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Modeling Experts Selection for Scientific Evaluations-A Scientometrics Based Study

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***Abstract*—An important problem faced by global scientific administrations is the problem of how to select the right peer-review experts for evaluating scientific studies, and the stakes could be potentially high. Identifying and selecting suitable evaluation experts is crucial to judging the studies' true intrinsic values, to deciding the success of the research personnel, to correctly nurturing the vigor of the involved disciplines, as well as to determining whether the related scientific administrations have done their jobs right: the more suitable their selected evaluation experts are, the better the tax payers' money is spent. To address this problem, we propose the use of Scientometrics methods such as scientific domain ontology, knowledge mapping, and co-word analysis to ensure selecting the most "knowledgeable" and suitable peer-review experts for studies inside a single discipline, and it also can be extended to do so for interdisciplinary studies.**

Keywords—interdisciplinary studies; experts selection modeling; scientific research policy; decision making; scientific evaluation

I. INTRODUCTION

Innovation is the marrow of a scientific study, and it is a basic criterion for screening scientific projects for funding. The expected cream of scientific evaluation shall be the evaluation of innovativeness. In reality, evaluations by scientific communities is the de facto essence of experts conducted peer-review. A scientific community is composed of scientists with the same or highly similar scientific norms, frameworks, standards and/or moral requirements, and one of its important jobs is to conduct scientific research. [1] Peer-review expert selection and their qualifications are perhaps the most important factors to decide appraisal quality and fairness. From the perspectives of technological and scientific administrations that normally arrange and configure the evaluations, their major concern is how to make sure that their selected experts are the most suitable choices for the target evaluation jobs. This paper is an extension of our work in experts recognition [2].

The traditionally used experts selection method is the selection based on the criterion of discipline: to select the experts in the disciplines that are informed by the studies (perhaps on the review form filled out by the researchers whose studies are to be evaluated). Such selection cannot more than often produce the expected results. Such selected experts are at most the colleagues of the ones to be reviewed in a big sense: they might not be knowledgeable about the detailed subdivided areas of each other even if they come from the same discipline that has been defined on a broad scope, e.g., Chemistry, Physics, Biology, Computer Science, etc.

The goal of peer-review experts selection is to make sure the selected experts should master as much as possible the needed/related professional languages, methodologies, research framework/norms, and trends of the major subject areas of the ones to be reviewed as well as to make sure that the selected are as much "knowledgeable" as possible about those in the small refined target scopes inside the areas so that objective, fair, informed, and insightful evaluations are made possible. The prevalent view on peer-review experts is that "They should be the frontline research scientists and not government employees. They must have rich experiences in doing research as well as ample achievements." Because "Only under these conditions they can provide objective analysis and judgment based on the merits of research projects." [3] To satisfy these requirements, we should emphasize selecting the peer-review experts who really "know the business". These experts normally compose the "scientific community" for "the business". Therefore, identifying such "scientific community" is the key to identifying the most suitable peer-review experts for scientific evaluations.

One must also take into consideration the selection of peer-review experts for studies that involve more than one major disciplines: the interdisciplinary study. The key of interdisciplinary study is the fusion of different knowledge systems with strong originality and potential for innovation. Evaluation of interdisciplinary study has been attracting a lot of attentions from research administrations and other cohort institutions in every major scientific societies. Indeed, discovering originality and innovativeness in interdisciplinary studies also come with difficulties. Two important problems stand out: first, how to channel the qualities of the studies from mixed subject areas (disciplines) to peer-review experts, and secondly (and perhaps the harder one to tackle), how to ensure the evaluations are effective (or the experts are the qualified one whose combined knowledge domains cover up the needed ones in depth well enough).

To answer the second question, one must understand the differences between intra-disciplinary studies and inter-disciplinary studies. In fact, interdisciplinary studies with strong originality presents a bigger challenge to peer-reviews: it fundamentally challenges the selection of experts. Research scopes of traditional disciplines are strictly confined to support in-depth studies to the problems in scopes [4]. In contrast, research problems of interdisciplinary studies are not confined to traditional disciplinary frameworks. Consequently, on one hand, the peer-review experts selected from traditional disciplines may not fully appreciate the originality and innovativeness of interdisciplinary studies, and, on another hand, such studies are quite often not so consistent with the established and/or default research norms of the experts and therefore the acceptance (a form of subjective evaluation) of such studies by the experts could be problematic. These problems make evaluating interdisciplinary study a difficult task for experts conducted peer-reviews.

