

THE KNOWLEDGE DOMAIN OF THE BALTIC JOURNAL OF ROAD AND BRIDGE ENGINEERING BETWEEN 2006 AND 2019

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Abstract. The Baltic Journal of Road and Bridge Engineering is a multidisciplinary journal, which provides a forum for a broad range of road and bridge engineering research. The topics such as the road and bridge research and design, the construction materials and technologies of roads and bridges, the construction financing and environmental issues, and the assessment management are included in the scope of the Baltic Journal of Road and Bridge Engineering investigation. Due to the reason that various road and bridge engineering related research directions are involved in this journal,

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it has become the first one that deals with the issues as mentioned above in Baltic countries. Therefore, it is believed that investigating the publications in the Baltic Journal of Road and Bridge Engineering assists researchers in great learning the development of road and bridge engineering research in Baltic countries. By analysing the annual publication distribution, the citation structure, the co-citation and cooperation networks, and the significant contributors in terms of countries and regions, institutions, cited journals and authors, the status of Baltic Journal of Road and Bridge Engineering is comprehensively presented. In addition, the emerging trends are revealed through the analyses of timeline view and burst detection. This study makes the contribution to the aspect of visualizing the complex and significant results based on objective and quantitative data. It provides readers with access to understand the development of Baltic Journal of Road and Bridge Engineering and helps researchers learn the hot issues in this journal clearly and directly.

Keywords: Baltic countries, The Baltic Journal of Road and Bridge Engineering (BJRBE), Bibliometrics, CiteSpace; VOSviewer, Road and Bridge Engineering, Web of Science.

Introduction

Being established in 2006, The Baltic Journal of Road and Bridge Engineering (BJRBE) provides a platform for researchers who are interested in the areas such as the road and bridge research and design, the construction materials and technologies of roads and bridges, the construction financing and environmental issues, and the assessment management. This journal is collected in the Social Science Index Expanded and ranked 106th among 128 journals in the research area of engineering with an impact factor of 0.622 in 2017 based on the Journal Citation Report. Due to the reason that various road and bridge engineering related research directions are involved in this journal, it has become the first one that deals with the issues as mentioned above in Baltic countries. Even though this journal gets the support from the different organizations in these three countries including the Lithuanian and Estonian Road Administrations, the state company "Latvian State Roads", the Vilnius Gediminas Technical University, the Riga Technical University, and the Tallinn University of Technology as well as the Baltic Road Association, the research outputs that BJRBE publishes also come from other countries with a full investigation scope. It is believed that investigating the development of BJRBE assists researchers in knowing more about the specific directions in road and bridge engineering area, especially in Baltic countries.

To provide a general picture of the knowledge domain of the research published by BJRBE, the practical bibliometric tools CiteSpace and VOSviewer are selected to investigate and analyse the status quo and emerging trends of the literature published in this journal. As a Java

application, CiteSpace provides visualized knowledge exploration in the bibliographic databases. It is utilized to detect and visualize the emerging trends and the transient patterns of a research area (Chen, 2006). Also, VOSviewer is a freely available software to construct and view bibliometric maps (Van Eck & Waltman, 2010). Therefore, the method has been broadly utilized in various fields. For instance, Morar & Agachi (2010) provided an easy understanding review of the development of heat integration and Heat Exchanger Network Synthesis (HENS). Yu (2015) investigated the aggregation operator from the perspective of scient metrics.

Moreover, CiteSpace and VOSviewer have also been applied to analyse the emerging trends in specific fields. Chen, Dubin, & Kim (2014) used CiteSpace to present the knowledge domain of regenerative medicine that introduces the emerging trend and the developments in this area. Also, as a practical approach, some investigations focus on applying VOSviewer to present diverse knowledge domains comprehensively. Kozak, Bornmann, & Leydesdorff (2015) attempted to analyse the development of the Eastern European countries of the former Warsaw Pact after 1990. In the medical area, the research trends, and the features of the publications on the emerging pathogens listed by the World Health Organization were investigated by Sweileh (2017). Besides, Yeung, Goto, & Leung (2017), and Awruch, Somoza, & Baldock (2019) respectively evaluated the changing landscape research and the Chondrichthyan research by utilizing VOSviewer. Also, the literature about transgender health is analysed to help the public understand the needs in terms of transgender health and rights (Sweileh, 2018). As a result, these bibliometric methods are of significance to assist researchers in learning the research outputs in various areas.

Some studies pay attention to the bibliometric study of papers published in the field of the journal or some specific journals. In the early years, Pierce (1992) analysed the origin and meaning of bibliometric indicators based on the journals in the social sciences. Hoffman & Holbrook (1993) overviewed the structure of the Journal of Consumer Research. Furthermore, the journal assessment was carried out by Foo (2009) to evaluate the nine significant journals in the research field of biomedical engineering by analysing the citation links, and by Hall (2011) to assess the research quality of the journals in tourism. This paper assesses the journal quality by identifying the stated preference, citation-based, derived, hybrid, and expert panels, which is different from the studies mentioned above.

Moreover, Wang, Li, & Ho (2011) presented an evaluation of water resources journals from the perspectives of the scientific output distributions of countries, institutions, and keywords. In addition, the

relation between the impact factor and H-index was also revealed in this article. Therefore, different approaches are applied to evaluate the journals research fields. Through diverse bibliometric methods, it is becoming crucial to provide an easily understandable overview of the journal development in different research fields. Specifically, some journals are also the investigation objects of bibliometric study. For example, Ramos-Rodríguez & Ruíz-Navarro (2004) identified the influential studies in strategic management research and analysed the changes in the intellectual structure of this area by presenting the citation and the co-citation analyses of the articles published by Strategic Management Journal. Merigó, Mas-Tur, Roig-Tierno, & Ribeiro-Soriano, (2015) analysed the papers published by the Journal of Business research, demonstrating the citation structure of the frequently cited articles and the influential authors, organizations, and countries.

Similarly, Guzeller & Celiker (2019), Laengle, Merigó, Miranda, Słowiński, Bomze, Borgonovo, ... & Teunter (2017), Şenel & Demir (2018), Yu, Xu, & Fujita (2019), Yu, Xu, & Šaparauskas (2019), and Yu, Xu, & Wang (2019) respectively gave the bibliometric overviews of the development of European Journal of Operational Research, Journal of Religion and Health, Technological and Economic Development of Economy, Fuzzy Optimization and Decision Making, Applied Intelligence, and Asia Pacific Journal of Tourism Research. The above studies provided a general picture of specific journals by illustrating the citation structure and the most influential contributors on the aspects of authors, institutions, and countries. Both CiteSpace and VOSviewer give access for researchers to know more about the research development in specific areas. This study attempts to specifically investigate the papers published by BJRBE that focuses on the road and bridge engineering related issues in Baltic countries. As a result, this paper aims to comprehensively investigate the status quo and emerging trends of the scientific outputs in BJRBE by using the bibliometric tools, namely CiteSpace and VOSviewer.

