The Assessment of the EPQ Parameter for Detecting H-Index Manipulation and the Analysis of Scientific Publications

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Abstract The work presents the analysis of mechanisms for determining the susceptibility of parametric indices (such as the h-index) of evaluation of scientific articles published on the modification of parameters not resulting from essential value of the research work. Currently, most methods for verifying the article is focused on the selection of works potentially strongly influence the international position of a journal. To this end, editorial offices wide use of parametric methods of assessment. In addition, the work attempts to identify the used criterion functions, namely the assessment parameters and guidance, the risks associated with using this type of method to change the popular parametric indexes for authors and journals. These parameters are divided into categories and offered their initial verification based on statistical analysis of already published articles in various journals. Each parameter has attributed weight function, which allows to define its impact on the total evaluation of an article, and also adaptation of formula to any academic journal. Weight functions will be determined with the usage of neural networks or genetic algorithms, aiming to their individual adaptation to particular journal.

1 Introduction

Relentless pursuit of scientific journals to obtain the greatest possible number of points in the created rankings enhances continuous improvement of parametric algorithms to verify the quality of the article and the assessment of its author (Philadelphia List, Impact Factor, quoting indicators etc.) [1–3].

All the time created a new methods of evaluation of journals and modifications of existing criteria result in a situation that merits evaluation of the article can be replaced by a parametric assessment forced by the publisher [4–12].

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The result is a situation that good, exploratory research publications may be assessed or unfairly withdrawn from the publications on the ground that have been poorly prepared for parametric criteria. Thus, the following aspects parameterization are to determine the influence of subjective factors in the evaluation of scientific articles in specific journals. Furthermore, there were presented series of factors which, if they are taken into consideration during writing of scientific articles, they have a chance to increase probability of obtaining positive review and in effect the acceptance of publication in renowned journals. In the further process of research works, realization of automatic information system is planned, which role will be connected with the verification of the working version of an article, before sending it to the journal and the definition of the probability of obtaining high parametric evaluation. Described parametric evaluation will determine the coefficient EPQ—Estimated Paper Quality. This co-efficiency will be helpful for scientists who concentrate mainly on essential, and less over the editorial part of their scientific article. The low value of EPQ should induce the author to analyze and supplement his publication before sending article to editorial office of the previously chosen journals.

2 Mathematical Models for Authors Evaluation

Authors of scientific articles are subject to verification by placing in the ranking reflects their contribution to the development of the field of scientific work. One of main parameters applied in relation to authors of publication is proposed in year 2005 the Hirsch index (h-index) [13]. As easily can be envisaged, such evaluation can be sensitive on manipulation on the side of several cooperating with each other authors, who mutually will quote their works (apart from their essential contribution into researches). The parametric evaluation of publication issues from the category of scientific research. Scientific researches require financing, and one of the popular sources of learning financing are exploratory grants. To obtain financing it is expected that the scientist will carry out planned investigations and their effect will have visible influence on a given exploratory field. How such influence is measured?

Most legible measures are publications and their quotations. For this reason, scientists who have a suitably high Hirsch index, are treated as trustworthy to commit to them public money on carried researches. Legible dependencies appear between the financing of research, with the quantity of publication, and with their quotations which put each other greater chance for future financial resources.

2.1 Mathematical Models for Journals Evaluation

The high quality journal tries to be visible for society of scientists. To found a difference between quality of journals, the special parametric factors was proposed.

Below are some of them [14–20]: Source-Normalized Impact per Paper (SNIP), Relative Citation Rates (RCR), SCImago Journal Rank (SJR), Journal to Field Impact Score (JFIS), Article Influence (AI), and the most popular—Impact Factor (IF) (1).

"IF" counts all citations from particular calendar year, and it divides them by the amount of "cited" publications from last two years (C).

$$IF = \frac{B}{C} \tag{1}$$

Other indicators also reflect the parametric quality rating of journal, but they are not so popular. Each of them characterizes different factors which influence final evaluation of journals. Different journal evaluation criteria cause the inhomogeneity in resultant rankings. Furthermore, algorithms of evaluation are subjected to continuous changes aiming to the most reliable definition of publications quality. For this reason, the aim of publishing companies, instead of valuing scientific publications, having less 'popular' character (though substantially equally good if not much better), could be the wish of achievement of the highest parametric coefficients evaluating the other of their publications.

