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Research Article

A review on manufacturing applications of the VIKOR approach

İmalat alanında VIKOR yaklaşımı uygulamalarının incelemesi

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Abstract

VIKOR is a selecting and sorting technique for addressing problems and optimising multi-criteria decision making in complex systems. This study sought the relevant literature to categorise, analyse, and discuss the content and extent of existing studies that used the VIKOR method for applications in manufacturing. The study examined 84 studies published throughout 2018–2020. The studies were categorised by publication dates, author(s) name, techniques and methods, weighting method, comparison method, description of comparison results (comparing a given method to others), testing applicability, and journal-title. Analyses revealed that approximately 35 of the published studies involving VIKOR were related to its strategic use in manufacturing decisions and applications. In 2019, manufacturing was represented more than any other field among all published VIKOR papers, and Sustainability published more of the VIKOR-related articles than any other journal. Interestingly, the integrated and fuzzy VIKOR methods were used more than the traditional VIKOR method. Furthermore, the review results show that VIKOR is flexible enough to be continuously improved by integrating it with the new multi-criteria decision-making methods. This literature review can be used to guide researchers and practitioners in applying VIKOR in various fields of manufacturing.

Keywords: VIKOR, Decision Problem, Multi-criteria Decision Making, Manufacturing, Review

Jel Codes: C44, M11, L60

Öz

VIKOR çok kriterli karmaşık karar problemlerinin optimizasyonu için geliştirilmiş seçim ve sıralama yapmaya odaklanan bir tekniktir. Bu makale imalat alanındaki VIKOR uygulamaları hakkındaki mevcut çalışmaları kategorize etmek ve analiz etmek için literatür taraması yapmaktadır. 2018-2020 yılları arasında yayınlanmış 84 adet çalışma incelenmiştir. Çalışmalar yayınlanma tarihleri, yazar(lar) adı, kullanılan yöntem ve yaklaşımlar, ağırlıklandırma yöntemi, karşılaştırılan yöntemler, kullanılan yöntem ile karşılaştırılan yöntemlerin sonuçları hakkında açıklama, kullanılan yöntemin uygulanabilirliğinin testi ve çalışmaların yayınlandıkları dergi isimleri olarak kategorize edilmiştir. Çalışmanın sonuçlarına göre 2019 yılında imalat alanında VIKOR yöntemi ile ilgili daha fazla makale yayınlanmıştır. Otuz beş çalışmanın imalat stratejisi alanında yapıldığı ve *Sustainability* dergisinin öne çıktığı bulunmuştur. Entegre edilmiş VIKOR ve bulanık VIKOR yöntemleri geleneksel VIKOR yönteminden daha çok kullanılmıştır. Literatür incelemesi sonuçları VIKOR' un yeni çıkan çok kriterli karar verme (ÇKKV) yöntemleriyle entegre edilerek sürekli olarak geliştirilebilecek kadar esnek olduğunu göstermiştir. Bu literatür incelemesi araştırmacılara ve uygulayıcılara imalat alanındaki VIKOR uygulamaları hakkında rehberlik edecektir.

Anahtar Kelimeler: VIKOR, Karar Problemi, Çok Kriterli Karar Verme, İmalat, İnceleme

JEL Kodları: C44, M11, L60

Introduction

Decision-making problems encountered in the real world are often complex, and structures that examine only one criterion or perspective and help reach an optimum decision are inadequate to solve the problem (Zavadskas & Turskis, 2011). The variety of criteria used while evaluating alternatives during the decision-making process and the complexity of real-world problems frequently obstruct the decision-making process; hence, processes have emerged to facilitate multi-criteria decision making (MCDM) (Gürsakal, 2015).

Rationale

At present, MCDM is of great significance in terms of medical diagnosis, information retrieval, financial decision making, pattern identification, and its use in new technologies (Pedrycz, Ekel & Parreiras, 2010; Yager, 2018). MCDM methods will be observed in the analysis of various scaling methods, analysis of aggregation operations, analysis of preference relations, the study of fuzzy relations, the study of grey relations, the development and modification of different mathematical models to find a solution to outranking problems in further studies (Zavadskas & Turskis, 2011).

