Journal of Cleaner Production 163 (2017) 1–14

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Review

A review of the first twenty-three years of articles published in the Journal of Cleaner Production: With a focus on trends, themes, collaboration networks, low/no-fossil carbon transformations and the future

Hongyang Zou [a], Huibin Du [a, b, c, *], Yutao Wang [d], Lin Zhao [e], Guozhu Mao [f], Jian Zuo [g], Yong Liu [a], Xi Liu [a], Donald Huisingh [h]

[a] College of Management & Economics, Tianjin University, Tianjin 300072, China
[b] Center for Energy & Environmental Policy Research, Institute of Policy and Management Chinese Academy of Sciences, Beijing 100190, China
[c] School of Public Policy, Georgia Institute of Technology, Atlanta, GA 30332, USA
[d] Department of Environmental Science and Engineering, Fudan University, Shanghai 200433, China
[e] School of Environmental Science and Engineering, Tianjin University, Tianjin 300072, China
[f] Tianjin Key Laboratory of Indoor Air Environmental Quality Control, School of Environmental Science and Engineering, Tianjin University, Tianjin 300072, China
[g] School of Architecture & Built Environment, Entrepreneurship, Commercialization and Innovation Centre (ECIC), The University of Adelaide, Adelaide, Australia
[h] Institute for a Secure and Sustainable Environment, University of Tennessee, Knoxville, TN, USA

ARTICLE INFO

Article history:
Received 1 January 2017
Received in revised form
26 April 2017
Accepted 26 April 2017
Available online 27 April 2017

Keywords:
Cleaner production999
Sustainable consumption999
Bibliometrics999
Social network analysis999
Low/no fossil carbon societies999

ABSTRACT

Sustainable Development (SD) has been a key theme of the contemporary world development in recent decades. The *Journal of Cleaner Production (JCLP)*, as an international, multi-disciplinary journal, has provided a platform for the exchange of concepts, policies, and technologies to help societies to make progress towards sustainability. This article characterized the articles published in the *JCLP* in the context of low or no-fossil carbon transformations by employing bibliometric techniques. The analyses revealed that 4919 articles were published in *JCLP* in the first twenty-two years of publication, between 1993 and 2015 and that the pace of publishing increased rapidly during the last five years. Authors from China were responsible for publishing the largest number of articles and they have played key roles in the collaboration networks among the twenty countries, whose authors published the majority of JCLP's articles Additionally, authors from Europe and the United States had strong international collaborative publication records. At the institutional level, the University of Tennessee was the university with the largest number of articles (79) and was central to the *JCLP*'s collaborative networking processes. By investigating the co-occurrences of keywords, some topic clusters for low-fossil carbon transformations and their distributions were identified, which were like the analyses of the research fields and trends of articles published in the *JCLP*. The category with the largest number of *JCLP* articles was the ecology/environmentally-related research with 2215 articles, followed by industrial sectors with 2215 articles, resource/energy-related research with 1905 articles, and methodology & methods with 1033 articles. The specific topical clusters under each research field were introduced and analyzed. Overall, the authors of this article anticipate that the *JCLP* will continue to provide a platform for multi-disciplinary, multi-cultural, multi-generational communications for academics, educators, researchers, enterprise leaders and policy-makers with the vision and mission to help to accelerate the transitions to equitable, sustainable, livable post-fossil carbon societies.

* Corresponding author. College of Management & Economics, Tianjin University, Tianjin 300072, China.
E-mail address: duhuibin@tju.edu.cn (H. Du).

http://dx.doi.org/10.1016/j.jclepro.2017.04.157
0959-6526/

Contents

1. Introduction

With the objective to meet the human development goals, Sustainable Development (SD) was envisioned to emphasize the significance of sustained availability of natural resources and responsible environmental performance upon which economic and social development are mutually interdependent. In that context, numerous actions have been conducted by policy makers, academicians, companies and other practitioners to seek to achieve SD (Rashidi et al., 2015; Santoyo-Castelazo and Azapagic, 2014). These actions have evolved along diverse developmental models, which reflect perspectives of researchers in various disciplines or specialties. For example, some researchers were convinced that technological innovations can be used to quickly prevent or solve unstainable resource usage and negative environmental and human health impacts. Others were convinced that proper policy reforms can or will be able to effectively reconcile economic and ecological development. A third group of scholars, underscored the need for fundamental shifts from mono-disciplinary foci to holistic, multi-disciplinary, integrative approaches in societal values to make effective progress toward truly sustainable societal developments (Hatfield-Dodds et al., 2015). Within that context, Cleaner Production, Sustainable Consumption and Circular Economies' concepts, policies, procedures and wide-spread applications are providing encouraging progress in helping to accelerate the transition to equitable, sustainable, livable, post-fossil carbon societies.

The *Journal of Cleaner Production (JCLP)*, is a, prevention-oriented journal, which was founded by Prof. Donald Huisingh in 1993. It has provided and continues to provide an international "multi-disciplinary" forum for the exchange of scientific information on research findings, concepts, policies, and technologies on Cleaner Production and Sustainable Consumption approaches designed to help to ensure progress towards making societies and regions more ecologically, ethically and economically sustainable".

With the intensification of ecological and environmental problems due to human population growth and climate change-related consequences, the vision of SD, is increasingly related to improved efficiency and to transitions to low/no-fossil carbon societies, which means that societies must be transformed from high energy and high resource consumption to low/no-fossil carbon, lower-resource consumption economic systems, which function sustainably within the global eco-systems, upon which all societies are mutually interdependent. Low/no-fossil carbon transformations must cover numerous systems, including ecological, environmental, economic, governmental, educational, and ethical. Relevant research in these areas is crucial for regions/countries, civil societies globally, and institutions to ensure systematic and effective transformations to SD.

The JCLP has been published for more than twenty-three years. It is focused upon a wide array of topics pertaining to Cleaner Production of Cleaner Products, Industrial Ecology, Circular Economy, Life-cycle approaches, Supply-Chain Management, Remanufacturing Sustainable Consumption, Ecosystem services, Climate Changes, Education for SD, Governmental Policies and Regulations for Transitions to Sustainable Societies, of the Future Based upon Low/No-Fossil Carbon Systems.

During the history of the *JCLP*, articles were mainly focused on four areas:

a. industrial applications;
b. environmental management initiatives;
c. governmental environmental policies and regulations;
d. education, training and facilitation of changes toward SD.

Many of the articles in the first three areas were closely related to research on low/no-fossil carbon system transformations as integral to achieving societal SD. In that context, the authors of this paper concluded that it was timely to perform a bibliometric analytical review of the articles published in the *JCLP*, which focused on the growing body of knowledge on the low/no-fossil-carbon transformations.

According to Tsay, bibliometric techniques can provide a way to quantitatively analyze the development of academic literature (Tsay, 2008). In that context, the authors developed this review paper based upon bibliometric analysis techniques. The subjects of the analyses included countries, research institutions, research findings and trends during the publication history of the *JCLP*. In addition, potential future research directions were investigated by means of keyword analyses (Zhou et al., 2007).

2. Methodology

Bibliometrics, as a method of scientometrics, has been used in the field of library and information science since 1969 (Pritchard, 1969). With the development of the method, it has been increasingly applied as a tool for research in many academic areas. The bibliometric method uses quantitative statistical analyses to evaluate the contributions of researchers or of different research fields, to obtain insights into the characteristics of the distributed architecture and collaborative relationships of scientific activities and findings from a macro perspective (Bjurström and Polk, 2011; Keiser and Utzinger, 2005; Zhang et al., 2010).

