

Major Trends in Public Sector Innovation: A Bibliometric Analysis

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ABSTRACT

It is well known that innovation plays a substantial role in the public sector. However, there are concerns about how far public sector innovation (PSI) research has contributed in providing ideas to the government in formulating and implementing public policy. This study intends to investigate how PSI research has progressed and been disseminated, explore major topics mentioned in PSI studies and determine the primary players in PSI studies. This research analysed the bibliometrics of scholarly publications on public sector innovation as of August 2021, as documented in the Scopus database. We analysed the evolution of PSI research in 53 years by assessing published studies, source titles, types of sources and documents, as well as the languages in which the papers have been published. We additionally analysed PSI's main research topics by examining popular subject categories, the most often used keywords and title analysis. Finally, we investigated the key actors in PSI research by focusing at the biggest contributions nations to PSI studies, the major establishments involved, as well as authorship and citation analysis. The conclusions suggested that during the initial stages of PSI development half a century ago, public sector innovation attracted the interest of Eastern and Western scholars, as well as the number of books and articles published each year which have increased dramatically. Although there has good inter-country cooperation exists, a deficit in PSI research also exists from specific nations compared to the rest of the globe. Our results contribute significantly to public sector innovation inclusiveness.

Keywords: Public Sector Innovation; Bibliometric Analysis; Innovation

INTRODUCTION

Innovation has become prevalent in the current era. The public sector organization's vision, purpose and objective statements increasingly include the "innovation" terms. Scholars and practitioners alike have shown a growing interest in public sector innovation (Osborne & Brown 2011a). Many people believe that innovation may boost the quality of services provided by the government and the capacity of government institutions to address problems in the face of social difficulties. (Damanpour & Schneider 2009) and develop novel ways to meet citizen demands for efficient service delivery (Pärna & von Tunzelmann 2007).

Several studies have looked into trends in public sector innovation (PSI) research. De Vries, Bekkers, and Tummers (2016) presented a comprehensive systematic

review of public sector innovation. They looked at the period from 1990 to 2014 and then investigated 181 articles and books on public sector innovation and categorized themes based on the definition of innovation, innovation types, goals of innovation, antecedents of innovation and outcomes of innovation. Potts and Kastle (2010) introduced an analytic context of PSI investigations, as well as a summary of the 9 papers and sought to develop a new research agenda in public sector innovation research from the fiscal perspective of public sector motivations to innovate.

Various research examined interdisciplinary aspects of public sector innovation. Previous studies have revealed common research themes such as measuring innovation (Arundel, Bloch & Ferguson 2019; Bugge, Bloch & Mortensen 2011; Bloch 2011; Hughes, Moore & Kataria 2011), managing innovation (Ab Rahman & Ismail 2018;

Ambtman et al. 2015; Anderson 2008; Walker, Damanpour & Devece 2011; Osborne & Brown 2011b), method to innovate (Arundel, Casali & Hollanders 2015), collaborative innovation (Torfing 2019; Bekkers & Tummers 2018), barriers in public sector innovation (Cinar, Trott & Simms 2019; Uyarra et al. 2014), innovation culture (Moussa, McMurray & Muenjohn 2018), open innovation (Kankanhalli, Zuiderwijk & Tayi 2017; Bekkers & Tummers 2018), innovation activities (Demircioglu & Audretsch 2017), innovation and public reform (Matei and Bujac 2016), smart government (Gil-Garcia, Helbig & Ojo 2014), public sector innovation theory (Gow 2014), barriers to innovation (Uyarra et al. 2014), innovation strategy (Collm & Schedler 2013), types of innovation (Damanpour, Szabat & Evan 1989; Koch & Hauknes 2005; Buchheim, Krieger & Arndt 2020), leadership and innovation (Borins 2002; Callender 2001; Borins 2001; Lewis, Ricard & Klijn 2018). The majority of the latest studies of the literature on public innovation sought to understand the significance and relevance of public sector innovation from a conceptual approach as opposed to the usual empirical point (for instance, using definitive data from sample cases and polls). (De Vries, Bekkers & Tummers 2016). However, few bibliometric analyses were done to investigate public sector innovation throughout its evolution, causing a lack of comprehensive grasp in this domain.

Bibliometric analysis is a quantitative analysis approach used to identify the current status and emerging trends in a variety of domains. This paper presents a bibliometric analysis of public sector innovation by investigating three key research issues: (a) how public sector innovation research has expanded and been dispersed, (b) What important areas of public sector innovation research have been discussed, and (c) identity of the main parties in PSI research and the way that they have done joint-research. The rest of our research discusses the research methodologies, findings and interpretation and the various considerations and issues involved in responding to the following aspects of the public sector innovation literature. The bibliometric analysis that was conducted had the objective of answering the 3 questions by taking into consideration the following parameters:

PSI research's development and dissemination:

1. Quantity of published studies per year;
2. Document types and their sources; and
3. Language used in the documents

PSI's main research areas:

1. Field of study;
2. Keyword's frequency; and
3. Title analysis.

Collaborations between key figures and researchers:

1. Nations with highest contributions;
2. Main institutes of higher learning;
3. Authorship analysis; and
4. Citation analysis.

Our study's objective is to gain a deeper insight into the public sector innovation phenomena, particularly its global reach and collaborative efforts. In addition, the most recent data were analysed researchers in making future research recommendations.

