Full length article

Characteristics of scientific impact of *Resources Conservation and Recycling* in the past 30 years

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A B S T R A C T

This paper was designed as a complement to a previous study to give deeper insights into the characteristics of scientific impact of Resources Conservation and Recycling (RCR) over the past 30 years. Our study brought transparency to the impact trends of RCR, the role of information amounts and contributors, and the evolution of research emphases. The results showed that RCR has become more mainstream with greater influence in the scientific community. International collaboration, inter-institutional collaboration and co-authorship made increasing contributions to the RCR publications, where the collaboration between the USA and China has been the most prominent one. Interestingly, single institution or single country publications were found to obtain more citations than those of inter-institutional and inter-national collaboration, which is nevertheless in line with the fact that many of the former were published earlier than the latter. While the comparative analysis of author keywords and *KeyWords Plus* revealed the diversity and complexity of research focuses of RCR throughout the study period, RCR has retained its commitment to fueling the sustainability discourses that transcends various disciplinary boundaries. "Recycling" and "management" have long been the research focuses of RCR publications and their references. Overall, this paper presented a systematic review and bibliometric analysis of literature in RCR, which could serve as a reference for the journal editors, authors, reviewers, readers, the publisher, and those who are interested in the state of the art in relevant areas of research.

1. Introduction

In 2018 we will celebrate the 30th anniversary of the publication of Resources Conservation and Recycling (RCR). As a matter of fact, the origin of the journal can be traced back to two predecessor journals, Resource Recovery and Conservation launched in 1975 and Conservation & Recycling launched in 1976 by Elsevier. In 1988, RCR was born as a result of the merger of these two journals. The primary aim of this study was to explore the bibliometric characteristics of scientific impact of RCR over past years in honor of the 30th anniversary of the journal.

Bibliometric analysis to compile and interpret the statistical data about publications, citations, and other related indicators has been widely recognized as a tool for revealing the dynamic performance of scientific journals (Fu and Ho, 2014; Wang et al., 2010). It has been conducted for single scientific journals such as *Zoo Biology* (Anderson et al., 2008), *Intelligence* (Wicherts, 2009), *Pain* (Dubner, 2009), *Water Research* (Wang et al., 2010), *Physical Therapy* (Coronado et al., 2011), *Journal of Membrane Science* (Fu and Ho, 2015), *Journal of Advanced*

Nursing (Zeleznik et al., 2017), with the intention of helping readers to get a quick overview of individual journals over years and guiding the development of analyzed journals.

Citation is one of the most important bibliometric indicators that have been widely used for academic evaluation and data mining. Ji et al. (2018) explored some basic characteristics of authors, institutions, countries, most cited articles and hot topics of RCR, but surprisingly, little attention was paid to citation impact, which are usually necessary to understand a journal's visibility and influence. Besides, Ji et al. (2018) merely made use of authors keywords to track the hotspots, while neglecting the *KeyWords Plus* terms that are independent of author keywords and able to describe the article's contents in far more detail (Garfield, 1990). For these reasons, there is a great need for further studies providing deeper insights into the evolution of scientific impact, the role of information amount (e.g., pages, cited references) and contributors (authors, institutions and countries) in citation impact, and the visualization of research emphases by RCR over the past 30 years, many of which remain largely unsettled by the scientific community.

In doing so, some classic and newly developed indicators of citations were employed. Impact factor, created in the early 1960s, has been a globally recognized measure of a journal's scientific impact (Garfield, 1997). Another commonly used indicator to feature scientific impact is total citations (TC). Although the TC of a paper makes great sense in evaluating the research (Hawkins, 1980), the indicator of TC cannot be verified easily due to the regular updates of databases (Fu et al., 2012). TC_{year}, which refers to the total number of citations of an article from its publication to a certain year (Chuang et al., 2011), was recently introduced to overcome the limitations of the traditional TC. In recent years, there has been a growing interest to identify possible patterns of collaborative behaviors and research themes. Recently developed software such as Science of Science (Sci2) and Gephi are able to visualize the interactive networks of complex patterns (Bender et al., 2015; Zeng et al., 2017).

By conducting a bibliometric analysis, this paper is expected to provide an overall picture of RCR's performance on scientific impact, the distribution of national contributors at the global level, and the evolution of research emphases. Structured in a way that enabled a multidimensional analysis of RCR, the research would contribute to a deeper understanding of the main features and publication patterns of the journal. To that end, the Results section would be divided into four aspects: (1) the overall scientific performance of RCR in the past 30 years with respect to scientific impact; (2) the amount of information and their influence on science impact, with a focus on the number of cited references and pages; (3) the influence of national, institutional and individual contributors on citation impact, and their collaborative effects; and (4) the visualization of research emphases to understand the role of RCR in academia. However, due to the difficulty of data integration and updating, the time span of this paper will be narrowed down to 1988–2016. Recently developed indicators and software such as TC_{year}, Science of Science (Sci2) and Gephi will be jointly used in a novel way to reflect the scientific characteristics of RCR.