2.1. The h-index

The indicator of the h-index was used in this study. The h-index was first proposed by Hirsch to measure the productivity and impact of published works (Hirsch, 2010). The h-index is defined as, "A scientist has an index of H if H of his/her Np articles have at least H citations each, and the other (Np-H) articles have no more than H citations each". Np is the number of articles published over n years. Therefore, the h-index includes the results of assessment of the impact (number of citations) and the quantity (number of articles) (Birks et al., 2014; McCarty et al., 2013; Miroiu, 2013). In the following analyses, the h-index was calculated to examine the publication characteristics of the countries and of academic institutes.

2.2. The social network

The social network analysis is a method of social science, which can be used to visualize networks based upon statistical and mathematical analyses (Ye et al., 2012). Social networks consist of two parts. The first is comprised of multiple points, which represent the social actors. The second was focused upon the collaborative interconnections between and among the researchers. (Jeong-Yeon et al., 2014). In this article, this method was also employed to investigate the collaborative relationships among the most productive countries and institutes.

2.3. Content analysis

To investigate the contributions of the *JCLP*'s published articles and the possible future content trends, this research team analyzed the topical clusters. The keywords and titles of articles were used as the basis for the analyses. The word frequency was calculated to identify the topical clusters of research in the different dimensions of CP, published in the *JCLP*. Then the research trends were analyzed and potential future directions were envisioned and described.

3. Results

The first issue of the *JCLP* was published in 1993 by Butterworth-Heinemann; they continued to publish the *JCLP* until 2000 when Elsevier obtained the rights to publish the *JCLP*.

To investigate the publication characteristics and research trends of the *JCLP*, a total of 4919 articles published between 1993 and 2015 were evaluated. The 4631 articles published between 2002 and 2015 were retrieved from the Science Citation Index Expanded (SCI-EXPANDED) because the database only included the articles published during that time-frame. The remaining 288 articles were accessed from Elsevier's JCLP website. The information analyzed from these articles included titles, keywords and year of publication. Thereby, 4919 articles published between 1993 and 2015 were used to investigate the publication trends and topical clusters. The publication distribution from countries and institutions and subjects were analyzed using the documents published between 2002 and 2015 in the *JCLP*.

3.1. Evolution of the numbers of articles published in the JCLP from 1993 through 2015

A total of 4919 articles published during the first 23 years of publication of the *JCLP* were analyzed. As shown in Fig. 1, the publication rate trends from 1993 to 2002 can be divided into three stages. The first stage was from 1993 to 2002. The characteristics of this stage were that because it was a new journal, in a new field, there was a slow increase from about 20 to 50 articles published per year. The articles in that stage also included some patent reports which were not included in the assessment of publications for this research. The second stage was from 2002 to 2011. During this period, there was a steady and consistent growth in the number of articles published, with an increase from about 100 per year in 2004 to 234 published in 2011. The third stage of the *JCLP* was one of rapid growth from 345 articles published in 2012 to 1178 published in 2015 with an average annual growth rate greater than 50%.

Table 1 presents trends in the numbers of articles published in the *JCLP articles published from* 2003 through 2015. It is evident that the number of articles published continued to increase each year.

Also, the numbers of authors per article increased from an average of 2.05 in 2002 to an average of 3.71 in 2015. Similarly, the average number of references cited per paper changed

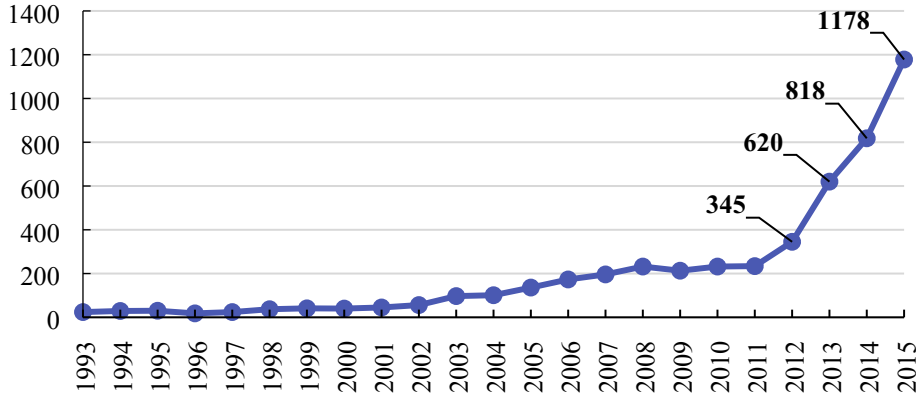

Fig. 1. The annual number of articles published in the *JCLP* during 1993–2015.

Table 1
The characteristics of articles published in the *JCLP* between 2002 and 2015.

Year	TP	AU	AU/TP	NR	NR/TP	PG	PG/TP
2002	56	115	2.05	1380	24.64	554	9.89
2003	97	239	2.46	1999	20.61	855	8.81
2004	101	236	2.34	2419	23.95	1007	9.97
2005	136	379	2.79	3284	24.15	1372	10.09
2006	173	377	2.18	3990	23.06	1603	9.27
2007	196	507	2.59	6150	31.38	1886	9.62
2008	232	654	2.82	7370	31.77	2204	9.50
2009	213	637	2.99	7199	33.80	1767	8.30
2010	232	467	2.01	8556	36.88	1937	8.35
2011	234	737	3.15	9911	42.35	2109	9.01
2012	345	1205	3.49	16649	48.26	3337	9.67
2013	620	2114	3.41	31200	50.32	6031	9.73
2014	818	2993	3.66	39293	48.04	8079	9.88
2015	1178	4365	3.71	61469	52.18	12262	10.41

PY: year; TP: the number of total papers published per year; AU: the number of authors; NR: the number of cited references; PG: the number of pages; AU/TP, PG/TP and NR/PG: the average of authors, pages and references in a paper.

dramatically. Before 2007, the number of citations per paper was less than twenty-five but by 2015, the average number of references per paper had increased to 52.18, which was the highest in the last fourteen years. This phenomenon reflected the dynamic development in research published in the *JCLP*. In addition, the average pages per article ranged between 8 and 11.

Overall, the average number of pages per article was quite stable. The average number of authors and references per paper had an increasing trend. Thus, it can be inferred that the problems or difficulties in developing articles tended to require more diversified and interdisciplinary inputs. The completion of an article required more wisdom and strength of researches from various fields. Meanwhile, the increase of the average citations per paper demonstrated that the findings of an article needed to be built upon more achievements from previous studies than was the case a decade or two earlier in the history of the *JCLP*.

3.2. The JCLP article distribution per country and academic institution

The contributions of authors from different countries/territories and academic institutions were evaluated by means of the addresses and affiliations of at least one author of each journal article. The geographic locations and the academic institutions of the author of 4604 articles were analyzed. During the period 2002 to 2015, authors from 92 countries contributed to the *JCLP*.

The twenty most productive countries with regard to articles published in the *JCLP*, were ranked using indicators that included: the total number of journal articles published in the *JCLP*, the number and the percentage of articles authored from a single country, and the number and the percentage of articles with authors from multiple countries (see Table 2). Authors from China published the most articles with the largest number of TP, SP, FP and RP, followed by authors from the USA. In the international collaborative authorship of articles, the USA ranked first. Authors from the UK, Spain and Sweden ranked third, fourth and fifth respectively in terms of the total number of articles published in the *JCLP*. Japan, India, and Malaysia were in the 11th, 13th and 19th place respectively with regard, to the number of articles with international collaboration among the authors. This is a relatively low-ranking of collaboration compared with authors from Europe and the U.S. That suggested that international cooperation depends, in part, upon geographic origin of the authors and level of economic development. In contrast, authors from European countries, such as UK, The Netherlands, Spain and Germany, had strong international collaborative publication records. Additionally, many authors from other countries published in the *JCLP*, although they have not contributed as many articles per author as authors from the other countries. These authors were mainly from small and/or island countries. The reasons why they submitted fewer articles is not known but that maybe because their scientific collaboration networks were less well developed therefore they contributed fewer papers than their counterparts in other countries.

