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МИНИСТЕРСТВО ВЫСШЕГО ОБРАЗОВАНИЯ, НАУКИ И ИННОВАЦИЙ
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НАУЧНО-ТЕХНИЧЕСКИЙ ЖУРНАЛ
МАШИНОСТРОЕНИЕ

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MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATIONS REPUBLIC OF UZBEKISTAN
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Tahririyat manzili: Andijon shahar, Bobur shox ko'cha, 56-uy. **Tel:** +998 74-224-70-88 (1016)
Veb sayt: www.andmiedu.uz
e-mail: andmi.jurnal@mail.ru

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TRANSPORT

Baynazarov Khayrullo Rakhimovich
Andijan Machine-building Institute,
head of the "Vehicle Engineering" department, Ph.D., dots.,
avtodoroj2012@gmail.com +998900602044

TRACTOR TRAILER: A REVIEW OF PAPERS FROM THE SCOPUS DATABASE PUBLISHED IN ENGLISH FOR THE PERIOD OF 2000-2022

TRAKTOR PRISEPLARI: 2000-2022 YILLAR UCHUN INGLIZ TILIDA NASHR ETILGAN SCOPUS MA'LUMOTLAR BAZASIDAGI MA'LUMOTLAR TAXLILI

ТРАКТОРНЫЙ ПРИЦЕП: ОБЗОР СТАТЕЙ ИЗ БАЗЫ ДАННЫХ SCOPUS, ОПУБЛИКОВАННЫХ НА АНГЛИЙСКОМ ЯЗЫКЕ ЗА ПЕРИОД 2000-2022 ГГ.

Annotation. This study aims to provide an extensive opportunity to review the published literature on trailer construction. The research includes general information about the world's leading scientists and journals.

Key word: Authors, citations, VOS visualization, journals, tractor trailer, review, review analysis, Scopus.

Аннотация. Ushbu tadqiqot treyler qurilishi bo'yicha nashr etilgan adabiyotlarni ko'rib chiqish uchun keng imkoniyat yaratishga qaratilgan. Tadqiqot dunyoning yetakchi olimlari va jurnallari haqida umumiy ma'lumotlarni o'z ichiga oladi.

Калит сўзлар: Mualliflar, iqtiboslar, VOS vizualizatsiyasi, jurnallar, traktor treyleri, ko'rib chiqish, sharh tahlili, Scopus.

Аннотация. Целью данного исследования является предоставление обширной возможности для обзора опубликованной литературы по конструкции прицепов. Исследование включает общую информацию о ведущих мировых ученых и журналах.

Ключевые слова: Авторы, цитирование, визуализация VOS, журналы, тракторный прицеп, обзор, анализ обзоров, Scopus.

Introduction. Vehicles are the main means of transport in the world and will remain so for the foreseeable future. Also, this process will continue in the coming years. [1]. Tractor trailers are mechanical means for transporting various goods, mainly agricultural goods [2]. The use of tractor trailers allows efficient use of vehicles and reduces traffic jams to a certain extent [3]. In addition, the tractor-trailer system can be expanded by adding or removing trailers to meet different trucking requirements. In addition, the coverage area of the tractor when turning is much smaller than that of a tractor of the same length. This feature allows the tractor trailer to move nimbly over narrow areas [4]. The significance of science and research lies in modeling and simulation. Daily, mechanical engineers rely on virtual designs and software to model road vehicles, which are a crucial aspect of their job. These models facilitate the examination of reactions and responses of road vehicles or road vehicle-trailer combinations to variations in input parameters, driving attributes, and other factors. Furthermore, they enable researchers to identify various methods for reducing the costs associated with development and testing [5]. The transport sector is a fundamental industry for the advancement of the national economy. However, the resulting copious amounts of

carbon emissions unavoidably lead to a range of ecological issues [6], making it a crucial domain for national energy preservation, reduction of emissions, and sustainable progress.

The research [5] introduces a study into how the distribution of the load on a trailer influences the driving stability of a vehicle–trailer combination. The research activities are based on simulation computations performed in commercial multibody software. While the results presented in the article are reached for a particular vehicle–trailer combination as well as for a particular set of driving conditions, the applicability of the findings can also be extended more generally to the impact that the load distributions corresponding to various vehicle–trailer combinations have on the related parameters and other driving properties.

