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Decision-making in Cybersecurity: A Bibliometric analysis

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ABSTRACT: This bibliometric analysis explores research trends and patterns in the intersection of decision-making and cybersecurity. Using Scopus data, we conducted a systematic search and identified 4,637 relevant documents published between 2018-2024. Quantitative analysis reveals rising annual publications with a peak in 2023, the predominance of journal articles, and robust international collaboration networks. China and the USA lead global scientific production. Key topics include risk assessment, network security, decision support systems, and emerging technologies like machine learning and artificial intelligence. Core journals with high citation impact such as IEEE Access and Expert Systems with Applications highlight significant sources of literature. The study provides a holistic overview of the landscape, evolution, contributors, and themes within decision-making and cybersecurity research.

Keywords: Bibliometric analysis, Decision-making, Cybersecurity, Research trends, Science mapping

1. INTRODUCTION

Effective decision-making is crucial for developing robust cybersecurity strategies and policies across different sectors [1–4]. However, the increasing scale and sophistication of cyber threats [5], [6]coupled with the complexities of modern technological environments [7], [8] pose significant challenges for decision-makers. Therefore, there is a growing need to advance knowledge on systematic and evidence-based approaches to decision-making pertaining to various aspects of cybersecurity.

Despite the importance, current literature lacks a comprehensive bibliometric assessment and science mapping analysis to understand the structure, dynamics, and conceptual themes in this critical domain. Most reviews employ qualitative scoping methods focusing only on specialized sub-topics such as security frameworks, risk analysis models, or network intrusion systems [9–11]. A cohesive overview mapping the trajectories, global contributors, interconnections, and evolving topics across the broader area of decision-making and cybersecurity can provide crucial insights [11–16].

This study aims to bridge this gap by conducting a large-scale bibliometric analysis using Scopus database, delineating the contours, growth trends, authorship patterns, core sources, prominent countries, underlying themes, and terminological structure within existing literature. The focus spans diverse aspects ranging from technical dimensions of security policies and controls to behavioral considerations in risk assessment and preparedness. The findings can inform future research directions and enable interested stakeholders to identify influential work, major contributors, and potential collaboration opportunities in this domain.

2. METHODOLOGY

2.1 RESEARCH SCOPE AND OBJECTIVES

The primary objective of this bibliometric analysis is to comprehensively explore the landscape of scholarly literature related to decision making in the context of cybersecurity. The study aims to identify trends, key contributors, and the evolution of research themes in this intersection of decision making and cybersecurity. To achieve this, we conducted a systematic bibliographic search in the Scopus database using carefully selected keywords.

2.2 SEARCH STRATEGY

The search query employed in Scopus was designed to be inclusive and cover various facets of decision making and cybersecurity. The search query utilized the following Boolean logic:

("decision making" OR "decision support") AND ("cybersecurity" OR "information security" OR "computer security" OR "risk assessment" OR "threat detection" OR "incident response" OR "information technology" OR "IT security" OR "cyber threats" OR "network security" OR "security policies" OR "security management" OR "vulnerability assessment" OR "attack detection" OR "security frameworks")

2.3 DATA SCREENING:

Total Documents: A total of 4637 documents were retrieved based on the search criteria.

Exclusion Criteria: Articles not relevant to the intersection of decision-making and cybersecurity were excluded during the screening process.

2.4 INCLUSION AND EXCLUSION CRITERIA

Articles included in this analysis were required to be related to decision making in the field of cybersecurity. Exclusion criteria involved removing irrelevant articles that did not contribute significantly to the understanding of the intersection between decision making and cybersecurity.

2.5 DATA COLLECTION

The Scopus database was queried using the defined search strategy, and the retrieved records were exported for further analysis. The search was conducted up to the latest available date at the time of data collection.

2.6 COMPLETENESS OF BIBLIOGRAPHIC METADATA ASSESSMENT

A crucial aspect of our analysis was the assessment of the completeness of bibliographic metadata. Various metadata fields, such as authorship details, document type, journal information, language, publication year, title, total citations, abstract, affiliation, DOI, keywords, corresponding author, keywords plus, cited references, number of cited references, and science categories, were evaluated. The completeness assessment is summarized in the table 1 below:

2.7 QUALITY CONTROL

To ensure the reliability of the data, quality control measures were implemented during data extraction and analysis. The process involved cross-checking and verification by multiple researchers to minimize errors and enhance the accuracy of the findings.

2.8 DATA ANALYSIS

Quantitative and qualitative analyses were performed on the collected data, providing insights into the publication trends, authorship patterns, and thematic clusters within the selected literature.

2.9 LIMITATIONS

It is important to acknowledge the limitations of this bibliometric analysis, such as potential biases in the Scopus database and the inherent limitations of bibliometric methods in capturing the entirety of the research landscape.

3. RESULTS

Table 1. data completeness

Metadata	Description	Missing Counts	Missing %	Status
AU	Author	0	0.00	Excellent
DT	Document Type	0	0.00	Excellent
SO	Journal	0	0.00	Excellent
LA	Language	0	0.00	Excellent
PY	Publication Year	0	0.00	Excellent
TI	Title	0	0.00	Excellent
TC	Total Citation	0	0.00	Excellent
AB		10	0.22	Good
C1	Affiliation	195	4.21	Good
DI	DOI	300	6.47	Good
DE		532	11.47	Acceptable
RP	Corresponding Author	698	15.05	Acceptable
ID		946	20.40	Poor
CR	Cited References	4637	100.00	Completely missing
NR	Number of Cited References	4637	100.00	Completely missing
WC	Science Categories	4637	100.00	Completely missing

3.1 MAIN INFORMATION ABOUT DATA:

Timespan: The analysis covers the period from 2018 to 2024.

Sources: A total of 1,040 sources, including journals, books, etc., were identified in the dataset.

Documents: The dataset comprises 4,637 documents related to decision-making and cybersecurity.

Annual Growth Rate %: The annual growth rate was calculated at -44.46%, indicating a decrease in the number of publications over the specified period.

Document Average Age: The average age of documents in the dataset is 2.08 years.

Average Citations per Document: On average, each document in the dataset has been cited 12.49 times.

References: Each document in the dataset has, on average, 1 reference.

3.1.1. Document Contents:

Author's Keywords (DE): There are 13,362 Author's Keywords (DE) identified in the dataset, indicating key thematic areas covered in the literature.

3.1.2. Authors:

Total Authors: A total of 12,844 unique authors contributed to the dataset.

3.1.3. Authors Collaboration:

Single-authored Docs: There are 473 documents with single authors.

Co-Authors per Doc: On average, each document is authored by 3.9 individuals.

International Co-authorships %: Collaboration on an international level is observed in 30.62% of the documents.

3.1.4. Document Types:

Article: The majority of documents (4,188) fall under the category of "article."

Article: There are 42 documents categorized as "article article."

Article Conference Review: Two documents are identified as "article conference review."

Article Review: One document is categorized as "article review."

Conference Review: A total of 189 documents are classified as "conference review."

Review: 214 documents fall under the "review" category.

Review Article: One document is identified as a "review article."

