Designing a Framework for Evaluating the Scientific Productions

Abstract

Background: Evaluation of scientific productions to attract, maintain, and promote faculty members is one of the necessary processes of academic societies and is of interest to policy makers in the field of higher education. This study aimed to provide a uniform and native framework for evaluating the scientific productions of researchers in the fields of science and health in Iran. **Methods:** The current research used the single-stage fuzzy Delphi technique and AHP. The research community comprised 50 top scientific experts and researchers from the country. The data collection tool was a researcher-made checklist obtained from the review of literature and laws and regulations of Iranian universities and research institutions. **Results:** Data analysis led to the identification, prioritization and weighting of eleven criteria and 124 items for the intended framework, which are, respectively, author's authority (scientific leaders) (15 items); database used in calculating the index (3 items); Innovation and technological impact (18 items); Gaining rank in national and international festivals related to the specialized field (6 items); Citations (7 items); subject area (3 items); level of cooperation (15 items); Types of scientific productions (54 items); scientific age (3 items); Evaluating, refereeing and monitoring of research, technology and innovation activities (2 items) Author's role and position (1 item). **Conclusion:** The final framework obtained for evaluating Iranian researchers has 11 criteria and 124 items that can be used to compile an author-centered and native scientometrics index that leads to the same evaluation of health and science researchers.

Keywords: *Author-oriented indicator, researcher evaluation, scientific production evaluation, scientometrics indicators*

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Introduction

Evaluation of the scientific productions of researchers is one of the necessary processes in academic societies[1] and has always been emphasized by officials and relevant institutions of various fields.[2] The evaluation of scientific productions of researchers is done for recruitment, annual promotion, promotion of scientific rank, selection of exemplary professor, top researcher, and the like.[3] Universities and research centers need to select and employ the best and most qualified researchers and graduates of scientific fields to complete their scientific staff. However, due to the variety and abundance of scientific and research activities of the candidates, they need to evaluate the scientific productions of the candidates, and these productions are the tools and criteria for evaluation.

On the other hand, scientific evaluations also help graduate students in identifying the leaders of each field and choosing the best supervisors or advisors to guide the thesis.[4,5] These evaluations also help the editors of scientific journals and specialized conferences to choose the best referee.[5] Therefore, the evaluation and ranking of researchers play a significant role in the implementation of decisions related to research.

One of the ways to evaluate scientific productions is to use scientific indicators. Among various scientific productions, attention to articles is more than other research outputs. In universities, the number of articles published in a year by each faculty member indicates her professional success.[6] Many faculty members believe that publishing articles in scientific journals is a suitable criterion for determining the quality of their research.[7] Also, studies show that due to the existence of coherent and integrated databases and the ease of extracting data necessary for evaluation, universities are more willing to evaluate articles. Therefore, currently, the most important indicator of science production worldwide is the number of articles indexed

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in international scientific databases and the number of their citations. The number of indexed articles indicates the quantitative growth of scientific productions, and the amount of citations indicates the impact of published articles and their quality level.[8]

Evaluation of researchers is necessary for making decisions regarding their employment in scientific and academic centers, promotion, and tenure of sensitive jobs. Many academic leaders believe that the current system of incentives and rewards for faculty members, and the way researchers are evaluated, is not appropriate, and is not aligned with needs. For this reason, efforts have been made to modify the criteria and indicators of researchers' evaluation. Such as The Leiden Manifesto, and The Declaration of Research Assessment (DORA), which were developed in the academic forums, and used internationally.[9,10] The Metric Tide was also developed to evaluate researchers in the UK, and to disseminate The UK's Research Excellence Framework, and provides recommendations for evaluating scientists.

In order to evaluate research productivity, it should be noted that scientific outputs, weight, and importance of evaluation indicators are different in various subject areas. In the Academic Careers Understood through Measurement and Norms (ACUMEN) consortium, three indicators of people's expertise, and scientific productions and their effects have been considered to evaluate researchers.[11] The alignment of existing indicators with different fields is one of the needs of researchers' evaluation systems. The UK REF evaluation system has also pointed to this and has evaluated the use of evaluation indicators in different disciplines and their potential contribution to the development of excellence and research impact.[12] In all evaluation systems, it is stated that meeting social needs is an essential research goal. Focusing on effective research based on social needs requires a more comprehensive and external view than scientific research.

In Iran, the recruitment of faculty members is done through recruitment calls by each university, conducting expert interviews, and reviewing candidates' resumes.[13] The evaluation criteria and the scoring method for the candidates' scientific productions are also the promotion regulation, which can change and adjust the scores based on the discretion and conditions of each university.[14] Therefore, in this evaluation, recruitment candidates face two ministerial and university levels. The first level is centralized and ministerial regulations that are communicated to all universities similarly. The second level is decentralized and academic, which add, remove, or change indicators or criteria according to the relative independence of universities and their internal regulations. Thus, there is a kind of pluralism in the existing indicators for evaluating Iranian researchers, this causes nonuniformity

and unfair comparison between researchers with the same expertise in different universities.