In all, to ensure the quality of expert selection for evaluating both intra-disciplinary and inter-disciplinary studies, we propose to use Scientometrics methods such as the scientific domain ontology, knowledge mapping, and co-word analysis. We will demonstrate that our method can be used for identifying suitable peer-review experts for studies in a single discipline, and it also can be extended to do so for interdisciplinary studies with minor differences in methodology.

The rest of paper is organized as follows. Section 2 introduces the needed Scientometrics methods and norms, explaining in detail what scientific context/communities and knowledge mapping are and why they are consequential in this research. Section 3 presents an empirical study of using domain specific ontology to identify qualified peer-review experts for intra-disciplinary studies. Section 4 presents another empirical study that does the same for interdisciplinary studies. Section 5 present related work. Section 6 presents discussions, limitations and future work for this study. It concludes this paper as well.

II. Scientific Community and Related Concepts/Theories

There are normally multiple scientific communities inside a discipline. Each of them may hold its own norms, which differ in research directions, emphasis, viewpoints, concept system and scientific thinking, which in turn result into a unique phenomenon: poor communications more than often exist between the communities inside a discipline; in contrast, the intra-community communications are very good. Two underlying factors contribute to this phenomenon.

A. Scientific Context

Members of a "small" science community often cite each other's' works and they together shaped the similar scientific research/language context for the community. They are also somehow bounded to each other because of their familiarities to each other's' works. [5] Peer-review experts for a scientific study themselves compose a scientific community that share the same scientific context. Sharing the same context fundamentally supports the fact that the "knowledgeable" experts often share similar professional views on matters within the scope of the community. Other than that, the "knowledgeable" peer-review experts more than often share an open and receptive attitude toward scientific research/documents inside their scope also because their same "background". Problems would arise when experts from a "small" scientific community review scientific research/studies beyond the scope of their community even if the research/studies fall into the same discipline as the one of their communities in a bigger sense: they either could not "fully" appreciate the work or the open and receptive attitude would not be present because of their unfamiliarity with the research subjects. In fact, differences in scientific contexts, "backgrounds", may lead to ambiguities, miss-interpretations, and uninformed decisions when experts from various distinct communities review each other's works.

B. Scientific Concepts System

We observe that "small" scientific communities share highly unified/generalized systems of concepts/context. Differences in the systems reflect differences in their respectively represented scientific contexts. Moreover, multiple clusters of concept systems of a discipline signify the existences of multiple communities within it. They also represent the variances of research problems between the communities. Peer-review experts for a scientific study belong to certain community/communities and their concept systems should be the same or at least be highly similar to each other that covers well the study object. The same understanding/meanings/definitions of specific scientific concepts effectively ensures that the experts share similar views on research methodology, norms, think pattern, etc., so as to stabilize the communities the experts belong to.

1) Importance of scientific context to scientific evaluations

Sharing similar scientific contexts, when experts from a community study a research subject, when they try to describe an observation using a specific scientific language, or when they evaluate a scientific study, they will conduct the matters in a well-defined, orderly and "common" manner. Their contexts already prescribe the questions they can ask, the descriptions they can write, and the comments they are able to offer. A context decides the "world view" of a community. It is indeed that the context background decides the "world view" of a community. [6]

A scientific community's view-scope of its common language is delimited by its context, which is the standing point of the community. If a community wants to transcend its scope, it has to make changes to its standing point. In other words, it has to construct a new scientific language that is consistent with its new standing point.

Quality peer-review relies on correct choices on peer-review experts, and only the "knowledgeable" experts from the same community (with the same context) as the one being reviewed are capable to make sound and informed reviews. Selection of the experts shall be made based on whether their scientific context(s) conform(s) to the one being reviewed. That is because with the correct context backgrounds they should be the ones that fully understand and appreciate the language used in the study, and the specific scientific language of a community has its own semantic rules and unique concepts system, which conforms to the community's context. Consequently, judging whether a candidate peer-review expert belongs to the same community as that of the study being reviewed can be made based on the scientific language used and/or the uses of concepts, themes, and keywords, etc.