METHODOLOGY

This study's technique is based on the manner by which data is collected and filtered, and takes into consideration all the steps required until the final data compilation is solid and suitable for analysis. Therefore, it is necessary to identify the study's topic and breadth before proceeding. We aim to focus on all papers linked to public sector innovation that are currently available in the Scopus database to fulfil the purpose of this study. Due to its reputation as the "largest single abstract and indexing database ever built and the largest searchable citation and abstract literature search list (Ahmi & Mohamad 2019) the Scopus database was chosen..

The materials acquired for this study were chosen after taking into consideration recommendations of the research protocol. as per Figure 1. The statistics taken from the Scopus database were obtained and current up to 1 August 2021. Given the limited research on innovation bibliometrics, we limited the papers connected to the public sector based on the document's title and used string search strategy. To achieve this objective, a synonym to the word public sector was searched, and then the following query was done; *TITLE(("public administrat*" OR "public organization*" OR government*" OR "public service" OR "public sphere" OR "public sector") AND innovation)*. A total of 1643 documents were returned from this query. A series of data cleanings revealed that the papers were not duplicated.; as a result, a similar number of papers were kept following the procedure. The Scopus database was used to compile all of the information which were then exported into search information systems (.ris) and comma-separated values (.csv) formatted files.

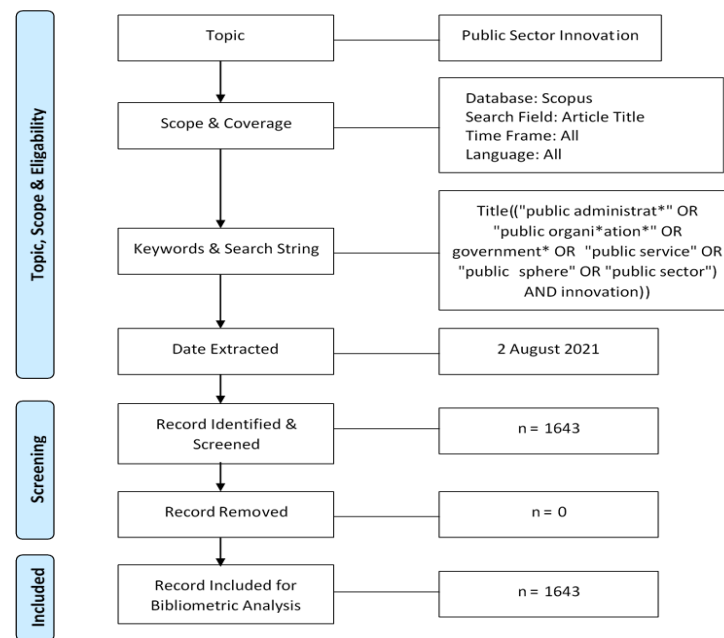


FIGURE 1. Flow diagram of the search strategy (Moher et al. 2009)

This study used the bibliometric technique to examine all of the public sector innovation research trends. The database contains information on publications such as year published, type of documents, published language, area of topic, source title, keywords, abstract, country, affiliation, citations and authorship. To analyse and visualize the data, we have utilised Microsoft Excel, Harzing's Publish or Perish and VOSviewer tools. In our study, we used the VOSviewer software for the constructing and visualising

of the bibliometric networks (Perianes-Rodriguez, Waltman, and van Eck 2016). VOSviewer graphically represents the nodal network using two uniform weights, which indicate the number and the connections' overall strength. VOSviewer's network size and interconnecting interlinking lines, which Leiden University established, represent the significance and strength of the connections. The procedures shown in Figure 2 can be used to accomplish the intended outcomes of doing the bibliometric analysis provided in this technique.

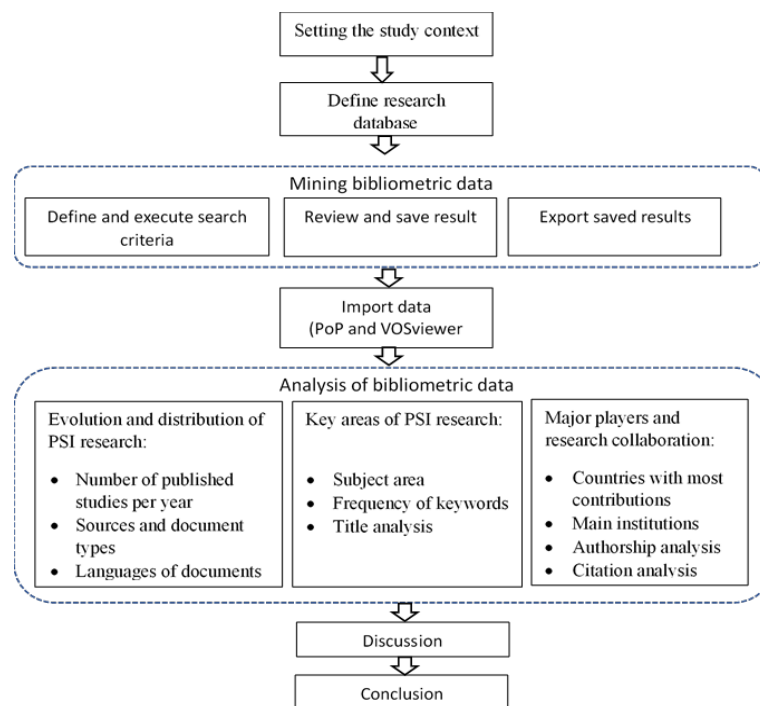


FIGURE 2. Stages of the bibliometric analysis procedures

RESULTS AND ANALYSIS OF FINDINGS

This paper's analysis incorporated the following elements of scholarly works to address the research questions outlined in the previous sections: year of publication, document category, publishing by source title, kind of source, country, and institution, document languages, subject areas, citation patterns and themes in public sector innovation according to the keywords & title, in addition to the abstract and authorship. Some of the research have been further developed by establishing the number of cited publications frequency and percentage (NCP), total citations (TC), average citation per publication (C/P), average citation per cited publication (C/CP), g-index and h-index. The publisher's name is reported for the most prolific source title with the current Cite Score, Scimago Journal Rank (SJR) 2020 and Source Normalized Impact per Paper (SNIP) 2020 as per the Scopus database. SJR measures the weighted citations obtained by the source title. In contrast, SNIP estimates the number of legitimate citations received compared to the citations anticipated in the topic area of the originating title. The citation analysis was published as citation metrics and 30 of the most often referenced articles in public sector innovation were made public.

