Evaluation Innovation Research Performance and Trend of the Worldwide

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***Abstract*---Innovation is one of the most important fields in research and development of new knowledge or service today, making research innovation trend is an important issue. This study evaluates the worldwide innovation development trend of research for the past sixteen years and provides insights into the characteristics of innovation research activities to identify an innovation development map, tendencies, or regularities that may exist in papers. Data are based on the online version of SSCI, Web of Science from 1993 to 2008. Articles referring to innovation were assessed according to many aspects including exponentially fitting publication outputs during 2002–2008, distribution of source title, author keywords, and keyword plus analysis. The exponential fitting of the yearly publications of the last decade can also calculate that, in 2014, the number of scientific papers on innovation will be twice the number of publications in 2008. Synthetically analyzing four kinds of keywords, this work analysis concludes that innovation application relates to issues based on knowledge, technology, R&D and entrepreneurship. The result displays that the USA is number one in innovation research totaling 6,317 papers, followed by UK totaling 2,354 papers. Other leading countries in innovation research include Canada, the Netherlands, Germany, France, Australia and Italy.**

I. INTRODUCTION

Innovation is one of the most important fields in research and development of new knowledge or new service innovation today, making research innovation an important topic. During the past decade, many promising research results indicate that innovation is the most important element of organizational knowledge creating processes [1, 2, 3, 4, 5, 6]. Organizational learning has many virtues which recent writings in strategic management have highlighted on management sciences [7]. Innovation promotes organizational learning resulting in more research performance. Continuing research on innovation has increased our understanding of some industry values like new products development, new technology, new service procedures and new service business models [8]. Despite the high growth rate of innovation, scholars have shown little interest in topics such as fellow management, economics, business, planning and development, environmental studies, information science and library science. The bibliometric method is a common research tool for this analysis, widely applied for the scientific production and research trends in many science and engineering disciplines [9, 10, 11].

The Science Citation Index (SCI), from the Institute for Scientific Information (ISI) Web of Science databases is the most important and frequently used database sources of choice for a broad review of scientific accomplishment in all fields of study [12]. Bibliometric analysis is a special advanced field of scientific research [13]. Conventional bibliometric methods often evaluate the research trend by publication outputs of countries, research institutes, journals, and research fields [14, 15] or by citation analysis [16, 17]. Merely depending on the change in citations or publication counts of countries and organizations cannot completely indicate the development trend or future orientation of the research field. More information, closer to the research itself, such as source title, author keywords, keywords plus, and abstracts should be introduced for studying the research trend. Arrue and Lopez [18] evaluate the growth pattern of conservation tillage research based primarily on abstracts published in *Soils and Fertilizers*. Qin [19] first attempted to use keywords plus to investigate antibiotic resistance research. The keyword plus in the SCI database supplied additional search terms extracted from article titles cited by authors in their bibliographies and footnotes [20].

The bibliometric method could be used to outline the advance of innovation in the last fifteen years. However, finding show little bibliometric study on the topic of current innovation or even in the whole field of innovation study [14]. Innovation has become a competitive weapon in business operational management that could help firms keep cost down, enhance competitiveness and improve performance. The innovation application domain is very large, including studies such as: Accelerating adaptive processes through product innovation in the global computer industry [21]; exploring the impact of information stickiness on the locus of innovation-related problem solving [22]; entry, exit, growth, and innovation over the product life cycle. A study model emphasizing differences in firm innovative capabilities and the importance of firm size in appropriating innovation returns to explain regularities [23]; exploring collaboration networks, structural holes, and innovation to assess the effects of a firm's network on innovation study [24]. Research innovation trend is the most one of research issues in the future.

This study synthetically uses the traditional method, study field and country analysis, and the innovative method, source title, author keyword, and keyword plus analysis, to map global innovation research during the period of 1993–2008. This investigation will help researchers realize the panorama of global innovation research, and establish further research direction.

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II. DATA SOURCES AND METHODOLOGY

The data for this study are based on the online version of the Social Science Citation Index (SSCI), Web of Science. The SSCI are a multidisciplinary database of the Institute for Scientific Information (ISI), Philadelphia, USA. The Journal Citation Reports (JCR), indexes 1,980 major journals with citation references across fifty-six scientific disciplines in 2008. The current study researched the online version of SSCI under the keyword "innovation" to compile a bibliography of all papers related on innovation research. This research reclassified articles originating from England, Scotland, Northern Ireland, and Wales as from the United Kingdom (UK), and obtained the reported impact factor (IF) of each journal from the 2008 JCR.

This investigation determined collaboration type by the addresses of authors, where the term "single country" was assigned if the researchers' addresses were from the same country. The term "international collaboration" was designated to those articles coauthored by researchers from different countries. The term "single institute publication" was assigned if the researchers' addresses were from the same institute. The term "inter-institutionally collaborative publication" was assigned if authors were from different institutes. All articles referring to innovation during the past sixteen years, including the last eight years of the 20th century and the first eight years of the 21st century were assessed by the following aspects: document type and language of publications, characteristics of publication outputs during 1993–2008, distribution of output in subject categories and journals, publication outputs of country, and source title, author keyword, and keyword plus analysis.

III. RESULTS AND DISCUSSION

A. Document type and language of publication

This work analyzed the distribution of the document type identified by ISI and found sixteen document types in the total 20,403 publications. Article (14,832) was the most frequently used document type comprising 73% of total production, followed distantly by book review (1,748; 8.6%), proceeding paper (1,747; 8.6%), review (1,087; 5.3%), and editorial materials (693; 3.4%). The others showing less significance included meeting abstracts (139), letters (70), notes (27), new items (23), corrections (16), reprints (8), discussions (5), addition corrections (4), biographical items (2), items about an individual (1) and software review (1). Journal articles represented the majority of document types that were also peer–reviewed within this field. This study only used 14,832 original articles for further analysis as relevant citable items, and discards all others. Ninety–seven percent of all these journal articles were published in English. Several other less used languages included: German (129), Spanish (115), French (109), Slovak (42), Russian (27), Czech (26), and Portuguese (17). Still other less published languages included: Croatian (8), Dutch (5), Norwegian (4), Polish (3), Japanese (3), Italian (3), Finnish (2), Slovene (2) and one for Hungarian, Swedish, and Danish respectively.

B. Characteristics of Publication Outputs during 1993–2008

Fig. 1 displays the total publication amounts of SSCI articles including "innovation" in their titles during the last 100 years. Innovation research continually grew along with SSCI development during this long period, increasing significantly in the year 1993 and rocketing in the 21st century. Built on many breakthroughs in the study period during 1993–2008, especially in the recent decade, innovation research has become one of the most important and dynamic fields of academic research [3, 5, 25, 26, 27, 28, 29, 32].

