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Are Some Citations Better than Others? Measuring the Quality of Citations in Assessing Research Performance in Business and Management

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Abstract— The quality of the journals of the received citations of a set of publications for evaluating the research performance in the case of individual researchers, research groups and academic departments is investigated. An adaptive model incorporating and examining variables, such as the journal quality rankings of the journals of the citing articles within a set of publications is considered. This hybrid bibliometric methodology, as an alternative methodology to citations counts, examines the quality of the journals of the citing articles that they have been published in and evaluates the quality of the received citations (citing articles) in the set of publications. The considered Journal Quality Citing index is used in combination with predetermined evaluation weight parameters in order to produce an efficient research quality evaluation methodology. The new academic research quality methodology has been tested in three leading UK business schools in the fields of business, economics, management, OR and management science. The obtained numerical results indicate that the new research assessment methodology can be also used in large scale academic research quality cases. The proposed Journal Quality citing methodology can be considered as a research performance evaluation approach by using efficient journal quality ranking indicators based on weighted parameters.

Index Terms— bibliometric indicators, hybrid bibliometric methodologies, journal quality citing index, journal quality ranking, research quality evaluation, quantitative methods.

I. INTRODUCTION

Research quality evaluation and decisions about allocating resources for science are mainly based on experts reviewing of research work. There are several approaches to research evaluation by using the scientific tool of quantitative analysis and bibliometrics (sometimes called scientometrics) for evaluating the impact and influence of research, as well as the monitoring and analysing the structure and growth of scientific knowledge. The publication and citation data of Thomson Reuters formed the main basis of bibliometric analyses of various bibliographic groups worldwide (ISI Garfield, 1955-1961). A thorough examination of the evolution of bibliometric indicators reveals the fact that most of the classic apparatus dates back to the 1970's (CHI Research [50]; SPRU, Science Policy Research Unit [58]; ISSRU, Information Science and Scientometrics Research Unit [2]).

During the last decade various advanced bibliometric indicators have been used for measuring the productivity and impact of research at several academic levels, such as at the level of individual researchers, research groups and university departments [30, 41, 43, 69, 72]. In this research work, we introduce a new research quality evaluation methodology that examines the number of citations of a publication as well as its source of publication. More specifically, this new methodology evaluates a publication by taking into account the following variables: (i) the total number of publications (productivity), (ii) the number of citations a paper has received (impact) and (iii) the quality of the journal that the citing article has been published in (citing quality factor). Traditionally, citation based metrics have only considered the number of citation a paper has received and not the quality of the citations. In this article we will investigate how one might take into account the quality of the citations and what might be the possible effects.

One basic assumption of bibliometric analysis is that scientists with important and original material endeavour to publish their results vigorously in the open international journal literature. Although journal articles differ widely in importance, it has been noticed that authors in most cases seek to publish in the better and, if possible, the best journals [25, 70]. As proposed by Garfield [22] “The number of times all the material in a given journal has been



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cited is an equally objective and enlightening measure of the quality of the journal as a medium for communicating research results" [22, p. 24]. Therefore one should consider whether citations from top journals are worth more than from citations from lower quality journals. Developing from this point, our secondary research question is "How can we measure the quality of journals and rank them accordingly?" In this research work we investigate the use of the citing documents and their sources (journals) as a mean of scientific quality, impact, utility or merit.

We consider the following two basic questions, "How can we measure the quality of a journal?" and "In what way can we incorporate the quality of the citation?" In this article we answer the first question by considering a class of well-known journal quality indicators. We test their efficiency at measuring the quality of a journal and determine how well the different journal quality indicators correlate with each other in order to decide which is the most suitable for our research study. In the second stage, we answer the second question by proposing an innovative bibliometric methodology. This methodology is based on weighted parameters affected by the journal quality rankings of the corresponding citing journals for the evaluation of each given citation, producing weighted citations. The significant idea of the 'influence weight', a recursive form of the impact factor, was introduced in the middle 70's [54]. This iterative process has been applied to hyperlinks within a random walk model by Brin and Page [11] and then applied to bibliometrics (journals) in the period 2000-2010 [9, 53] with explicit implementation of Pagerank algorithm to bibliometrics [6, 15].

Even though the weighted citations concept is not entirely new, in the following text we present certain similarities and differences that the proposed methodology has with other similar approaches, such as the Pagerank, Eigen factor and SJR [SCImago Journal Rank] [27] algorithmic mechanisms and other related applications. Given that citations come from journals, so far all citations have been treated equally regardless of whether the citations have been received by papers that have been published in high quality journals or low quality journals. This practice does not consider that citations from top journals should, perhaps, count for more than citations from average/poor quality journals. At this point we need to consider the following primary research question "In research quality performance evaluation, should we consider and treat all citations equally?" The purpose of our research study is to consider the eventuality that all citations are not equal and that they differ in some way. The Pagerank algorithm [11] is used by Google online search engine to assign weights in web pages depending on how heavily they have been used in order to measure their relative importance within a set i.e. the World Wide Web (www). A web page that has received many inbound links from other web pages in the given set receives a high Pagerank and is considered of significant importance. The Pagerank algorithmic procedure however, does not rank highly solely the number of inbound links. According to Page and Brin [52], an incoming link from an important web page (i.e. www.yahoo.com) bares significantly more weight and is allocated with a higher Pagerank, higher than many inbound links of obscure web pages altogether. The higher the Pagerank of an inbound link, the more the weight it allocates to the recipient web page. Pagerank has been characterized as "an attempt to see how good an approximation to importance can be obtained just from the link structure" [52, p.3]. The same principles apply in the case of the Eigen factor index; received citations from highly ranked journals carry more weight than received citations from average/lower ranked journals. In the case of Eigenfactor algorithm, the journals are ranked according to the number of their citations; the more the citations of a journal, the higher the rank of the journal and the higher the weight it is allocated with. The Eigefactor index is considered to be a journal ranking measure that examines only quantitative bibliometric elements i.e. the total number of citations.