These results provide a comprehensive overview of the main characteristics of the dataset, including the temporal distribution, sources, document content, authorship details, collaboration patterns, and document types within the realm

of decision-making and cybersecurity literature from 2018 to 2024. Table 2 show the summary of main information

Table 2. main infomration

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2018:2024
Sources (Journals, Books, etc)	1040
Documents	4637
Annual Growth Rate %	-44.46
Document Average Age	2.08
Average citations per doc	12.49
	1
DOCUMENT CONTENTS	
	22114
Author's Keywords (DE)	13362
AUTHORS	
Authors	12844
Authors of single-authored docs	266
AUTHORS COLLABORATION	
Single-authored docs	473
Co-Authors per Doc	3.9
International co-authorships %	30.62
DOCUMENT TYPES	
article	4188
article article	42
article conference review	2
article review	1
conference review	189
review	214
review article	1

3.2 ANNUAL SCIENTIFIC PRODUCTION

The annual scientific production in the field of decision-making and cybersecurity, based on the provided table, is summarized as follows:

Table 3. 3 - annual scientific production

Year	Articles
2018	511
2019	609
2020	691
2021	784
2022	1005
2023	1022
2024	15

This representation illustrates the changing landscape of scientific production in this domain over the specified years, with a noticeable increase in the number of articles until 2023, followed by a significant decrease in 2024. Figure 1 shows the annual scientific production

3.3 AVERAGE CITATION PER YEAR

The average citation per year, based on the provided table, is presented as follows:

- **2018:**
- Mean Citations per Article: 25.55
- Number of Articles: 511

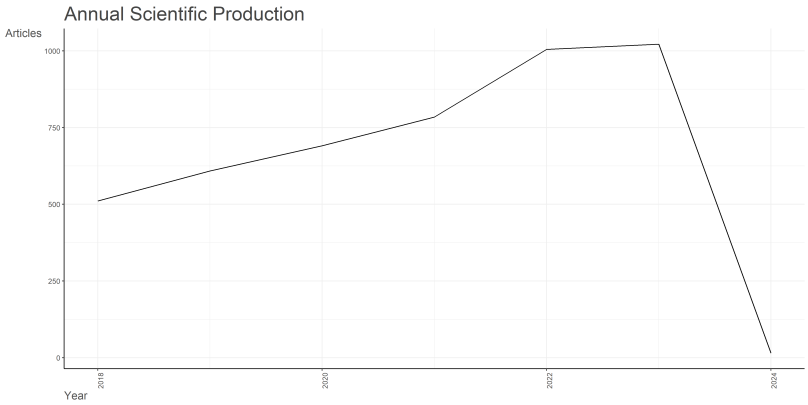

FIGURE 1. annual scientific production

- Mean Citations per Year: 4.26
- Citable Years: 6
- **2019:**
- Mean Citations per Article: 21.89
- Number of Articles: 609
- Mean Citations per Year: 4.38
- Citable Years: 5
- **2020:**
- Mean Citations per Article: 20.18
- Number of Articles: 691
- Mean Citations per Year: 5.04
- Citable Years: 4
- **2021:**
- Mean Citations per Article: 13.5
- Number of Articles: 784
- Mean Citations per Year: 4.5
- Citable Years: 3
- **2022:**
- Mean Citations per Article: 5.27
- Number of Articles: 1005
- Mean Citations per Year: 2.63
- Citable Years: 2
- **2023:**
- Mean Citations per Article: 1.68
- Number of Articles: 1022
- Mean Citations per Year: 1.68
- Citable Years: 1
- **2024:**
- Mean Citations per Article: 0.07
- Number of Articles: 15
- Mean Citations per Year: 0
- Citable Years: 0

This analysis provides insights into the citation trends over the specified years, indicating variations in the mean citations per article, mean citations per year, and the number of citable years for each respective year. Table 4 and figure 2 show the summary of average citation per year

3.4 MOST RELEVANT SOURCES

3.4.1. IEEE ACCESS

- **Articles:** 203

Table 4. average citation per year

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
2018	25.55	511	4.26	6
2019	21.89	609	4.38	5
2020	20.18	691	5.04	4
2021	13.5	784	4.5	3
2022	5.27	1005	2.63	2
2023	1.68	1022	1.68	1
2024	0.07	15	0	0

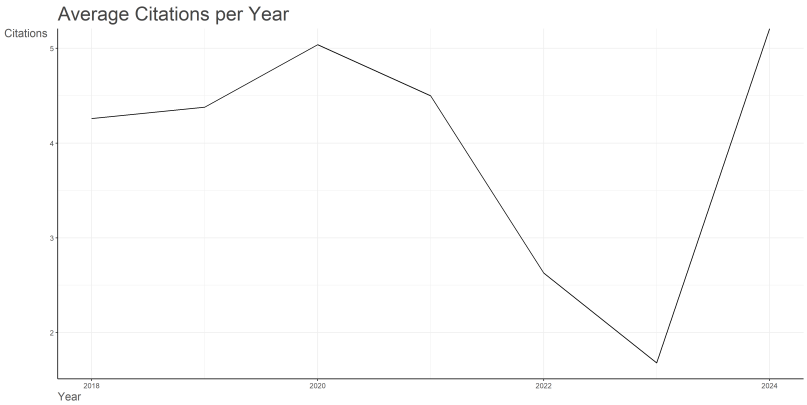

FIGURE 2. average citation per year

• **Details:** IEEE ACCESS has emerged as a prominent source in the field, with 203 articles contributing to the body of knowledge on decision-making and cybersecurity. The breadth and depth of publications in this source suggest its significance in shaping the discourse within the research domain.

3.4.2. SUSTAINABILITY (SWITZERLAND

• **Articles:** 169

• **Details:** The journal Sustainability (Switzerland) is a noteworthy source with 169 articles. Its focus on sustainability aligns with the broader themes of decision-making and cybersecurity, indicating a crucial intersection between environmental considerations and information security.

3.4.3. ENERGIES

• **Articles:** 89

• **Details:** Energies, with 89 articles, is a key source providing insights into the intersection of decision-making and cybersecurity in the context of energy systems. The contributions from this source likely cover a spectrum of topics related to energy security and resilience.

3.4.4. JOURNAL OF INTELLIGENT AND FUZZY SYSTEMS

• **Articles:** 74

• **Details:** The Journal of Intelligent and Fuzzy Systems is a significant source with 74 articles. Its focus on intelligent systems suggests a connection between decision-making processes and advanced computational approaches, contributing to the evolution of cybersecurity strategies.

3.4.5. EXPERT SYSTEMS WITH APPLICATIONS

• **Articles:** 68

• **Details:** Expert Systems with Applications, with 68 articles, is a source emphasizing the practical applications of decision support systems. The contributions from this source likely explore real-world implementations and solutions in the cybersecurity domain.

3.4.6. SENSORS

• **Articles:** 61

• **Details:** Sensors, with 61 articles, signifies the importance of sensor technologies in decision-making and cybersecurity. The content from this source may delve into the role of sensors in threat detection, incident response, and overall information security.

