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THE EVOLUTION OF "TECHNOLOGICAL AND ECONOMIC DEVELOPMENT OF ECONOMY": A BIBLIOMETRIC ANALYSIS

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Abstract. The *Technological and Economic Development of Economy* (TEDE) journal was founded 25 years ago and it plays an important role in the economic field. The purposes of this study are to present a bibliometric analysis of the TEDE publications that are included in the Social Science Citation Index (SSCI) database and identify the characteristics and evolution of the TEDE journal through some commonly used as well as various kinds of newly designed indicators. Firstly, annual and geographical distributions, author and manuscript characteristics of the TEDE publications are explored. Secondly, leading contributors including countries/territories, institutions, and authors are presented. The thematic analyses based on co-occurrence of keywords are presented lastly. The main advantages of this study are that all the analysis results are entirely based on objective data and the complex and important results are visualized. This study helps in understanding the development of the TEDE journal and has certain reference value for scholars in the economic field.

Keywords: bibliometric analysis, evolution, Technological and Economic Development of Economy, characteristics.

JEL Classification: C02, C40, C69.

Introduction

The *Technological and Economic Development of Economy* (TEDE) was founded 25 years ago and it is a reputable journal in the field of sustainable economic development. It is indexed in the Social Science Citation Index (SSCI) database, with an impact factor of 3.244 according to the Journal Citation Report (2017) and ranked 31th among 353 journals in the economics field. Professor E. K. Zavadskas from Vilnius Gediminas Technical University

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(VGTU) founded the TEDE journal and VGTU press publishes it at present. To date, the TEDE journal has been in existence for 25 years and has published more than 600 articles. Therefore, it is necessary to use scientific and effective methods to summarize and analyze the characteristics, internal structure and development process of the journal.

Bibliometrics is a branch of library and information science, which takes all kinds of literature as the research object and uses mathematical and statistical methods to study the status and development trend of science and technology (Price, 1976; Yu, 2015; He, Wu, Yu, & Merigó, 2017). Bibliometrics has been widely used to reveal the research status and development trends of a subject area, and it has an important role for scholars to deeply understand a certain research field (Van Oorschot, Hofman, & Halman, 2018). In addition, scholars also use bibliometric methods to systematically study the publications of a journal to reveal its past, present and future. Especially in recent years, there have been many valuable research results of this kind. Merigó, Mas-Tur, Roig-Tierno, and Ribeiro-Soriano (2015) used a bibliometric approach to analyze all the publications in the *Journal of Business Research*. The study showed that the USA is the most influential country in the journal. At the research institution level, universities from Europe and Asia occupy more important positions in the journal. Based on the bibliometric methods and visual softwares, Calma and Davies (2016) took *Academy of Management Journal*, a top journal in the field of management, as the research object, systematically studied the leading authors, institutions and countries as well as the theme changes of the journal. Laengle et al. (2017) provided an overview on all the *European Journal of Operational Research* publications through bibliometric indicators. A comparative study of the performance of the journal with other authoritative journals in the field of operations research and management science was presented. The key authors, institutions, countries, and trends of the journal were investigated. To celebrate the 50th anniversary of the *European Journal of Marketing*, Martínez-López, Merigó, Valenzuela-Fernández, and Nicolás (2018) conducted a bibliometric analysis of all the papers in this journal. Research indicated that the most productive authors and institutions come from the UK, and the contributions from Australia have increased significantly. In our previous works, some reputable journals such as *Applied Intelligence* (Yu, Xu, & Fujita, 2019) and *IEEE Transactions on Fuzzy Systems* (Yu, Xu, , Kao, & Lin, 2018) were investigated based on bibliometric methods.

The above studies showed that the use of bibliometric methods to analyze a journal is reasonable and effective, and the research results have important reference value for scholars in this field. However, up to now, there is no comprehensive analysis of the TEDE journal by bibliometric methods. In this study, all the TEDE publications that are included in the SSCI (2008–2018) database are analyzed. The main purpose of this study is to explore the basic characteristics, development process and trend of the TEDE journal.

This study is structured as follows: Section 1 investigates the basic characteristics of the TEDE publications, including annual and geographical distributions, author and manuscript characteristics. Section 2 studies the productive and influential countries, institutions and authors, and visualizes some complex and important results. Section 3 explores the changes in topics over time based on co-occurrence of keywords. Section 4 concludes this study.

1. Basic characteristics of the TEDE publications

Data selection and standardization are the basis for data analysis and research. Effective and accurate data can provide sufficient quality assurance for subsequent data analysis (Liao, Tang, Luo, Li, Chiclana, & Zeng, 2018; Yu, Xu, & Wang, 2018). The SSCI is a world-renowned citation database for scientific literature in the field of humanities and social sciences. It covers more than 50 research fields, including economics, management, history, and news communication. It includes more than 2,000 academic journals and tens of thousands of academic papers. It provides great convenience for researchers in the social science field to engage in academic research. The SSCI database is also commonly used for bibliometric analysis (Liu, Hu, Tang, & Wang, 2015).