In-depth research should be done to obtain insights into the reasons for these differences and to explore ways to involve and to empower those scientists to become more fully involved in such networks and to expand their joint contributions to the *JCLP* and to related, relevant journals.

The time-trend analysis of the scholar's contributions to the *JCLP* from the five most productive countries is shown in Fig. 2. Before 2012, the number of articles published from the five leading countries had similar trends with some fluctuations below 50 articles/per country per year. However, from 2012 to 2015, the pace of

Table 2
The top twenty countries, according to the number of articles published in the *JCLP* by their authors from 2003 through 2015.

Country	TP	TP R (%)	SP R (%)	CP R (%)	FP R (%)	RP R (%)	h-index
China	591	1 (12.79)	1 (8.22)	2 (4.57)	1 (11.10)	1 (10.90)	36
USA	538	2 (11.64)	2 (5.58)	1 (6.06)	2 (7.18)	2 (7.12)	46
UK	359	3 (7.77)	5 (3.87)	3 (3.89)	3 (5.11)	5 (5.08)	40
Spain	356	4 (7.70)	3 (5.08)	5 (2.62)	4 (6.64)	3 (6.73)	31
Sweden	316	5 (6.84)	4 (4.82)	9 (2.01)	5 (5.84)	4 (5.76)	41
Australia	293	6 (6.34)	5 (3.87)	6 (2.47)	6 (4.93)	6 (5.04)	33
Netherlands	293	7 (6.34)	9 (2.86)	4 (3.48)	8 (4.37)	7 (4.39)	37
Italy	240	8 (5.19)	8 (3.14)	8 (2.06)	7 (4.46)	8 (4.37)	32
Germany	234	9 (5.06)	10 (2.73)	7 (2.34)	10 (3.53)	10 (3.57)	32
Brazil	213	10 (4.61)	7 (3.35)	15 (1.25)	9 (4.07)	9 (4.00)	26
Canada	201	11 (4.35)	12 (2.34)	9 (2.01)	11 (3.05)	11 (3.20)	29
France	162	12 (3.50)	14 (1.77)	12 (1.73)	14 (2.51)	16 (2.47)	25
Malaysia	155	13 (3.35)	16 (1.64)	13 (1.71)	12 (2.86)	12 (2.88)	23
India	147	14 (3.18)	11 (2.44)	19 (0.74)	13 (2.75)	13 (2.66)	25
Japan	141	15 (3.05)	17 (1.25)	11 (1.80)	17 (1.97)	17 (1.99)	21
Denmark	127	16 (2.75)	18 (1.17)	14 (1.58)	18 (1.75)	18 (1.95)	26
Finland	121	17 (2.62)	13 (1.95)	20 (0.67)	16 (2.25)	15 (2.25)	19
Portugal	120	18 (2.60)	15 (1.67)	18 (0.93)	15 (2.27)	14 (2.29)	22
Belgium	93	19 (2.01)	20 (0.84)	16 (1.17)	19 (1.34)	19 (1.36)	17
Switzerland	87	20 (1.88)	19 (0.91)	17 (0.97)	20 (1.21)	20 (1.32)	22

TP: the number of total articles; SP: the number of single country articles; CP: the number of internationally collaborative articles; FP: the number of articles with the first author's country; RP: the number of articles with corresponding author's country; R (%): the rank and the ratio of the number of one country's articles to the total number of articles during 2002–2015.

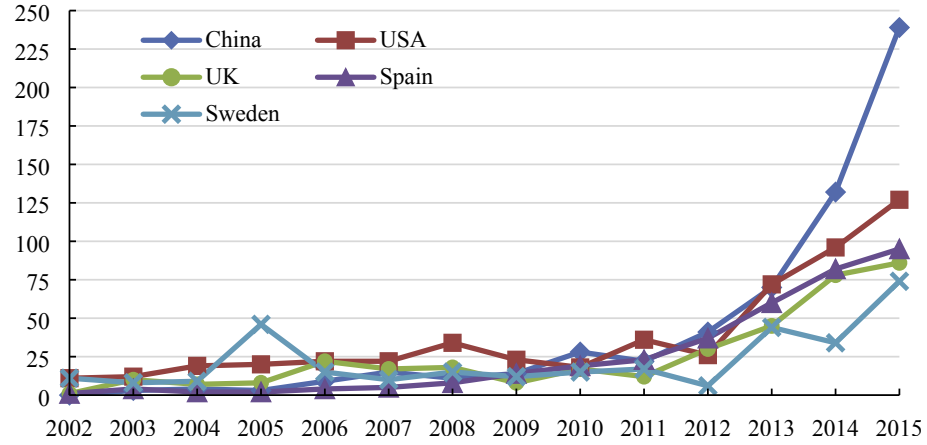

Fig. 2. The annual number of articles published in the *JCLP* by authors from each of the top five countries during 2002–2015.

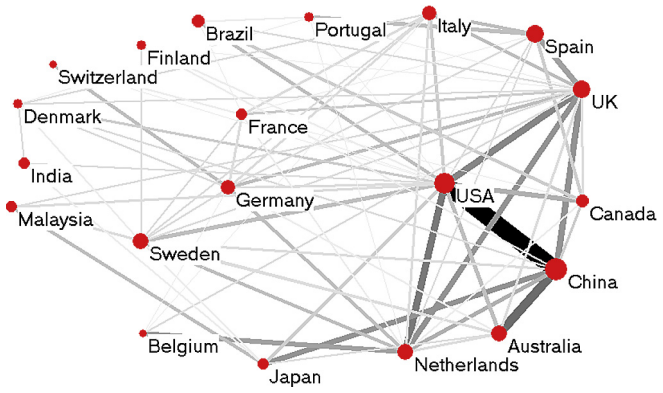

Fig. 3. The cooperation network of the top twenty most productive countries regarding publication of articles in the *JCLP* between 2002 and 2015.

publication of articles from authors in those five countries increased significantly. As is clear from the data presented in Fig. 2, Chinese authors ranked first in 2015 by publishing 239 articles while authors from the U.S.A, ranked second by publishing 127 articles. This demonstrated that the *JCLP* is increasingly recognized and used by Chinese scholars. Authors from the UK and Spain had similar growth trends. The fifth country among the top five was Sweden. The publication numbers from Sweden fluctuated dramatically during the last four years.

The cooperative relationships among the top twenty most productive countries contributing to the *JCLP* from 2002 to 2015 were documented, as presented by the cooperation network diagram in Fig. 3. It was found that Chinese authors played key roles in the collaboration network of the twenty most productive countries with collaboration with colleagues in every country within the global network. Among them, cooperation between the USA and China was particularly strong, which was depicted by the *fattest* line and the *darkest* color in Fig. 3. In addition, taking the USA and China as the two core countries, strong collaborative relationships were also evident with Australia, UK and Japan, The Netherlands and the UK. This is probably why China and the USA are the two countries with the largest annual number of articles. This underscores the importance of partnerships in promoting relevant international cooperation in research and in publication of scientific articles.

Table 3
The *JCLP* publication performance of the authors of the twenty most productive institutions during 2002–2015.

