust ventilation systems operate to control these exposures. Although not visible in the provided text, the network visualisation map would typically illustrate the interconnections between these keywords. The high link strengths, particularly for keywords with fewer occurrences, indicate that these concepts are tightly integrated with the central theme of local exhaust ventilation and other related keywords. This illustrates the study's multidisciplinary character and the possibility of exchanging ideas and approaches across various fields of application.

This bibliometric methodology offers significant discernments for academics and policymakers interested in comprehending the present status of research concerning local exhaust ventilation and occupational health and safety. By focusing on the most effective interventions informed by evidence from the literature. This methodology enables the identification of gaps in research with the prioritisation of upcoming research domains, resource allocations and the formulation of plans to enhance occupational health and safety.

The analysis also reveals potential research trends and gaps. While there is a strong emphasis on specific industries and contaminants, the absence of keywords related to emerging technologies or specific control strategies might indicate potential areas for future research. It could include exploring new applications of local exhaust ventilation in emerging industries or investigating novel techniques for enhancing its effectiveness in controlling worker exposure to hazardous substances. This analysis unveils a rich and interconnected field of study centred around local exhaust ventilation. It spans multiple industrial contexts, focusing on construction and welding. The emphasis on exposure and specific contaminants underscores the critical importance of this work in occupational health and safety [27]. The study provides a comprehensive overview of the current research landscape and suggests future directions for investigation and innovation in occupational exposure control through local exhaust ventilation systems.

3.6 Co-authorship countries collaboration

The bibliometric map depicted in **Fig. 6** visually represents the cooperation network between countries and territories engaged in LEV culture research. This network visualisation serves as a potent instrument in comprehending the scientific collaboration's structure by uncovering the links among various nodes (countries), which can signify knowledge sharing, collaborative research initiatives, and the dissemination of scientific knowledge. The density and complexity of the network provide insights into the level of international engagement and the potential for the diffusion of innovation in the field.

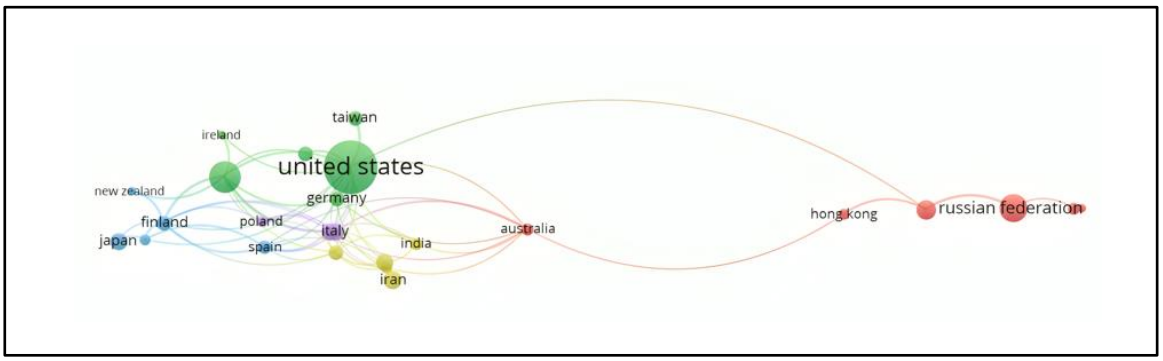

Fig. 6. Cooperation network between countries and territories in Local Exhaust Ventilation (LEV) culture research.

Table 8 shows that, it complements the visual analysis by presenting a quantitative summary of the top ten most productive countries regarding their scholarly output and impact. The table lists the number of documents and citations for each country and a metric labelled "Total Link Strength." This metric is exciting as it likely reflects the sum of a country's collaborative ties with others, indicating the breadth and depth of its international research partnerships.

Table 8.
Top ten most productive countries' documents and citations on Local Exhaust Ventilation (LEV) culture research.