In the past sixteen years, the annual number of published articles devoted to innovation research increased from 374 in 1993 to 1,910 in 2008, with a stable increase in the number of journals article (Table 1). The average article length fluctuated slightly, with an overall average length of sixteen to eighteen pages. The average number of authors per article rose from 1.7 authors per article in 1993 to 2.2 in 2008. Papers in 1993 cited thirty-six references, compared to forty-six cited references per paper in 2008, averaging forty-three cited references per paper. Fig. 2 shows the progression in the cumulative number of articles published each year from 1993 through 2008. This work simulated the growth pattern using two models. The logarithmic model plotted the regression line from 1993 to 2002. The exponential model plotted the regression line from 2002 to 2008, which the plot of the data revealed a high coefficient of determinations ($r^2 = 0.9998$) in the period from 2002 to 2008. Findings show the relationship between the cumulative number of articles published each year (P) and the year studied since 2002 to 2008 (Y) to be:

$$P = 1680\exp(0.1360Y)$$

The exponential model during 2002–2008 can also calculate that, in 2014, the number of scientific papers on the topic of innovation (4,252) will be twice the number of publications in 2008.

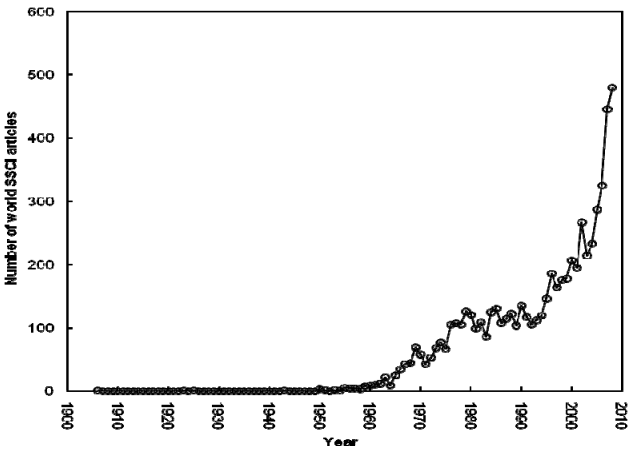

Fig. 1 Number of SSCI journal articles referring to "innovation" in the title

TABLE 1 CHARACTERISTICS BY YEARS OF PUBLICATION OUTPUTS FROM 1993 TO 2008

Year	TP	AU	AU/P	PG	PG/P	NR	NR/P
1993	374	631	1.7	5,993	16	13,458	36
1994	465	806	1.7	7,558	16	17,125	37
1995	517	902	1.7	8,567	17	18,936	37
1996	590	1,087	1.8	9,808	17	21,986	37
1997	609	1,115	1.8	10,452	17	23,248	38
1998	663	1,217	1.8	11,163	17	26,045	39
1999	684	1,270	1.9	11,825	17	27,093	40
2000	779	1,465	1.9	13,824	18	31,447	40
2001	873	1,688	1.9	15,475	18	36,261	42
2002	962	1,913	2.0	16,619	17	40,418	42
2003	1,029	2,105	2.0	18,695	18	46,480	45
2004	1,060	2,123	2.0	18,816	18	47,031	44
2005	1,227	2,557	2.1	21,927	18	55,491	45
2006	1,366	2,945	2.2	23,599	17	62,338	46
2007	1,724	3,832	2.2	30,884	18	79,858	46
2008	1,910	4,232	2.2	32,315	17	87,483	46
Total	14,832	29,888		257,520		634,698	
Average			2.0		17		43

TP: Number of publications; PG: Page count; NR: Cited reference count; AU: Number of authors;
PG/P, NR/P, and AU/P: average of pages, references, and authors in a paper.

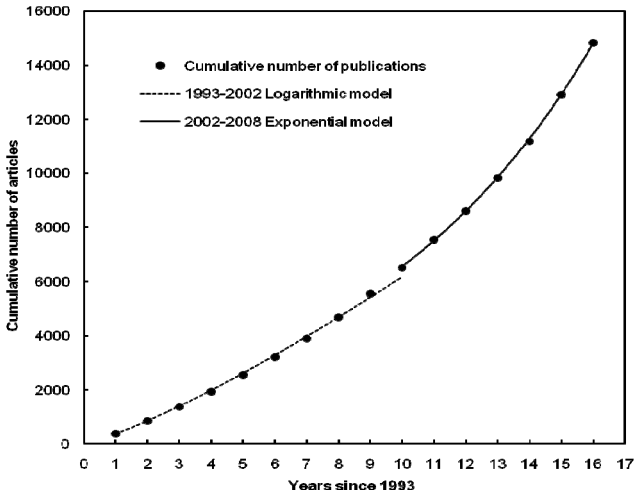

Fig. 2 Cumulative numbers of publications during 1993-2008

C. Distribution of publication output of subject categories and journals

Based on the classification of subject categories in JCR, the publication output data of innovation research is distributed in 174 subject categories including fifty-six SSCI and 108 SCI subject categories, and other ten are not SSCI or SCI subject categories in 2008. To further study global trends on innovation research, this work compares between "management," "economics," "business," "planning and development," "environment studies," and "information science & library science" during the period of 1993–2008.

All author keywords of articles referring to "management," "economics," "business," "planning and development," "environment studies," and "information science & library science" are statistically analyzed in Figure 3. "Management" is a general topic issue (*e.g.*, knowledge management, operational management, business management, technology management, financial management, human resource and knowledge management). Knowledge management issue first appears in the innovation study field, in the context of organizational knowledge creation in 1994. While individuals develop new knowledge, organizations play a critical role in articulating and amplifying that knowledge [29]. Scholars combines the concept of weak ties from social network research and the notion of complex knowledge to explain the role of weak ties in sharing knowledge across organization subunits in a multiunit organization [33]. During the last four years, the number of articles related to management had the highest growth rate, successfully transcending other articles in 2008 (Fig. 3).

"Economics" is also a popular keyword (*e.g.*, market economics, individual economics, macroenconomics and industrial economics). Clustering and the new economics of competitive economic geography in an era of global competition pose a paradox. Open global markets, rapid transportation, and high-speed communications should allow any company to source anything from any place at any time [34]. Creating competitive economics geography has become one of the most important innovation factors. The analysis data show that economics issues have a smooth incremental curve from 1993 to 2001. But the economics topic became a hot issue in 2002 when American economics declined after the 911 event in 2001, drawing down economies worldwide. Many scholars discuss innovation in light of world economics. From 2008 to 2009 global economics faced a recession that has become a popular topic for economic discussions.

"Business" research focuses on the corporate culture, customer orientation, innovativeness, and market performance [35]. Business performance (relative profitability, relative size, relative growth rate, and relative

share of market) positively correlates with customer's evaluation of the supplier's customer orientation, but the supplier's own assessment of customer orientation does not correspond well to that of the customer [36]. Business issue topics experienced stable growth from 1993 to 2009.

