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Performance analysis of Civil Engineering Journals based on the Web of Science® database

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ABSTRACT

The presented study analyses the development and performance measures of research journals in the field of civil engineering. As the paper was prepared on the occasion of the 20th anniversary since the Journal of Civil Engineering and Management (JCEM) was founded, it presents detailed description of its evolution. This journal is currently ranked in the 12th position worldwide, based on the values of Impact Factors (IF) published by the Thomson Reuter's Institute for Scientific Information (ISI) Web of Knowledge Journal Citation Reports. JCEM entered the first quartile (Q1) of its peer journals based on its worldwide impact in "Engineering, Civil" category of the ISI Web of Science. However, it has been argued that the IF value is not the sole and possibly not the best measure of journal quality. A number of metrics as well as bibliometric indicators have been developed to measure the impact of scholarly journals. The paper proposes an integrated multiple criteria approach for ranking journals. The essence of the approach lies in the ability to rank journals considering several criteria simultaneously and applying Multiple Criteria Decision Making (MCDM) methods to derive the rankings. Journals from the Q1 quartile of the "Engineering, Civil" category of the Web of Science were analyzed based on seven indicators derived from Journal Citation Reports while applying Weighted Aggregated Sum Product Assessment (WASPAS) method. Integrated rankings with the use of this method were then compared with journal rankings based on their ISI Impact Factor values.

1. Introduction

Publication in a scientific journal is one of the most important elements of research communication. Lately, much attention has been paid to the prestige of journals chosen for publicizing research.

A number of metrics have been developed for quantitative measures of scientific impact, quality and visibility of a journal and for ranking of scholarly journals. Several recognized metrics are based on citation counts [1]. In 2005, Hirsch index (h-index) was declared [2] as a useful index to characterize the scientific output. Also, the g-index for quantifying scientific

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productivity based on publication record was suggested by Egghe [3]. ISI Impact Factor (IF) for those journals indexed in Thomson Reuter's Journal Citation Reports was proposed by Garfield [4] and became one of the most frequently used measures of journal's impact assessment at present. Metrics that represent combination of quantitative and qualitative indicators have been also developed recently [5–7]. Eigenfactor theory for measuring the value and prestige of scholarly journals was suggested by Bergstrom [8]. A new approach to the metric of journals' scientific prestige as the SCImago Journal Rank (SJR) was developed by Gonzalez-Pereira et al. [9]. Also, internal journal's quality evaluation using relevant qualitative factors can be performed following Adeli [10]. A relatively simple method that uses publicly available data to assess the presence of factors to recognize scientific excellence and merit was proposed by Araujo et al. [11]. Methodology for evaluating long-term impact and predicting future citations was proposed by Wang et al. [12].

A number of publications present the analysis of relevance and effectiveness of metrics and the comparison of different bibliometric indicators. SJR for evaluating the journals in the Scopus data base were compared to Journal Citation Reports of the ISI [13]. Some similarities between h-index and the journal IF were underlined as well [14]. Differences between Scopus and Web of Science among major research fields were indicated [15]. Currently, a discussion is held on quantity versus quality of citations, analyzing Google Scholar versus Web of Science as well as providing threats for Web of Science and weaknesses of Google Scholar [16].

A new family of research on journal rankings is based on the application of a multiple criteria approach used for the analysis. The paper by Forgionne and Kohli [17] presents the criteria and a methodology for consolidating multiple criteria into an integrated measure of journal quality and application of Analytic Hierarchy Process for multiple criteria evaluation. Statistical Standard Scores (z-scores) are used for various criteria to create a unified index score in a paper by Raj and Zainab [18]. Garcia et al. [19] applied fuzzy clustering and demonstrated the relationship between four quartiles of ISI Impact Factor and four impact classes from the highest to the lowest, identified applying seven evaluation criteria simultaneously.

The purpose of the presented paper is to evaluate the progress and the current status of scientific journals using currently available multiple information and based on multiple criteria in the international context. Once a journal reaches an anniversary, it becomes even more relevant to assess its progress in the period. Accordingly, special attention is paid to the development of the Journal of Civil Engineering and Management. 2014 is the 20th anniversary of the journal.

This paper focuses on multiple criteria evaluation and ranking of journals, applying Multiple Criteria Decision Making (MCDM) method. At first, the universally adaptable methodology for ranking of journals using Weighted Aggregated Sum Product Assessment (WASPAS method) is suggested. Next, the limitations of the presented research are as follows: indicators (criteria) are derived exclusively from ISI Web of Knowledge Journal Citation Reports and seven criteria are proposed to be applied. The presented study analyses journals from the first quartile (Q1) in the category ''Engineering, Civil'' from the Web of Science.

2. Bibliometric analysis in the field of civil engineering

So far, only two studies have been published analyzing the field ''Engineering, Civil'' with the help of bibliometric methods. One of the studies was devoted to measuring the impact of open access on citation of scholarly publications and determining if open access articles from the field of civil engineering received more citations than non-open access articles [20]. Journal of Civil Engineering and Management does not belong to the open access category.