The VIKOR (VIseKriterijumska Optimizacija I Kompromisno Resenje) method was developed by Opricovic and Tzeng (2004) for multi-criteria optimisation in complex systems. The method facilitates the selection using a compromise ranking list and weight stability intervals from a set of alternatives; the process employs a multi-criteria ranking index based on particular measurements of closeness to the ideal solution (Opricovic & Tzeng, 2004). VIKOR is an effective method for MCDM in cases wherein decision-makers cannot express a preference at the initial phase of a system design. The compromise solution obtained using VIKOR might be accepted by the decision-makers since it provides the maximum *group utility* for the majority and a minimum of individual regret for the opponent (Opricovic & Tzeng, 2004).

The VIKOR method is often used in line with traditional methods in the relevant literature such as the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), the Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), the multi-objective optimisation by ratio analysis (Ratio System, Reference Point Approach, and Full Multiplicative Form; (MULTIMOORA), the grey relational analysis (GRA) and the Elimination Et Choix Traducian la Realité (ELECTRE).

Decision-makers have difficulty in expressing their preferences precisely regarding difficult decision-making due to time constraints, environmental uncertainties, lack of knowledge, or lack of experience. Traditional methods have been avoided because of these difficulties. Expression forms such as the linguistic terms *interval-valued number term set, fuzzy set*, *hesitant fuzzy* (HF) *set*, *Atanassov's intuitionistic fuzzy* (AIF) *set*, and *dual hesitant fuzzy* (DHF) *set* have been developed so that the decision-maker can convey their knowledge (Xue, Tang, Feng, 2016). The VIKOR method was also developed with the use of these expression forms.

The VIKOR method is used in various areas such as energy (Çolak & Kaya, 2020; Rathi, Prakash, Singh, Krolczyk, Pruncu, 2020; Zheng & Wang, 2020), production (Jing, Niu, Chang, 2019; Mohammed, 2020; Rajesh, 2020), environment (Arabameri, Cerda, Rodrigo-Comino, Pradhan, Sohrabi, 2019; Dang & Dang, 2019; Hassangavyar, Samani, Rashidi, Tiefenbacher, 2020), information systems (Yue, 2020), aviation (Kumar, Kumar, Tak, Meena, Sharma, Kumar, 2020; Lu, Hsu, Liou, 2018; Liu, Liu, Ji, Lu, Li, 2020), construction (Antucheviciene & Zavadskas, 2008; Ghanbarizadeh, Heydari, Razmi, Bozorgi-Amiri, 2019; Yan, Lai, Lin, 2014;), tourism (Dinçer & Yüksel, 2019; Liang, Liu, Wang, 2019; Lin & Kuo, 2019).

Objectives

This study attempts to provide a comprehensive literature review regarding the applications and methodology of the VIKOR technique, as used in studies in the field of manufacturing. We aimed to curate a data set from published articles, develop a classification scheme for analysing the related literature, and to collect and clarify the significant information regarding applications of the VIKOR method so it can be used by researchers and practitioners in manufacturing.

Research methodology

In recent years, researchers have applied the VIKOR technique to solve problems in various fields of science by developing the theoretical part of the technique. This review study examined the articles published on the VIKOR method applications in the field of manufacturing. In this regard, the study utilised a method consisting of four steps.

In the first step, related articles that included 'VIKOR' and manufacturing keywords in titles, keywords, and abstracts published between 2018–2020 that were listed on Web of Science, Scopus, and Google Scholar databases were examined. Book chapters, book, conference proceedings, master's thesis, doctoral dissertations, textbook, unpublished working papers were excluded from the review. The resulting dataset included 84 articles. In the second step, we noted the stages of analysis, classification, and coding, respectively. Studies were classified by field, publication dates, author(s) name, publication, techniques and methods (including weighting methods and compared methods), descriptions of the results of the compared methods, testing applicability and journal titles.

In the third step, the studies were classified by the relevant subfields of manufacturing based on the classifications used by Gül, Çelik, Aydın, Gümüş, Güneri (2016) and Mardani, Zavadskas, Govindan, Amat Senin, Jusoh (2016). The four sub-classes of the *manufacturing field* used in the present study were *material selection*, *manufacturing strategy* and *other papers*. Finally, the contribution of each of the articles to the related subject was clarified.

