

Scientometrics Analysis for Research Performance Evaluation: Methodological Issues at Meso and Micro Levels

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Newly introduced scientometric indices have gained much popularity and have been widely discussed. The application of such indices and their validity for Research Performance Evaluation (RPE) focuses on various contexts and aggregate levels. Several methodological concerns have been raised regarding the application of these indices for RPE purpose. This study aims at describing the methodological issues faced and lessons learned from the investigations carried out on engineering research data in Malaysia, using the scientometric approach at meso and micro levels. This scientometric case study employed a set of newly introduced RPE indices along with traditional metrics. The unit of analysis was Malaysian engineering research. At meso level, twelve Malaysian universities were selected. While, at the micro level, a hundred most productive Malaysian related researchers were chosen. The data were retrieved from Web of Science (WoS) for the duration of ten years (2001-2010) and limited to nine WoS engineering categories only. This study enlightens the issues and suggests the possible measures that should be taken into account while conducting the empirical studies by applying scientometric approach to RPE.

Keywords Research Performance Evaluation; Publications; Citations; Engineering research; Malaysia

Introduction

To study the application of mathematical and statistical methods to books and other media of communication is called bibliometric (Pritchard, 1969). Nalimov and Mulchenko (1969) defined scientometric as “the application of those quantitative methods which are dealing with the analysis of science viewed as an information process”. These terms are often used as synonyms. Scientometric is more multifaceted encompassing subareas such as structural, dynamic, evaluative and predictive endeavor of scholarly communication (Lundberg, 2006; Zavaragi & Reza Fadaie, 2012). The term ‘scientometric’ is used instead of ‘bibliometric’ when our purpose is to carry scientific research productivity analysis for RPE (Hassan & Loebbecke, 2010).

Mostly, the scientometric approach is applied to address the quantitative core (productivity or growth patterns) of research. However, the qualitative core (impact) of research is going to become crucial and difficult with the advent of online reference enhanced databases, introduction of new h-type indices and the global trends of institutions’ ranking by well-known agencies e.g. Times Higher Education World University Rankings, QS top universities ranking,

Academic Ranking of World Universities, National Taiwan University Ranking, and the Leiden Rankings of Universities. Consequently, to examine the capabilities of traditional metrics and to seek potentialities of newly introduced indices for RPE have become much important tasks in the area of study.

Publication activity as a quantitative core and citation as an impact, influence or quality core, are two critical indicators of research performance. In general, the dimensions of research productivity are explored by quantity (number of publications) and quality (total citation counts) of output records with traditional activity and impact measures (Van Raan, 2004; Hirsch, 2007). In developing countries, research performance evaluation (RPE) exercises have faced somewhat more different challenges than the one prevailing in developed countries. Developing countries have comparatively lesser publications and lower citations trends internationally, and low recognition in popular reference enhanced databases (Tahira, Alinda & Bakri, 2012, 2013). Furthermore, the culture of RPE in these countries is also not very established (Imperial & Rodriguez- Navarro, 2007; Bakri, 2010). In Malaysia, the indicators of scholarly activity (publication) and impact (citation and its subsequent metrics and journal impact factor score) are considered for researcher (micro level) and institutional (meso level) for decision making (Glosari MYRA 1 and 11).

The previous research studies demonstrate a range of frequently used metrics. The application of these metrics causes some methodological issues during the collection, retrieval, handling and cleaning of data. The methodological considerations are very important as a striking agreement is found among the metrics/indices and RPE used in UK (Norris, 2010; Oppenheim, 1997), in Italy (Abramo & D'Angelo, 2011, 2013) and in the Netherlands (Van Raan, 2006). Whereas a weak correlation is found in Malaysia (Bakri, 2010; Tahira, 2014). These issues are subjected to careful considerations, especially when we link

the use of metrics and indices to RPE of individuals and institutions.

Research Objective

One of the data collection principles mentioned in the recent Leiden manifesto named "Bibliometrics: The Leiden Manifesto for research metrics" (Hicks, et al., 2015) is to "keep data collection and analytical processes open, transparent and simple". Therefore, this study briefly describes the methodological issues related to scientometric data collection at meso and micro levels, and also to the lesson learned from a case study of Malaysian engineering research. This case study was conducted through the use of the scientometric approach for RPE at meso and micro level.