3.4.7. APPLIED SCIENCES (SWITZERLAND

• **Articles:** 57

• **Details:** Applied Sciences (Switzerland) is another Swiss-based source with 57 articles. The interdisciplinary nature of applied sciences suggests a holistic exploration of decision-making aspects in cybersecurity, potentially addressing practical challenges and solutions.

3.4.8. COMPUTERS AND SECURITY

• **Articles:** 53

• **Details:** Computers and Security, with 53 articles, is a source specifically dedicated to the intersection of computing technologies and security concerns. The articles in this source may provide insights into technological advancements and their implications for decision-making in cybersecurity.

3.4.9. JOURNAL OF LOSS PREVENTION IN THE PROCESS INDUSTRIES

• **Articles:** 50

• **Details:** The Journal of Loss Prevention in the Process Industries, with 50 articles, suggests a focus on risk assessment and management in industrial contexts. The content from this source may contribute to understanding decision-making strategies to prevent and mitigate security incidents.

3.4.10. SOFT COMPUTING

• **Articles:** 48

• **Details:** Soft Computing, with 48 articles, indicates a source that explores the application of soft computing techniques in decision-making processes related to cybersecurity. The content may involve fuzzy logic, neural networks, and other computational methods.

These sources collectively represent a diverse range of journals, each contributing significantly to the understanding of decision-making and cybersecurity. Researchers in the field can find valuable insights and perspectives by exploring the content published in these key sources. Table 5 and figure 3 show the summary of most relevant sources.

Table 5. most 10 relevant sources

Sources	Articles
IEEE ACCESS	203
SUSTAINABILITY (SWITZERLAND)	169
ENERGIES	89
JOURNAL OF INTELLIGENT AND FUZZY SYSTEMS	74
EXPERT SYSTEMS WITH APPLICATIONS	68
SENSORS	61
APPLIED SCIENCES (SWITZERLAND)	57
COMPUTERS AND SECURITY	53
JOURNAL OF LOSS PREVENTION IN THE PROCESS INDUSTRIES	50
SOFT COMPUTING	48

3.5 CORE SOURCES BASED ON BRADFORD LAW

Bradford's Law of Scattering provides insights into the distribution of literature in a field, emphasizing that a small number of sources contribute significantly to the overall body of knowledge. The following core sources, based on the provided table, adhere to Bradford's Law and play a central role in the field of decision-making and cybersecurity:

Zone 1: Core Sources

1. IEEE ACCESS (Rank 1) :

• **Frequency (Freq):** 203

• **Cumulative Frequency (cumFreq):** 203

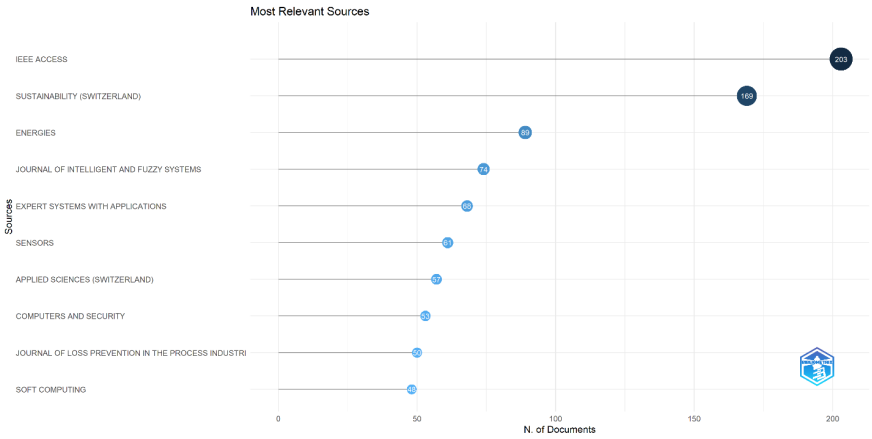

FIGURE 3. most relevant sources

• **Zone:** Zone 1

2. SUSTAINABILITY (SWITZERLAND (Rank 2) :

• **Frequency (Freq):** 169

• **Cumulative Frequency (cumFreq):** 372

• **Zone:** Zone 1

3. ENERGIES (Rank 3) :

• **Frequency (Freq):** 89

• **Cumulative Frequency (cumFreq):** 461

• **Zone:** Zone 1

4. JOURNAL OF INTELLIGENT AND FUZZY SYSTEMS (Rank 4) :

• **Frequency (Freq):** 74

• **Cumulative Frequency (cumFreq):** 535

• **Zone:** Zone 1

5. EXPERT SYSTEMS WITH APPLICATIONS (Rank 5) :

• **Frequency (Freq):** 68

• **Cumulative Frequency (cumFreq):** 603

• **Zone:** Zone 1

6. SENSORS (Rank 6) :

• **Frequency (Freq):** 61

• **Cumulative Frequency (cumFreq):** 664

• **Zone:** Zone 1

7. APPLIED SCIENCES (SWITZERLAND) (Rank 7) :

• **Frequency (Freq):** 57

• **Cumulative Frequency (cumFreq):** 721

• **Zone:** Zone 1

8. COMPUTERS AND SECURITY (Rank 8) :

• **Frequency (Freq):** 53

• **Cumulative Frequency (cumFreq):** 774

• **Zone:** Zone 1

9. JOURNAL OF LOSS PREVENTION IN THE PROCESS INDUSTRIES (Rank 9) :

• **Frequency (Freq):** 50

• **Cumulative Frequency (cumFreq):** 824

• **Zone:** Zone 1

10. SOFT COMPUTING (Rank 10) :

• **Frequency (Freq):** 48

• **Cumulative Frequency (cumFreq):** 872

• **Zone:** Zone 1

These core sources, concentrated in Zone 1, are pivotal in shaping the discourse on decision-making and cybersecurity. Researchers and practitioners can consider these sources as primary outlets for accessing foundational knowledge and staying abreast of developments in the field. Table 6 and figure 4 show the summary of this section

Table 6. Core Sources Based on Bradford Law

SO	Rank	Freq	cumFreq	Zone
IEEE ACCESS	1	203	203	Zone 1
SUSTAINABILITY (SWITZERLAND)	2	169	372	Zone 1
ENERGIES	3	89	461	Zone 1
JOURNAL OF INTELLIGENT AND FUZZY SYSTEMS	4	74	535	Zone 1
EXPERT SYSTEMS WITH APPLICATIONS	5	68	603	Zone 1
SENSORS	6	61	664	Zone 1
APPLIED SCIENCES (SWITZERLAND)	7	57	721	Zone 1
COMPUTERS AND SECURITY	8	53	774	Zone 1
JOURNAL OF LOSS PREVENTION IN THE PROCESS INDUSTRIES	9	50	824	Zone 1
SOFT COMPUTING	10	48	872	Zone 1