Although the TEDE journal will celebrate its 25th anniversary for its important contributions in the field of sustainable economic development, the SSCI database only included its publications from 2008 to now. A total of 569 TEDE publications were found in the SSCI database on January 11, 2019, including articles (541), reviews (13), book reviews (1), correction (1), editorial materials (13) and proceedings papers (10). In this study, only articles (541) and reviews (13) are used as the data source for analysis.

Next, we will analyze the basic characteristics of the TEDE publications including the annual distribution characteristics, the author characteristics, the geographical distribution characteristics, and the manuscript characteristics.

1.1. Annual distribution characteristics

As mentioned above, there are 554 TEDE publications included in the SSCI database over the last decade and more. This section provides a detailed analysis of all the TEDE publications by year. Various kinds of indicators (Yu, Xu, Pedrycz, & Wang, 2017) are designed to describe the characteristics of these publications and their corresponding meanings are given as follows:

≥100: The publication numbers with more than 100 citations. ≥50, ≥20, ≥10 and ≥1 have similar meanings.
TP: Total publication number.
TC: Total citation number.
NICN: Non-international cooperation publication number.
ICN: International cooperation publication number.
SIPN: Single institution publication number.
IICPN: Inter-institution collaboration publication number.
SAPN: Single author publication number.
MAPN: Multiple author publication number.
IC Rate: International cooperation rate.
IIC Rate: Institutional cooperation rate.
MA Rate: Author cooperation rate.
AN: Author number.
RN: Reference number.
AN/TP: Average number of authors per paper.
RN/TP: Average number of references per paper.

h: The h Index was proposed in 2005 (Hirsch, 2005). The h index of a scientist means that h articles in the published Np papers are cited at least h times, while the rest of the Np-h papers are cited less than or equal to h times (Bornmann & Daniel, 2007; Hirsch, 2007).

Table 1 gives the comprehensive analysis results of the TEDE publications. As shown in Table 1, the number of papers published each year by the TEDE journal is relatively stable. Besides the 65 publications in 2013 and 109 publications in 2018, the numbers of publications in other years are less than 50. Of these 554 TEDE publications, 6598 citations were received. There are 4 TEDE publications cited more than 100 times, including two in 2010, one in 2011 and one in 2014. The most cited publication is Zavadskas and Turskis (2011), a literature review on the applications of multi-attribute decision making theory and methods in the economic field.

It can be seen that the IC Rate in the TEDE journal is not high, and the number of ICN is 144, account for only 26.47%. For the papers published in each year, 16 of the 44 papers published in 2016 were authored through international cooperation, account for 36.36%, which is the highest IC Rate. In terms of institutional cooperation, 297 publications were completed through inter-institutions cooperation, account for 54.60%. In 2014, the IIC Rate was the highest. Of the 40 papers published in this year, 30 were completed through inter-institution collaboration and account for 75%. Ranked second are the publications in 2016, with an IIC Rate of 65.91%. Most of the papers are completed through cooperation among multiple authors, which means that the number of papers by only one author in the TEDE journal is very small, only 75 papers account for 13.79%.

Figure 1 shows the values of NICN, ICN, SIPN, IICPN, SAPN, MAPN, IC Rate, IIC Rate and MA Rate in different years.