The article [7] presents the development of a structure model and numerical analysis of the trailer frame assembly intended for transporting bales of compressed straw, which may be a potential source of cheap and ecological energy. Numerous scholars [8, 9] have researched the course plotting and path pursuit of the tractor-trailer mechanism. The majority of investigations employed a tractor with differential steering. Nevertheless, differential steering tractors encounter limitations on their movement direction and can get trapped in certain scenarios.

Bibliometric analysis is a method of studying this field of research by analyzing the literature published in a specific field [10]. In doing so, it explores collaboration between authors, institutions and countries across research fields. Also, studies are analyzed based on years, authors, institutions, citations, and countries. In this study, the analysis of existing research on the production and use of tractor trailers is presented in a holistic way and will help in the formulation of research plans for those who want to conduct research in this field in the future. There are not many statistical reviews or bibliometric studies in the field of tractor trailers.

The main purpose of our research is to help you make clear conclusions about the current situation by summarizing the most popular magazines, the best authors, the most popular articles, and the research on tractor trailers in the best countries. Thus, this study systematically analyzes the existing research conducted from 2000 to 2022 regarding tractor trailers, which are one of the main means of transportation of various loads of the national economy. The main goal is to provide a detailed content analysis of qualitative research conducted in the field. In particular, bibliometric analysis is carried out to analyze trends in existing literature and answer the following research questions:

RQ1: How has the field of trailer research developed in recent years?

RQ2: What will be the current topics and future development of the industry?

Methodology. To review the existing literature on tractor trailers, this study used a mixed method approach including quantitative and qualitative analysis as described in this section. In particular, the following subsections detail the search strategy, data collection and analysis methods adopted in this study. "Tractor trailer" was used as a keyword to search and select studies relevant to this study. Chronologically, this study was conducted on peer-reviewed journal articles published between 2000 and 2022. Specifically, this study limited its search criteria to journal articles published in English. The Scopus database was chosen for data collection in this study because it is one of the most reliable sources of scientific publications. It should be noted that the Scopus database is ideal for finding quality scientific articles for peer review. The Scopus database is considered to contain most of the quality literature on tractor trailers. Alternative synonyms were also used to search for articles related to this study. The filtering criteria are shown in Figure 1 below. Thus, a total of 1482 studies were included as the final sample for review analysis. The methodology of this study is presented in Figure 2 below. The study used bibliometric, textual and content analysis methods to analyze the development of the field of research related to tractor trailers.

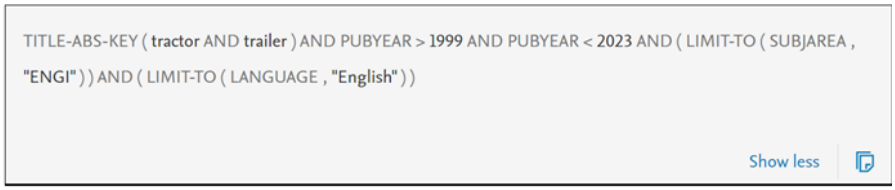

Figure 1. Extraction criteria.

The method of bibliometric analysis is mainly used in the study of research sources and development prospects [4]. Statistical information about previous researches, authors, institutions and countries is important for quick analysis and understanding of the problems of the field. A citation-by-citation analysis like this one reveals important details about authoritative literature and researchers [5]. Researchers can use bibliometric analysis to identify internal relationships in the literature and analyze key citations and key knowledge groups. Therefore, this study reviewed the tractor trailer literature using bibliometric analysis to examine literature characteristics in more detail, evaluate research trends, and provide innovative insights into the literature.