Each faculty member has several duties, including personal, executive and managerial development, specialized activities outside the university, cultural activities, educational and research duties, and health-treatment services (medical sciences universities), which is evaluated periodically. However, the teaching and research duties of faculty members are better known and more critical in evaluations. This evaluation is done based on the components in the promotion regulations, and if the minimum score is obtained, the annual promotion is achieved; otherwise, scientific stagnation is considered. In addition, after at least four years, in case of acquiring educational, scientific, and research qualifications, a person can be promoted to a scientific rank. Also, every year, universities choose the best and most worthy people at the institutional, national, or even international level, and they are awarded scientific awards and badges[5] or even deserve to receive scholarships and study opportunities.[15,16] Accordingly, educational, scientific, and research evaluation is considered necessary in Iranian universities. Therefore, this study aims to design a uniform framework for evaluating the scientific productions of researchers in the fields of science and health in Iran so that in this way it is possible to compile a fair native index based on the country's needs to evaluate all researchers in Iran.

Methods

Study population

The population included experts in the field of scientology and evaluation of researchers and the group of top scientists and science leaders in Iran who had the highest number of citations or the highest H-index in their scientific field. Sampling was done purposefully ($N = 50$).

Data collection

To collect data, first by referring to the literature, the components and items related to each component were extracted. Then a questionnaire was designed and given to 10 experts to determine the face and content validity. After completing the necessary tests, the final questionnaire including 12 components and 210 items was sent to the research sample ($N = 50$). They were asked to express their opinion about each item in the form of verbal variables included in the questionnaire. Finally, 32 people (24 scientometrics experts and 8 top researchers) responded.

Statistical analysis

This study was performed using the fuzzy Delphi, and AHP technique. The fuzzy Delphi method is a combination of the Delphi method and fuzzy set theory. Using the fuzzy Delphi method for group decision-making can resolve the ambiguity of common understanding of experts' opinions.[17] The algorithm for implementing the fuzzy

Table 1: Verbal expressions of triangular fuzzy numbers					
Nonessential	Very low necessity	Low necessity	Medium necessity	High necessity	Very high necessity
0, 0, 0.2	4.0، 2.0، 0	6.0، 4.0، 2.0	8.0، 6.0، 4.0	1، 8.0، 6.0	1، 1، 8.0

Delphi technique includes the following steps: identifying the appropriate spectrum for fuzzifying verbal expressions, Fuzzy summation of fuzzed values, Defuzzification of values, Selection of threshold intensity, and screening criteria.[18] In the algorithm for implementing the fuzzy Delphi technique for screening, first, a suitable fuzzy spectrum should be developed to fuzzize the verbal expressions of the respondents [Table 1].

If each expert's point of view is displayed as a triangular fuzzy number (l, m, u), the fuzzy average of n triangular fuzzy numbers will be calculated as the following equation:

$$F_{AVE} = \frac{\sum l}{n}, \frac{\sum m}{n}, \frac{\sum u}{n}$$

After the fuzzy aggregation of the experts' point of view, it is necessary to defuzzify the obtained values. There are different methods for defuzzification. In this research, the relation F = (L + M + U) was used for defuzzification.

After choosing the appropriate method and defuzzifying the values, a threshold should be considered for screening the items. The tolerance threshold is usually considered to be 0.7.[19] In this research, the threshold limit of the average points of the items (arithmetic mean of the definite numbers obtained for all the items included in the research), which was equal to 0.701, was considered the threshold limit. Due to the large number of subjects included in the research, it was necessary to screen the subjects and select the most necessary ones. For this purpose, the one-step fuzzy Delphi method was used to determine suitable items.

An analytical hierarchy process (AHP) was used to determine the weight of the components and critical items identified, and finally, their rank was determined. The steps were as follows: 1) normalizing the matrix of pairwise comparisons; 2) obtaining the arithmetic mean of each line of the matrix to the normalized pairwise comparisons (relative weights); 3) multiplying the relative weights of the items by the arithmetic mean of the options; and 4) ranking the items.

After these four steps, the "inconsistency rate" should be calculated, because in the current study, quantitative data was used; therefore, the inconsistency rate was zero and there was no need to calculate it.

Results

The results of fuzzification and defuzzification calculations in the Delphi technique are shown in Table 2. At this stage, by applying the overall threshold limit of 0.701, 86 items whose definite number was lower than the threshold limit
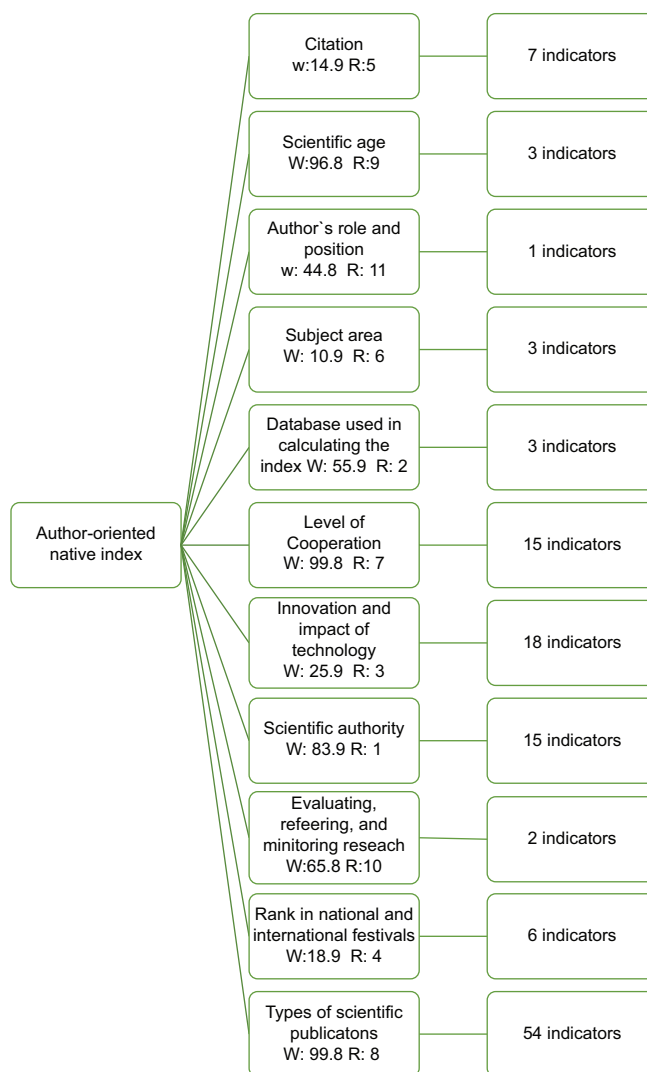
Figure 1: The final proposed framework for evaluating the scientific productions of researchers

