






## BIBLIOMETRIC ANALYSIS OF THE JOURNAL OF CIVIL ENGINEERING AND MANAGEMENT BETWEEN 2008 AND 2018

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**Abstract.** The Journal of Civil Engineering and Management (JCEM) is a prestigious international journal in the field of engineering. This paper uses the method of bibliometric to study the status and development trends of the journal. Information was collected from the Science Citation Index (SCI) database. Firstly, the general citation structure and basic characteristics of the JCEM journal are investigated. Then, the most influential institutions, countries as well as their networks of cooperation are identified. Finally, the main research topics of the JCEM journal are explored by using the frequently used keywords. This paper explores the internal structure and development trend of the JCEM journal, which not only provides an important reference for the future development of this journal, but also provides an effective analysis method for the future evaluation of journals.

**Keywords:** bibliometric analysis, citation structure, Web of Science, journal, VOSviewer, CiteSpace.

### Introduction

The Journal of Civil Engineering and Management (JCEM) is a prestigious journal in the field of engineering published 8 times a year by Vilnius Gediminas Technical University (VGTU) Press. It was created by Prof. Edmundas Kazimieras Zavadskas from Lithuanian Academy of Sciences and VGTU. According to the Journal Citation Reports of Clarivate Analytics Web of Science, the latest impact of the JCEM journal is 1.66 and it ranks 55th out of 128 “engineering, civil” categorized journals. Today, it is officially encouraged journal of the International Council for Research and Innovation in Building and Construction (CIB) and is one of the outstanding journals in the research domain of civil engineering. So far, the JCEM has published more than 1000 papers in the field of civil engineering. Therefore, it is necessary to conduct a comprehensive analysis and summary of the journal from the perspective of bibliometric.

Bibliometrics is a discipline that is produced by the extensive intersection and combination of philology, in-

formation science, mathematics, and statistics (He, Wu, Yu, & Merigó, 2017; Yu, Xu, & Wang, 2018). It is also a relatively mature and important branch of intelligence science (Pritchard, 1969; Borgman & Furner, 2002; White, 2018). At present, bibliometrics has been widely used to many fields, such as computer science (Hao, Chen, Li, & Yan, 2018; Ortega, 2019), engineering (Maditati, Munim, Schramm, & Kummer 2018; Wu et al., 2018), sustainable energy (Yu & Xu, 2017; Hache & Palle, 2019) and economics (Ertz & Leblanc-Proulx, 2018; Cui & Zhang, 2018). Using the methods and techniques of bibliometrics to comprehensively analyze all the papers in a specified journal to reveal its internal structure and development trend is one of the research hotspots in the field of bibliometrics. Recently, Laengle et al. (2017) presented a bibliometric analysis of the European Journal of Operational Research journal to celebrate its 40th anniversary. Martínez-López, Merigó, Valenzuela-Fernández, and Nicolás (2018) explored the leading trends of the European Jour-

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nal of Marketing during the past 50 years by using bibliometric indicators. Yu, Xu, Kao, and Lin (2018) studied the IEEE Transactions on Fuzzy Systems publications and revealed the important factors that affect the development of this journal. Yu, Xu, and Fujita (2019) examined the inner structure and the evolution of the Applied Intelligence journal based on bibliometric methods. Using some visualization tools, such as VOSviewer and CiteSpace, many bibliometric research results have been achieved for some journals (Yu, Xu, Pedrycz, & Wang, 2017; Tur-Porcar, Mas-Tur, Merigó, Roig-Tierno, & Watt, 2018; Wang et al., 2018).

The existing research results show that the bibliometric analysis of a journal can find out a lot of valuable information, and this kind of study is of great significance. However, up to now, there is no research for the JCEM journal based on the bibliometric methods. The rest of this paper is organized as follows: Section 1 studies the general citation structure and basic characteristics of the JCEM journal. Section 2 illustrates the different kinds of networks of cooperation and explores the research topics of this journal. The concluding remarks are presented in last Section.

## 1. General analysis of the JCEM publications

The information analyzed in this study is 821 JCEM publications (only articles and reviews) which are indexed in the Science Citation Index (SCI) database dating between 2008 and 2018 and is retrieved in January 25<sup>th</sup>, 2019.