Country	TP	TP R (%)	CP R (%)	FP R (%)	RP R (%)	h-index
The University of Tennessee, USA	79	1 (1.709)	1 (1.709)	18 (0.389)	19 (0.368)	20
Chinese Academic of Science, China	73	2 (1.579)	2 (1.579)	3 (0.930)	2 (1.017)	20
Lund University, Sweden	69	3 (1.493)	3 (1.493)	1 (1.168)	1 (1.039)	23
Delft University of Technology, The Netherlands	69	3 (1.493)	3 (1.493)	4 (0.736)	5 (0.692)	20
Linkoping University, Sweden	53	5 (1.147)	5 (1.147)	2 (0.952)	3 (0.952)	15
University Autonoma De Barcelona, Spain	43	6 (0.930)	6 (0.930)	7 (0.671)	7 (0.649)	16
University of Sao Paulo, Brazil	42	7 (0.909)	7 (0.909)	10 (0.627)	13 (0.541)	14
Erasmus University, The Netherlands	40	8 (0.865)	8 (0.865)	4 (0.736)	5 (0.692)	18
University of Malaya, Malaysia	40	8 (0.865)	8 (0.865)	4 (0.736)	4 (0.779)	16
Utrecht University, The Netherlands	39	10 (0.844)	10 (0.844)	16 (0.519)	13 (0.541)	13
The University of Manchester, UK	38	11 (0.822)	11 (0.822)	13 (0.584)	10 (0.627)	15
Tsinghua University, China	37	12 (0.801)	12 (0.801)	10 (0.627)	7 (0.649)	12
The University of Queensland, Australia	37	12 (0.801)	12 (0.801)	10 (0.627)	13 (0.541)	9
University of South Australia, Australia	37	12 (0.801)	12 (0.801)	19 (0.346)	18 (0.433)	13
Wageningen University, The Netherlands	36	15 (0.779)	15 (0.779)	17 (0.498)	17 (0.519)	9
Shandong University, China	35	16 (0.757)	16 (0.757)	7 (0.671)	7 (0.649)	10
The University of British Columbia, Canada	35	16 (0.757)	16 (0.757)	14 (0.563)	12 (0.563)	13
University Teknologi Malaysia, Malaysia	35	16 (0.757)	16 (0.757)	9 (0.649)	11 (0.606)	12
University of Santiago de Compostela, Spain	34	19 (0.736)	19 (0.736)	14 (0.563)	13 (0.541)	12
City University of Hong Kong, China	32	20 (0.692)	20 (0.692)	20 (0.260)	20 (0.238)	11

TP: the number of total articles; CP: the number of inter-institutionally collaborative articles; FP: the number of articles of as the first author's institute; RP: the number of articles as corresponding author's institute; R (%): the rank and the ratio of the number of one institute's articles to the total number of articles during 2002–2015.

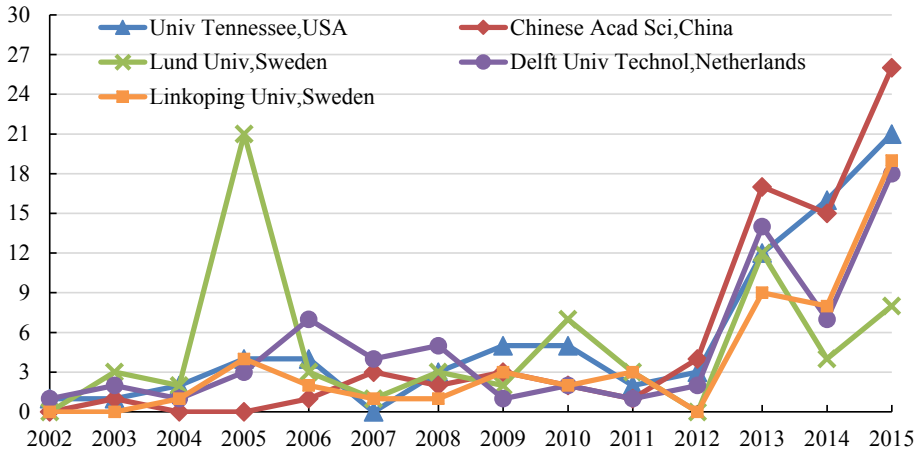

Fig. 4. The *JCLP* article publication trends of the top five most productive institutes during 2002–2015.

Authors from 6151 institutions contributed to 4604 articles published in the *JCLP* from 2002 to 2015. More than 99% of these articles involved multi-institutional collaborations. The contributions to the *JCLP* of authors from the twenty most productive institutions during the period 2002 to 2015 are presented in Table 3. Among the top twenty institutions, four are from China, four are from The Netherlands. Further, Sweden, Spain, Malaysia and Australia had two highly productive institutions respectively. The USA, Brazil, UK and Canada each have one highly productive institution respectively. These countries also belong to the twenty most productive countries. Authors from the University of Tennessee published 79 articles during this period, which was the largest number from any institution, globally. The second place was held by authors from the Chinese Academic of Science in China with seventy-three articles. The third place was held by authors from Lund University in Sweden and by authors from Delft University of Technology in The Netherlands, both of which published sixty-nine articles. It is interesting that the h-index of the University of Tennessee was twenty which was slightly lower than the h-index of twenty-three, which was earned by authors from Lund University.

The growth of the five most productive institutions during 2002–2015 was documented and presented in Fig. 4. Before 2012, the articles of these five institutions showed no significant change. But it is interesting that authors from Lund University, Sweden published twenty-one of papers in 2005, which was due to the fact, that they published a special volume in that year. Since 2012, it can be observed that the number of articles from these five institutions fluctuated but all had some growth in but authors from the University of Tennessee, USA had the most consistent and sustained growth in number of articles published per year. In addition, authors from the Chinese Academic of Science published one article in 2003 and twenty-six articles in 2015 respectively, which ranked the first among the top five most productive institutions.

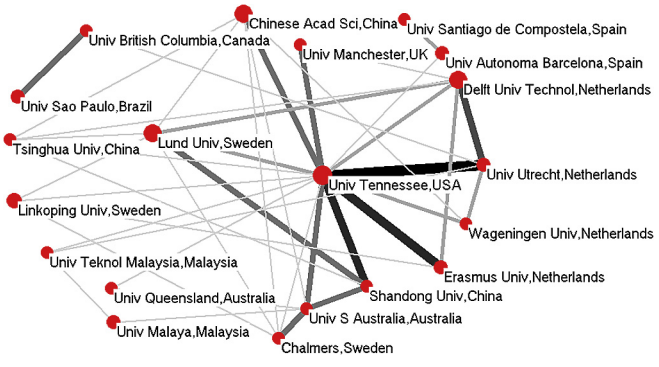

Fig. 5. The cooperation network of researchers among the top twenty most productive institutions, regarding contributions to the *JCLP*.

The cooperative relationships among the authors of the most productive institutes to the *JCLP* from 2002 to 2015 were also analyzed. The relevant cooperation network diagram is shown in Fig. 5, from this, it is clear, that authors from the University of Tennessee in the USA and from Utrecht University in The Netherlands have a strong cooperative relationship, which was represented by the darkest line. The University of Tennessee, USA is in the center of the collaborative network, which has cooperative relationships with fifteen institutions, especially with the Erasmus University and Utrecht University in The Netherlands and with Shandong University in China. In addition, the University of South Australia, Australia also has extensive cooperative relationships with other institutions, such as Shandong University in China and Chalmers University of Technology in Sweden. Overall, the most active cooperative relationships were among researchers in countries in Asia, Europe and the USA.

3.3. Keyword network analysis: distribution and trend in the JCLP

The interconnection network among the top most frequently used keywords in articles published in the *JCLP* were obtained by using social network analysis tools. By investigating the co-occurrences of keywords, some topical clusters for low-fossil carbon transformations and their distributions are identified. As shown in Fig. 6, carbon-related research has always been studied since the publication of the *JCLP*. Meanwhile, it was receiving an increasing level of attention based upon the increasing numbers of co-occurrences. This demonstrated that in recent years, the theme of low/no-fossil carbon transformations in the *JCLP* has been receiving rapidly increasing numbers of relevant articles. In addition, the energy field has received much broader focus upon renewable energy systems, improved energy efficiency, improved product design and holistic, life-cycle approaches to help to ensure that the embedded energy of materials and products are used increasingly effectively within circular economies.