The concept of the Page rank algorithm can be adapted to any set of reciprocal interactive entities, in our case a set of publications where the inbound links can be identified as the received citations a paper receives (*citing* articles) and the outbound links can be identified as the referenced papers (*cited* articles). The methodology presented in this paper proposes a quantitative method (citation count) that incorporates the journal quality rankings of the journals of the citing papers using weighted parameters in a hybrid methodology, based on existing and novel research performance quality assessments. The term hybrid here denotes the combined use of advanced bibliometric methods and journal quality rankings. In this chapter we introduce our novel methodology for research quality performance evaluation. Characteristic model problems and numerical results are also given.



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II. CITATION METHODOLOGIES AND JOURNAL RANKING INDICATORS

The industrialization process in the production of indicators started in 1980's with the increase of bibliometric teams and the appearance of ISI sources. The practical measure of publications is the share of the citation index (CI)-covered publications in the total research output. The CI refers to the following citation indices: Science Citation Index, Social Science Citation Index, Arts and Humanities Citation Index and the specialty citation indexes (such as CompMath, Biotechnology, Neuroscience, Material Science, Biochemistry and Biophysics) published by the Institute for Scientific Information (ISI/Thomson Scientific). The citation analysis has been efficiently used by several academic and research institutions mainly for research policy making, visualization of scholarly networks, monitoring scientific developments, promotions, tenure, salary raise and grants decisions, etc. Several bibliometric indicators that have been used by various online citation databanks as complementary quality performance measures in the process of ranking scientific journals have been presented. The citation information can be used for academic research journal ranking by following several citation methodologies, such as (i) the direct citation data [17], (ii) the citations indicators for journal ranking [74], (iii) a combination of peer review and citation studies [33].

New methodologies for the evaluation of research quality performance are mainly focused on the efficient use of advanced bibliometric indicators and scientometric information (data), efficient adapted peer reviewing methods and certain hybrid methodologies for identifying excellent researchers of all types [51]. Furthermore, new classes of hybrid methodologies incorporating both qualitative and quantitative advantageous elements are being developed. More specifically, certain quantitative elements are present in the class of qualitative methods, while qualitative elements appear also in the quantitative methods. The derivation of new and extended (modified) methodologies for measuring the research output quality of an individual researcher and/or a research unit in science and social sciences is a challenging research topic currently under investigation. Several bibliometric studies have focused more on the citation impact of a journal rather than that of the published research paper [51].

Various recent studies have focused on new methods of assessing scholarly influence based on journal ranking indicators. For example, a recent study examined the use of the Hirsch-type indices for the evaluation of the scholarly influence of Information Systems (IS) researchers [67]. Another study assessed the impact of a set of IS journals, publications and researchers using a weighted citations count on authors and institutions where a publication with less authors receives more weight than a publication with more authors [36]. The presentation of a method, using advanced statistical methods, is based on cumulative n^{th} citation distributions on a publications ranking classification scheme has also been considered [19]. Additionally, a study on the complementary Hirsch type index, the h_m , for the comparison of journals within the same subject field [49] has also been presented.

Several journal quality ranking indicators have been presented and are used to quantitatively measure the quality/impact of scientific and scholarly journals. In the following, a general class of selected classic and hybrid journal quality ranking indicators and measures are presented, examining certain characteristics, such as the methodological approach, applications and limitations. The *journal impact factor (IF)*, published by ISI/Thomson Reuters, is a well-known indicator for ranking scientific journals [21] and calculates the average number of citations for published papers in academic journals over a two year evaluation period. In a review of journal impact measures in the area of bibliometrics published in the *Scientometrics* journal, the journal impact factor has been proposed to be "*comprehensible*", "*stable*", "*robust*" and "*fast available*" [26]. Well known online databases, such as Web of Science (WoS) use this indicator for ranking research journals. The *journal impact factor 5 years (IF5)*, is a variation of this indicator for a five year evaluation period. The journal impact factor is considered to be an important scientometric indicator, most widely used for journal and academic research and evaluation within the scientific community [48, 67]. One of the criticisms of the journal impact factor is that the citations bear the same weight and the sources of citations are ignored [6, 7]. Also, there is no adjustment for differences between journals and subject fields [7, 64, 71]. However when journals are classified within subject fields, for example following WoS's JCR subject classification, the different variations of journal impact factors (1, 5 or 15 year impact factors) do not differ significantly [23]. Impact factors have been noticed to increase over time. For example, in 1969 only 7 journals had IF's ≥ 10 whereas in 2006, 109 journals had IF's ≥ 10 , and it was found that for the time period 1994-2005 the average IF of all journals indexed in SCI and SSCI have increased by approximately 2.6% per year [3, 21]. One of the main reasons for that was found to be the increasing number of citing and cited articles. However in a recent study it was found that the inflation in the scientific literature in combination with the



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differences in different subject mixes and growth rate of individual subject areas, have very little influence on the inflation of the IF or on cross-field differences in the IF [3]. The issue concerning the field normalization process led to a large number of related publications in recent years.

The *Eigenfactor indicator (EI)*, like the journal impact factor 5 years, measures the number of times that papers published in a given year provide citations to articles published during the time period of five years ago and is considered to be a measure of the journal's influence within the scientific community [7]. The Eigenfactor is considered more robust than the journal impact factor [9], although both indicators are highly correlated [14]. It has been also proposed that the Eigenfactor is strongly correlated with the total number of citations received by a journal [14, 20]. The Eigenfactor algorithmic approach is considered to be a direct estimation of how much a journal is to be used (www.eigenfactor.org, 2013). The Eigenfactor algorithm can be applied to cross-citation data at the level of journals, academic departments, researchers and publications. In the case of journal ranking, the Eigenfactor algorithm is calculated using the citation data provided by the WoS JCR indexed journals. Using the WoS JCR citation data, the Eigenfactor algorithm extracts a 5-year cross citation matrix M , where $M_{A, B} =$ Citations from journal A in the year Y to articles published in journal B during the time period (Y-5) - (Y-1), (www.eigenfactor.org, 2013). Matrix M is normalized and after a series of computational procedures, the Eigenfactor Score is defined (www.eigenfactor.org, 2013). Citations from a publication of a given journal to another publication of the same journal are excluded so that Eigenfactor Score is not influenced by journal self-citation (www.webofknowledge.com, 2013). Note that the eigenfactor score allows the use of the so-called Article Influence Score (AIS) [7, 73].