The other study [21] focused on the evolution of research activity in the field of civil engineering, analyzing papers in the category ''Engineering, Civil'' from the Web of Science in a 5-year period with the help of bibliometric methods, i.e. quantitative and qualitative parameters such as Impact Factor, number of citations, h-index, international collaborations, number of authors and research centers. It has been estimated that a clear relationship exists between the average IF of a journal and the internationalization of the journal. Usually, journals with high IF have contributions from a larger number of countries, and vice versa. Nevertheless, it happens that a lot of journals with a high IF also have high percentages from certain countries because of national contributions or great scientific production of countries. Among the journals with the highest IF, the high number of publications from Lithuania in the Journal of Civil Engineering and Management (32% in 2007–2011 according to [21]) is observed, which explains the high IF of the country and of its centers [21].

3. Development and evaluation of the Journal of Civil Engineering and Management

3.1. *History and development of the Journal*

Twenty years ago, Vilnius Technical University started publishing the research journal ''Statyba'' (Civil Engineering), ISSN 1392-1525. The Journal was aimed at integrating science editions in civil engineering that were published by Vilnius branch of Kaunas Polytechnic Institute, since 1969 – by Vilnius Engineering Construction Institute, and later – by Vilnius Technical University.

During the Soviet period, the Civil Engineering science was divided into several specializations. When defending the candidate dissertation (PhD at present) or doctorate (Doctor Habil later in Lithuania), the papers had to be published in specialized editions. The volume of central Soviet magazines was rather small and opportunities to publish papers for Lithuanian scientists were rather limited. Consequently, Vilnius Gediminas Technical University started publishing the following series of studies in civil engineering:

- Lithuanian Collection of Mechanics (No. 1–33, 1967–1994; ISSN 0460-2242, Editor Prof. A. Čyras);
- Reinforced Concrete Structures (No. 1–16, 1967–1989, ISSN 0372-3070, Editor Prof. A. Kudzys);

Table 1 – Frequency of publication (Journal issues per year) and the number of published papers each year.

Years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Issues	4	4	4	4	6	6	6	4	4	4	4	4	4	4	4	4	4	6	6
Papers	26	46	46	46	53	58	68	39	43	38	37	44	37	38	43	66	57	88	101
The total: 982 papers (19 volumes, 87 issues)																			

- Building Materials and Structures (No. 1–9, 1971–1981, ISSN 0202-3210, Editor Prof. G. Marčiukaitis);
- Building Structures (No. 10–20, 1983–1995, ISSN 0208-2500, Editor Prof. G. Marčiukaitis);
- Building Economy and Organization (No. 1–17, 1971–1990, ISSN 0202-3210, Editor Prof. K. Antanavičius);
- Building Economy and Management (No. 18, 1993, ISSN 0208-2497, Editor Prof. K. Antanavičius);
- Construction Technology and Management (No. 1–7, 1984–1993, Editor Prof. E. K. Zavadskas);
- Structural Repair and Strengthening (No. 1–2, 1992 and 1995, Editor Prof. Z. Kamaitis).

Following the restoration of Lithuania's independence, Vilnius Engineering Construction Institute was reorganized into Vilnius Technical University. Multidisciplinary wide profile civil engineering doctoral studies were established and the decision was made to integrate different science editions in civil engineering into a single journal. It was decided to publish ''Statyba'' on a quarterly basis, papers could be submitted in four languages: Lithuanian, English, German and Russian. Table 1 presents publication frequency and the number of published papers in the period 1995–2013.

In the period 1995–2001, 34 Journal numbers were produced and 545 papers were published.

Since 2002, the Journal title was changed to ''Journal of Civil Engineering and Management'' (JCEM), with the sub-title ''International Research and Achievements''. Aiming to correspond to the change in the Journal title, only papers in English were accepted. Between 2002 and 2007, twenty-four issues of the Journal were produced containing 238 papers in English.

Since 2008, the Journal reached a new stage of development. The Journal was abstracted/indexed by international databases, including SCOPUS and Thomson Reuters Web of Science and encouraged by CIB (International Council of Research and Innovation in Building and Construction).

In the period 2008–2013, 28 Journal numbers and one supplement (in 2013) were produced and 393 papers were published.

The Impact Factor was provided in 2010. Due to increased international visibility and popularity of the Journal and extreme growth in the number of submissions, the decision was made to enlarge the volume of the Journal by 1.5 times and publish 6 issues in a year starting with 2012.

The first Impact Factor published in 2010, had a value of 3.711 (2010 Thomson Reuters, 2009 Journal Citation Report). The values of Impact Factor were 2.171 and 2.016 in 2011 and 2012, respectively.

In 2012, JCEM was evaluated by SCOPUS as follows: SJR = 0.725 (SCImago Journal Ranking), SNIP = 1.360 (Source Normalized Impact per Paper).

Currently, the papers published in the Journal are also abstracted/indexed by Compendex (Engineering Information database), INSPEC (Database of Institution of Engineering and Technology); SCA (Cambridge Scientific Abstract: Civil Engineering, Engineering Materials, Corrosion, Mechanical and Transportation Engineering, METADEX, Aerospace & High Technology Database, Computer and Information Systems, Electronics and Communications, Aluminum Industry, Ceramic, Copper Data Center Database, Composite Industry, Materials Business File), GALE, EBSCO (Academic Search Complete); IRBdirekt and ICONDA; VINITI RAN, Index Copernicus.

In terms of electronic publishing of the Journal, the decision was made to use the Digital Object Identification (DOI) to achieve a wider dissemination of electronic media. DOI is assigned to every paper that consists of two parts, namely of apposition which is by CrossRef to a publisher and of access which structure is comprised by a publisher at its discretion [22].