In the first stage (1993–1998), the top twenty keywords were used to form the interconnection network because of the limited co-occurrences of keywords. Four main clusters were formed in this stage, i.e. carbon, environment, sectors and sustainability. By contrast, during the second stage (1999–2004) there were three

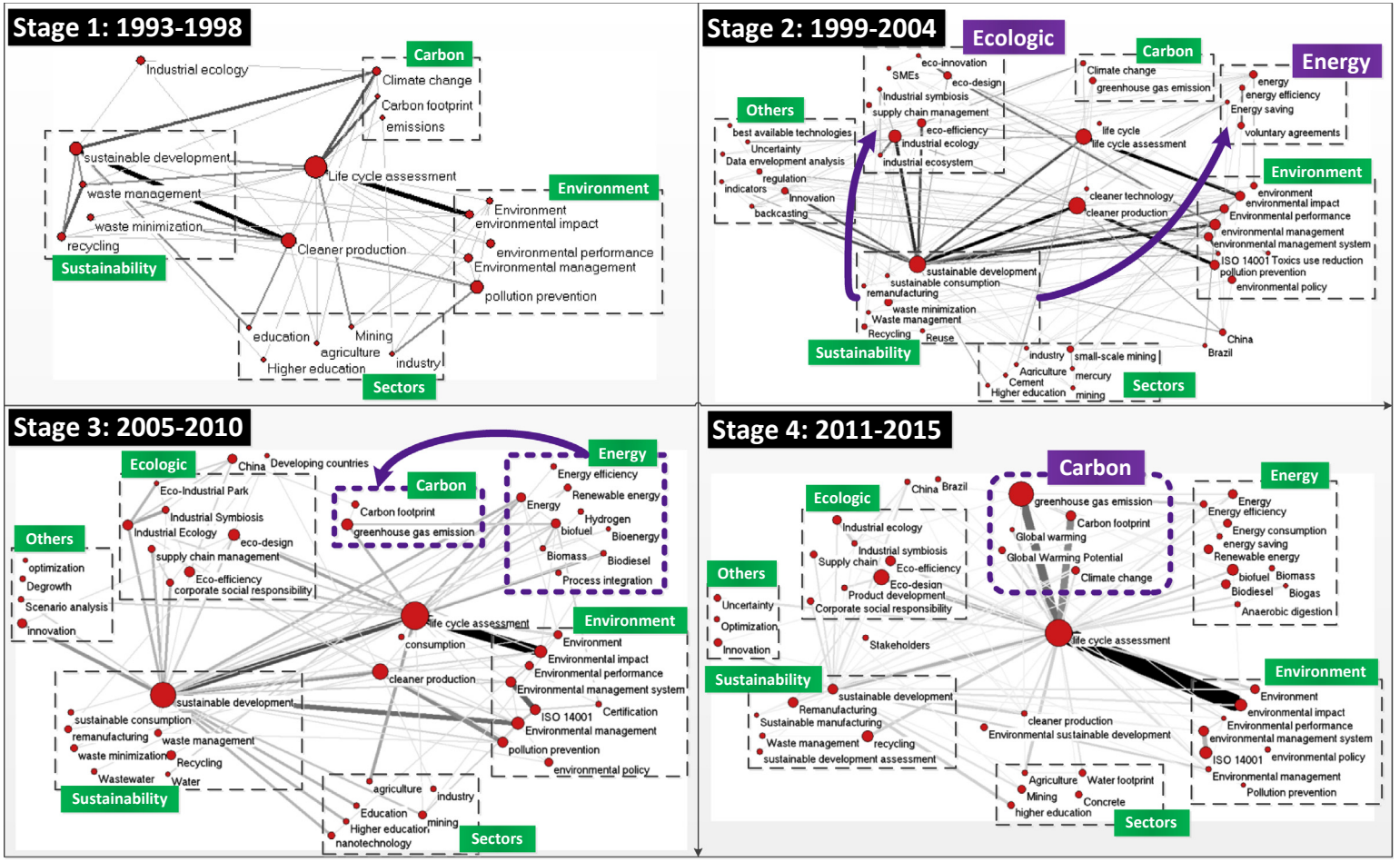

Fig. 6. The interconnection network and evolution of keywords in articles published in the *JCLP* during 1993–2015. **Notes**: ① The relative number of keywords is represented by the size of red dot. The larger the red dot is, the more frequently that keyword appeared in the related articles. ② The number of co-occurrences is represented by the pattern of the grey lines. The thicker and darker the line is, the larger the number of co-occurrences of two keywords that were used by the authors. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

more topical clusters, i.e. ecological, energy and others. These research fields are closely related to the key phrase of sustainable development. However, post fossil carbon-related research received very little attention by the authors during that stage. During third stage (2005–2010) due in part to the fact that the Kyoto Protocol came into effect, more keywords related to the topical cluster of energy were used. Utilization of renewable energy and reductions in emissions due to fossil-carbon-based energy consumption are underscored, increasingly strongly by the authors as being crucial for low/no-fossil carbon transformations. Consequently, the keywords of renewable energy and biofuels accounted for a larger proportion of the articles in the energy field. The authors of articles in this stage were among the leaders at the beginning of post-fossil carbon societies with foci upon alternative pathways for shifting to low/no-fossil carbon societal development. In the last stage (2011–2015), more keywords appeared in the topical cluster of fossil carbon. Some of these keywords were used sporadically during the previous stage but in this stage co-occurrences of these keywords increased significantly. The number of co-occurrences between LCA and greenhouse gas emissions was thirty-one. The number of co-occurrences between LCA and carbon footprint was twenty-seven. These two co-occurrences ranked in the second and third place in all co-occurrences respectively. In addition, the number of articles with the keyword of greenhouse gas emissions increased to 295 during this stage, which underscored the dramatic shift, within the *JCLP*, of research on low/no-fossil carbon transformations.

In each stage, articles based upon LCA as a tool, were increasingly prominent. The importance of LCA in fossil-carbon-related research became stronger. Authors of papers published in non-JCLP journals observed similar trends, thus supporting the changes observed in the JCLP. Hou et al. (2015) used a bibliometric method to analyze the trends of LCA-related publications. Analyses of the content of papers published in journals, which *'compete'* with the *JCLP* revealed similar content trends. The results showed that the *JCLP* ranked second among journals, which publish LCA-related papers. The number of LCA-related articles published in the *JCLP* increased rapidly after 2011. It was important to highlight that, in the LCA-related research, the most frequently addressed topic was GHG/CO_2/carbon. Many authors focused on ways of reducing greenhouse gas emissions and on mechanisms for mitigating climate change related impacts.

Overall, the evolving research trends were highlighted by using purple arrows. Prior to 2005, the research on sustainable development was extended to considering ecology and diverse energy fields, rather than purely on environmental issues. Since the Kyoto Protocol, authors of LCA studies increasingly addressed fossil-carbon emissions and energy consumption together. Climate change and global warming received dramatically increased attention. These trends and shifts in foci, strongly highlighted the dynamic roles of the *JCLP* as a catalyst for accelerating the transition to equitable and sustainable, post-fossil carbon societies.

3.4. Research fields and topical clusters in the JCLP

Cleaner Production is a multi-disciplinary, preventative approach, designed to help societies and regions become more ecologically and economically sustainable. It involves research and development in numerous fields, such as new structures, systems, processes, materials, products, polices, education and ethics. In that context, numerous key issues have been investigated since 1993. With the intensification of concerns about global climate changes and with the many inter-related environmental problems, it is crucial to identify the development of climate change related research trends. Based upon the review and analysis of keywords from published articles, the authors of this paper divided the research fields published in the *JCLP* into four 'topical clusters':

a. ecology/environment-related research;
b. industrial sectors;
c. resource/energy-related research;
d. methodology & methods.

In the last three years, a large percentage of articles under the four topical clusters focused on the challenges associated with low/no-fossil carbon transformation which is also the central theme of this SV. Wang et al. (2017) analyzed the research clusters of low carbon development transformation according to bibliometric results. They defined three clusters, (a) climate change, (b) low carbon economy, (c) low carbon development, which were similar to the topical clusters used in this article: (1) *'climate change'* was involved in our topical cluster *resource/energy-related research*. Industrial structure and carbon market mechanisms was included in the (2) *'low carbon economy'* that was like the topical cluster *industrial sectors* in our article. In addition, the LCA method was used in (3) '*low carbon development*' as a tool of fossil-carbon footprint reduction research. Thus, the classification of low/no-fossil carbon transformations in this article was like Wang et al.'s findings of trends in other journals.