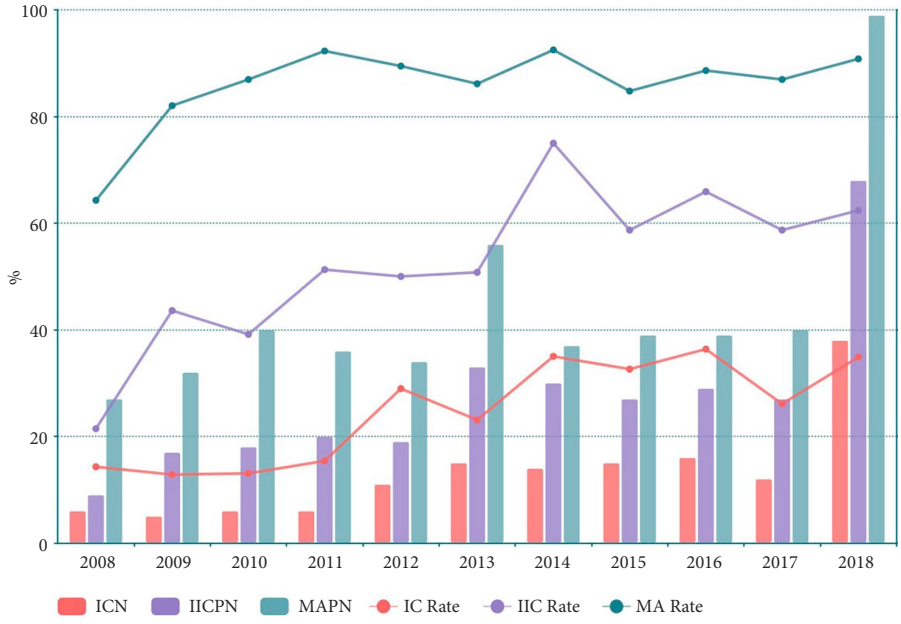

Figure 1. The number of cooperative papers and the rates of cooperation

From Figure 1, we can see that the IC Rate and the IIC Rate of TEDE journal have clear upward trends, and the MA Rate has been stable at a relatively high level. Furthermore, we find that since 2009, the MA Rate has stabilized at more than 82%, and in some years, such as 2011 and 2014, the MA Rate exceeded 90%. The IIC Rate has basically stabilized at over 40% since 2009, except for 39.13% in 2010. The IC Rate has risen sharply since 2012, and it has remained basically above 22%.

Table 1. General citation structure of the TEDE publications according to WoS

Year	TP	TC	≥100	≥50	≥20	≥10	≥1	NICN	ICN	SIPN	IICPN	SAPN	MAPN	AN/TP	RN/TP	h
2008	42	29	0	5	13	12	12	36	6	33	9	15	27	2.05	29.36	18
2009	39	226	0	4	11	11	13	34	5	22	17	7	32	2.46	30.77	17
2010	46	591	2	3	5	12	23	40	6	28	18	6	40	2.41	36.67	13
2011	39	440	1	2	8	8	19	33	6	19	20	3	36	2.44	43.23	14
2012	38	495	0	2	10	7	19	27	11	19	19	4	34	2.58	45.00	15
2013	65	552	0	0	10	10	38	50	15	32	33	9	56	2.57	43.28	15
2014	40	567	1	0	5	11	21	26	14	10	30	3	37	2.83	48.35	14
2015	46	661	0	1	0	7	35	31	15	19	27	7	39	2.96	42.89	8
2016	44	870	0	1	1	6	31	28	16	15	29	5	39	2.93	54.45	9
2017	46	1007	0	0	1	1	29	34	12	19	27	6	40	3.07	49.20	6
2018	109	1127	0	0	0	0	37	71	38	41	68	10	99	3.11	55.21	5
Total	554	6565	4	18	64	85	277	410	144	257	297	75	479			

From Table 1, we find that the average number of authors and references for each paper is gradually increasing. In 2008–2011, the AN/TP values were all below 2.5, however the value of this indicator has been significantly greater than 2.5 since 2012. The values of RN/TP were all below 37 in 2008–2010, rose to 40 to 50 in the period of 2011–2015, and basically stabilized over 50 since 2016. The largest h value is 18 in 2008, indicating that of the 42 papers published in the year, 18 papers were cited at least 18 times each.

1.2. Author characteristics

In this section, the distributions of the TEDE publications with different numbers of authors, countries and institutions are investigated and presented in Table 2. Only 13.54% of the TEDE publications are with single authorship, almost half of the publications include one or two authors (13.54% with one and 34.12% with two). However, the proportions of these two kinds of publications have dropped significantly. Over time, the publications with single authorship have been declining from 22.05% in 2008–2010 to 10.44% in 2011–2014 and 11.43% in the most recent four years. The share of the two-authored publications has decreased from 44.09% in 2008–2010 to 23.67% in the period 2015–2018. On the contrary, the contributions from four or more authors have been steadily increasing. For example, the

share of the publications with four authors has increased from 6.30% in 2008–2010 to 12.09% in 2011–2014 and a peak of 25.71% in recent four years. The publications with five or more authors have a similar growth trend though their absolute share is relatively low.

We also analyzed the countries and institutions to which the authors belong and tried to find some useful trends. The scholars from a sole country authored the majority of the TEDE publications (74.01%), and 46.39% were authored by the scholars from one institution. Although the proportions of these two types of publications are large, they have shown a downward trend in recent years. The share of the publications with the authors from only one country has declined from 86.61% in 2008–2010 to 66.94% in 2015–2018, as has the proportion of the publications with the authors from one institution (65.35% to 38.37%) over the same period. Although the publications with the authors from two or more countries do not account for a large proportion, they show continuous growth trends. This phenomenon is similar to that of the publications with the authors from two or more institutions.

In summary, the TEDE publications with two or three authors account for the majority, but the proportions of one or two authors are gradually decreasing, and the proportions of three or more authors are gradually increasing. The TEDE publications with the authors from one country or institution account for the vast majority, but their proportions continue to decline. However, the proportions of the authors from two or more countries or institutions have a totally different trend. This shows that the TEDE journal is paying more and more attention to cooperation, which is also in line with the current academic development rules.