and did not obtain the minimum score were excluded from the research. Finally, 124 items were approved [Table 2].

From the total of 12 criterion included in the research, only the "theorizing chairs" criteria was removed and 11 elements remained [Figure 1]. Also, the appropriateness of the position of the research indicators in each criterion was evaluated based on the opinions of the experts, and the position of all accepted indicators was confirmed based on the opinions of the experts in the relevant criteria. In the final stage of the research, the verified criteria and indicators were weighted and prioritized using the AHP technique, and based on that, a uniform framework was proposed for evaluating the scientific productions of researchers in the fields of science and health in Iran [Figure 1].

Table 2: Results of fuzzy Delphi calculations

Criteria	Indicator	Fuzzy value			Definite	Result
		Upper line	Middle line	Lower line	amount	
Citation	Citations received from articles in related subject areas	0.994	0.931	0.731	0.885	Accept
	Citations received from articles in unrelated subject areas	0.825	0.663	0.469	0.652	Delete
	Citations received from invalid and fake journal articles	0.563	0.381	0.244	0.396	Delete
	Citations received from retracted articles	0.613	0.431	0.288	0.444	Delete
	Citations received from patent licenses, educational manuals, textbooks, and reference books such as encyclopedias and encyclopedias.	0.931	0.831	0.631	0.798	Accept
	The ratio of citations to the researcher's total publications	0.913	0.756	0.563	0.744	Accept
	Self-citation (more than 20%)	0.769	0.625	0.456	0.617	Delete
	Citations received from colleagues within the institution (organizational self-citation more than 20%)	0.719	0.569	0.394	0.560	Delete
	Citations received from national colleagues (national self-citation)	0.806	0.650	0.463	0.640	Delete
	Citations received from prominent researchers (top 1%) at the national level	0.850	0.744	0.563	0.719	Accept
	Citations received from prominent researchers (top 1%) at the international level	0.850	0.750	0.575	0.725	Accept
	H index of the researcher	0.938	0.856	0.656	0.817	Accept
	Inaccurate citations (incorrect bibliographic information, or external absence)	0.569	0.400	0.275	0.415	Delete
	Total citations received by the researcher	0.900	0.769	0.575	0.748	Accept
	Citations received during the researcher's evaluation period	856.0	0.713	0.519	0.696	Delete
scientific age	The scientific age of the researchers (the time of publication of the first article of the person until the time under review) in their research evaluation	0.919	0.831	0.638	0.796	Accept
	The age of scientific productions and the year of publication of each article for the researcher (the age of scientific productions: the time of publication of an article is essential in receiving citations, so usually newly published articles receive fewer citations than articles with older publication years)	0.881	0.788	0.600	0.756	Accept
	The age of received citations and the process of receiving them in the researcher`s evaluation (the received citations of the researcher's articles can decrease over time or stop at a particular time. Therefore, in the evaluation of new citations, an article published in previous years can be considered necessary.)	0.875	0.750	0.563	0.729	Accept
Author`s role and position	Assigning the same and equal points to all authors	0.506	0.319	0.188	0.338	Delete
	Assigning a score of one to all authors	0.494	0.319	0.200	0.338	Delete
	Assigning points 1.n based on the position or order of mentioning the names of the authors (for example, the second author 1.2)	0.688	0.531	0.363	0.527	Delete
	Assign points only to the first author	0.300	0.113	0.063	0.158	Delete
	Allocating equal points to the first author and the responsible author and points according to the contribution ratio or order of naming for the rest of the authors	0.856	0.744	0.563	0.721	Accept
	Dividing the points between the authors in the form of an arithmetic mean (a type of measurement of the tendency to the center (central index), and it is the sum of the values in a data set divided by their number)	0.600	0.425	0.263	0.429	Delete
	Dividing points between authors as a geometric mean (equal to the nth root of the product of n variables)	0.600	0.419	0.269	0.429	Delete
	Dividing points between authors as a harmonic mean (used when calculating average rates is essential. This value is the number of values multiplied by the inverse sum of the values in a data set)	0.594	0.6	0.263	0.421	Delete
	Considering the number of authors in the calculation of a native author-centered composite index	0.669	0.519	0.369	0.519	Delete

Contd...

Table 2: Contd...