The Eigenfactor index ranks journals in a similar way as the Pagerank algorithm used by the Google internet search engine. The Pagerank algorithm takes into consideration the number of hyperlinks a web page receives as well as their source [7, 11]. The Eigenfactor algorithm is also based on the principle that scholarly communication is based on a formed network amongst journals, publications, citing and cited articles. This network can be used to assess the significance of citations from its various sources [6, 56]. The journal ranking procedure of Eigenfactor depends on the number of citations received; citations from highly ranked journals carry more weight in comparison to the citations received from lower ranked journals. The Eigenfactor algorithm ranks journals based on the number of citations (productivity) the journals have received and/or given. For example, in the case of a journal with very high numbers of citations, the journal is allocated with a significant weight and the Eigenfactor score of the journal increases considerably. According to Eigenfactor algorithm, journals with large volume of citing and cited articles are more highly ranked and carry more weight, in comparison to journals with lower numbers of citing and cited articles. It has been proposed that the Eigenfactor score is directly proportional affected by the size of a journal, even in the case that the quality of its articles remains constant. For example, if a given journal increases its publications three times more while the quality of its articles remains constant, it is expected that the Eigenfactor score will triple [7]. So the Eigenfactor index is considered a measure for journal ranking that is directly influenced by the size of a journal as it increases or decreases. The journal self-citation, the SCImago Journal Rank (SJR) [27, 48] and the Source Normalised Impact per Paper (SNIP) [45] with special attention to size dependence problems are also topics of interest.

The *Immediacy index (II)* is another journal ranking indicator published by ISI/Thomson Reuters. It is used for comparing the relevant importance of journals and measures how fast the average cited publication is cited in a given journal [23, 26]. The immediacy index can be calculated by dividing the total number of citations to the number of journal articles published in a given year by the total number of articles published during that year (<http://webofknowledge.com>, 2012). The immediacy index is an average of publications and does not discriminate between journal size (large or small); however, the frequency of the publication or speed of indexing plays a significant role in the determination of the index. For example, if an article is published early in the year, it has more time to receive a higher number of citations. It has been proposed that journals which do not publish frequently, or publish later in the year, have lower immediacy indices. The journal impact factor and immediacy index have been found to be highly correlated in both sciences and social sciences, with emphasis on rapidly developing disciplines [77]. The immediacy index can be connected with citation windows (IF5 & IF2) referring to general models of citation cycles and related obsolescence.



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The *Hirsch index (h-index)*, defined by Hirsch [30], is an efficient bibliometric indicator combining two important aspects of a researcher's scientific output, i.e. productivity (number of different published papers) and impact (number of citations per paper). The h-index can be used for the evaluation of research journals and can be considered to be a single measure of the visibility of whole groups of articles. The h-index is easily computable and can be efficiently applied to the ranking of journals [10, 63]. The h-index is a favourable alternative to the journal impact factor of the institute for scientific information (ISI) and is now part of ISI citation reports in WoS, as well as in the Elsevier's Scopus author search features [4]. It has been reported that the h-index however ignores the number of citations to each individual paper above and beyond what is needed to achieve a certain h-index.

An alternative bibliometric indicator for evaluating collections of publications is the so-called *Citations per Paper (CPP)*. The number of citations per paper can be calculated by dividing the total number of citations for a certain time period by the number of articles. The citations per paper indicator aims to weigh impact (citations) in relation to output, under the premise that more papers are likely to produce more citations. It has been reported that in some cases the difference between interdisciplinary scientific areas, in terms of average citation counts, can be as much as 10:1. In that case, comparing research outputs of the same scientific area is considered fundamental for the efficient use of citation analysis and does not discriminate between differences in subject. As with the journal impact factor, cpp index treats all citations the same, regardless of the quality of the journal they have been published.

Various journal ranking lists have been presented. The *Association of Business Schools (ABS) academic journal quality guide* [1] is one of the most widely used for journal quality ranking [61]. It provides journal rankings for 823 journals in the wider area of business and management. The compilation of the journals and their ratings are based on both qualitative and quantitative methodologies. For example, peer surveys conducted based on the assessments of experts in the field, results of previous Research Assessment Exercise (RAE) [57] submissions, citation statistics and mean citation impact scores. During the compilation and ranking procedure of the ABS guide it was decided by the editors that the great majority of journals without a journal impact factor would be ranked as grade two or lower, whereas all the higher rated journals (grade three and above) should have a journal impact factor [1]. The results of the ABS academic journal quality ranking guide were published in 2010 [1]. The ABS journal quality ranking has been downloaded 90,000 times from the ABS website (<http://www.associationofbusinessschools.org>, 2012) during 2010 from approximately 100 countries [61]. The ABS journal ranking list has become a standard journal ranking guide by the UK HEI's to inform members of academic staff for the efficient selection of quality journals for the submission of their research work.

Several research studies measuring the perceived quality of journals have been also presented. The use of citation analysis for the evaluation of the most influential management journals in the area of management has been presented by Tahai and Meyer [65]. The authors analyse 17 management academic journals and their related bibliometric information, i.e. number of publications and citations, as found in the SCI for the time period 1992-1993, focusing on cited references occurring within a time framework of the last four years since their publications. The proposed quantitative model is used in order to trace the number of the received citations and which journals have cited the examined scientific research work. It was found that a publication can receive approximately 30% of its citations in top management journals within the time period of four years since its publication and more than 50% within seven years. The obtained journal ranking information can be used by academic members of staff for the efficient selection of journals for research submissions, for promotion and tenure within academic departments.

The evaluation of the relative quality of 30 academic journals in the area of International Business (IB) for the time period 1995-1997 has been presented by DuBois and Reeb [18]. The main objective of this study is to present an objective analysis of journal quality for promotion and tenure procedures and to inform the academic society about the International Business publication outlets [32]. The authors use two main approaches for journal quality evaluation; citation analysis and surveys, using a set of five core IB journals, which primarily publish cross functional research work and 25 IB journals selected by the authors. The citation analysis included measurements of bibliometric indicators such as, the number of total citations, citations per publications and the impact factor of the selected 30 journals. It was found that there was a strong correlation between the measures of journal quality presented in this study. The journals that were highly ranked showed high correlation between the qualitative and



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quantitative evaluations of journal quality. The authors also concluded that there is a relation between the circulation of the journals and their availability and citation and their perception ratings [18].