Table 2. Author characteristics of the TEDE publications

Author characteristics	Total (n = 554)%	Time period		
		2008–2010 (n_1 = 127)%	2011–2014 (n_2 = 182)%	2015–2018 (n_3 = 245)%
Number of authors				
One	13.54	22.05	10.44	11.43
Two	34.12	44.09	41.21	23.67
Three	27.98	22.83	31.32	28.16
Four	16.79	6.30	12.09	25.71
Five or more	7.58	4.72	4.95	11.02
Number of countries				
One	74.01	86.61	74.73	66.94
Two	20.76	11.81	22.53	24.08
Three	4.51	1.57	2.75	7.35
Four or more	0.72	0.00	0.00	1.63
Number of institutions				
one	46.39	65.35	43.96	38.37
two	30.87	29.13	34.62	28.98
three	15.70	4.72	17.58	20.00
four or more	7.04	0.79	3.85	12.65

1.3. Geographical distribution characteristics

The TEDE journal has 1,136 authors from around the world. This section not only systematically studies the author's geographical distribution, but also divides the entire research cycle into three different stages to explore the changing trend of the author distribution. The authors from European and Asia countries predominately contribute the TEDE publications. As shown in Table 3, 55.19% of contributors are from Europe, with Lithuania (23.50%), Spain (4.84%), Poland (3.70%), Portugal (3.43%) and Romania (3.52%). 40.14% of the authors are from an Asia countries/ territories, with China (13.91%), Taiwan (7.22%) and Iran (5.11%). The Lithuania occupies an absolute position in the TEDE journal, and it was followed by China. However, the absolute advantage of Lithuania is gradually replaced by China in recent years since 16.95% of Chinese authors surpass 10.62% of Lithuania authors during the period of 2015–2018. Table 3 shows the detailed distribution of the TEDE authors and their change trends.

Table 3. Location of authors of the TEDE journal

Author characteristics	Total (n = 1136)%	Time period		
		2008–2010 (n_1 = 199)%	2011–2014 (n_2 = 353)%	2015–2018 (n_3 = 584)%
Europe	55.19	89.95	51.27	45.72
Lithuania	23.50	55.78	26.63	10.62
Poland	3.70	10.55	2.55	2.05
Portugal	3.43	1.51	1.98	4.97
Romania	3.52	0.00	1.98	5.65
Spain	4.84	1.01	1.70	8.05
others	16.20	21.11	16.43	14.38
Asia	40.14	8.54	43.06	49.14
China	13.91	3.02	15.01	16.95
Iran	5.11	2.01	7.37	4.79
Taiwan	7.22	0.00	7.37	9.59
Turkey	5.81	3.52	4.82	7.19
others	8.10	0.00	8.50	10.62
North America	2.73	1.51	2.55	3.25
Canada	0.35	0.50	0.00	0.51
USA	2.38	1.01	2.55	2.74
Africa	0.35	0.00	1.13	0.00
Oceania	0.44	0.00	0.85	0.34
South America	1.14	0.00	1.13	1.54

1.4. Manuscript characteristics

In this Section, the manuscript characteristics include number of pages, number of references and citations structures are investigated. Table 4 shows the majority (94.94%) of the TEDE publications had 11–30 pages, including 61.37% with 11–20 pages and 33.57% with 21–30 pages. However, only 1.62% contained ten or fewer pages and 3.43% had 31 or more pages. Over the years, the publications with 11–20 pages have been dominated at three different stages. Although the share of the publications is lower than those with 11–20 pages, the publications with 21–30 pages has the fastest growth rate, from 11.81% in 2008–2010 to 32.97% in 2011–2014 and a peak in 2015–2018 with 45.31%. In addition, the proportion of the publications with 31 or more pages is also rising. It should be noted that in recent years, the publications with 10 or less pages have not appeared, although there is 5.51% in the period of 2008–2010.

Table 4. Characteristics of the TEDE publications

Manuscript characteristics	Total (n = 554)%	Time period		
		2008–2010 (n_1 = 127)%	2011–2014 (n_2 = 182)%	2015–2018 (n_3 = 245)%
Number of pages				
10 or less	1.62	5.51	1.10	0.00
11–20	61.37	81.89	63.19	49.39
21–30	33.57	11.81	32.97	45.31
31 or more	3.43	0.79	2.75	5.31
Number of references				
9 or less	0.36	1.57	0.00	0.00
10–19	6.14	20.47	3.30	0.82
20–39	40.97	54.33	45.60	30.61
40 or more	52.53	23.62	51.10	68.57
Number of citation				
None	21.48	0.79	5.49	44.08
1–9	47.65	37.80	53.30	48.57
10–19	15.52	27.56	20.33	5.71
20–39	9.03	18.90	13.74	0.41
40 or more	6.32	14.96	7.14	1.22

As shown in Table 4, the publications with 20 or more references dominated the TEDE journal, with 20–39 accounts for 40.97% and 40 or more accounts for 52.53%. The publications with a small number of references not only have a small share, but also show a significant downward trend. The share of the publications with 10–19 references decreased from 20.47% in 2008–2010 to 0.82% in the last four years. During the same period, the proportion of the TEDE publications with 9 or fewer references has decreased from 1.57% to 0.00%. The trend of more and more references is explicable. On the one hand, sustainable

economic development is a research hotspot in recent years, and more and more scholars and institutions are paying attention to the development of this field. On the other hand, with the ubiquity of computer networks, it is easier for scholars to obtain relevant reference materials than before. This research phenomenon is similar to the research in other fields, such as wine (Paschen, Wilson, Nehajowich, & Prpić, 2016) and applied intelligence (Liu, Hu, & Tang, 2018; Yu, Xu, & Fujita, 2019).