Criteria	Indicator	Fuzzy value			Definite amount	Result
		Upper line	Middle line	Lower line		
Subject area	Considering the differences in citation patterns specific to each subject area (such as humanities compared to medical sciences)	0.881	0.800	0.613	0.765	Accept
	Considering the differences in authorship patterns specific to each subject area (such as humanities compared to medical sciences)	0.869	0.769	0.581	0.740	Accept
	Comparison of researchers in a subject field or homogeneous and peer group	0.906	0.813	0.619	0.779	Accept
The database (used in calculating the index)	Using the national reference database (such as the ISC database) in the calculation	0.850	0.719	0.531	0.531	Delete
	Using the international citation database (such as WoS and Scopus) in the calculation	0.988	0.919	0.719	0.875	Accept
	Using specialized databases (such as PubMed for the medical field or US Patent for inventions) in the calculation	0.906	0.813	0.619	0.779	Accept
	Verification of the correctness of the name of the researcher (such as the presence of similar names or different spellings of names) in the calculation through an identifier such as ORCID	0.888	0.794	0.619	0.767	Accept
Level of cooperation	The number of publications resulting from the researcher's collaboration at the institute level	0.894	0.750	0.563	0.735	Accept
	The number of publications resulting from the researcher's collaboration at the national level	0.925	0.800	0.613	0.779	Accept
	The number of publications resulting from the researcher's cooperation at the regional level	0.919	0.813	0.625	0.785	Accept
	The number of publications resulting from the researcher's collaboration at the international level	0.969	0.888	0.694	0.850	Accept
	The number of publications resulting from the researcher's collaboration with domestic industries, companies, and organizations	0.931	0.813	0.619	0.788	Accept
	The number of publications resulting from the researcher's collaboration with foreign industries, companies, and organizations	0.944	0.838	0.644	808.0	Accept
	Dissertations resulting from researcher collaboration with companies, organizations, and industries	894.0	769.0	0.581	0.748	Accept
	Dissertations resulting from the researcher's collaboration with scientific centers at the institute level	0.844	0.700	0.519	0.688	Delete
	Dissertations resulting from the researcher's collaboration with scientific centers at the national level	0.869	0.744	0.563	0.725	Accept
	Dissertations resulting from the researcher's collaboration with scientific centers at the regional level	0.888	0.763	0.575	0.742	Accept
	Dissertations resulting from the researcher's collaboration with scientific centers at the international level	0.906	0.794	0.600	0.767	Accept
	Research projects resulting from researcher collaboration with companies, organizations and industries	0.919	0.788	0.588	0.765	Accept
	Research projects resulting from the researcher's collaboration with scientific centers at the institute level	0.869	0.731	0.538	0.713	Accept
	Research projects resulting from the researcher's collaboration with scientific centers at the national level	0.906	0.781	0.588	0.758	Accept
	Research projects resulting from the researcher's collaboration with scientific centers at the regional level	0.906	0.781	0.588	0.758	Accept
	Research projects resulting from the researcher's collaboration with scientific centers at the international level	0.944	0.838	0.638	0.806	Accept
Innovation and the impact of technology	The number of national patent licenses of the researcher	0.913	0.794	0.594	0.767	Accept
	The number of international patent licenses of the researcher	0.956	0.875	0.675	0.835	Accept
	The number of publications cited in patents	0.956	0.863	0.663	0.827	Accept
	Effective cooperation establishing universities, research centers, higher education and research institutes, science and technology towns and parks, growth centers and knowledge-based companies.	0.813	0.669	0.475	0.652	Delete

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Table 2: Contd...