CURRENT STATE OF PUBLICATION IN PUBLIC SECTOR INNOVATION

In order to respond to the first research question, (What is the current state of public sector innovation?), We looked into the publication trend in public sector innovation based on total publications by year, type of document, publication by source title, publication by nation, publication by institution, language and publishing topic area. The Scopus database was used to acquire bibliographic data which was then used in the study to calculate the data.

PUBLICATION BY YEAR

The detailed statistics of annual publications on public sector innovation are shown in Table 1. According to the Scopus database, 108 papers were published in 2018, with an increase to 124 publications in 2019, followed by an increase to 169 publications in 2020, and a slight decrease to 103 papers in the final 4 months of 2020. The publication trend, as shown in Figure 3, is indicating the imminent tremendous rise of PSI research. The five earliest papers written by Thompson (1968) discussed scientific management and innovation; Boaden (1971) discussed innovation and change; Ashford and Heaton (1975) on the effect of innovation on government activity; Pavitt and Walker (1976) on government policies towards innovation; and (Staats 1976) discussed innovation climate. The topics discussed in those five publications still captivates our attention to this day.

TABLE 1. Year of Publication

Year	TP	%	NCP	TC	C/P	C/CP	h	g
2021	103	6.27	26	61	0.59	2.35	4	4
2020	169	10.29	89	465	2.75	5.22	11	15
2019	124	7.55	93	910	7.34	9.78	15	25
2018	109	6.63	82	1062	9.74	12.95	18	28
2017	107	6.51	77	1105	10.33	14.35	18	30
2016	91	5.54	61	1352	14.86	22.16	17	36
2015	96	5.84	73	1054	10.98	14.44	18	30
2014	98	5.96	78	1421	14.50	18.22	20	35
2013	117	7.12	87	1934	16.53	22.23	22	41
2012	61	3.71	41	1100	18.03	26.83	15	33
2011	82	4.99	53	1566	19.10	29.55	14	39
2010	69	4.20	45	927	13.43	20.60	16	30
2009	58	3.53	48	1161	20.02	24.19	14	33
2008	40	2.43	33	1399	34.98	42.39	12	37
2007	42	2.56	35	665	15.83	19.00	12	25
2006	23	1.40	21	746	32.43	35.52	12	23

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Year	TP	%	NCP	TC	C/P	C/CP	h	g
2005	26	1.58	21	2327	89.50	110.81	10	26
2004	12	0.73	10	535	44.58	53.50	6	12
2003	25	1.52	22	983	39.32	44.68	10	25
2002	11	0.67	9	719	65.36	79.89	8	11
2001	15	0.91	13	432	28.80	33.23	16	32
2000	11	0.67	8	4008	364.36	501.00	9	15
1999	8	0.49	6	66	8.25	11.00	3	8
1998	7	0.43	6	62	8.86	10.33	4	7
1997	4	0.24	4	110	27.50	27.50	4	4
1996	13	0.79	13	278	21.38	21.38	6	14
1995	5	0.30	3	143	28.60	47.67	3	5
1994	2	0.12	2	50	25.00	25.00	1	2
1993	4	0.24	4	61	15.25	15.25	4	4
1992	9	0.55	9	208	23.11	23.11	7	9
1991	4	0.24	4	66	16.50	16.50	3	4
1990	6	0.37	3	65	10.83	21.67	2	6
1989	6	0.37	5	55	9.17	11.00	3	6
1988	2	0.12	2	26	13.00	13.00	1	2
1987	1	0.06	1	1	1.00	1.00	1	1
1986	7	0.43	4	24	3.43	6.00	3	4
1985	11	0.67	4	28	2.55	7.00	2	5
1984	6	0.37	6	64	10.67	10.67	5	6
1983	8	0.49	4	54	6.75	13.50	4	7
1982	6	0.37	5	35	5.83	7.00	3	5
1981	7	0.43	4	16	2.29	4.00	3	4
1980	2	0.12	2	39	19.50	19.50	2	2
1979	6	0.37	3	30	5.00	10.00	2	5
1978	13	0.79	11	147	11.31	13.36	5	12
1977	10	0.61	9	87	8.70	9.67	5	7
1976	4	0.24	4	101	25.25	25.25	3	4
1975	1	0.06	1	1	1.00	1.00	1	1
1971	1	0.06	1	1	1.00	1.00	1	1
1968	1	0.06	0	0	0.00	0	0	0
Total	1643	100						