The rankings of keywords and topical clusters of articles were

Table 4a
The numbers of articles by the research field, *Ecology/environment-related research*.

	Total	1993–1998	1999–2004	2005–2010	2011–2015
Ecology/environment-related research	2215	73	189	542	1411
(1) Environmentally-related research	1662	71	170	446	975
environmental performance(s)/impact(s)	1193	30	88	280	795
environmental management (system(s))	342	17	67	111	147
pollution prevention/reduction/control/abatement	214	25	42	76	71
environmental policy/regulation	147	14	23	54	56
air pollution(s)	46	2	2	5	37
design for environment	31	0	5	11	15
environmental management accounting	22	0	1	10	11
(2) Carbon-related research	614	0	10	71	533
Greenhouse gas emission(s)/GHG emissions/greenhouse gas(es)/CO_2 emission(s)	540	0	10	67	463
carbon footprint	160	0	0	5	155
(3) Eco-related research	316	5	21	96	194
eco-design/ecodesign	144	4	6	45	89
eco-efficiency	120	1	12	47	60
eco-innovation	36	0	2	4	30
ecological footprint	35	0	3	4	28

Table 4b
The numbers of articles by the research field, *Industrial sectors*.

	Total	1993–1998	1999–2004	2005–2010	2011–2015
Industrial sectors	2215	43	160	496	1516
(1) Sectors	1706	32	119	384	1171
education/training/learning	443	15	47	115	266
cement/concrete	418	3	18	60	337
mining	335	5	29	92	209
food	279	3	18	59	199
metal (iron and steel, aluminum, copper)	144	6	5	23	110
agriculture	134	1	10	27	96
others (plastic, dyeing, tourism)	218	1	17	59	141
(2) Technological process & enterprise behavior	568	1	21	110	436
supply chain (management)	267	0	14	57	196
remanufacturing/sustainable manufacturing/reverse logistics	122	1	3	19	99
ethical responsibility (corporate/social responsibility, extended producer responsibilities)	116	0	1	25	90
mechanical properties	67	0	1	4	62
process integration	34	0	3	17	14
(3) Industrial parks	191	13	31	45	102
industrial ecology/industrial symbiosis	161	12	31	34	84
eco-industrial park	52	3	7	15	27
circular economy	27	0	0	5	22

Table 4c
The numbers of articles by the research field, *Resource/energy-related research*.

	Total	1993–1998	1999–2004	2005–2010	2011–2015
Resource/energy-related research	1905	36	107	375	1387
(1) Energy management	537	4	38	87	408
energy consumption	318	3	16	45	254
energy efficiency	236	1	22	37	176
energy conservation/saving(s)	128	0	8	18	102
(2) Waste	531	24	39	105	363
solid waste	331	10	12	63	246
waste management/treatment/hierarchy/utilization	218	6	17	41	154
waste minimization/minimization/prevention/reduction/recovery	102	11	20	25	46
(3) Renewable energy	474	1	8	93	372
Bio-	404	1	8	79	316
biomass	197	0	6	37	154
biofuel(s)	118	0	1	33	84
biodiesel	76	0	0	17	59
biogas	75	0	0	9	66
bioenergy	53	0	0	9	44
anaerobic digestion	52	1	1	8	42
bioethanol	33	0	0	3	30
Solar	62	0	0	11	51
photovoltaic/solar PV/PV learning curve	41	0	0	4	37
solar energy/power	34	0	0	7	27
Wind	20	0	0	2	18
wind energy/power	18	0	0	2	16
wind farm	5	0	0	0	5
wind resource	2	0	0	0	2
(4) Electricity	320	3	12	63	242
(5) Water	315	10	16	80	209
wastewater	256	10	16	76	154
water footprint	47	0	0	4	43
water scarcity	30	0	0	1	29
(6) Others	281	2	19	66	194
mineral(s)	155	0	9	31	115
forest(try)	115	2	8	24	81
marine	51	0	2	12	37

Table 4d
The numbers of articles by the research field, *Methodology and methods*.

	Total	1993–1998	1999–2004	2005–2010	2011–2015
Methodology and methods	1033	34	60	227	712
(1) LCA-related research	990	35	56	220	679
life cycle assessment/analysis (LCA)	876	32	44	178	622
life cycle impact/life cycle thinking/cost/benefit/approach	160	1	8	45	106
life cycle inventory	97	3	9	23	62
(2) Data Envelopment Analysis	36	0	3	1	32
(3) System Dynamics	27	0	0	3	24
(4) Input-output analysis	21	0	2	6	13
(5) Substance flow analysis	18	0	3	2	13

presented in Table 4. The category with the largest number of *JCLP* articles was the ecology/environmentally-related research cluster with 2215 articles, followed by the industrial sectors cluster with 2215 articles, the resource/energy-related research cluster had 1905 articles and the methodology & methods cluster contained 1033 articles.

These topical clusters reflected the development of some important subjects and the coverage of research fields in the JCLP. Based on the analyses of the main topics and subtopics, some focal points and research gaps for future cleaner production were identified and summarized.

(1) Environmental impact continues to be a crucial focus, which is catalyzing and guiding the transition to post-fossil carbon societies. Fossil-carbon emission's reduction will continue to be key in catalyzing the transition to sustainable, post-fossil carbon societies. That will require much research and implementation technological innovations, new mechanisms, new governmental and industrial policies, new economic values and systems, changes in education, from the kindergarten through life-long learning.
(2) Researchers gave priority to energy-intensive industries and enterprise behavior as their research objects. Sustainable education was also viewed as an increasingly important branch for support of research on sustainable industrial development.
(3) Researchers worked on a wide array of dimensions within energy-related topics. Because of the close connections between improved energy and material's production/consumption and sustainable development, interdisciplinary research was necessary and vital for helping to make progress in transitioning to low/no-fossil carbon societies.)
(4) Improved, real-world applications of LCA must be innovatively implemented, documented and where possible successful changes must be locally or regionally adapted and implemented broadly within and across sectors, regions and countries.
(5) Additionally, it was clear that new and improved decision-support management tools must be tested, improved and widely utilized to help to prevent and/or to solve eco-environmental/social/ethical problems in catalyzing the transition to equitable, sustainable, livable, post-fossil carbon societies.

Some specific analyses are presented in the following sections.

3.4.1. Ecology/environment-related research

Ecological, environmental, economic and ethical problems have and continue to cause widespread concerns at the local, regional and international levels. Actions designed to prevent or to reduce these problems have been conducted by researchers and policy-makers in many countries and regions. Under the subject of ecology and environment, 2215 articles were published in the *JCLP*; this category had the highest number of articles of the four fields. The number of articles published per year has dramatically increased in recent years. As presented in Table 4(a), the main topics included: environmentally-related research, carbon-related research and eco-related research.

Environmental performance(s)/impact(s), as the general evaluation focus, was widely used in many articles, such as the coordinated implementation of environmental foci and sustainable finance in enterprises, reducing environmental impacts of product-service systems, identifying the relationships among energy and material saving technologies and environmental performance, etc., (Muhammad et al., 2015; Pons et al., 2013; Salazar et al., 2015). These research foci had much broader scopes, involving microcosmic aspects (products, technologies, processes, etc.) and macrocosmic aspects (structure, system, correlation, policies, education, eco-systems bio-diversity, etc.). Therefore, under this topic, the number of papers that addressed environmental performance(s)/impact(s) was the highest with 1193 articles; also, this category continues to maintain a high growth rate. Environmental management with 342 articles was in second place in this topic. Although the number was much less than environmental performance, it continues to increase each year. Researchers applied environmental management tools in industries and firms as they sought to make industrial progress toward SD. (Vintró et al., 2014; Zutshi and Creed, 2015).