This paper is organized as follows: The focuses and editor list are illustrated in Section 1. Section 2 introduces the publication and citation numbers and the citation structure of BJRBE. The influential contributors in terms of papers, countries and institutions are illustrated and analysed in Section 3. Besides, the co-authorship network of the author and the co-citation network of authors are also presented. Furthermore, some burst detections for the most-cited authors and the most cited journals are given in Section 4. Also, the keyword co-occurrence network and the timeline view for the keywords of the articles in BJRBE are demonstrated to show the hotspots and the specific research directions of this journal in the defined period, which is presented in Section 5. Lastly, the conclusions are provided.

1. Focuses and editor list

To briefly understand the specific research directions of the publications in BJRBE, the focuses of BJRBE are listed in Table 1. The direction of road and bridge research and design ranks in the first place, following with the construction materials and technologies in terms of road, railway, and bridge. The research scope starts from designing to maintaining, from general concepts to specific objectives. The primary process of the road and bridge construction is included in the scope of the investigation of BJRBE, other aspects such as traffic safety, environmental issues and road climatology are also involved. It implies that the research scope of this journal is multidisciplinary.

Besides, the change of editors in BJRBE is also demonstrated in Table 2. It is introduced that BJRBE was transferred from Vilnius Gediminas Technical University (Lithuania) to Riga Technical University (Latvia) since 11 June 2018. Prof. Dr Ainārs Paeglītis from Riga Technical University has been elected Editor-in-Chief of the journal. Most of the

Table 1. The focuses of the Baltic Journal of Road and Bridge Engineering publications

Rank	Focus and scope
1	Road and bridge research and design
2	Road construction materials and technologies
3	Railway construction materials and technologies
4	Bridge construction materials and technologies
5	Road, railway, and bridge repair
6	Road, railway, and bridge maintenance
7	Road traffic safety
8	Road and bridge information technologies
9	Environmental issues
10	Road climatology
11	Low-volume roads
12	Normative documentation
13	Quality management and assurance
14	Road infrastructure and its assessment
15	Asset management
16	Road and bridge construction financing
17	Specialist pre-service and in-service training

Table 2. The list of Editorial Board of The Baltic Journal of Road and Bridge Engineering

Editor	Name	Country	Institution
Editor-in-Chief	Ainārs Paeglītis	Latvia	Riga Technical University Riga
Associate Editors	Alfredas Laurinavičius	Lithuania	Vilnius Gediminas Technical University
	Juris Smirnovs	Latvia	Riga Technical University
	Andrus Aavik	Estonia	Tallinn University of Technology
Managing Editor	Atis Zarins	Latvia	Riga Technical University
International Editorial Board	Hojjat Adeli	USA	Ohio State University
	Dago Antov	Estonia	Tallinn University of Technology
	Halil Ceylan	USA	Iowa State University
	Donatas Čygas	Lithuania	Vilnius Gediminas Technical University
	Gianluca Dell'acqua	Italy	Federico II University of Napoli
	Mindaugas Dimaitis	Lithuania	PE Road and Transport Research Institute
	Alfredo Garcia Garcia	Spain	Polytechnic University of Valencia
	Viktors Haritonovs	Latvia	Riga Technical University
	Inge Hoff	Norway	Norwegian University of Science and Technology
	Siim Idnurm	Estonia	Tallinn University of Technology
	Vilma Jasiūnienė	Lithuania	Vilnius Gediminas Technical University
	Gintaris Kaklauskas	Lithuania	Vilnius Gediminas Technical University
	Lev Khazanovich	USA	University of Pittsburgh
	Jose Campos Matos	Portugal	University of Minho
	Dainius Miškinis	Lithuania	LRA under the Ministry of Transport and Communications of the Republic of Lithuania
	Algis Pakalnis	Lithuania	PE Road and Transport Research Institute
	Virgaudas Puodžiukas	Lithuania	Vilnius Gediminas Technical University
	Piotr Radziszewski	Poland	Warsaw University of Technology
	Filippo Giammaria Praticò	Italy	University Mediterranea of Reggio Calabria
	Valentin Siljanov	Russia	Moscow State Technical University
	Henrikas Sivilevičius	Lithuania	Vilnius Gediminas Technical University
	Dariusz Sybilski	Poland	Road and Bridge Research Institute

Editor	Name	Country	Institution
	Audrius Vaitkus	Lithuania	Vilnius Gediminas Technical University
	Andras Varhelyi	Sweden	Lund University
	Edmundas Kazimieras Zavadskas	Lithuania	Vilnius Gediminas Technical University
	Adam Zofka	Poland	Road and Bridge Research Institute
	Daiva Žilionienė	Lithuania	Vilnius Gediminas Technical University

editors are from the institutions in European, especially in the three countries of Baltic. Also, some editors in the international editorial board mainly come from the universities in Northern Europe.

2. The publications, citation numbers and citation structure

2.1. Data collection

As aforementioned, CiteSpace and VOSviewer are utilized to present a bibliometric overview of BJRBE. Moreover, the Web of Science (WoS) is selected as the data source due to the reason that it is an excellent platform for researchers to learn more about a considerable amount of papers in the world. The platform includes the data of Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Emerging Sources Citation Index (ESCI), Conference Proceedings Citation Index-Science (CPCI-S), Conference Proceedings Citation Index- Social Science & Humanities (CPCI-SSH) (Van Leeuwen, 2006). Based on the above method, 445 publications of BJRBE are found from WoS between 2006 and 2018.

2.2. Types of BJRBE publications

As shown in Figure 1, all the papers of BJRBE are divided into six types based on the analytic results on the WoS database. Notably, the type of articles takes up a significant proportion. Moreover, nine papers belong to edition material, and eight papers are classified as proceedings paper. In addition, biographical item, news item and review, each of them only has one article as reported by the searching results.