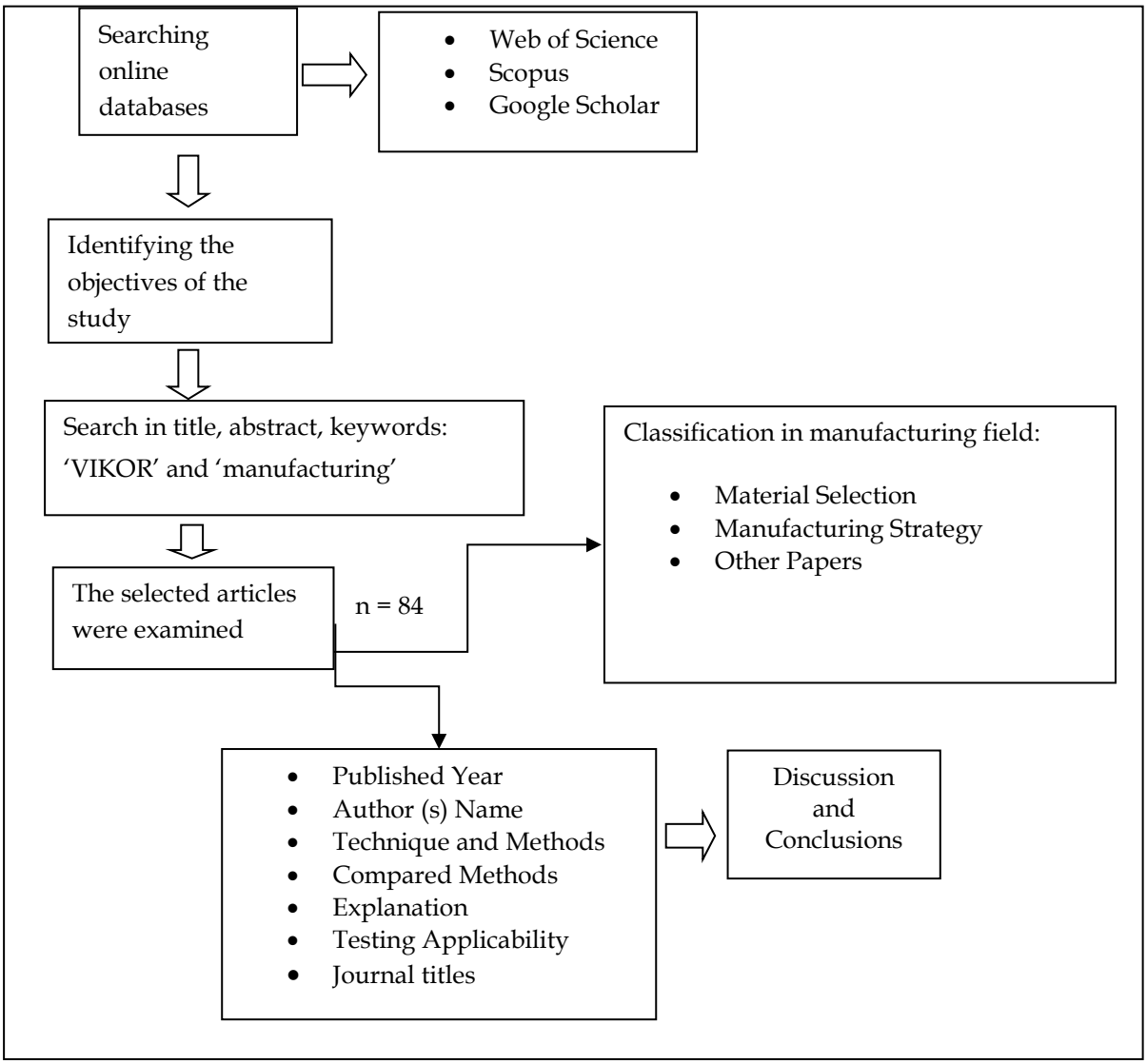

Figure 1. A summary diagram regarding the analysis process of the scoping review of VIKOR studies

Results

Classifications

This study examined the development of the theory and practice related to the VIKOR technique in the subfields of manufacturing. The literature review focused on the classification of articles published between 2018–2020. Table 1 depicts how VIKOR was used in the 84 studies in the manufacturing field by dividing them into three subfields.