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

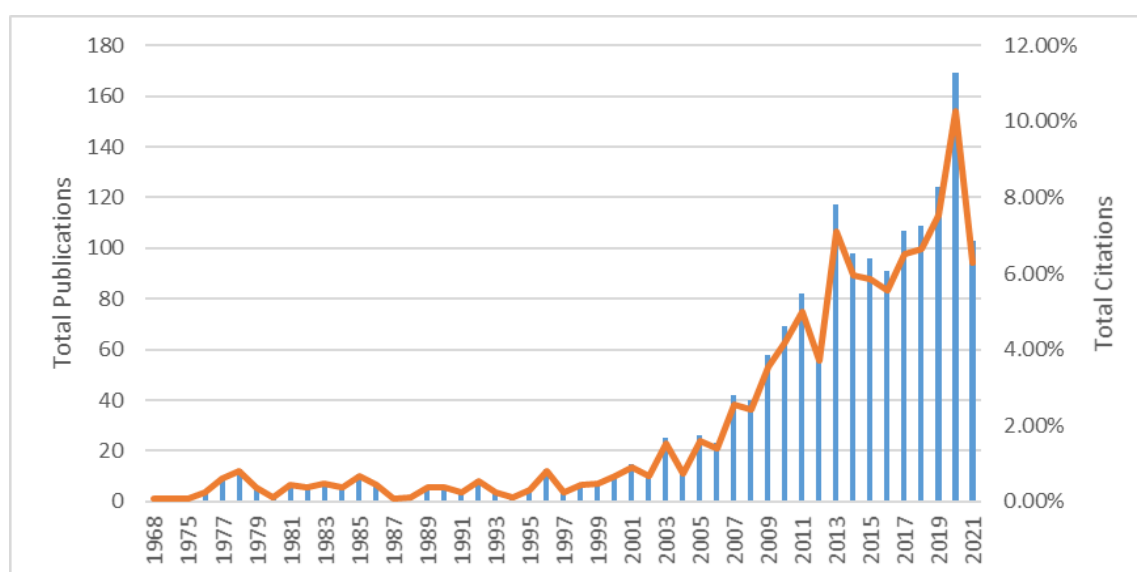


FIGURE 3. Publication and citation trend in public sector innovation research

SOURCES TYPES

In addition, the goal of this research was to find out where public sector innovation related. Table 2 reveals that the most widely used source was journals, accounting for 1,097 of the total (66.77%), after that, it was followed by conference proceedings (n = 269, 16.37, a huge difference

in materials had already been made public by analysing the data depending on the source document type when compared to journals. The least common document was trade journals (n = 14, 0.85%), which were generally meant for a certain industry, trade, or kind of company, which excluded one undefined source. They are generally published in a magazine periodically with a topical subject.

TABLE 2. Sources for public sector innovation research

Source Type	Total Publications (TP)	Percentage (%)
Journal	1097	66.77
Conference Proceeding	269	16.37
Book	177	10.77
Book Series	85	5.17
Trade Journal	14	0.85
Undefined	1	0.06
Total	1643	100

The data were also used to analyse the document types. Scopus indexes serial publications' main document types, which indicates that the researcher is also the author responsible for the reported results. Types of secondary documents, such as book reviews, in which the author is not the researcher, are not listed in the Scopus database. As a result of this analysis, we were able to determine the number of research by researchers on public sector innovation and the number of publications produced by these academics.

CATEGORY OF DOCUMENT

Category of document type pertains to the published documents and how it is categorised into a few groups: conference paper, book chapter, article, editorial, review, review and note. Table 3 sums up the dispersion of published documents on public sector innovation which fall within 11 document types. As illustrated in Table 3, a majority of the total number of publications originated from articles by researchers (n = 1025, 62.39%). This was followed by conference papers (n = 309, 18.81%). Book

chapters represented 10.04% (n = 165) of the publication on public sector innovation. The remaining document types, such as editorials, books, reviews, notes, short

surveys, letters, conference reviews and erratum, accounted for fewer than 4% of the overall number of publications.

TABLE 3. Public sector innovation document type

Document Type	Total Publications (TP)	Percentage (%)
Article	1025	62.39
Conference Paper	309	18.81
Book Chapter	165	10.04
Review	51	3.10
Book	26	1.58
Editorial	26	1.58
Note	18	1.10
Conference Review	9	0.55
Erratum	7	0.43
Short Survey	4	0.24
Retracted	3	0.18
Total	1643	100

SOURCE TITLE

Table 4 summarised the most active source titles with a minimum of ten publications. Research Policy contributed the highest number of publications on public sector innovation (n = 40). Research Policy is widely regarded as the leading journal in innovation studies, with a remarkably high 'Impact Factor' for a multidisciplinary social science journal. This was followed by the Public Management Review (PMR) (n = 30). PMR is a well-known journal that has evolved alongside the evolution

of public management and provides a forum for healthy discourse on public management-related issues. ACM International Conference Proceeding Series contributed a third of the publications on public sector innovation (n = 28). ACM Publications is the preeminent platform for presenting cutting-edge research and ground-breaking findings, pragmatic options to real-world problems, technological news, and opinions from the world's leading thinkers in computing.