### 1.1. Who is paying attention to the JCEM

The JCEM is a highly internationalized academic journal in the field of civil engineering, which has attracted extensive attention from experts and scholars all over the world. This section focuses on the question of which journals, countries/territories, institutions, authors and WOS categories are particularly concerned about the JCEM? Research findings are presented in Table 1.

As far as the journal is concerned, the JCEM itself ranked first with 468 publications. This means that there are one or more JCEM papers in the references of these 468 publications. Following are Construction and Building Materials with 207 and Procedia Engineering with 142 papers cited the JCEM publications, respectively. Two other journals with more than 100 papers cited the JCEM publications are Automation in Construction and Technological and Economic Development of Economy. In terms of the countries/territories, Lithuania (782) and China (766) ranked first and second positions, respectively. Poland, Iran and USA have 372, 361 and 329 publications cited the JCEM publications and ranked in the third to fifth places. Australia, Malaysia, England, Czech Republic and Spain complete the top 10 positions.

VGTU from Lithuania has 718 papers cited the JCEM publications, and it is far ahead of Brno University of Technology from Czech Republic and Islamic Azad University from Iran which are ranked second and third posi-

tions, respectively. The founder & Editor-in-Chief of the JCEM, prof. E. K. Zavadskas from VGTU, has 203 papers cited the JCEM publications. The followed authors are Z. Turskis and J. Antuchevičienė, both from VGTU. The fourth and fifth authors are M. Z. Jumaat from University of Malaya and Z. Kala from Brno University of Technology, respectively. The WOS category of Engineering Civil is the most popular area of the JCEM. As shown in Table 1, there are 2014 papers from this area cited the JCEM publications.

### 1.2. Characteristics of the JCEM publications

A comprehensive analysis from 2008 to 2018 was designed to evaluate the evolution of the characteristics of the JCEM Journal. The changes in characteristics often reflect some significant developing processes of the journal. To show the trajectory of the development of the JCEM journal, this study presents three characteristics of the JCEM journal, (1) the number of pages, (2) the number of references and (3) the number of authors, and shown in Table 2.

According to the number of pages, at a general level, we can easily get that 52.86% papers are equal to or less than 10 pages. There is clear evidence of an increase in the average number of pages of the JCEM papers. To deepen the result, we focus on the table throughout years and divide the whole period into three different stages. It is clear that the papers with 14 or more pages rose most rapidly. During the first period (2008–2010), they only accounted for 2.84%, however, this share climb to 17.80 in the latest stage. Contrary to this, the papers with 7 or less pages decreased mostly from 29.79% to 3.11%.

Another interesting characteristic related to the papers in the JCEM journal is the number of references. As we can see, the number of references cited by the JCEM publications concentrate on 21–40, which accounts 52.62% of the total. Among these, there are the publications with 21–30 references (31.91%) and those with 31–40 references (20.71%). The share of papers with more than 30 references increased significantly and there is an upward trend. Furthermore, this analysis provides the fact that the share of papers with less than 20 references has been reduced, especially the papers citing equal or less than 10 references have almost disappeared in the JCEM journal.

Regarding the number of authors which refer to the degree of co-authorship (Köseoglu, Okumus, Putra, Yildiz, & Dogan, 2018; Silva, Schulz, & Noyons, 2019), the most popular pattern of co-authorship is 2 or 3 authors (58.59%). Furthermore, a substantial increase occurred in the average number of authors during the whole period. The publications with more than 3 or more authors occupied more proportion, whereas those with 1–2 authors decreased. Especially the publications with 4 authors increased approximately 9% while the publications written by single author declined most from 19.86% to 6.21%. A probable reason is that with the development of the JCEM journal, the issues in this field have been becoming more complicated and diversified, which need more researchers to work out together.