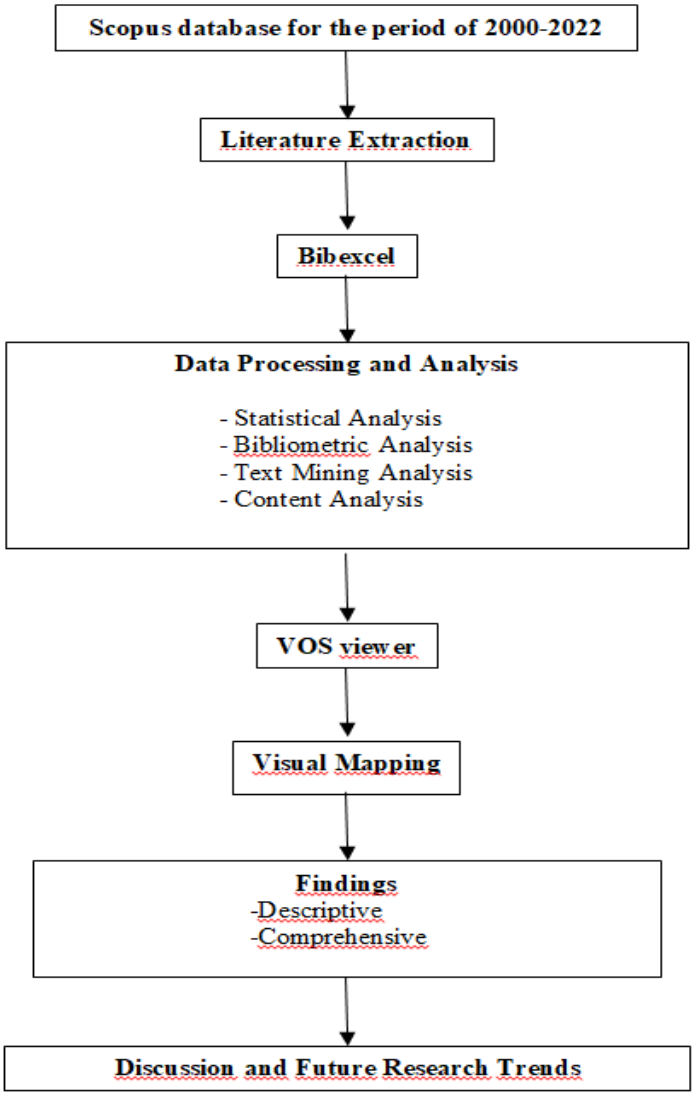

Figure 2. Research process diagram for bibliometric analysis.

When using the method of text analysis in the analysis of areas and topics of research, the degree of correlation of data with each other is obvious. The study also used text analysis to extract important information from the collected articles. As a result, hidden research topics, main designs and directions associated with tractor trailers were revealed. This study then also included content analysis as an additional qualitative method to provide further in-depth understanding of the quantitative results. In this regard, the retrieved articles were classified based on common clusters, and a content analysis was performed to identify the most influential published works in the field of study to identify theoretical orientations. This study used several tools for data analysis. For example, Bib excel was used to perform fundamental bibliometric analysis of data from the Scopus database. Similarly, VOS visualization software was used for further analysis related to data visualization. In particular, the VOS viewer has been used to generate maps based on various data classifications. Compared with other visualization applications, its main advantage is that the graphic display is rich and clear, which makes it easy to explain the results of bibliometric analysis.

Results and discussion.

1. Development of the Literature over Time. This study examines the current literature by analyzing published articles from reputable authors, countries, and popular journals. The development of the number of articles published between 2000 and 2022 is presented in Figure 3 and Table 1 below. Total of 1482 papers published for the period of 2000-2022 on tractor trailer issue. The results show a gradual increase in wave form during the study period. From the observed trend, it can be assumed that the field of research on the problems of tractor trailers will continue to develop in the future. Researchers' interest in the problems of this field can be explained by the need for energy-efficient vehicles due to the increasing demand for energy in the world and limited energy sources.

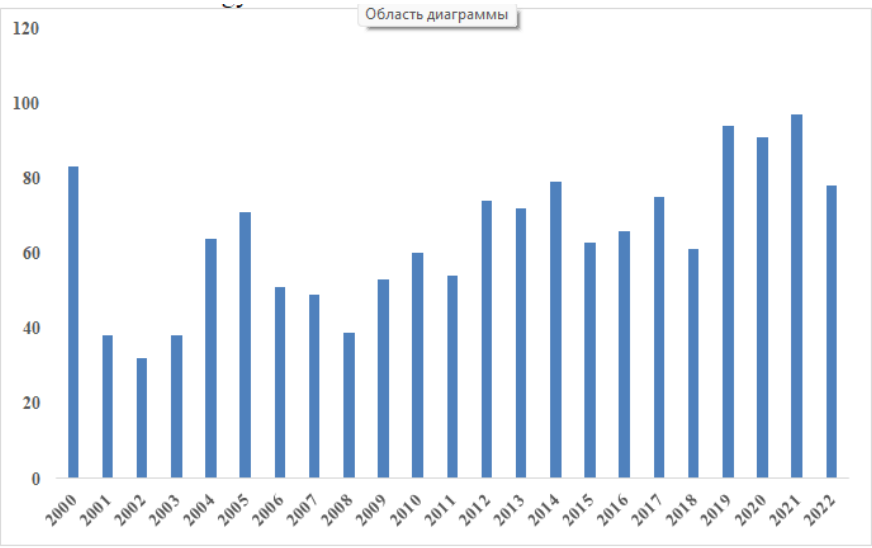

Figure 3. Development of literature over the time

Table 1. Citation analysis by year.