TABLE 4. Most Active Source Title

Source Title	TP	Publisher	Cite Score	SJR 2020	SNIP 2020	NCP	TC	C/P	C/CP	h	g
Research Policy	40	Elsevier B.V.	11.4	3.666	3.663	39	4824	120.60	123.69	24	40
Public Management Review	30	Taylor and Francis Ltd.	6.4	1.622	2.443	25	748	24.93	29.92	14	27
ACM International Conference Proceeding Series	28	Association for Computing Machinery	N/A	N/A	N/A	41	558	19.93	13.61	13	22
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	26	Springer Verlag	1.8	0.249	0.628	16	94	3.62	5.88	6	8

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Source Title	TP	Publisher	Cite Score	SJR 2020	SNIP 2020	NCP	TC	C/P	C/CP	h	g
Government Information Quarterly	22	Elsevier Ltd	11.6	2.121	3.393	24	1173	53.32	48.88	19	22
Handbook of Innovation in Public Services	19	Edward Elgar Publishing Ltd.	N/A	N/A	N/A	17	173	9.11	10.18	7	12
Innovation Journal	19	Innovation Journal	2.6	0.371	1.699	16	272	14.32	17.00	6	16
Public Money and Management	18	Routledge	2.3	0.492	1.006	16	932	51.78	58.25	9	18
Technological Forecasting and Social Change	16	Elsevier Inc.	12.1	2.226	3.037	8	307	19.19	38.38	8	8
Sustainability Switzerland	15	MDPI AG	3.9	0.612	1.242	12	154	10.27	12.83	6	12
Australian Journal of Public Administration	14	Blackwell Publishing Ltd	2.4	0.524	1.09	14	166	11.86	11.86	8	12
Journal of Cleaner Production	13	Elsevier Ltd	13.1	1.937	2.475	13	285	21.92	21.92	9	13
Proceedings of the Annual Hawaii International Conference on System Sciences	13	IEEE Computer Society	N/A	N/A	N/A	3	9	0.69	3.00	1	2
Technovation	13	Elsevier Ltd	10.4	2.3	2.937	8	625	48.08	78.13	9	8
Information Polity	12	IOS Press	3.6	0.582	1.409	11	279	23.25	25.36	10	11
International Journal of Public Administration	12	Taylor and Francis Inc.	2.4	0.465	1.067	9	120	10.00	13.33	5	10
International Review of Administrative Sciences	12	SAGE Publications Ltd	4.2	0.863	1.843	11	150	12.50	13.64	8	12
Public Administration	12	Wiley-Blackwell	3.9	1.313	1.985	9	674	56.17	74.89	8	9
Innovation Management Policy and Practice	11	eContent Management Pty Ltd	5.5	1.377	1.561	11	237	21.55	21.55	7	11
Innovation and The Public Sector	10	IOS Press	-1	0.106	0.37	3	5	0.50	1.67	2	2
Journal of Technology Transfer	10	Springer New York LLC	8.8	1.768	2.462	98	6	0.60	0.06	5	6

Notes: TP=total number of publications; SJR=SCImago Journal Rank; SNIP=Source Normalized Impact per Paper; TC=total citations; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index; N/A=not applicable.

DOCUMENTATION LANGUAGES

Table 5 indicated that English was the most often utilised language, accounting for 94.77% of the 1,643 publications

on PSI research. The second most popular language was Spanish, which accounted for only 1.20% of total publications. The remaining publications were written in 17 other languages, namely Chinese, Portuguese, French,

Russian, Deutsch, Italian, Japanese, Dutch, Finnish, Norwegian, Hungarian, Lithuanian, Moldavian, Moldovan, Polish, Romanian and Ukrainian, however these made up

less than 1% of the total documents respectively. Although there were articles on public sector innovation that were published in languages other than English, they represented a small proportion of the total.

TABLE 5. Languages used for public sector innovation research publications

Language	Total Publications (TP)	Percentage (%)
English	1577	94.77
Spanish	20	1.20
Chinese	10	0.60
Portuguese	10	0.60
French	9	0.54
Russian	6	0.36
German	4	0.24
Italian	4	0.24
Japanese	4	0.24
Dutch	2	0.12
Finnish	2	0.12
Norwegian	2	0.12
Hungarian	1	0.06
Lithuanian	1	0.06
Moldavian	1	0.06
Moldovan	1	0.06
Polish	1	0.06
Romanian	1	0.06
Ukrainian	1	0.06
Undefined	7	0.42
Total	1643	100

KEY AREAS OF PUBLIC SECTOR INNOVATION RESEARCH

The most important aspects of PSI research were examined in the context of (a) principal topic areas, (b) keywords frequency, and (c) titles of document.

PRINCIPAL TOPIC AREAS

As illustrated in Table 6, this study categorised the documents according to their subject area. The data indicated that PSI research had been conducted in a range of subject areas. However, most PSI studies were in the field of social sciences (42.12%) and business, management

TABLE 6. Subject Area

Subject Area	Total Publications (TP)	Percentage (%)
Social Sciences	692	42.12
Business, Management and Accounting	674	41.02
Computer Science	299	18.20
Engineering	242	14.73
Economics, Econometrics and Finance	205	12.48
Decision Sciences	184	11.20
Environmental Science	134	8.16

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Subject Area	Total Publications (TP)	Percentage (%)
Mathematics	70	4.26
Energy	62	3.77
Medicine	43	2.62
Arts and Humanities	40	2.43
Earth and Planetary Sciences	38	2.31
Psychology	23	1.40
Agricultural and Biological Sciences	19	1.16
Chemical Engineering	16	0.97
Materials Science	15	0.91
Multidisciplinary	15	0.91
Physics and Astronomy	15	0.91
Biochemistry, Genetics and Molecular Biology	13	0.79
Pharmacology, Toxicology and Pharmaceutics	12	0.73
Chemistry	11	0.67
Nursing	3	0.18
Health Professions	2	0.12
Immunology and Microbiology	2	0.12
Veterinary	2	0.12
Neuroscience	1	0.06
Total	1643	100

and accounting (41.02%) accounted for the rest of the total articles. The subject areas of computer sciences, engineering, economics, econometrics and finance each contributed with more than 200 documents on public sector innovation. More than 100 documents on public sector innovation were found in the topic areas of decision sciences and environmental sciences.