It can be accepted that, as the evaluation of the given journal is higher in the ranking, an article published in it has the chance to obtain greater range, and consequently receive greater quantity of quotations. It seems that there exists the conformity of business among a journal and an author of the article, however this concerns only the wishes of obtaining the maximum quotations quantity at other publishers through the large number of scientists.

Willing to check our chances for the publication in the given journal, we often set incorrect question—*Will this journal publish my article?*

To show existing dependences and conflicts of interests between an author and an editor, one ought to set himself the question:

How will my article help the journal to obtain better position in the ranking (more points in the parametric evaluation of journals)?

The answer depends on many factors, which can subjectively influence the evaluation of an article, apart from its essential value. Figure 1 shows a general scheme of the relations between a publishing house and an author.

2.2 Mathematical Models for Article Evaluation

Each article has its own essential value which cannot be measured automatically. The article evaluation is limited to a group of parameters defining its quality from the interest of a journal point of view. Unfortunately this can cause a conflict of interests between publishing houses and authors [21].

During the evaluation of an article, the essential value can be estimated by additional parameters: the range of carried out researches, description of theoretical

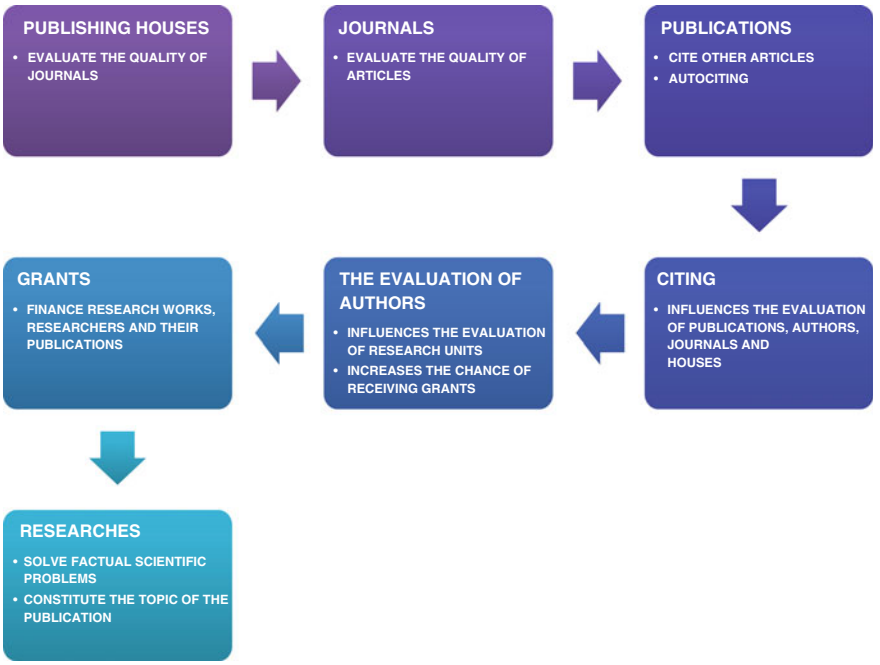

Fig. 1 The scheme of the relations between a publishing house and an author

models, simulation models, experiment. If it has only theory it can be classified lower than articles containing simulation or experiment.

Articles containing the experimental verification of carried researches will be evaluated as the best ones. Separately, articles containing rich and complex reviews of the literature from the given field can display significantly high classification, because this type of articles are quoted often many times. This results from the specific approach of scientists to carried out researches and wishes of using elaborated earlier literature review, which often requires a lot of time and belongs to "less attractive" researches.

Thereby, at the evaluation of articles' value, nobody can foresee how often he will be quoted in the future. To put it simply, it can be assumed, that at the initial phase of article analysis, each has the evaluation for the essential value on the same level. Since the quantity of elaborated article future quotations cannot be influenced, it can be influenced who the author quotes in his own publication. This way the quantity of "gained" quotations from the journal's point of view, can be controlled. The issue here is the period of time in which journals are subjected to evaluation in rankings. For the calculation of Impact Factor, last 2 years are taken into consideration which means that the auto quotation of other articles which appeared in the same publishing house within a period of last 2 years have a positive influence on IF indicator increase. Therefore, the publishing house will be willingly promoting articles which already