S. No	Year	Articles	Citations
1	2000	83	529
2	2001	38	264
3	2002	32	355
4	2003	38	685
5	2004	64	503
6	2005	71	584
7	2006	51	580
8	2007	49	297
9	2008	39	518
10	2009	53	366
11	2010	60	448
12	2011	54	457
13	2012	74	480
14	2013	72	529
15	2014	79	963
16	2015	63	677
17	2016	66	709
18	2017	75	516
19	2018	60	413
20	2019	94	717
21	2020	92	428
22	2021	98	227
23	2022	77	65

Table **1** presents citation analysis for the previous twenty-three years. The results indicate that the largest number of articles were published in the year 2021 (98), followed by 2019 (94), 2020 (92), and 2000 (83). However, their number of citations is still relatively small compared with articles from other years. It can be seen in table that papers from the year 2014 have the highest number of citations in the entire selected period. A total of 79 articles from the year 2014 have been cited 963 times in the literature. Likewise, 94 articles from 2019 and 66 articles from 2016 have the second (717) and third (709) highest number of citations in the previous literature. Also, Table 1 shows that the trend of citations was higher in 2014-2016, while the number of articles and citations fluctuated unevenly during the full research year.

2. Influential Researchers

Figure 4 highlights the 15 most influential researchers who have produced quality articles in the last twenty-two years. In the field of tractor trailer issue, D. Sebon from the University of *Cambridge* is found to be the most influential researcher with twenty-one Scopus indexed publications in the period 2000–2022. Similarly, Cebon, D. and Guenther, D.A., based at *Ohio State* University, USA, also respectively published eighteen and seventeen articles in the same period. Hence, both Cebon, D and Guenther, D.A. are identified as top researchers in the field of tractor trailer issue.

3. Influential Institutions

Selection of the appropriate journal is essential during the publication process. Scopus based 1482 papers on tractor trailer issue published in 123 different journals. The total number of articles published in the top 50 journals listed in Table 2 is 769, representing 51.8% of the total number of articles. The analysis shows that the SAE Technical Papers stands out with 259 research papers.

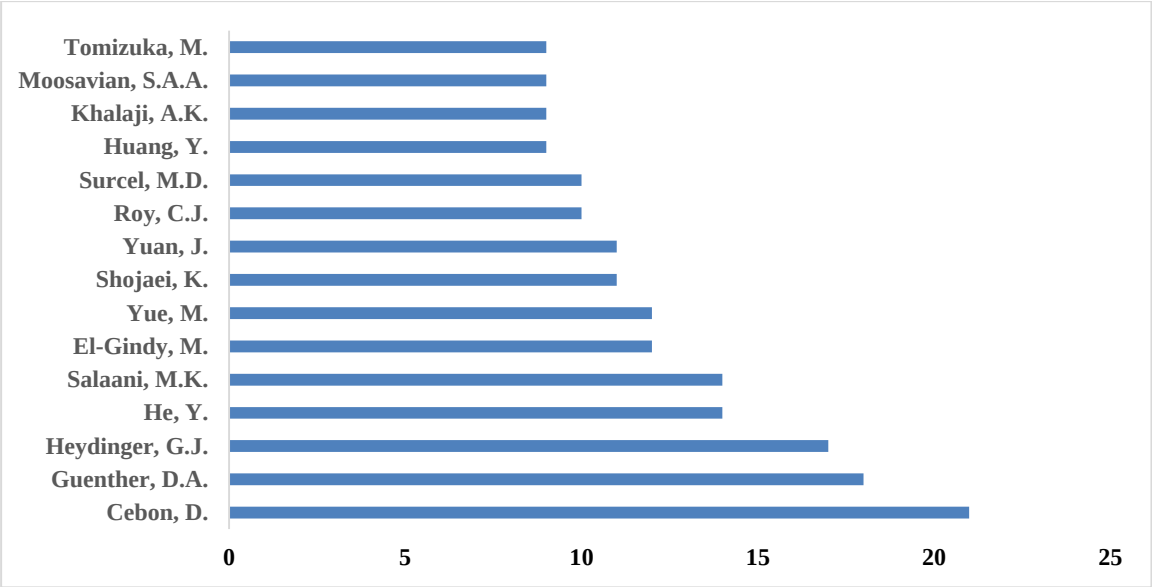

Figure 4. Influential researchers.