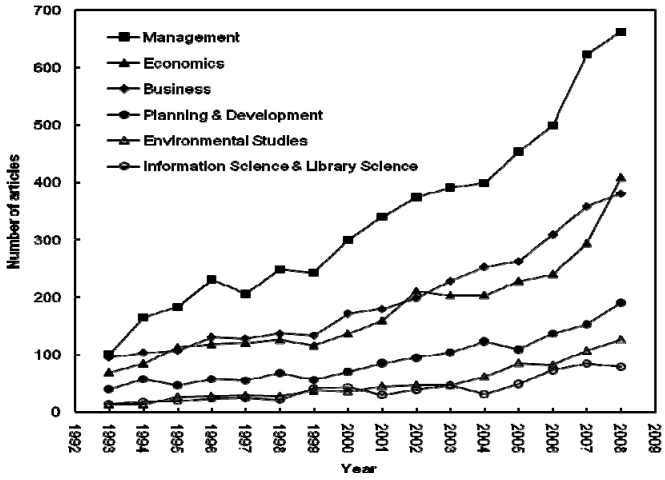

Fig. 3 Comparison the growth trends of subject categories

Scholarship on innovation has an extensive history, including research on national technological output from national systems to generate innovation, and firm-level management of new product planning and development [37]. Network positions and propensities to collaborate are key issues of environmental studies. Organizations in crowded positions are those that participate in technological segments in which many firms actively innovate, and prestigious firms are those with a track record of developing seminal inventions [38]. Documentation, information science, and library science in the U.S.A. address three questions related to innovation research field. What were the issues in the "information science vs library science" argument? Technological innovation was a vital force in library science in the late 19th century and again after 1950 [39]. Articles on the above three related issues of innovation research experienced a stable growth trend from 1993 to 2008.

Innovation research related to "economics" and "business" application to enterprise innovation will undoubtedly maintain innovation research hotspots in the future.Table 2 analyzes subject categories containing over 14,380 innovation related articles and the top thirty most published journals on innovation. The analysis data displays that 15.3% of the articles reside in seven core journals, whereas the remainder reside in another 1,926 journals. These top seven core journals rank as follows: *Research Policy* (643; 4.3%), *International Journal of Technology Management* (464; 3.1%), *Technovation* (321; 2.2%), *Technological Forecasting and Social Change* (225; 1.5%), *Journal of Product Innovation Management* (214; 1.4%), *R & D Management* (210; 1.4%), *Strategic Management Journal* (203; 1.4%). As the use of statistics in any scientific discipline can be considered a key element in evaluating its degree of maturity [40], the result provides a current view of innovation research emphases of this topic. A total of 14,382 articles were published in a wide range of 1,933 journals including specialty journals, but also in journals of other disciplines belonging to 174 subject categories above.

D. Distribution of country publications

This study estimated the contribution of different countries by the location of at least one published author. The investigation ranked the top thirty countries by number of publications, including the number and percentage of single country articles and internationally collaborated articles (Table 3). Two North American countries, two South American countries, seventeen European countries, seven Asian countries, South African and Australia ranked in the top thirty publications. South African country ranked with the top twenty-eight productive country. The six major industrial countries (G6: Canada, France, Germany, Italy, UK, and the USA) ranked in the top eight for world publications and the Japan was ranked at thirteen. The G7 (seven major industrial countries) demonstrated high productivity in independent papers, totaling 11,831 (81.9% of all independent papers). Publication domination was not surprising from mainstream countries since the innovation issue has occurred in most scientific fields [41, 42]. To a certain extent, the number of research papers reflecting the activity and academic level of these countries was likewise high [43, 44, 45]. The earliest innovation research occurred in these industrial countries, which conducted the earliest and the most relative research performances. The U.S.A. showed the greatest counts of world publications, followed distantly by other countries. The U.S.A. also had the most–frequent partners, accounting for 53 percent of all international collaborative articles during the last sixteen years. But compared to its total publications, the U.S.A. presented a very low percentage (19%) of collaboration with outside authors.

The analysis data in Fig. 4 display U.S.A. predominance in global innovation research. The publications share of the U.S.A. distinctly increased in our study period, especially in the latest decade. The U.K. ranked second position in global innovation research fields. The global trend of innovation research accords with developmental trends toward world multi-polarization and scientific research globalization, while other countries in the world gradually increased their disparities with the U.S.A. Fig. 5 displays the time–trend analysis among six others major countries. The figure shows an obvious rise in the number of articles related to innovation research in all six countries, while the rapid development of global innovation research in the last sixteen years was partly driven by these countries' contributions [26, 27, 46, 47, 48, 49].

TABLE 2 TOP THIRTY MOST PUBLISHED JOURNALS ON INNOVATION

Journal name	IF	TP (%)	Subject Category	Position
Research Policy	2.211	634 (4.3)	Management; Planning & Development	
International Journal of Technology Management	0.356	464 (3.1)	Multidisciplinary Engineering Management; Operations Research & Management Science	
Technovation	1.004	321 (2.2)	Industrial Engineering Management; Operations Research & Management Science	
Technological Forecasting and Social Change	0.889	225 (1.5)	Business; Planning & Development	
Journal of Product Innovation Management	1.585	214 (1.4)	Business; Industrial Engineering Management	
R & D Management	0.597	210 (1.4)	Business; Management	
Strategic Management Journal	2.829	203 (1.4)	Business; Management	
Technology Analysis & Strategic Management	0.638	184 (1.2)	Management; Multidisciplinary Sciences	
Management Science	1.931	174 (1.2)	Management; Operations Research & Management Science	
Research–Technology Management	0.476	172 (1.2)	Business; Industrial Engineering; Management	
IEEE Transactions on Engineering Management	0.962	150 (1)	Business; Industrial Engineering; Management	
Regional Studies	1.797	137 (0.92)	Environmental Studies; Geography	
Harvard Business Review	1.323	133 (0.9)	Business; Management	
European Planning Studies	0.688	122 (0.82)	Planning & Development	
Organization Science	3.13	121 (0.82)	Management	
International Journal of Industrial Organization	0.464	118 (0.8)	Economics	
Small Business Economics	1.168	118 (0.8)	Business; Economics	
Academy of Management Journal	5.017	116 (0.78)	Business; Management	
Energy Policy	1.901	111 (0.75)	Energy & Fuels ; Environmental Sciences ; Environmental Studies	
Journal of Engineering and Technology Management	N/A	109 (0.73)	Business; Industrial Engineering; Management	
Journal of Business Research	0.878	106 (0.71)	Business	
Industrial Marketing Management	0.911	88 (0.59)	Business; Management	
Industrial and Corporate Change	1.325	84 (0.57)	Business; Economics; Management	
Journal of Management Studies	1.926	80 (0.54)	Business; Management	
Journal of Business Venturing	1.875	80 (0.54)	Business	
Scientometrics	1.472	76 (0.51)	Computer Science; Interdisciplinary Applications; Information Science & Library Science	
Organization Studies	2.042	73 (0.49)	Management	
Health Affairs	3.004	71 (0.48)	Health Care Sciences & Services; Health Policy & Services	
Journal of Evolutionary Economics	0.562	70 (0.47)	Economics	
Long Range Planning	1.667	66 (0.44)	Business; Management; Planning & Development	

IF: impact factor; TP: total published articles in the 16 years; %: percentage of all articles published in the years