Two approaches for measuring the quality of 29 academic journals in the fields of economics and finance for the time period 1991-1992 have been presented by McNulty and Boekeloo [38]. The first approach focuses on citation counts for the investigated journals and the second approach uses the average age of the received citations. The average age of the citation can be calculated as the difference between the year a publication has been cited and the year it has been published, and measures how likely is a journal to publish papers that become “classics” in a given subject area. A comparison between the two journal qualities measures showed that the proposed methodology can be efficiently used in interdisciplinary academic fields in order to discover journal that have the potential to publish papers that in due course will become “classics” [38].

In a recent research study [12], the quality evaluation of 110 academic journals in the field of Statistics & Probability using the ISI subject category classification has been presented. Chang and McAleer [12] propose four distinct classes for the classification of 15 “*quantifiable research assessment measurements*” (RAMs) for journal quality assessment. The four proposed classes of the so-called RAMs are the following:

- (i) Class 1: journal quality measures such as the 2 year journal impact factor (IF₂) and several of its variations, mean citations and non-citations.
- (ii) Class 2: indices reflecting journal policy such as, the Impact Factor Inflation (IFI), Historical Self-citation Threshold Approval Rating (H-STAR), etc.
- (iii) Class 3: journal quality indicators reflecting the number of high quality publications such as the Hirsch index (h-index).
- (iv) Class 4: journal quality indicators reflecting the influence and article influence of a journal such as, the Eigenfactor Index (EI), the Article Influence Index (AII) and the Cited Article Influence (CAI).

The authors also include calculations of the harmonic averages of the journal rankings, as an alternative journal quality measure, by allocating equal weights for all the proposed classes. It was shown that the harmonic average of the ranks can be considered as a robust ranking methodology and that the sole use of the 2 year journal impact factor could lead to distorted journal quality assessments when compared to the harmonic average of the journal rankings of the proposed four classes [12].

The evaluation of the 40 top cited journals in the fields of business, economics, finance and management for the time period 2008-2009 using the so-called “*research assessment measurements*” (RAMs) has been also presented [13]. A series of journal ranking indicators i.e. the journal impact factor and its variations, the immediacy index, the eigenfactor score, the h-index, etc, have been used for the evaluation of research in the most highly cited economics journals extracting related bibliometric data from the ISI online citation database Web of Science. The harmonic average of the rankings of the journal ranking indicator of the selected journals was also presented. It was observed that the journal impact factor should be used in combination with the proposed RAM criteria for an efficient quality journal ranking assessment in the fields of business, economics, finance and management ISI subject categories. Furthermore, various quantitative studies proposing the use linear programming for determining and assigning weights within a set of journals in a given field have been presented for journal quality ranking [16, 31, 44, 62, 68].

A class of journal ranking indicators on a large data set of journals in the wider area of business and management has been considered in our research study including the following: the journal impact factor, the journal impact factor 5 years, the Immediacy index, the Eigenfactor indicator, the Hirsch index, the Citations per Paper (CPP) and the Association of Business Schools (ABS) academic journal quality rankings. A series of statistical analyses using SPSS software to investigate which the most efficient journal is ranking indicator for the application of our proposed new methodology for research quality evaluation based on journal ranking indicators is also presented.

In this article we propose a new methodology for research quality evaluation based on journal ranking indicators that assess the quality of the journals of the received citations of a publication. In the first stage of our research study we consider a class of well-known journal ranking indicators for the measurement of journal quality. We test how efficiently they measure the quality of journals using a large data set of over 1,000 journals. We investigate the similarities and differences, how they relate with each other, compare the results and discover which journal ranking indicator is more suitable for the application of our proposed methodology



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III. DATA COLLECTION AND JOURNAL RANKING METHODOLOGY

In the previous section (literature review), various journal quality measures have been presented. In our proposed methodology presented in this paper, we introduce weighted parameters affected by the journal quality for the evaluation of each given citation in a set of publications. In order to determine which journal quality measure is more efficient to be used as a weighted parameter for the application of our methodology, we consider a class of well known journal quality ranking measures presented in the literature review, which is tested and assessed for their efficiency and effectiveness on a large dataset of journals, in the wider area of business and management. A series of statistical analyses using SPSS software to investigate the most efficient journal ranking indicator for the application of our proposed new methodology for research quality evaluation based on journal ranking indicators is performed.

The considered data collection includes a total of 1,151 journals in the wider area of business and management. The selected 1,151 journals consist of all the journals included in both the ABS Journal Quality Guide 2010 and the Harzing Journal Quality List 2011 [28]. For each journal in our data set we have collected the numerical values of eight well known journal ranking indicators. The eight journal ranking indicators were: the total number of citations (TC), the citations per publications index (CPP), the 2 year journal impact factor (IF2), the 5 year journal impact factor (IF5), the immediacy index (II), the eigenfactor score (ES), the h-index and the ratings of the ABS journal ranking quality guide (ABS). All the journal ranking indicators, except the ABS journal quality ratings, are calculated and published by ISI/Thomson Reuters and can be found in the Journal Citations Reports (JCR) section of the online citation database Web of Science (WoS). For each journal, we recorded the corresponding numerical values of the eight journal ranking indicators available by WoS.

The WoS online citation database has been used for the numerical values of the journal ranking indicators and the selected time period of data collection of the TC, CPP and h-index was 2000-2010. The selected starting year of the data collection for the IF, IF5, II, ES was 2010. For the data collection of the ABS journal quality rankings of the journals in our dataset we used the Association of Business Schools journal quality guide, 2010, version 4 [1].

The obtained numerical results of the correlations between the journal ranking indicators are presented in Table 1. All eight journal ranking indicators show positive correlations and in some cases, high positive correlations. This means that they are highly related in terms of their performance in assessing the scientific research output of our data set of journals. Particularly strong positive correlation is shown between certain journal ranking indicators such as, between the Impact Factor 2 years and the Impact Factor 5 years (0.907); CPP and Impact Factor 5 years (0.872); Total Cites and h-index (0.861).