KEYWORD ANALYSIS

Figure 4 depicts a network representation of the author's keywords, each of which had at least ten occurrences. This research employed VOSviewer, a computer programme for creating and visualising authors' keywords which are then mapped using bibliometric networks. Relationships with other keywords are shown by the colour, the diameter of the circle, size of the font and the thickness of the connecting lines. Keywords that had the same colour were frequently grouped. In our study, innovation, government, innovation policy, government subsidies, innovation

performance, green innovation, innovation system, China and triple helix have similar colours, implying that these keywords were inextricably linked and frequently co-occurred (Sweileh et al. 2017).

The following table summarises the most often mentioned terms in research on public sector innovation. After omitting the search query's core keywords, the data revealed that "innovation" was the keyword most closely associated with public sector innovation (n = 489, 29.76%). The keyword "public sector" and "government" were used interchangeably in the documents and present 9.74% (public sector) and 6.27% (government) of the total documents. Other terms that appeared more than 50 times including: (a) e-government; (b) local government; (c) public policy; (d) government data processing; (e) China; (f) public administration; (g) public services; (h) open innovation; (i) public sector innovation; and (j) technological innovation. The majority of these keywords were grouped around public sector innovation.

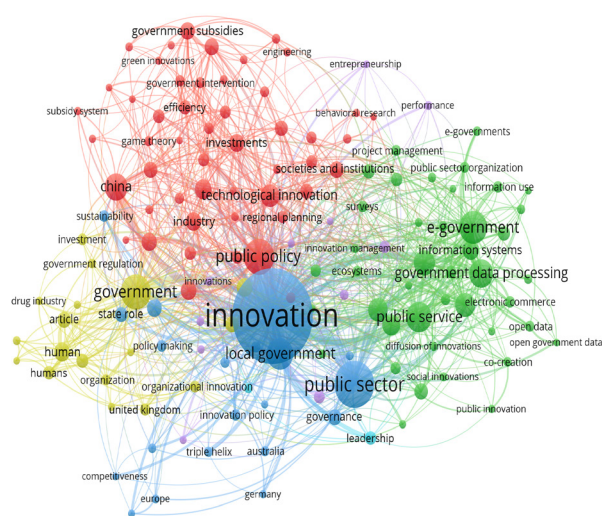


FIGURE 4. Network visualization map of author keywords with at least 10 occurrences.

TABLE 7. Keywords in public sector innovation research and their frequency

Keyword	Number of documents	Percentages (%)
Innovation	489	29.76%
Public Sector	160	9.74%
E-government	105	6.39%
Government	103	6.27%
Local Government	86	5.23%
Public Policy	86	5.23%
Government Data Processing	72	4.38%
China	66	4.02%
Public Administration	60	3.65%
Public Services	60	3.65%
Open Innovation	55	3.35%
Public Sector Innovation	52	3.16%
Technological Innovation	51	3.10%
Economics	41	2.50%
Information Systems	40	2.43%
Human	38	2.31%
Industry	37	2.25%
Management	37	2.25%
Technology	36	2.19%
Investments	35	2.13%
Research And Development	35	2.13%
Governance Approach	34	2.07%
Information Technology	34	2.07%
Government Subsidies	33	2.01%
Innovation Performance	32	1.95%
Societies And Institutions	32	1.95%
Public Service	30	1.83%
Research	30	1.83%

TITLE ANALYSIS

Figure 5 depicts a network of word co-occurrences according to the title fields with at least ten instances of a word. We applied a binary counting technique in which the frequency with which a noun phrase appears in the title of a publication is irrelevant. A noun phrase that appears just once in the title of a publication is regarded in the same way as a noun phrase that appears 10 times, according to Perianes-Rodriguez, Waltman, and van Eck (2016). Figure 5 shows that the keyword “innovation” was the dominant term in PSI study, functioning as the core node of the entire network. The relative relevance of occurrence words is

represented by the size of the nodes and the intensity of the link between the words is shown by the thickness of the connecting lines. As shown by the same hue, related terms were frequently reported together. The illustrated diagram, for example, suggests that (a) innovation, (b) government, (c) public administration, (d) public service, (e) local government, (f) social innovation, (g) innovation policy, (h) application, and (i) business (all coloured green) are strongly linked and frequently occur simultaneously. VOSviewer produced eight distinct colours from the titles of the articles in our investigation, indicating five clusters with 44 terms that are closely related and appear frequently together.