TABLE 3 TOP THIRTY MOST PRODUCTIVE COUNTRIES OF ARTICLES DURING 1993-2008

Country/territory	TP	TPR (%)	SPR (%)	CPR (%)	FAR (%)	RPR (%)	%C
USA	6,317	1 (44)	1 (42)	1 (53)	1 (40)	1 (40)	19
UK	2,354	2 (16)	2 (14)	2 (29)	2 (14)	2 (14)	28
Canada	869	3 (6.0)	3 (4.6)	3 (13)	3 (4.9)	3 (4.9)	36
Netherlands	827	4 (5.7)	4 (4.5)	4 (12)	4 (4.8)	4 (4.8)	34
Germany	717	5 (5.0)	5 (3.9)	5 (11)	5 (4.1)	5 (4.0)	35
France	522	6 (3.6)	9 (2.5)	6 (9.3)	9 (2.7)	9 (2.7)	42
Australia	519	7 (3.6)	6 (2.9)	8 (7.1)	6 (3.0)	6 (2.9)	32
Italy	511	8 (3.5)	8 (2.8)	7 (7.5)	7 (2.9)	7 (2.9)	34
Spain	451	9 (3.1)	7 (2.9)	11 (4.4)	8 (2.8)	8 (2.8)	23
Taiwan	287	10 (2.0)	10 (1.9)	21 (2.2)	10 (1.8)	10 (1.8)	18
Sweden	261	11 (1.8)	11 (1.5)	13 (3.6)	11 (1.5)	11 (1.5)	32
Hong Kong	242	12 (1.7)	14 (1.1)	10 (4.6)	12 (1.2)	13 (1.3)	45
Japan	225	13 (1.6)	12 (1.2)	18 (3.3)	14 (1.2)	14 (1.2)	34
South Korea	218	14 (1.5)	13 (1.2)	18 (3.3)	12 (1.2)	12 (1.3)	35
Belgium	203	15 (1.4)	21 (0.65)	9 (5.4)	18 (0.91)	17 (0.93)	62
Finland	196	16 (1.4)	15 (1.0)	16 (3.4)	15 (1.1)	15 (1.1)	40
Denmark	190	17 (1.3)	16 (0.93)	16 (3.4)	16 (1.0)	16 (1.0)	41
Switzerland	173	18 (1.2)	18 (0.75)	15 (3.5)	19 (0.89)	18 (0.92)	47
Israel	170	19 (1.2)	17 (0.84)	20 (3.0)	17 (1.0)	19 (0.89)	41
Singapore	150	20 (1.0)	25 (0.55)	14 (3.6)	20 (0.81)	20 (0.8)	55
China	146	21 (1.0)	26 (0.47)	12 (3.8)	26 (0.58)	26 (0.61)	61
Norway	136	22 (0.94)	19 (0.73)	24 (2.1)	21 (0.78)	21 (0.79)	35
India	126	23 (0.87)	20 (0.72)	25 (1.7)	22 (0.67)	22 (0.72)	31
Austria	121	24 (0.84)	23 (0.58)	22 (2.2)	22 (0.67)	23 (0.67)	42
New Zealand	118	25 (0.82)	24 (0.56)	23 (2.2)	24 (0.65)	24 (0.64)	42
Brazil	100	26 (0.69)	22 (0.60)	30 (1.2)	25 (0.6)	25 (0.61)	27
Greece	85	27 (0.59)	27 (0.45)	27 (1.3)	27 (0.45)	27 (0.46)	36
South Africa	78	28 (0.54)	29 (0.40)	28 (1.3)	29 (0.38)	29 (0.39)	38
Portugal	71	29 (0.49)	30 (0.35)	29 (1.2)	29 (0.38)	29 (0.39)	41
Ireland	65	30 (0.45)	31 (0.27)	26 (1.4)	31 (0.33)	31 (0.34)	49

TP (%): the number of total publications; TPR (%): the share in total publications; SPR (%), CPR (%), FAR (%), RPR (%): the rank and percentage of single country publications, internationally collaborative publications, first author publications, corresponding author publications in total publications.

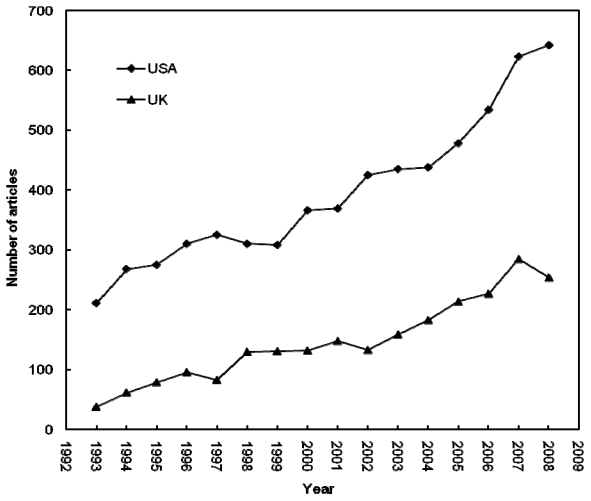

Fig. 4 Growth comparison trends of the top two countries

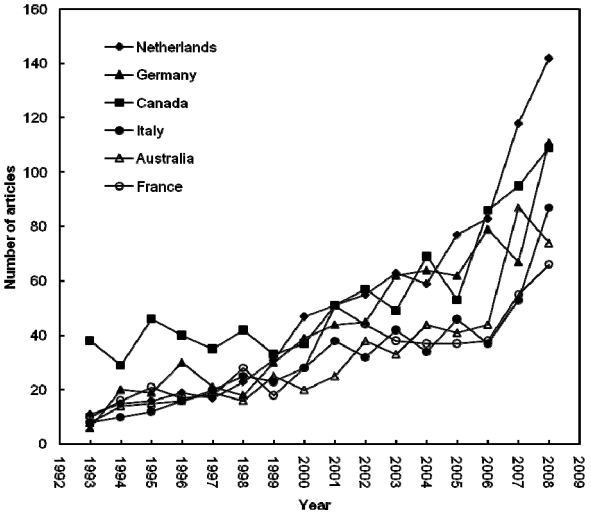

Fig. 5 Growth comparison trends of the Netherlands, Germany, Canada, Italy, Australia, and France

The Netherlands has the highest growth rate in the past ten years, with the lowest share (12%) of international collaborative articles in its total publications among the top thirty productive countries, representing its powerful independence in innovation related research field. The scholars draft report outlines a process for both public and private funded scientists to follow in deriving and working with innovation [50, 51, 52]. A series of positive policies undoubtedly motivate the rapid development of the innovation research in the Netherlands. Another significant point is that Canada (6%) and Germany (5%), have kept ahead of other countries in the last decade. The percentage of publications from Italy, Australia and France in the period of 1993–2008 has slightly increased, indicating that the growth rate of innovation research in these three countries is a little slower than in other productive countries. The increase could be attributed to various factors, while innovation research itself refers to science, technology, competitiveness and national politics. Innovation has become an important indication of national competitiveness, the research and development facility of products, and widespread application of marketing and brand building [21, 24, 54, 55]. To some extents, government policy, including law and regulations of industries in these countries, could decisively encourage the progress of innovation research [23, 50, 55, 56].