It was most common to find researchers who applied one or more of the International Organization for Standardization (ISO) standards such as ISO 9001, 14001, 18000, and 26000 in their work with companies. In addition, a total of 214 articles on pollutant prevention and 147 articles on environmental policy were included in this topic, but the growth in numbers of articles published was limited.

Carbon emissions produced by human activities was/is the main factor causing climate change and global warming. The Kyoto Protocol was designed to help companies, cities and countries to prevent and to reduce global warming by reducing emissions of greenhouse gases. The Kyoto Protocol entered effect in 2005 and the first commitment period ended in 2012. Du et al. (2015) used bibliometric methods to collect and research the diverse impact of the carbon market. Results showed that the number of publications increased exponentially during the first commitment period of the Kyoto Protocol. Based on the history of the JCLP, as shown in Table 4(a), the number of carbon-related articles surged from 2011 to 2015. The serious, long-term, climate change-related impacts of carbon emissions and the numerous mechanisms for achieving fossil-carbon emissions reductions were addressed under this topic. The research included carbon-dioxide emissions reducing potential within a wide array of industrial sectors, the different carbon abatement strategies or policies, education on these areas and other ways to help to accelerate development and implementation of best practices to achieve transitions to low/no fossil carbon societies. (Bing et al., 2015; Huisingh et al., 2015; Jiang et al., 2013; Zhou et al., 2014).

Thus, research, policies, education and other foci on how to accelerate the transition to equitable, sustainable, livable, post-fossil carbon societies must be central to short and long-term research in the future.

The last topical area was eco-related research. The number of articles in this cluster was limited to 316. Under this topic, researchers sought to use eco-design tools for solving specific product-related problems in different industrial sectors (Casamayor and Su, 2013; Favi et al., 2012). The methodology or platform that the authors proposed were useful to integrate eco-design concepts and tools into product optimization and design process. All the integration processes were designed to reduce product environmental impacts, via improvements in energy and material's efficiency and based upon more sustainable consumption.

3.4.2. Industrial sectors

The second topical cluster included diverse industrial sectors; this category had 2215 articles. Based upon the different analytical dimensions, the authors of this review paper divided the topics in this cluster into industrial sectors with 1706 articles, technological processes & enterprises behavior with 568 articles and industrial parks with 191 articles.

Under the topic of industrial sectors, education was addressed

by authors of 443 articles, which underscored the increasing importance of education in the JCLP. This was reflected by the fact that the *JCLP's* leadership supported the planning, development and publication of twelve SVs focused upon the roles of all dimensions of higher education for achieving sustainable societal development. The editors of those SVs selected articles focused upon relevant initiatives to improve higher educational paradigms, concepts and tools to make the necessary transitions to sustainable societies.

In other foci of the *JCLP*, many researchers selected energy-intensive industrial sectors for their studies. As shown in Table 4(b), cement/concrete were addressed in 418 articles, mining with 335 articles, food with 279 articles, metal with 144 articles, agriculture with 134 articles and others were included in this cluster of papers. As an especially energy-intensive industry, the cement industry releases 5–7% of total global CO_2 emissions (Benhelal et al., 2013). Some researchers focused upon making improvements in the technological processes by using CO_2 capture technologies in the production phase (García-Gusano et al., 2015; Vatopoulos and Tzimas, 2012). Other researchers examined energy efficiency improvement approaches and reduction of CO_2 emissions of the cement industry from the national development perspective. Their purposes were to provide policy guidance, including improvements in cost-effectiveness, designing emissions reduction targets, achieving emissions reduction of multi-sectors, etc.

Some of the keywords used in the articles on the topic of technological processes and enterprise's behavior was addressed in 568 articles, included: Supply chain was addressed in 267 articles, remanufacturing was focused upon within 122 articles and ethical responsibility in 116 articles, which belonged to the category of business management, while others were related to the technical dimensions of manufacturing.

Supply chain management ranked in first place of all the topics in this group of articles. By incorporating supply chain management, some studies investigated environmental impacts and carbon footprints of specific industries or firms. (Lee, 2011, 2012). In addition, some researchers proposed holistic, sustainable supply chain management inputs for the integrative benefits of enterprises including environmental, economic and social performance (Mota et al., 2015). In general, the research on supply chain management was the key hotspot of enterprise management addressed by JCLP authors.

3.4.3. Resource/energy-related research

Social and economic development depends on resource and energy consumption. Proposing low/no-fossil carbon transformations to achieve SD was focused upon to achieve reductions of excessive consumption of resources, especially of fossil-carbon-based energy. Under the subject of resource/energy, 1905 articles were published in the *JCLP*. To identify the trends of topical clusters within this area, the authors divided the topics into two different clusters.

Energy management with 537 articles ranked in the first place of all fields. The number of articles in each topic under this field increased rapidly during the last ten years, which means that energy-related research was receiving more and more attention. It was clear that the topic of energy consumption with 318 articles, had the largest number of articles under energy management, The articles were focused upon a wide range of macro and micro foci, such as national energy planning and carbon emissions reduction (Chen and Yang, 2015; Shao et al., 2014), energy-saving potential of different industrial sectors (Nissinen et al., 2015), energy consumption of numerous processes/technologies/products (Garg et al., 2015; Sahoo et al., 2014).

From the micro foci perspective, many researchers evaluated energy efficiency improvements within individual companies in relation to improvements in Cleaner Production. Many not only focused upon low-fossil carbon transformations via improvements in technologies and/or products, but many also focused upon more systematic approaches to SD. In other words, the macroscopic analyses were also important for foci such as optimization of regional energy development, and adjustment of the entire industrial structure (Song et al., 2015; Wesseh and Lin, 2015).

The number of articles in the field of waste was 531; this revealed a similar growth trend to that of making improvements in energy efficiency management. As the published results showed, solid waste with 331 articles was a key focus, which also had the largest number of articles. It included municipal solid and liquid wastes, food wastes, construction and demolition wastes, industrial wastes and other waste categories. In general, with 218 articles, the research on solid waste was primarily focused upon environmental impact assessments or comparisons of waste treatment approaches and not much on how to reduce or how to prevent the generation of the wastes in the first place via CP concepts and approaches (Erses Yay, 2015). It was found that analyses, which only considered the technical feasibility, cost-effectiveness and environmental performance were insufficient; they should also have considered source prevention or minimization approaches as well as the social, ethical and equity dimensions. (Huang et al., 2014).

Within the field of renewable energy with 474 articles, the topic of bio-energy related research was addressed in 404 articles, which contained the largest number of articles in this cluster. There were 62 articles on solar energy and 20 articles on wind energy systems. Studies of article trends in related journals showed the similar ranking trends. Mao et al. (2015a) analyzed alternative energy research from 1994 to 2013 using a bibliometric method. They found that the main alternative energy types were bioenergy, wind energy and solar energy. The number of publications about hydropower, nuclear energy and other types was fewer than the number articles on alternative energy. The bio-energy related research included a wide range of topics, such as biomass was addressed by authors of 197 articles, biofuel was addressed in 118 articles, and biodiesel in 76 articles.

Research often focused upon a specific technology and case studies, energy and environmental evaluations were the primary foci of these papers (Nguyen et al., 2013; Wiloso et al., 2014). In addition, increasing numbers of researchers focused upon regional developmental strategies for utilization of biomass energy (Maes et al., 2015; Mao et al., 2015b; Ng et al., 2012; Ooba et al., 2015). This trend was also found in solar energy research. In previous studies, solar materials and technologies were the primary focus. (Du et al., 2014). In recent years, more research on market diffusion of the photovoltaic industry was published in the *JCLP* (Li and Yu, 2016; Saikku et al., 2017).