Table 1 Defining parameters for the calculation of the EPQ indicator—basic parameters

P_i	Meaning of value substituted to P_i	Range	Formula on Pi
P_1	H—authors' Hirsch index	H=[0:inf]	$P_1 = (1 - \frac{1}{1-H}) * w_1$
P_2	I—the quantity of authors' indexed publications	I=[0:inf]	$P_2 = (1 - \frac{1}{1-I}) * w_2$
P_3	C—quantity of authors' indexed quotations	C=[0:inf]	$P_3 = (1 - \frac{1}{1-C}) * w_3$
P_4	S—degree/ the scientific title of the author (none/engineer/MSc/the doctor/assistant professor/professor)	S=[0:5]	$P_4 = (1 - \frac{1}{1+20*S}) * w_4$

show quotations from their own journal, is a method to obtain higher place in the ranking. However, if there exists a group of journals given by the common institution, then cross quotations of other journals belonging to the same publisher constitute also an added value. Here arises a threat regarding the reliability of one published articles, because one can apply the mechanism which would permit ranking speculations between journals. Following the paragraphs of this article, they contain the case study describing such situations.

3 The New Indicator for the Parametric Evaluation of an Article—EPQ

All articles can be parameterized by the Estimated Paper Quality coefficient (EPQ). This model can indicate many factors which participate in the evaluation of given article. It can be presented as weighted mean of individual parameters, with suitably assorted weights functions. The value of parameters is standardized so that it contains itself in the range from 0 to 1. This type of method descends from Churchman and Ackoff (1954) researches, under the name Simple Additive Weighting (SAW) [22, 23]. SAW is one of most popular solutions in Multi-Attribute Decision Making type (MADM) problems of which undoubtedly is the problem described in the work. Elaborated process of EPQ calculation is similar to the above methods, however differences in designating of individual parameters appear. Differences are caused by different ways of P_i parameters of values determination.

$$EPQ = \frac{1}{n} \sum_{i=1}^{n} P_i * w_i \tag{2}$$

where P_i is appropriate parameter of evaluation with following index n appointed, and w_i is the weight for a given parameter. Below, in the table (cf. Tables 1, 2 and 3) the list of parameters together with their asserted values and ranges is presented. All parameters P_i are situated in the same range: $P_i \in [0, 1]$.

Table 2 Defining parameters for calculation of the EPQ Indicator—content rating of an article

P_i	Meaning of value substituted to P_i	Range	Formula on Pi
P_5	The calculated Gaussian distribution basing on the quantity of all quotations contained by an author in the article, where: d—the height of the Gaussian curve top, x—quantity of all quotations contained by an author in the article, σ—standard deviation of Gaussian distribution, μ—expected value, equal average quantity of quotations devolving on one article in the given journal, a—quotations devolving on one article (k) in the given journal	d = [0:1] x = [0:inf] σ = [0:inf] μ = [0:inf] a = [0:inf] k = [0:inf]	$P_5 = \left(d * e^{\frac{-(x-\mu)^2}{2\sigma^2}}\right) * w_5$ $\sigma = \sqrt{\frac{1}{k-1}\sum_{k}^{i=1}(x_i - \mu)^2}$ $\mu = \frac{1}{k}\sum_{i=1}^{k} a_i$
P_6	A—the quantity of quotations coming from archival numbers of the same journal to which the publication is submitted	A=[0:inf]	$P_6 = \left(1 - \frac{1}{1-A}\right) * w_6$
P_7	B—the quantity of quotations coming from archival numbers of remaining journals belonging to the same publishing house to which publication is submitted	B=[0:inf]	$P_7 = \left(1 - \frac{1}{1-B}\right) * w_7$
P_8	The indicator of the publication originality. O—the quantity of similar articles earlier published by the author. D—the sum of "duplicates", measured by the coefficient of similarity of genuine text and small pictures between previous articles of the author, and with his current publication	O=[0:inf] D=[0:inf]	$P_8 = \left(1 - \frac{1}{1+O}\right) * w_8$ $O = \sum_{i=1}^{n} D_i$
P_9	R_d—the quantity of cited publications of the current editor of journal to which publication is submitted	R_d=[0:inf]	$P_9 = \left(1 - \frac{1}{1+R_d}\right) * w_9$
P_{10}	R_c—the quantity of cited publications of current reviewer of journal to which publication is submitted	R_c=[0:inf]	$P_{10} = \left(1 - \frac{1}{1+R_c}\right) * w_{10}$