47.65% of the TEDE publications received 1–9 citations, whereas 15.52% received 10–19 citations and 21.48% have not been cited. The publications with no citations increased from 0.79% in 2008–2010 to 44.08% in 2015–2018. 44.08% of the TEDE publications in the period of 2015–2018 have not been cited. This is not surprising, as it takes a certain amount of time from publication to citation.

2. The productive and influential contributors

The TEDE is an international and influential academic journal whose authors come from all over the world. In the following, the leading countries/territories, institutions as well as authors are analyzed.

2.1. Leading countries/territories

Table 5 shows the 15 most productive countries/territories with at least 15 TEDE publications. Lithuania has an absolute advantage in this list, and the number of the TEDE publications is more than two times that of China, which ranks the second. The third and fourth places are Taiwan and Turkey, respectively. Most of the countries/territories in the list are

Table 5. Productive and influential countries/territories of the TEDE journal

Country/Territory	TP	TC	TC/TP	h	≥200	≥100	≥50	≥20	≥10	≥1
Lithuania	191	3519	18.42	33	1	3	12	34	36	84
China	83	1097	13.22	19	0	0	6	11	17	34
Taiwan	42	362	8.62	10	0	0	2	2	7	20
Turkey	38	269	7.08	10	0	0	0	4	7	17
Poland	34	425	12.50	14	0	0	0	6	15	9
Iran	29	445	15.34	13	0	0	0	10	6	9
Spain	29	212	7.31	8	0	0	2	1	2	14
USA	28	231	8.25	8	0	0	1	2	3	15
England	21	176	8.38	6	0	0	1	2	1	11
Latvia	19	154	8.11	8	0	0	0	2	4	9
Romania	19	82	4.32	5	0	0	0	0	3	13
Czech Republic	16	126	7.88	7	0	0	0	1	4	9
Serbia	16	80	5.00	5	0	0	0	1	1	11
Portugal	15	74	4.93	5	0	0	0	0	3	8
Slovenia	15	111	7.40	5	0	0	0	2	2	10

from Europe and Asia. In addition to the TP, Lithuania also leads the list in almost all indicators. It should be noted that Iran has achieved remarkable results in TC (445) and TC/TP (15.34), and ranked third and second positions based on these two indicators respectively, although it ranked sixth position according to TP. Table 5 also presents the h-index, highly cited publication numbers of these productive countries/territories.

The countries/territories cooperation network of the TEDE publications is presented in Figure 2 that is constructed based on VOSviewer (Van Eck & Waltman, 2010, 2017). Different circles represent different countries/territories, and the lines between the circles indicate the cooperative relationships between these two countries. The size of the circle represents the number of the TEDE publications, and the thickness of the line represents the strength of cooperation. As shown in Figure 2, the intensity of cooperation between Lithuania and Iran is the strongest. In addition, Lithuania and Slovenia, China and USA, China and England also have strong cooperative relations.

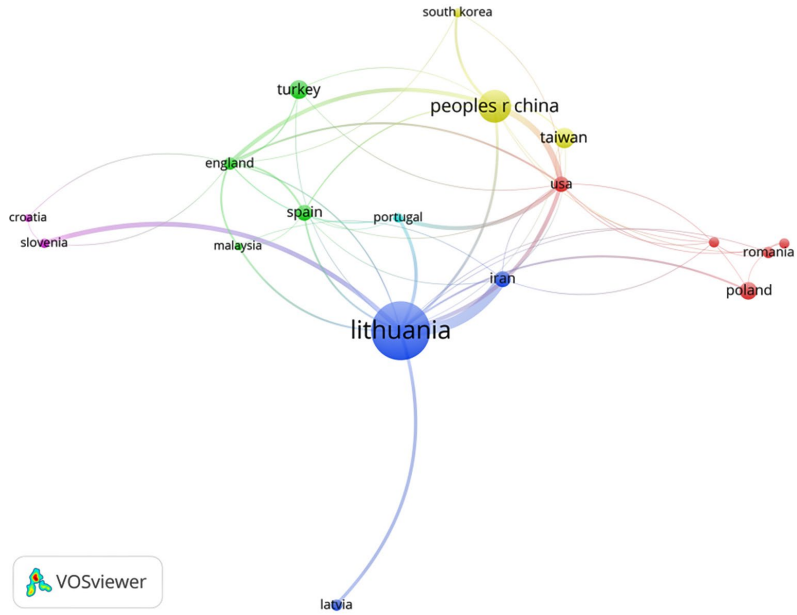

Figure 2. Countries/territories cooperation network of the TEDE journal

2.2. Leading institutions

The academic institutions (such as colleges and universities) where the authors of the papers worked are the main organizational forms for undertaking scientific research. The institutions in which influential and productive authors are located represent the core institutions and are the focus of many researchers in this field. It is of great significance to study the TP, TC, cooperation and other aspects of the research institutions.