Table 1. The contribution of subfields to manufacturing

Subfields	Number of the publications	Percentage (%)
Material Selection	16	19.05
Manufacturing Strategy	35	41.66
Other	33	39.29
TOTAL	**84**	**100**

Material selection

Material selection has a significant place in the production process. Material selection is a difficult process for decision-makers, given the presence of numerous materials around the world. Decision-makers should consider all factors to choose the most suitable material (Mousavi-Nasab & Sotoudeh-Anvari, 2017). Analysis of the MCDM methods used in the relevant literature indicated that VIKOR is frequently used to solve material selection problems; among the 84 studies, 16 (19.05%) used the VIKOR technique in material selection. Five studies (6.0%) used entropy as a weighting technique, and AHP-VIKOR was the most used method, as it was applied in five (6.0%) of the studies (Table 2). Table 2 (Appendix 1) shows the studies that contributed to the subject of material selection and their characteristics (comparison methods, technique, etc.).

Manufacturing strategy

Production strategy has been a hot topic in recent years (Dangayach & Deshmukh, 2001). There is a tendency in the related literature to name the content of the production strategy as the dimensions of the production strategy. The main dimensions of the production strategy are cost, flexibility, quality, and dependability. The sub-dimensions of cost are economies of scale, inventory policies, product design/manufacture ability, learning/forgetting, and JIT. The sub-dimensions of flexibility include economy of scope, set up time, technology, information systems, and JIT. The sub-dimensions of quality are total quality control, training, technology, materials, JIT, etc. The sub-dimensions of dependability include planning systems, scheduling and control systems, inventory policies, vendor management, capacity planning, and MRP (Buffa, 1985; Wheelwright, 1984; Swamidass & Newell, 1987). Thirty-five studies (41.66%) used the VIKOR method with regard to manufacturing strategy. The most commonly used weighting method is AHP (n = 7), while Fuzzy VIKOR (n = 19) is the most-used method. Sensitivity analysis (n = 13) and Spearman's rank correlation (n = 3) were used to test the applicability of the studies. Table 3 (Appendix 2) shows the studies that contributed to the subject of manufacturing strategy.

Other papers

Of the 84 included VIKOR method studies, the 33 (39.29%) that focused on applications other than material selection and manufacturing strategies were classified as *other papers*. Thirteen studies (15.48%) used the fuzzy VIKOR, and eleven studies (13.09%) used a weighting method through an expert view (Table 4). Table 4 (Appendix 3) provides the details of all of the *other papers*.

Publication numbers by year

Table 5 displays the number of publications using the VIKOR method in the field of manufacturing. The study analysed the distribution of 84 studies in the field of manufacturing carried out between 2018 and 2020 through the use of the VIKOR approach as a methodology. More studies were conducted in 2019 (n = 29) than in 2018 or 2020.

Table 5. The Contribution of Publications to the Field by Year

Year	Publication Numbers	Percentage (%)
2018	27	32.14
2019	29	34.52
2020	28	33.33
Total	**84**	**100**

Journals contributing to the field

Eighty-four studies used within the scope of this review study were scanned on Web of Science (WOS), Scopus, and Google Scholar databases and were published in 60 journals. Table 6 shows the journals in which studies contributing to the manufacturing field were published.

Table 6. Distribution of the papers included in the literature review by journal title