E. Distribution of source title analysis

Rodríguez and Moreiro [57] primarily assess the growth and development of research by dissertation title analysis. They used the length of key words per title to compare the complexity of titles between countries. The title of an article always includes the information which the author would most like to express to their readers, because it is seen first. This study statistically analyzed all single words in titles of innovation related articles. Some prepositions such as "of" and "in," are apparently used frequently during our study period, however, they contain no useful meanings for research trend analysis. This research discarded empty words including "of," "in," "and," "the," "a," "for," "with," "by," and etc. in the analysis in Table 4. After eliminating fourteen empty words above, this study analyzed twenty-five of the most frequently used single words in titles, which are all substantives, during the past sixteen-year and in four-year periods respectively. Along with the growing number of articles, almost all the single words increased in the study period. "innovation," "technology," and "new" were emphasis words in innovation research articles during the sixteen-year study period, indicating the innovation application in research and development, business, and service processing. Technology and new concepts in business operation have always been the mainstream issue in research. The words "development" and "knowledge" more frequently appeared in titles, while the percentage of articles with these two words increased from 5.3% and 1.5% to 6.7% and 7.1%. Once researchers recognized the extraordinary potential of knowledge, the ability of knowledge management to manage different issues became one of the most knowledge management topics of the 21st century [2, 3, 25, 26, 58, 59, 60]. Some words such as "performance," "study," and "R&D" have an apparently higher growth rate than any other words, and have been more frequently used in recent periods. Taking "performance" as an example, the number and percentage of articles related to innovation research with "performance" in the title went up from the ranked number of 26, 2.2% in 1993–1996 to the ranked number of 7, 5.3% in 2005–2008, highly according with the great attention given to innovation research transfer performance in recent decades [61, 62]. The percentage of some words such as "organization," "information," "diffusion," and "process" obviously reduced, due to two possible explanations. Some words are general words in management research which are replaced by more specific or definite single words in article titles. "Organization" might belong to this case. Another possible explanation is that researchers gradually disregard

some title words, or retreated from the mainstream of innovation research. "Information," "diffusion," and "process" might belong to this case. For example, earlier innovation application focused on information change management and technology diffusion, as one of various organizations concerned with primal understanding of enterprise management functions. Since researchers have found that organizations could be the source of all types of clinically relevant management, not only information and technical diffusion, they tired of using innovation to treat many other management needs, such as innovation (being studied in 3,673 articles), technology (1,135), new (1,019), development (979), and knowledge (833), which ultimately declined in frequency of "process" in the last sixteen years [21, 63].

TABLE 4 TOP THIRTY MOST FREQUENT SUBSTANTIVES IN SOURCE TITLES DURING 1993-2008

Words in title	93–08 TP	93–08 R (%)	93–96 R (%)	97–00 R (%)	01–04 R (%)	05–08 R (%)
innovation	3,673	1 (25)	1 (28)	1 (26)	1 (23)	1 (24)
technology	1,135	2 (7.7)	2 (9.2)	2 (9.3)	3 (7.4)	4 (6.6)
new	1,019	3 (6.9)	3 (6)	3 (7.3)	2 (7.4)	5 (6.6)
development	979	4 (6.6)	5 (5.3)	4 (6.4)	4 (7.2)	3 (6.7)
knowledge	833	5 (5.6)	44 (1.5)	20 (3.3)	5 (6.9)	2 (7.1)
product	785	6 (5.3)	4 (5.5)	5 (6.4)	6 (5.7)	11 (4.5)
case	776	7 (5.2)	8 (4.5)	8 (4.8)	8 (4.9)	6 (5.9)
industry	759	8 (5.1)	7 (4.5)	7 (5.2)	7 (5.5)	8 (5.1)
management	646	9 (4.4)	12 (3.6)	9 (4.2)	11 (4.4)	10 (4.6)
technological	642	10 (4.3)	6 (5)	6 (5.7)	10 (4.4)	19 (3.4)
firms	633	11 (4.3)	13 (3.5)	11 (4.1)	9 (4.5)	12 (4.4)
performance	615	12 (4.1)	26 (2.2)	24 (3)	13 (4.2)	7 (5.3)
research	604	13 (4.1)	10 (4.1)	12 (3.9)	12 (4.2)	13 (4.1)
study	579	14 (3.9)	36 (1.7)	13 (3.8)	16 (3.7)	9 (4.8)
policy	524	15 (3.5)	15 (3.1)	13 (3.8)	22 (3.2)	15 (3.8)
learning	519	16 (3.5)	19 (2.8)	17 (3.5)	15 (3.9)	18 (3.5)
R&D	508	17 (3.4)	36 (1.7)	18 (3.5)	14 (4.1)	17 (3.5)
analysis	503	18 (3.4)	23 (2.6)	21 (3.2)	22 (3.2)	14 (3.9)
organizational	494	19 (3.3)	11 (3.9)	15 (3.7)	20 (3.3)	21 (3)
role	482	20 (3.2)	18 (2.8)	30 (2.5)	18 (3.5)	16 (3.5)
information	463	21 (3.1)	9 (4.1)	9 (4.2)	24 (3.1)	38 (2.4)
change	453	22 (3.1)	19 (2.8)	15 (3.7)	26 (3)	26 (2.9)
model	444	23 (3)	15 (3.1)	27 (2.8)	25 (3)	21 (3)
market	426	24 (2.9)	40 (1.6)	28 (2.7)	19 (3.4)	23 (3)
evidence	424	25 (2.9)	101(.87)	31 (2.4)	17 (3.5)	20 (3.2)
growth	418	26 (2.8)	31 (1.9)	29 (2.7)	21 (3.2)	27 (2.9)
adoption	416	27 (2.8)	21 (2.7)	21 (3.2)	28 (2.7)	28 (2.7)
diffusion	411	28 (2.8)	17 (3)	18 (3.5)	30 (2.6)	33 (2.5)
systems	402	29 (2.7)	26 (2.2)	25 (2.9)	32 (2.5)	25 (2.9)
process	392	30 (2.6)	14 (3.4)	26 (2.9)	27 (2.8)	39 (2.2)

TP: the number of total publications; R (%): the rank and percentage of words in titles in total publications.

F. Distribution of author keyword analysis

The source titles and author keywords supply "reasonable" details of the articles' subject. Author keyword analysis offers research trend information for researchers. The bibliometric method concerning author keyword analysis only manifests in recent years [64], whereas author keywords analyzing the research trend is much more infrequent [65]. Statistical analysis of keywords discovers directions of science, and is important for monitoring science development and programs. An examination of author keywords in this study period revealed that 16,895 author keywords were used. Among them, 13,120 keywords (78%) appeared only once, and 1,664 keywords (10%) appeared twice. The large number of once–only author keywords probably indicates a lack of continuity in research and a wide disparity in research focuses [66]. Most authors did not consider their research articles to be mainstream innovation research. Author keywords appearing in the articles referring to innovation from 1993 to 2008 were calculated and ranked by a sixteen-year study and 4 four-year time periods.

Except for "innovation" which was a searching keyword in this study, only the single "innovation" keyword ranked in the top number one, with 1,711 articles, or 22% of total articles (Table 5). Other multiple keywords such as "technological innovation," "product innovation," and "diffusion of innovation" ranked number 13, with 102 articles (1.3% of total articles); ranked number 16, with 93, articles (1.2%); ranked number 23, with 77 articles (1.0%). These three words are also the basis of all worldwide innovation research, while "R&D" is the foundation of creation innovation, and "technology" is the presentation approach of innovation research [46, 51, 67, 68]. This study ranked "R&D" number 2, with 201 articles (2.6%), "technology" ranked 3, with 145 articles (1.8%), one of the most frequently used author keywords. The other keywords, "knowledge management" and "knowledge" are also currently some of the most frequently used management issues [3, 4], ranking number 4 and 5 of the top thirty author keywords (Table 5).