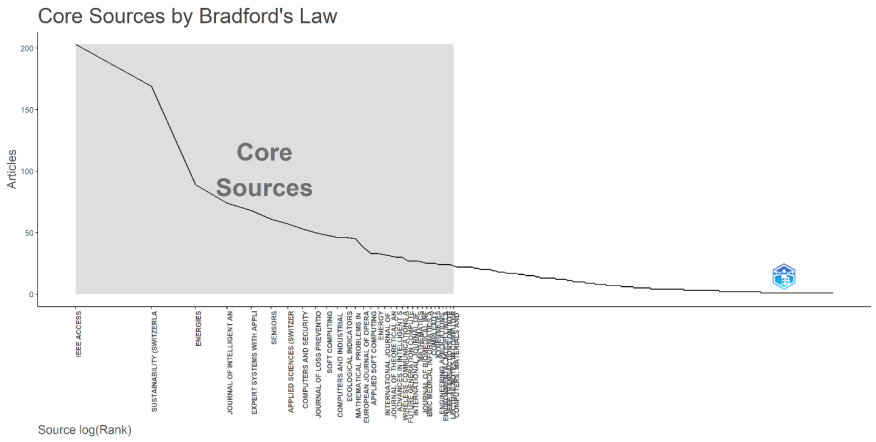

FIGURE 4. Core Sources Based on Bradford Law

3.6 SOURCE LOCAL IMPACT BY H-INDEX

The h-index, g-index, and m-index are key bibliometric indicators that provide insights into the impact and productivity of sources within a specific field. The following section explores the local impact of selected sources in the realm of decision-making and cybersecurity:

1. IEEE ACCESS:

- **h-Index:** 30
- **g-Index:** 50
- **m-Index:** 5
- **Total Citations (TC):** 3368
- **Number of Publications (NP):** 203
- **Publication Year Start (PY_start):** 2018
- **Details:** IEEE ACCESS demonstrates a robust local impact, with a high h-index of 30, indicating that 30 articles have been cited at least 30 times each. The g-index and m-index further reinforce its influence in the field.

2. EXPERT SYSTEMS WITH APPLICATIONS:

- **h-Index:** 22
- **g-Index:** 33
- **m-Index:** 3.67
- **Total Citations (TC):** 1259
- **Number of Publications (NP):** 68
- **Publication Year Start (PY_start):** 2018

• **Details:** Expert Systems with Applications exhibits a solid local impact, with a respectable h-index of 22. The g-index and m-index highlight its contribution to the field, balancing productivity and citation impact.

3. SUSTAINABILITY (SWITZERLAND) :

• **h-Index:** 19
• **g-Index:** 29
• **m-Index:** 3.17
• **Total Citations (TC):** 1301
• **Number of Publications (NP):** 169
• **Publication Year Start (PY_start):** 2018
• **Details:** Sustainability (Switzerland) demonstrates a significant local impact, as reflected in its h-index of 19. The g-index and m-index further emphasize its influence in the field of decision-making and cybersecurity.

4. JOURNAL OF LOSS PREVENTION IN THE PROCESS INDUSTRIES:

• **h-Index:** 18
• **g-Index:** 25
• **m-Index:** 3.0
• **Total Citations (TC):** 751
• **Number of Publications (NP):** 50
• **Publication Year Start (PY_start):** 2018
• **Details:** The Journal of Loss Prevention in the Process Industries holds a substantial local impact, with an h-index of 18. The g-index and m-index highlight its contribution to the field's literature.

5. COMPUTERS AND INDUSTRIAL ENGINEERING:

• **h-Index:** 17
• **g-Index:** 31
• **m-Index:** 2.83
• **Total Citations (TC):** 1005
• **Number of Publications (NP):** 46
• **Publication Year Start (PY_start):** 2018
• **Details:** Computers and Industrial Engineering showcases a noteworthy local impact, with a solid h-index of 17. The g-index and m-index further affirm its significance in the field.

6. ECOLOGICAL INDICATORS:

• **h-Index:** 17
• **g-Index:** 31
• **m-Index:** 2.83
• **Total Citations (TC):** 996
• **Number of Publications (NP):** 46
• **Publication Year Start (PY_start):** 2018
• **Details:** Ecological Indicators exhibits a robust local impact, with an h-index of 17. The g-index and m-index emphasize its contribution to the literature at the intersection of decision-making and ecological considerations.

7. ENERGIES:

• **h-Index:** 17
• **g-Index:** 25
• **m-Index:** 2.83
• **Total Citations (TC):** 874
• **Number of Publications (NP):** 89
• **Publication Year Start (PY_start):** 2018
• **Details:** Energies demonstrates a substantial local impact, with an h-index of 17. The g-index and m-index underscore its significance in the field of decision-making and cybersecurity within the context of energy systems.

8. ENERGY:

• **h-Index:** 17
• **g-Index:** 26
• **m-Index:** 2.83
• **Total Citations (TC):** 718
• **Number of Publications (NP):** 33
• **Publication Year Start (PY_start):** 2018
• **Details:** Energy maintains a solid local impact, with an h-index of 17. The g-index and m-index highlight its contribution to the broader discourse on decision-making in the energy sector.

9. EUROPEAN JOURNAL OF OPERATIONAL RESEARCH:

- **h-Index:** 17
- **g-Index:** 30
- **m-Index:** 2.83
- **Total Citations (TC):** 957
- **Number of Publications (NP):** 38
- **Publication Year Start (PY_start):** 2018
- **Details:** The European Journal of Operational Research has made a significant impact in its local community, which is evident from its h-index of 17. The g-index and m-index provide additional evidence of its reputation in the field of decision-making and operational research.

10. INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH:

- **h-Index:** 15
- **g-Index:** 32
- **m-Index:** 2.5
- **Total Citations (TC):** 1312
- **Number of Publications (NP):** 32
- **Publication Year Start (PY_start):** 2018
- **Details:** The International Journal of Production Research has a significant impact locally, as evidenced by its h-index of 15. The g-index and m-index emphasize its importance in the field of decision-making in production and manufacturing.

The local impact metrics give us important information about how influential and impactful the selected sources are in the decision-making and cybersecurity field. Researchers can use these metrics to assess how important and influential each source is in the academic and practical aspects of the field. Table 7 and Figure 5 provide a summary of this section.

Table 7. Source Local Impact by h-Index

Element	h_index	g_index	m_index	TC	NP	PY_start
IEEE ACCESS	30	50	5	3368	203	2018
EXPERT SYSTEMS WITH APPLICATIONS	22	33	3.66666667	1259	68	2018
SUSTAINABILITY (SWITZERLAND)	19	29	3.16666667	1301	169	2018
JOURNAL OF LOSS PREVENTION IN THE PROCESS INDUSTRIES	18	25	3	751	50	2018
COMPUTERS AND INDUSTRIAL ENGINEERING	17	31	2.83333333	1005	46	2018
ECOLOGICAL INDICATORS	17	31	2.83333333	996	46	2018
ENERGIES	17	25	2.83333333	874	89	2018
ENERGY	17	26	2.83333333	718	33	2018
EUROPEAN JOURNAL OF OPERATIONAL RESEARCH	17	30	2.83333333	957	38	2018
INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	15	32	2.5	1312	32	2018