Criteria	Indicator	Fuzzy value			Definite amount	Result
		Upper line	Middle line	Lower line		
	The totality of innovative services (realizing, objectifying, and presenting the results of creativity, which is in the form of offering a new concept, definition of a case, or a new proposal, which usually appears in the form of a scientific article, product design, or a new service.)	0.850	0.738	0.544	0.710	Accept
	The number of treaties, licenses, memorandums, and cooperation agreements for research and development	0.794	0.663	0.475	0.644	Delete
	Percentage of inventions with exploitation license	0.925	0.838	0.638	0.800	Accept
	Level one patent (international patent in America (US patent), China, Russia, Australia, Japan (Japan patent), England (UK intellectual) and European Union (European patent))	0.969	0.894	0.694	0.852	Accept
	Second level patent (international patent in other foreign countries)	0.938	0.819	0.619	0.792	Accept
	National patent	0.913	0.794	0.594	0.767	Accept
	patent license or intellectual property registration (patent);	0.856	0.731	0.531	0.706	Accept
	Gene sequence registration	0.900	0.788	0.588	0.758	Accept
	Registration of specific species and varieties	0.913	0.794	0.594	0.767	Accept
	Registration of a knowledge-based company	0.856	0.756	0.556	0.723	Accept
	Compilation of valid standards	0.888	0.788	0.594	0.756	Accept
	Compilation of new technical knowledge or localization of existing technologies	0.938	0.838	0.638	0.804	Accept
	Presenting scientific theory or providing solutions for the country's significant problems	0.938	0.844	0.644	0.808	Accept
	Production of technical knowledge, invention, or discovery leading to the production and commercialization of a product or process	0.956	0.863	663.0	0.827	Accept
	Invention, discovery, and production of registered applied research products	0.944	0.844	0.644	0.810	Accept
	Designing new systems, methods, and services in the country	0.925	0.819	0.619	0.788	Accept
Scientific authority (scientific leaders)	The number of articles published in Scopus-Top 1% journals	0.988	0.906	0.706	0.867	Accept
	The number of articles published in Scopus-Top 5% journals	0.988	0.894	0.694	0.858	Accept
	The number of articles published in Scopus-Top 10% journals	0.981	0.875	0.675	0.844	Accept
	The number of articles published in Scopus-Top 25% journals	0.950	0.850	0.650	0.817	Accept
	Number of researcher's articles among 1% of highly cited publications (Highly Cited articles)	0.988	0.913	0.713	0.871	Accept
	The number of highly cited articles by the researcher among the top 1.0% publications (Hot Paper articles)	0.994	0.913	0.713	0.873	Accept
	Articles with JCR profile and ranked in the top 1% of specialized journal groups in JCR	0.988	0.900	0.700	0.863	Accept
	Articles with JCR profile and ranked in the top 5% of specialized journal groups in JCR	0.981	0.894	0.694	0.856	Accept
	Articles with JCR profile and ranked in the top 10% of specialized journal groups in JCR	0.975	0.881	0.681	0.846	Accept
	Articles with JCR profile and ranked in the top 25% of specialized journal groups in JCR	0.956	0.863	0.663	0.827	Accept
	Number of articles published in Nature and Science journals	0.994	0.931	0.731	0.885	Accept
	Presentation as a keynote or invited speaker at prestigious world congresses	0.925	0.825	0.625	0.792	Accept
	Presentation as a guest speaker at prestigious world congresses	0.875	0.763	0.569	0.735	Accept
	The number of articles with the position of responsible author	0.931	0.819	0.619	0.790	Accept
	The number of national dissertations under supervision at the doctoral level	0.838	0.700	0.500	0.679	Delete
	The number of international dissertations under supervision at the doctoral level	0.906	0.775	0.575	0.752	Accept
	The number of conferences organized by the researcher at the national level	0.850	0.688	0.488	0.675	Delete

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Criteria	Indicator	Fuzzy value			Definite amount	Result
		Upper line	Middle line	Lower line		
	The number of conferences organized by the researcher at the international level	0.831	0.694	0.500	0.675	Delete
Evaluating, refereeing and monitoring of research, technology and innovation activities	refereeing scientific research articles based on the type of journal index (ISI articles, journal articles with IF higher than 2 or Q1, PubMed articles, Scopus articles, ISC articles)	0.894	0.781	0.581	0.752	Accept
	Refereeing scientific-research articles	0.844	0.688	0.488	0.673	Delete
	Refereeing scientific-promotional articles	0.731	0.563	0.381	0.558	Delete
	Refereeing conference papers	0.694	0.525	0.350	0.523	Delete
	Refereeing encyclopedia articles	0.813	0.663	0.469	0.648	Delete
	Refereeing of original and valuable works of art (judging of artistic activities, architecture, urban planning, industrial design, festivals and competitions, judging for the best ideas festival)	0.831	0.681	0.481	0.665	Delete
	Refereeing the book based on the type of book (authored, edited or translated)	0.819	0.694	0.350	0.671	Delete
	Refereeing research and technology projects (technology and innovation projects, research projects)	0.806	0.663	0.469	0.646	Delete
	Refereeing the Dissertation (specialization, PhD, master's degree, general doctorate (dentistry, medicine, and pharmacy))	0.775	0.625	0.438	0.613	Delete
	Refereeing the invention and discovery	0.863	0.744	0.544	0.717	Accept
Chair of theorizing	Theorizing chairs (presentation of scientific chairs, presentation of achievements and scientific-research results taken from theorizing chairs, scientific criticism, innovation, theorizing)	0.813	0.675	0.488	0.658	Delete
	Theorizing chairs at the level of conferences and round tables of scientific centers	0.763	0.619	0.431	0.604	Delete
	Theorizing chairs at the level of national conferences and roundtables	0.769	0.625	0.438	0.610	Delete
	Theorizing chairs at the level of regional conferences and roundtables	0.775	0.631	0.444	0.617	Delete
	Theorizing chairs at the level of international conferences and roundtables	0.825	0.694	0.500	0.673	Delete
	Scientific-promotional chairs at the level of conferences and round tables of scientific centers	0.750	0.613	0.425	0.596	Delete
	Scientific-promotional chairs at the level of national conferences and roundtables	0.756	0.619	0.425	0.600	Delete
	Scientific-promotional chairs at the level of regional conferences and roundtables	0.775	0.631	0.438	0.615	Delete
	Scientific-promotional chairs at the level of international conferences and roundtables	0.819	0.688	0.494	0.667	Delete
Gaining rank in national and international festivals related to the specialized field	Obtaining rank in domestic festivals (such as Khwarazmi, Motahari, Razi, Allameh Tabatabai, Farabi, Fajr, etc.)	0.919	0.800	0.600	0.773	Accept
	Getting ranked in foreign festivals (such as Fields, Nobel, etc.)	0.975	0.913	0.713	0.867	Accept
	Obtaining the title of the top researcher (university, province, country)	0.881	0.744	0.544	0.723	Accept
	Obtaining national badges (such as Ferdowsi badge and artistic badge)	0.894	0.763	0.563	0.740	Accept
	Book of the year (like the selected book of the Islamic Republic of Iran)	0.913	0.794	0.594	0.767	Accept
	Obtaining the title of top 1% researcher of ESI	0.950	0.844	0.644	0.813	Accept