Country	Documents	Citations	Total Link Strength
United States	170	2968	20
Netherlands	17	739	19
United Kingdom	58	811	19
Finland	14	233	15
Italy	18	381	15
Spain	11	115	12
France	13	80	11
Germany	14	210	10
Australia	10	169	9
Sweden	8	142	8

The United States' dominance in Local Exhaust Ventilation (LEV) culture research is manifested through several key indicators of research impact and collaboration, as presented in the bibliometric analysis. Firstly, the United States has the highest number of documents (170) in LEV culture research, which indicates a substantial volume of scholarly output. This extensive publication record suggests that the U.S. is a major producer of knowledge in this field, with a significant investment in research activities related to LEV culture. Secondly, the United States boasts the most important citations (2,968) compared to all other countries mentioned. Citations are a standard metric used to assess the impact and influence of scientific research. The substantial number of citations received by documents originating from the United States indicates that the research output from this country is highly acknowledged, extensively cited, and deemed impactful by the international research community. It may be attributed to the research's quality, the discoveries' originality, and the efficiency of dissemination approaches.

Regarding collaboration, the United States has a "Total Link Strength" of 20, the highest among the countries listed. This metric likely reflects the number and strength of a country's collaborative ties with others in the network. The high Total Link Strength for the U.S. indicates its strong and extensive cooperative relationships with other countries in LEV culture research. It could be through joint research projects, co-authorship of publications, or shared research programs, all of which contribute to advancing knowledge and practice in LEV culture. The combination of these factors—high document count, high citation count, and collaborative solid links—suggests that the United States plays a central role in the global research network for LEV culture. Its dominance is not only in terms of the quantity of research produced. It is also in the quality and influence of that research and in fostering international collaboration and partnerships that drive the field forward.

The United Kingdom, Finland, Italy, and Spain follow with varying degrees of productivity and citation impact. Notably, the Nordic countries of Finland and Sweden appear in the top ten, which may be attributed to their strong traditions in environmental health research and occupational safety regulations. France, Germany, Australia, and Sweden are among the top ten countries, highlighting the worldwide scope of research in LEV culture, involving participation from nations within and outside of Europe. Analysing the bibliometric discoveries necessitates a thorough examination of the data's constraints. The focus on document counts and citations may not fully capture the research's quality or the findings' societal impact. Furthermore, the assessment fails to consider individual researchers' impact, institutions' significance, or the likelihood of language bias in citation patterns.

3.7 Authorship-based co-citation network mapping

The document presents a sophisticated bibliometric analysis focusing on network mapping based on co-citation by authorship. This approach, widely used in scientometric studies, offers valuable insights into a research field's intellectual structure and dynamics. The analysis integrates visual representation (Figure 5.7) alongside quantitative data (Table 5.7) to clarify the connections between prominent authors and their influence on the field. Figure 5.7, entitled "Visualization of the Co-citation Network," probably illustrates a sophisticated network comprising nodes (which symbolise authors) and edges (which symbolise co-citation connections). While the specific details of the visualisation are not accessible, such diagrams typically employ various visual cues to convey information. Node size often correlates with citation count, while edge thickness usually represents the strength of co-citation relationships. This visual representation allows for an intuitive understanding of the field's structure, highlighting clusters of closely related research and bridging authors who connect different subfields.