Table 6 shows the top 10 institutions in the TEDE journal ranked by TP. There are four institutions from Lithuania and occupy the top four positions. Turkey, Slovenia, Latvia, China, Taiwan, Poland and Serbia each have one. The VGTU in Lithuania published the most

articles (120) including one publication with more than 200 citations, 3 publications with more than 100 citations, and 12 publications with more than 50 citations. It can be seen from Table 6 that besides the TC/TP, the VGTU has almost overall advantages in terms of not only TP, but also TC, h index and highly cited papers. According to the indictor of TC/TP, Shandong University of Finance Economics from China is on the first position with the value of 30.64, and VGTU in Lithuania (24.78) and Poznan University of Technology in Poland (15.80) followed it.

Table 6. Productive and influential institutions of the TEDE journal

Institution	Country/ Territory	TP	TC	TC/TP	h	≥200	≥100	≥50	≥20	≥10	≥1
Vilnius Gediminas Technical University	Lithuania	120	2974	24.78	33	1	3	12	27	23	42
Vilnius University	Lithuania	52	567	10.90	14	0	0	0	9	11	27
Mykolas Romeris University	Lithuania	21	246	11.71	8	0	0	0	3	3	14
Kaunas University of Technology	Lithuania	17	97	5.71	5	0	0	0	1	3	12
Istanbul Technical University	Turkey	15	143	9.53	6	0	0	0	3	3	6
University of Ljubljana	Slovenia	12	94	7.83	5	0	0	0	2	1	8
Riga Technical University	Latvia	11	60	5.45	5	0	0	0	1	0	6
Shandong University of Finance Economics	China	11	337	30.64	10	0	0	2	2	6	1
Natitonal Taipei University	Taiwan	10	104	10.40	4	0	0	1	1	1	4
Poznan University of Technology	Poland	10	158	15.80	7	0	0	0	0	3	4
University of Belgrade	Serbia	10	25	2.50	3	0	0	0	0	0	8

2.3. Leading authors

In this Section, the productive and influential TEDE authors are studied. Table 7 shows the detailed information of the 14 prolific ones. Some other information such as the institutions, countries, positions in the publications and citation structures of these prolific authors are also provided in this Table. E. K. Zavadskas from the VGTU is the most dominant author in the TEDE journal and far away from the next ones. He leads the list in many indicators such as TP, TC, h-index and highly cited papers. Z. Turskis also from the VGTU leads the list in TC/TP (88.78). In terms of the number of the first author publications, M. Skare from Juraj Dobrila University of Pula leads the list. However, according to the number of the correspondence author publications (CAP), P. D. Liu from Shandong University of Finance Economics and D. Streimikiene from Vilnius University ranked the first position. We also

Table 7. Productive and influential authors of the TEDE journal

Name	Institution	Country/ Territory	TP	TC	TC/TP	h	≥100	≥50	≥20	≥10	≥1	Author rank				CAP
												1st	2nd	3rd	other	
Zavadskas E. K.	Vilnius Gediminas Tech Univ	Lithuania	19	1322	69.58	15	4	4	7	2	2	5	6	8	0	8
Kahraman C.	Istanbul Tech Univ	Turkey	13	142	10.92	6	0	0	3	3	5	4	6	3	0	5
Streimikiene D.	Vilnius Univ	Lithuania	13	59	4.54	5	0	0	0	3	7	4	2	3	4	10
Liu P. D.	Shandong Econ Univ	China	11	337	30.64	10	0	2	2	6	1	7	4	0	0	10
Tzeng G. H.	Kainan Univ	Taiwan	10	199	19.90	5	0	2	1	1	4	0	5	3	2	4
Skare M.	Juraj Dobrila Univ Pula	Croatia	9	12	1.33	1	0	0	0	0	5	9	0	0	0	9
Turskis Z.	Vilnius Gediminas Tech Univ	Lithuania	9	799	88.78	6	3	3	0	0	1	1	6	0	2	2
Balezentis T.	Vilnius Univ	Lithuania	7	150	21.43	5	0	0	3	1	1	1	3	2	1	2
Ginevicius R.	Vilnius Gediminas Tech Univ	Lithuania	7	221	31.57	4	0	2	1	1	1	4	2	1	0	4
Tamosaitiene J.	Vilnius Gediminas Tech Univ	Lithuania	7	234	33.43	6	0	1	3	2	1	1	1	1	4	5
Vasilecas O.	Univ Ljubljana	Slovenia	7	28	4.00	4	0	0	0	0	7	1	6	0	0	3
Antucheviciene J.	Vilnius Gediminas Tech Univ	Lithuania	6	136	22.67	6	0	1	1	3	1	1	2	2	1	4
Dzemydiene D.	Mykolas Romeris Univ	Lithuania	6	44	7.33	5	0	0	0	1	5	5	1	0	0	5
Tvaronaviciene M.	Vilnius Gediminas Tech Univ	Lithuania	6	109	18.17	4	0	0	3	1	2	0	1	5	0	2