In the last issue of each volume, keywords index for the volume, authors' index for the given volume and the reviewers list are included. That serves as an acknowledgment of scholars' contributions in the form of reviews that help promoting the quality of the Journal.

Aiming to improve the Journal's publishing process, Vilnius Gediminas Technical University entered into an agreement with Taylor & Francis Publishers. ScholarOne Manuscripts electronic systems were implemented within ten VGTU journals for manuscript submission and review management.

3.2. *Internationalization of the Journal*

As noted above, the Journal has been published in English since 2002. It aims to increase its international visibility and its impact on the scientific community. Fig. 1 presents the information about the internationalization of the Journal. Additionally, Fig. 1 suggests that although the Journal ''Statyba'' was published in four languages, it contained 81% of publications authored by Lithuanian scholars and only 17% of publications by foreign authors (Fig. 1a). Following the reorganization, the Journal of Civil Engineering and Management had received 49% of publications authored by Lithuanian scholars, while 45% had been submitted by foreign authors and 6% had been joint papers of Lithuanian and foreign authors (Fig. 1b). Six years of abstracting in WoS database resulted in 24% of papers authored by Lithuanian scholars, 70% – foreign authors and 6% – joined papers (Fig. 1c). The percentage of authors from other countries in the Journal is an important indicator of internationality, describing not only the foreign authors' willingness and ability to be published in the Journal, but also the global diffusion of the Journal.

3.3. *Analysis of assignment to institutions*

A part of the papers of Vilnius Gediminas Technical University authors in the Journal of Civil Engineering and Management

Fig. 1 – Internationalization of the Journal: (a) until 2008; (b) 2008–2012; (c) 2013.

demonstrates the selfishness indicator. Striogienė [23] analyzed assignment of published papers to institutions in 1995–2010. She aimed to determine the composition of the Journal:

- VGTU and other contributors from other Lithuanian institutions and other countries–VGTU/Lithuania/foreign institutions;
- authors from other Lithuanian institutions and co-authors from other countries–Lithuania/foreign institutions;
- authors from other countries (foreign institutions).

Results showed that in the period 1995–2003, the majority of articles were still produced by researchers of VGTU. In 2009, already 30 articles were published with co-authors of other Lithuanian and foreign institutions and 26 papers were authored by foreign scholars. In 2010, the number of papers authored by other scholars was two times greater than that of VGTU authors, while VGTU scholars co-authored 21 paper with colleagues from other institutions [23].

In the beginning of 2014, a survey was made in order to determine the further development of volume of assignments to Lithuanian and foreign institutions in the period 2008–2013, i.e. since JCEM has been indexed by WoS database. Table 2 shows the number of countries in Authors affiliations in published papers for the analyzed period. Fig. 2 provides information on the distribution of papers by continents.

In 2008–2013, there were assignments to 47 different countries in the Journal. China and Hong Kong accounted for 27%, Lithuania – 22.8%, Poland – 8.5%; U.S. – 6.9%, Taiwan and Iran – 6.4% each, Malaysia and Turkey – 6% each, United Kingdom – 4%, South Korea – 2.4%, India – 2%, Austria and Australia – 1.6% each, followed by Egypt, Nigeria, Ukraine, Sweden, Canada, Croatia, Spain, Uganda, Algeria, Jordan, Italy, Belarus, Germany, Denmark, Estonia, Slovenia, Israel, Kuwait, Russia, Thailand, Oman, Bangladesh, Singapore, Belgium, Sri Lanka, Saudi Arabia, Finland, the Arab Emirates, Palestine, Latvia, Indonesia, Tunisia and Slovakia.

Table 2 – Number of assignments of papers in 2008–2013.

Years	2008	2009	2010	2011	2012	2013
Number of countries The total: 149	17	22	25	22	30	33

3.4. *Measuring the quality of a research journal*

It is obvious that Journal of Civil Engineering and Management is becoming better known, popular and appreciated not only in Lithuania, but also in other countries. The number of published as well as received papers of high scientific quality is growing rapidly, the journal internationality and global dispersion is increasing.

What influences the success of a journal? How to measure the quality of a scientific journal, impact or its significance in the academic world?

According to Hojjat Adeli, professor of Ohio State University, Editor of the Journal with the highest Impact Factor in civil engineering category and active researcher, that is Editor-in-Chief whose scientific reputation, experience and purposeful as well as careful long-time work are the most important factors contributing to the success of the a journal.

Next, performance factors of the Journal of Civil Engineering and Management are reviewed following the evaluation criteria of a scientific journal suggested by Adeli [10]:

(1) Reputation and professional standing of Editor(s)

Journal Editors establish the policy and scientific quality standards. They set up the Editorial Board, select competent reviewers, assess the reviewers' comments and the scientific value of a paper, the novelty and relevance of a research, and make the final decision regarding accepting/rejection of an article.

The Editor-in-Chief of the Journal of Civil Engineering and Management Professor Edmundas Kazimieras Zavadskas, Member of the Lithuanian Academy of Sciences, Lithuanian Science Award Winner (awarded in 1996 and 2004) is a reputed scholar with many years of editorial experience. Professor Zavadskas is the founder of the Journal and serves in the position of the chief editor from the beginning of the journal publishing, i.e. for 20 years. During this period of hard work and due to enormous efforts of the Editor-in-Chief, the Journal has achieved remarkable results: the Journal has become abstracted/indexed by several international databases; it has obtained the Impact Factor, the number of submissions as well as publishing frequency increased, internationalization and visibility expanded in the international academic world.

