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Review

Mapping the Landscape of Romanian Automotive Research: A Bibliometric Analysis

Eugen Valentin Butilă and Răzvan Gabriel Boboc *

Department of Automotive and Transport Engineering, Transilvania University of Brasov, RO-500036 Brasov, Romania; butila@unitbv.ro
* Correspondence: razvan.boboc@unitbv.ro

Abstract: The automotive sector plays an essential role in the Romanian economy, making a significant contribution to industrial production and employment. This study conducts a comprehensive bibliometric analysis of scholarly publishing in the Romanian automotive sector. By analyzing publication trends, citation patterns, and collaboration networks, the study maps the evolution of research in this field and highlights key contributions and future directions. The findings reveal a significant increase in research output over the past two decades, with a focus on emerging fields such as artificial intelligence, electric and autonomous vehicles, and sustainable mobility solutions. The analysis also identifies leading researchers and institutions and explores collaboration networks between Romanian and international actors. These insights provide valuable benchmarks for assessing Romania's position in the global automotive research arena and inform strategies for future research efforts.

Keywords: bibliometric analysis; Romanian automotive industry; research trends; collaborative networks; citation patterns

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1. Introduction

The automotive sector is an important component of Romania's economy, substantially contributing to industrial production and employment. Over recent decades, Romania has emerged as a significant player in the European automotive landscape, attracting substantial investments from major global automakers while developing a robust network of local suppliers and research institutions. As this industry undergoes transformation, understanding the trends and impact of academic publishing becomes essential for tracking technological advances, research priorities, and policy implications within the sector.

The rapid digitalization of automotive manufacturing processes coupled with increasing focus on sustainable mobility solutions has catalyzed significant shifts in Romania's automotive research landscape. Research institutions and universities have broadened their focus beyond traditional mechanical engineering to encompass emerging fields including artificial intelligence, cybersecurity, and environmental impact assessment [1–5].

Despite the growing body of research in the Romanian automotive sector, several significant research gaps persist. There remains a notable absence of comprehensive analyses that effectively map the evolution of research in this domain and highlight key contributions and future directions. The collaboration networks driving innovation in this field have not been thoroughly examined, limiting understanding of the interconnections between academic and industrial research. Furthermore, Romania's position in the global automotive research arena lacks proper benchmarking, making it difficult to assess its competitive standing internationally.

Additional gaps include insufficient assessment of thematic focuses in Romanian automotive research, which hinders strategic planning for future research initiatives. The sector also suffers from inadequate evaluation mechanisms for research impact within the global context, preventing full appreciation of Romanian contributions to international automotive knowledge. These gaps highlight the need for a strategic approach to research that can guide more targeted and impactful efforts in this rapidly evolving field.

This study aims to address these gaps through a comprehensive bibliometric analysis of scholarly publishing in the Romanian automotive sector, using the Scopus database for data collection and analysis. By examining publication trends, citation patterns, and the collaboration landscape, this research seeks to provide valuable insights that can inform research strategies and drive innovation in an industry facing unprecedented challenges and transformations, particularly with the shift towards electric vehicles and autonomous driving technologies.

2. Literature Review

Automotive research in Romania has evolved considerably in recent years, with researchers addressing a diverse range of topics that reflect both global trends and local priorities. This development demonstrates the sector's adaptability and commitment to innovation in the face of rapid technological change.

Communication systems for connected vehicles represent a significant area of focus in Romanian automotive research. Studies have explored the development of robust communication technologies tailored to the unique requirements of vehicular environments, addressing challenges such as signal reliability, data security, and interoperability across different vehicle types and infrastructure systems [6–9]. These advancements have the potential to enable the next generation of intelligent transportation systems and connected mobility solutions.

Sustainable manufacturing is another important research topic as the automotive industry faces environmental concerns and regulatory pressures [10]. Romanian researchers have investigated various approaches to reduce the environmental footprint of automotive production processes, including resource efficiency, waste reduction, and implementation of circular economy principles [11–13]. Environmental management practices in the automotive sector have also received attention [14]. These studies contribute to the broader goal of creating more environmentally responsible manufacturing practices across the automotive value chain.

Digital innovations for enhanced safety and personalization have gained prominence in Romanian automotive research. Scholars have examined how digital technologies can improve vehicle safety systems, driver assistance features, and customization options that enhance the user experience [15–18]. This research stream reflects the growing importance of software and digital interfaces in modern vehicle design and functionality.

The field of electromobility has attracted significant research interest, with a particular focus on electromagnetic challenges associated with electric vehicle technologies [19,20]. Romanian scholars have investigated issues related to electric motor design, battery management systems, charging infrastructure, and electromagnetic compatibility [21–23]. This research supports the ongoing transition toward electric mobility and helps address technical barriers to widespread electric vehicles adoption.

Advancements in artificial intelligence and machine learning are highlighted in [24,25], which explore autonomous driving applications and vehicle suspension monitoring. In [26] a genetic algorithm optimization is proposed to enhance autonomous vehicle coordination in roundabouts by strategically balancing the number of vehicles crossing from the yielding road with minimizing delays on the priority road. Voinea et al. examined how Microsoft

HoloLens 2 in a mixed reality environment enhances social presence in autonomous driving, finding significant improvements over traditional communication tools [27].

The emphasis on aligning academic training with industrial requirements is highlighted in [28]. The potential of solar energy in powering electric vehicles (EVs) is explored in [29], while in [30] the frictional and wear behavior of a novel brake pad material was investigated. Other studies delve into system-level sustainability [31] and logistics innovation [32]. These contributions collectively underscore Romania's significant strides in advancing automotive technology and sustainable mobility.

Through these diverse research streams, Romanian scholars have contributed significantly to the advancement of automotive technology and sustainable mobility. However, a comprehensive understanding of how these individual contributions fit into the broader landscape of automotive research, both nationally and internationally, remains a critical gap that this study aims to address using a bibliometric approach.

Bibliometric analysis is a powerful tool for evaluating research output, revealing patterns, and identifying influential works and emerging trends in scientific literature [33,34]. This method has been widely used across various disciplines to provide insights into research dynamics and guide future research directions [35,36]. In the context of the automotive industry, bibliometric analysis can offer valuable perspectives on the thematic focus, collaboration networks, and impact of research [37,38].

The bibliometric analysis presented in this study provides a data-driven overview of Romanian automotive research over the past two decades. By analyzing Scopus-indexed publications, the study identifies key research themes, highlighting how Romanian research has shifted toward emerging global trends. Additionally, citation analysis helps to identify the most influential studies, authors, and institutions, offering insights into research impact and academic leadership. The study also uses network analysis tools to visualize co-authorship and international collaboration patterns. This approach not only tracks progress and research focus areas but also identifies gaps in innovation, funding, and interdisciplinary integration, providing valuable guidance for future research directions and policymaking in Romania's automotive sector.

The paper is organized as follows: Section 3 presents the methodology for data collection and analysis, Section 4 describes the results of the analysis, Section 5 presents the discussions and offers recommendations for future research directions, Section 6 point out the limitations of the study, followed by the Conclusion and recommendations for future research.

3. Materials and Methods

This section outlines the methodology, beginning with the description of the literature data collection process, then detailing the quantitative metrics employed for research impact and productivity analysis, and concluding with the tools and techniques used for research entity relationship mapping.

3.1. Data Collection

To thoroughly examine scholarly publishing in the Romanian automotive sector, we adopted a systematic data collection approach guided by PRISMA guidelines [39], initially focusing on two major academic databases: Web of Science from Clarivate Analytics and Scopus from Elsevier.

3.1.1. Database Selection

Based on a comparative analysis of the two databases, which demonstrated Scopus's superior coverage and the presence of a considerable number of redundant entries, we

opted to utilize Scopus as the exclusive source for data extraction in this study. The broad coverage of the Scopus database has been previously acknowledged by other researchers [40,41]. It was chosen due to its comprehensive indexing of journals and conference proceedings, providing a broad spectrum of academic outputs relevant to the automotive sector. As Web of Science has a more selective indexing approach, which could limit the dataset's comprehensiveness, by using Scopus as the exclusive data source, the study ensures a wide representation of scholarly output.

Also, a single database was used to avoid complexities in merging data from Scopus and Web of Science (WoS), which differ in formats, indexing, and search algorithms. Standardizing results across databases risks inconsistencies and duplicates, while varying metadata structures require extensive cleaning. By focusing on Scopus, the study ensures consistency, minimizes errors, and streamlines analysis, though some relevant WoS-indexed studies may be excluded.

3.1.2. Search Strategy

The search strategy was designed to capture all relevant publications about the automotive sector in Romania. The following search query was utilized to identify a representative corpus of documents relevant to the automotive field in Romanian:

(AFFILCOUNTRY (romania) AND TITLE-ABS-KEY (automotive))

3.1.3. Inclusion and Exclusion Criteria

The following criteria were employed to select studies for inclusion:

- publications related to the automotive sector in Romania, including research articles, review papers, and conference papers;
- studies published between 2004 and 2025 to capture the most recent trends and developments;
- studies published in English or Romanian.