2) The concepts in knowledge mapping

(Scientific) Knowledge Mapping is a graphic that represents the development of scientific knowledge and their structural relationships within a domain. [11] Taking the measurement of scientific knowledge as its object, Knowledge Mapping belongs in the area of Scientometrics. Knowledge mapping is defined as the "visualized knowledge resources obtained throughout time, and their vectors" Zeyuan Liu, Rui Chen and other scholars, which draws, mines, analyzes and visualizes scientific knowledge and the connections of them. With the establishment of a knowledge sharing environment inside organizations, the co-operations and the deepening of scientific and technological research is promoted [12].

A spatial structure is utilized to present the connection between the subject frontiers in scientific mapping [13]. It has been demonstrated that scientific citation and those cited usually have relationship on the subject content. Through citation clustering analysis, especially with the focus on the reticular relationship of citation, the genetic relationship between the subjects and the corresponding structures can be detected, besides the determination of Interdisciplinary scholars in the areas. The intersection and infiltration and development trend of these subjects can also be completed by knowledge mapping. The dynamic structure and development law of subjects can be disclosed with the analysis of the background, status, breaking achievements and intersection and direction of a certain subject. [14]

C. *Domain Specific Ontology*

Domain specific ontology describes knowledge domain elements such as concepts, properties of concepts, their relationships and constraints. [7] A concept of a domain, a.k.a. class, is a clear and formalized description of domain knowledge. Domain specific ontology, aiming at specific application domain. It defines the structures and contents of the abstract domain knowledge like types of knowledge, terminology and concepts, and it also constrains them to shape the very foundations of domain descriptions. [8]

D. *Concept Networks*

It is important to utilize the theories of ontology in order to construct concept networks of domain knowledge, to analyze the relationships within it, and to construct its deduction rules. It is also important to visualize domain specific ontology by using computerized assistances to facilitate understanding and information processing. Although on a knowledge network, the relationships could be quite numerous and complicated, every knowledge network is characteristically and implicitly structured. For instance, in a technology domain, knowledges from multiple disciplines exhibit certain intricately defined structural and networking properties. They are represented using concept networks on a graph that consists of dots and lines connecting the dots. A dot on a concept network stands for a concept, and a connection between the dots stands for a relationship between the concepts. The more connections between two dots, the more related the two represented concepts are.

E. *Co-word Analysis*

By analyzing words and phrases in document resources, co-word analysis determines the relationships between the themes reflected by the resources. The more frequently two words appear together in a document, the more related their represented themes are to each other. Consequently, statistical analysis on the frequencies of keywords in a set of documents can be used to produce the related concept network, onto which the distances between dots (words) reflect their affinity. Co-word analysis is based on such analytical process that treats targets words (themes) as analytical objects. It employs a set of multivariate statistical analytical methods, for example, cluster analysis, factor analysis, etc. Moreover, we can graphically represent the intricate co-word relationships among the analytical objects. [9]

III. Empirical Study: Using Domain Specific Ontology to Find the "Knowledgeable" Peer-review Experts for Intra-disciplinary Study

In this section, we will demonstrate an empirical study to find "knowledgeable" peer-review experts for intra-disciplinary studies. It uses domain specific ontology, its concept network and co-word analysis.

A. *Data Source and Process*

The most authoritative journal for Scientometrics research discipline in the world is Scientometrics. Established in 1978, it has long been on the research frontlines in this discipline. It reports all major international subjects related to the developments of Scientometrics and almost all conferences in it. The journal provides a sound platform for quantified and qualified developmental scientific evaluations in this field. As this journal represents well the discipline of Scientometrics, it is selected as our research target to select "knowledgeable" peer-experts for Scientometrics study. All data in this study are selected from the journal papers from 2012 to 2017 in the database of ISI Science Citation Index. The journal papers are used as our data sources. Based on the papers' attached data such as keywords and theme words, experts' academic norms (concept) network for Scientometrics and the related research subjects network are visualized using computerized assistances. Different scientific communities inside the discipline are determined based on the networks. We study the differences on research subjects between the communities to find out the different scientific contexts, which is a key to selecting peer-review experts.