Table 2. Top list of the journals on tractor trailer issue.

Scopus Source title	Number
SAE Technical Papers	241
SAE International Journal Of Commercial Vehicles	59
Vehicle System Dynamics	29
International Journal Of Heavy Vehicle Systems	28
Proceedings Of The Institution Of Mechanical Engineers Part D Journal Of Automobile Engineering	24
Transportation Research Record	24
Iop Conference Series Materials Science And Engineering	18
Lecture Notes In Mechanical Engineering	17
Proceedings Of The American Control Conference	16
VDI Berichte	15
Journal Of Wind Engineering And Industrial Aerodynamics	14
Proceedings Of SPIE The International Society For Optical Engineering	14
Lecture Notes In Applied And Computational Mechanics	12
Applied Mechanics And Materials	11
Proceedings IEEE International Conference On Robotics And Automation	11
Proceedings Of The Institution Of Mechanical Engineers Part K Journal Of Multi Body Dynamics	11
Biosystems Engineering	10
AMA Agricultural Mechanization In Asia Africa And Latin America	9
Advanced Materials Research	9
IEEE ASME Transactions On Mechatronics	9

IEEE Intelligent Vehicles Symposium Proceedings	9
IFAC Proceedings Volumes IFAC Papersonline	9
Accident Analysis And Prevention	8
Heavy Vehicle Systems	8
IEEE International Conference On Intelligent Robots And Systems	8
Journal Of Bridge Engineering	8
Proceedings Of The World Congress On Intelligent Control And Automation WCICA	8
Applied Sciences Switzerland	7
IEEE Conference On Intelligent Transportation Systems Proceedings ITSC	7
Lecture Notes In Electrical Engineering	7
Transport	7
Transportation Research Part D Transport And Environment	7
IEEE Transactions On Control Systems Technology	6
IEEE Transactions On Intelligent Transportation Systems	6
IFAC Papersonline	6
International Journal Of Automotive Technology	6
Mathematical Problems In Engineering	6
Advances In Intelligent Systems And Computing	5
Agricultural Engineering International Cigr Journal	5
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Energies	5
International Journal Of Vehicle Design	5
International Journal Of Vehicle Performance	5
International Journal Of Vehicle Systems Modelling And Testing	5
Journal Of Agricultural Engineering	5
Journal Of Safety Research	5
Journal Of The National Academy Of Forensic Engineers	5
Lecture Notes In Networks And Systems	5
Proceedings Of The ASME Design Engineering Technical Conference	5
SAE International Journal Of Passenger Cars Mechanical Systems	5

4. Influential Countries

From 2000 to 2022, 63 different countries were identified publishing articles relating to tractor trailer issue. Figure 5 presents results concerning the top twenty countries and the number of published articles. It can be seen that the USA and China hold the top two positions with 476 and 214 articles, respectively. Similarly, the Canada ranks third with 112 published articles during the targeted period. A total of 15 countries have produced more than 1270 articles. The results also reveal that most of the top 15 countries, such as Japan, Germany, the USA, China, Korea, etc., have highly developed automobile industries. Further, results also indicate that 162 articles in the sample have an undefined country affiliation.