Title of the Journal	N	%
Advanced Engineering Informatics	1	1.19
Australian Journal of Mechanical Engineering	1	1.19
Advances in Materials Science and Engineering	1	1.19
Applied Soft Computing	2	2.38
Arabian Journal for Science and Engineering	1	1.19
Arabian Journal of Geosciences	1	1.19
Civil Engineering Journal	1	1.19
Computers & Operations Research	2	2.38
Data Science and Applications	1	1.19
Decision Science Letters	1	1.19
Efoque Ute	1	1.19
Energy	1	1.19
Expert Systems with Application	3	3.57
Fuel	1	1.19
Global Business Review	2	2.38
Global Journal of Environmental Science and Management	1	1.19
Granular Computing	1	1.19
High Performance Polymers	1	1.19
Human and Ecological Risk Assessment	1	1.19
Industrial Engineering Journal	1	1.19
Industrial Management & Data Systems	2	2.38
Information Sciences	2	2.38
International Journal Energy Research	1	1.19
International Journal for Quality Research	1	1.19
International Journal of Advanced Operations Management	1	1.19
International Journal of Engineering Research and Technology	1	1.19
International Journal of Environmental Research and Public Health	1	1.19
International Journal of Healthcare Management	1	1.19
International Journal of Occupational Safety and Ergonomics	1	1.19
International Journal of Production Research	1	1.19
International Journal on Interactive Design and Manufacturing	1	1.19
Journal of Advanced Mechanical Design, Systems, and Manufacturing	1	1.19
Journal of Applied Mathematics and Computing	1	1.19
Journal of Cleaner Production	4	4.76
Journal of Economic and Social Research	1	1.19
Journal of Engineering and Management in Industrial System	1	1.19
Journal of Management, Marketing and Logistic	1	1.19
Journal of Manufacturing Systems	1	1.19
Journal of The Institution of Engineering (India) Series E	1	1.19
Journal of Traffic and Transportation Engineering	1	1.19
MANAS Journal of Social Studies	1	1.19
Materials and Design	1	1.19

Materials Today	1	1.19
Mathematical Problems in Engineering	2	2.38
Mathematics	1	1.19
Measurement	2	2.38
Metals	1	1.19
Oxidation of Metals	1	1.19
Polymer Composites	1	1.19
Resources, Conservation and Recycling	1	1.19
Risk Management-An International Journal	1	1.19
Scientia Iranica, Transactions E: Industrial Engineering	1	1.19
Semiconductors	1	1.19
Silicon	2	2.38
Soft Computing	5	5.95
Sustainability	5	5.95
Symmetry	4	4.76
Technology in Society	1	1.19
Transactions on Electrical and Electronic Materials	1	1.19
Waste Management	1	1.19

Discussion

The VIKOR method is a prominent method used in the solution of multi-criteria decision-making methods. However, there are no published studies specifically about the role and application of the VIKOR method in the manufacturing field. The aim of this review was to systematically classify and summarise 84 studies that used the VIKOR technique in the field of manufacturing between 2018 and 2020 to clarify how the method may be useful for industry leaders and other professionals in manufacturing.

In the literature, there has not been a significant change in the number of studies using the VIKOR method in the field of manufacturing in the last three years. Of the studies in this review that used the VIKOR method, 12 used traditional VIKOR, 37 used fuzzy VIKOR, 5 employed modified VIKOR, and 30 used an integrated VIKOR method. Twenty-three studies combined AHP with VIKOR, while six integrated DEMATEL-ANP (DANP) and VIKOR. The VIKOR results were compared with those of other methods in forty-seven studies. With a view to weighing criteria, 16 of the reviewed studies used AHP, 9 involved fuzzy AHP, 25 included entropy, 5 used the DANP method, and 19 involved the views of experts. In recent years, the increase in fuzzy methods and integrated methods has outpaced growth in the popularity of the traditional VIKOR method. In the three-year period included in this review, the journal *Sustainability* published the most studies that included the VIKOR method. Sensitivity analysis was performed in 28 of 84 studies to suggest the applicability of the methodology; 7 studies used Spearman's rank correlation and one study involved both sensitivity analysis and Spearman's rank correlation. This result shows that the applicability and sensitivity of the method applied in most of the studies.

Conclusions

As one of the multi-criteria decision-making techniques, the VIKOR method has been expanded, integrated, and hybridised due to some deficiencies, and this study also describes the use of these evolved methods. The study is expected to guide further research conducted in this field by demonstrating the uses, applications, and approaches of the VIKOR technique for making complex decisions related to aspects of manufacturing. The scope of further studies may be extended to include various databases apart from WOS, Scopus, Google Scholar.

Finally, the results of the literature review demonstrate that the VIKOR method is flexible enough to be continuously improved by integrating it with newly emerging MCDM methods in various types of manufacturing. The results suggest that VIKOR methods will be as applicable in the future as they are today for solving complex problems in many fields of manufacturing.