Electricity, with 320 articles and Water with 315 articles were the last two fields in resource/energy-related research. The numbers of articles in these groups was less than in the previous topics. However, the numbers of articles in this group increased dramatically, in recent years. This underscored the fact that electricity and water, were two important resources for past research and continue to become more crucial, especially in the context of climate change and with the related impacts and consequences on global food security.

3.4.4. Methodology and methods

The last topical cluster of articles for this review, focused upon methodology and methods, which included 1033 articles. As shown in Table 4(d), it is obvious that the articles of LCA-related research were much more abundant than those that focused upon other

Table 5
The *JCLP*'s most frequently cited articles during each year in the 2002–2015 timeframe.

Pub. year	TC-2015	TC/Y	Article	Country	Authors
2002	384	27	Clarifying the concept of product-service system	Sweden	O.K Mont
2003	349	27	A strategic decision framework for green supply chain management	USA	Joseph Sarkis
2004	189	16	Developing a framework for sustainable development indicators for the mining and minerals industry	England	Adisa Azapagic
2005	211	19	Methods for life cycle inventory of a product	Netherlands	Sangwon Suh, Gjalt Huppes
2006	240	24	Acid Mine Drainage (AMD): causes, treatment and case studies	Turkey	Ata Akcil, Soner Koldas
2007	265	29	A review of assessments conducted on bio-ethanol as a transportation fuel from a net energy, greenhouse gas, and environmental life cycle perspective	USA	Harro von Blottnitz, Mary Ann Curran
2008	657	82	From a literature review to a conceptual framework for sustainable supply chain management	Germany	Stefan Seuring, Martin Müller
2009	168	24	A life-cycle assessment of Portland cement manufacturing: comparing the traditional process with alternative technologies	USA	Deborah N. Huntzinger, Thomas D. Eatmon
2010	114	19	Transitioning to sustainable production - Part I: application on machining technologies	Slovenia	Franci Pusavec, Peter Krajnik, Janez Kopac
2011	129	26	Costs and carbon emissions for geopolymer pastes in comparison to ordinary Portland cement	Australia	Benjamin C. McLellan, Ross P. Williams, Janine Lay, Arie van Riessen, Glen D. Corder
2012	147	37	A Review of Footprint analysis tools for monitoring impacts on sustainability	Hungary, Slovenia	Lidija Čuček, Jiří Jaromír Klemeš, Zdravko Kravanja
2013	202	67	Recycling of rare earths: a critical review	Belgium, Netherlands, UK, Germany	Koen Binnemans, Peter Tom Jones, Bart Blanpain, Tom Van Gerven, Yongxiang Yang, Allan Walton, Matthias Buchert
2014	61	31	A literature and practice review to develop sustainable business model archetypes	UK	N.M.P. Bocken, S.W. Short, P. Rana, S. Evans
2015	26	26	Multi criteria decision making approaches for green supplier evaluation and selection: a literature review	Denmark, India, USA	Kannan Govindan, Sivakumar Rajendran, Joseph Sarkis, P. Murugesan

TC: total citations; TC/Y: average annual citations since publication.

methods. This tool was widely used in many research areas, including environmental impact assessment, improving cost-effectiveness, process optimization, new product development and others. This methodology helped researchers to consider problems comprehensively. However, with the growth of LCA applications, the breadth, depth and novelty of the LCA studies needs to be expanded and improved.

It was found that management methods, such as Data Envelopment Analysis (DEA) with 36 articles, and System Dynamics (SD) with 27 articles, were not as widely used in articles published in the *JCLP* as were those that used LCA in all its variant dimensions, however these two approaches are very important and were sometimes used in conjunction with LCA. The authors of this review article recommend that more integrative, multi-disciplinary research between eco-environmental problems and diverse decision-support management methods should be performed in the coming years and that some of the other relevant tools should be used in addition to or in combination with LCA.

3.5. The most frequently cited articles

To investigate the most frequently cited articles in each year, authors of this review article used parameters such as the total citations, average annual citations and the country of origin of the author(s) of the papers for the 2002–2015 timeframe. Yearly variations in the number of citations were used to trace the impacts of articles. As shown in Table 5, it was clear that the most frequently cited article with 657 citations was published in the *JCLP* in 2008 by S. Seuring and M. Müller with the title, '*From a literature review to a conceptual framework for sustainable supply chain management.*'.

The second most frequently cited paper '*Clarifying the concept of product-service systems*' was published in 2002, by O.K. Mont. As of 2016, Mont's article had received 384 citations and it received the most citations in a single year with 27.

It is noteworthy that eleven of the most frequently cited articles were all authored by single country teams. The articles in this group had foci such as, 'sustainable business models & industrial development (economic aspects)', 'carbon emissions reductions (environmental aspects),'and life-cycle assessment (technical aspects). The authors of these articles underscored the growing emphasis upon future societal development as well as on the future impacts of the *JCLP*.

4. Conclusions

The authors of this review paper used bibliometric analysis tools to investigate the array of topics of the articles published in the *JCLP* since it was founded in 1993–2015. After a slow and gradual growth during the first years, the *JCLP* has become increasingly important among the journals in the Sustainability Field. Especially, during the last four years there was a dramatic increase in articles published; in 2015, the *JCLP* published a record high of 1178 articles.

Chinese scholars contributed 591 articles in the *JCLP* in 2015, which was the largest number from any country. During the same year, authors from the USA were second by publishing 127 articles and authors from the UK were third by publishing 86 articles in the *JCLP*. The authors of the USA had an H-index of 46, which is the highest ranking among the country's rankings.

Chinese scholars have played and are playing vital roles in the international collaboration networks among the twenty most productive countries and regions. Scholars from the University of Tennessee published 79 papers, which is the largest number from a single institution. Furthermore, its authors were/are at the center of the collaboration network among the twenty most productive institutions; they have strong cooperation relationships with fifteen other institutions, especially with Erasmus University and Utrecht University in The Netherlands and with Lund University in Sweden.

The authors of this review article also analyzed the co-occurrences and distributions of keywords in articles published in the *JCLP*. The results were similar, to the development trends and topical clusters of articles published in the *JCLP*. The main topic and subtopic analysis indicated that ecology/environment-related and industrial sectorial research were the most important fields addressed in articles published in the *JCLP*. The challenges of how to

improve environmental performance to reduce environmental and social impacts and to reduce fossil-carbon emissions were addressed by increasing numbers of authors.

In addition, researchers focused upon ways of making improvements in material's and energy resource management and in improving worker's health and safety. Authors with skills in applying LCA and other tools to reduce or to solve environmental and social problems in many industrial sectors published, many, excellent articles in the *JCLP*.

These results document that the authors who published in the *JCLP* have made many significant contributions to societal knowledge, practice and education about ways to accelerate the transition to equitable, sustainable, livable post-fossil carbon societies. However, much more must be done to slow-down and to reverse the rapidly increasing global atmospheric emissions of carbon dioxide and other greenhouse gasses.

The authors of this review article anticipate and hope that future *JCLP*'s authors will continue to play increasingly active scientific, policy and educational leadership roles in accelerating the transitions to post-fossil carbon societies, which function sustainably within the ecological limits of healthy eco-systems, and which provide equitable, and ethically sound lives for present and future generations. The authors anticipate that the *JCLP* will continue to provide an open global platform for prevention-oriented, multi-disciplinary, multi-cultural, multi-generational communications of cutting-edge knowledge for academics, educators, researchers, enterprise leaders and policy makers as we/they co-work to prevent, to reduce and to solve the dynamic problems facing societies now and in the near and long-term future.

Acknowledgements

This study was supported by the National Natural Sciences Foundation of China under Grant 71673198, 71431005, 51641407, 71273185, 41571522 and 71561137003, and the National Science & Technology Pillar Program under Grant 2014BAC26B00.

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