The North American editor, Professor Miroslaw J. Skibniewski, is a member of the American Society of Civil

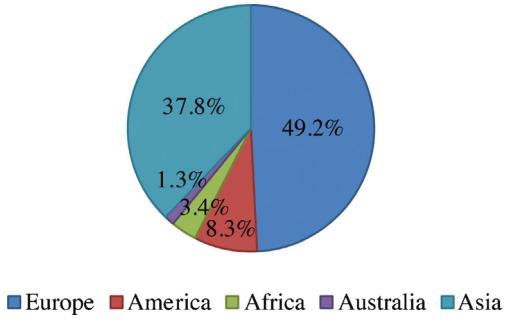

Fig. 2 – Distribution of papers by continents.

Engineers (ASCE) and other international organizations. He contributes to internationalization and dissemination of the Journal outside Europe.

Research-active and reputable scholars help to ensure the scientific quality of the journal: Professor Gintaris Kaklauskas, who supervises the reviews and publications of papers in the area of building materials and structures; Professor Artūras Kaklauskas, responsible for papers in construction technology and management; Professor Rimantas Kačianauskas, responsible for papers in structural mechanics, building physics, and information technologies. All three editors are Members of the Lithuanian Academy of Sciences and Lithuanian Science Award winners.

The smooth path from submission to publishing as well as the scientific and technical quality of publications is ensured by Managing Editors Jurgita Antuchevičienė and Laura Tupėnaitė who also maintain regular communication with authors and reviewers.

(2) Rigor of the review process

Quality of a journal is closely related to and directly depends on the rigorous, thorough and skilled reviewing process. Quality of a review process is determined by two factors: competent, experienced reviewers with a good reputation and recognition within the scientific community as well as a sufficient number of reviewers, ensuring an objective and comprehensive evaluation.

Editors of the Journal of Civil Engineering and Management ensure the quality of reviewing through a minimum of two to three reviewers for each item or inviting more additional reviewers in a case of contradicting assessments. Acceptance rate after reviewing is approximately 20% of the papers corresponding to the highest standards of scientific novelty and quality.

It should be noted that a very large number of scientists contribute to the effective peer review process. In 2012–2013, papers were reviewed by over 500 reviewers, 14% of them were Lithuanian scientists and the rest 86% were reputed scientist from other countries of the world. The editors of the Journal would like to express their sincere appreciation to all experts for their contribution to the quality of papers.

(3) Editorial Board

"After the journal Editor, members of the Editorial Board are the primary gate keepers" [10]. If members of the editorial board are experienced and have a good reputation in the field of research they represent, that always reflects on the quality of the journal.

JCEM Editorial Board consists of 61 members, including 23 Lithuanian scientists and 38 (62%) meritorious scientists from other European countries (Latvia, Estonia, Poland, Germany, Belgium, Austria, the United Kingdom, Finland, Croatia, Czech Republic, Hungary and Portugal) and other countries of the world (USA, Israel, Japan, Korea, Taiwan and South Africa).

(4) Age of the journal

Evolution of a journal since the day of its launch till becoming a high-quality and respected publication is an especially thorough and slow process. It is said to take about ten years for a journal to really establish itself. Many of newly founded periodicals disappear before reaching their fifth anniversary. Reaching the tenth anniversary is a significant operational phase of a journal and at the same time, it is the factor for measuring the quality of a journal. According to Adeli [10], the 20-year anniversary is the next important phase in the life of a journal. We are pleased that the Journal of Civil Engineering and Management is just approaching the current maturity stage. It has been successfully published for almost 20 years!

(5) Citation indices

Citation indicators are certainly very important, but not the only ones that describe the quality of a journal [10]. One of the most valuable characteristics of this type is journal Impact Factor (IF). Basically, the above-listed four criteria are indirectly reflected when determining the annual citation rate.

As stated previously, the Journal's current value of the ISI IF is 2.016 (2012 Journal Citation Report). The Journal of Civil Engineering and Management occupies the 12th place among 122 journals in the field of civil engineering as indicated by the value of IF. The Journal's IF is more than 2.5 times higher than the average IF (0.786) for this civil engineering category.

(6) Publisher

Journal publishers have an indirect influence on the quality, because they do not control the content of papers. However, the well-known publishers generally follow a sound business strategy, which also affects the quality of the publication.

For the fourth consecutive year, JCEM is being published with Taylor & Francis Publishers. Electronic peer review and publishing platforms were launched for convenience of contributors, editors and reviewers as well as to ensure the fluency, objectivity and quality of the process from manuscript submission to publication. The journal uses tools for measuring scientific dishonesty, for avoiding conflicts of interest and for copyright protection. In cooperation with Taylor & Francis, the Journal became more active in distribution and its international visibility was increased.

(7) Frequency of publication

Journals with a larger frequency of publication have certain advantages. They report the research findings to a larger community of researchers and, most importantly, are able of publishing accepted papers faster, which

frequently allows breaking the news on the latest scientific discoveries. In 2012, JCEM became a bi-monthly journal instead of a quarterly, the volume and the frequency of publication increased by 1.5 times.