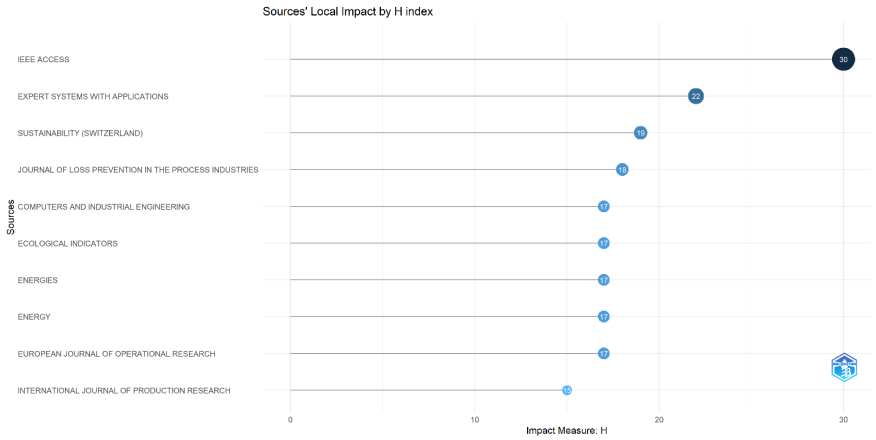

FIGURE 5. Source Local Impact by h-Index

3.7 COUNTRY SCIENTIFIC PRODUCTION

The distribution of scientific production across different regions provides insights into the global landscape of research in the field of decision-making and cybersecurity. The following section outlines the scientific production of selected countries:

1. China (Freq: 3121) :

• China leads the scientific production in the field with a substantial frequency of 3121 articles. This underscores China's significant contribution to the ongoing discourse on decision-making and cybersecurity.

2. USA (Freq: 1486) :

• The United States follows closely with a frequency of 1486 articles, reflecting the active engagement of American researchers and institutions in advancing knowledge in this domain.

3. India (Freq: 701) :

• India contributes significantly to the scientific production, with a frequency of 701 articles. This emphasizes the growing interest and involvement of Indian researchers in decision-making and cybersecurity research.

4. UK (Freq: 569) :

• The United Kingdom, with a frequency of 569 articles, stands as a notable contributor to the global scientific output in this field. British researchers play a key role in shaping discussions on decision-making and cybersecurity.

5. Australia (Freq: 340) :

• Australia's scientific production, with a frequency of 340 articles, highlights the country's commitment to advancing knowledge in decision-making and cybersecurity.

6. Saudi Arabia (Freq: 318) :

• Saudi Arabia demonstrates a strong presence in scientific production, with a frequency of 318 articles. This reflects the country's active engagement in research related to decision-making and cybersecurity.

7. Italy (Freq: 316) :

• Italy contributes significantly to the global scientific output in this field, with a frequency of 316 articles. Italian researchers play a crucial role in advancing knowledge and innovation.

8. Iran (Freq: 311) :

• Iran's scientific production, with a frequency of 311 articles, showcases the country's involvement in decision-making and cybersecurity research, contributing valuable perspectives to the global discourse.

9. Canada (Freq: 265) :

• Canada's scientific production, with a frequency of 265 articles, reflects the country's active participation in research related to decision-making and cybersecurity.

10. Spain (Freq: 253) :

• Spain, with a frequency of 253 articles, is a significant contributor to the global scientific output in this field. Spanish researchers contribute diverse perspectives to decision-making and cybersecurity discussions.

11. Germany (Freq: 237) :

• Germany's scientific production, with a frequency of 237 articles, underscores the country's commitment to advancing knowledge and innovation in decision-making and cybersecurity.

12. Brazil (Freq: 228) :

• Brazil, with a frequency of 228 articles, plays a noteworthy role in the global scientific landscape of decision-making and cybersecurity.

13. Turkey (Freq: 218) :

• Turkey's scientific production, with a frequency of 218 articles, reflects the country's active engagement in decision-making and cybersecurity research.

14. South Korea (Freq: 201) :

• South Korea's contribution to scientific production, with a frequency of 201 articles, emphasizes the country's involvement in advancing knowledge in this field.

15. Pakistan (Freq: 185) :

• Pakistan, with a frequency of 185 articles, is a significant contributor to the global scientific discourse on decision-making and cybersecurity.

16. Ukraine (Freq: 179) :

• Ukraine's scientific production, with a frequency of 179 articles, showcases the country's participation in research related to decision-making and cybersecurity.

17. France (Freq: 177) :

• France, with a frequency of 177 articles, contributes to the global scientific output in decision-making and cybersecurity, adding valuable perspectives to the field.

18. Malaysia (Freq: 141) :

• Malaysia, with a frequency of 141 articles, is actively involved in advancing knowledge in decision-making and cybersecurity.

19. Netherlands (Freq: 136) :

• The Netherlands, with a frequency of 136 articles, plays a notable role in the global scientific landscape of decision-making and cybersecurity.

20. Portugal (Freq: 120) :

• Portugal's scientific production, with a frequency of 120 articles, reflects the country's active participation in research related to decision-making and cybersecurity.

This overview provides a glimpse into the global distribution of scientific production, showcasing the active engagement of various countries in advancing knowledge and contributing to the ongoing dialogue on decision-making and cybersecurity, table 7 and figure 6 show the summary of this section

Table 8. Country Scientific Production

region	Freq
CHINA	3121
USA	1486
INDIA	701
UK	569
AUSTRALIA	340
SAUDI ARABIA	318
ITALY	316
IRAN	311
CANADA	265
SPAIN	253
GERMANY	237
BRAZIL	228
TURKEY	218
SOUTH KOREA	201
PAKISTAN	185
UKRAINE	179
FRANCE	177
MALAYSIA	141
NETHERLANDS	136
PORTUGAL	120

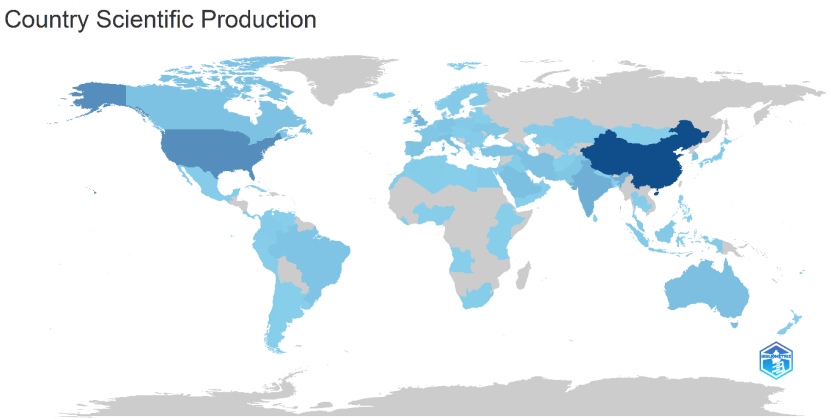

FIGURE 6. Country Scientific Production

3.8 WORD CLOUD:

1. Decision Making (Frequency: 3063) :

• The term "decision making" stands out as the most frequently occurring, indicating its central role in the literature. It encompasses a wide range of discussions on the decision-making process in the context of cybersecurity.