Conversely, the following exclusion criteria were applied:

- articles not focused on the automotive sector or those that did not specifically address the Romanian context;
- non-peer-reviewed publications and grey literature were excluded to maintain the quality and reliability of the data;
- papers published in languages other than English or Romanian and outside the specified time frame.

3.1.4. Data Extraction

The search was conducted on 5 December 2024, and the results were updated on 10 March 2025. The initial search yielded a substantial number of articles. After applying the inclusion and exclusion criteria, 2024 articles were selected for detailed analysis. The results were transferred to EndNote (Clarivate, version 20.6) for further analysis and management. Figure 1 presents a flowchart illustrating the search and screening process.

For each article, metadata including the title, authors, affiliations, publication year, journal name, keywords, abstract, and citation count, was extracted and stored in an Excel file. This metadata forms the basis for subsequent bibliometric analysis. Both authors independently conducted the analysis, and any discrepancies were resolved through discussion and consensus.

3.1.5. Data Processing and Cleaning

The extracted data underwent a thorough cleaning process to remove duplicates and correct any inconsistencies in author names, affiliations, and publication details. Standard

bibliometric techniques were employed to normalize author names and affiliations to ensure accurate mapping of collaboration networks and institutional contributions.

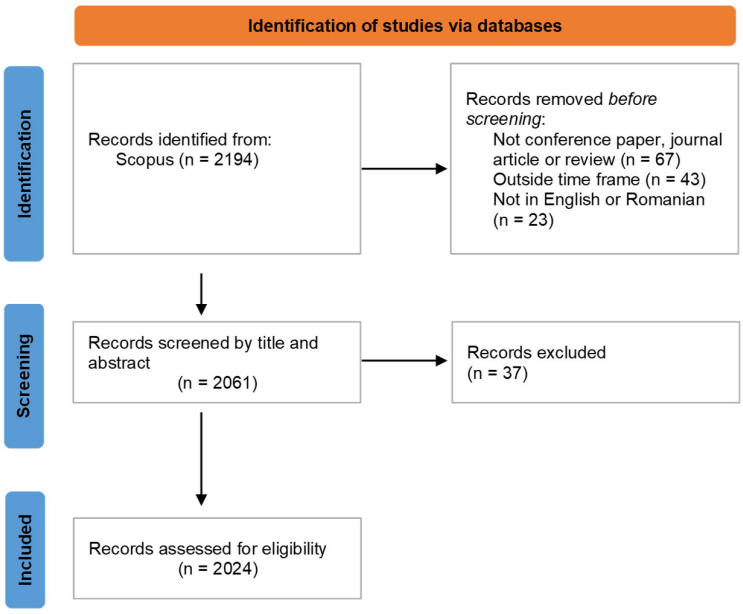

Figure 1. Visual representation of the literature screening process.

3.2. Bibliometric Indicators

To provide a comprehensive analysis of scholarly publishing in the Romanian automotive sector, we employed a variety of bibliometric indicators. These indicators offer insights into productivity, impact, and collaboration patterns within this research domain.

3.2.1. Publication Counts

Publication counts are a fundamental metric in bibliometrics, reflecting the overall research output. By analyzing the number of publications per year, we identified trends and growth patterns in the Romanian automotive sector. This indicator helps in understanding the development trajectory of research activities over time.

3.2.2. Citation Analysis

Citation analysis evaluates the impact of research by examining how frequently a publication is cited by other works. High citation counts indicate influential research. We extracted the total number of citations for the selected articles, as well as for authors and publication sources. This analysis highlights key contributions and influential works within the sector.

3.2.3. H-Index

The h-index is a widely used metric that simultaneously measures both the productivity and citation impact of a researcher's or an institution's publications. An h-index of "x" means that "x" papers have received at least "x" citations each. For this study, we extracted the h-index for the entire dataset to measure the overall impact and quality of the research outputs in the Romanian automotive sector.

3.3. Network Analysis

Network analysis is a powerful tool for visualizing and interpreting collaborative networks among researchers, institutions, and countries. By employing network analysis

tools, we aimed to uncover the structure and dynamics of these collaborations in the Romanian automotive research landscape.

3.3.1. Tools and Techniques

To conduct the network analysis, we utilized VOSViewer (version 1.6.20) specialized software. This tool enables the visualization of networks based on co-authorship and citation data. Nodes in the network represented individual researchers, institutions, or countries, while edges indicated collaborative relationships or citation links.

3.3.2. Researcher Collaboration Networks

We created co-authorship networks to visualize collaborative relationships among researchers. By identifying clusters of closely collaborating authors, we gained insights into research communities and key players in the field.

3.3.3. International Collaboration Networks

To understand the global context of Romanian automotive research, we constructed networks based on international collaborations. By examining the connections between Romanian institutions and their international counterparts, we identified the most significant international partnerships. This analysis highlighted the extent of global engagement and the influence of international collaborations on the research output.

The use of network analysis tools like VOSviewer proved highly effective in identifying key research collaborations and thematic trends. By visualizing co-authorship networks, the study mapped leading researchers, institutions, and their collaborative links. Additionally, keyword co-occurrence analysis helped highlight emerging research themes. However, the effectiveness of network analysis depends on data quality, and the study's reliance on Scopus may have excluded some relevant but non-indexed publications.

4. Results

4.1. Patterns in Published Works

In this section, we present and discuss the key findings from our bibliometric analysis, focusing on publication trends in the Romanian automotive sector over the past two decades.

4.1.1. Overview of Publication Growth

The analysis of publication data from the Scopus database revealed significant trends in the growth of scholarly output in the Romanian automotive sector. Over the last two decades, there has been a noticeable increase in the number of publications, reflecting the sector's expanding research activity and academic interest.

Figure 2 illustrates the annual publication counts and the total number of citations received by publications from 2004 to 2025. The data shows a steady growth in the number of articles published each year, with a notable spike in the last eight years. This upward trend can be attributed to increased research funding, heightened academic collaboration, and the sector's technological advancements.

The analysis revealed that 2013 of the articles were published in English, whereas only 11 were published in Romanian. With regard to publication type, conference articles were most prevalent (n = 1257), followed by journal articles (n = 728) and a smaller number of review articles (n = 39) (Figure 3).

The result reflect the field's strong emphasis on disseminating emerging research findings and technological advancements through conferences, while peer-reviewed journal publications provide more in-depth analyses and validation of results.

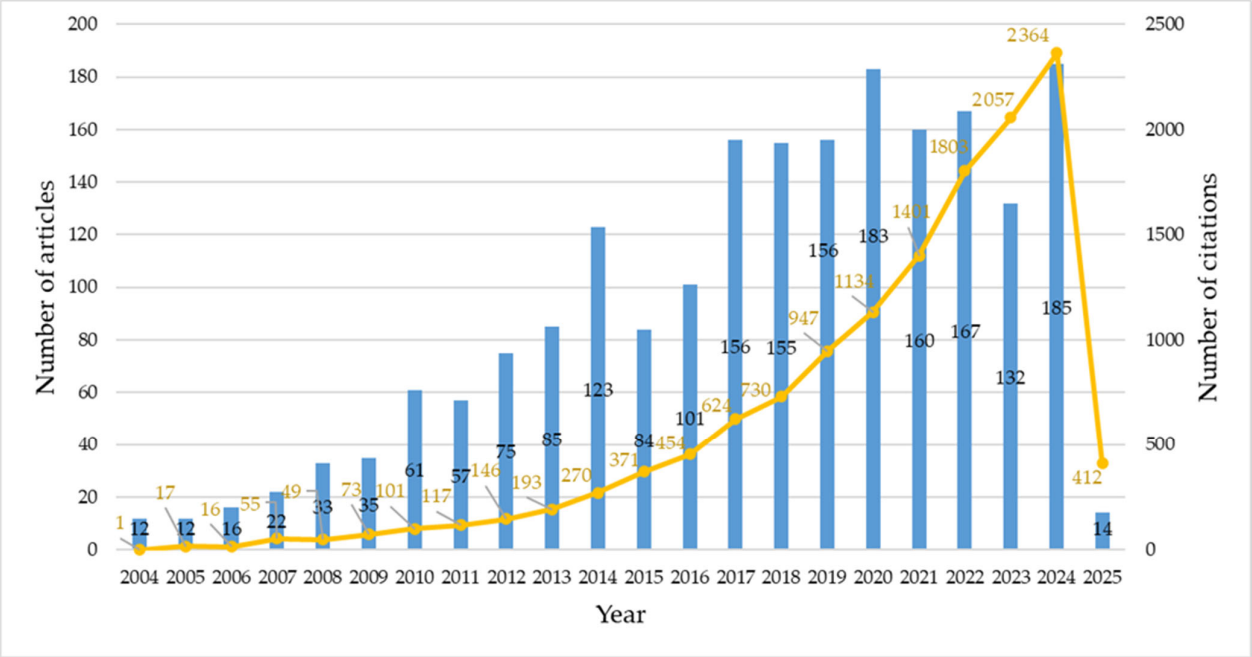

Figure 2. Trends in the annual number of publications (blue bars) and the corresponding citation counts (gold line).