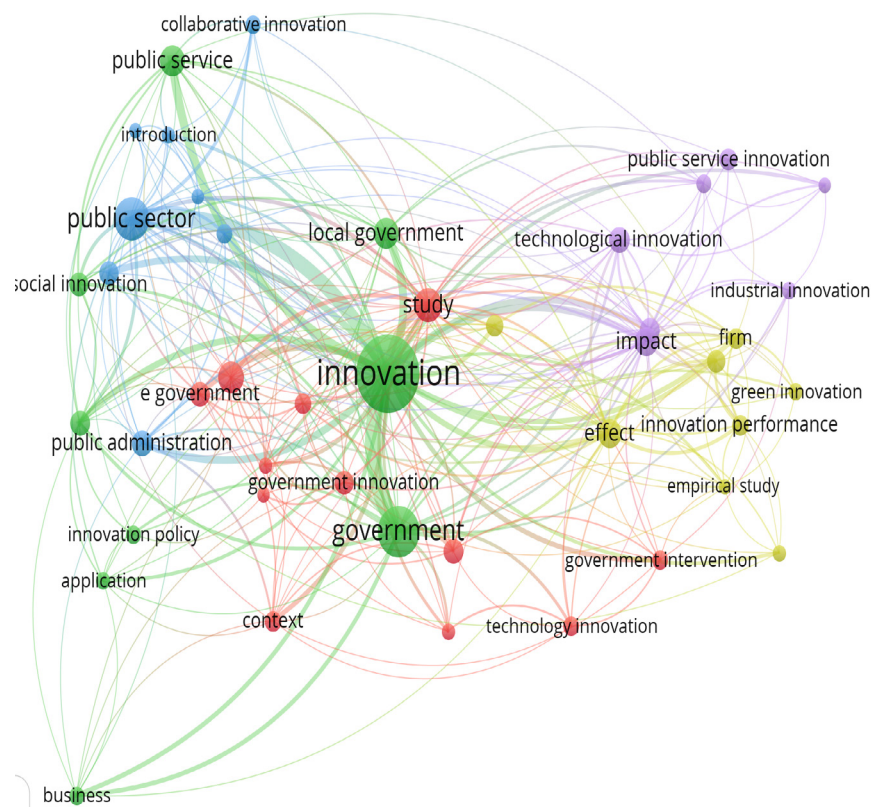


FIGURE 5. VOSviewer visualization of a term co-occurrence network based on title fields (binary counting).

COLLABORATION AND MAJOR PLAYERS IN PUBLIC SECTOR INNOVATION STUDIES

The features of scientific partnerships on PSI research were examined in this study, which included (a) the nations that produced the most often, (b) the major institutions involved in PSI research, (c) authorship analysis, and (d) citation analysis.

NATIONS PROVIDING THE MOST PUBLIC SECTOR INNOVATION STUDIES

Figure 6 illustrates 10 of the world's most productive countries, leading to the growth of PSI research activities. The United States, China, and the United Kingdom all contribute significantly to the advancement of PSI research.

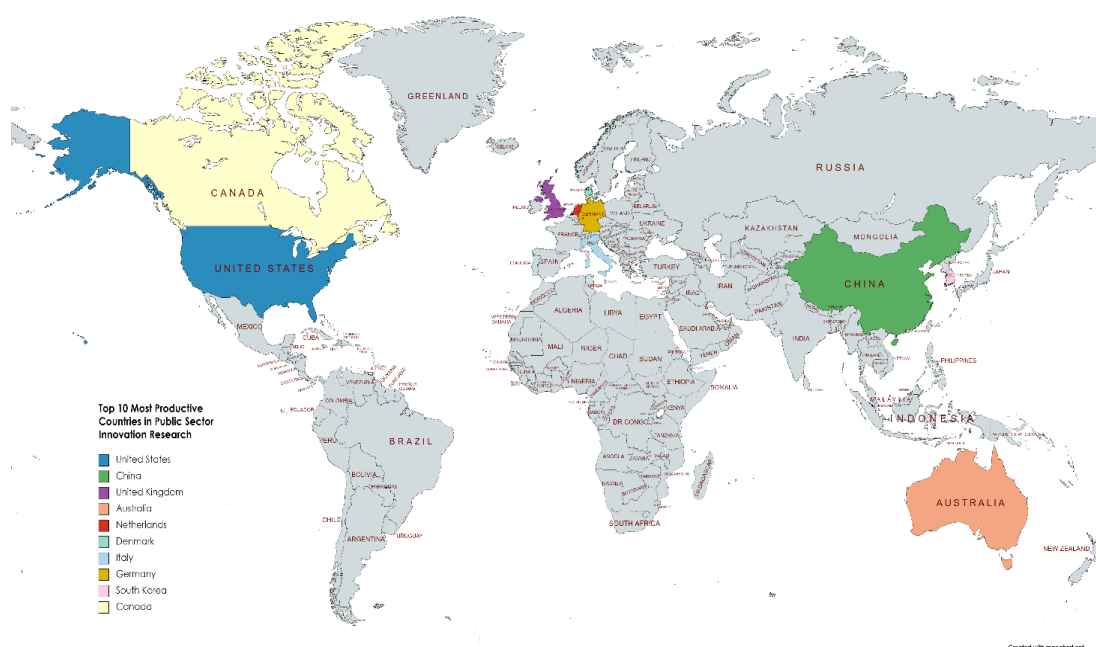


FIGURE 6. Top 10 most productive countries in PSI research

Table 8 shows the top 30 nations where the majority of public sector innovation research is conducted. The United States was the premier country with 286 publications, covering 17.41% of the world's total publication on public sector innovation. While China and United Kingdom contributed 262 publications (15.95%) and 204 publications (14.42%) each to the world total publications. The remaining writers' country connections accounted for less

than 10% of the total and were dispersed around the world—Australia, Netherlands, Denmark, Italy, Germany, South Korea, Canada, Spain, Norway, Brazil, Finland, Malaysia, Sweden, France, Singapore, Russian, Taiwan, Hong Kong, Indonesia, India South Africa, Belgium, Japan, Switzerland, Greece, Ireland and Mexico. Clearly, public sector innovation plays an essential function in a variety of geographically diverse places.