2. Risk Assessment (Frequency: 2343) :

• "Risk assessment" emerges prominently, reflecting the significant attention given to evaluating and managing risks within the cybersecurity landscape.

3. Network Security (Frequency: 687) :

• "Network security" is a critical aspect of the word cloud, underscoring the focus on securing digital networks in the decision-making processes related to cybersecurity.

4. Decision Support Systems (Frequency: 522) :

• The term "decision support systems" highlights the integration of technological tools and systems to aid decision-making in the field of cybersecurity.

5. Human (Frequency: 436) :

• The presence of "human" suggests a focus on the human element in decision-making processes, emphasizing the importance of understanding human behavior and cognition in cybersecurity contexts.

6. Risk Management (Frequency: 379) :

• "Risk management" is a recurrent theme, indicating a strong emphasis on strategies and frameworks for effectively managing risks in cybersecurity decision-making.

7. Risk Analysis (Frequency: 348) :

• The term "risk analysis" signifies a detailed examination of potential risks, contributing to informed decision-making in the cybersecurity domain.

8. Machine Learning (Frequency: 347) :

• "Machine learning" is a significant term, reflecting the increasing integration of artificial intelligence techniques in decision-making processes for cybersecurity.

9. Decisions Makings (Frequency: 326) :

• The term "decisions makings" highlights variations in the expression of the decision-making concept, underlining the diversity in the literature.

10. Artificial Intelligence (Frequency: 315) :

• "Artificial intelligence" is a key focus, indicating the growing role of AI in enhancing decision-making capabilities within the cybersecurity landscape.

11. Humans (Frequency: 303) :

• The term "humans" further emphasizes the human-centric aspect of decision-making, considering the impact of human factors on cybersecurity decisions.

12. Internet of Things (Frequency: 285) :

• "Internet of Things" (IoT) signifies the interconnectedness of devices and its relevance in decision-making processes related to cybersecurity in the era of IoT.

13. Behavioral Research (Frequency: 276) :

• The term "behavioral research" suggests an interest in understanding and incorporating behavioral aspects into the decision-making frameworks within cybersecurity.

14. Risk Perception (Frequency: 239) :

• "Risk perception" highlights the importance of how individuals perceive and interpret risks, influencing decision-making strategies in cybersecurity.

15. Decision Theory (Frequency: 236) :

• "Decision theory" indicates a theoretical approach to understanding decision-making processes, providing a foundation for discussions in the field.

The word cloud visually encapsulates the richness and diversity of topics within decision-making and cybersecurity literature, showcasing the prominence of certain terms and themes in the academic discourse, table 9 and figure 7 show the summary of this section.

3.9 TOPIC TREND ANALYSIS

The provided table offers insights into the trends and evolution of specific topics in the field, as reflected by their frequencies over different years. the trajectory of each topic in detail are:

1. Problem Solving (Freq: 18) :

• **Year Q1 (2018):** 18 articles

Table 9. Word Cloud

Terms	Frequency
decision making	3063
risk assessment	2343
network security	687
decision support systems	522
human	436
risk management	379
risk analysis	348
machine learning	347
decisions makings	326
artificial intelligence	315
humans	303
internet of things	285
behavioral research	276
risk perception	239
decision theory	236

FIGURE 7. Word Cloud

• **Year Median (2018):** 18 articles
• **Year Q3 (2019):** 18 articles
• **Discussion:** The topic of problem-solving had a consistent presence in 2018 and maintained a steady frequency until 2019. While there was no increase in frequency, its sustained appearance suggests continued interest in the application of problem-solving methodologies.

2. Organization and Management (Freq: 14) :
• **Year Q1 (2018):** 14 articles
• **Year Median (2018):** 14 articles
• **Year Q3 (2020):** 14 articles
• **Discussion:** Similar to problem-solving, the frequency of articles related to organization and management remained stable in 2018. Interestingly, it continued to be a focus through 2020, indicating a prolonged interest in organizational and managerial aspects within the field.

3. Non-Insulin Dependent Diabetes Mellitus (Freq: 10) :
• **Year Q1 (2018):** 10 articles
• **Year Median (2018):** 10 articles
• **Year Q3 (2020):** 10 articles
• **Discussion:** The frequency for non-insulin dependent diabetes mellitus remained constant across 2018 and sustained until 2020. While the number of articles is relatively small, the consistency suggests a continued interest in this specific health-related topic within the field.

4. Priority Journal (Freq: 80) :
• **Year Q1 (2018):** 80 articles
• **Year Median (2019):** 80 articles
• **Year Q3 (2020):** 80 articles
• **Discussion:** The term "priority journal" appears consistently across 2018 and 2019. The sustained frequency suggests that discussions around priority journals were prevalent, perhaps indicating a focus on selecting and prioritizing journals for publication.

5. Procedures (Freq: 75) :

• **Year Q1 (2018):** 75 articles
• **Year Median (2019):** 75 articles
• **Year Q3 (2021):** 75 articles
• **Discussion:** The term "procedures" shows a consistent frequency from 2018 to 2019 and maintains its level through 2021. This suggests a continued emphasis on detailing and discussing procedures within the field.

6. Models (Freq: 41) :
• **Year Q1 (2019):** 41 articles
• **Year Median (2019):** 41 articles
• **Year Q3 (2020):** 41 articles
• **Discussion:** The term "models" sees a surge in frequency in 2019, suggesting an increased focus on modeling within the field. The sustained frequency through 2020 indicates continued interest in this topic.

7. Male (Freq: 210) :
• **Year Q1 (2019):** 210 articles
• **Year Median (2020):** 210 articles
• **Year Q3 (2022):** 210 articles
• **Discussion:** The term "male" sees a consistent frequency, indicating a continued focus on gender-related aspects within the field. The sustained interest may suggest ongoing discussions on the role of gender in decision-making and cybersecurity.

8. Security of Data (Freq: 118) :
• **Year Q1 (2019):** 118 articles
• **Year Median (2020):** 118 articles
• **Year Q3 (2021):** 118 articles
• **Discussion:** The term "security of data" maintains a consistent frequency, highlighting the enduring importance of data security within the field. The sustained interest suggests a continuous exploration of strategies and technologies for securing data.