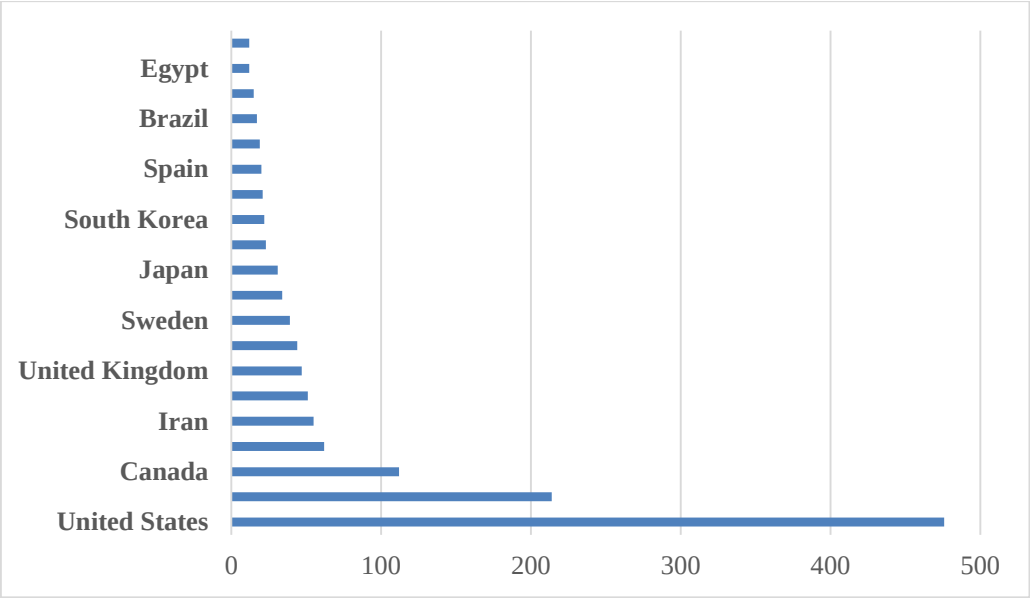

Figure 5. Publications by countries

6 Publication type on Tractor trailer issue

There are different publication types where researchers can show their results. Papers published on tractor trailer issue in world for the given period presented in 9 different publication types shown in Figure 6. Seven hundred and forty conference papers and six hundred and thirteen research papers published on tractor trailer issue. After them comes fifty-six conference review and thirty-eight review papers published during this period. Next comes chapter type of publication with sixteen papers from the total publications. Also, thirteen short survey, four note and both one papers published on tractor trailer issue in this period.

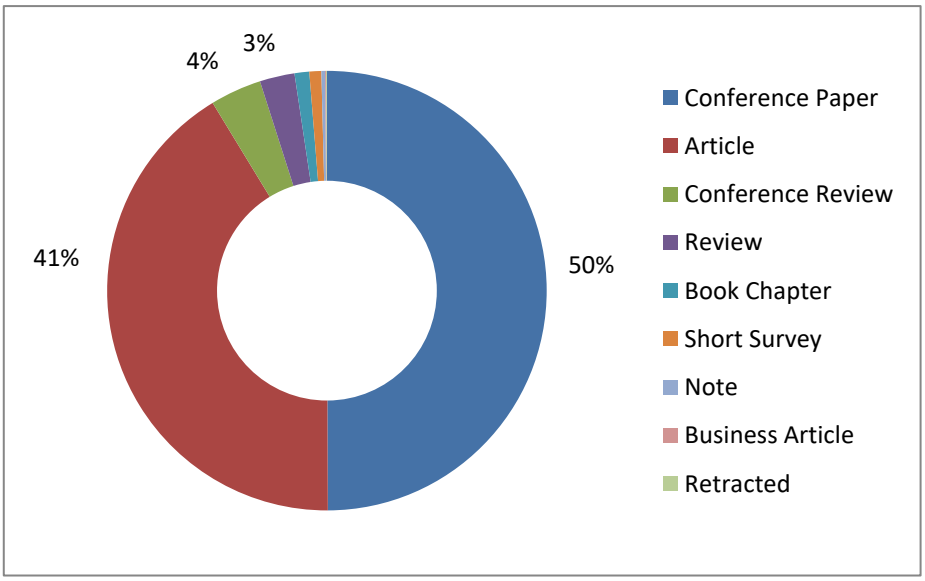

Figure 6 List of publication type on Tractor trailer issue.

7. Top cited papers on tractor trailer issue

Number of citations shows the quality and novelty of the conducted research. Ten mostly cited papers on tractor trailer issue shown in the Figure 7 [11–20]. Total of 11310

citations given to 1021 publications on tractor trailer issue for the given period. Almost 11,5% of citations given to 10 papers from the Figure 7. First 10 top cited papers are consisting of one review and 9 research articles.