4. Ranking journals in the civil engineering category

As it was mentioned above, the IF is not the single measure of journal quality and not the only possible criterion for ranking of journals. The authors propose using several criteria simultaneously when measuring performance of a journal. Multiple Criteria Decision Making methods could be suitable for that purpose.

4.1. *Methodology for multiple criteria evaluation of journals*

It is suggested to apply a recently developed Weighted Aggregated Sum Product Assessment (WASPAS) method [24] in the current research. WASPAS enables to reach the highest accuracy of estimation applying suggested methodology for optimization of weighted aggregated function. It was successfully applied for decision making in civil engineering when ranking strategies for construction works [25,26], house modernization [27,28], or selecting the most appropriate location [29].

Suppose that a given MCDM problem is defined using m alternatives (journals covered by the analysis) and n decision criteria, applied for ranking the journals. Next, suppose that w_j denotes the relative significance (weight) of the criterion; and x_{ij} is the performance value of alternative i ($i = 1, 2, \ldots, m$) when it is evaluated in terms of criterion j ($j = 1, 2, \ldots, n$). An integrated value of utility function Q_i of each alternative is called the Weighted Aggregated Sum Product Assessment:

$$Q_i = \lambda \sum_{j=1}^{n} \bar{x}_{ij} w_j + (1-\lambda) \prod_{j=1}^{n} (\bar{x}_{ij})^{w_j}, \quad \lambda = 0, \ldots, 1, \tag{1}$$

where linear normalization of initial criteria values is applied:

$$\bar{x}_{ij} = \frac{x_{ij}}{\max_i x_{ij}} \text{ or } \bar{x}_{ij} = \frac{\min_i x_{ij}}{x_{ij}}, \tag{2}$$

if $\max_i x_{ij}$ or $\min_i x_{ij}$ criterion value is preferable, respectively.

The proposed methodology for optimization of weighted aggregated utility function when calculating the optimal values of coefficient λ enabled the highest accuracy of estimation to be reached [24]. In the current case, a generalized WASPAS method was applied, assuming that $\lambda = 0.5$ [25,29]. Then, an integrated value of utility function for each alternative can be determined as follows:

$$Q_i = 0.5 \sum_{j=1}^{n} \bar{x}_{ij} w_j + 0.5 \prod_{j=1}^{n} (\bar{x}_{ij})^{w_j}. \tag{3}$$

4.2. *Evaluation criteria*

The object for the analysis are journals of the civil engineering category (i.e. subject category ''Engineering, Civil'') from the Q1 quartile of ISI Impact Factor in the Web of Science database. Q1 quartile covers 30 journals from the total of 122 attributed to the civil engineering category.

Criteria are taken from ISI Web of Knowledge Journal Citation Reports (2012 JCR Science Edition). The seven criteria used in the current analysis are:

1. *The journal Impact Factor (IF)*. It means the average number of times articles from the journal published in the past 2 years have been cited in the JCR year. The Impact Factor is calculated by dividing the number of citations in the JCR year by the total number of articles published in the 2 previous years.
2. *The Immediacy Index*. It indicates how quickly articles in a journal are cited. The journal Immediacy Index is the average number of times an article is cited in the year it is published. It is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year.
3. *The Eigenfactor Score*. Its calculation is based on the number of times articles from the journal published in the past 5 years have been cited in the JCR year, but it also considers which journals have contributed these citations so that highly cited journals will influence the network more than lesser cited journals. References from one article in a journal to another article from the same journal are removed, so that Eigenfactor Scores are not influenced by journal self-citation.
4. *Journal Self Cites*. Self-citations are references to articles from the same journal. Self-citations often make up a significant portion of the citations a journal gives and receives each year. Divide the total number of times the journal cited itself by the number of total cites received and multiply by 100. The result is the percent of all references to the journal from articles published in the same journal.
5. *Self Cites to Years Used in Impact Factor Calculation*. It shows the contribution of the journal's self cites to its IF. Based on the current data, IFs without self-cites can be recalculated.
6. *h-index*. This field displays the h-index count and is based on a list of publications ranked in descending order by the Times Cited count. The h-index is indicated by going through the Year/Total Year columns. The number of items above this line, which is ''h'' have at least ''h'' citations. (For example, an h-index of 20 means there are 20 items that have 20 citations or more.) This metric is useful because it discounts the disproportionate weight of highly cited papers or papers that have not yet been cited.
7. *Average Citations per Item*. This field displays a formula that calculates the average number of citing articles for all items in a set. It is the sum of the Times Cited count divided by the number of results found.

4.3. *Ranking results*

30 journals were evaluated in terms of seven suggested criteria. The initial decision making matrix is presented in Table 3. Calculations were performed using Eqs. (2) and (3). The weighted normalized decision making matrix is presented in Table 4.

Table 3 – Initial decision making matrix: criteria values for assessment of journals performance.