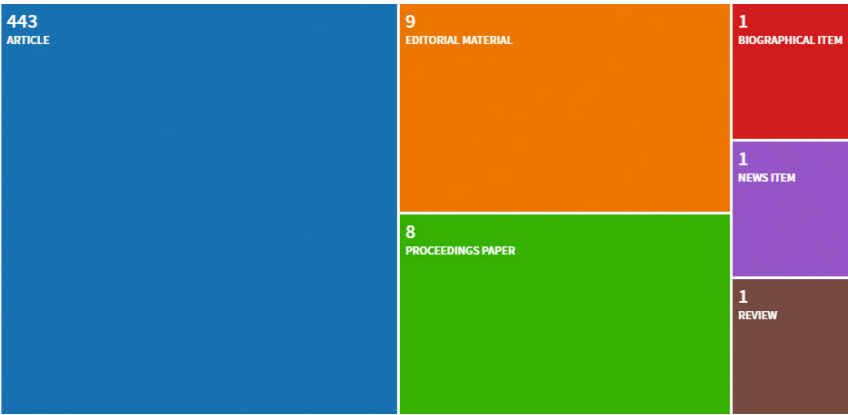


Figure 1. Types of the Baltic Journal of Road and Bridge Engineering publications

2.3. Publication and citation structure of BJRBE

There are 455 articles published between 2006 and 2018. Their distribution is shown in Figure 2. It is noted that even though BJRBE published the papers in the first issue in 2019, they are absent in the WoS database. Therefore, the data in 2019 are excluded from the publication number analysis. It is found that annual publications among the 13 years are all above 25. The numbers of papers published between 2016 and 2018 are relatively stable. Notably, the publications in 2015 reached the top with the number of 46. The publications in 2005 focused more about the issues of the highway.

Figure 3 lists the distribution of the citations of the BJRBE publications from January 2007 to April 2019. Owing to the reason that the citation number in 2006 is only 1, the data in 2007 is selected. The numbers of citations are rising sharply from 2007 to 2010. Accurately, the citations in 2010 reached a peak with 252 citations. This phenomenon indicates that more authors paid more attention to the field of engineering between 2007 and 2010, the development of the investigations about road and bridge construction has overgrown. Although the citations in the recent eight years are fewer than those in 2010, the numbers keep at 200 approximately.

In terms of the details of the citations of BJRBE, Table 3 is presented with the information about the total citations (TC), the total publications (TP) and the average citations per paper (AC). "No less than 50", "no less than 20", "no less than 10", "no less than 5", and "no less than 1" are different intervals of publication numbers. Besides, Hirsch (2005)

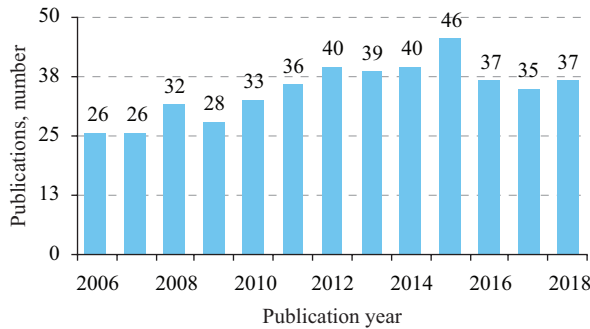


Figure 2. Distribution of the Baltic Journal of Road and Bridge Engineering publications between 2006 and 2018

proposed H-index. It accurately reflects and evaluates academic achievement. A high H-index indicates that the corresponding publication has significant academic progress. It is found that the publications in 2008 have the maximum H-index, and the highest TC, hence those papers published in 2008 have great scientific achievements. Through observing the data of AC, the papers published in 2009 have more average citations per paper with 11.96. Based on the data collecting from the WoS database, there are only three papers have cited more than 50 times. One is a paper by Zavadskas, Kaklauskas, Peldschus, & Turskis (2007) “Multi-attribute assessment of road design solutions by using the COPRAS method” and it has the most citations with 75. This paper utilized the COPRAS method to evaluate multi-attribute decision support for road design alternatives. Another one is “Analysis and evaluation of possibilities for the use of warm-mix asphalt in Lithuania” (Vaitkus, Čygas, Laurinavičius, & Perveneckas, 2009), this paper introduced different technologies of

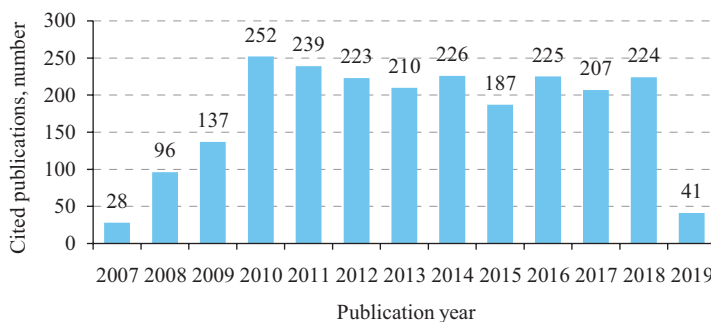


Figure 3. Distribution of the publication citations of the Baltic Journal of Road and Bridge Engineering between 2007 and 2019

Table 3. Annual citation structure of the publications in BJRBE.

Year	Average Citations per paper	Total		H-index	No less than				
		Publications	Citations		50	20	10	5	1
2006	5.73	26	149	4	0	0	4	13	24
2007	11.62	26	302	10	1	3	12	19	25
2008	10.88	32	348	12	1	3	12	24	29
2009	11.96	28	335	10	1	6	13	20	26
2010	7.03	33	232	8	0	1	8	21	30
2011	7.03	36	253	8	0	3	8	18	34
2012	6.03	40	241	9	0	1	7	20	39
2013	3.41	39	133	6	0	0	2	13	30
2014	2.78	40	111	5	0	0	2	7	32
2015	2.20	46	101	5	0	0	2	5	31
2016	1.65	37	61	4	0	0	1	2	25
2017	0.69	35	24	3	0	0	0	1	12
2018	0.16	37	6	1	0	0	0	0	6
Total	–	455	2296	–	3	17	71	163	343
Percentage	–	–	–	–	0.66%	3.78%	15.60%	35.82%	75.38%

producing warm mix asphalt, and for all the techniques. It also depicted the advantages and disadvantages. The last one is by Zavadskas, Liias, & Turskis (2008) “Multi-attribute decision-making methods for assessment of quality in bridges and road construction: state-of-the-art surveys”. They are summarizing that in term of bridge and road construction and multi-attribute decision-making methods are significantly useful for it. Compared to the three papers, it is found that Zavadskas wrote two of them, and they are all related to the multi-attribute method.

The latest article is “Evaluation of real-time intelligent sensors for structural health monitoring of bridges based on SWARA-WASPAS: a case in Iran” (Bitarafan, Zolfani, Arefi, Zavadskas, & Mahmoudzadeh, 2014). It used the method based on SWARA and WASPAS to concentrate on the research of real-time health monitoring system of Iran bridges. There are 75.38% of the publications cited more than one time, while 35.82% of them are cited even more than five times. Moreover, the TC and AC values after 2012 are less. More details about the influential papers published in BJRBE are illustrated and analysed in the next section.