Peer-review:

Externally peer-reviewed

Conflict of interests:

The author(s) has (have) no conflict of interest to declare.

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Appendix 1

Table 2. Distribution of papers in material selection

Author(s) and Year	Technique and Approach	Weighting Technique	Compared Methods	Explanation	Testing Applicability
Singh et al., 2018	VIKOR	AHP	AHP-VIKOR AHP-TOPSIS AHP-PROMETHEE	AHP-VIKOR result is same as AHP-PROMETHEE and similar to AHP-TOPSIS	
Reddy et al., 2018	Ashby TOPSIS VIKOR	Expert view	TOPSIS VIKOR	Similar	
Doolabi et al., 2018	VIKOR	AHP			
Moradian et al., 2019	MOORA TOPSIS VIKOR	Entropy AHP	MOORA TOPSIS VIKOR	MOORA TOPSIS had similar, while VIKOR had different results.	SRC
Farhadinia & Herrera-Viedma, 2019	TOPSIS Blok-TOPSIS VIKOR ELECTRE Kapsamlı VIKOR AHP-Kapsamlı VIKOR AHP-TOPSIS	Expert view	Ordinary TOPSIS Block-TOPSIS VIKOR ELECTRE Comprehensive VIKOR AHP-comprehensive VIKOR AHP-TOPSIS	Ordinary-TOPSIS, AHP-VIKOR results are the same. Different from block-TOPSIS, VIKOR, ELECTRE and comprehensive VIKOR results are similar.	
Kim & Ahn, 2019	Extended VIKOR	Incomplete Criteria Weights			
Yogi & Solanki, 2019	VIKOR TOPSIS	Entropy	Hybrid entropy VIKOR ve entropy TOPSIS	Similar	
Adeyeye et al., 2019	VIKOR	Entropy			
Gadhave et al., 2020	TOPSIS VIKOR EXPROM2	Ahp Entropy	TOPSIS VIKOR EXPROM2	As a result of the 3 methods, the best alternative is the same.	
Zhang et al., 2020	Bulanık G-VIKOR	Fuzzy Best worst method (BW)			Sensitivity Analysis

Madhu et al., 2020	VIKOR TOPSIS EDAS PROMETHEE-2 Graph Teori ve Matris yaklaşımı	FAHP	VIKOR TOPSIS EDAS PROMETHEE-2 Graph Theory and matrix approach	The results of VIKOR and PROMETHEE-2 are the same. TOPSIS and EDAS results are similar.	SRC
Kumar et al., 2020	VIKOR	AHP			
Angira & Deshmukh, 2020	VIKOR TOPSIS	Equal weighting	VIKOR TOPSIS	As a result of the 2methods, the best alternative is the same.	
Yurdakul et al., 2020	VIKOR TOPSIS ELECTRE	Expert view	VIKOR TOPSIS ELECTRE	Similar	SRC
Dev et al., 2020	VIKOR	Entropy			Sensitivity analysis
Chamba et al., 2020	VIKOR COPRAS TOPSIS	Expert view	VIKOR COPRAS TOPSIS	TOPSIS and VIKOR have same ranking	

Appendix 2

Table 3. Distribution of papers in manufacturing strategy

Author(s) and Year	Technique and Approach	Weighting Technique	Compared Methods	Explanation	Testing applicability
Guo et al., 2018	Delphi method (T-WA) VIKOR	T-WA Expert View	FAHP fuzzy centre of gravity method (FCG) FTOPSIS OM (the ordering method)	The ranking of other methods is the same except for FAHP	
Zhou et al., 2018	FVIKOR	Anti-entropy weighting technique			Sensitivity Analysis
Feng et al., 2018	FVIKOR	Interval uncertainty DANP	Traditional VIKOR	The evaluations of the experts were found to be significant in the model.	
Singla et al., 2018	TOPSIS VIKOR	AHP	TOPSIS VIKOR	Same	
Gul, 2018	Pythagorean fuzzy analytic hierarchy process (PFAHP) FVIKOR	PFAHP	Proposed approach with IFAHP-FVIKOR	Similar	Sensitivity Analysis
Ghezelbash & Maghsoudi, 2018	VIKOR	AHP			
Nejati et al., 2018	FVIKOR	Expert view			
Cui et al., 2018	Pythagorean fuzzy VIKOR (PF-VIKOR)	Pythagorean fuzzy weight - PFOWGSD operator was used.	The recommended method was compared with FGRA-VIKOR. FTOPSIS Pythagorean FTOPSIS.	Same	
Simab et al., 2018	VIKOR normal boundary intersection (NBI) methods	Equal weighting			Sensitivity Analysis
Ren, 2018	Interval VIKOR	Interval BW			Sensitivity analysis
Zare et al., 2018	Grey group TOPSIS Fuzzy groupVIKOR	Expert view	Grey group TOPSIS Fuzzy groupVIKOR	Same	
Li et al., 2018	Fuzzy based hybrid Taguchi-VIKOR ANOVA	Fuzzy relative weight			