Table 1. Numbers of Sources citing the JCEM articles

Rank	Journals	TP	Country/ Territory	TP	Institution	TP	Authors	TP	Categories	TP
1	Journal of Civil Engineering and Management	468	Lithuania	782	VG TU	718	Zavadskas E. K.	203	Engineering Civil	2014
2	Construction and Building Materials	207	China	766	Brno University of Technology	128	Turskis Z.	85	Construction Building Technology	1106
3	Procedia Engineering	142	Poland	372	Islamic Azad University	121	Antucheviciene J.	49	Materials Science Multidisciplinary	538
4	Automation in Construction	108	Iran	361	Wroclaw University of Science Technology	101	Jumaat M. Z.	45	Engineering Industrial	277
5	Technological and Economic Development of Economy	100	USA	329	University of Malaya	99	Kala Z.	45	Management	264
6	Sustainability	88	Australia	272	Hong Kong Polytechnic University	98	Tamosaitiene J.	38	Economics	260
7	Journal of Construction Engineering and Management	72	Malaysia	211	Kaunas University of Technology	76	Sivilevicius H.	34	Engineering Multidisciplinary	250
8	Baltic Journal of Road and Bridge Engineering	71	England	184	Tongji University	58	Kaklauskas A.	29	Engineering Mechanical	246
9	Modern Building Materials Structures and Techniques	61	Czech Republic	168	Malaysian University of Technology	53	Skitmore M.	29	Environmental Sciences	223
10	Journal of Management in Engineering	59	Spain	166	Queensland University of Technology	51	Kaklauskas G.	28	Green Sustainable Science Technology	220
11	Archives of Civil and Mechanical Engineering	56	Turkey	164	Chinese Academy of Sciences	50	Sadowski L.	28	Energy Fuels	197
12	Journal of Cleaner Production	55	Taiwan	157	University of New South Wales Sydney	49	Adeli H.	27	Mechanics	149
13	Engineering Structures	52	South Korea	131	Poznan University of Technology	48	Chan A. P. C.	27	Computer Science Interdisciplinary Applications	138
14	KSCE Journal of Civil Engineering	47	Italy	129	Indian Institute of Technology System	44	Valivonis J.	26	Computer Science Artificial Intelligence	131
15	Transport	47	India	125	Amirkabir University of Technology	43	Yazdani-Chamzini A.	26	Engineering Environmental	125

Table 2. Characteristics of the JCEM publications

Characteristics	Total (n = 821) %	Time Period		
		2008–2010 (n <sub>1</sub> = 141) %	2011–2014 (n <sub>2</sub> = 326) %	2015–2018 (n <sub>3</sub> = 354) %
Number of pages				
7 or less	10.48	29.79	10.12	3.11
8	12.30	19.15	9.20	12.43
9	15.10	15.60	15.03	14.97
10	14.98	12.06	17.79	13.56
11	13.89	8.51	15.95	14.12
12	11.57	9.22	9.82	14.12
13	8.40	2.84	9.20	9.89
14 or above	13.28	2.84	12.88	17.80
Number of references				
10 or less	0.73	3.55	0.00	0.28
11~20	18.03	32.62	17.79	12.43
21~30	31.91	32.62	31.29	32.20
31~40	20.71	15.60	21.17	22.32
41~50	13.89	10.64	14.42	14.69
51~60	7.43	2.84	8.59	8.19
61~70	3.17	0.71	3.07	4.24
71 or more	4.14	1.42	3.68	5.65
Number of authors				
One	9.74	19.86	9.20	6.21
Two	27.41	32.62	28.83	24.01
Three	31.18	28.37	31.90	31.64
Four	17.66	12.06	15.95	21.47
Five	10.60	6.38	10.74	12.15
Six	2.44	0.00	3.37	2.54
Seven or more	0.97	0.71	0.00	1.98

### 1.3. Most productive countries/territories

Table 3 demonstrates ten most productive countries/territories in three different stages. They are sorted in a decreasing manner according to their total publications (TP). Note that several other indicators are considered including the total citations (TC) and h-index.

Lithuania clearly dominates the list with more than twice the number of papers of Poland (85), which is in the second place. Besides, Lithuania is also far away from the other countries in terms of the TC and h-index. There is no doubt that Lithuania plays the most significant role in the JCEM journal with both the most publications and influence.

Next, let us analyze the publication of countries through the different stages. In general, the number of papers is emerging strongly. Although, compared with Stage 2, the TC and h-index in Stage 3 decreased, it does not affect this emerging trend. It must be highlighted that papers need several years to be cited after their publications. So it is understandable that publications in current years received a low citation which also results a low h-index.

During every period of the journal, the Lithuania is the most productive country in the journal. However, China has made a great progress over time. Moreover, a more dramatic improvement happened in the third stage, China replaced Poland becoming the second productive country in the list. It shows that China is paying a tremendous attention on the JCEM and contributes a lot to the development of this journal in current years. However, Malaysia, Algeria and Czech Republic, which was the top 10 at first two stages, now they are out of the list.