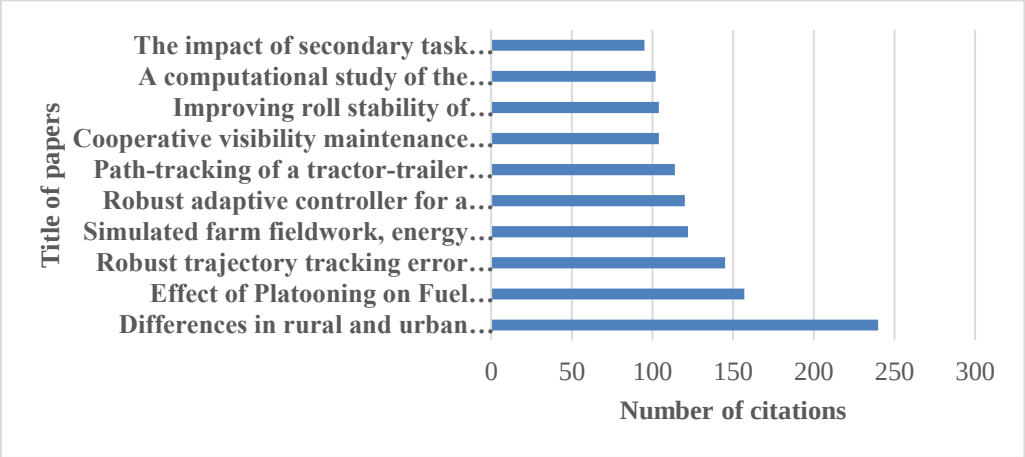

Figure 7. List of top cited publications on tractor trailer issue.

7. Top cited journals on tractor trailer issue

Total of 132 journals selected to publish 1482 papers on tractor trailer for the period of 2000-2022. Top cited 10 journals selected and shown in Figure 8. Almost 11.52 % of total citations given to papers published in these 10 journals. Journal Accident Analysis and Prevention, SAE International Journal of Commercial Vehicles and IEEE/ASME Transactions on Mechatronics journals are leading the list of top cited journals with the number of citations 240, 157, 145 respectively.

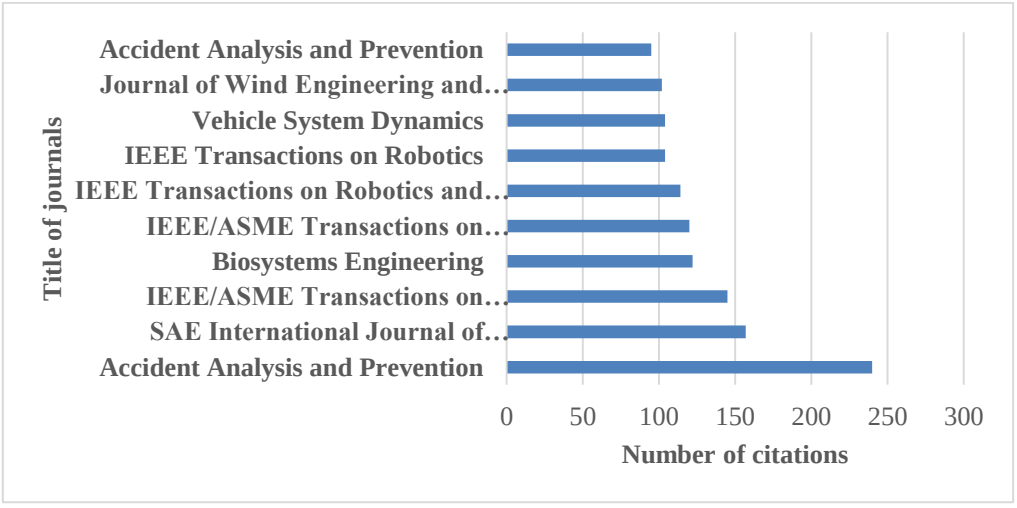

Figure 8. List of top cited journals on tractor trailer issue

8. Analyzing Research Areas

Finally, this research identified various domains within tractor trailer issue-related research by analyzing keywords clusters. The primary information contained in the article can be mainly represented by keywords, which allows us to understand the subject area of the research topic through keyword analysis. This research specifically used VOS viewer to

examine the author's keywords. The original data were preprocessed, and comparable keywords were merged to make the data more understandable. Because most terms appeared only once, the top keywords were chosen based on a threshold of three occurrences. Hence, a total of 883 keywords were used; out of these, 159 keywords met the threshold with a minimum of three occurrences.