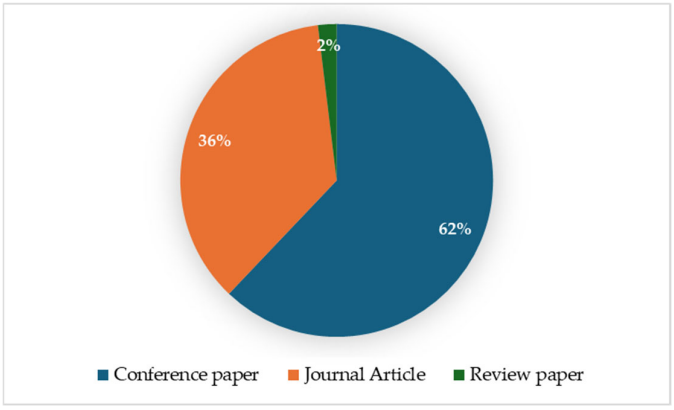

Figure 3. Distribution of articles by publication type.

4.1.2. Identification of Leading Researchers and Institutions in the Field

Our analysis identified the leading researchers and institutions contributing to the Romanian automotive research landscape. Table 1 lists the top researchers based on their publication counts and citation impact (total citations received and h-index value). Dr. Bogdan Groza emerged as the most prolific author, with his work frequently cited, indicating significant influence in the field. Murvay, P.S. from Politehnica University of Timișoara ranked second in terms of publication output, followed by Martis, R. from the Technical University of Cluj-Napoca. These researchers have consistently contributed to high-impact studies, often collaborating with international experts, enhancing the global reach of their research.

The key factors contributing to the prominence of these automotive researchers include their specialized expertise in crucial areas like in-vehicle network security, automotive control systems, and electric vehicle development. Their extensive publication records in high-impact journals and conferences demonstrate consistent contributions to automotive technology advancement. Their leadership roles in research projects, academic departments, and specialized laboratories have established dedicated automotive research ecosystems.

Additionally, their international collaborations through conference committees, journal reviews, and visiting professorships have expanded their influence globally.

Table 1. The top 10 most influential authors.

No.	Name	Affiliation	TP [1]	TC [2]	H-Index
1	Groza, Bogdan	Politehnica University of Timișoara, Timișoara	39	576	12
2	Murvay, Pal-Ștefan	Politehnica University of Timișoara, Timișoara	30	361	10
3	Marțiș, Radu	Technical University of Cluj-Napoca, Cluj Napoca	28	138	7
4	Silaghi, Andrei-Marius	Politehnica University of Timișoara, Timișoara	28	97	6
5	Lazăr, Corneliu	Technical University "Gheorghe Asachi", Iași	27	275	9
6	De Sabata, Aldo	Politehnica University of Timișoara, Timișoara	26	87	6
7	Negurescu, Niculae	University Politehnica of Bucharest, Bucharest	23	148	8
8	Ruba, Mircea	Technical University of Cluj-Napoca, Cluj Napoca	22	191	9
9	Căruntu, Constantin Florin	Technical University "Gheorghe Asachi", Iași	22	215	5
10	Cernat, Alexandru	University Politehnica of Bucharest, Bucharest	22	142	8

[1] TP—total publications, [2] TC—total citations.

Table 2 highlights the leading institutions in the Romanian automotive sector. Polytechnic University of Bucharest and Politehnica University of Timișoara are at the forefront, producing the highest number of publications. These institutions are recognized for their robust research programs and strong industry connections, facilitating cutting-edge research and innovation.

Table 2. Top 10 Romanian institutions contributing to automotive publications.

No.	Affiliation	TP [1]	TC [2]	TCeSC [3]	>50 [4]	H-Index
1	University Politehnica of Bucharest, Bucharest	420	1789	1385	4	18
2	Politehnica University of Timișoara, Timișoara	385	3457	2957	8	26
3	Technical University of Cluj-Napoca, Cluj Napoca	252	1838	1496	6	18
4	Technical University "Gheorghe Asachi", Iași	190	1154	878	3	14
5	Transilvania University of Brașov, Brașov	154	856	695	2	15
6	Lucian Blaga University of Sibiu, Sibiu	86	342	292	1	9
7	University of Pitești, Pitești	72	272	218	0	7
8	Continental AG	69	274	197	1	9
9	"Dunărea de Jos" University of Galați, Galați	51	415	332	2	9
10	University of Craiova	49	167	127	0	8

[1] TP—total publications, [2] TC—total citations, [3] TCeSC—total citations excluding self-citation, [4] >50—the number of papers with more than 50 citations.

Other notable contributors include the Technical University of Cluj-Napoca, Technical University "Gheorghe Asachi" of Iași, and Transilvania University of Brașov, universities with established expertise in automotive specialization. Lucian Blaga University of Sibiu, the University of Pitești, and Continental AG also play key roles, with the latter being a major industry player advancing innovations in sensors, control systems, and electric mobility. The "Dunărea de Jos" University of Galați and the University of Craiova further strengthen Romania's automotive research sector through their academic efforts and industry collaborations.

4.2. Analysis of Research Influence

We conducted a comprehensive citation analysis to assess the influence of Romanian automotive research publications. In this regard, we identified the publication sources with the highest article output. The 10 most prolific sources are summarized in Table 3. "IOP Conference Series: Materials Science and Engineering", an Open Access proceedings

journal, ranked first. This was followed by "Materiale Plastice", an impact factor journal edited by Revista de Chimie, and "Lecture Notes in Networks and Systems", a Springer series renowned for its swift and high-quality publication of the latest advancements in the field of networks and systems.

Table 3. Leading sources for automotive research in Romania.

No.	Publication	TP [1]	TC [2]	H-Index	IF [3]	CS [4]
1	IOP Conference Series: Materials Science and Engineering	137	731	10	-	-
2	Materiale Plastice	40	222	7	0.6	1.4
3	Lecture Notes in Networks and Systems	38	18	2	-	0.9
4	Applied Mechanics and Materials	37	1	4	-	-
5	Matec Web Of Conferences	34	86	6	-	-
6	UPB Scientific Bulletin Series D Mechanical Engineering	29	48	4	-	0.5
7	Proceedings of the International Semiconductor Conference CAS	25	56	4	-	-
8	Applied Sciences Switzerland	25	125	5	2.5	5.3
9	Polymers	24	302	9	4.7	8.0
10	Quality—Access to Success	23	48	3	-	1.4

[1] TP—total publications, [2] TC—total citations, [3] IF—impact factor, [4] CiteScore is based on the 2024 Journal Citation Reports.

In addition to the top 10 sources (including both journals and conference proceedings), Figure 4 presents a Sankey diagram illustrating journals with more than 10 published papers. Notably, MDPI journals, such as Applied Sciences, Polymers, Materials, Sensors, and Sustenability, dominate this list. Journals published by Revista de Chimie s.R.L. (Materiale Plastice, Revista de Chimie) and those affiliated with the Politehnica University of Bucharest (UPB Scientific Bulletin) also feature prominently.

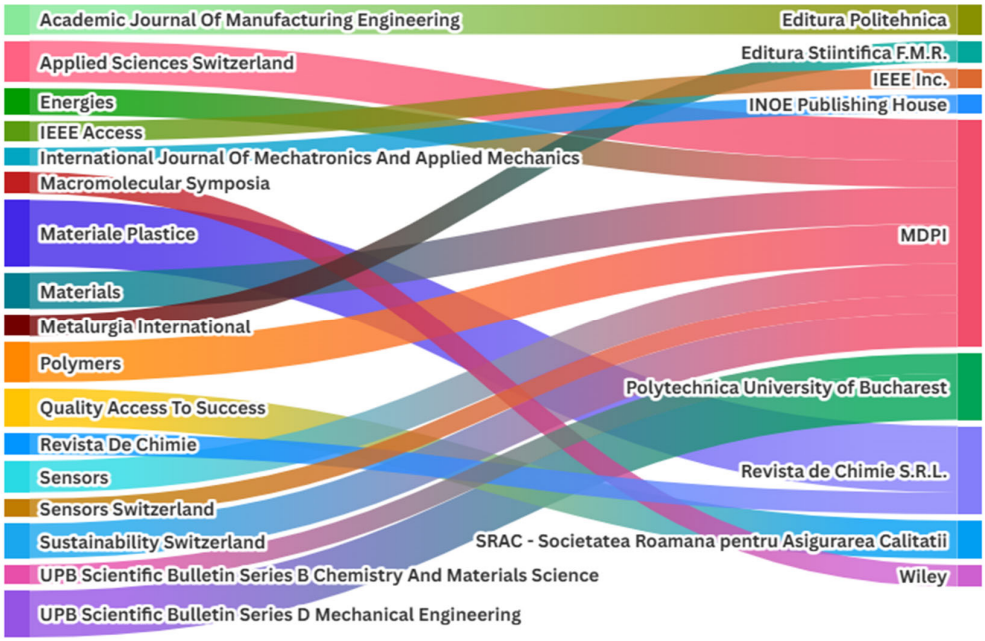

Figure 4. Mapping high-impact journals and their publishers in Romanian automotive research.