3.1 The Methodology of Calculation the EPQ

Calculation of the EPQ coefficient is based on a lot of other indicators described bellow. Particularly essential from the usage of EPQ indicator point of view, is the

Table 3 Defining parameters for calculation of the EPQ indicator—other parameters

P_i	Meaning of value substituted to P_i	Range	Formula on Pi
P_{11}	J—the quantity of authors' publications quoted by a current editor or reviewer of the journal to which publication is submitted	[0:inf]	$P_{11} = (1 - \frac{1}{1+J}) * w_{11}$
P_{12}	K—the quantity of authors' common publication articles and a current editor or reviewer of a journal to which publication is submitted	[0:inf]	$P_{12} = (1 - \frac{1}{1+K}) * w_{12}$
P_{13}	Z—the quantity of elements from the range of carried out researches (the form of survey): review, theory, model, simulation, experiment, lack/other	[0:5]	$P_{13} = (1 - \frac{1}{1+20+Z}) * w_{13}$

possibility of weights definition w_i in way compatible to parametric evaluations applied by the given journal. The large number of academic journals cause different approach to the parametric evaluation of accepted articles to editorial office and the review of article. Basing on the data from previous years, considering all publications printed within the framework of one publishing-title, we are able to determine weights of individual parameters individually for the given journal.

For that purpose we will use neural networks with the feedback which will learn to recognize the influence of the given parameter on the positive acceptance of article to the publication. In case of the analysis, already printed publications, we will subordinate the quantity of published articles from the value of individual parameters. The more articles will have e.g. the high parameter P6, the greater influence on the printing of publication has the quantity of archival articles quotations laded from the same journal.

Initial values of the weight parameter w_1 amount to 1. Due to the implication of matching algorithm, the weights shall be modified in the 0 to 1 bracket through artificial neural networks. The aim of the modification is the selection of appropriate levels of weights to a given journal.

3.2 The Example of the EPQ Calculation

The definition of the exact value EPQ does not decide about "the success" and the publication of the given magazine article. This will permit however finishing up and improving of the editorial part which could not take into the above-mentioned factors influencing decision of editors and reviewers. System elaborated in such a way, using the IT network will permit quick definition of the article modification. Outwardly, basing on obtained result EPQ it will enable to propose the alternative academic

Table 4 The results from this case are as follows

No	Parameter P_i	Initial data	P_i results
1	P_1	$H = 5$	0,833
2	P_2	$I = 100$	0,990
3	P_3	$C = 500$	0,998
4	P_4	$S = 5$	0,990
5	P_5	$d = 1; x2 = 90; a1 = 80; a2 = 100; a3 = 120$	0,882
6	P_6	$A = 2$	0,667
7	P_7	$B = 2$	0,667
8	P_8	$D = 0; O = 0$	1
9	P_9	$Rd = 0$	0
10	P_{10}	$Rc = 2$	0,667
11	P_{11}	$J = 0$	0
12	P_{12}	$K = 0$	0
13	P_{13}	$Z = 3$	0,984
Average			0,667
EPQ			0,67

journal which parameters answer to the result. The value EPQ was calculated basing on the example of the publication based on the *Matlab* software.

Below, the calculated value of EPQ was presented for a model publication.

(a) Data concerning the author: The current Hirsch index of the author amounted to 5, for 100 indexed publications and 500 of all his connective cited publications. The author obtains the academic title of professor.
(b) Data concerning a publication: The article contains 90 of citations, from which 2 citations come from archival journal, to which the publication is being composed. In total, there are 2 citations from other archival issues of journals belonging to the same publishing house, to which the publication is being composed. The publication demonstrates original quality, since there have not been any of its duplicate samples and publications of similar content of the same author. In the publication there are no citations from the works of the members of editorial board, however there have been 2. citations of works developed by reviewers. The publication contains at least 3. elements of scientific publication (e.g. review, theory, model).
(c) Data concerning the journal: The statistical average number of citations in a single article published in this journal amounts to 100. Editors and reviewers have not cited any other works of the author, they have not had any mutual articles with the author.

The range of the selected parameters together with separate results of the calculations are depicted above (Table 4).