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		Fuzzy value			Definite	Result
Criteria	**Indicator**	**Upper line**	**Middle line**	**Lower line**	**amount**	
Types of scientific productions	Articles published in journals with WoS-JCR index (Q1)	0.956	0.900	0.706	0.854	Accept
	Articles published in journals with WoS-JCR index (Q2)	0.950	0.869	0.675	0.831	Accept
	Articles published in journals with WoS-JCR index (Q3)	0.919	0.775	0.581	0.758	Accept
	Articles published in journals with WoS-JCR index (Q4)	0.869	0.719	0.525	0.704	Accept
	Articles published in journals with ISI and IF (0-1)	0.881	0.756	0.563	0.733	Accept
	Articles published in journals with ISI and IF (1-2)	0.925	0.800	0.600	0.775	Accept
	Articles published in journals with ISI and IF (2-3)	0.938	0.819	0.619	0.792	Accept
	Articles published in journals with ISI and IF (3-4)	0.950	0.838	0.638	0.808	Accept
	Articles published in journals with ISI and IF (4-5)	0.950	0.850	0.650	0.817	Accept
	Articles published in journals with ISI and IF (>5)	0.956	0.869	0.669	0.831	Accept
	Articles published in WoS-ESCI indexed journals	0.919	0.788	0.588	0.765	Accept
	Articles published in PubMed-Medline indexed journals	0.931	0.838	0.638	0.802	Accept
	Articles published in PubMed-PMC indexed journals	0.894	0.788	0.600	0.760	Accept
	Articles published in journals with Scopus-CiteScore-Q1 index	0.975	0.894	0.694	0.854	Accept
	Articles published in journals with Scopus-CiteScore-Q2 index	0.950	0.856	0.656	0.821	Accept
	Articles published in journals with Scopus-CiteScore-Q3 index	0.888	0.750	0.556	0.731	Accept
	Articles published in journals with Scopus-CiteScore-Q4 index	0.850	0.706	0.513	0.690	Delete
	Articles published in journals with Scopus index (high citation) 5 to 9 citations	0.869	0.738	0.538	0.715	Accept
	Articles published in journals with Scopus index (high citation) 10 to 14 citations	0.906	0.775	0.575	0.752	Accept
	Articles published in journals with Scopus index (high citation) 15 to 19 citations	0.938	0.831	0.631	0.800	Accept
	Articles published in journals with Scopus index (high citation) 20 to 24 citations	0.963	0.863	0.663	0.829	Accept
	Articles published in journals with a Scopus index (highly cited) of 25 or more citations	0.969	0.881	0.681	0.844	Accept
	Articles published in journals with ISC profile A or Q1	0.888	0.756	0.556	0.733	Accept
	Articles published in journals with ISC profile B or Q2	0.850	0.706	0.506	0.688	Delete
	Articles published in journals with ISC profile C or Q3	0.813	0.663	0.463	0.646	Delete
	Articles published in journals with ISC profile D or Q4	0.794	0.650	0.463	0.635	Delete
	Articles published in ISC index with IF	0.788	0.656	0.481	0.642	Delete
	Articles published in ISC index without IF	0.763	0.606	0.431	0.600	Delete
	Articles published in journals with ISC index in the category of core journals	0.838	0.700	0.513	0.683	Delete
	Articles published in the ISC index in the waiting publications category	0.750	0.581	0.400	0.577	Delete
	Articles published in the ISC index in the category of primary publications	0.744	0.588	0.406	0.579	Delete
	Articles published in scientific journals approved by two ministries of health and science, and seminary (normal)	0.756	0.594	0.419	0.590	Delete
	Articles published in scientific journals approved by two ministries of health and science, and seminary (ISC)	0.775	0.625	0.456	0.619	Delete
	Articles published in scientific journals approved by two ministries of health and science, and seminary (Affiliated with related associations)	0.794	0.644	0.469	0.635	Delete
	Articles published in scientific journals approved by two ministries of health and science, and seminary (English)	0.800	0.650	0.475	0.642	Delete
	Original scientific research articles published in first-level domestic journals (ISI)	0.900	0.788	0.600	0.763	Accept
	Original scientific research articles published in second-level domestic journals (Medline, PubMed, PMC)	0.931	0.813	0.613	0.785	Accept
	Original scientific research articles published in level three domestic journals (Scopus)	0.900	0.756	0.563	0.740	Accept

Contd...

Table 2: Contd...