Table 4 summarizes the ten most cited documents in Scopus database that address topics in the automotive field. Of the 10, 4 are journal articles, 3 are conference papers and 3 are review articles.

Table 4. Top 10 highly cited papers of Romanian scholar in automotive.

No.	Ref.	Title	Publication	TC [1]
1	[42]	Automotive electric propulsion systems with reduced or no permanent magnets: An overview	IEEE Transactions on Industrial Electronics	706
2	[43]	Current Challenges for Visible Light Communications Usage in Vehicle Applications: A Survey	IEEE Communications Surveys and Tutorials	329
3	[44]	Comparison of Different Battery Types for Electric Vehicles	IOP Conference Series: Materials Science and Engineering	213
4	[45]	Prediction of electric vehicle range: A comprehensive review of current issues and challenges	Energies	143
5	[46]	LiBrA-CAN: A lightweight broadcast authentication protocol for controller area networks	Lecture Notes in Computer Science	139
6	[47]	Impact of IEEE 802.15.7 standard on visible light communications usage in automotive applications	IEEE Communications Magazine	107
7	[48]	Combined Active Flux and High-Frequency Injection Methods for Sensorless Direct-Flux Vector Control of Synchronous Reluctance Machines	IEEE Transactions on Power Electronics	106
8	[49]	Efficient Intrusion Detection with Bloom Filtering in Controller Area Networks	IEEE Transactions on Information Forensics and Security	96
9	[50]	Autonomous shuttle bus for public transportation: A review	Energies	94
10	[51]	An Overview of Current Methods for Thermal Comfort Assessment in Vehicle Cabin	Energy Procedia	92

[1] TC—total citations.

Based on the citation analysis of the most cited works, the Romanian automotive sector's most influential research areas focus on several key domains. Electric and hybrid vehicle technologies represent a significant area of interest, with research on innovative electric machines and drive systems [42,48,52], battery technologies for electric vehicles [44,53], and range prediction in electric vehicles [45]. Another prominent research direction is autonomous vehicle technology, including the implementation of autonomous shuttle buses [50] and the challenges of driving automation [54]. Vehicle communication systems also represent an important focus, particularly visible light communications for vehicular applications [47]. Other influential areas include automotive security protocols [46,49], thermal comfort in vehicles [51], semi-active suspension control [55], and Industry 4.0 manufacturing systems in the automotive sector [56].

Additionally, we assessed the impact of Romanian research in comparison to global trends to contextualize our findings and identify strengths and areas for improvement. Using the keyword "automotive" in Scopus, we found that Romania ranks 19th globally in terms of the number of publications in the automotive field (Figure 5). Notably, Romania outperforms its neighboring European countries. For instance, Hungary holds the 33rd position with 881 publications, less than half of Romania's output. Ukraine (57th, 256 publications) and Bulgaria (58th, 231 publications) also lag considerably behind, while the Republic of Moldova ranks 107th. Thus, Romania's strong position reflects its robust academic and industrial contributions to the automotive field, positioning it as a regional leader in automotive innovation and development.

On a global scale, the most frequently used publication sources include SAE Technical Papers, Proceedings of SPIE—The International Society for Optical Engineering, and Materials Today: Proceedings (see Table 5). Notably, IOP Conference Series Materials Science

and Engineering and Applied Mechanics and Materials, which are prominent in Romania, also rank among the top 10 most productive sources worldwide.

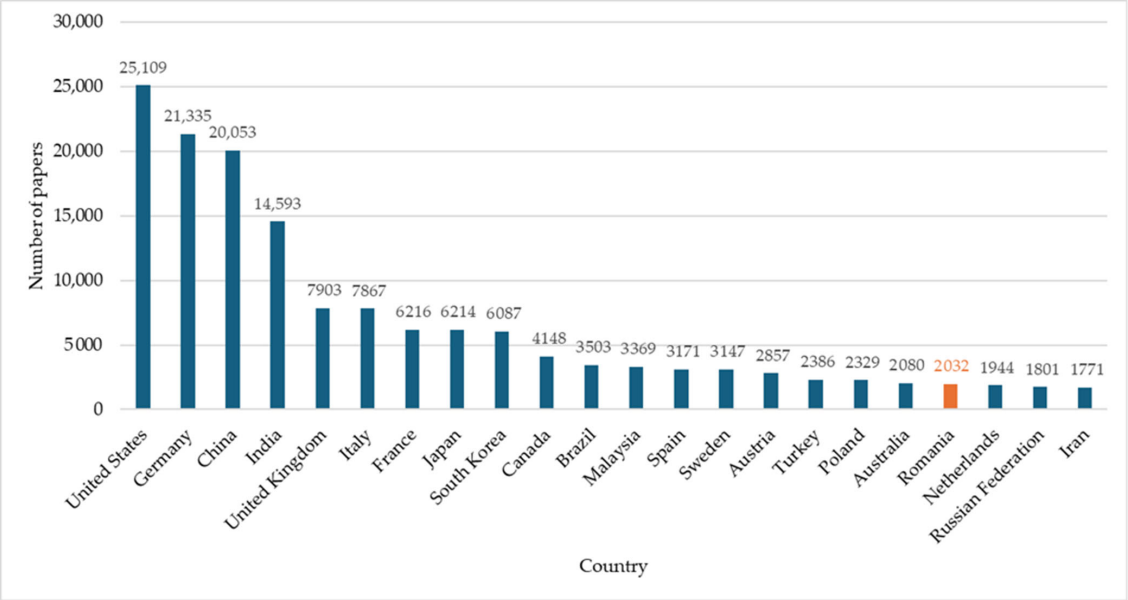

Figure 5. Top 30 most productive countries in the automotive sector.

Table 5. Leading sources for automotive research worldwide.

No.	Publication	TP [1]	TC [2]	H-Index	IF [3]	CS [4]
1	SAE Technical Papers	11,658	32,946	47	-	1.0
2	Proceedings of SPIE—The International Society for Optical Engineering	1350	5431	28	-	-
3	Lecture Notes in Computer Science	1288	12,373	42	-	2.6
4	Materials Today: Proceedings	1262	18,319	54	-	4.9
5	AIP Conference Proceedings	1247	3138	19	-	0.5
6	IOP Conference Series: Materials Science and Engineering	1087	5967	27	-	-
7	Lecture Notes in Mechanical Engineering	903	1302	13	-	0.9
8	Journal of Physics: Conference Series	878	2894	19	-	1.2
9	International Journal of Automotive Technology	870	15,215	52	1.5	3.1
10	Applied Mechanics and Materials	854	1895	15	-	-

[1] TP—total publications, [2] TC—total citations, [3] IF—impact factor, [4] CiteScore is based on the 2024 Journal Citation Reports.

A Sankey diagram in Figure 6 illustrates the distribution of automotive research publications across the top 18 journals worldwide. This analysis reveals also a significant presence of MDPI journals, including Applied Sciences, Metals, Materials, Sensors, and Energies. Elsevier journals, encompassing the Journal of Cleaner Production, Journal of Power Sources, International Journal of Hydrogen Energy, and Materials Science and Engineering A, constitute the second-largest group. Additionally, Automotive Industries AI, edited by Diesel and Gas Turbine Publications, contributes a notable share of automotive research publications.

Table 6 presents a comparative analysis of the top 18 journals for publications worldwide and within Romania, incorporating journal impact factors and quartile rankings. While some overlap exists (e.g., MDPI's Energies, Materials, Applied Sciences), the globally preferred journals exhibit significantly higher impact factors (totaling 59.3) and generally reside in higher quartiles compared to those predominantly utilized by Romanian researchers (totaling 26.3).

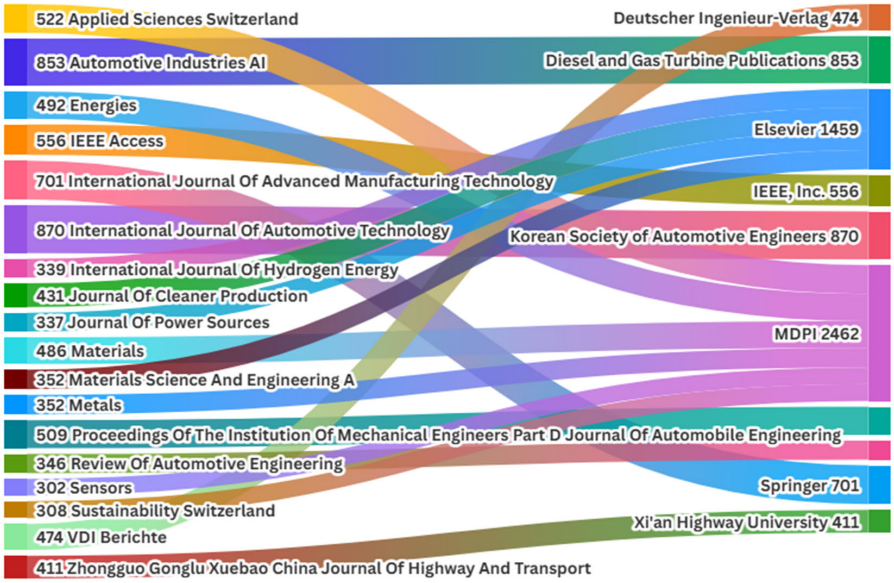

Figure 6. Mapping high-impact journals and their publishers in global automotive research.