4 SEO, Hirsch Index and Impact Factor

4.1 The Similarity of the Hirsch Index and Impact Factor to Page Rank, and Threats Resulting from Black Hat SEO Methods

The growth of the Hirsch index and IF strictly depends on the quantity of the given author's publication quotations. This model can be compared to the published ranking of websites (PR—Page Rank) used in Google search engine [24–26]. The similarity refers to the quantity of quotations which correspond to quantities of returnable links indicating given page of data sources.

There are known general methods of influencing the algorithm of search engine in this way, so that the indicated page will be higher in the Search Engine Results Page ranking (SERP). These methods are divided on the so-called white and black. White Hat SEO—means the positioning of the website in compliance with official guidelines of search engines, which should result in better page adaptation to Web-crawler's and engines of search engines requirements. Good preparation of the website facilitates, quick indexing of it in the search engine base of data, however increasing number of valuable references to page (gained naturally and resulting from its popularity and uniqueness) permits its positioning and obtaining of high place in the SERP ranking. As valuable references are acknowledged, links from pages about high PR are often visited by users (e.g. thematic, community websites). There also exists Black Hat SEO which is characterized by the use of all possible gaps in the search engine, for the purpose of raising the ranking of given website. Such effects are achieved through the manipulation with the quantity of returnable links and their "artificial" addition through generating large quantity of pages with links. So many of manipulation methods constitute the necessity of continuous algorithms change of search and qualitative selection of websites.

From obvious reasons, exact parameters of the algorithm are not revealed for the purpose of their protection before the manipulation. There can be only estimated general dependencies and on their base there can be created algorithms improving the position of website in ranking of searches. Methods of rankings creating e.g. PR and IF, and also H-index cause the risk of appearing methods taken from SEO, which in the artificial way will manipulate results of the above-mentioned rankings. Probably there is no possibility of obtaining 100 % reliable and objective ranking not burdened with the above risk.

From this reason, the essential evaluation of publication can be shaken, in the interest of the parametric evaluation. This can cause the reverse to intended effect i.e. these rankings will promote less ambitious scientific discoveries, but artificially will overvalue indexes across the elaboration of their manipulation method. The case study is presented below, which in the mental experiment, could result with "artificial" increasing of IF for the journal or with "artificial" increasing of the H-index for given scientist.

H-indexof Person A	Number of publications of Person A	Number of citations of Person B*	Number of citations of Person A*	Number of publications of Person B	H-index of Person B
0	1	0	0	1	0
1	2	1	1	2	1
1	3	2	2	3	1
2	4	3	3	4	2
2	5	4	4	5	2
3	6	5	5	6	3
3	7	6	6	7	3

Fig. 2 Mutual citations of 2 authors

4.2 Threats Resulting from the Usage of Artificial Methods of Increasing the indexes

Among academic researchers, there is no unambiguous method of scientific achievements' evaluation, which would credibly and objectively determine the value of a research work. There are numerous publications that describe threats connected with manipulation of indexes [27, 28]. A short analysis of the case that highlights the susceptibility of the used indexes for artificial manipulation is shown below. It is a similar situation that the search engine Google encountered. It is subjected to continuous attempts of manipulation of websites' rankings that are displayed in the first 10 results of a search. The search engine algorithm was evolving, taking into account increasingly different parameters so as to extract artificial positioning. If the algorithms of calculating the indexes are not modified, the intentional manipulation to increase indexes is very likely to occur, which is shown below.

4.3 Hirsh Index Manipulation

The Hirsch index has lots of advantages, however it is also subjected to the risk of being manipulated. Suppose there are at least 2 researchers working in similar field of study, they may cite each other's work (Fig. 2), only to increase each other's Hirsch index.

Of course the publication that contains several or a dozen of citations of the same author may focus the attention of the reviewer as far as the legitimacy of citing is