Tian et al., 2018	FVIKOR based error type and effect analysis	Fuzzy BWM and Relative Entropy	Traditional FMEA FTOPSIS and proposed approach	Similar	Sensitivity Analysis
Gul et al., 2018	FVIKOR	Pythagorean FAHP	FVIKOR VIKOR	Similar	
Liu et al., 2018	VIKOR	DANP			
Zhao et al., 2018	Fuzzy-Delphi. VIKOR	BWM Entropy	TOPSIS	Similar	
Mamdouh et al., 2018	FVIKOR	Equal weighting	Conventional method (CM) Multi-objective Ranking Method (ranking). Multi-objective Fuzzy Decision Method (FDM)VIKOR. Weighting Factor Elimination Method (WFE)	The ranking based method has the worst performance. The performance of FVIKOR and FDM VIKOR methods is good	
Rani et al., 2019	FVIKOR	Entropy Divergence measurement			Sensitivity analysis
Zheng et al., 2019	VIKOR	AHP			Sensitivity analysis
Zarei et al., 2019	FVIKOR FMULTİMOORA FARAS FCOPRAS FCOPELAND	FAHP	FVIKOR FMULTİMOORA FARAS FCOPRAS FCOPELAND	Similar	
Dwimas et al., 2019	VIKOR	AHP			
Jamalnia et al., 2019	Additive value function (AVF), TOPSIS VIKOR	AHP	AVF TOPSIS VIKOR	AVF TOPSIS ranking is the same but VIKOR is different	Sensitivity analysis
Wang et al., 2019	FVIKOR	FAHP			Sensitivity analysis
Çalı & Balaman, 2019	Integrated interval fuzzy ELECTRE-1 VIKOR	Entropy	Integrated interval fuzzy ELECTRE-1 VIKOR	Same	Sensitivity analysis
Büyüközkan et al., 2019	IF-VIKOR	IF-AHP	IF-AHP IF-TOPSIS	Similar	Sensitivity analysis
Raykar & D'Addona, 2019	VIKOR				
Hu et al., 2019	HAZOP FVIKOR Factor analysis	Expert view			

Singh et al., 2020	VIKOR Factor Analysis				
Lee et al., 2020	VIKOR	DEA			SRC
Lukic et al., 2020	AHP GRA MOORA TOPSIS ROV COPRAS ARAS WASPAS VIKOR OCRA EDAS MABAC SAW SPW	AHP	AHP GRA MOORA TOPSIS ROV COPRAS ARAS WASPAS VIKOR OCRA EDAS MABAC SAW SPW	The results of the AHP and ARAS method are the same.	SRC
Moiduddin et al., 2020	TOPSIS VIKOR	FAHP	FAHP TOPSIS VIKOR	Different	Sensitivity analysis
Chen et al., 2020	VIKOR-AS	DANP	SAW-AS VIKOR-AS MOORA Multi-MOORA GRA TOPSIS	Same	
Ghaleb et al., 2020	TOPSIS VIKOR	AHP	TOPSIS VIKOR	Similar	
Lo et al., 2020	FMEA TOPSIS SAW VIKOR GRA COPRAS	DEMATEL	SAW VIKOR GRA COPRAS MOORA ARAS	Different	SRC
Qi et al., 2020	Integrated rough VIKOR (IR-VIKOR)	Entropy	MR-VIKOR R-VIKOR R-TOPSIS R-WASPAS R-COPRAS	R-VIKOR, R-TOPSIS, R-WASPAS results are the same	Sensitivity Analysis