Different from segmenting the title into single words in source title analysis, this section preserved intact words that

the authors wanted to transmit to readers. The same single word or phrase can therefore be seen in different author keywords. For instance, of all the 14,832 innovation related articles in the last sixteen–years, more than 4,488 (39%) articles refer to "innovation" comprising "technological innovation" (102), "product innovation" (93), "diffusion of innovation" (77), and other 1,711 different author keywords with the single word "innovation". Large amounts of promising research progress make various R&D technologies in innovation application research increasingly absorbing to researchers [68, 69]. During the past sixteen years, especially the last decade, "knowledge management" and "entrepreneurship" had extremely high increasing ranking rates of all the author keywords in the study period. Summary above data analysis display knowledge, technology, R & D and Entrepreneurship four author keywords indication the trend of research topics. Figure 6 showing four keywords has similar strong growth rate from 1993 to 2008 (Fig. 6).

TABLE 5 TOP THIRTY FREQUENTLY USED AUTHOR KEYWORDS DURING 1993-2008

Author Keywords	93–08 TP	93–08 R (%)	93–96 R (%)	97–00 R (%)	01–04 R (%)	05–08 R (%)
innovation	1,711	1 (22)	1 (22)	1 (23)	1 (23)	1 (21)
R&D	201	2 (2.6)	29 (1.0)	2 (2.9)	2 (3)	2 (2.5)
technology	145	3 (1.8)	3 (3.3)	3 (2.5)	6 (2.1)	9 (1.4)
knowledge management	143	4 (1.8)	232 (0.19)	12 (1.6)	3 (2.4)	4 (1.8)
knowledge	133	5 (1.7)	10 (1.7)	12 (1.6)	4 (2.2)	7 (1.4)
new product development	132	6 (1.7)	20 (1.2)	7 (2.1)	5 (2.1)	8 (1.4)
technology transfer	128	7 (1.6)	4 (2.9)	8 (1.8)	9 (2.0)	11 (1.3)
entrepreneurship	128	7 (1.6)	68 (0.58)	47 (0.73)	12 (1.5)	3 (2.1)
patents	122	9 (1.6)	68 (0.58)	14 (1.6)	8 (2.0)	6 (1.4)
learning	109	10 (1.4)	6 (2.3)	21 (1.3)	10 (1.9)	16 (1.0)
networks	108	11 (1.4)	14 (1.5)	16 (1.5)	12 (1.5)	10 (1.3)
diffusion	108	11 (1.4)	7 (2.1)	8 (1.8)	15 (1.4)	13 (1.2)
technological innovation	102	13 (1.3)	9 (1.9)	3 (2.5)	16 (1.3)	26 (0.89)
organizational learning	97	14 (1.2)	10 (1.7)	8 (1.8)	11 (1.6)	28 (0.85)
internet	94	15 (1.2)	N/A	35 (0.91)	7 (2.1)	20 (1.0)
product innovation	93	16 (1.2)	17 (1.3)	6 (2.2)	20 (1.0)	22 (1.0)
product development	89	17 (1.1)	68 (0.58)	14 (1.6)	12 (1.5)	23 (0.92)
China	86	18 (1.1)	104 (0.38)	81 (0.46)	27 (0.86)	5 (1.5)
biotechnology	84	19 (1.1)	68 (0.58)	18 (1.4)	19 (1.1)	16 (1.0)
information technology	83	20 (1.1)	5 (2.5)	5 (2.4)	17 (1.2)	77 (0.46)
technological change	81	21 (1.0)	2 (3.5)	23 (1.2)	18 (1.1)	50 (0.63)
research and development	78	22 (1.0)	7 (2.1)	18 (1.4)	48 (0.67)	23 (0.92)
diffusion of innovation	77	23 (1.0)	10 (1.7)	43 (0.82)	21 (1.0)	23 (0.92)
growth	77	23 (1.0)	20 (1.2)	23 (1.2)	41 (0.72)	16 (1.0)
performance	76	25 (1.0)	29 (1.0)	55 (0.64)	41 (0.72)	12 (1.2)
knowledge transfer	71	26 (0.9)	104 (0.38)	81 (0.46)	36 (0.81)	14 (1.1)
collaboration	68	27 (0.87)	42 (0.77)	35 (0.91)	22 (1.0)	30 (0.82)
creativity	68	27 (0.87)	42 (0.77)	161 (0.27)	24 (0.91)	19 (1.0)
absorptive capacity	67	29 (0.85)	104 (0.38)	108 (0.36)	38 (0.76)	15 (1.1)
strategy	66	30 (0.84)	20 (1.2)	21 (1.3)	27 (0.86)	41 (0.68)

TP: the number of total publications; R (%): the rank and percentage of author keywords in total publications.

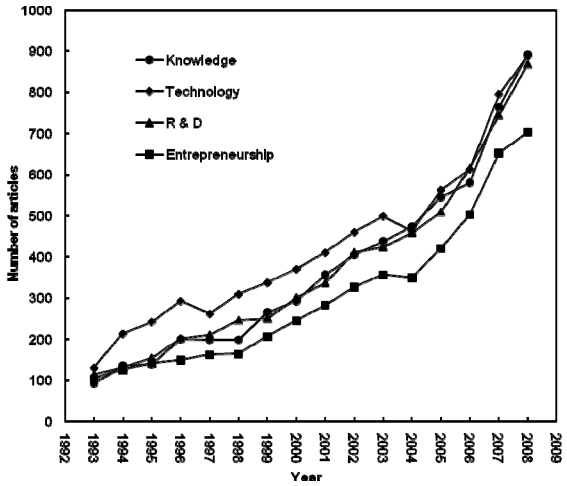

Fig. 6 Comparison of the trends of research topics of knowledge, technology, R & D, and entrepreneurship

In a dynamic theory of organizational "innovation" written by Nonaka was published in *Organization Science* in 1994, "innovation" is very attractive research incentive for scholars [2]. Organizational units produce more innovations and enjoy better performance if they occupy central network positions that provide access to new knowledge developed by other units [70]. Scholars have explored the innovation domain, namely the creation and development of high cost, complex products and systems (CoPS), and how they might affect innovation and industrial organization [71]. Scholars immediately found "innovation" to be the most flexible innovative for knowledge management, research and development of new products, which is also an optimal choice as a good competitive source for business operational management [3, 67, 68]. Similarly, the keywords plus show rank and percentage of "knowledge", "research and development" as its plural form change from "39th, 1.5%," "34th, 1.7%" in 1993–1996 to "6th, 8.4%," "9th, 7.1%" in 2003–2008 (Table 6). This result indicates that innovation

attracted extensive attentions during the last four years. Survival has long been recognized as a basic goal for a manufacturing firm, and relates to various measures of performance, such as market share and profitability [72]. "Innovation" is an element that maintains long term survival advantages for firms by utilizing R&D spillovers and geography of innovation and production [46].