B. *Results Analysis*

Figure 1 shows the research subjects/themes network based on the statistical analysis on the keywords data from the downloaded Scientometrics journal papers from SCI database, with keywords disclosing research themes and subjects. The frequency of a keyword is proportional to the popularity it receives. Gradually, a highly-popular keyword would become the focus or hot spot research problem. We can see from the graph that hot keywords from Scientometrics are: CITATION, SCIENCE, INDICATOR, COLLABORATION, COCITATION, PERFORMANCE, BIBLIOMETRIC, and SCIENTIST, etc.

A dot on the graph represents a research subject/theme. A line connecting two dots represents their inter-relationship. Connections between dots vary significantly because of the richness of scientific languages/words used, the different but equivalent research methodologies, and the view angles on research subjects, etc. They regardless render each subject/theme somehow related to some other one(s).

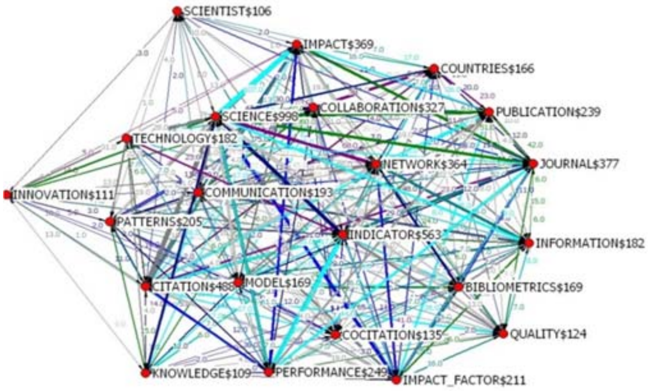

FIGURE I. RESEARCH SUBJECT/THEMES NETWORK GRAPH OF SCIENTOMETRICS

Figure 2 shows the scientific communities' network graph for highly cited peer-review experts in Scientometrics. Figure 2 also visualizes the interactions of each of "academic cliques" in Scientometrics. The red dots on the graph stand for highly cited peer-review experts. The directed lines between red dots represent academic relationships. Directions on the lines stand for influences. Based on the map, we select two "small" scientific communities: BRAUN T and SCHUBERT A and INGWERSEN P and THELWALL M to discern their differences.

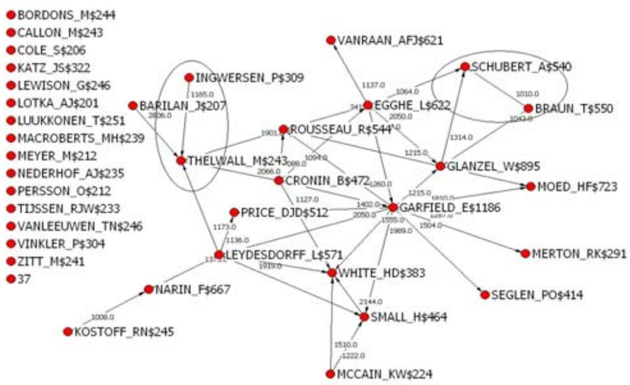

FIGURE II. RESEARCH SUBJECT/THEMES NETWORK GRAPH OF SCIENTOMETRICS

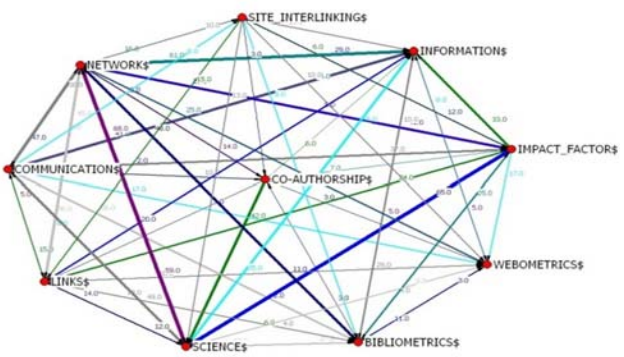

FIGURE III. MAJOR RESEARCH SUBJECTS/THEMES OF INGWERSEN P. & THELWALL M

Statistical analysis on the keywords used by the four experts is performed and we keep records on the common keywords used by the two communities respectively in Table 1. We also produced the scientific context/language network graphs for them. It can be seen from Table 1, Figure 3 and 4 that though the four experts belong to the same discipline (Scientometrics), there are much differences in research subjects/themes and interests in their respective "small" communities. Therefore, we recommend that the experts from their respective "small" communities compose the respective peer-review experts candidate pools for Scientometrics studies using the high frequency keywords of their own communities.