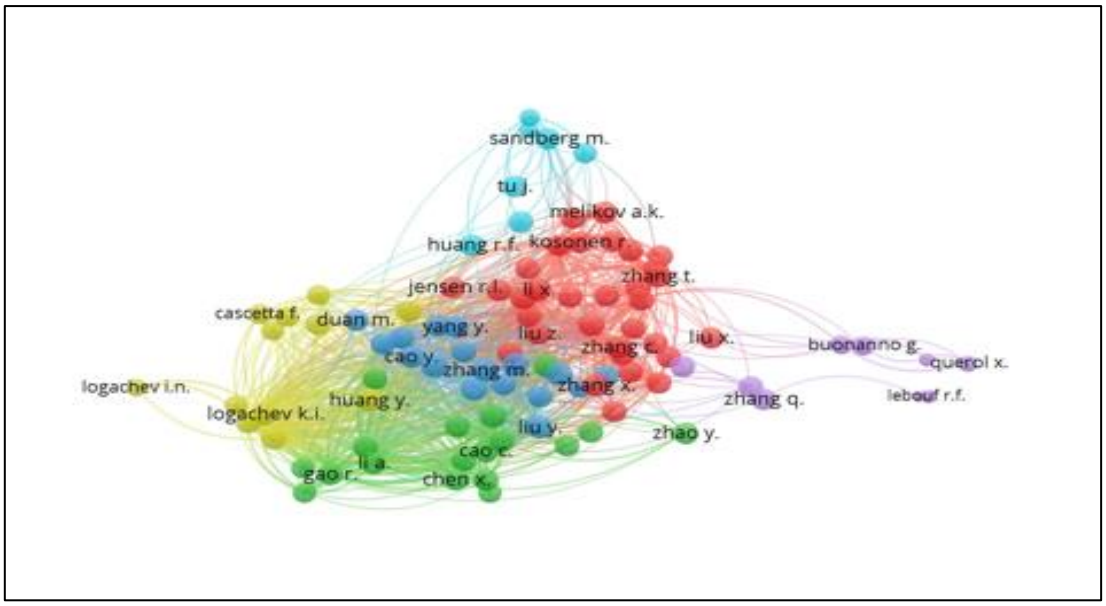

Fig. 7. Visualising the Co-citation Network.

Table 9 complements the visual data by providing quantitative metrics for the ten most prominent authors in the network. The table presents two key bibliometric indicators: Total Link Strength and Citations. These metrics offer different but complementary insights into an author's influence within the field. The total links strength is crucial as a bibliometric measure to assess an author's significance within the co-citation network. It indicates the frequency of references and the level to which an author's research is referenced alongside other significant publications. Wang Y., with a total link strength of 13,549, emerges as the central figure in this research landscape. This substantial lead over other authors (the second-highest, Logachev K.I., has a strength of 7,788) suggests that Wang Y.'s work serves as a key reference point, often bridging different research streams or subfields.

Table 9.
The ten prominent authors with the highest total link strength

Author	Total Link Strength	Citations
Wang Y.	13549	244
Logachev K.I.	7788	151
Ziganshin A.M.	7323	142
Averkova O.A.	6462	128
Li A.	5974	90
Huang Y.	5491	84
Li X.	4689	87
Gao J.	4543	69
Cao Z.	4169	63
Nielsen P.V.	3950	86

Citations accurately represent how much an author has affected others, but co-citation research shows that the number of citations may not always reflect an author's network fame. For instance, Nielsen P.V. ranks 10th in total link strength but 5th in citations. This discrepancy highlights the nuanced nature of academic influence, where some works might be highly cited but within a more specialised or isolated subfield. The proximity in rankings and similar patterns in link strength among authors like Logachev K.I., Ziganshin A.M., and Averkova O.A. suggest the presence of a tightly knit research cluster. It could indicate a school of thought, a collaborative research group, or a specific subfield where these authors' works are frequently cited. Such patterns are valuable for understanding the social and intellectual organisation of the research field.

The diverse surnames in the top ten list (e.g., Wang, Li, Huang, Gao, Nielsen) point to the international nature of the research field. This diversity suggests a globally collaborative research area where contributions from various geographic and potentially cultural backgrounds shape the discourse. Such international representation often indicates a mature and well-developed research field with global relevance. The ratio of total link strength to citations varies among authors, providing insights into their influence. Authors with higher ratios, such as Li A. (66.4) compared to Wang Y. (55.5), may have work that is more consistently co-cited, suggesting papers that are central to specific discussions or methodologies within the field. While the data doesn't provide temporal information, the presence of authors with varying citation counts in the top ten suggests a field with established leaders and emerging influential researchers. This mix indicates a dynamic research area where new contributions can quickly gain prominence alongside established works.