Table 1: Correlations between 8 Journal Ranking indicators for measuring the quality of 744 business and management journals (SPSS v.19 software)

Correlations	Total Citations (TC)	H-index	Citations Per Publication (CPP)	Impact Factor 2 years (IF2)	Impact Factor 5 years (IF5)	Immediacy Index (II)	Eigenfactor Score (ES)	ABS Quality Rankings (ABS)
Total Cites (TC)								
Pearson Correlation	1	.861**	.568**	.494**	.533**	.270**	.843**	.222**
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000
N	744	744	744	744	744	744	744	744
H-index								
Pearson Correlation	.861**	1	.776**	.681**	.766**	.374**	.779**	.341**
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000
N	744	744	744	744	744	744	744	744
Citation Per Publication (CPP)								
Pearson Correlation	.568**	.776**	1	.818**	.872**	.470**	.526**	.301**
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000
N	744	744	744	744	744	744	744	744



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Impact Factor years (IF2)	Pearson Correlation 2Sig. (2-tailed) N	.494** .000 744	.681** .000 744	.818** .000 744	1 .000 744	.907** .000 744	.574** .000 744	.466** .000 744	.284** .000 744
Impact Factor years (IF5)	Pearson Correlation 5Sig. (2-tailed) N	.533** .000 744	.766** .000 744	.872** .000 744	.907** .000 744	1 .000 744	.527** .000 744	.490** .000 744	.325** .000 744
Immediacy Index (II)	Pearson Correlation Sig. (2-tailed) N	.270** .000 744	.374** .000 744	.470** .000 744	.574** .000 744	.527** .000 744	1 .000 744	.231** .000 744	.135** .000 744
Eigenfactor Score (ES)	Pearson Correlation Sig. (2-tailed) N	.843** .000 744	.779** .000 744	.526** .000 744	.466** .000 744	.490** .000 744	.231** .000 744	1 .000 744	.300** .000 744
ABS Quality Rankings (ABS)	Pearson Correlation Sig. (2-tailed) N	.222** .000 744	.341** .000 744	.301** .000 744	.284** .000 744	.325** .000 744	.135** .000 744	.300** .000 744	1 .000 744

(**) Correlation is significant at the 0.01 level (2-tailed).

The very strong correlation between Impact Factor 2 years and Impact Factor 5 years can be explained by the fact that the two journal ranking indicators, although different, are calculated in a very similar way. The main difference is the time period used for their calculation; the Impact Factor 2 years uses the citations and publications of a journal for a two year time scale, whereas the Impact Factor 5 is calculated in the same way but for a five year time scale. The next step is to look at the content of the journal ranking indicators and try to identify common themes. In Graph 2 we can see the journal ranking indicators in rotated space and the clusters they form in terms of how they relate to each other. We can also observe two formed clusters. Let us call *Cluster A* the cluster that contains the Total Citations, the h-index and Eigenfactor Score and *Cluster B* the cluster that contains the citation per publication index, the immediacy index, the journal impact factor for 2 years and journal impact factor for 5 years. In Graph 2 we can see that the ABS journal quality ranking index is located in some distance from both formed *Clusters A* and *B* standing out between both clusters.

At this stage we are interested to select an indicator that most efficiently reflects the quality a journal. Cluster A includes indicators, such as the Total Citations, the h-index and Eigenfactor score which depend on the number of published papers. Cluster B includes indicators, such as the citation per publication index, the immediacy index, the journal impact factor for 2 years and journal impact factor for 5 years which have already incorporated the number of papers published by a journal in their calculations, therefore they cannot be affected by any fluctuations of the quantity of publications. The indicators of Cluster B are ratios of citations over publications. These journal ranking indicators have already incorporated the number of the published papers of a journal in their algorithm. That means that they can measure the quality of a journal without being directly affected by the size of a journal. For the efficient selection of the journal ranking indicator of our proposed research quality evaluation methodology based on journal indicators we should take into account the data which will be used for the application of our methodology. We will test our proposed methodology in a large dataset comprised of the research output of three UK leading business schools which primarily conduct research within social sciences. It has been proposed that in natural and life sciences the maturity period in terms of number of citations is the 3rd or 4th year, while in the social sciences it is the 5th or 6th year [39, 69]. If we examine the time periods that the journal ranking indicators take into account, we can see that the immediacy index evaluates the quality of a journal on an annual basis, the Impact Factor 2 years examines a two year time period, the Impact Factor 5 years examines a five year time period and the



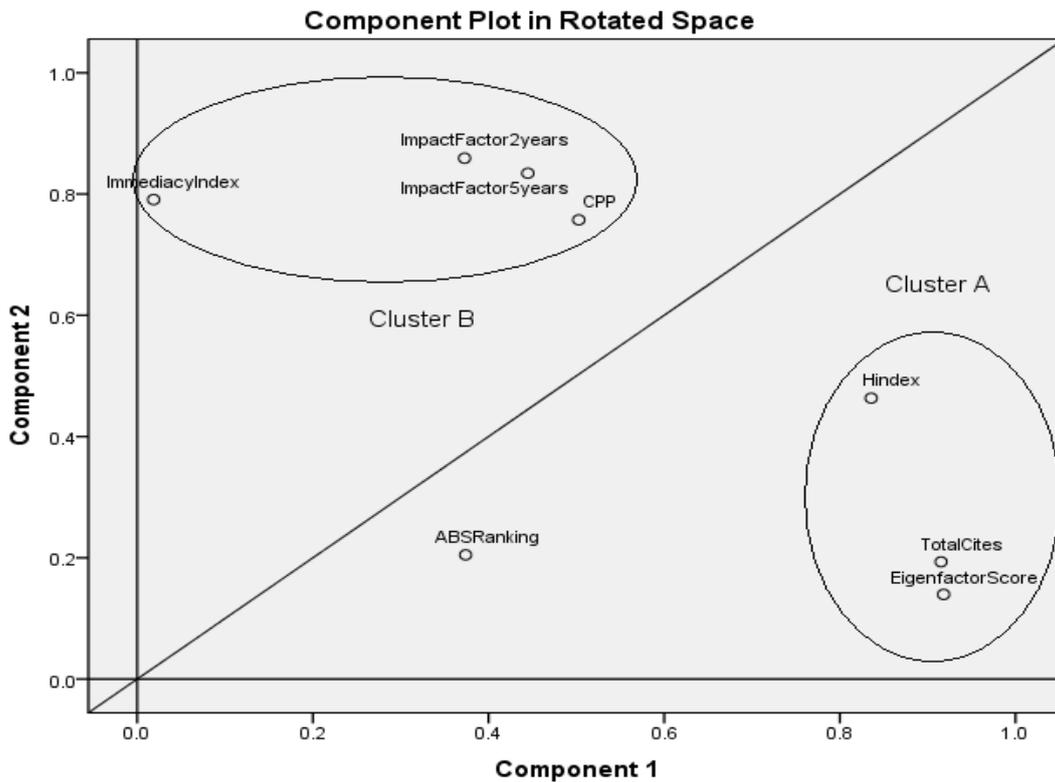
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Citation Per Publication index examines a ten year period. The impact factor 5 year is an indicator that can reflect the maturity period of the academic research output of business schools, which publish mainly in the social sciences, more efficiently than the other indicators of cluster B. For the above reasons it was decided that in this study we will proceed with the application of the Impact Factor 5 years (IF5) as our proposed weighted parameter of our quantitative approach for the research quality performance evaluation. In the next part of our research study, we will propose a generalized version of a new research evaluation methodology using weighted parameters based on research journal quality ranking indicators. Our proposed journal ranking indicator will be the *journal impact factor 5 years*, based on the results of our statistical analysis as presented in this section.