3. Influential contributors on the aspects of papers, countries, and institutions

To comprehensively understand the status of BJRBE, the influential contributors from the most cited papers to the most productive institutions are listed and analysed. From Table 4, the frequently cited 30 papers are presented to show the articles made significant theoretical and practical contributions. Similarly, the influential countries and the country co-authorship network, the active institutions and the organization citation network, the productive author and the author co-authorship network, and the co-citation network of authors are analysed in detail to provide a general picture of the status quo the research outputs and environment of this journal. Table 4 shows the top 30 highly cited publications in BJRBE. All the 30 papers were published before 2014, and it means that the papers published in that period are relatively more influential. In the top 30 highly cited publications in BJRBE, the author Sivilevičius appears for four times. His most cited paper, "Quality attributes and complex assessment methodology of the asphalt mixing plant" (Sivilevičius, Zavadskas, & Turskis, 2008) put a kind of multi-attribute model for evaluating the efficient quality of the Asphalt Mixing Plants and proposed a case study.

Table 4. Most cited papers in the Baltic Journal of Road and Bridge Engineering from 2006 to 2019

Rank	Title	Author(s)	Total Citations	Year	Average Citations per paper
1	Multi-attribute assessment of road design solutions by using the COPRAS method	Zavadskas, Kaklauskas, Peldschus, & Turskis	75	2007	5.77
2	Analysis and evaluation of possibilities for the use of warm mix asphalt in Lithuania	Vaitkus, Čygas, Laurinavičius, & Perveneckas	61	2009	5.55
3	Multi-attribute decision-making methods for assessment of quality in bridges and road construction: state-of-the-art surveys	Zavadskas, Liias, & Turskis	55	2008	4.58

Rank	Title	Author(s)	Total Citations	Year	Average Citations per paper
4	Quality attributes and complex assessment methodology of the asphalt mixing plant	Sivilevičius, Zavadskas, & Turskis	41	2008	3.42
5	Application of expert evaluation method to determine the importance of operating asphalt mixing plant quality criteria and rank correlation	Sivilevičius	34	2011	3.78
6	Evaluation of soil shear strength parameters via triaxial testing by height versus diameter ratio of sample	Amšiejus Dirgėlienė, Norkus, & Žilionienė	30	2009	2.73
7	Prioritizing constructing projects of municipalities based on AHP and COPRAS-G: A case study about footbridges in Iran	Aghdaie, Hashemkhani, & Zavadskas	29	2012	3.63
8	Research of asphalt pavement structures on Lithuanian roads (I)	Čygas, Laurinavičius, Vaitkus, Perveneckas, & Motiejūnas	29	2008	2.42
9	Speed factors on low-volume roads for horizontal curves and tangents	Dell'Acqua & Russo	28	2010	2.80
10	Factors determining the inhomogeneity of reclaimed asphalt pavement and estimation of its components content variation parameters	Mučinis, Sivilevičius, & Oginskas	26	2009	2.36
11	Evaluation of interlayer shear bond devices for asphalt pavements	Raab, Partl, & El Halim	26	2009	2.36
12	Speed reduction effects of urban roundabouts	Antov, Abel, Sürje, Rök, & Rõivas	25	2009	2.27
13	Multiple criteria assessment of pile-columns alternatives	Sušinskas, Zavadskas, & Turskis	24	2011	2.67
14	Safety performance functions for low-volume roads	Dell'Acqua & Russo	23	2011	2.56
15	Finite element model updating of Senyuva historical arch bridge using ambient vibration tests	Bayraktar, Birinci, Altunişik, Türker, & Sevim	23	2009	2.09

Rank	Title	Author(s)	Total Citations	Year	Average Citations per paper
16	Analysis and evaluation of the efficiency of road safety measures applied to Lithuanian roads	Ratkevičiūtė, Čygas, Laurinavičius, & Mačiulis	22	2007	1.69
17	Investigation of automobile wheel impact on the road border	Sokolovskij, Prentkovskis, Pečeliūnas, & Kinderytė-Poškienė	21	2007	1.62
18	A procedure to improve safety inspections effectiveness and reliability on rural two-lane highways	Cafiso, La Cava, Montella, & Pappalardo	19	2006	1.36
19	The road of experimental pavement structures: experience of five years operation	Vaitkus, Laurinavičius, Oginskas, Motiejūnas, Paliukaitė, & Barvidienė	18	2012	2.25
20	Evaluation of real-time intelligent sensors for structural health monitoring of bridges based on SWARA-WASPAS; a case in Iran	Bitarafan, Zolfani, Arefi, Zavadskas, & Mahmoudzadeh	17	2014	2.83
21	Investigation of concrete cracking effect in deck slab of continuous bridges	Gribniak, Kaklauskas, Čygas, Bačinskas, Kupliauskas, & Sokolov	17	2010	1.70
22	Necessary measures for ensuring the quality of hot mix asphalt in Lithuania	Petkevičius & Sivilevičius	17	2008	1.42
23	Dynamics of vehicle loads on the asphalt pavement of European roads, which cross Lithuania	Sivilevičius & Šukevičius	17	2007	1.31
24	Dependence of the recycled asphalt mixture physical and mechanical properties on the grade and amount of rejuvenating bitumen	Čygas, Mučinis, Sivilevičius, & Abukauskas	16	2011	1.78
25	Comparison of bridge dynamic amplification due to articulated 5-axle trucks and large cranes	Cantero, González, & O'Brien	15	2011	1.67

Rank	Title	Author(s)	Total Citations	Year	Average Citations per paper
26	Use of pulsating water jet technology for removal of concrete in repair of concrete structures	Sitek, Foldyna, Martinec, Scucka, Bodnárová, & Hela	15	2011	1.67
27	Finite element mesh size effect on deformation predictions of reinforced concrete bridge girder	Gribniak, Kaklauskas, Idnurm, & Bačinskas	15	2010	1.50
28	Research on the dependence of asphalt pavement stiffness upon the temperature of pavement layers	Motiejūnas, Paliukaitė, Vaitkus, Čygas, & Laurinavičius	15	2010	1.50
29	Research on motor transport produced noise on gravel and asphalt roads	Leipus, Butkus, & Januševičius	15	2010	1.50
30	An analysis of the effect of roadway design on driver's workload	Pellegrino	15	2009	1.36

Table 5 lists the top productive10 countries. From Table 5, it is evident that Lithuania makes significant contributions to the development of BJRBE. It has the highest TP, TC and H-index. As for the research outputs that are from Lithuania, there are 12 papers obtained more than 20 citations, and 23 papers have more than 15 citations, they are far more than other countries. Following with Lithuania, Poland is in the second place. Although Estonia has only published 20 papers, its AC is the maximum. It means its 20 articles have significantly impacted on the further investigations.