### 1.4. Top H-index countries/territories

Lithuania, Poland and China remain in the top three based on the h-index, in line with the ranking of published numbers. To deepen the results, let us take a threshold analysis. The number of publications with more than 100 citations is three in total. Those papers are the most representative and influential in the JCEM journal. Note that these three papers are all come from Lithuania. Besides, the papers with more than 50 citations are counted as six, and two of them published by Lithuania, while Poland, China, Turkey and Australia each have one.

Table 3. Most productive influential countries/territories in three different stages

Rank	2015–2018				2011–2014				2008–2010			
	Country/ Territory	H	TP	TC	Country/ Territory	H	TP	TC	Country/ Territory	H	TP	TC
1	Lithuania	8	58	222	Lithuania	15	78	703	Lithuania	18	54	1336
2	China	5	53	109	Poland	12	37	375	Poland	10	17	300
3	USA	7	44	164	Taiwan	9	32	236	Turkey	8	8	194
4	Poland	6	31	128	USA	10	30	278	USA	4	8	96
5	South Korea	4	31	78	Malaysia	8	27	206	China	7	7	187
6	Iran	7	30	113	Iran	10	24	290	Taiwan	5	7	56
7	Taiwan	6	28	105	China	9	24	204	England	4	5	78
8	Turkey	6	26	123	Turkey	9	21	200	Algeria	4	4	78
9	Portugal	5	15	66	England	5	11	63	CzechRepublic	3	4	154
10	Spain	6	14	78	South Korea	4	11	44	South Korea	3	4	48

Table 4. TOP H-index countries/territories

Country/Territory	H	TP	TC	TC/TP	≥100	≥50	≥20	≥10	≥1	CR
Lithuania	23	190	2261	12	3	2	25	37	100	47.37%
Poland	16	85	803	9	0	1	11	15	47	36.47%
China	12	84	500	6	0	1	6	10	45	63.10%
USA	12	82	538	7	0	0	7	11	52	71.95%
Iran	12	56	425	8	0	0	4	10	36	66.07%
Turkey	12	55	517	9	0	1	6	9	36	54.55%
Taiwan	11	67	397	6	0	0	3	12	44	32.84%
Malaysia	10	42	300	7	0	0	3	7	28	66.67%
England	8	26	177	7	0	0	2	5	14	76.92%
Australia	8	24	182	8	0	1	1	3	12	95.83%
Portugal	8	24	151	6	0	0	0	7	15	37.50%

A special indicator considered in this Table is CR (cooperation rate), it illustrates the degree of cooperation between different countries. Considering the individual, Australia owns the highest rate of 95.83% while Taiwan gets the lowest one of 32.84%.

### 1.5. Top productive institutions

Table 5 analyzes the top 11 productive institutions during 2008–2018. It contains some significant indicators including h-index, TP, TC, TC/TP, citation threshold and CR. The institutions are in a descending order decided by the TP. Among these 11 institutions, Lithuania and USA have two institutions respectively. The first institution in the ranking is VGTU with a total of 171 studies published in the JCEM, where 23 of these studies have received at least 23 citations. Furthermore, it contains more than four times TP as of the second one, Kaunas University of Technology. Focus on threshold, four papers gain a citation one hundred and more. They belong to the VGTU. In terms of CR, Yonsei University from South Korea ranked first with 100% cooperation rate.

### 1.6. The most productive and influential authors

Table 6 presents the 13 most productive authors in the JCEM journal, with a minimum publication of eight papers. M. J. K. Skibniewski from University of Maryland, USA leads the rank in TP. Z. Turskis from VGTU, Lithuania leads the list in TC, and E. K. Zavadskas, also from VGTU, leads the list in TC/TP. We also found that although China, Poland and South Korea are highly productive countries, there are no prolific authors from these countries.

According to the number of publications by the first author (FTP), M. Y. Cheng from National Taiwan University of Science and Technology, Taiwan ranked the first position, followed by R. Maciulaitis from VGTU, Lithuania with 9 publications. In terms of the number of publications by the corresponding authors (CTP), Z. Kala from Brno University of Technology, Czech Republic led the list, and H. P. Tserng from National Taiwan University, Taiwan ranked the second position.