Graph 2: The component plot of the 8 journal ranking indicators in rotated space (SPSS v.19 software)

IV. THE JOURNAL QUALITY CITING METHODOLOGY

In the framework of our new approach to research quality performance evaluation of a research group or academic departments, we propose the following bibliometric methodology using weighted parameters based on research journal quality ranking indicators. The Journal Quality Citing (JQC) index calculates the weighted citations of a publication, incorporating in its algorithm the quality of the journals of the citing articles. The Journal Quality Citing approach is an alternative research quality evaluation methodology to citation counts. The JQC index suggests the use of a weighted parameter that will act as a quality evaluation parameter of the journal of the citing article of a publication. The generalized theoretical framework of our research evaluation approach, which uses weighted parameters based on research journal quality ranking indicators, is presented in the following text.

Following this quantitative approach, we evaluate each received citation of a set of publications. We note that the sum of the citations will be affected by the corresponding research journal's quality weight ϵ_j , in such a way we can obtain the Journal Quality Citing (JQC) index that can be defined as follows:

$$JQC \text{ index} = \sum_{i=1}^{\max NCD} \left(\sum_{j=1}^{\max NCG} \epsilon_j \cdot c_{i,j} \right), j=1,2,\dots, \max NCG \text{ and } i=1,2,\dots, \max NCD \quad (1)$$



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Table 3. Definition of the Journal Quality Citing index (numbers of cited and citing papers and their upper bounds).

i	Number of <i>cited</i> papers (Examined research output)
J	Number of <i>citing</i> papers (Received citations)
maxNCD	Number of total <i>cited</i> papers (Total examined research output)
maxNCG	Number of total <i>citing</i> papers (Total number of received citations)

Note that in equation (1) the term $c_{i,j}$ corresponds to the citations received by the publication/paper- i of an individual researcher, with $i=1,2,\dots, \text{maxNCD}$, where maxNCD is the max number of papers of individual researcher. The first index i of $c_{i,j}$ denotes the number of publications i of the individual researcher, while the second index j denotes the number of citing papers j of the other researchers that have cited in their papers the above paper i of the individual researcher.

Example 1: Let us assume that an individual researcher has published a total of 100 papers. In the term $c_{i,j}$ the first index i can take the values $i=1,2,\dots,\text{maxNCD}$, with $\text{maxNCD}=100$. Let us also assume that the 10th paper of the individual researcher has received a number of 50 citations, then in the term $c_{i,j}$ the second index j can take the values $j=1,2,\dots, \text{maxNCG}$, where $\text{maxNCG}=50$. Let us assume that the value $j=12$, i.e. the 12th citation referring to the original 10th paper of the individual researcher is of special interest, then this particular paper corresponds to $c_{10,12}$.

A. JQC Methodology: The Case of the 5 year Impact Factor as weighted parameter

In this section we propose and apply a modified version of the Journal Quality Citing index which normalizes for subject field and time, based on our selected weighted parameter; the 5 year impact factor. The proposed methodology can be used as an alternative quantitative research quality evaluation approach for the assessment of the research output of academic departments to citation counts. In the following sections, we test the proposed new methodology using the research output of three leading UK business schools.

The purpose of the JQC indicator is to investigate the citations a paper has received and evaluate these by allocating to each citation a different weight, according to the journal quality ranking of the journal they have been published in. So far, the traditional citation is a metric that reflects the impact of a paper, by counting how many times the given paper has been used in another researcher’s work. The JQC indicator weighs citations according to the impact of the journal they have been published in. Its aim is to evaluate the number of publications (productivity), the number of the citations a publication has received (impact) and the received citations by assessing the impact of the journal of the citing articles the so-called *citing quality factor* [34, 41].

In the following we propose a modification to the JQC index presented in equation (1) that uses the 5 year journal impact factor as a weighted parameter. Additionally, we explain why these modifications are necessary for the 5 year Impact Factor as the weighted parameter ϵ_j . The proposed modified Journal Quality Citing index is the following:

$$\text{JQC index} = \sum_{i=1}^{\text{max NCD}} \left(\sum_{j=1}^{\text{max NCG}} \epsilon_{\text{IF}5j} \cdot c_{i,j} / \text{Field Mean } \epsilon_{\text{IF}5i} \right), \quad (2)$$

where $j=1,2,\dots, \text{maxNCG}$ and $i=1,2,\dots,\text{maxNCD}$, with

$\epsilon_{\text{IF}5}$ is the numerical value of IF5 of the journal (as found in WoS- JCR) and Field Mean IF5 is the Mean number of the IF5 of all the journals within a WoS subject field.