TABLE I. DIFFERENCES IN THE SCIENTIFIC LANGUAGES OF THE TWO SELECTED SMALL COMMUNITIES (FREQUENCY > 1)

BRAUN T. & SCHUBERT A.			INGWERSEN P. & THELWALL M.		
ord	freq	Keyword-plus Words	ord	freq	Keyword-plus Words
1	8	SCIENCE	1	7	IMPACT FACTOR
2	6	COUNTRIES	2	4	SITE INTERLINKIN G
3	3	INDICATOR	3	4	SCIENCE
4	2	DATAFILES	4	4	INFORMATIO N
5	2	RANKING	5	4	WEBOMETRI CS
6	2	SCIENTIST	6	4	BIBLIOMETRI CS
7	2	COLLABORATI ON	7	3	COMMUNICA TION
			8	3	LINKS
			9	2	CO-AUTHORSHIP
			10	2	NETWORK

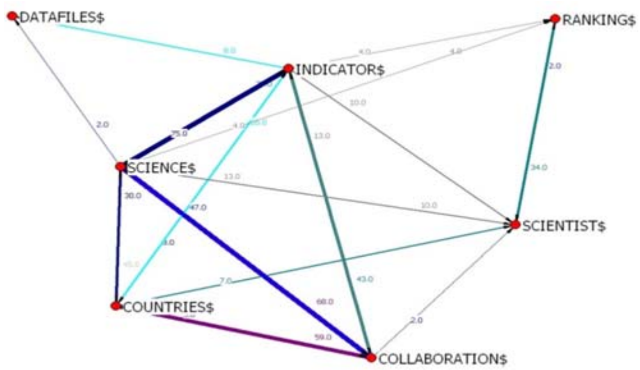

FIGURE IV. MAJOR RESEARCH SUBJECTS/THEMES OF BRAUN T. & SCHUBERT A

IV. Empirical Study: Selecting Peer-Review Experts for Interdisciplinary Studies Using Scientific Knowledge Mapping

The problem of peer-review expert selection for interdisciplinary studies and the problem of experts searching/indexing and expertise identification (ESIEI) (partially illustrated in the last section) has something in common. A quick identification of the experts in certain domains or organizations is the goal of ESIEI, which is to obtain their help and share their implicit expertise and knowledge, utilizing documents and other resources characterizing the works of the experts inside or outside the filed to identify the professional degree of an expert on certain field and arrange the result in a list from high to low [15]. In spite of ESIEI's theoretical supports to peer-review expert selection in scientific research administration, scientific knowledge mapping has rarely been used as an identification tool in the past. As a result, the selection of peer-review experts can hopefully be solved with the use of scientific knowledge mapping.

For empirical study setup, we pick "water" as an interdisciplinary study object. We will demonstrate how to find the peer-review experts from Environmental Sciences to evaluate interdisciplinary studies related to keyword "wastewater".

Technically speaking, scientific studies about water range across various domains: Physics, Chemistry, Biology, Ecology, Economics, etc. Employing scientific knowledge mapping, concept networks of major research themes about water and networks of disciplines (domains) are constructed. Suitable peer-review experts for certain hot spot interdisciplinary research theme (e.g. wastewater) from certain domain (like environment science) can be found.

A. Data Source

Water Research is the most authoritative journal about scientific water studies. SCI database shows that, between 2015 and 2017, there were totally 1063 articles that were cited. Using those citations, we have found 3386 citing articles and download their data, including author(s), title, keywords or keywords-plus and subject category.

B. Process

A candidates' pool for peer-review expert is constructed containing the authors of the citing articles. The selection is done as shown in the following steps.

1. Analyze important data units related to water science research to ascertain the disciplines closely related to water and to visualize them to determine their quantative relevancies to water.

2. Analyze keywords from the downloaded articles to determine high frequency science words in water research and visualize their inter-relationships to determine the semantic relevancies between the words.

3. From the disciplines closely related to water research, fetching the words with the highest relevancies and determining the authors of the related articles. Finally, these authors are selected as the most suitable peer-review experts [10] for water related interdisciplinary studies using the target keyword(s) (in this case, "wastewater") from the selected disciplines.