Criteria	Indicator	Fuzzy value			Definite amount	Result
		Upper line	Middle line	Lower line		
	Articles published in journals with other valid indexes (Biological Abstracts, Biosis, CAS, Chemical Abstract, CINAHL, Current Contents, EMBASE, IC, .)	0.875	0.713	0.513	0.700	Delete
	Book reviews	0.800	0.644	0.463	0.635	Delete
	Articles published in nonindexed journals	0.550	0.375	0.238	0.388	Delete
	Scientific productions related to the expertise and field of study of the researcher	0.744	0.725	0.544	0.704	Accept
	Scientific productions unrelated to the researcher's specialization and field of study	0.688	0.519	0.356	0.521	Delete
	Interdisciplinary scientific productions	0.894	0.750	0.563	0.735	Accept
	All scientific productions of the researcher	0.900	0.750	0.556	0.735	Accept
	Other types of articles (such as letters to the editor, short articles, original articles, review articles, conference articles, educational guides, Brief Reports, Case Reports, Comments, Communication, Discussions, Editorials, Full Paper, Letter, Material, Rapid Communication, Rapid Publication, Review, Short Communication, Technical Note)	0.869	0.738	0.544	0.717	Accept
	Case reports (1-3 patients)	0.881	0.725	0.525	0.710	Accept
	Case reports (4-7 patients)	0.881	0.738	0.538	0.719	Accept
	Case reports (more than 7 patients)	0.906	0.763	0.563	0.744	Accept
	Articles Letters to the editor to provide a point of view on an article (agree or disagree)	0.738	0.569	0.388	0.565	Delete
	Miscellaneous articles (editor's notes, etc.)	0.694	0.531	0.363	0.529	Delete
	review articles (with at least 3 articles by the author in its references that they are indexed in valid international indexes)	0.944	0.831	0.631	0.802	Accept
	Review articles (without any articles by author in its references)	0.869	0.744	0.544	0.719	Accept
	Systematic reviews and meta-analysis (with at least 3 articles by the author in its references that they are indexed in valid international indexes)	0.938	0.838	0.638	0.804	Accept
	Systematic reviews and meta-analysis (without any articles by author in its references)	0.900	0.775	0.575	0.750	Accept
	Systematic reviews and meta-analysis (without citing the author in its references that indexed in valid international indexes)	0.894	0.775	0.575	0.748	Accept
	Systematic reviews and meta-analysis (with at least one citation from the author in its references that indexed in valid international indexes)	0.900	0.788	0.588	0.758	Accept
	Scientific articles and book annotations published in scientific-promotional publications	0.756	0.594	0.400	0.583	Delete
	Printed entries in encyclopedias and dictionaries	0.838	0.713	0.513	0.688	Delete
	Full text of scientific articles published in conference proceedings	0.788	0.625	0.425	0.613	Delete
	Abstracts of scientific articles in conferences	0.700	0.531	0.338	0.523	Delete
	Scientific research articles extracted from the researcher's thesis	0.888	0.756	0.563	0.735	Accept
	Articles extracted from a confidential research project without the possibility of publication, with the approval of the audit committee of the ministers	0.838	0.669	0.481	0.663	Delete
	Articles extracted from the approved program of the researcher (at least 50% of that program helps to solve the country's problems)	0.950	0.813	0.613	0.792	Accept
	Journal type (in terms of Peer Review)	0.913	0.788	0.588	0.763	Accept
	The effectiveness of scientific productions and their applicability (the application and implementation of research results in related sectors such as the health system or industry, etc.)	0.956	0.850	0.650	0.819	Accept
	The full text of the scientific article presented in prestigious national conferences (poster)	0.725	0.556	0.356	0.546	Delete
	The full text of the scientific article presented in prestigious national conferences (speech)	0.763	0.600	0.406	0.590	Delete

Contd...

Criteria	Indicator	Fuzzy value			Definite amount	Result
		Upper line	Middle line	Lower line		
	The full text of the scientific article presented in prestigious international conferences (poster)	0.794	0.619	0.419	0.610	Delete
	The full text of the scientific article presented in prestigious international conferences (speech)	0.860	0.650	0.450	0.635	Delete
	Abstract of the scientific article presented in prestigious national conferences (poster)	0.694	0.519	0.325	0.513	Delete
	Abstract of the scientific article presented in prestigious national conferences (speech)	0.725	0.556	0.363	0.548	Delete
	Abstract of the scientific article presented in prestigious international conferences (poster)	0.725	0.550	0.356	0.544	Delete
	Abstract of the scientific article presented in prestigious international conferences (speech)	0.775	0.613	0.419	0.602	Delete
	Book editing	0.900	0.769	0.569	0.746	Accept
	Book authoring	0.925	0.813	0.613	0.783	Accept
	Critical correction of the book	0.850	0.700	0.500	0.683	Delete
	Book translating	0.794	0.625	0.4255	0.615	Delete
	book compilating	0.750	0.569	0.369	0.563	Delete
	Reprint of authored book	0.794	0.606	0.413	0.604	Delete
	Reprint of edited book	0.781	0.600	0.406	0.596	Delete
	Scientific editing of the book	0.800	0.625	0.425	0.617	Delete
	Literary editing of the book	0.750	0.575	0.375	0.567	Delete
	Reference book entry	0.875	0.719	0.519	0.704	Accept
	textbook	0.913	0.781	0.581	0.758	Accept
	supplementary textbook	0.806	0.663	0.463	0.644	Delete
	Nontextbook	0.731	0.581	0.381	0.565	Delete
	Encyclopedia	0.919	0.794	0.594	0.769	Accept
	Encyclopedia and dictionary	0.913	0.788	0.588	0.763	Accept
	The book is extracted from the thesis	0.844	0.706	0.513	0.688	Delete
	The book is extracted from the researcher's master or doctorate thesis	0.844	0.706	0.513	0.688	Delete
	Book chapters in reputable domestic publications	0.825	0.669	0.469	0.654	Delete
	Book chapters in reputable foreign publications	0.881	0.763	0.563	0.735	Accept
	A book related to the researcher's expertise	0.913	0.794	0.594	0.767	Accept
	A book not related to the researcher's expertise	0.675	0.500	0.319	0.498	Delete
	Printed book	0.856	0.719	0.525	0.700	Delete
	Electronic book	0.863	0.719	0.525	0.702	Accept