Moreover, among the ten countries, six of them are in Europe. Thus, more European countries published papers in BJRBE. The following is Asia. Figure 4 is presented to show the connections among the countries made significant contributions to the research of this journal.

As shown in Figure 4, the threshold value is set as 8, and 13 of the countries meet the thresholds. The set of the most extensive collection of connected to 11 countries is shown. It is a country co-authorship network of the BJRBE publications. Lithuania is the main contributor to this journal. In the thresholds, Lithuania has eight links, and its total link strength is 28. Therefore, Lithuania has the most frequent connections with other countries. Lithuania and Iran have the maximum link strength of 4, and it means the scholars from Lithuania and Iran

Table 5. The ten most influential countries of the Baltic Journal of Road and Bridge Engineering publications

Rank	Country	Continent	Total				No less than				
			Publications	Citations	Average Citations per Paper	H-index	20	15	10	5	1
1	Lithuania	Europe	190	1328	6.99	17	12	23	42	87	158
2	Poland	Europe	50	170	3.40	8	0	0	5	14	36
3	Italy	Europe	31	188	6.06	9	2	4	9	14	21
4	Latvia	Europe	31	110	3.55	6	0	0	4	10	23
5	China	Asia	30	64	2.13	5	0	0	2	5	18
6	USA	North America	25	54	2.16	4	0	0	0	2	19
7	Estonia	Europe	20	171	8.55	7	2	3	5	10	15
8	South Korea	Asia	13	47	3.62	4	0	0	0	4	13
9	Czech	Europe	12	44	3.67	4	0	1	2	2	10
10	Turkey	Asia	11	60	5.45	5	1	1	2	6	8

completed four papers in cooperation. Similarly, Poland has three links, Poland, Lithuania, the USA, and China have clear co-authorships, and the total link strength of Poland is 8. International communication in this field is vital and beneficial for each country.

Table 6 lists the top 5 productive and influential institutions in BJRBE. As the three served organizations, the Vilnius Gediminas Technical University, the Riga Technical University, and the Tallinn University of Technology have the most TP, TC and H-index. Nevertheless, the University of Naples Federico II has the most AC with 9. As a result, although the University of Naples Federico II has lower TP among the five institutions, its AC is the highest. The articles owned by

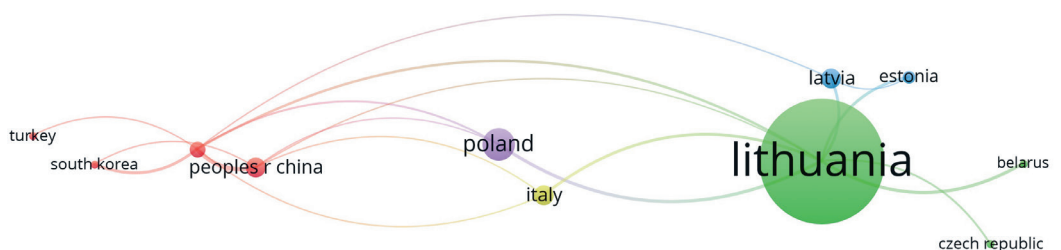


Figure 4. Country co-authorship network of the BJRBE publications

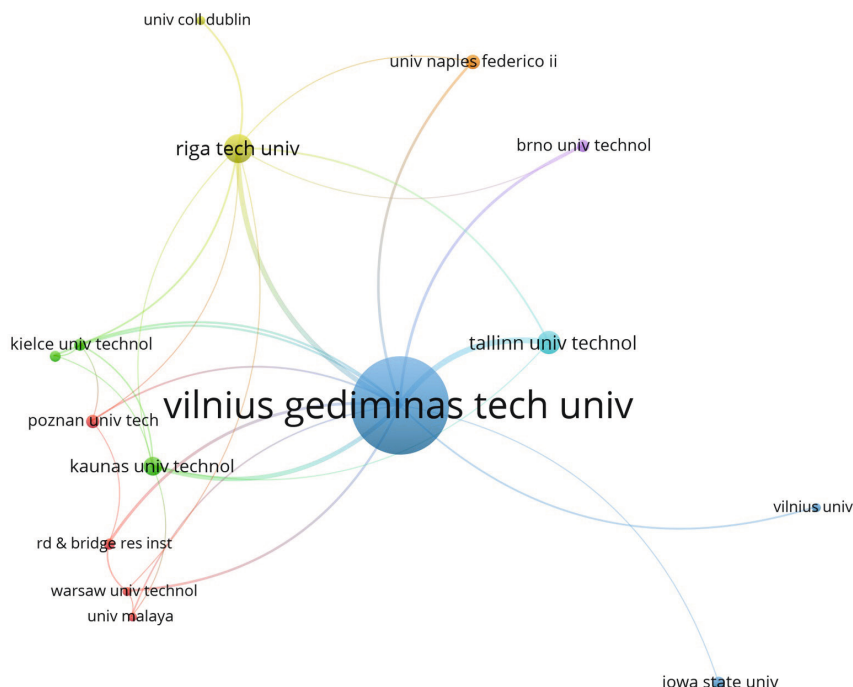


Figure 5. Organization citation network of the Baltic Journal of Road and Bridge Engineering publications

this university are relatively less shown in BJRBE than other institutions, but each of them is influential. Moreover, a more intuitionistic organization citation network of the articles published by BJRBE is found in Figure 5. The threshold value is set as 5, and 15 of the organizations meet the thresholds. Every organization is presented as a node. An organization is presented as a significant node if it has numerous publications. Additionally, Vilnius Gediminas is the most distinguished organization. Furthermore, Figure 6 reveals that the organization co-authorship network of the BJRBE publications, the co-authorship network directly describes the collaboration among the influential authors in different organizations. In the same way, the organization citation network indicates the connections among the various organizations, and it makes a significant contribution to this area. Also, the lines and distance represent the mutual relationship between the two organizations. If two organizations have a shorter line and closer distance, it means that they have a better relationship. Figure 6 is a visualization of the organization co-authorship network of the BJRBE publications. The threshold value is set as 5, and 15 of the organizations