This co-citation analysis provides a snapshot of the intellectual structure of the field, revealing key influencers, potential research clusters, and patterns of knowledge dissemination. Such insights are valuable for researchers, helping them identify central works, understand the relationships between different research streams, and potentially spot gaps or emerging areas for future investigation. Several additional steps are needed to improve this analysis, such as temporal analysis to track the evolution of the network over time and content analysis of the most central papers to identify critical themes or methodologies [28]. Another step is comparing with other bibliometric indicators like bibliographic coupling or co-authorship networks and incorporating subject-specific metrics or classifications to provide context to the co-citation pattern [29]. This co-citation network analysis offers a robust framework for understanding the complex interactions and influences within the research field. Combining quantitative metrics with network visualisation provides a multi-faceted view of the academic landscape, highlighting individual contributions and broader knowledge construction and dissemination patterns [30]. Such analyses are instrumental in guiding research strategies, identifying potential collaborations, and understanding the trajectory of scientific discourse in the field.

4.0 Conclusions

This comprehensive bibliometric analysis of Local Exhaust Ventilation (LEV) research from 2020 to 2024 offers valuable insights into the field's current state, trends, and collaborative patterns. The study addresses seven key research questions and provides a multifaceted view of LEV research dynamics, focusing on publication trends, author productivity, document classification, citation analysis, keyword analysis, co-authorship networks, and co-citation network mapping. The following conclusions can be drawn:

i. Research Question (RQ1) shows that the analysis reveals a fluctuating pattern in publication output. The area encountered a period of advancement between 2020 and 2022, reaching its highest point with 67 publications in 2022 before witnessing a decrease in 2023 and 2024.

This trend suggests an initial surge of interest, possibly driven by increased awareness of indoor air quality and occupational health concerns, followed by a potential shift in research focus or funding priorities. The observed decline in recent publications warrants further investigation to ensure continued innovation and relevance in this crucial occupational and environmental health area.

ii. Research Question 2 (RQ2) sought to determine the most productive authors in LEV research. The analysis highlighted Logachev, K.I., Averkova, O.A., and Wang, Y. as the top three contributors, underscoring their remarkable impact on the field. The concentration of publications among a few authors suggests a "Matthew effect," where well-established researchers receive disproportionate recognition.

iii. Research Question 3 (RQ3) examined the types of documents by subject of research. The investigation highlighted Engineering, Environmental Science, and Medicine as the key subject fields, making up 52.2% of the published works. This interdisciplinary approach reflects LEV systems' complex challenges, considering technical efficiency, environmental impact, and health outcomes.

iv. Research Question 4 (RQ4) investigated the most-cited articles and their authors' affiliations. The analysis revealed that the United States was the most productive country in LEV culture research, followed by the Netherlands, the United Kingdom, and Finland. The U.S. also had the highest citation count and total link strength, indicating its central role in the global research network for LEV culture.

v. Research Question 5 (RQ5) explored the popular keywords related to LEV studies. The examination revealed that 'Local Exhaust Ventilation' emerged as the predominant term, succeeded by 'Construction,' 'Welding,' 'Exposure,' and 'Occupational Exposure' These terms highlight the focus on specific industrial contexts and contaminants of concern in LEV research.

vi. Research Question 6 (RQ6) analysed co-authorship collaborations between countries. The findings suggested that intercontinental coordination was vital in studying Local Exhaust Ventilation, with the United States, China, and the Russian Federation leading in publication output. This global engagement underscores the universal relevance of occupational health and safety challenges addressed by LEV systems.

vii. Finally, Research Question 7 (RQ7) mapped the co-citation network based on authorship. The analysis identified Wang Y. as the most influential author based on the total link strength metric. This mapping revealed the intellectual structure of the field, with prominent authors and their connections, providing insights into knowledge dissemination and research clusters.

The bibliometric analysis offers valuable insights into the state of LEV research, highlighting its interdisciplinary nature, key contributors, and collaborative networks. Future directions for the field include expanding research participation to include more diverse perspectives, exploring emerging technologies for enhancing LEV effectiveness and addressing evolving industrial challenges. The study's findings can guide future research directions, resource allocation, and policy formulation to improve occupational health and safety by effectively implementing LEV systems.