The proposed JQC index presented in equation (2) includes two major modifications compared to the general theoretical approach presented in the previous section; the 5 year journal impact factor as our selected weighted parameter ϵ and the variable Field Mean $\epsilon_{\text{IF}5,i}$. The first modification is that we have substituted the weighted parameter ϵ with the 5 year journal impact factor. The 5 year journal impact factor acts as a journal quality ranking evaluation parameter of the journal of each citing article. The second modification Field Mean $\epsilon_{\text{IF}5,i}$ is the mean numerical value of the 5 year impact factor of a journal in a given WoS field. It can be calculated by the sum of the 5 year journal impact factors of all available journals divided by the number of all journals with a 5 year impact factor. It should be noted that not all journals are provided with a 5 year journal impact factor by WoS. In our calculations of the Field Mean $\epsilon_{\text{IF}5,i}$ we have divided by the number of journals that actually have a corresponding



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5 year journal impact factor. To calculate the JQC indicator the sum of the 5 year impact factors of the citing journals of a publication i is divided by the average 5 year impact factor in the given field of the publication i to obtain field normalized results

The JQC indicator gives more weight to citations of papers that have been published in high impact journals, compared to citations that have been published in low impact journals. Therefore, the JQC indicator produces weighted citations and allows us to compare these with the actual citations of the same set of publications. If the number of the weighted citations of the JQC index is smaller than the number of the actual citations of the publication, this means that the majority of the citations have been published in low impact journals. If the JQC index is larger, it means that the majority of the citations have been published in high impact journals. If we assume that high impact journals publish significant and original scientific research then the weighted citations JCR indicator reflects both the productivity and impact of a set of publications in a given field.

Example 2: Based on the information given on Example 1, let us assume that the value $j=12$, i.e. the 12th citation referring to the original 10th paper of the individual researcher is of special interest, then this particular paper corresponds to $c_{10,12}$. Let us assume that the journal in which $c_{10,12}$ has been published, is the MISQ journal. The Impact Factor 5 years (IF5) of MISQ journal equals to 9.821 (see results of numerical experimentation related to chapter 6 in attached Thesis DVD) and $\epsilon_{IF5,12} = 9.821$. MISQ is classified by WoS under the Management field, therefore the mean numerical value of the 5 year impact factor of MISQ in the Management WoS field is Field Mean $\epsilon_{IF5,12} = 2.93$ (see results of numerical experimentation related to Chapter 6 in attached Thesis DVD). In this case, the JQC index for $c_{10,12}$ will be $JQC \text{ index} = \frac{9.821}{2.93} = 3.35$. According to the JQC indicator, the one WoS citation received by $c_{10,12}$ counts as 3.35 WoS citations in the field of Management, because of the very high quality of the MISQ journal were the citation derived from.

Next, we state some clarifications concerning the Journal Quality Citing methodology and JQC indicator. The Journal Quality Citing methodology proposes a quality performance evaluation approach, using weighted parameters based on research journal quality ranking indicators. It is not confined to the use of the 5 year journal impact factor as the only weighted parameter, but can be used with any alternative efficient journal quality ranking indicator. Furthermore, in our research study we consider only one publication type; journal articles. When we refer to ‘publication(s)’ or ‘research output’, we mean journal article(s). This mainly because in this research study we investigate the use of 5 year impact factor, as a journal ranking weighted parameter, which is currently only available for journals by JCR/WoS. Certain important issues concerning the usage of WoS online citation for the numerical experimentation [29, 37, 41, 42, 69, 72] and the impact factor as a measure of quality for the evaluation of journals [47, 66] have been presented in various related publications.

V. DATA COLLECTION AND JQC METHODOLOGY

For the numerical experimentation of the Journal Quality Citing methodology and the calculation of the Journal Quality Citing indicator we have used the research output of three leading UK business schools, namely the Cambridge Judge Business School (JBS), the Liverpool Management School (LMS) and the Kent Business School (KBS) in the fields of Business, Economics, Management and O/R & Management Science. We present the data collection and methodology for our numerical experimentation of the application of the Journal Quality Citing methodology for the time period 2001-2008. For our research study we have considered only the journal articles that were available in the online citation database WoS. In the following table the research output of the three UK business schools in its various forms can be shown.

Table 4. Overview of the research output of the three UK business schools

2001-2008	JBS	LMS	KBS	TOTAL
Total Research Output (various publications types)	1,681	1,191	1,025	3,897
Total Journal Articles	679	593	473	1,745
Total Journal Articles found in WoS	341	266	314	921
Total Journal Articles found in WoS classified as BEMO/R*	240	108	158	506
Total Number of WoS Citations in BEMO/R* Journal Articles	3,683	908	1,496	6,087
Total Number of (different) Citing Journals of BEMO/R* Journal Articles	783	304	456	1,543



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*by BEMO/R, we mean the subject areas of Business, Economics, Management and O/R & Management Science.

In the framework of the application of the Journal Quality Citing methodology we considered the research output of the three business schools, which consisted of 506 journal articles in the area of BEMO/R and their 6,087 corresponding citations as found in WoS for the time period 2001-2008. Then we proceeded by allocating the available numerical value of the IF5 to the corresponding journals of the 6,087 citing publications. For the journals that did not have an IF5 numerical value in WoS, we allocated the *Field Median IF5*. The Field Median IF5 is the median value of the IF5 of all the journals in the journal list, for a given subject area (BEMO/R). Following this approach, we obtained 6,087 citing publications and the corresponding IF5 for their journals. Next, we proceeded by calculating the *Field Mean IF5* for each one of the BEMO/R subject categories. The Field Mean IF5 is used as the denominator of the Journal Quality Citing indicator and is calculated by dividing the sum of the total numerical values of all available IF5 by the total number of the journals with an available IF5, in a given subject area journal list. Note that in the case of the cited publications with more than one WoS fields, the Field Median IF5 and the Field Mean IF5 of a publication *i*, can be computed by considering the harmonic average [34]. Finally, we calculated the Journal Quality Citing indicator for the research output of the three UK business schools for the time period 2001-2008 in the fields of BEMO/R.

VI. NUMERICAL EXPERIMENTATION AND RESULTS

In this section we will present the indicative numerical experimentation and obtained results of the application of the Journal Quality Citing methodology in three leading UK business schools in the subject areas of business, economics, management and O/R & management science for the time period 2001-2008. In Tables 5 and 6 we can see the results of the calculated Field Mean IF5 for all four subject fields and publications with overlapping fields. The JCR journal lists in certain fields are currently somewhat limited. For instance, the O/R & management science area includes 75 journals (from which 63 had an IF5). The WoS subject area classification and journal coverage in the social sciences area can be considered poor, usually less than 50%, in comparison to other citation databases such as Google Scholar (GS), [42, 46] but at this point GS does not include a subject area classification. If the Field Mean IF5 and Field Median IF5 could be calculated from a larger journal subject classification environment perhaps they could produce more comprehensive and indicative results.