2. Methodology

Documents were derived from the Science Citation Index Expanded (SCI-Expanded) database of the Web of Science, the Clarivate Analytics. The Journal Citation Reports (JCR) indexed 8856 journals with citation references across 174 scientific disciplines in 2016. By searching "publication name" with "Resources Conservation and Recycling", we collected 2410 publications published in RCR from 1988 to 2016 (Fig. 1). These publications included seven document types. Article was the dominant one making up 92.37% of the total publications, followed by review, editorial material, note, correction, reprint and item. Since articles and reviews made a great contribution to scientific research published in RCR, only these two types were selected for further analysis.

All articles and reviews were examined by indicators including impact factor (IF), peak year citations per publication (PCPP), TC_{2016}, single country publications and multi-country publications. Amongst TC_{2016} is a newly developed indicator that assesses the number of citations to an article during its publication year to the end of 2016. Collaboration type of country/territory was determined by the addresses of affiliations. The articles and reviews were classified into four types in the light of the information provided on country/territory and

institution: (1) "Single country publication" denotes that the authors come from the same country; (2) "Single institution publication" denotes that the authors come from the same institution; and (3) "Internationally collaborative publication"/"multi-country publication" was designated to those authors who were from multiple countries (Chiu and Ho, 2005).

3. Results and discussion

3.1. Journal citation life and impact factor

3.1.1. Journal citation life

In order to provide an overview of the citation history of RCR, the cited impact has been first investigated. A total number of 2347 articles and reviews were published during 1989–2016. Impact factor (IF) has been globally used to rank and evaluate journals (Garfield, 1996; Moed, 2002). It is defined as all citations to the journal in the current JCR year concerning items published in the previous two years, divided by the total number of scholarly items comprising articles, reviews and proceedings papers published in the journal in the previous two years). One factor that significantly affects IF is the speed at which a publication is cited (Garfield, 1999). To understand the meaning of IF of RCR, CPP (Citations per publication) by year (journal citation life) were examined in Fig. 2. The CPP increased quickly in the first two years, continued to reach a maximum in the fifth year (PCPP = 2.56), then started to fell until a minimum in the 25th year (0.52), and finally experienced a fluctuation (Fig. 2). However, the greatest growth rate of received citations was observed in the first year (1.32) and the second year (2.17), both of which were used for calculating the IF that represents the initial citation rate of RCR. The increasing trend within the first five years suggested a longer time window of accumulative citations for a publication of RCR. Publications have their own citation life curves, and the most-cited publications in the last year could help us quickly grasp the hotspots.

The three most influential RCR articles in 2016 include "The possibility of in-situ heavy-metal decontamination of polluted soils using crops of metal-accumulating plants" by Baker et al. (1994), "Microwave heating applications in environmental engineering - a review" by Jones et al. (2002), and "Production of levulinic acid and use as a platform chemical for derived products" by Bozell et al. (2000), all of which got more than 50 citations in 2016. The list of top cited articles altered when it comes to TC_{2016}. For instance, the paper entitled "Determining the drivers for householder pro-environmental behaviour: waste minimisation compared to recycling" by Tonglet et al. (2004) was found to have the highest TC_{2016}, which nevertheless ranked 15th in top cited articles in 2016. On the contrary, the most highly cited paper in 2016, namely "The possibility of in situ heavy metal decontamination of polluted soils using crops of metal-accumulating plants" by Baker et al. (1994), ranked 3rd in terms of TC_{2016}.

It is a bit surprising that there were only 22 papers with "circular economy" in their keywords. Of these, 10 were authored by those who were affiliated with Chinese institutions. This was followed by German with 4 papers and British with 3 papers. None could be labeled with "top cited article", suggesting that circular economy was more likely to be a regional environmental concern than a global one.
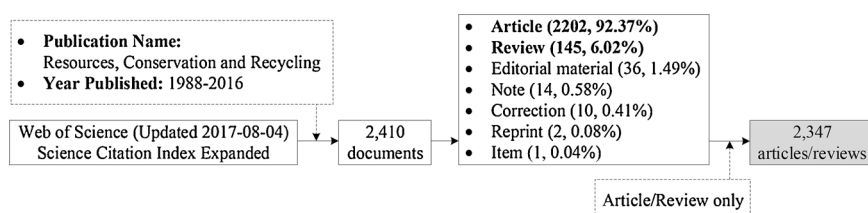

- **Publication Name:**
  Resources, Conservation and Recycling
- **Year Published:** 1988-2016

Web of Science (Updated 2017-08-04)
Science Citation Index Expanded → 2,410 documents →

- **Article (2202, 92.37%)**
- **Review (145, 6.02%)**
- Editorial material (36, 1.49%)
- Note (14, 0.58%)
- Correction (10, 0.41%)
- Reprint (2, 0.08%)
- Item (1, 0.04%)

→ 2,347 articles/reviews

Article/Review only

Fig. 1. Schematic for searching publications of Resources Conservation and Recycling.