Table 6. A comparative analysis of the top 18 journals for automotive research publications worldwide and in Romania.

	Worldwide			Romania		
No.	**Publication**	**IF** [1]	**Q** [2]	**Publication**	**IF**	**Q**
1	Automotive Industries AI	-	-	Materiale Plastice	0.6	Q4
2	International Journal of Automotive Technology	1.5	Q3	UPB Scientific Bulletin Series D Mechanical Engineering	-	-
3	International Journal of Advanced Manufacturing Technology	2.9	Q2	Applied Sciences Switzerland	2.5	Q2
4	IEEE Access	3.4	Q2	Quality Access To Success	0.5	Q4
5	Applied Sciences Switzerland	2.5	Q2	Polymers	4.7	Q1
6	Proceedings of the Institution Of Mechanical Engineers Part D Journal Of Automobile Engineering	1.5	Q3	Materials	3.1	Q2
7	Energies	3	Q3	Sustainability Switzerland	3.3	Q2
8	Materials	3.1	Q2	Academic Journal Of Manufacturing Engineering	-	-
9	VDI Berichte	-	-	Sensors	3.4	Q2
10	Journal Of Cleaner Production	9.8	Q1	Macromolecular Symposia	-	-
11	Zhongguo Gonglu Xuebao China Journal Of Highway And Transport	-	-	Metalurgia International	-	-
12	Materials Science and Engineering A	6.1	Q1	Revista De Chimie	-	-
13	Metals	2.6	Q3	IEEE Access	3.4	Q2
14	Review Of Automotive Engineering	-	-	UPB Scientific Bulletin Series B Chemistry And Materials Science	0.3	Q4
15	Journal Of Power Sources	8.1	Q1	International Journal Of Mechatronics And Applied Mechanics	-	-
16	International Journal of Hydrogen Energy	8.1	Q1	Energies	3	Q3
17	Sustainability Switzerland	3.3	Q2	Environmental Engineering and Management Journal	0.9	Q4
18	Sensors	3.4	Q2	Journal Of Optoelectronics And Advanced Materials	0.6	Q4

[1] IF—impact factor, [2] Q—quartile category according to Scimago Journal Rank 2024.

A significant portion of Romanian publications appear in lower-ranked, locally published journals with lower impact factors and quartile positions.

4.3. Investigating Collaborative Relationships

A network analysis tool (VOSViewer, version 1.6.20) was used to visualize co-authorship networks, revealing key collaborators and research clusters within the Romanian automotive sector (Figure 7). Among the 4787 authors, 152 were identified as productive based on a minimum publication threshold of five documents. While not all 152 authors collaborated, 17 formed 4 distinct clusters. Notably, A.-M. Silaghi, at the center of the green cluster (comprising five authors), exhibited the highest total link strength (34). Similarly, M. Dimian, within the red cluster, demonstrated the most prolific authorship and strongest connections to other authors, with a total link strength of 31.

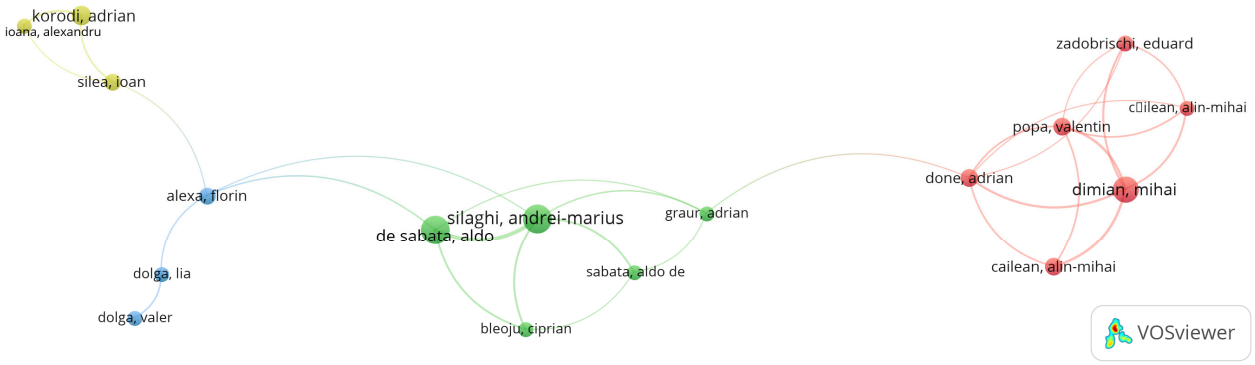

Figure 7. Author contributions and collaborative networks.

VOSviewer software was also used to generate a visual representation of international collaborations. The co-authorship network, comprising 27 of the 67 participating countries, was divided into 9 distinct clusters (Figure 8). A minimum publication threshold of 5 documents per country was applied.

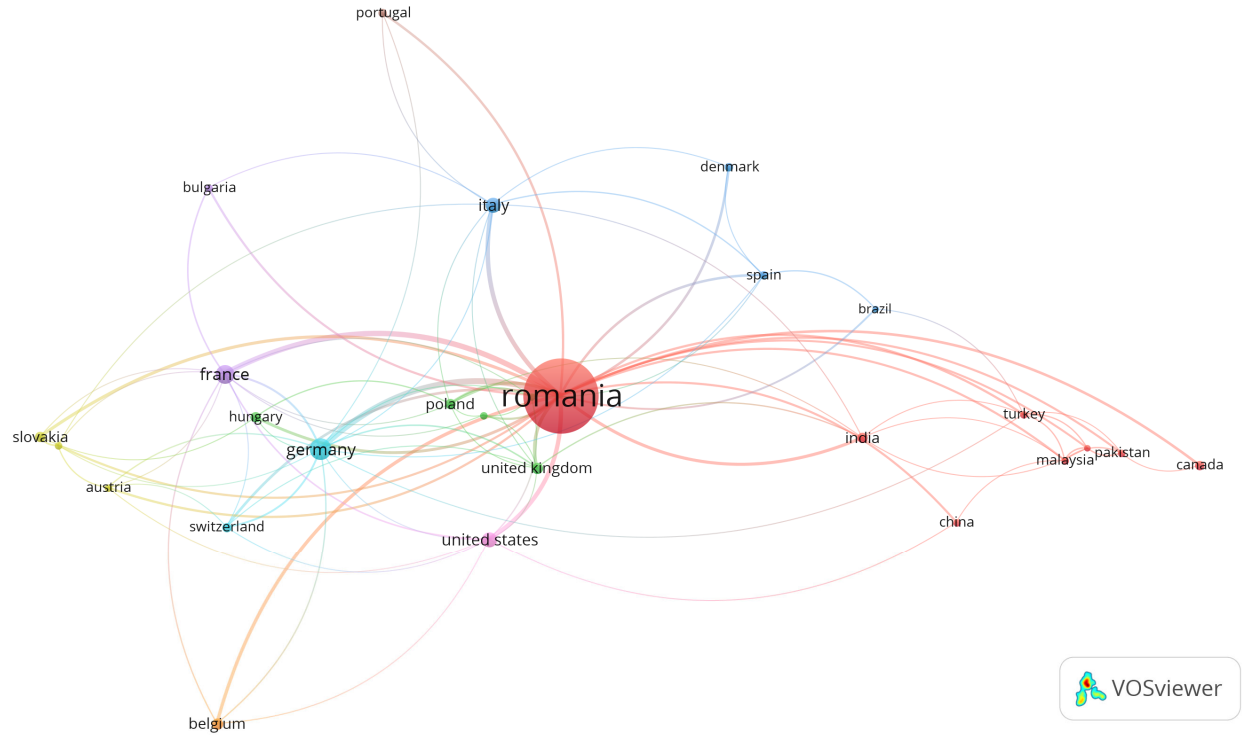

Figure 8. The international co-authorship network.

The analysis revealed the strongest collaborations with Germany (90 documents, total link strength—116), followed by France (67 documents, total link strength—88) and Italy (41 documents, total link strength—51).

4.4. Keyword Co-Occurrence Analysis

To identify the research trends of applications in the automotive field, this study conducted keyword co-occurrence analysis using VOSviewer. A total of 116 keywords (out of 14,700) with a minimum occurrence frequency of 20 were selected. The full counting method was applied to generate a co-occurrence network, where each keyword link has equal weight. The resulting network was visualized in Figure 9 and revealed seven distinct clusters, suggesting thematic groupings of keywords.