Appendix 3

Table 4. Distribution of papers in other papers

Author(s) and Year	Technique and Approach	Weighting Technique	Compared Methods	Explanation	Testing applicability
Banaeian et al., 2018	FTOPSIS FVIKOR FGRA	Expert view	FTOPSIS FVIKOR FGRA	Similar	
Krishankumar et al., 2018	Three-way hesitant fuzzy VIKOR (TWHFV)	Expert view	HF-VIKOR HF-TOPSIS HF-ELECTRE HF-PROMETHEE	Similar	Sensitivity analysis
Rajesh, 2018	Grey clustering and VIKOR	Linguistic terms Grey number			Sensitivity analysis
Chakraborty et al., 2018	DEMATEL-VIKOR	AHP	AHP-TOPSIS GRA-TOPSIS VIKOR	DEMATEL-VIKOR more effective	
Majumder & Maity, 2018	Hybrid FVIKOR	Expert view			
Singh et al., 2018	VIKOR				
Zhou et al., 2018	FVIKOR	Fuzzy AHP			Sensitivity Analysis
Narayana et al., 2019	Interval valued intuitionistic hesitant fuzzy VIKOR	Interval valued intuitionistic hesitant fuzzy entropy			
Ecer et al., 2019	VIKOR	AHP			
Wu et al., 2019	Interval type-2 fuzzy best-worst and extended VIKOR	Expert view	Interval type-2 fuzzy TOPSIS and interval type-2 fuzzy TODIM	Similar. The proposed method was found to be better.	Sensitivity analysis
Liu et al., 2019	Fuzzy QFD-VIKOR	Expert view			Sensitivity analysis
Azizi et al., 2019	Integrated BWM-VIKOR	BWM			
Joshi & Kumar, 2019	IF-VIKOR	IF-entropy	IF-TOPSIS	Similar	

Sharaf, 2019	Interval-valued FVIKOR	Expert view			
Amini et al., 2019	TOPSIS, VIKOR and DEA are integrated with the belief structure. (new proposed method)	Expert view (belief structure is expressed by linguistic variables)			
Tabak et al., 2019	VIKOR	CRITIC-AHP			
Bai & Sarkis, 2019	Neighbourhood rough set TOPSIS and VIKOR	Expert view			Sensitivity analysis
Okatan Sayin et al., 2019	DANP-VIKOR	ANP			
Bathaei et al., 2019	VIKOR	FANP	TOPSIS ARAS EDAS MABAC	Same	
Meksavang et al., 2019	Picture fuzzy distance operator and VIKOR	Expert view	FTOPSIS IF-VIKOR IF-GRA	Similar	
Paul et al., 2019	FVIKOR	Expert view BWM			
Li et al., 2020	Fuzzy DEMATEL Later defuzzication VIKOR (LDVIKOR)	Entropy		Similar	Sensitiviy analysis
Huang et al., 2020	DANP-mV	DANP Entropy			
Kim & Ahn, 2020	Hierarchical VIKOR	Incomplete criteria weight			
Bahadori et al., 2020	Fuzzy VIKOR	Artificial neural network			Sensitivity analysis
Perez-Velazquez et al., 2020	IFS-VIKOR	Entropy			
Gao et al., 2020	VIKOR q-RIVOF-VIKOR	Expert view	q-RIVOFWA q-RIVOFWG q-RIVOF-VIKOR	Same result for q-RIVOFWG and q-RIVOF-VIKOR	
Abdolazimi et al., 2020	VIKOR Soyster Mulvey WSM				Sensitivity analysis

Wang et al., 2020	DEMATEL VIKOR	DANP	DEMATEL VIKOR		Sensitivity analysis
Abdel-Basset et al., 2020	VIKOR TOPSIS	AHP	VIKOR TOPSIS	Different	Sensitivity analysis
Singh & Modgil, 2020	DEMATEL FVIKOR				
Rajesh, 2020	TOPSIS VIKOR	AHP	TOPSIS VIKOR	Different	Sensitivity analysis