C. Results Analysis

Table 2 demonstrates the research domains that have high citation frequencies. The top five are Environmental Science, Environmental Engineering, Water Resources, Chemical Engineering, and Biotechnology and Applied Microbiology. They are all highly relevant to water research. In general, using the table as references, a scientific evaluation administration can pick peer-review experts for water research projects from the top disciplines. Figure 5 is the visualization of the relevancies of water research related disciplines. Dots in the figure represent the disciplines.

TABLE II. DOMAINS WITH ARTICLES CITING WATER RESEARCH ONES FROM 2015 TO 2017 (FREQUENCY > 250)

Order	Frequency	Major Research Discipline
1	1587	Environmental Sciences
2	1127	Environmental Engineering
3	708	Water Resources
4	500	Chemical Engineering
5	408	Biotechnology & Applied Microbiology
6	294	Civil Engineering,
7	255	Physical Chemistry

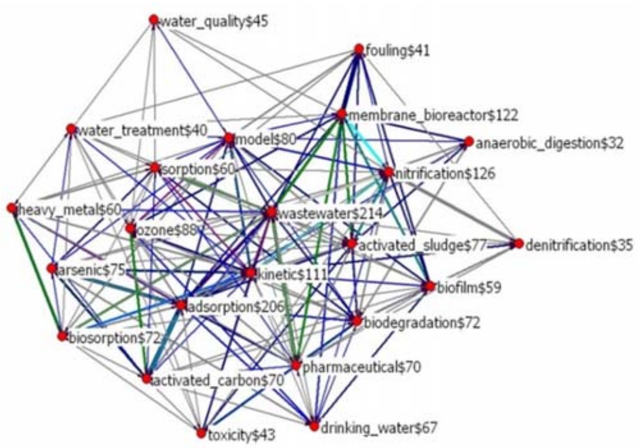

FIGURE V. VISUALIZATION OF HOT SPOTS WATER RELATED RESEARCH SUBJECTS/THEMES.

Table 3 demonstrates the ordering of the high frequency keywords in the citing articles. A keyword indicates a research theme. The higher frequency a keyword has, the more attention its similar research theme in the interdisciplinary research attracts, and as its popularity grows, it gradually becomes a hot spot research problem. Figure 6 is visualized the hot spots themes related to water research.

TABLE III. HIGH FREQUENCY KEYWORDS IN CITING ARTICLES FROM 2015 TO 2017 (PARTIAL)

Order	Frequency	Keywords
1	214	wastewater
2	206	adsorption
3	126	nitrification
4	122	membrane bioreactor
5	111	kinetic
6	88	ozone
7	80	model
8	77	activated sludge
9	75	arsenic
10	72	biodegradation

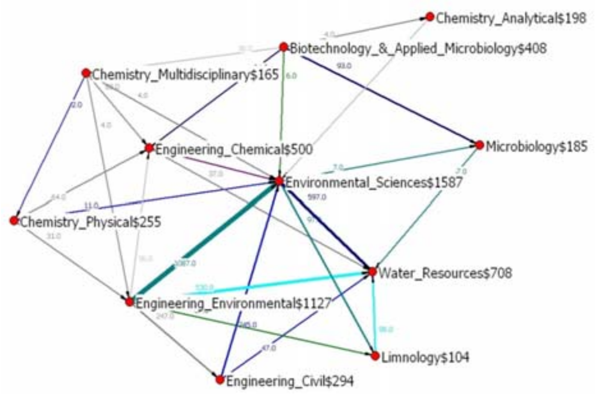

FIGURE VI. VISUALIZATION OF RELEVANCE OF WATER RELATED RESEARCH DOMAINS

TABLE IV. HIGH FREQUENCY KEYWORDS IN CITING ARTICLES FROM 2015 TO 2017 (PARTIAL)

Order	Frequency	Keywords
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2	206	adsorption
3	126	nitrification
4	122	membrane bioreactor
5	111	kinetic
6	88	ozone
7	80	model
8	77	activated sludge
9	75	arsenic
10	72	biodegradation

Environmental sciences are chosen from water related interdisciplinary subjects to find the research focus and the corresponding experts who might be the most suitable peer-review expert candidates in this field. The processed AU, DE and SC segment data information of papers citing WaterResearch is contained in Table 4. AU stands for Author. DE stands for keyword. SC stands for discipline. Environmental sciences are searched in SC segments with every keyword in DE segments recorded. High frequency keywords are counted to show the research focus's direction of water related interdisciplinary studies from Environmental Sciences, as shown in Table 5