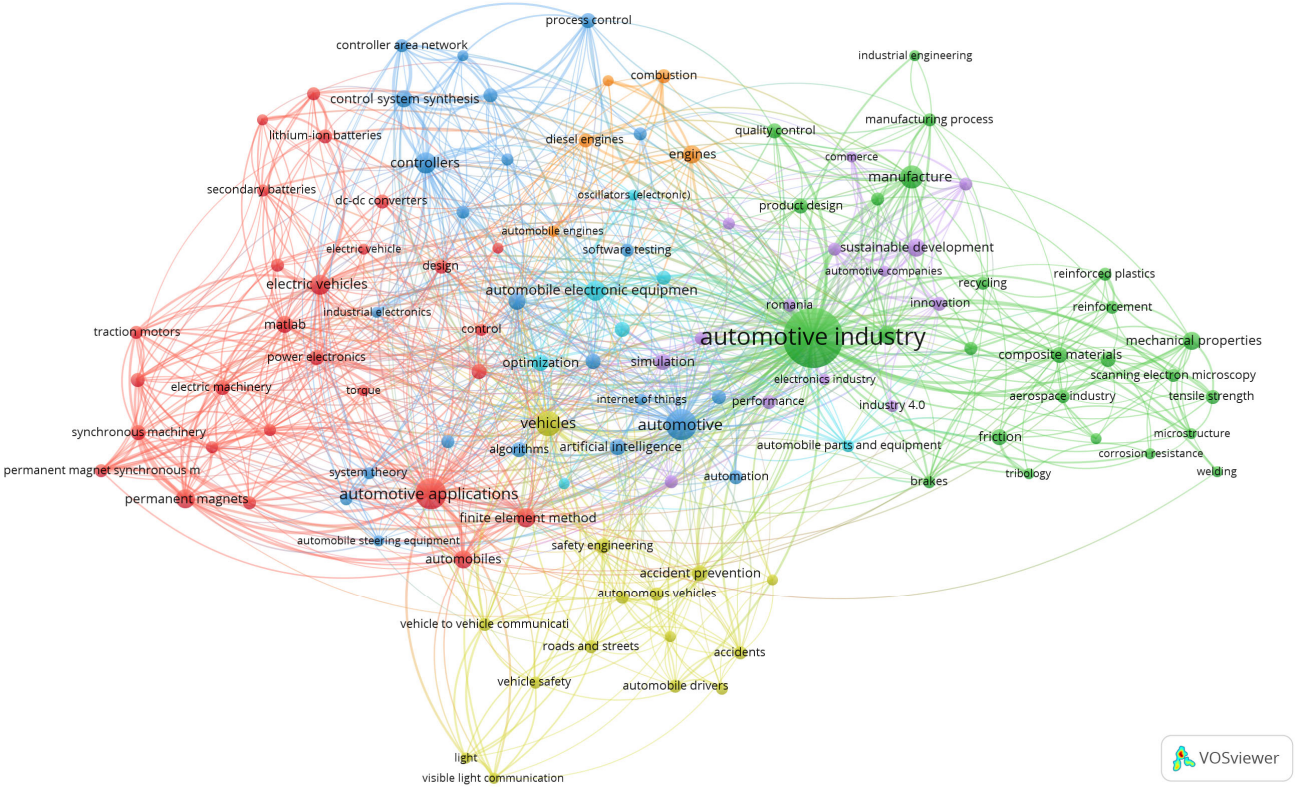

Figure 9. Keywords co-occurrence network of automotive studies.

Cluster analysis revealed that core research themes within this domain encompass automotive manufacturing, accident analysis and safety, electric vehicles, control systems, simulations, automotive parts, and engines.

4.4.1. Cluster 1 (Red): Electric Vehicles

This cluster encompasses 27 items, with notable keywords including: automotive applications (148 occurrences, 93 links, 410 total link strength), electric vehicles (62 occurrences, 64 links, 224 total link strength), permanent magnets (58 occurrences, 42 links, 245 total link strength), finite element method (57 occurrences, 50 links, 176 total link strength), electric drives (37 occurrences, 48 links, 151 total link strength), lithium-ion batteries (31 occurrences, 36 links, 103 total link strength), and power electronics (29 occurrences, 33 links, 115 total link strength).

The increasing adoption of EVs necessitates advancements in various aspects, including power electronics, energy storage, and motor technology. As highlighted in [57], the trend towards higher voltage levels in EV power systems, ranging from 42 Vdc to 600 Vdc,

enables the development of smaller, lighter, and more efficient electrical machines, while facilitating faster charging and extending driving range. Furthermore, reliable and efficient power management is essential. In [58], the importance of electronic fuses as a replacement for thermal fuses in auxiliary loads is emphasized, demonstrating faster disconnection times for enhanced safety and reliability. Additionally, ensuring the longevity and optimal performance of critical components like bearings is essential. Szabo et al. demonstrate the effectiveness of advanced fault diagnosis techniques, such as those employing minimum entropy deconvolution, in detecting bearing faults early on, thereby preventing catastrophic failures [59].

Enhancing the driving experience and ensuring safety requires continuous advancements in vehicle systems. In [60], a novel lighting control and diagnosis strategy for EVs is proposed, aiming to improve safety, reduce costs, and minimize weight. For energy storage, the potential of hybrid supercapacitor-battery systems to improve energy recovery and extend battery life is explored in [61]. Optimizing motor control algorithms is fundamental for maximizing efficiency and performance. Bejenar et al. investigate the dynamic response of electric actuators driven by scalar control algorithms for Permanent Magnet Synchronous Motor (PMSM) and Brushless Direct Current (BLDC) motors [62], while Carpiuc et al. focus on optimizing torque control strategies for Interior Permanent Magnet Synchronous Machine (IPMSM) motors in hybrid electric vehicles [63]. As emphasized in [45], accurate range prediction is vital for consumer acceptance of EVs. Furthermore, advancements in power electronics, such as the development of efficient power factor correction (PFC) solutions like the Independent Double-Boost Interleaved Converter (IDBIC) as described in [64], significantly improve the efficiency and reliability of EV powertrains, contributing to overall vehicle performance and reducing energy consumption.

4.4.2. Cluster 2 (Green): Manufacturing

This cluster, containing 25 items, include terms such as automotive industry (occurrences: 538, links: 112, total link strength: 1142); automobile manufacturing (occurrences: 48, links: 64, total link strength: 169); manufacture (occurrences: 80, links: 59, total link strength: 221); mechanical properties (occurrences: 49, links: 30, total link strength: 107); quality control (occurrences: 35, links: 37, total link strength: 84); product design (occurrences: 34, links: 43, total link strength: 94).

Automotive manufacturing has seen significant advancements, driven by innovations in materials, design, and safety protocols. Studies emphasize the role of R&D investments in maintaining the EU automotive sector's global competitiveness through innovation and automotive clusters [65]. The integration of computer-aided design (CAD) and finite element analysis (FEA) enables the development of lighter and more efficient vehicle components, reducing energy consumption across traditional, hybrid, and electric vehicles [66]. Material innovations, such as Transformation-induced plasticity (TRIP) steels, enhance vehicle safety by improving shock absorption in critical components [67]. Sustainable practices include recycling and repurposing retired Li-ion batteries for secondary applications, reducing environmental impact [68]. The use of ISO 26262 standards in functional safety ensures manufacturers align quality with safety requirements, mitigating risks in complex electronic systems [69]. Additionally, manufacturing technologies like optimized assembly line structures for wiring harnesses [70] and 3D printing for customized components [71] enhance production efficiency, reduce waste, and improve sustainability within the automotive industry. The influence of laser power on the micro-perforation of automotive parts was investigated in [72]. These developments reflect the industry's commitment to innovation, environmental responsibility, and passenger safety.

4.4.3. Cluster 3 (Blue): Control Systems

This cluster contains 23 items, with key components including controllers (65 occurrences, 65 links, 253 total link strength), control system synthesis (43 occurrences, 43 links, 173 total link strength), control systems (44 occurrences, 62 links, 156 total link strength), embedded systems (37 occurrences, 50 links, 97 total link strength), artificial intelligence (41 occurrences, 48 links, 88 total link strength), product design (34 occurrences, 43 links, 94 total link strength), and automation (30 occurrences, 38 links, 66 total link strength).

The automotive industry relies on complex electronic control units (ECUs) and sophisticated control systems. As highlighted in [28], increasing system complexity requires innovative approaches to education and training. Integration of real-world examples, like smartphones and IoT devices, enhances student understanding of automotive architectures and control principles. Efficient ECU testing ensures product quality and safety, with Bogorin-Predescu et al. demonstrating the value of parallel testing algorithms for improved production efficiency [73,74].

Testing technology advancements enable thorough ECU evaluation. Gross and Svasta demonstrate that solid-state switches, particularly MOSFET relays, outperform electromechanical switches in test equipment [75,76]. For network security, Caprita and Selisteanu propose a configurable end-to-end communication protection module for automotive sensors [9]. Effective thermal management ensures reliable ECU operation, with Lates et al. presenting a forced convection dielectric cooling concept for centralized ECU platforms [77]. For system integration, Ioana and Korodi explore VSOMEIP and OPC UA protocols to enable ECU interoperability and vehicle integration into the Industrial Internet of Things [78]. These developments in control systems, testing methodologies, and communication protocols advance safe, efficient automotive technologies.