Table 5. Top 20 productive institutions during 2008–2018

No	Institution name	Country/ Territory	TP	TC	TC/TP	h-index	>100	>50	>20	>10	>1	CR
1	Vilnius Gediminas Technical University	Lithuania	171	2127	12	23	3	2	24	34	86	60.23%
2	Kaunas University of Technology	Lithuania	36	262	7	10	0	0	1	9	24	63.89%
3	National Taiwan University of Science Technology	Taiwan	21	132	6	6	0	0	2	1	17	66.67%
4	Wroclaw University of Science Technology	Poland	21	180	9	9	0	0	2	6	13	19.05%
5	Islamic Azad University	Iran	19	170	9	8	0	0	2	4	11	84.21%
6	Universiti Malaya	Malaysia	17	154	9	7	0	0	2	2	11	64.71%
7	University System of Maryland	USA	17	217	13	9	0	0	5	3	9	88.24%
8	University of Maryland College Park	USA	16	215	13	9	0	0	5	3	8	87.50%
9	Yonsei University	South Korea	14	65	5	4	0	0	0	2	10	100.00%
10	Brno University of Technology	Czech Republic	13	275	21	7	0	2	5	0	3	38.46%
11	Tarbiat Modares University	Iran	13	92	7	5	0	0	1	2	8	76.92%

Table 6. The most productive and influential authors of the JCEM publications

Rank	Name	Institution	Country/ Territory	TP	TC	TC/TP	FTP	CTP	H	≥50	≥20	≥10
1	Skibniewski, M. J. K.	University of Maryland	USA	18	256	14	2	3	10	0	6	4
2	Turskis, Z.	VGTU	Lithuania	15	625	42	2	5	8	3	3	2
3	Cheng, M. Y.	National Taiwan University of Science and Technology	Taiwan	12	69	6	12	1	5	0	1	1
4	Maciulaitis, R.	VGTU	Lithuania	12	54	5	9	5	4	0	0	2
5	Sivilevicius, H.	VGTU	Lithuania	12	108	9	3	3	7	0	1	5
6	Ustinovichius, L.	VGTU	Lithuania	11	86	8	3	2	5	0	1	2
7	Kala, Z.	Brno University of Technology	Czech Republic	9	269	30	7	8	7	2	5	0
8	Zavadskas, E. K.	VGTU	Lithuania	9	613	68	3	4	8	3	4	1
9	Adeli, H.	Ohio State University	USA	8	71	9	0	6	5	0	1	2
10	Daniunas, A.	VGTU	Lithuania	8	59	7	2	1	6	0	0	2
11	Kavussi, A.	Tarbiat Modares University	Iran	8	45	6	4	4	4	0	0	2
12	Stankevicius, V.	Kaunas University of Technology	Lithuania	8	32	4	2	0	4	0	0	0
13	Tserng, H. P.	National Taiwan University	Taiwan	8	52	7	6	7	5	0	0	2

## 2. Networks of cooperation and research topics

In the following, the cooperation networks at the country/territory level is investigated and shown in Figure 1 (a threshold of 10). It can be seen that the cooperation network between countries /territories is very dense. In addition, South Korea, China and Australia have strong cooperative relations with the USA. The partnership between Australia and China, Lithuania and Poland, Lithuania and Iran are also very strong.

The largest cooperation network at the institution level of the JCEM journal is presented in Figure 2. It should be noted that the size of the node indicates the frequency of cooperation with other institutions, rather than the publication number of this institution. In this network, VGTU

cooperates most with other institutions. In addition, Kaunas University of Technology Lithuania, Wrocław University of Science and Technology from Poland, National Taiwan University of Science and Technology from Taiwan, Islamic Azad University from Iran and University of Malaya from Malaysia occupy important positions in the cooperative network. In addition, the lines in the figure indicate the collaboration between the institutions. The color and thickness of the connections reflect the cooperation model in the JCEM journal.

We investigate the frequently used keywords in journal papers in order to identify the main research topics of the JCEM journal. It should be pointed out that here we only analyze the keywords provided by the author.