An increasing understanding of innovation by global researchers will exploit its extraordinary potential to suggest innovation strategies that eventually could benefit enterprises with management issues [73, 74]. Researchers did not begin using "entrepreneurship" as an author keyword in their articles until 1997. Scholars once thought that entrepreneurship innovation could only differentiate into the original innovation; however, subsequent studies suggest that entrepreneurship innovation can differentiate into an innovative domain other than the original innovation [75, 76, 77]. Although most studies did not conclusively demonstrate that a single innovative–specific innovation differentiates into an innovative function of multiple innovations, entrepreneurship has still become a popular topic in the field of innovation research in the 21st century.

TABLE 6 TOP THIRTY FREQUENTLY USED KEYWORDS PLUS DURING 1993-2008

Keyword plus	93–08 TP	93–08 R (%)	93–96 R (%)	97–00 R (%)	01–04 R (%)	05–08 R (%)
innovation	4,488	1 (39)	1 (36)	1 (35)	1 (42)	1 (40)
performance	1,360	2 (12)	4 (5.9)	2 (10)	2 (12)	2 (14)
technology	1,002	3 (8.8)	3 (7.9)	3 (9.0)	3 (9.3)	5 (8.6)
model	1,000	4 (8.8)	2 (10)	4 (7.6)	4 (8.6)	3 (8.9)
management	871	5 (7.6)	5 (5.8)	6 (6.1)	7 (7.4)	4 (8.8)
industry	832	6 (7.3)	8 (5.2)	5 (6.8)	6 (7.7)	7 (7.7)
firms	808	7 (7.1)	6 (5.5)	7 (5.9)	5 (8.2)	8 (7.2)
knowledge	711	8 (6.2)	39 (1.5)	20 (3.1)	8 (6.5)	6 (8.4)
research–and–development	661	9 (5.8)	34 (1.7)	10 (4.2)	10 (6.2)	9 (7.1)
firm	622	10 (5.4)	12 (3.5)	13 (3.6)	9 (6.4)	11 (6.1)
growth	587	11 (5.1)	13 (3.4)	9 (4.5)	11 (5.1)	12 (5.8)
perspective	556	12 (4.9)	16 (2.9)	21 (2.9)	13 (4.7)	10 (6.2)
organizations	500	13 (4.4)	19 (2.8)	13 (3.6)	12 (5.0)	15 (4.7)
strategy	491	14 (4.3)	9 (4.6)	11 (4.0)	15 (4.0)	16 (4.5)
diffusion	489	15 (4.3)	6 (5.5)	8 (4.9)	16 (4.0)	21 (3.9)
networks	475	16 (4.2)	36 (1.6)	27 (2.6)	14 (4.2)	13 (5.3)
systems	463	17 (4.1)	18 (2.9)	25 (2.6)	17 (3.9)	14 (5.0)
determinants	419	18 (3.7)	25 (2.4)	12 (3.7)	19 (3.7)	20 (3.9)
competition	417	19 (3.7)	11 (3.9)	16 (3.5)	22 (3.5)	24 (3.8)
competitive advantage	408	20 (3.6)	39 (1.5)	27 (2.6)	20 (3.7)	18 (4.4)
information	406	21 (3.6)	22 (2.6)	21 (2.9)	18 (3.9)	23 (3.9)
impact	405	22 (3.5)	28 (2.1)	34 (2.2)	22 (3.5)	17 (4.4)
policy	387	23 (3.4)	19 (2.8)	31 (2.5)	24 (3.4)	22 (3.9)
product development	357	24 (3.1)	57 (1.1)	46 (1.4)	29 (2.9)	19 (4.4)
united–states	349	25 (3.1)	19 (2.8)	17 (3.4)	26 (3.1)	29 (3.0)
organization	343	26 (3.0)	28 (2.1)	24 (2.7)	21 (3.5)	28 (3.0)
adoption	332	27 (2.9)	10 (4.2)	19 (3.3)	30 (2.9)	34 (2.5)
market	316	28 (2.8)	27 (2.3)	27 (2.6)	31 (2.8)	30 (2.9)
models	314	29 (2.8)	22 (2.6)	15 (3.5)	31 (2.8)	35 (2.4)
spillovers	313	30 (2.7)	79 (0.73)	33 (2.4)	28 (3.0)	27 (3.2)

TP: the number of total publications; R (%): the rank and percentage of keywords plus in total publications.

On the contrary, this study noticed a visible decline in ranking of the keyword "technological change," "information technology," "diffusion of innovation," "research and development," and "strategy". The decreased innovation factor might attribute to the reason mentioned above, that more specific or definite words replaced this general word. The word "R&D" containing "research and development" promotes mobilization of innovation from research and development of new product to R&D of a new business service procedure. "Information technology (IT)" is the earliest discovered innovative technology in the 20th century and is also a competitive tool for enterprise [42, 78]. The literature has strongly concept of IT as a powerful competitive weapon. The resource–based theory as a means of analyzing sustainability and develops a model founded on this resource–based view of the firm. Scholars then apply this model to four attributes of IT-capital requirements, proprietary technology, technical IT skills, and managerial IT skills that might be sources of sustained competitive advantage [79]. In the innovation research field, the decline in the ranking and percentage of author keywords above is attributed to the related lower growth rate of other relate words. We may conjecture that these gradually declining trends will continue in the future innovation research field.

G. Distribution of keywords plus analysis

Keywords plus provides search terms extracted from the titles of papers cited in each new article in the database in ISI [20]. In source title analysis, as we segment the title into single words, the result is not repeated and can be statistically analyzed by rule and line. However, this process breaks the integrality of phrases in the title. In author keyword analysis,

we preserve intact words that authors want to transmit. Although it makes same single word or phrase appear in different author keywords, we can compare discrimination between author keywords, or sum up the dissimilar keywords with common phrase or single word for further study. Keyword plus analysis, as an independent supplement, reveals the articles' contents with more details. There are similar and dissimilar trends between their statistical results in this study periods. Table 6 revealed the distribution of keywords plus with its rank and percentage in different periods. Just as the author keywords rank, some words (e.g., "innovation," "performance," "technology," "knowledge," "research and development," "growth," "strategy," "diffusion," "networks," and "product development") were also emphases of keywords plus in the study period. Except for "innovation," "performance," "technology," and "knowledge", however, almost all other words show a low growth rate or even a decline in recent years. The decline of these words might be due to the gradual maturity of these orientations in innovation research. Keywords plus analysis, as an additional search term, are usually more concerned about the novel research direction than the mature direction in the field [20]. The keyword plus analyzing in Table 6 shows that more attention was given to "firm" and "model" in our study period. "Firm" is a basic enterprise organization of innovation research that is the foundation for research innovation practice, together with "model" approach studies then presentation innovative performance [41, 42, 80]. Electricity sector reforms across the world have led to a search for innovative approaches to regulation that promote efficiency in natural monopoly distribution networks and that reduce their service charges. A number of countries have adopted incentive regulation models based on efficiency benchmarking. Through adopt engineering-designed frontier-based benchmarking methods, presentation innovative performance [81]. Firms worldwide have been implementing enterprise resource planning (ERP) systems since the 1990s to have a uniform information system in their respective organizations and to reengineer their business processes. Through a case-type analysis conducted in six manufacturing firms with one of the widely used ERP systems, the study investigated various contextual factors that influenced these firms to implement this technology using the six-stage model [82]. The rank of many other keywords plus does not fluctuate clearly in study periods which show that innovation research development is basically a steady concentration in the past sixteen years [83, 30, 31, 53].