TABLE V. AU, DE AND SC SEGMENT DATA IN CITING ARTICLES (PARTIAL)

AU	DE	SC
Tafangenyasha,C; Dube, LT;	agricultural runoff; water quality; nutrients; benthic invertebrates;	Engineering, Civil; Water Resources;
de Vicente,I; Jensen,HS; Andersen, FO;	eutrophication; restoration; aluminum; phosphate; humic acid; lakes;	Environmental Sciences;
Carissimi,E; Miller, JD; Rubio, J;	flocculation; hydrodynamic; coiled reactor; stiffed vessel;	Engineering, Chemical; Mineralogy; Mining & Mineral Processing;
Ying, GG; Kookana, RS; Kumar, A;	estrogens; alkylphenols; bisphenol A; removal; effluent;	Environmental Sciences; Toxicology;
Zanetti, F; De Luca, G; Sacchetti, R; Stampi, S;	wastewater; peracetic acid; disinfection; bacterial indicators; bacteriophages;	Environmental Sciences;
Tafangenyasha,C; Dube, LT;	agricultural runoff; water quality; nutrients; benthic invertebrates;	Engineering, Civil; Water Resources;
de Vicente,I; Jensen,HS; Andersen, FO;	eutrophication; restoration; aluminum; phosphate; humic acid; lakes;	Environmental Sciences;
Carissimi,E; Miller, JD; Rubio, J;	flocculation; hydrodynamic; coiled reactor; stiffed vessel;	Engineering, Chemical; Mineralogy; Mining & Mineral Processing;
Ying, GG; Kookana, RS; Kumar, A;	estrogens; alkylphenols; bisphenol A; removal; effluent;	Environmental Sciences; Toxicology;
Zanetti, F; De Luca, G; Sacchetti, R; Stampi, S;	wastewater; peracetic acid; disinfection; bacterial indicators; bacteriophages;	Environmental Sciences;

The recorded AU data segment information is ranked according to their frequency from the keywords selected above. Table 7 contains a rank of experts from the review experts pool constructed with the use of authors' information in AU data segment after selecting wastewater as key words. The result applies to the discovery of most suitable peer-review experts who take wastewater as their research focus in water related interdisciplinary subjects from environmental sciences. The fact that these experts are all active front-line experts for water environment pollution control corroborates what has been achieved in the experiment, and so they are the peer-review experts wastewater research needs.

TABLE VI. HIGH FREQUENCY KEYWORDS IN WATER STUDIES FROM ENVIRONMENTAL SCIENCES (PARTIAL)

Order	Frequency	Keywords
1	136	wastewater
2	106	adsorption
3	64	ozone
4	60	kinetic
5	60	nitrification

TABLE VII. HIGH FREQUENCY AUTHORS FOR WASTEWATER STUDIES FROM ENVIRONMENTAL SCIENCES (PARTIAL)

Author	Frequency
Logan, BE	6
Barcelo, D	4
Garcia, J	4
Korbahti, BK	4
Ma, HZ	4
Muller, J	4
Tyagi, RD	4

V. RELATED WORK

Experts recommendation is an established research topic. There are many approaches proposed to select suitable experts for scientific review, and each of them (or their cohorts) takes a unique angel toward the problem. This section will cover the major ones.

Duanduan Liu et al. proposed an experts selection method based on big data technique and a mathematical relevance analytical model. [17] This method can be used to find review experts for a particular applicant (the researcher). Balog et al. proposed a language model based method to seek suitable experts to help solve problems. [18] Daud, Li, Zhou, & Muhammad suggested a temporal (time topic) model to seek experts from a specific domain of expertise. [19] Fang et al. used a probabilistic model to find experts. [20] Macdonald & Ounis, interestingly, recognized the experts finding problem as a voting one and thus suggested a voting model to solve it. [21] Wang et al. suggested an expert finding algorithm, ExpertRank, which considers both document-based relevance and the expert's standing (authority) to find suitable review experts. [22] A research content based method was proposed by Yukawa et al. [23] Balog & Rijke applied expert profiling to expert finding. [24]

A key difference between our research ideology and the above ones is that we focus purely on objectively documented data with as few manual transformation or interpretation as possible in order to eliminate any potential subjectivity. Even if we did not apply a mathematical and transformational data relevance model (as we are still trying to find a “purely objective” one), the idea of social network is present in our work in another form: scientific community. However, in our form, the connectivity is based only on research keywords in publications and nothing else.