4.4.4. Cluster 4 (Yellow): Accident Analysis and Safety

This cluster, comprising 15 keywords, feature terms like accident prevention (39 occurrences, 61 links, 135 total link strength), safety engineering (35 occurrences, 49 links, 120 total link strength), automobile drivers (27 occurrences, 32 links, 65 total link strength), accidents (26 occurrences, 32 links, 78 total link strength), autonomous driving (26 occurrences, 39 links, 92 total link strength), and vehicle safety (24 occurrences, 32 links, 79 total link strength).

Vehicle safety remains central to automotive advancement. Airbag systems help mitigate accident impact [79], while Failure Mode and Effects Analysis (FMEA) enables risk assessment and prevention [80,81]. Testing and validation procedures, including ECU testing [82] and ISO 26262 compliance [69], ensure system reliability. Ulian et al. address thermal stress in braking systems for optimal performance [83], while Ungureanu et al. propose anti-glare solutions using eye tracking and sun sensors [84]. For passenger protection, Soica presents methods to analyze safety belt pretensioner tube deformation during collisions [85]. Alternative materials research by Petrici et al. in towing systems contributes to safety improvements and weight reduction [86,87]. Another study explores driver-in-the-loop simulations can be used to detect personalized driving styles in safety-critical scenarios for autonomous vehicles [88]. In [89], a solution is proposed to equip semi-autonomous vehicles with an IoT-based sensor system that monitors and transmits drivers' and passengers' physiological signals, enhancing road safety and health monitoring. Additionally, another paper explores the cultural and technical challenges of replacing human drivers with artificial agents in autonomous vehicles, addressing interdisciplinary aspects from automotive engineering to AI [90]. These technological advances and safety practices collectively enhance road safety and accident mitigation.

4.4.5. Cluster 5 (Purple): Simulation

This cluster contains 14 items, with key components such as simulation (39 occurrences, 56 links, 96 total link strength), computer software (26 occurrences, 46 links, 85 total link strength), computer simulation (25 occurrences, 34 links, 64 total link strength), and computer aided design (24 occurrences, 28 links, 52 total link strength).

Simulation advances automotive R&D through system design and optimization. Vasiliu et al. integrated mathematical models with Simcenter Amesim libraries to study hydrostatic transmissions and address cavitation challenges [91]. Guran et al. validated automotive systems through precise low-dropout regulator models [92,93], while Molnar et al. developed electrical models for high-pressure fuel pumps using Synopsys Saber™ [94]. Dobre et al. employed AMESim to optimize suspension and brake systems [95], and Bățăuș et al. analyzed clutch models for drivetrain simulations [96]. In manufacturing, Popa et al. used WITNESS Horizon to optimize automotive rear axle assembly logistics [70,97]. These applications demonstrate simulation's value across automotive development, from component design to production optimization.

4.4.6. Cluster 6 (Turquoise): Automobile Parts

This cluster comprises 7 items, including: automobile electronic equipment (occurrences: 63, links: 57, total link strength: 208); optimization (occurrences: 40, links: 50, total link strength: 119); electromagnetic compatibility (occurrences: 37, links: 31, total link strength: 70); and automobile parts and equipment (occurrences: 24, links: 34, total link strength: 89).

The automotive industry is continuously striving to improve vehicle performance, efficiency, and sustainability. This ongoing effort has driven advancements in areas such as power systems, materials, and control systems. Refs. [98,99] emphasize the importance of optimizing energy management to enhance fuel efficiency and reduce emissions. These advancements include innovations in alternator technology to increase power output and the development of more efficient energy storage systems.

Lightweighting initiatives are also becoming increasingly significant, with advanced materials like aluminum composites gaining widespread use. Crăciun and Pinca-Bretotean investigate the incorporation of natural fibers, such as coconut, in the development of lightweight, environmentally friendly brake components, addressing concerns about weight reduction and material sustainability [100,101]. Moreover, as highlighted in [102], advancements in control systems play a vital role in improving vehicle performance and fuel economy.

4.4.7. Cluster 7 (Orange): Engines

This cluster comprises 7 items, centred around the following: engines (occurrences: 50, links: 53, total link strength: 140); automobile engines (occurrences: 21, links: 42, total link strength: 71); diesel engines (occurrences: 32, links: 39, total link strength: 90); and combustion (occurrences: 32, links: 23, total link strength: 70).

Improving engine efficiency and reducing emissions remain top priorities in the automotive industry. Although internal combustion engines have seen substantial advancements, research continues to explore alternative fuels and refine combustion processes. Rashid et al. studied the effects of various gasoline grades (RON95, RON97, and RON102) on engine performance and emissions, highlighting the advantages of higher-octane fuels in terms of fuel economy, power output, and reduced emissions [103].

The use of alternative fuels, such as natural gas, offers significant potential for enhancing engine efficiency while minimizing environmental impact. Rotaru et al. (2020) investigated compressed natural gas (CNG) in dual-fuel mode, demonstrating its ability

to lower fuel consumption and CO_2 emissions while examining its effect on combustion stability [104,105]. Efficient operation of internal combustion engines also depends on precise control and optimization. Stoica et al. introduced a minimal algorithm for engine control, allowing researchers and students to experiment with engine control strategies using accessible and cost-effective hardware [106]. Another article compares lubricant specifications for internal combustion engines and hybrid vehicle transmissions, highlighting their unique properties and essential role in engine efficiency [107].

These advancements in engine technology, combined with ongoing research into alternative fuels and optimized control systems, are paving the way for a more sustainable future in the automotive industry.

5. Discussion

The findings of this bibliometric analysis shed light on several aspects of the Romanian automotive research sector, including publication trends, research impact, and collaborative networks. These elements are important for understanding the current state of the field and for identifying pathways for future improvement.

5.1. Publication Trends

The analysis reveals a relatively steady growth in the number of publications related to the automotive sector in Romania over the last two decades. This trend indicates an increasing interest and investment in automotive research within the country. English emerged as the dominant language for publication, underscoring the focus on reaching a global audience. Conference articles represented the largest share, highlighting the importance of disseminating research findings at international forums and fostering collaboration within the academic and industrial communities.

The study identified several leading researchers and institutions shaping the Romanian automotive research landscape. Among individuals, Dr. Bogdan Groza from Politehnica University of Timișoara stood out as the most prolific author, contributing 39 publications with 576 citations and an h-index of 12. Other notable contributors included Pal-Ștefan Murvay and Radu Marțiș, both of whom have significantly influenced the field through high-impact publications and collaborations.

Institutional contributions highlighted Politehnica University of Timișoara and University Politehnica of Bucharest as frontrunners, collectively accounting for a significant portion of publications and citations. These institutions' robust research programs and industry linkages have facilitated innovation and knowledge dissemination.

5.2. Research Impact

The citation analysis indicates that Romanian automotive research has a growing influence, as evidenced by increasing citation counts and h-index values. However, when compared to global benchmarks, there is room for improvement in terms of impact. Romanian publications often lag behind those from worldwide leading automotive research.

The Romanian automotive sector's research has gained visibility in key journals and conferences, as evidenced by citation metrics and publication sources. "IOP Conference Series: Materials Science and Engineering" emerged as the leading publication outlet, followed by "Materiale Plastice" and "Lecture Notes in Networks and Systems". The prominence of MDPI journals and those affiliated with Romanian universities further underscores the sector's alignment with global publication trends.

Highly cited works, such as [42] on automotive electric propulsion systems and [43] on visible light communications in vehicles, illustrate the sector's focus on addressing technological challenges and advancing sustainable mobility.

5.3. Collaborative Networks

Collaboration networks, analyzed using VOSViewer, revealed clusters of co-authorship among Romanian researchers and international partners. A.-M. Silaghi and M. Dimian emerged as key nodes in national networks, while international collaborations were strongest with Germany, France, and Italy.

The visualization of co-authorship networks reveals limited collaborative links, both nationally and internationally. The majority of research collaborations occur within institutions, with limited inter-institutional connections. The limited international collaborations hinder Romanian automotive research by restricting its global impact, slowing the adoption of advanced technologies, and limiting access to competitive funding. Without strong global partnerships, research visibility remains low, and integration with industry trends is slower. To overcome these challenges, Romania should actively engage in EU-funded programs like Horizon Europe, establish joint research initiatives with top automotive nations, and encourage researcher mobility through academic exchanges. Strengthening ties with multinational automotive companies, increasing participation in international conferences, and leveraging digital collaboration platforms can further enhance networking opportunities. By adopting these strategies, Romanian researchers can boost their influence, secure more funding, and accelerate innovation in key automotive sectors.

5.4. Keyword Analysis

The keyword co-occurrence analysis in automotive research, conducted using VOSviewer, revealed seven distinct thematic clusters. These clusters cover core areas such as electric vehicles, manufacturing, control systems, accident analysis and safety, simulations, automobile parts, and engines. The electric vehicle cluster highlights advancements in power electronics, motor technology, and energy storage systems. Manufacturing focuses on innovations in materials, design, and sustainable practices, while control systems emphasize the integration of embedded systems, AI, and testing methodologies. The analysis also identifies the growing importance of safety technologies, simulation tools for design and optimization, and advancements in engine efficiency and emissions reduction. These findings illustrate the diverse research trends shaping the automotive industry, particularly towards sustainability, safety, and technological integration.