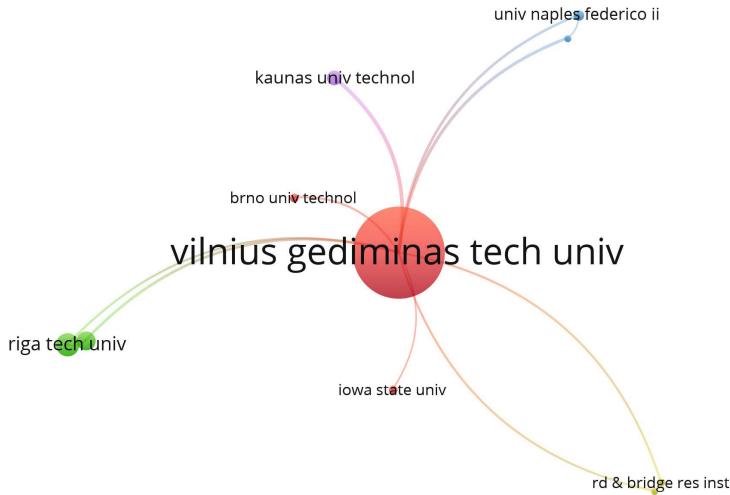


Figure 6. Organization co-authorship network of the Baltic Journal of Road and Bridge Engineering publications

meet the thresholds. As the agency for publishing BJRBE, the Vilnius Gediminas Technical University also has frequent collaboration with other organizations. It cooperates with most institutions, such as the Kaunas University of Technology, the University of Naples Federico II, the Iowa State University, the Road and Bridge Research Institute, and the Brno University of Technology. Other organizations have far less collaboration with others than the Vilnius Gediminas Technical University.

The author collaboration network is presented in Figure 7. The threshold value is set as 6, and 28 of all the 884 authors meet the thresholds. Čygas has 12 collaborations with other authors in this threshold, including Norkus, Aavik, Vaitkus, Žilionienė, Laurinavičius. There is the most link strength with nine between Čygas and Laurinavičius, so they have closer cooperation with each other. From Figure 8, It is known that Žilionienė, Vaitkus and Laurinavičius have much collaboration with other authors. Table 7 puts the top 11 productive authors in BJRBE. There are four authors have above 20 publications from 2006 to 2018, they are Laurinavičius, Vaitkus, Čygas and Žilionienė, as well as, it is found that they are all the editors of BJRBE. It is known that Laurinavičius is the most productive author who has 28 publications between 2006 and 2018, occupying the proportion of 6.15% in the 455 publications. And then, all the top 11 active authors have published more than eight among 13 years. Notably, the top 11 productive authors published 164 papers that account for 36.04% of

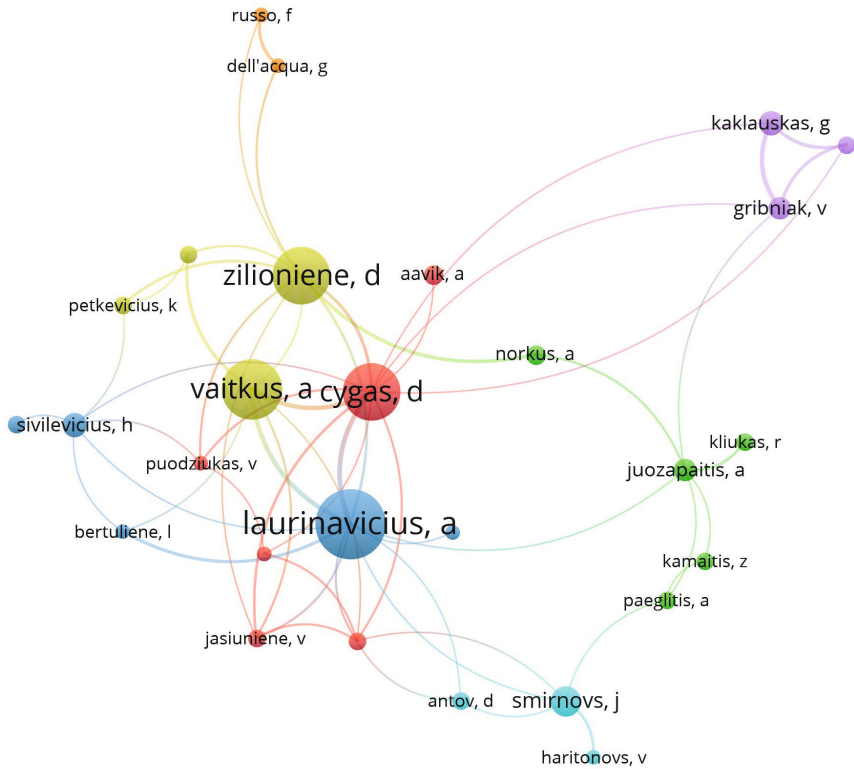


Figure 7. Author co-authorship network of the Baltic Journal of Road and Bridge Engineering publications

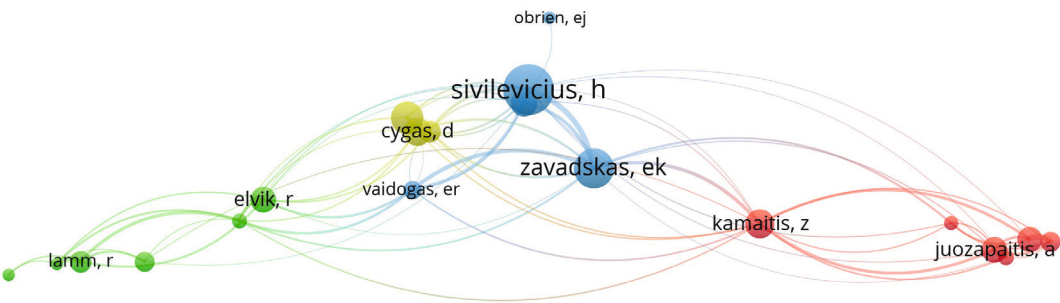


Figure 8. Co-citation network of authors cited by the Baltic Journal of Road and Bridge Engineering publications

Table 7. Top eleven productive authors in BJRBE

Rank	Number of publications	Author	Percentage
1	28	Laurinavičius, A.	6.15%
2	24	Vaitkus, A.	5.27%
3	23	Čygas, D.	5.05%
4	23	Žilionienė, D.	5.05%
5	12	Smirnovs, J.	2.64%
6	10	Kaklauskas, G.	2.20%
7	10	Sivilevičius, H.	2.20%
8	9	Gribniak, V.	1.98%
9	9	Juozapaitis, A.	1.98%
10	8	Aavik, A.	1.76%
11	8	Norkus, A.	1.76%
Total	164		36.04%

the total publications. It is a significant proportion occupied by the only 11 authors.