H. Production institutes of articles

This study analyzes the publication contribution of production institutes regarding innovation articles. The analysis data displays the top thirty most productive institutes of articles during 1993–2008 (Table 7). We found the top ten

TABLE 7 TOP THIRTY MOST PRODUCTIVE INSTITUTES OF ARTICLES DURING 1993-2008

Institute	TP	TPR (%)	SPR (%)	CPR (%)	FAR (%)	RPR (%)	%C
Harvard University, USA	275	1 (1.9)	1 (1.3)	1 (2.7)	1 (1.4)	1 (1.4)	61
University of Pennsylvania, USA	195	2 (1.4)	6 (0.70)	2 (2.2)	2 (0.84)	6 (0.70)	70
Massachusetts Institute of Technology, USA	181	3 (1.3)	2 (0.79)	3 (1.9)	5 (0.73)	3 (0.75)	64
University of California, Berkeley, USA	164	4 (1.1)	3 (0.77)	6 (1.6)	3 (0.83)	2 (0.83)	61
University of Michigan, USA	151	5 (1.0)	7 (0.68)	7 (1.5)	4 (0.76)	5 (0.71)	63
University of Manchester, UK	142	6 (1.0)	4 (0.76)	11 (1.3)	5 (0.73)	4 (0.72)	56
Stanford University, USA	142	6 (1.0)	23 (0.41)	4 (1.8)	11 (0.56)	14 (0.55)	76
University of Texas, USA	140	8 (1.0)	11 (0.57)	8 (1.5)	7 (0.66)	7 (0.67)	66
University of North Carolina, USA	138	9 (1.0)	19 (0.45)	5 (1.6)	10 (0.56)	14 (0.55)	73
Michigan State University, USA	135	10 (0.94)	15 (0.53)	9 (1.5)	12 (0.55)	8 (0.61)	67
University of Wisconsin, USA	128	11 (0.89)	8 (0.64)	12 (1.2)	9 (0.60)	9 (0.6)	59
University of Minnesota, USA	122	12 (0.85)	27 (0.37)	9 (1.5)	20 (0.45)	20 (0.43)	75
Columbia University, USA	121	13 (0.84)	12 (0.56)	12 (1.2)	12 (0.55)	10 (0.58)	62
University of Toronto, Canada	118	14 (0.82)	9 (0.60)	17 (1.1)	12 (0.55)	12 (0.56)	58
University of Illinois, USA	117	15 (0.81)	12 (0.56)	15 (1.2)	15 (0.54)	16 (0.53)	61
University of Sussex, UK	114	16 (0.79)	5 (0.71)	30 (0.90)	8 (0.62)	10 (0.58)	48
New York University, USA	112	17 (0.78)	16 (0.52)	16 (1.1)	15 (0.54)	13 (0.56)	62
University of Cambridge, UK	108	18 (0.75)	10 (0.59)	23 (1.0)	18 (0.5)	17 (0.48)	55
University of Warwick, UK	104	19 (0.72)	12 (0.56)	25 (0.95)	17 (0.51)	19 (0.46)	56
Erasmus University, Netherlands	101	20 (0.70)	36 (0.34)	14 (1.2)	21 (0.44)	20 (0.43)	72
Duke University, USA	101	20 (0.70)	18 (0.46)	21 (1.0)	23 (0.42)	22 (0.43)	62
Pennsylvania State University, USA	96	22 (0.67)	24 (0.39)	18 (1.0)	26 (0.37)	25 (0.38)	67
University of Maryland, USA	94	23 (0.65)	29 (0.36)	18 (1.0)	27 (0.37)	25 (0.38)	68
Eindhoven University of Technology, Netherlands	92	24 (0.64)	36 (0.34)	18 (1.0)	24 (0.41)	23 (0.41)	70
National University of Singapore, Singapore	91	25 (0.63)	19 (0.45)	32 (0.88)	19 (0.49)	17 (0.48)	59
University of California, Los Angeles, USA	88	26 (0.61)	24 (0.39)	27 (0.91)	29 (0.36)	40 (0.33)	64
Boston University, USA	83	27 (0.58)	36 (0.34)	30 (0.90)	25 (0.40)	27 (0.38)	66
Rutgers State University, USA	83	27 (0.58)	32 (0.35)	32 (0.88)	29 (0.36)	41 (0.32)	65
University of Nottingham, UK	82	29 (0.57)	50 (0.28)	23 (1.0)	29 (0.36)	29 (0.36)	72
Indiana University, USA	81	30 (0.56)	48 (0.29)	26 (0.93)	40 (0.33)	37 (0.33)	70
University of Amsterdam, Netherlands	81	30 (0.56)	32 (0.35)	37 (0.85)	38 (0.34)	32 (0.35)	63

TP: the number of total publications; TPR (%): the rank and share in total publications; SPR (%), CPR (%), FAR (%), RPR (%): the rank and percentage of single institute publications, inter–institutionally collaborative publications, first author publications, corresponding author publications in total publications.

productive institutes except one institute (University of Manchester, UK) and USA institute ranked as having the most publication are as follows: Harvard University, University of Pennsylvania, Massachusetts Institute of Technology (MIT), University of California Berkeley, University of Michigan, Stanford University, University of Texas, University of North Carolina and Michigan State University. Harvard University has previously had the most publication articles on innovation research. Harvard University in its percentage of single institute publications, inter–institutionally collaborative publications, first author publications, and corresponding author publications in total publications of the four criterion domains obtains number one ranking. Number 11 to 15 ranking data show those five institutes also North American region university institutes that mean point out research energy respect on North American country. Following the top thirty productive institutes, analysis data shows USA institutes rank number one, UK institutes rank second, the Netherlands institutes rank third, Canada and Singapore institutes have the same ranking position. Analysis data results point out the top ten universities worldwide that focus on innovation issues to do research.

IV. CONCLUSION

This study on innovation papers dealing with SSCI, obtained some significant points on research performance throughout the period from 1993 to 2008. This study used an exponential model analysis from 2002 to 2008. The exponential model fitting showed that yearly publicans had a distinct growth with a high rate during this decade. There were a total of 1,933 journals listed in the 174 subject category. Subject categories for mainstream research on innovation included six domains of management, economics, business, planning and development, environment studies and information science and library science, while increasing attention was paid to the field of innovation in the 21st century. As the flagship journal of the field, *Research policy* published the most articles. The G7, which had a longer tradition in research in this field, held the majority of total world production. The USA notably contributed the most independent and international collaborative articles, and had the most first author and corresponding author publications in total publication articles. The regulation of industries innovation in each country could be a decisive factor to the progress of innovation research. By synthetically analyzing the distribution and change of source title, author keywords and keyword plus, this paper describe research development on innovation during the last decade, and predict the future orientation of innovation research. This study concludes that application of innovation approach to business operation management, especially research related on "knowledge", "technology", "R&D" and "entrepreneurship" are the orientation of all innovation research in the 21st century. The result analysis by this new bibliometric method can help relevant researchers realize the panorama of global innovation research, and establish the further research direction.

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