Abbreviated journal title	IF	Immediacy index	Eigenfactor score	Self cites (%)	Self cites in IF (%)	h-index	Average citations per item
Comput-Aided Civ Inf	4.460	0.623	0.00266	38	56	32	9.27
J Hazard Mater	3.925	0.480	0.13651	6	8	85	16.18
IEEE T Intell Transp	3.064	0.354	0.00510	28	44	47	11.14
J Hydrol	2.964	0.489	0.04608	13	14	132	20.02
Transport Res B-Meth	2.944	0.347	0.00953	13	25	78	2.03
Struct Infrastruct E	2.805	0.200	0.00171	66	72	14	3.38
Energ Buildings	2.679	0.242	0.01650	28	35	60	9.33
Build Environ	2.430	0.660	0.01907	16	24	51	8.72
Transport Res E-Log	2.272	0.419	0.00692	10	15	43	11.32
Water Resour Manag	2.259	0.388	0.00829	31	44	39	7.27
Coast Eng	2.239	0.683	0.00714	17	26	66	15.15
J Civ Eng Manag	2.016	0.216	0.00121	34	35	17	4.63
Stoch Env Res Risk A	1.961	0.325	0.00366	23	32	29	6.13
J Hydro-Environ Res	1.899	0.379	0.00180	1	2	13	3.95
Earthq Eng Struct D	1.898	0.260	0.00867	14	24	33	8.01
Struct Saf	1.840	0.241	0.00417	6	8	45	12.3
Automat Constr	1.820	0.181	0.00388	30	35	33	6.59
Eng Struct	1.713	0.216	0.02229	17	27	57	8.43
J Water Res Pl-ASCE	1.709	0.101	0.00268	10	14	53	10.86
Transportation	1.657	0.344	0.00328	7	9	42	8.13
Struct Control Hlth	1.544	0.175	0.00282	12	7	19	5.06
Comput Struct	1.509	0.287	0.01393	5	10	85	9.74
Balt J Road Bridge E	1.478	0.250	0.00052	32	24	14	4.03
Smart Struct Syst	1.430	0.177	0.00133	20	20	17	3.33
J Environ Eng-ASCE	1.399	0.182	0.00574	5	12	68	9.64
Earthq Struct	1.381	0.022	0.00020	53	55	6	1.24
J Hydrol Eng	1.379	0.159	0.00463	18	22	44	7.34
J Wind Eng Ind Aerod	1.342	0.170	0.00563	22	36	52	7.48
Mar Struct	1.333	0.118	0.00203	11	20	20	6.43
J Constr Steel Res	1.327	0.237	0.00823	24	28	39	6.79

Table 4 – Weighted normalized decision making matrix.

Abbreviated journal title	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Comput-Aided Civ Inf	0.1430	0.1304	0.0028	0.0038	0.0051	0.0347	0.0662
J Hazard Mater	0.1258	0.1005	0.1430	0.0238	0.0358	0.0921	0.1156
IEEE T Intell Transp	0.0982	0.0741	0.0053	0.0051	0.0065	0.0509	0.0796
J Hydrol	0.0950	0.1024	0.0483	0.0110	0.0204	0.1430	0.1430
Transport Res B-Meth	0.0944	0.0727	0.0100	0.0110	0.0114	0.0845	0.0145
Struct Infrastruct E	0.0899	0.0419	0.0018	0.0022	0.0040	0.0152	0.0241
Energ Buildings	0.0859	0.0507	0.0173	0.0051	0.0082	0.0650	0.0666
Build Environ	0.0779	0.1382	0.0200	0.0089	0.0119	0.0553	0.0623
Transport Res E-Log	0.0728	0.0877	0.0072	0.0143	0.0191	0.0466	0.0809
Water Resour Manag	0.0724	0.0812	0.0087	0.0046	0.0065	0.0423	0.0519
Coast Eng	0.0718	0.1430	0.0075	0.0084	0.0110	0.0715	0.1082
J Civ Eng Manag	0.0646	0.0452	0.0013	0.0042	0.0082	0.0184	0.0331
Stoch Env Res Risk A	0.0629	0.0680	0.0038	0.0062	0.0089	0.0314	0.0438
J Hydro-Environ Res	0.0609	0.0794	0.0019	0.1430	0.1430	0.0141	0.0282
Earthq Eng Struct D	0.0609	0.0544	0.0091	0.0102	0.0119	0.0358	0.0572
Struct Saf	0.0590	0.0505	0.0044	0.0238	0.0358	0.0488	0.0879
Automat Constr	0.0584	0.0379	0.0041	0.0048	0.0082	0.0358	0.0471
Eng Struct	0.0549	0.0452	0.0233	0.0084	0.0106	0.0618	0.0602
J Water Res Pl-ASCE	0.0548	0.0211	0.0028	0.0143	0.0204	0.0574	0.0776
Transportation	0.0531	0.0720	0.0034	0.0204	0.0318	0.0455	0.0581
Struct Control Hlth	0.0495	0.0366	0.0030	0.0119	0.0409	0.0206	0.0361
Comput Struct	0.0484	0.0601	0.0146	0.0286	0.0286	0.0921	0.0696
Balt J Road Bridge E	0.0474	0.0523	0.0005	0.0045	0.0119	0.0152	0.0288
Smart Struct Syst	0.0458	0.0371	0.0014	0.0072	0.0143	0.0184	0.0238
J Environ Eng-ASCE	0.0449	0.0381	0.0060	0.0286	0.0238	0.0737	0.0689
Earthq Struct	0.0443	0.0046	0.0002	0.0027	0.0052	0.0065	0.0089
J Hydrol Eng	0.0442	0.0333	0.0049	0.0079	0.0130	0.0477	0.0524
J Wind Eng Ind Aerod	0.0430	0.0356	0.0059	0.0065	0.0079	0.0563	0.0534
Mar Struct	0.0427	0.0247	0.0021	0.0130	0.0143	0.0217	0.0459
J Constr Steel Res	0.0425	0.0496	0.0086	0.0060	0.0102	0.0423	0.0485

Table 5 – Journals rankings: IF versus integrated assessment.