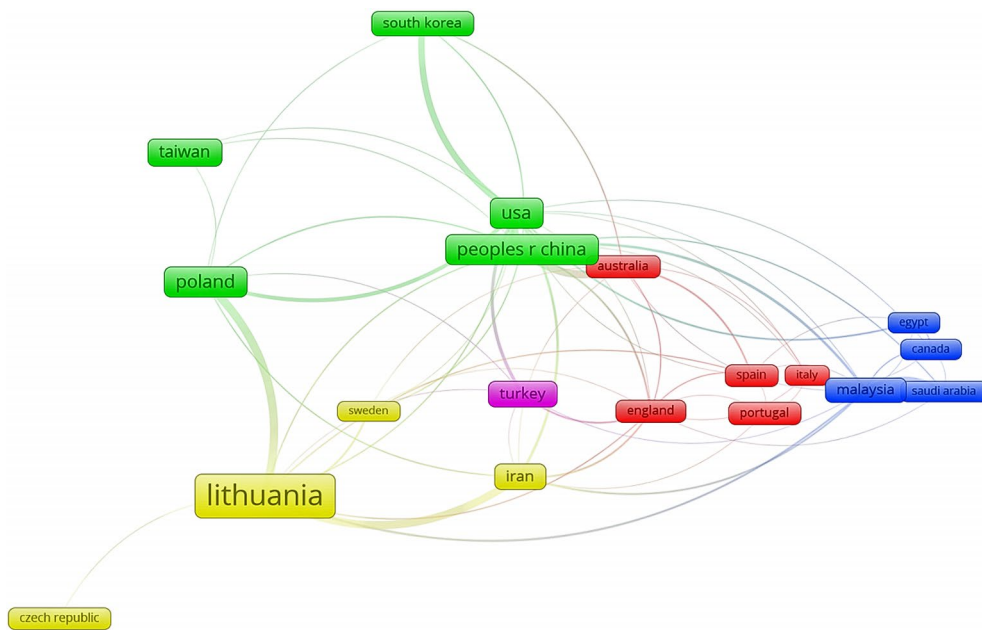


Figure 1. Cooperation networks at the country/territory level

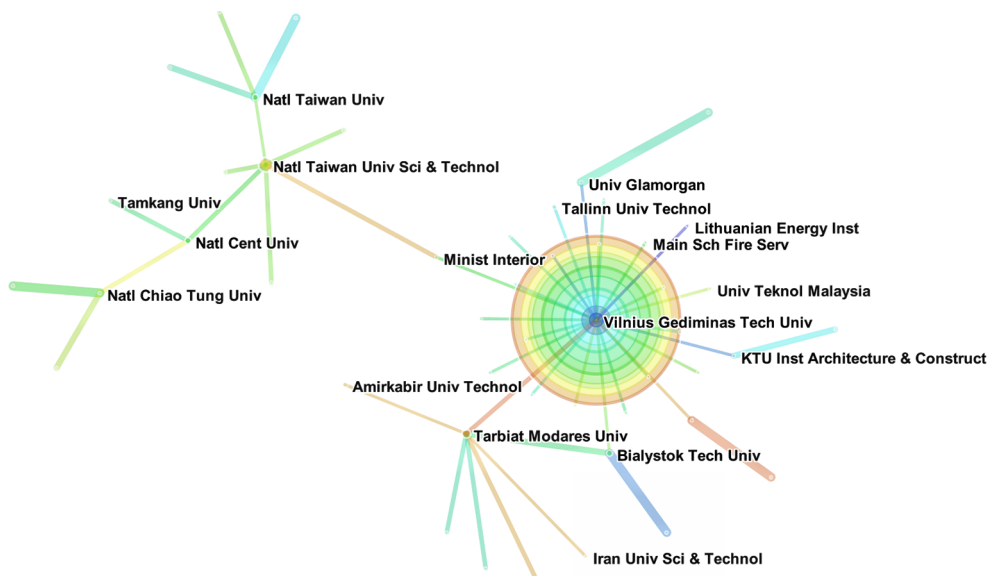


Figure 2. The biggest cooperation network at the institution level

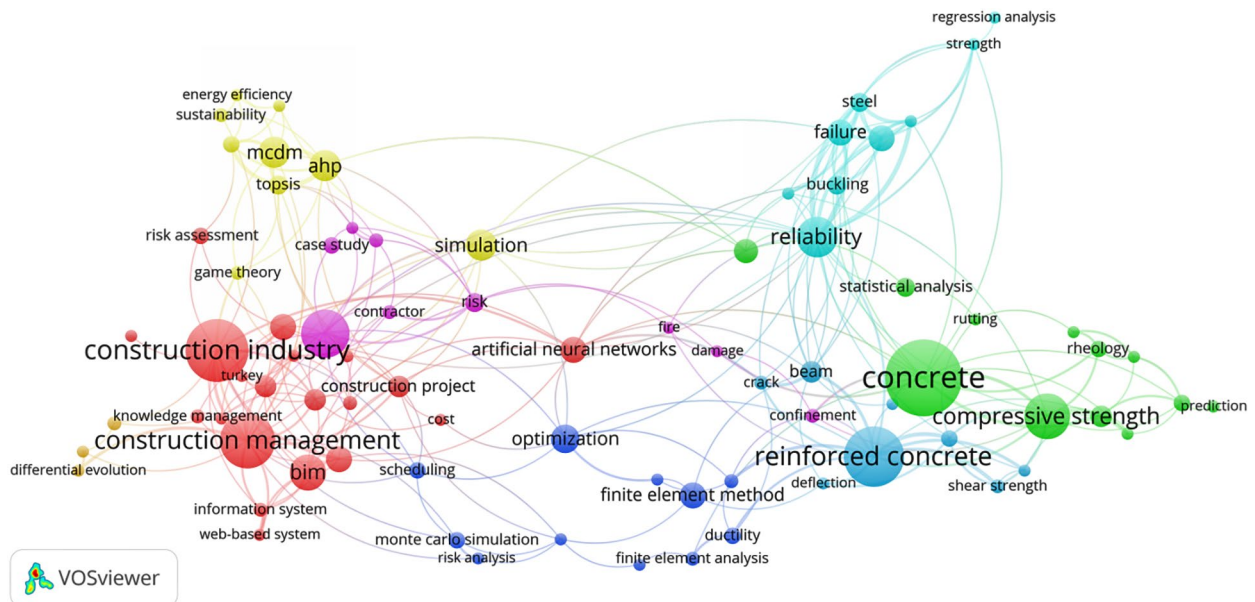


Figure 3. Co-occurrence of author keywords of the JCEM publications

The map presents those keywords that appear frequently in the JCEM publications and the lines in the network indicate co-occurrence of the keywords in the same paper. Figure 3 shows the co-occurrence network of the frequently appeared author keywords (a threshold of 5). The word “concrete” is the most frequently used author keyword in the journal. Some other keywords are construction industry, construction management, reinforced concrete and compressive strength, also MCDM, simulation and optimization. The above keywords represent the main topics of the journal. In addition, there are some thick lines in the network, for example, the connections between reliability and steel, reliability and failure, construction management and differential evolution, indicated that these keywords appear frequently in the same JCEM publication.

### Concluding remarks

Since the first issue of the JCEM journal published in 1995, it has contributed hundreds of articles by 2018. It plays an important role for the accumulation and dissemination of knowledge in the field of engineering. In this paper, we mainly analyzed all the papers of the JCEM journal from 2008 to 2018 by using bibliometric methods and knowledge map tools, and revealed the knowledge structure and development process of this journal.