Table 5. Field Median IF5 for BEMO/R WoS subject fields

WoS Fields	Field Median IF5
Business	2.26
Economics	1.25
Management	2.32
O/R & Management Science	1.36

Table 6. Field Mean IF5 for BEMO/R WoS subject fields and overlapping fields

WoS Fields	Field Mean IF5
Business	2.70
Economics	1.59
Management	2.93
O/R & Management Science	1.58
Business/Economics	2.00
Business/Management	2.81
Economics/Management	2.06
Business/Economics/Management	2.24
Management/ O/R & Management Science	2.05

In Table 7 we can see a part of the obtained results by the application of the Journal Quality Citing methodology and the weighted citations of the Journal Quality Citing index. The number of publications reflects the productivity of each department in the BEMO/R fields.



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Table 7. A comparison between the actual citations and weighted citations and the cpp index and JQC (weighted) cpp index.

	Publications	WoS Citations (unweighted citations)	CPP (unweighted cpp)	JQC index (weighted citations)	JCQ CPP (weighted cpp)
2001-2008					
JBS	240	3,683	15.35	3,718	15.49
LMS	108	908	8.41	793	7.34
KBS	158	1,496	9.47	1,524	9.65

If we compare the weighted citations of the JQC index with the actual number of citations, we can see that they have a different numerical value. That happens because the JQC index has incorporated in its algorithm the journal quality ranking of the journals of the citing articles. In the case that the number of the weighted citations of a set of publications is larger than the number of actual citations that means that, overall, the set of publications has received citations that have been published in more prestigious journals in a given subject area. If the number of the weighted citations of a set of publications is smaller than the number of actual citations, it means that the set of publications has received citations that have been published in lower impact journals. The number of weighted cpp is calculated by dividing the total number of weighted citations by the number of publications. We can clearly see that the weighted cpp of JBS and KBS have increased and that LMS weighted cpp has decreased when compared with the unweighted cpp.

Our results presented in Table 7 reveal that for the considered time period 2001-2008, the weighted citations for the research output of JBS are higher than the actual number of citations. That suggests that JBS research output tends to be cited in papers that are published in better quality journals than the average publication. The same applies for KBS which has a larger number of weighted citations than the actual citations. LMS has lower weighted citations than the actual citations. LMS is the department with the least publications and citations in the area of BEMO/R while at the same time is quite active in Health Care Sciences and other related medical areas and has spend a share of its research output in subject areas that we have not included in this study. However the results show that its research output tends to be cited in average/lower impact journals.

Finally, it would be useful to compare the results of this study with the results of the 2008 UK Research Assessment Exercise (RAE). According to the 2008 RAE assessments, each university department was evaluated on a 4-point scale, where grade four is “world leading quality” and grade one “national” quality [57]. The RAE 2008 results consist of the Business and Management Studies Unit of Assessment (UoA) that includes 100 selected submissions per institution in the fields of business, economics, management, management science and any other field or subfield aligned to business and management, for the time period 2008-2001 [57]. The data we have used for the application of the JQC methodology comprise the research output in the WoS areas of BEMO/R for the time period 2001-2008. Our sample is not identical to that submitted to the RAE 2008, but it is directly comparable because it examines published research output of same subject area and time period, within a larger size of set of publications of the examined HEIs. The results showed that JBS scored 3.05, KBS scored 2.50 and LMS scored 2.45. These results agree with the results of the application of the Journal Quality Citing methodology, for the time period 2001-2008, so based on a small sample of the application of the methodology, we can say that the Journal Quality Citing index produced similar results with to the RAE peer review assessment in terms of ranking the business schools. An analysis on full dataset including the effects of corrections, weighted vs. un-weighted measures by extending the considered sample and the comparison of multistep weighting and recursive weightings will be an interesting future research work.

Table 8. A comparison between the results of RAE 2008, cpp index and weighted cpp of the Journal Quality Citation methodology 2001-2008

	RAE scores 2001-2008	CPP (unweighted cpp)	JCQ CPP (weighted cpp)
JBS	3.05	15.35	15.49
KBS	2.50	9.47	9.65
LMS	2.45	8.41	7.34



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VII. CONCLUSIONS

The purpose of the proposed methodology is to examine the quality of the received citations of a set of publications and evaluate the quality of the received citations according to the journal quality ranking of the journal they have been published in. This is a research quality performance methodology alternative to citation counts. The considered JQC index is used in combination with predetermined evaluation weight parameters in order to produce an efficient research quality evaluation methodology. The proposed academic research quality methodology has been tested in three leading UK business schools in the fields of business, economics, management and O/R & management science. The obtained numerical results have indicated that the new research quality methodology can be efficiently used in large scale academic research quality cases.

The proposed approach is a research quality performance methodology alternative to citation counts. The differences between the research outputs of the three UK business schools have been examined. We have applied the JQC indicator that has weighted the research output according to the quality of the journal they have been published in. We have used the 5 year journal impact factor in order to give more weight to the citing articles that have been published in journal with higher 5 year journal impact factors. The results for field and time have been normalized. The obtained results showed that this methodology magnifies the existing differences between the schools and discriminates better the research outputs in the given fields. Although the applicability has been demonstrate, we state that further numerical experimentation is needed in order to demonstrate the full advantages of the proposed methodology. More specifically, we need to include more data in our further numerical experimentations to examine a greater dispersion between different academic environments. Furthermore, we state that in future work we are planning to consider the use of wider, moving time periods for the more efficient application of the methodology and comparison of results.

At this stage the proposed Journal Quality Citing methodology investigates the quality of the journal of the received citations of a set of publications for the evaluation quality performance evaluation in the case of an academic department or a researcher using as a surrogate for quality/impact journal quality ranking indicators. An extensive modified model that incorporates and examines more variables such as the quality of the journals of the publications of the academic/researcher's research output, as well as publications and journals of the cited references of the publications is currently under investigation. Furthermore an extended classification that includes other publication types (such as books, conference papers, etc.) is considered.

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