find that E. K. Zavadskas and Z. Turskis both from VGTU are the only two authors who have TEDE publications with more than 100 citations. Besides these two authors, P. D. Liu from Shandong University of Finance Economics, G. H. Tzeng from Kainan University, J. Tamosaitiene, J. Antucheviciene and R. Ginevicius from VGTU have the publications with more than 50 citations.

3. Thematic analysis based on co-occurrence of keywords

In order to identify the changes in topics over time of the TEDE publications, this section divides 2008–2018 into three different stages and analyzes the co-occurrence networks of their keywords separately. Figures 3–5 show the keyword co-occurrence networks of the TEDE journal in three different stages, respectively. The top 20 frequently used keywords in three different stages are presented in Table 8.

As shown in Table 8, the most frequently used keyword is "selection" in the first stage, while "model" is the most used keyword in both the second and third stages. It can be seen that in recent years, decision analysis has become an important research topic in the TEDE journal, for example, the keywords "TOPSIS", "Data envelopment analysis" and other important keywords in the field of decision analysis first appeared in the third stage. Keywords such as "AHP" and "aggregation operators" have improved over the previous two stages.

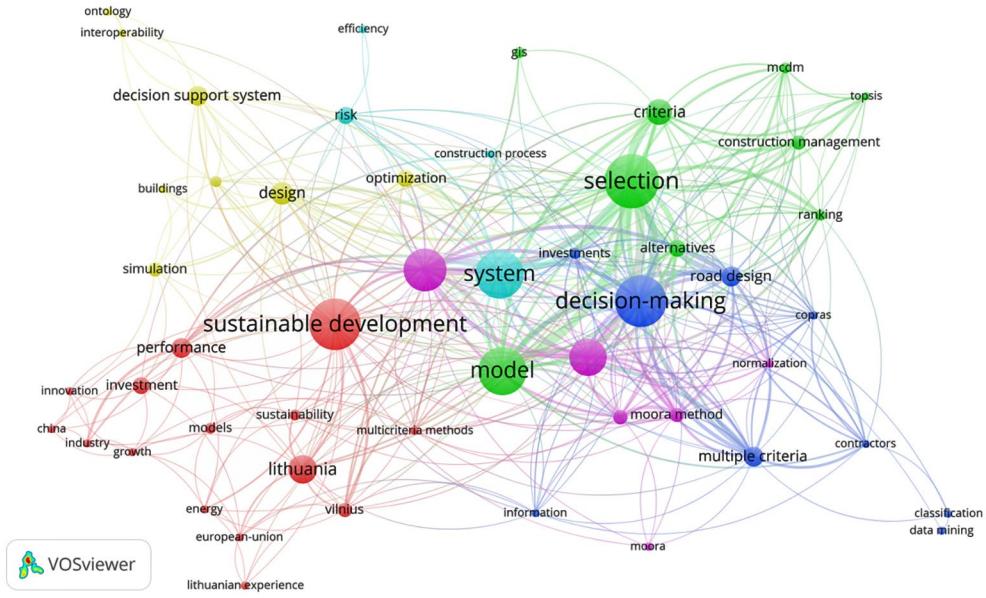

Figure 3. Co-occurrence network of keywords of the TEDE publications, 2008–2010

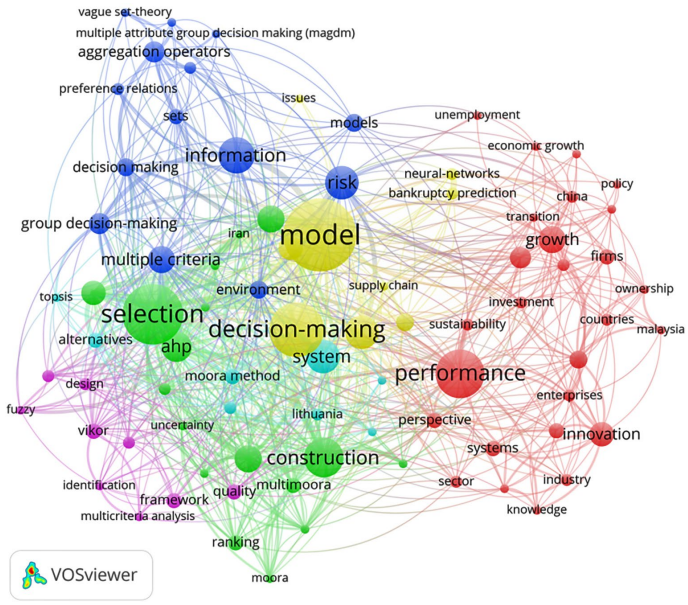

Figure 4. Co-occurrence network of keywords of the TEDE publications, 2011–2014

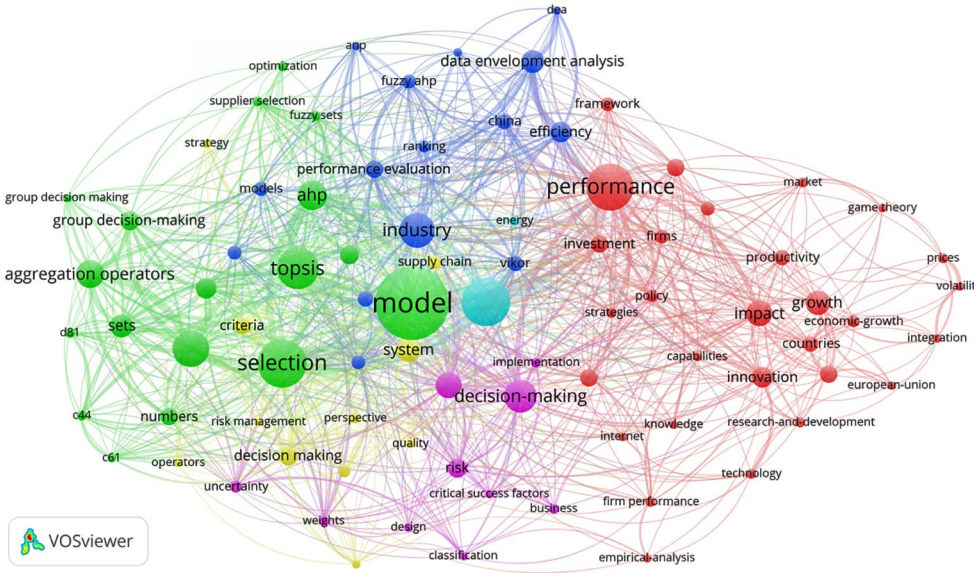

Figure 5. Co-occurrence network of keywords of the TEDE publications, 2015–2018

Table 8. Top 20 keywords used in three different stages

2008–2010		2011–2014		2015–2018	
Keywords	Frequency	Keywords	Frequency	Keywords	Frequency
selection	19	model	24	model	42
decision-making	18	selection	20	management	28
sustainable development	18	decision-making	18	selection	28
model	17	performance	16	performance	27
system	17	construction	13	TOPSIS	24
management	15	information	12	information	21
construction	13	management	11	industry	20
Lithuania	10	risk	11	decision-making	19
criteria	9	system	11	AHP	17
design	8	AHP	10	aggregation operators	16
decision support system	7	growth	9	impact	15
multiple criteria	7	MCDM	9	systems	15
performance	7	MCDM methods	9	growth	14
road design	7	multiple criteria	9	system	14
alternatives	6	criteria	8	data envelopment analysis	13
investment	6	innovation	8	sets	13
optimization	6	optimization	8	efficiency	12