Research Design

The overall data collection procedure and measures adopted for all phases in the Malaysian case study are described here. Firstly, a modified top-down approach (Van Leeuwen, 2007) was used to collect data at the meso level. The data were retrieved from Web of Science (WoS) through its host website that claimed itself being the "first choice of about twenty thousand million researchers of ninety countries who want to stay relevant and evaluate the impact" with the slogan "The Discovery Starts Here" (New Web of Knowledge). Our field of observation was engineering research in Malaysian universities, which was narrowed by nine engineering subcategories in WoS; time span of ten years (2001-2010); and document type article along with only review. The nine categories were those which had Engineering as a common term in their initials.

Methodological Issues

In a scientometric study, the standard methods of data strategies regarding the adoption and handling of data are required at each phase. In our case study, the adopted data strategies and the management issues handled at meso and micro level are described in detail in this paper. Taking it as the initial point, we discuss the micro and meso level data collection issues.

Databases Selection

The three most popular reference enhanced databases are WoS via ISI Web of Knowledge, Scopus via Elsevier and Google Scholar (GS). The first two databases are compared in a favourable way, while Google Scholar has the advantage of being available to everyone without a subscription fee. It is very critical to select an appropriate database that has a sound policy for journal selection, offers maximum evaluation services, metrics and indices for evaluation purpose, and mapping efficiency for initial results. To date the Web of Science is an acknowledged database mostly used by scientometricians. This database has more coverage and a long history to pre-1996 scholarly literature. The strength of WoS falls in its coverage, time span and journal selection policies. Its usage has been reported in numerous bibliometric studies; more than that of Scopus or any other database (Lazaridis, 2010; Imperial and Rodriguez-Navarro, 2007). However, it is also assumed superior to Google Scholar (GS) because of its functionality and sophistication (Norris and Oppenheim, 2007). Its competitor SciVerse Scopus has a better coverage to science discipline, conferences and has a better abstracting service. However, Jacaso (2008) feels that somehow it is being underestimated. To clean up data is a cumbersome task, and this exercise is multiplied in case of GS. GS is more criticized because of its hidden features, messy data, and errors in publication and citation counts. Therefore, the metrics/indices considered for RPE face methodological concerns in the collection of data and precision.

Methodological Issues Related to Meso and Micro Level

Data collection has several shortcomings due to poor coverage, improper visibility by several databases, national coverage, language barriers, cultural and regional issues. This is a time consuming, and cumbersome work that requires careful observations, through the following of standard exercises. Inaccurate and insufficient

data can lead to wrong interpretations and decisions. Therefore, data collection is a difficult task and requires careful handling at each stage. We are discussing the issues which have been faced during the process of data collection at two separate phases; micro and macro level.

At Meso Level

The first step was the removal of sixty records which had no affiliation with Malaysians universities. These were either personal records or affiliated to institutions other than Malaysians universities. Further, 24 records of The University of Nottingham (UNM) and 12 records of Monash University (MUS) were excluded as they belonged to the England and Australian campuses instead of the Malaysian campuses. There were 112 records with the affiliation University Pertanian Malaysia (now University Putra Malaysia, UPM). Based on the objective of this study, it was important to consider proper time span, threshold or cut off point and the use of specific counting scheme. Such record recognition was further complicated, by some problematic records that used abbreviations such as IIUM, USM, UTM etc.

Overview of Micro Level Data

Malaysia is multi-ethnic and multi-cultural, with three major races. The culture, religion, belief, norms and policy, etc. have sound effects on the person's name. "It is typical for Malaysian names to consist of a variety of different formats depending on their cultural and ethnic background, such as Malay, Chinese, Indian, or other minorities. There are many possible names that might be indexed in the WoS (Bakri, 2010). Scientometric data always require a cleaning process, and this problem gets multiplied at the individual level.

Year wise 80th percentile (20%) of Highly Cited Publications (HCP) was extracted from meso level data. We extracted the first 100 most productive Malaysians researchers in the area under study for micro level analysis. Websites of the researchers and universities were checked to detect affiliation and author's name. Author's last affiliation was considered as the final. All the

data at this level were also cleaned manually for affiliation, homonym, and homograph problems.

At Micro Level

There was a lot of problematic data at researchers' level in our dataset. Most common problems noted in our dataset are: the use of different names with a slight change in spelling, changing universities and having same initials and last names. These problems are elaborated here with a few examples in each case.

Name Recognition Problem

There are many different authors from different institutions with the same initial name. For example, when we searched for Ismail, F, the outcomes were Ismail, F, Ismail, FA, Ismail, FM.