52.86% of the JCEM papers were equal to or less than 10 pages and there was clear evidence of an increase in the average number of pages. The number of references of the JCEM papers concentrated on 21–40, which accounted 52.62% of the total. The share of papers with more than 30 references increased significantly. The most popular pattern of co-authorship was 2 or 3 authors. Lithuania was the most productive country with more than twice the number of papers of Poland, which is in the second

place. Within the top 11 productive institutions, Lithuania and USA have two institutions respectively. South Korea, China and Australia have strong cooperative relations with the USA. The partnership between Australia and China, Lithuania and Poland, Lithuania and Iran are also very strong.

VGTU cooperated most with other institutions. In addition, Kaunas University of Technology Lithuania, Wrocław University of Science and Technology from Poland, National Taiwan University of Science and Technology from Taiwan, Islamic Azad University from Iran and University of Malaya from Malaysia occupied important positions in the cooperative network. “Concrete” is the most frequently used author keyword in the JCEM journal. Some other keywords are construction industry, construction management, reinforced concrete, compressive strength, MCDM, simulation and optimization.

This paper made a bibliometric analysis of all publications of the JCEM journal and it hopes to contribute to the field of engineering. In the future, we will analyze the research hotspots and their changes of the journal from different perspectives in combination with the method of text mining.

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