5.0 Acknowledgement

This research was supported by the Grant TIER 1 [H923]. The author would like to thank the University of Tun Hussein Onn Malaysia for providing the necessary research facilities for this study.

6.0 References

[1] M. F. Ejaz, S. Kilpeläinen, P. Mustakallio, W. Zhao, and R. Kosonen, "An experimental study on the efficacy of local exhaust systems for the mitigation of exhaled contaminants in a meeting room," *Buildings*, vol. 14, no. 5, p. 1272, 2024, doi: 10.3390/buildings14051272.

[2] M. J. Zdilla, "Local exhaust ventilation systems for the gross anatomy laboratory," *Bull. Assoc. Anat. (Nancy).*, vol. 105, no. 350, pp. 237–246, 2021, doi: 10.1016/J.MORPHO.2020.11.002.

[3] K. I. Logachev *et al.*, "Developing a mathematical simulation method for three-dimensional separated airflow at inlet of local exhaust devices," *J. Build. Eng.*, vol. 63, no. 105490, p. 105490, 2023, doi: 10.1016/j.jobe.2022.105490.

[4] M. N. A. De Sousa, E. P. de O. Almeida, and A. L. D. Bezerra, "Bibliometrics: what is it? What is it used for? And how to do it?," *Cuad. Ed. Desar.*, vol. 16, no. 2, p. e3042, 2024, doi: 10.55905/cuadv16n2-021.

[5] M. M. Parivazh, M. Rahmani, and M. Akrami, "Numerical investigation on a liquid–gas ejector for carbon dioxide removal using Amine solution: Hydrodynamics and mass transfer evaluation," *Appl. Sci.*, vol. 12, no. 9, p. 4485, 2022, doi: 10.3390/app12094485.

[6] M. Turmuzi, I. G. P. Suharta, I. W. P. Astawa, and I. N. Suparta, "Mapping ethnomathematical research directions and trends in the Scopus database: A bibliometric analysis," *Int. J. Educ. Method.*, vol. 10-2024, no. volume-10--3-august-2024, pp. 431–453, 2024, doi: 10.12973/ijem.10.3.431.

[7] M. Maral, "A bibliometric analysis of global research on education in the Scopus database, 2013–2022," *Glob. Knowledge, Mem. Commun.*, vol. ahead-of-p, no. ahead-of-print, Jan. 2024, doi: 10.1108/GKMC-01-2024-0039.

[8] A. Y. Nageye, A. D. Jimale, M. O. Abdullahi, and Y. A. Ahmed, "Emerging trends in data science and big data analytics: A bibliometric analysis," *Int. J. Electron. Commun. Eng.*, vol. 11, no. 5, pp. 84–98, 2024, doi: 10.14445/23488549/ijece-v11i5p109.

[9] N. Pathak, Z. J. Radford, J. B. Kahan, J. N. Grauer, and L. E. Rubin, "Publication frequency and Google Trends analysis of popular alternative treatments to arthritis," *Arthroplast. Today*, vol. 14, pp. 76–80, 2022, doi: 10.1016/j.artd.2021.12.009.

[10] J. P. A. Ioannidis, "Prolific non-research authors in high impact scientific journals: meta-research study," *Scientometrics*, vol. 128, no. 5, pp. 3171–3184, 2023, doi: 10.1007/s11192-023-04687-5.

[11] G. Pech, C. Delgado, and S. P. Sorella, "Classifying papers into subfields using Abstracts, Titles, Keywords and KeyWords Plus through pattern detection and optimization procedures: An application in Physics," *J. Assoc. Inf. Sci. Technol.*, vol. 73, no. 11, pp. 1513–1528, 2022, doi: 10.1002/asi.24655.

[12] G. Parthasarathy and D. C. Tomar, "A survey of sentiment analysis for journal citation," *Indian J. Sci. Technol.*, vol. 8, no. 35, 2015, doi: 10.17485/ijst/2015/v8i35/55134.