9. Cloud Computing (Freq: 114) :
• **Year Q1 (2019):** 114 articles
• **Year Median (2020):** 114 articles
• **Year Q3 (2022):** 114 articles
• **Discussion:** "Cloud computing" experiences a consistent frequency, indicating an ongoing exploration of its impact on decision-making and cybersecurity. The sustained interest suggests a continuous evolution in understanding and adopting cloud technologies, table 9 and figure 8 show the summary of this section

Table 10. Topic Trend Analysis

item	freq	year_q1	year_med	year_q3
problem solving	18	2018	2018	2019
organization and management	14	2018	2018	2020
non insulin dependent diabetes mellitus	10	2018	2018	2020
priority journal	80	2018	2019	2020
procedures	75	2018	2019	2021
models	41	2019	2019	2020
male	210	2019	2020	2022
security of data	118	2019	2020	2021
cloud computing	114	2019	2020	2022
decision making	3063	2020	2021	2022
risk assessment	2342	2019	2021	2022
network security	687	2020	2021	2022
machine learning	347	2021	2022	2023
decisions makings	326	2022	2022	2023
artificial intelligence	315	2020	2022	2023
machine-learning	118	2022	2023	2023
risks management	91	2022	2023	2023
reinforcement learnings	38	2022	2023	2023

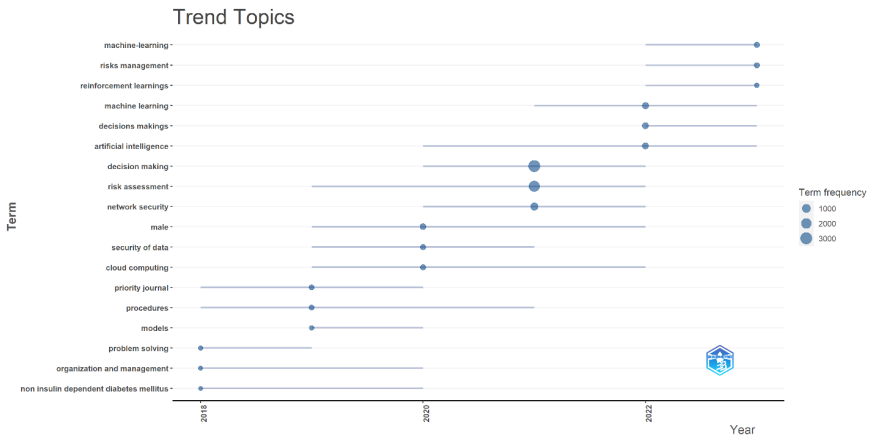

FIGURE 8. Topic Trend Analysis

3.10 CO-OCCURRENCE NETWORK ANALYSIS

The exported data provides insights into the co-occurrence network of terms in the field of decision-making and cybersecurity. Each node represents a specific term, and the table includes information about the cluster, betweenness centrality, closeness centrality, and PageRank for each term. Let's delve into the key findings and discuss the implications of the co-occurrence network:

1. Cluster and Grouping:

• All the terms belong to Cluster 1, indicating a high degree of interconnectedness among these terms. This suggests a cohesive thematic group within the field of decision-making and cybersecurity where these terms are frequently discussed together.

2. Betweenness Centrality:

• **Decision Making and Risk Assessment:** "Decision making" and "risk assessment" exhibit high betweenness centrality, indicating their critical role as bridges connecting different terms in the network. They likely serve as central concepts that link various aspects of decision-making and cybersecurity.

• **Network Security and Decision Support Systems:** "Network security" and "decision support systems" also have notable betweenness centrality, suggesting their significant influence in connecting different topics within the field.

3. Closeness Centrality:

• **Decision Making and Risk Assessment:** Similar to betweenness centrality, "decision making" and "risk assessment" have high closeness centrality, emphasizing their proximity to other terms in the network. This suggests that these terms are closely related to a wide range of other concepts in the field.

• **Internet of Things and Deep Learning:** "Internet of things" and "deep learning" also show relatively high closeness centrality, indicating their close connection to other terms in the network.

4. PageRank:

• **Decision Making and Risk Assessment:** Once again, "decision making" and "risk assessment" demonstrate high PageRank, highlighting their importance and influence in the network. These terms are likely central in shaping discussions and research within the field.

• **Artificial Intelligence and Learning Systems:** "Artificial intelligence" and "learning systems" have notable PageRank values, indicating their significant contribution to the overall structure and prominence in the co-occurrence network.

5. Key Observations:

• **Diversity of Topics:** The co-occurrence network includes a diverse range of topics, from foundational concepts like "decision making" and "risk assessment" to emerging technologies like "artificial intelligence" and "deep learning."

• **Interconnected Themes:** The high betweenness and closeness centrality of certain terms suggest that these concepts play pivotal roles in connecting and influencing various aspects of decision-making and cybersecurity.

• **Influence of Emerging Technologies:** Terms such as "artificial intelligence," "machine learning," and "deep learning" have notable centrality measures, indicating the growing influence of these technologies in the field.

6. Implications:

• Researchers and practitioners in decision-making and cybersecurity should pay particular attention to the central terms like "decision making" and "risk assessment," as they form critical links between different themes in the field.

• The network analysis highlights the interconnected nature of topics, emphasizing the need for a holistic understanding of various concepts to navigate the complex landscape of decision-making in cybersecurity.

• Emerging technologies like "artificial intelligence" and "machine learning" are prominent within the network, suggesting their increasing relevance and impact on decision-making processes in cybersecurity.

The co-occurrence network analysis provides a visual representation of the interconnectedness of key terms in the field, offering valuable insights into the thematic structure and influential concepts within decision-making and cybersecurity research, figure 9 show the summary of this section.

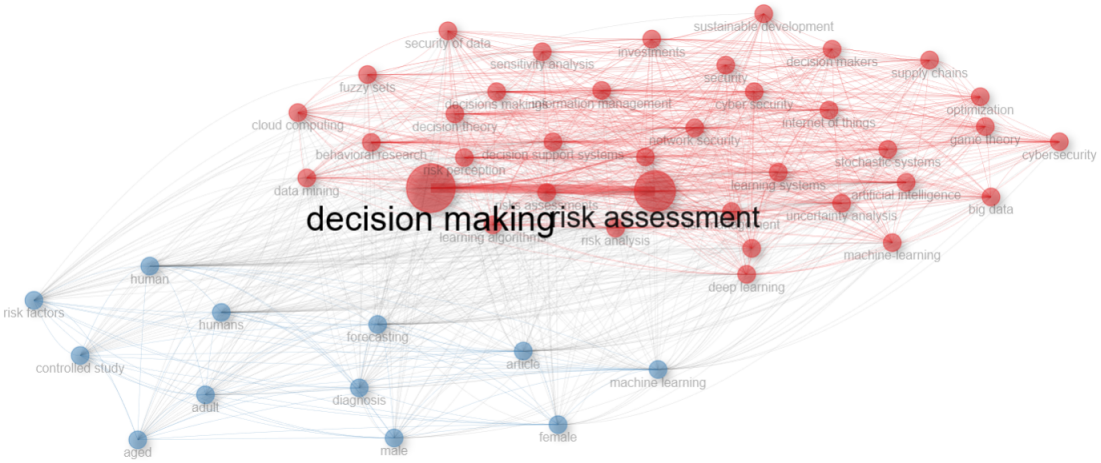

FIGURE 9. **Co-occurrence Network Analysis**

3.11 COLLABORATION WORLD MAP ANALYSIS

The collaboration world map, represented by the frequency of collaborations between different countries, provides insights into the global nature of research partnerships in the field of decision-making and cybersecurity. The table reveals the most frequent collaborations between countries. Let's delve into the findings and discuss the implications:

1. Major Collaborations:

• **China-USA Collaboration (Frequency: 122):**

• The collaboration between China and the USA emerges as the most frequent, indicating a robust partnership in decision-making and cybersecurity research. This collaboration suggests a pooling of expertise and resources between two major players in the field.