The same kind of issue was with another name, Ain Mohammad. Variant names such as Ain, MF, and Mohammad, A, appeared. Another problem was the difference in the use of the last abbreviation. We found that Najafpour, G and Najafpour, GD or Omar, M. Omar MK were the same author.

Institutional Recognition

In our dataset, most of the problems are related to the author and his institutional recognition. Several such examples are illustrated:

1. Kamaruddin, A and Kamaruddin, AH are two different authors belonging to the same university - USM.
2. Omar, M.; Omar MK is an author who was previously from MMU, but is now affiliated with USM. Another author, Omar MZ is from UKM.
3. Mohammad, A and Mohammad, AR are two different people belonging to USM
4. Zakaria, Z and Zakaria, ZA are two different people belonging to UTM.

Change of Institution Address

1. Reaz, MBI, who has 18 publications from MMU and only one publication from UKM, is now affiliated to UKM.

2. Choudhury, PK, was initially from MMU, but is presently at UKM
3. Tan, CP (full name Tan Chee Pin) is from MMU and Tan, CP (Tan, Chin Ping) is from MUS.
4. Mahdi, MA, is now at UPM but also has five publications with affiliation to IIUM.
5. De Carvalho, F was from MMU but is now affiliated with UTP
6. Mandeep, JS, was initially from USM and has now moved to UKM

We checked both the first and the last name of researchers one by one. The selected publications were assigned to the exact author through the synchronicity of the address from publication records with their departmental websites. Their last affiliation of 2010 was considered final. The experiment was performed on one hundred; most productive researchers from Malaysian universities working in engineering research.

Data Validation and Verification

Various practices are observed from the previous research to meet the ethical issue of data verification and validation. Experts and library professionals from the authentic data source conducted most of these studies. In the present study, we used various practices. Firstly, all the records on both levels were checked manually for validity and completeness under the supervision of the supervisor. Secondly, all the data and other documentation were kept in the record and attached as appendices.

Asking the researcher to verify their publications and to provide their researcher ID the level of researcher's data were further verified through the e-mails sent to them. Several of them sent their researcher ID, their CV, or publication's list or confirmed the provided list. A few of them showed concern about their publication record. They further explained the research methodology and research design of the study. Their various responses were listed and kept as a record. In addition to ensure the reliability

issues, the third party audit (Van Leeuwen, 2007) option was also used for meso and micro level data. Meso and micro levels data were verified for their accuracy and completeness by the senior librarian from Perpustakaan Sultanah Zanariah, UTM.

For citation count, we used time cited feature of WoS TM and manually checked year wise citations one by one for the period 2001-2010. The websites of the researchers and their universities as well were checked to detect affiliation and author's name. Author's last affiliation was considered as the final. All the data at this level were also cleaned manually for affiliation, homonym, and homograph problems.

Concluding Remarks

Citation, its subsequent metrics and root indicator publication have a sound place and essential role in RPE. These play an essential role for peer-based, metrics based or hybrid approaches. Metrics are helping in making the process more accurate, transparent and fair for all. A range of issues regarding the use of metrics for RPE arises. Whatever metric and approach is considered appropriate for evaluation purpose, it requires the best, transparent and valid data and research design. This study enlightens the issues and suggests the possible measures to make the empirical analysis reliable and also to produce valid results.

The research objectives, search strategies, document types, time span and subject categories have a sound impact on publication and citation counts vis-à-vis on other metrics indices. Several issues need to be considered at the phase of the employment of a scientometric approach to RPE. Furthermore, the culture of research, policies of the Ministry of Education and uneven international visibility can be influential factors.

For the Malaysian engineering case, the most common problems at meso level are: international and national publications records affiliated to institutions other than universities, the change of university name, the change of the institution's name, the unification of addresses,

the use of abbreviations and the presence of sub-campus of international universities. We have observed an interesting fact that the institutions and researchers in Malaysia other than HEI's have interest to get publish in a prestigious database like WoS. While at micro level the recognition of name, the change of institutions and address are major problem in our dataset.

The following are the common lessons learned from data collection issues which have been identified in the processes of conducting the experiments at micro and meso levels. Manual checking of the records and third party audit should be carried out for data validation and verification at each level. Data should be available for verification and validation purposes and should be kept in the record because any inaccuracy and insufficiency in the data may lead to wrong results and consequently can be challenged.

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