[13] N. K. Anil and B. P. Kaur, "Term frequency inverse document frequency based sentiment analysis using machine learning approaches," *2023 International Conference on Data Science, Agents & Artificial Intelligence (ICDSAAI)*. IEEE, Chandigarh university,CSE Department,Mohali,Punjab,India, 2023. doi: 10.1109/icdsaai59313.2023.10452661.

[14] A. Manyani, R. Biggs, L. Hill, and R. Preiser, "The evolution of social-ecological systems (SES) research: a co-authorship and co-citation network analysis," *Ecol. Soc.*, vol. 29, no. 1, 2024, doi: 10.5751/es-14694-290133.

[15] C. M. Trujillo and T. M. Long, "Document co-citation analysis to enhance transdisciplinary research," *Sci. Adv.*, vol. 4, no. 1, p. e1701130, 2018, doi: 10.1126/sciadv.1701130.

[16] M. T. Fernandez, A. Cabrero, M. A. Zulueta, and I. Gomez, "Constructing a relational database for bibliometric analysis," *Res. Eval.*, vol. 3, no. 1, pp. 56–62, 1993, doi: 10.1093/rev/3.1.55.

[17] N. Amida, "ANALISIS BIBLIOMETRIK MENGGUNAKAN VOSVIEWER: TREND RISET KETERAMPILAN BERPIKIR SISTEM DALAM PENDIDIKAN KIMIA," *Alo*, vol. 8, no. 1, pp. 12–21, 2024, doi: 10.33369/alo.v8i1.32623.

[18] R. K. Vedder, "Technology and a safe workplace," *SSRN Electron. J.*, 2000, doi: 10.2139/ssrn.246445.

[19] M. J. Jeffries, "Some aspects of industrial and academic change," *Proceedings Frontiers in Education Twenty-First Annual Conference. Engineering Education in a New World Order*. IEEE, 2002. doi: 10.1109/fie.1991.187541.

[20] I. N. Logachev, K. I. Logachev, and O. Averkova, *Local exhaust ventilation*. London, England: CRC Press, 2015. doi: 10.1201/b18488.

[21] Y. Z. Frances Rapport, "Methodological diversity," 2022, pp. 99–102. doi: 10.4324/9781003109945-28.

[22] R. Jackson, "The Matthew Effect in science.," *Int. J. Dermatol.*, vol. 27, no. 1, p. 16, 1988, doi: 10.1111/J.1365-4362.1988.TB02325.X.

[23] G. Rinzivillo, "Some turning points in the early sociology of Robert King Merton," *Int. Rev. Sociol.*, pp. 1–17, 2021, doi: 10.1080/03906701.2021.1947457.

[24] M. N. Saidi, A. Djebara, V. Songmene, and A. Bahloul, "Experimental evaluation of three local exhaust ventilation

systems designed to reduce ultrafine dust emission during a polishing process," *Aerosol Sci. Eng.*, vol. 4, no. 1, pp. 9–17, 2020, doi: 10.1007/s41810-019-00050-5.

[25] A. Jerin, M. A. P. Mahmud, A. Michalczyk, and A. Z. Kouzani, "Environmental impact assessment of assisted ventilation," *2023 IEEE Engineering Informatics*. IEEE, School of Engineering, Deakin University,Geelong,Victoria,Australia,3216; School of Mathematical and Physical Sciences, University of Technology,Sydney,Australia,NSW 2007; School of Life & Env Sciences, Deakin University,Burwood,Victoria,Australia,3125, 2023. doi: 10.1109/ieeeconf58110.2023.10520431.

[26] Y. A. Setyawan, S. Y. Arini, and S. Widodo, "Evaluation of the implementation of the Local Exhaust Ventilation System in the Testing Laboratory," *Indones. J. Occup. Saf. Heal.*, vol. 11, no. 1, pp. 83–93, 2022, doi: 10.20473/ijosh.v11i1.2022.83-93.

[27] M. E. Dueck *et al.*, "Welding fume exposure and health risk assessment in a cohort of apprentice welders," *Ann. Work Expo. Heal.*, vol. 65, no. 7, pp. 775–788, 2021, doi: 10.1093/annweh/wxab016.