Abbreviated journal title	Impact Factor		WASPAS	
	IF	Ranks	Q_i	Ranks
Comput-Aided Civ Inf	4.460	1	0.8064	7
J Hazard Mater	3.925	2	1.1206	1
IEEE T Intell Transp	3.064	3	0.7500	10
J Hydrol	2.964	4	1.0125	2
Transport Res B-Meth	2.944	5	0.7490	11
Struct Infrastruct E	2.805	6	0.5890	26
Energ Buildings	2.679	7	0.7402	12
Build Environ	2.430	8	0.8388	5
Transport Res E-Log	2.272	9	0.7902	8
Water Resour Manag	2.259	10	0.7100	16
Coast Eng	2.239	11	0.8535	4
J Civ Eng Manag	2.016	12	0.5912	25
Stoch Env Res Risk A	1.961	13	0.6638	18
J Hydro-Environ Res	1.899	14	0.8632	3
Earthq Eng Struct D	1.898	15	0.6921	17
Struct Saf	1.840	16	0.7617	9
Automat Constr	1.820	17	0.6184	24
Eng Struct	1.713	18	0.7155	15
J Water Res Pl-ASCE	1.709	19	0.6608	19
Transportation	1.657	20	0.7393	13
Struct Control Hlth	1.544	21	0.6326	21
Comput Struct	1.509	22	0.8147	6
Balt J Road Bridge E	1.478	23	0.5690	28
Smart Struct Syst	1.430	24	0.5642	29
J Environ Eng-ASCE	1.399	25	0.7307	14
Earthq Struct	1.381	26	0.3947	30
J Hydrol Eng	1.379	27	0.6289	22
J Wind Eng Ind Aerod	1.342	28	0.6280	23
Mar Struct	1.333	29	0.5777	27
J Constr Steel Res	1.327	30	0.6437	20

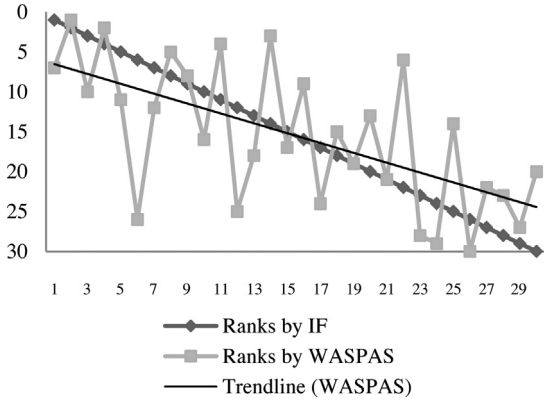

Fig. 3 – Comparison of rankings.

Results of the research, i.e. calculated integrated journal ranking, and ranking according to the values of IF are presented in Table 5.

In Fig. 3 visual comparison of rankings, i.e. IF versus proposed multiple criteria integrated assessment can be observed.

5. Conclusions

The paper discussed performance measures of research journals. It provided a short overview of a number of different indicators for measures of scientific impact, quality and visibility of a journal and for ranking of scholarly journals. The presented research aimed to propose an integrated multiple-criteria approach to evaluate and rank scientific journals using a number of indicators simultaneously.

The object for the analysis were the journals of Q1 quartile of the subject category ''Engineering, Civil'' in the Web of Science database. The special attention was given to the Journal of Civil Engineering and Management on the occasion of its 20th anniversary and its evolution was described in detail.

Journals were ranked based on seven criteria from the number of the available criteria from ISI Web of Knowledge Journal Citation Reports. 2012 JCR Science Edition was used as the data source.

Thirty journals from Q1 in ''Engineering, Civil'' were sorted by the value of IF; also they were ranked applying the proposed Weighted Aggregated Sum Product Assessment and integrating seven indicators from JCR. Results were compared.

Calculation results revealed that the ranking order of journals was different when applying both approaches. The Journal of Civil Engineering and Management occupies the twelfth position according to Impact Factor, while it was ranked as the 25th among 30 journals from Q1 when 7 different indicators were considered and the proposed aggregated approach was applied.

Generalized results of calculation showed a tendency for higher IF journals to be ranked lower when applying the

multiple-criteria approach; and vice versa, there was a tendency for lower IF journals to be ranked higher when more indicators were considered.

REFERENCES

[1] A.F.J. van Raan, Measuring science, in: H. Moed, G. Wolfgang, S. Ulrich (Eds.), Handbook of Quantitative Science and Technology Research, Kluwer, Dordrecht, 2004, pp. 19–50.

[2] J.E. Hirsch, An index to quantify an individual's scientific research output, Proceedings of National Academy of Sciences of the United States of America, Proceedings of the National Academy of Science 102 (46) (2005) 16569–16572.

[3] L. Egghe, Theory and practise of the g-index, Scientometrics 69 (1) (2006) 131–152.

[4] E. Garfield, The history and meaning of the journal impact factor, Journal of the American Medical Association 295 (1) (2006) 90–93.