VI. DISCUSSIONS AND CONCLUSIONS

The study on peer-review experts selection system inspired this work.

It is reasonable that high quality peer-review must be performed by “knowledgeable” experts that belongs to the “small community” that the study to be evaluated falls into, as those experts must be quite familiar with the study subjects and the related scientific context/languages used. They also should possess/maintain/uphold common understandings to the scientific concepts used and so be capable to appreciate the related ways of thinking. Only when these requirements are satisfied, the quality of such a review can be ensured. Scientometrics methods are important tools that help to do so.

Scientometrics methods like co-word analysis and knowledge mapping are used to grasp the first-hand knowledge about the expertise of candidates for peer-review experts. It also helps a scientific research administration conduct effective screening of the candidates in order to ensure the selected ones fit well the evaluations jobs instead of making purely subjective and uninformed judgments on their qualifications, which will not usually yield sound decisions. The methods also help to construct the related network graphs visualizing research themes/hot topics and inter-relationships among the experts in a discipline and hence it provides an intuitionistic support/evidence to the administrations for understanding the expertises of the experts and the characteristics/developmental trends of the discipline(s).

By knowledge mapping and analysis on the citations on articles from certain interdisciplinary study domain and the citing articles from other related disciplines, the research areas overlap between that domain and the disciplines can be accurately determined. It can also provide related background information of peer-review experts and data support to discover development trends of an interdisciplinary study domain to various scientific research administrations [16].

Substantial evidences to the expertises of peer-review experts appear rarely on the traditional experts recommendation forms. Move over, the related contents are usually filled in by the experts themselves. Co-word analysis proves to be an objective alternative to evaluate the credentials of the peer-review expert candidates. As it provides evidences to substantiate the credentials.

A key to the expert selection system is intelligent selection. It is a scientific instrument to minimize manual interferences in order to ensure the selection process is open and fair. The methods demonstrated in this paper can be used to implement such a system, which will be our extended work in recent future.

For a study to be evaluated, a system using the methods intelligently and automatically selects the scientific communities which consist of “knowledgeable” experts in the subject area of the study, or the system can automatically select “knowledgeable” experts given a set of keywords with a nomination of discipline. Scientometrics methods like domain specific ontology and co-word analysis provide a solid, reasonable, logical, scientific and technological foundations onto which such an intelligent experts selection system can be built and managed.

Interdisciplinary studies are essentially domains influenced by the interactions of multiple traditional disciplines with strong innovativeness and originality. Those disciplines interact with each other based on the common understanding of the scientific languages and words used. Knowledge mapping provides information of the hot spot themes in interdisciplinary studies to scientific research administrations. Such themes serve as important references based on which the studies’ innovativeness and originality can be judged. At the same time，the involved disciplines of an interdisciplinary study domain can also be determined [16].

Given an interdisciplinary study, a set of disciplines involved in the study and a set of research keywords that an interdisciplinary study used, using the method illustrated in Section 4, the most suitable peer-review experts from the disciplines for the study can be determined. It objectively discovers the experts with the set of expertise matching the needs to evaluate the study. Therefore, it provides a solid tool that a scientific research administrations can use to judge the suitability of certain peer-review experts to certain evaluation jobs [16].

Finally, we must point out that our proposed method should only be used for more or less “not new” intra-disciplinary and interdisciplinary study themes with keywords recognized inside or across the related domain(s). In addition, co-word analysis also has its limitations: it is based on the assumption that a keyword would correctly reflect the essence of an article and the no important keyword would slip from an author’s memory when the author finalizes his/her paper.

In fact, every method has its “comfort zone” that may deviate from a real world scenario, which renders the method not very effective in the case. To systematically address the problem, in the future we are to find an auxiliary method to supplement our current one, which would focus solely on how to identify peer-review experts for the “new” study themes. Our final goal is to construct a practically usable and integrated method for expert selection composed with several components (with the proposed method as one of them). The union of the components’ “comfort zones” are supposed to cover as many non-trivial scenarios as possible so that the integrated method will be employed with high confidence by various scientific research administrations.

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