• **China-United Kingdom (Frequency: 63) and USA-United Kingdom (Frequency: 48):**

• Collaborations between China and the United Kingdom, as well as between the USA and the United Kingdom, are notable. These partnerships likely contribute to the exchange of knowledge and perspectives between these countries.

• **India-Saudi Arabia (Frequency: 46):**

• The collaboration between India and Saudi Arabia suggests a connection between countries with distinct cultural and economic backgrounds, reflecting the global nature of cybersecurity research collaborations.

2. Regional Partnerships:

• **China's Collaborations:**

• China's collaborations extend beyond its borders, involving countries such as Hong Kong, Canada, Australia, India, Singapore, Pakistan, and Saudi Arabia. This comprehensive network highlights China's active engagement in international research collaborations.

• **USA's Collaborations:**

• The USA's collaborations extend to Canada, Australia, Germany, and Spain, showcasing a diverse set of international partners. This reflects the USA's role as a key player in global cybersecurity research efforts.

• **United Kingdom's Collaborations:**

• The United Kingdom collaborates extensively with Italy, Australia, Germany, Spain, and the Netherlands. These partnerships indicate a wide-reaching influence and involvement of the United Kingdom in international research endeavors.

3. Intercontinental Collaborations:

• **Saudi Arabia's Collaborations:**

• Saudi Arabia's collaborations with India, Pakistan, and Egypt demonstrate an intercontinental reach, fostering partnerships across Asia and Africa in the realm of decision-making and cybersecurity research.

• Global Network:

• The collaborative efforts involve countries from different continents, showcasing the truly global nature of research in decision-making and cybersecurity. These partnerships contribute to a diverse exchange of perspectives and methodologies.

4. Implications:

• Knowledge Exchange and Diversity:

• The frequent collaborations suggest a rich exchange of knowledge and expertise, contributing to a comprehensive understanding of decision-making and cybersecurity from diverse perspectives.

• Emerging Research Hubs:

• Certain collaborations, such as China's partnerships with Hong Kong and Singapore, indicate the emergence of regional research hubs in Asia. These hubs likely play a pivotal role in advancing research in the field.

• Global Impact:

• Collaborations between major players like China, the USA, and the United Kingdom highlight the global impact of their joint efforts, potentially influencing international policies and strategies in cybersecurity.

• Opportunities for Future Collaborations:

• The identified collaborations provide insights for researchers and institutions seeking potential partners for future collaborations. Establishing partnerships with countries that have active research networks can enhance the global impact of research endeavors.

The collaboration world map reveals a dynamic landscape of international partnerships in decision-making and cybersecurity research, emphasizing the interconnected and global nature of the field. These collaborations contribute to a collective effort in addressing the complex challenges and advancing knowledge in this critical domain, table 11 and figure 10 show the summary of this section.

Table 11. Collaboration World Map Analysis

From	To	Frequency
CHINA	USA	122
CHINA	UNITED KINGDOM	63
USA	UNITED KINGDOM	48
INDIA	SAUDI ARABIA	46
CHINA	HONG KONG	42
CHINA	CANADA	38
CHINA	AUSTRALIA	37
CHINA	INDIA	36
USA	CANADA	35
CHINA	SINGAPORE	34
SAUDI ARABIA	PAKISTAN	34
USA	AUSTRALIA	31
CHINA	PAKISTAN	30
CHINA	SAUDI ARABIA	29
USA	GERMANY	28
USA	INDIA	26
UNITED KINGDOM	ITALY	23
USA	ITALY	23
SAUDI ARABIA	EGYPT	22
CHINA	IRAN	21
UNITED KINGDOM	AUSTRALIA	21
UNITED KINGDOM	SPAIN	21
UNITED KINGDOM	NETHERLANDS	20
USA	SAUDI ARABIA	20
CHINA	SWEDEN	18
UNITED KINGDOM	GERMANY	18
USA	SPAIN	18
INDIA	UNITED KINGDOM	17
ITALY	FRANCE	17
ITALY	SPAIN	17

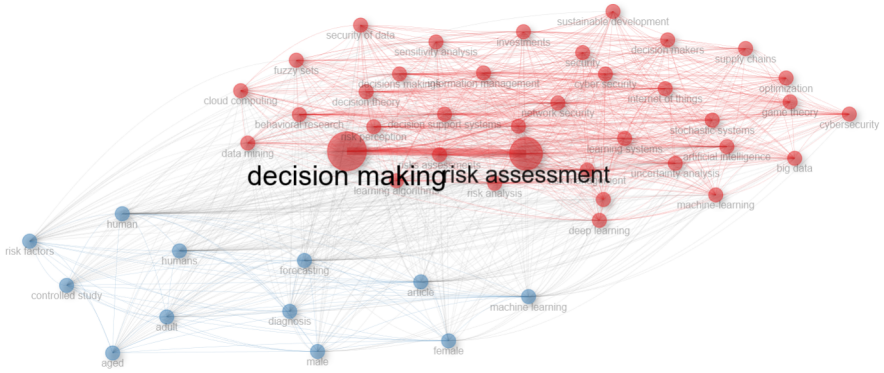

FIGURE 10. - Collaboration World Map Analysis

4. DISCUSSION

This bibliometric analysis offers the most comprehensive investigation into global research activities regarding decision-making in the context of cybersecurity. By examining 4,637 documents from Scopus spanning 2018-2024, we delineated key patterns related to scientific production, authorship collaborations, regional contributions, prominent journals, underlying conceptual structure, and topical trajectories that define current literature. Several interesting observations emerge - steady growth peaking in 2023 signals rising stakeholder interest, Chinese and American institutions dominate research outputs reflecting geopolitical strongholds, prolific national and international partnerships highlight interconnected priorities, core journals such as IEEE Access and Expert Systems cement cross-disciplinary discourse, and critical themes like risk assessment and network security underpin the field alongside emerging technologies like machine learning. Some limitations provide avenues for future work - assessing document quality, comparing datasets from other databases, investigating policies and events influencing research, and conducting surveys to understand barriers around decision-making. Additionally, updated studies to track advances as the literature evolves would be beneficial.

our analysis provides a valuable evidence-base for researchers to identify influential work, key contributors, major knowledge hubs, critical technology trends, and potential collaborators to advance sophisticated decision-making frameworks and systems tackling pressing cybersecurity challenges worldwide.

5. CONCLUSION

This bibliometric study offers a comprehensive global overview and science mapping analysis of research efforts surrounding decision-making in cybersecurity published over 2018-2024. Findings reveal accelerating outputs and robust international collaborations dominated by China and the USA, highlighting the field's growing prominence. Moreover, critical issues around risk assessment, network security, decision support systems, and emerging AI/ML technologies underpin the literature. The results can help stakeholders discern major research directions, recognize leading contributors, facilitate targeted partnerships, exploit real-world developments shaping the discourse, and inform policies and practices linking decision science and cybersecurity. As rapid technological advances persist, updated reviews tracing the knowledge landscapes evolution remain vital.

6. FUNDING

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7. ACKNOWLEDGEMENT

None

8. CONFLICTS OF INTEREST

The author declares no conflict of interest.

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