The results mapped in Figure 8 show that three different keyword clusters can be identified in the literature. The significant clusters relating to tractor trailer research can be identified as of tractor trailer structural elements, operational characteristics of tractor trailers and their economical use, and truck transportation. The results also show strong interdependence among various tractor trailers research clusters. As shown in Figure 8, the red cluster represents the system of tractor trailer structural elements and includes keywords such as braking, steering, kinematics, wheels, stability, etc. It can be seen that most of the literature on this subject includes articles focusing on various issues related to the construction of trailers. The second cluster, shown in green, mainly includes keywords such as aerodynamics, aerodynamic drag, computation fluid dynamics, wind tunnels, automobile testing, fuel economy, commercial vehicles, trucks, fuels, automobiles, etc. These keywords include articles with topics related to the operational characteristics of tractor trailers and their economical use. Also, looking at blue cluster trailers from a transportation point of view, we can see in them work related to the transportation of goods. Keywords of this cluster include: truck transportation, accident, roads and streets, and semi-trailers.

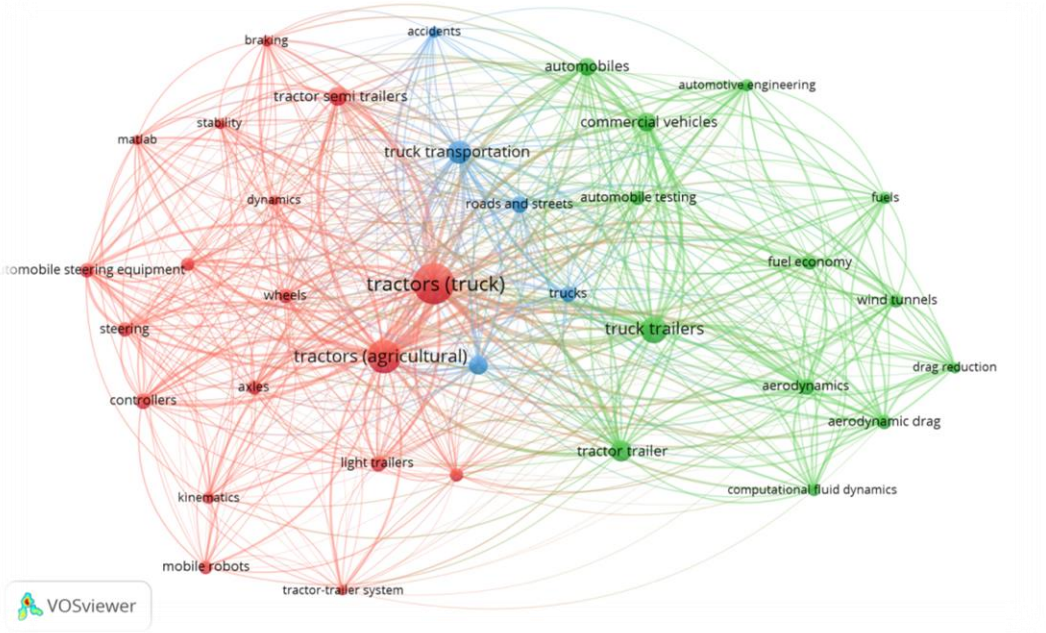

Figure 8. Visualization map of subject keywords clusters.

Conclusion.

This research provides a comprehensive bibliometric assessment of the existing literature in the field of tractor trailer issue-related research. In total, 1482 research publications were extracted from the period 2000 to 2022. The results showed an increase in the number of articles published in recent years. The USA, China, and Canada were found to be producing most of the influential research relating to tractor trailer. Among the institutions, Jilin universities were found on the top in publishing the highest number of tractor trailer -related articles around the globe. Likewise, it is also identified that Cebon D. has produced the highest number of tractor trailer -related articles among individual researchers during the

targeted period of research. Overall, this research identifies three major clusters of tractor trailers research, which can be categorized as tractor trailer structural elements, operational characteristics of tractor trailers and their economical use, and truck transportation. Further, the results also indicate considerable interrelations between distinct tractor trailers research clusters. It was found that most of the existing studies focused on local scenarios and specific processes of improving trailer structures. Therefore, it has become crucial to conduct detailed analysis incorporating more global and general perspectives relating to tractor trailers.

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