A visualization of the author co-citation network shows the co-citation relationship to the authors in the area. Figure 8 demonstrates the co-citation network of the authors cited by the BJRBE publications. Based on the analytic results given by VOSviewer, there are 5641 authors have been cited by the BJRBE publications. The threshold value is set as 17, 20 authors meet the threshold. From Figure 8, different clusters are classified into different colours, the distance and the thickness of the line present an equal relevance to the authors, and every node represents an author. For example, the line of Sivilevičius & Zavadskas is relatively thick, so they have closer connections about co-citation. Meanwhile, the close distance between them also reflects that they also have stronger research relationships. Different sizes of the nodes represent different co-citation amounts.

4. Burst detection analyses of cited authors and cited journals

In this section, two burst detections for the cited authors and the cited journals are demonstrated to show the authors and the journals that received citation bursts in specific periods. It is be noted that the

cited journals with citation burst are the ones, which are frequently cited by the BJRBE publications, implying the connections and relations between this journal and others in specific time intervals. More significantly, by analysing the citation bursts of cited authors and cited journals, the emerging trends of the research outputs published by BJRBE are also found.

Citation burst means it has explosive data of concerned papers in a certain period. It reflects the dynamic change of the field (Kleinberg, 2003). From Table 8, Kamaitis is the first author whose strongest citation bursts started in 2006, and it is also the first year of the BJRBE established as the cited authors, Petkevičius, Radziszewski, Zavadskas and O'Brien have the most extended duration for four years. Moreover, the period of the strongest citation bursts of O'Brien is the closest to the present; therefore, the investigations conducted by O'Brien are of great help to the development of the research on BJRBE, they are also the hot topics of this journal.

The top 16 cited journals with the strongest citation bursts by BJRBE are listed in Table 9. The first cited journal with the strongest citation burst is Journal of Civil Engineering and Management, and it began in 2006 and end in 2011. Journal of Civil Engineering and Management focuses on many areas of civil engineering and management. It aims to provide a multidisciplinary forum for researchers, designers, users, and manufacturers of the field of civil engineering and management. Journal of Civil Engineering and Management also has the highest value of strength from 2006 to 2011, and it is far more than other journals.

Table 8. Top ten cited authors with the strongest citation bursts



























Cited Authors	Year	Strength	Begin	End	2006–2019
Kamaitis, Z.	2006	3.2586	2006	2008	
Juozapaitis, A.	2006	3.2859	2008	2009	
Petkevičius, K.	2006	3.1383	2008	2011	
Viteikienė, M.	2006	3.1134	2008	2009	
Radziszewski, P.	2006	2.8725	2008	2011	
Zavadskas, E. K.	2006	2.8079	2009	2012	
Ratkevičiūtė, K.	2006	3.1866	2010	2012	
Elvik, R.	2006	3.2824	2012	2013	
Čygas, D.	2006	3.0111	2012	2014	
O'Brien, E. J.	2006	3.4123	2016	2019	

Table 9. Top sixteen cited journals with the strongest citation bursts

Cited Journals	Year	Strength	Begin	End	2006–2019
Journal of Civil Engineering and Management	2006	16.952	2006	2011	
Transport	2006	7.6283	2006	2011	
Baltic Journal of Road and Bridge Engineering	2006	7.2756	2007	2009	
Technological and Economic Development of Economy	2006	4.7463	2007	2011	
Computers & Structures	2006	4.5204	2010	2013	
Transportation Research Record	2006	3.3406	2011	2012	
Transportation Research Part C: Emerging Technologies	2006	2.7230	2012	2014	
Archives of Civil and Mechanical Engineering	2006	3.1583	2012	2016	
Procedia Engineering	2006	3.4515	2014	2019	
International Journal of Pavement Engineering	2006	2.9810	2014	2015	
Road Materials and Pavement Design	2006	2.8020	2014	2016	
Journal of the Association of Asphalt Paving Technologist	2006	2.7081	2014	2017	
Structure and Infrastructure Engineering	2006	3.9703	2016	2019	
Journal of Performance of Constructed Facilities	2006	2.7254	2016	2019	
Transportation Research Procedia	2006	3.3284	2017	2019	
Thesis	2006	11.0119	2017	2019	

Journal of Civil Engineering and Management, Transport and Procedia Engineering have the most extended duration. Here, Transport is published by the Vilnius Gediminas Technical University, it devotes to research transportation science and technology, and Procedia Engineering is an open-access collection of conference proceedings published, with emphasis on civil, chemical, aerospace, mechanical and structural engineering issues. From the last two columns, the strongest citation bursts of Procedia Engineering, Structure and Infrastructure Engineering, Journal of Performance of Constructed Facilities, Transportation Research Procedia, and Thesis are continuing, so these five journals are still influential to BJRBE.

5. Keyword co-occurrence network and timeline view for the keywords

The keywords co-occurrence network and the timeline view for the keyword analysis are provided to make apparent hot issues in the field of BJRBE. Figure 9 is presented to show the keywords co-occurrence

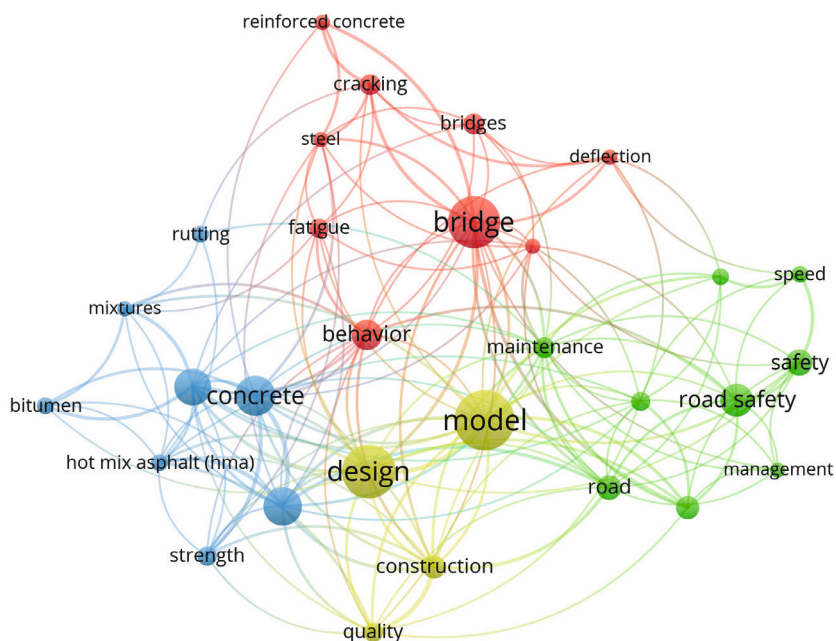


Figure 9. All keyword co-occurrence network of the Baltic Journal of Road and Bridge Engineering publications