risk	6	aggregation operators	7	environment	12
construction management	5	group decision-making	7	innovation	12
MOORA method	5	impact	7	group decision-making	11

Concluding remarks

This study presented a bibliometric analysis on all the TEDE publications indexed in the SSCI database. The basic characteristics of the TEDE journal, including annual and geographical distributions, author and manuscript characteristics, as well as the influential contributors were studied in detail.

The results indicated that the number of papers published each year by the TEDE journal was relatively small and stable. The IC Rate of the TEDE journal was not high, however, 54.60% publications were authored through inter-institutions cooperation, and most of the papers were published through cooperation among multiple authors. The TEDE publications with two or three authors accounted for the majority, but the proportion of one or

two authors was gradually decreasing. The publications with authors from one country or institution accounted for the vast majority, but their shares continue to decline. Authors from European and Asia countries predominately contributed the publications in the TEDE journal. Lithuania occupied an absolute position in the TEDE journal, and it was followed by China. However, the absolute advantage of Lithuania was gradually replaced by China in recent years. Publications with 11–20 pages have been dominated at three different stages. Meanwhile, the publications with 20 or more references accounted for the vast majority of proportion. As explored by co-occurrence analysis of keywords, decision analysis has become an important research topic in the TEDE journal.

The results of this study showed that the authors of the TEDE journal were mainly distributed in Lithuania, China, Taiwan, Turkey, Poland and other countries/territories. How to make more countries with strong scientific research strength pay attention to this journal is an important challenge in the future. In addition, the number of papers published since 2018 has increased considerably, in which case how to maintain or improve the IF of this journal is another important challenge.

Future research will consider the use of data mining methods for text analysis of all the TEDE publications, so as to study the theme change of the journal more comprehensively. This study is of great help to scholars in understanding the development and trend of the TEDE journal. In addition, it is also useful for editors to grasp the status quo and formulate development strategies of this journal.

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