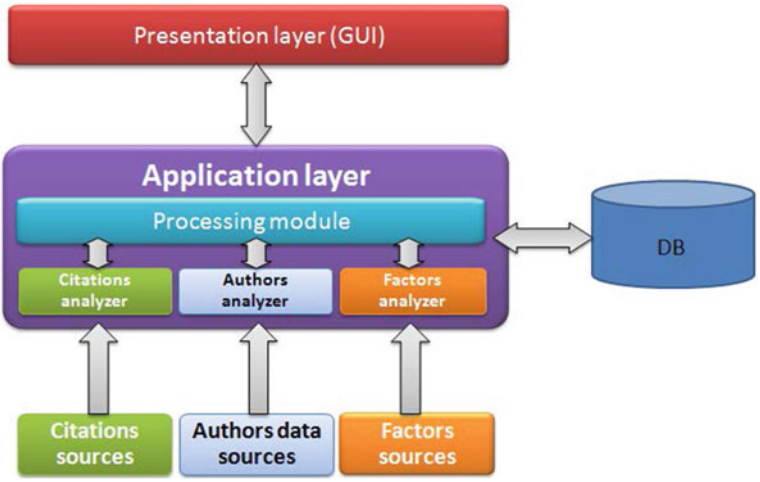

Fig. 3 The architecture of a proposed IT system to determine EPQ indicator

concerned. In such a case there exists the possibility of developing the model for a specified group of authors, where division of citations between each other will be evenly determined so as not to undermine the legitimacy. Furthermore, it is worth to add that the publication drawn up by an author A that contains more or less 5 citations of an author B is fully sufficient to increase the Hirsch index from 0 to 3 level. In the cooperation of at least 6 authors, the increase of H index to the level 5 for each of the author will demand only the cooperation in the scope of citing of 5 publications (6 counting from the first one, which has not been cited before by nobody).

*—for each next publication one person has to cite other person's all publications (the number of citations per new publication).

5 Application Realizing EPQ Designation

Determination of the individual parameters can be achieved through the use of available databases of scientific publications and names of authors like: SCOPUS, WEB OF KNOWLEDGE, Google Scholar and other smaller databases. The system collects this data, it will turn collecting the following information: author, citations, journals, publications, and then assessed the parametric analyzed publication. Based on this evaluation, it can propose suggestions, ref. introductions of changes in the article or present proposal of the alternative journal to which the parametric evaluation was better. The system architecture may be built based on the client-server methodology which is presented on Fig. 3.

5.1 The Architectural Schema

On the after-mentioned Fig. 3 the general architectural schema of the system is presented.

In presented architecture system we distinguish:

1. *Presentation layer*—a layer of the application responsible for the presentation of results and communication with user, receiving data from user (proposed article, survey for the author)
2. *Application layer*—layer responsible for the resumption of data and processing of results which consists of:
   - *citations' analyzer* (module processing the quotation categorizing and counting quotations of authors works.)
   - *authors' data analyzer* (module processing data of authors (also reviewers and editors), checking relations of author with journals across quotations as well as categorizing his achievement)
   - *authors' analyzer* (module being supposed for the task to process available data sources information of used in the algorithm coefficients for journals and authors)
3. *DB*—a layer of database recording source data and results of calculations with application layer, permitting caching of data sources in the situation when data don't need to be refreshed at every operation of weight-coefficients calculation weight-coefficients.
4. *Sources*—a layer of gaining data from chosen sources dividing into sources of quotations gaining ("citations sources"), given authors ("authors the date sources") and coefficients used in the algorithm of EPQ count ("factors sources").

The system architecture in case of further development can be calibrated because the module of processing may receive partial results of calculations (weights of component parameters) from individual modules which can be found on separate instances of servers. Each module of gaining data can have the separate database in which it will store the received results of the data sources indexing. In case of presentation layer, the system can communicate with software of the thin client type in case of approach users (authors of articles) and with the software of the fat client type in case of the administrator who can control work of the processing module (settings control).

6 Conclusion

Determining the actual accuracy of parametric evaluation for scientific journal article by calculating the proposed EPQ parameter is possible only after verification on figures. Methodology is based on foundations that a substantially good article can

be evaluated wrongly due to remaining factors on which reviewers and editors of journals pay attention to. The elaborated system, proper verifying of targets and correction of an article before its delivery to publishing houses will permit to carry out essential research on equally high level and to regard subjective 'expectations' from the side of publishing house in relation to an author. So an improved article has greater chance for printing in a renowned journal, which can positively rebound on future publications of many authors.

On the other hand, it will be possible to verify retrogradely articles that have too high parametric evaluation to indicate potential authors or journals, which were subjected to artificial mechanisms that are used to increase index parameters. Through this process it will be possible definition of what elements have been streamlined parametric evaluation of the use of illegal solutions, which include the use of observed SEO methods.

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