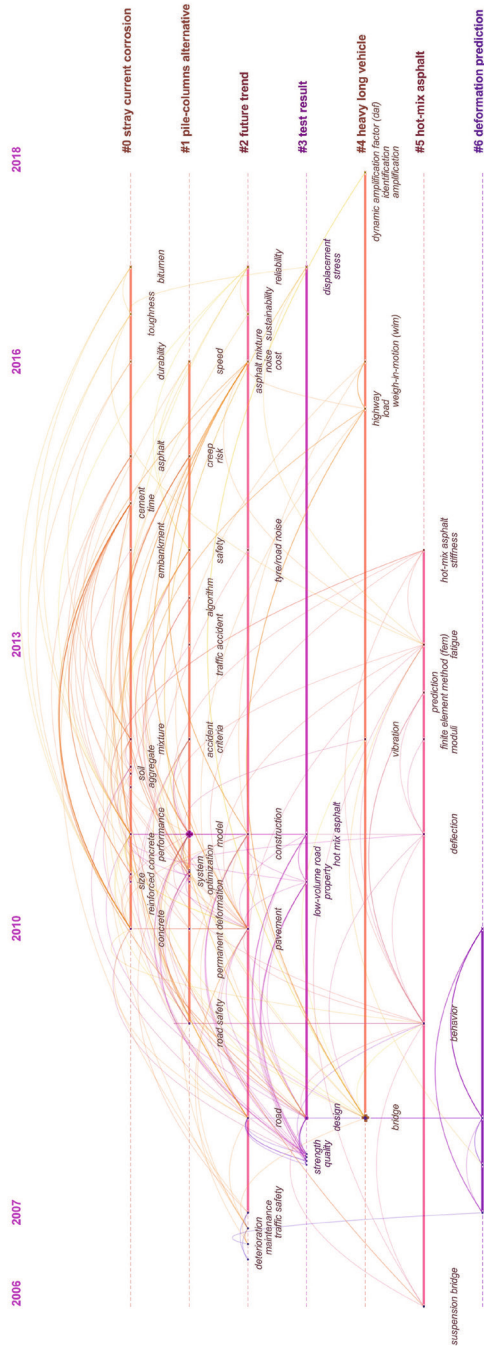


Figure 10. Timeline view for the Baltic Journal of Road and Bridge Engineering keywords

network of the BJRBE publications. The threshold value is set as 17, 30 keywords have involved the threshold. As shown in the analytic results, the keywords of “model”, “design”, “bridge”, “concrete”, “pavement”, and “performance” appeared most frequently. “Model” appears for 31 times, following with “design”, it has 28 occurrences. “Bridge” has 27 occurrences. It is found that all the common keywords are more related to bridge and pavement construction.

The timeline view of keywords explores what issues this journal is focusing on at various periods. Figure 10 is a timeline visualization of the 7 clusters. The most significant cluster is “stray current corrosion”, it harms the buildings, electrical equipment. The keywords of the publications of BJRBE between 2006 and 2010 are “suspension bridge”, “deformation”, “strength”, “quality”, “road safety”, and “pavement”, it shows that people focus on the details of engineering in that period. The keywords between 2010 and 2016 changed to “model”, “accident criteria”, “traffic accident”, “algorithm”, “tire and road noise”, and “creep risk”, it shows people pay more attention to the external factors in that period. The keywords between 2016 and 2018 are “cost”, “sustainability”, and “reliability”, showing that people devote more to the economy in the period. From the timeline view, the keywords are updating all the time with the development of times. People begin to care more about sustainability and environmental protection.

Conclusions

The paper has presented a bibliometric overview and visualized research structure of the Baltic Journal of Road and Bridge Engineering from 2006 to 2019. CiteSpace and VOSviewer are utilized to comprehensively analyse the data retrieved from the WoS database about articles published on Baltic Journal of Road and Bridge Engineering. In this paper, the focus and scope, the editor list of the Baltic Journal of Road and Bridge Engineering, the publication and the citation structure of Baltic Journal of Road and Bridge Engineering, the most influential author-paper-country-institution and their citation and co-authorship network of the Baltic Journal of Road and Bridge Engineering, the most cited authors, cited authors and journals with the strongest citation bursts and keywords analysis are presented. This journal published many articles in 2015, and the articles published in 2010 have been cited most frequently. “Multi-attribute assessment of road design solutions by using the COPRAS method” published in 2007 by Zavadskas, Kaklauskas, Peldschus, & Turskis is the most cited paper in BJRBE. Lithuania, Poland, and Italy are the countries published most

articles, and among the top 10 influential countries, most countries are from Northern Europe. Lithuania has more connections with other countries. As the agency for publishing the Baltic Journal of Road and Bridge Engineering, the Vilnius Gediminas Technical University is the most influential organization that published most papers. Čygas has most collaborations with other authors. The top 18 cited journals of the Baltic Journal of Road and Bridge Engineering have listed with the strongest citation bursts between 2006 and 2019, and Journal of Civil Engineering and Management and Transport and Procedia Engineering have the most extended duration. The strongest citation bursts of Procedia Engineering, Structure and Infrastructure Engineering, Journal of Performance of Constructed Facilities, Transportation Research Procedia, and Thesis continue until 2019. Besides, Laurinavičius is the most productive author who has 28 publications in the Baltic Journal of Road and Bridge Engineering. Petkevičius, Radziszewski, Zavadskas, & O'Brien have the most extended duration of citation burst. The keywords are analysed to learn hot topics and the emerging trends of the research field of BJRBE. The most significant cluster of the main keyword is "stray current corrosion" and the keyword of "model" appears most frequently, it shows the hot topics and emerging trends of this journal recently. In addition, based on the timeline of keywords, it is found that the hot keywords "accident criteria", "traffic accident", "tire and road noise", and "creep risk" have been changed into "cost", "sustainability", and "reliability". They have gained increasing attention from the scholars in the journal and this research field. By providing an overview for the Baltic Journal of Road and Bridge Engineering, the current station and the trends of the journal are comprehensively analysed. This research helps researchers learn about the development of the Baltic Journal of Road and Bridge Engineering deeply.

As for future research, more bibliometric approaches are considered to be utilized to analyse the Baltic Journal of Road and Bridge Engineering publications from diverse perspectives. Besides, more journals related to road and bridge engineering need also to be involved in making detailed comparisons on the aspect of the development of this research area.

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