Conclusions

This research aimed to develop a uniform and native framework for evaluating the scientific productions of researchers in the fields of science and health in Iran. The criteria and indicators identified in this study are consistent with global indicators. These findings are in line with Hirsch[20] and all the research based on Hirsch's index, which introduced the indicators "scientific productions" and "citation" as influential indicators in compiling the author-oriented evaluation index. In the study of Sidiropoulos, Katasaror, and Manolopoulos,[21] Jin *et al*.,[22] Belikov, and Belikov,[23] Gunthe, and Gettu,[24] criteria "academic age" as one of the most critical evaluation factors and the ranking of universities is mentioned. In the studies of Kaur, Radicchi and Menczer[25] and Hirsch,[26] the indicator of

the difference between scientific disciplines in the evaluation has been mentioned as one of the most essential criteria for developing an index for the evaluation of researchers, which is consistent with the findings of the present research. The studies of Egghe,[27] Fu and Ho,[28] and Bihari *et al*.[29] have named the criteria "how to allocate author points" as one of the primary and most important criteria influencing the compilation of the author-oriented index, which is consistent with the findings of the present study.

On the other hand, by looking more closely at the exclusion criteria in the current research and comparing them with the results of the previous parts of the research, it seems that although there are criteria for theorizing chairs in the regulations of the Ministry of Science, Research and Technology, this criteria is only applicable to humanities

and social sciences, and other fields of study in this ministry do not pay much attention to this criteria. Also, this criteria is generally not applicable in the Ministry of Health.

Placing the criteria of "scientific authority (scientific leaders)" at the top of the research criteria is justified considering that scientific authority a perspective and horizon for the country's scientific community that must be moved towards. Scientific authority leads to solving scientific problems in the context of correct policy-making. The criteria of "database used in calculating the index" and "innovation and technological impact" are placed in the second and third positions, respectively, which indicates the importance of the mentioned criteria from the point of view of the experts participating in the present study. The idea of transforming Iran's universities into third- and fourth-generation universities is accepted and important, and universities tend to push their research in a direction where the results, while being practical, end up as an innovation or problem solving; because innovations, technologies and entrepreneurship are solutions for creating jobs, increasing productivity, economic development and promoting social welfare. In recent years, the focus of the two ministries of science, research and technology, as well as health, treatment and medical education, is on demand-oriented research based on the needs of society, industry and clinical practice. The results of this part of the research are in line with the realization of the goals of the "Executive Regulations of the Law on the Support of Knowledge-Based Companies and Institutions and the Commercialization of Innovations and Inventions (approved on 21.08.1391 with subsequent amendments and additions until 2019)".[30] In the promotion regulations, these criteria have particular points and up to 50 research points can be calculated for each promotion (clauses 8 and 9 of the promotion regulations 2014).[14]

"Gaining a rank in national and international festivals related to the specialized field" has also been emphasized as the fourth criterion. This item has particular points in two ministries and can be calculated up to 10 points. Therefore, it was confirmed by experts in this research. These criteria are considered in different scientific metrics at the international level and are one of the evaluation criteria of researchers in university evaluations.[11]

Citations was the fifth essential criteria. This is significant in several ways. First, in the evaluation system of Iranian researchers, the number of articles and the type of index are significant, while the place of publication of the article and its scientific impact is of the following importance. Second, the existing regulations force researchers to publish more articles instead of paying attention to the publication of quality articles. Especially in the annual promotion where the researcher is required to publish at least two articles per year and this may reduce the quality. The only thing that is taken into consideration in the promotion regulations is the

highly cited and hot article score, which can be increased up to 1.5 times with the approval of the audit committee. This result was in line with all indexes based on H index, which consider citation the second most important criteria.[31-34] This result is contrary to some evaluation systems that consider the best research with the most scientific impact and citations.[35-37] Therefore, the results of this part of the research were not consistent with international indicators. However, in counting received citations, the reverse role of negative citations, self-citations or other nonscientific methods of citations should also be taken into account.

The placement of the criteria "subject area" in the sixth place means that the citation and authorship patterns are different in different scientific fields and it is not possible to compare the researchers of different fields with each other. In different literature, the comparison of the researchers of each subject field in the same field has been emphasized. The results of the present study are in line with Batista, Campiteli and Kinouchi,[38] Kaur, Radicchi, and Menczer[25] in this regard.

Placement of "level of cooperation" criteria, in the next place; Also, placing the criteria of "type of scientific productions", "scientific age", "Evaluating, refereeing, and monitoring or research", and "author's role and position" in the following positions shows that the experts put less emphasis on these criteria. Perhaps the reason for placing these criteria in the lower positions is due to the connection and overlapping of these criteria with the criteria that have been emphasized more.

Thus, based on the results obtained from the present research, a uniform and native framework with 11 criteria and 124 items was proposed. This framework can help to compile a native author-oriented scientometrics index for Iranian researchers as a national need. Also, provide conditions for equal and fairer evaluation of all researchers in the country, both in the field of science and health. This can lead to a review of the existing assessment criteria and more cooperation between the two ministries of science and health in the direction of developing and evaluating the country's scientific productions.

Availability of data and materials

The corresponding authors are prepared to disclose the acquired data upon receiving reasonable requests.

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Conflicts of interest

There are no conflicts of interest.

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