The publication trends in Romanian automotive research over the last two decades show steady growth and alignment with global advancements in areas like electric vehicles, autonomous driving, and sustainable mobility. However, certain key areas lag behind compared to global trends. For instance, hydrogen fuel technologies and solid-state batteries, which are gaining significant attention worldwide, receive less focus in Romanian research. Additionally, while AI and IoT applications in automotive systems are explored, deep learning for autonomous driving and cybersecurity for connected vehicles remain underdeveloped. The study also highlights limited interdisciplinary research integrating advanced materials, quantum computing, and 6G-enabled vehicle communication, which are shaping the future of global automotive innovation. Strengthening international collaborations, securing higher research funding, and enhancing technology transfer partnerships could help bridge these gaps and align Romanian research more closely with cutting-edge global developments.

5.5. Future Directions

Based on the current trends and industry needs, several recommendations can be made to enhance the research output and impact of the Romanian automotive sector:

- fostering international collaborations by establishing joint research projects with partners from leading global institutions, facilitating scholar and student exchange pro-

grams to strengthen international networks, actively presenting research findings at international automotive and engineering conferences;

- targeting high-impact journals by identifying high-impact journals relevant to the automotive sector, providing training on scientific writing, peer review, and publication ethics to produce high-quality submissions, collaborating with established authors;
- promoting interdisciplinary initiatives by integrating emerging technologies, establishing interdisciplinary research centers that bring together experts from diverse domains, and addressing topics such as sustainable mobility, electric and autonomous vehicles, and smart transportation systems to align with global priorities;
- enhancing visibility of research by encouraging the publication in open-access journals to increase global readership and citations, promoting research findings;
- taking advantage of funding opportunities by applying for funding from international programs, collaborating with automotive companies for funding, internships;
- investing in capacity building—by conducting regular workshops on advanced research methodologies, data analysis, and bibliometric tools, upgrading research facilities and provide access to advanced simulation tools and databases.

Future research in the automotive field should focus on several key directions. Firstly, advancements in electric vehicles should continue, particularly in improving energy storage systems like lithium-ion batteries and hybrid capacitors, enhancing power electronics, and optimizing motor control algorithms for better performance and efficiency. Additionally, with the increasing complexity of automotive manufacturing, future work could explore innovative materials, such as lightweight composites and recyclable components, to further reduce vehicle weight and environmental impact. The development of autonomous driving technologies and robust safety systems remains crucial, especially in accident prevention and enhancing the reliability of vehicle control systems.

Moreover, the integration of AI and machine learning into automotive control systems offers vast potential for improving vehicle autonomy and efficiency. Research into simulation tools will also be an important aspect, as they play a key role in testing and optimizing automotive systems under various conditions. Finally, efforts should be directed towards alternative fuels and combustion technologies, particularly in improving the efficiency and sustainability of internal combustion engines to support a transition toward greener transportation. These directions will ensure that the automotive industry continues to evolve in line with technological advances and sustainability goals.

To enhance Romania's automotive research impact, interdisciplinary collaboration should prioritize areas at the intersection of engineering, artificial intelligence, and sustainability. Key focus areas include electric vehicle technologies, particularly battery management and energy-efficient power electronics, autonomous and connected vehicles, integrating AI-driven control systems and cybersecurity, and advanced manufacturing, leveraging Industry 4.0 innovations like additive manufacturing and smart robotics. Additionally, research on alternative fuels and hydrogen propulsion, alongside road safety and accident prevention using IoT-based monitoring, can drive impactful advancements.

These emerging technologies such as AI, IoT and cybersecurity has the potential to transform Romanian automotive research, enabling autonomous driving, smart vehicle connectivity and enhanced safety systems. AI-based algorithms optimize predictive maintenance, traffic flow and energy management in electric vehicles, while IoT facilitates real-time data exchange for connected mobility solutions. Cybersecurity is crucial in protecting vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications against cyber threats. While Romanian research is gradually embracing these advances, integration remains uneven, with a stronger focus on traditional engineering topics. Strengthening part-

nerships between automotive engineering, computer science, and environmental sciences will accelerate innovation and align Romania with global automotive trends.

Also, Romanian researchers can increase their presence in high-impact journals by focusing on innovative, globally relevant research, strengthening international collaborations, and targeting high-quality data-driven studies that align with current industry challenges. Writing workshops, mentorship programs, and partnerships with experienced researchers from leading institutions can improve manuscript quality and acceptance rates. Additionally, securing more research funding would enable access to advanced experimental setups and broader datasets, making studies more competitive. However, barriers such as limited funding, language proficiency challenges, and a preference for publishing in lower-ranked local journals often hinder visibility.

By building on its strengths and addressing current gaps, the Romanian automotive research sector has the potential to contribute significantly to global advancements in automotive science and technology.

6. Limitations

While this study provides a thorough bibliometric analysis of Romanian automotive research, it's important to consider its inherent limitations.

First, our data collection strategy relied exclusively on the Scopus database. While Scopus offers extensive coverage of academic publications, this single-database approach may have excluded relevant literature indexed in other databases such as Web of Science, IEEE Xplore, or domain-specific repositories. Although our comparative analysis demonstrated Scopus's superior coverage for automotive research, the exclusion of complementary databases potentially limits the comprehensiveness of our dataset.

Second, our methodology excluded non-peer-reviewed publications and grey literature, including technical reports, white papers, patents, and industry documents. In the automotive sector, where industrial applications and proprietary innovations are common, excluding these sources may have overlooked valuable contributions that influence industry practices but remain outside traditional academic publishing channels.

Third, the search strategy employed specific keywords centered around "automotive" in combination with Romanian affiliations. This approach may have missed relevant publications that use alternative terminology or domain-specific language without explicitly mentioning automotive applications. Particularly interdisciplinary work at the boundaries of automotive engineering and other fields might be underrepresented in our analysis.

Fourth, the bibliometric indicators used in this study, while widely accepted, have inherent limitations. Citation metrics, for instance, may be influenced by self-citations, citation networks, or publication age, potentially distorting the assessment of research impact. Additionally, the h-index, while useful for measuring both productivity and impact, does not fully account for the quality or influence of individual publications.

Fifth, our analysis focused primarily on quantitative metrics rather than qualitative assessment of research content. The emphasis on publication counts and citation numbers might not fully capture the innovative nature or practical significance of certain research contributions, especially those with industry applications that may not generate high citation counts.

Finally, language bias is another limitation, as we primarily included publications in English and Romanian. This approach may have excluded relevant research published in other languages, particularly from neighboring countries with which Romania might have collaborative relationships.

Despite these limitations, our findings provide valuable insights into the Romanian automotive research landscape and serve as a foundation for future studies that might employ more diverse methodological approaches or data sources.

7. Conclusions

The bibliometric analysis presented in this study offers valuable insights into the evolution of automotive research in Romania, highlighting key aspects such as growth patterns, leading contributors, thematic evolution, research impact, collaboration networks, and quality indicators. By examining 2024 articles from the Scopus database over the past two decades, the analysis reveals both significant progress and areas for strategic development within this sector of Romania's economy.

The findings of this study highlight a crucial path forward for Romania's automotive industry, emphasizing the need for stronger collaboration between academia and industry. Romanian researchers have made notable advances in areas such as electromobility, vehicle safety, and control systems, but the transition from research breakthroughs to commercial applications remains limited. To bridge this gap, automakers and suppliers must harness these insights to fuel technology transfer, accelerate product innovation, and boost global competitiveness. Areas like battery management systems, autonomous vehicle control, and advanced materials research hold particularly promising opportunities for large-scale industrial implementation.

For policymakers, the study reveals gaps in research funding, collaboration, and international visibility, gaps that could be addressed through strategic, targeted interventions. To position Romania as a leading hub for automotive innovation, several key priorities emerge:

- increase investment in R&D in electric and autonomous vehicles, sustainable manufacturing and digital transformation;
- provide and grants to encourage stronger industry-university partnerships, supporting applied research and faster commercialization;
- strengthen international ties by integrating Romania into European and global research consortia to increase visibility and attract high-level collaborations;
- develop specialized research centers focused on emerging technologies, such as artificial intelligence-based mobility, advanced materials and next-generation propulsion systems, aligning with the EU Green Deal and global sustainability goals.

Looking forward, Romania's automotive research sector must adapt to keep pace with global technological advancements. Emphasizing next-generation energy storage, digital manufacturing, and smart mobility, while fostering interdisciplinary collaboration and reinforcing industry-government-academia partnerships, will be essential. This approach can solidify Romania's position as a significant player in the global automotive arena, fueling technological innovation and sustainable economic development.

In future research, the continued development of electric vehicles, control systems, and safety technologies should remain priorities, while innovations in manufacturing processes and alternative fuels will play an essential role in achieving a more sustainable automotive industry. Simulation tools will also continue to be indispensable for optimizing designs and validating complex systems. Furthermore, advancements in engine technologies and automobile components will contribute to improved efficiency and reduced emissions, shaping the future of automotive engineering.

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