[5] I. Palacios-Huerta, O. Volij, The measurement of intellectual influence, Econometrica 72 (3) (2004) 963–977.

[6] N. Ma, J. Guan, Y. Zhao, Bringing Page Rank to the citation analysis, Information Processing and Management 44 (2) (2008) 800–810.

[7] M.A. Rodriguez, J. Bollen, H. Van De Sompel, Automatic metadata generation using associative networks, ACM Transactions on Information Systems 27 (2) (2009) 1–20.

[8] C. Bergstrom, Eigenfactor: measuring the value and prestige of scholarly journals, College and Research Libraries News 68 (5) (2007) 314–316.

[9] B. Gonzalez-Pereira, V.P. Guerrero-Bote, F. Moya-Anegon, A new approach to the metric of journals' scientific prestige: the SJR indicator, Journal of Informetrics 4 (3) (2010) 379–391.

[10] H. Adeli, Measuring research journals, Computer-Aided Civil and Infrastructure Engineering 22 (1) (2007) 1–5.

[11] J. Araujo, N.D. Ghiya, A. Calugar, T. Popovic, Analysis of three factors possibly influencing the outcome of a science review process, Accountability in Research Policies and Quality Assurance 21 (4) (2014) 241–264.

[12] D. Wang, Ch. Song, A.-L. Barabási, Quantifying long-term scientific impact, Science 342 (6154) (2013) 127–132.

[13] L. Leydesdorff, F. Moya-Anegon, V.P. Guerrero-Bote, Journal maps on the basis of Scopus data: a comparison with the Journal Citation Reports of the ISI, Journal of the American Society for Information Science and Technology 61 (2) (2010) 352–369.

[14] L. Czarnecki, M.P. Kazmierkowski, A. Rogalski, Doing Hirsch proud; shaping H-index in engineering sciences, Bulletin of the Polish Academy of Sciences, Technical Sciences 61 (1) (2013) 5–21.

[15] T. Bartol, G. Budimir, D. Dekleva-Smrekar, M. Pusnik, P. Juznic, Assessment of research fields in Scopus and Web of Science in the view of national research evaluation in Slovenia, Scientometrics 98 (2) (2014) 1491–1504.

[16] J.C.F. de Winter, A.A. Zadpoor, D. Dodou, The expansion of Google Scholar versus Web of Science: a longitudinal study, Scientometrics 98 (2) (2014) 1547–1565.

[17] G.A. Forgionne, R. Kohli, A multiple criteria assessment of decision technology system journal quality, Information & Management 38 (7) (2001) 421–435.

[18] R.G. Raj, A.N. Zainab, Relative measure index: a metric to measure the quality of journals, Scientometrics 93 (2) (2012) 305–317.

[19] J.A. Garcia, R. Rodriguez-Sanchez, J. Fdez-Valdivia, J. Martinez-Baena, On first quartile journals which are not of highest impact, Scientometrics 90 (3) (2012) 925–943.

[20] T. Koler-Povh, P. Juznic, G. Turk, Impact of open access on citation of scholarly publications in the field of civil engineering, Scientometrics 98 (2) (2014) 1033–1045.

[21] I. Cañas-Guerrero, F.R. Mazarrón, A. Pou-Merina, C. Calleja-Perucho, M.F. Suárez-Tejero, Analysis of research activity in the field "Engineering, Civil" through bibliometric methods, Engineering Structures 56 (2013) 2273–2286.

[22] N.K. Paliulis, E. Dagienė, Features, possibilities and problems of academic e-publishing in Lithuania, Business: Theory and Practice 10 (2) (2009) 159–171 (in Lithuanian).

[23] A. Striogienė, Research journals of Vilnius Gediminas Technical University in 1995–2010, Evolution of Science and Technology 3 (2) (2011) 179–190 (in Lithuanian).

[24] E.K. Zavadskas, Z. Turskis, J. Antucheviciene, A. Zakarevicius, Optimization of weighted aggregated sum product assessment, Electronics and Electrical Engineering–Elektronika ir Elektrotechnika 6 (122) (2012) 3–6.

[25] E.K. Zavadskas, J. Antucheviciene, J. Saparauskas, Z. Turskis, MCDM methods WASPAS and MULTIMOORA: verification of robustness of methods when assessing alternative solutions, Economic Computation and Economic Cybernetics Studies and Research 47 (2) (2013) 5–20.

[26] T. Dėjus, J. Antuchevičienė, Assessment of health and safety solutions at a construction site, Journal of Civil Engineering and Management 19 (5) (2013) 728–737.

[27] M. Staniūnas, M. Medineckienė, E.K. Zavadskas, D. Kalibatas, To modernize or not: ecological–economical assessment of multi-dwelling houses modernization, Archives of Civil and Mechanical Engineering 13 (1) (2013) 88–98.

[28] E. Šiožinytė, J. Antuchevičienė, Solving the problems of daylighting and tradition continuity in a reconstructed vernacular building, Journal of Civil Engineering and Management 19 (6) (2013) 873–882.

[29] S. Hashemkhani Zolfani, M.H. Aghdaie, A. Derakhti, E.K. Zavadskas, M.H. Morshed Varzandeh, Decision making on business issues with foresight perspective; an application of new hybrid MCDM model in shopping mall locating, Expert Systems with Applications 40 (17) (2013) 7111–7121.