TABLE 8. Geographic origin of public sector innovation research

Country	Number of documents	Percentage (%)
United States	286	17.41%
China	262	15.95%
United Kingdom	204	12.42%
Australia	88	5.36%
Netherlands	74	4.50%
Denmark	64	3.90%
Italy	63	3.83%
Germany	61	3.71%
South Korea	49	2.98%
Canada	46	2.80%
Spain	46	2.80%
Norway	42	2.56%
Brazil	34	2.07%
Finland	33	2.01%
Malaysia	33	2.01%
Sweden	33	2.01%

continue ...

... cont.

Country	Number of documents	Percentage (%)
France	31	1.89%
Singapore	30	1.83%
Russian Federation	26	1.58%
Taiwan	26	1.58%
Hong Kong	23	1.40%
Indonesia	21	1.28%
India	19	1.16%
South Africa	18	1.10%
Belgium	17	1.03%
Japan	17	1.03%
Switzerland	17	1.03%
Greece	15	0.91%
Ireland	14	0.85%
Mexico	14	0.85%

MAIN INSTITUTION

Table 9 lists the institutions where the majority of the articles on the public sector's innovation were produced. Out of the 1,643 documents, National University of Singapore (n = 24), which ranked consistently among the most prestigious institutions in the world, provided the

highest number of articles on public sector innovation. Other institutions which also had high number of contributions were (a) Roskilde Universitet (n = 20); (b) The University of Manchester (n = 18); (c) Delft University of Technology (n = 14); (d) Erasmus Universiteit Rotterdam (n = 14); (e) Xi'an Jiatong University (n = 13); and Tsinghua University (n = 13).

TABLE 9. Most influential institutions with minimum of ten publications on public sector innovation

Institution	Country	TP	NCP	TC	C/P	C/CP	<i>h</i>	<i>g</i>
National University of Singapore	Singapore	24	24	524	21.83	21.83	12	22
Roskilde Universitet	Denmark	20	16	693	34.65	43.31	9	20
The University of Manchester	United Kingdom	18	16	242	13.44	15.13	8	15
Delft University of Technology	Netherlands	14	12	343	24.50	28.58	7	14
Erasmus Universiteit Rotterdam	Netherlands	14	11	442	31.57	40.18	8	14
Xi'an Jiaotong University	China	13	8	225	17.31	28.13	7	13
Tsinghua University	China	13	9	184	14.15	20.44	6	9
Queensland University of Technology	Australia	12	12	336	28.00	28.00	8	12
State University of New York Albany	United States	12	8	288	24.00	36.00	6	12
Brunel University London	United Kingdom	12	11	270	22.50	24.55	7	12
The University of Edinburgh	United Kingdom	12	10	341	28.42	34.10	8	12
Westfälische Wilhelms-Universität Münster	Germany	11	9	93	8.45	10.33	6	9
University of Toronto	Canada	11	9	468	42.55	52.00	7	11
Copenhagen Business School	Denmark	11	10	207	18.82	20.70	6	11
NUS - Lee Kuan Yew School of Public Policy	Singapore	11	11	178	16.18	16.18	8	11
Seoul National University	South Korea	10	8	409	40.90	51.13	7	10
Inland Norway University of Applied Sciences	Norway	10	9	44	4.40	4.89	5	6

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; *h*=*h*-index; and *g*=*g*-index.

AUTHORSHIP ANALYSIS

The following table summarises the number of authors for each document. 547 (33.29 %) of the 1,643 publications included in this study were single-authored, while the rest had multiple authors.

Almost 497 papers (30.24%) had two writers who collaborated on the paper, whereas three authors co-authored 324 documents (19.72%). There was one document with more than 22 co-authors.

TABLE 10. Number of author(s) per document

Author Count	Total Publications (TP)	Percentage (%)
1	547	33.29
2	497	30.24
3	324	19.72
4	162	9.86
5	54	3.29
6	17	1.03
7	9	0.55
8	1	0.06
9	2	0.14
10	1	0.06
11	3	0.18
13	1	0.06
14	1	0.06
22	1	0.06
0*	23	1.40
Total	1643	100

*Conference review document. No author is listed.

The authors listed in Table 11 were the most productive in terms of their contributions to public sector innovation research. Demircioglu had the most publications on public sector innovation, with 11 publications affiliated with the National University of Singapore. The second most productive author publishing on public sector innovation was Niehave (10 publications) from Universität Siegen, Information Systems, Germany. The third most productive author was Osborne (9 publications) from the University

of Edinburgh Business School, Edinburgh, United Kingdom. Finally, with ten publications each respectively, Bekkers, affiliated with Erasmus Universiteit Rotterdam, Department of Public Administration and Sociology, Rotterdam, Netherlands and Etzkowitz affiliated with International Triple Helix Institute Palo Alto VA, International Triple Helix Institute, Palo Alto, United States were the fourth and fifth placed authors who had the most publications on public sector innovation.

TABLE 11. Most Productive Authors

Author Name	Affiliation	Country	TP	%	NCP	TC	C/P	C/CP	h	g
Demircioglu	National University of Singapore, Singapore City	Singapore	11	0.67	12	178	16.18	14.83	8	12
Niehave, B.	Universität Siegen, Information Systems, Siegen	Germany	10	0.61	9	100	10.00	11.11	6	10
Osborne	University of Edinburgh Business School, Edinburgh	United Kingdom	9	0.5	9	464	51.56	51.56	7	9

continue ...

... cont.

Author Name	Affiliation	Country	TP	%	NCP	TC	C/P	C/CP	h	g
Bekkers	Erasmus Universiteit Rotterdam, Department of Public Administration and Sociology, Rotterdam, Netherlands	Netherlands	8	0.4	7	382	47.75	54.57	5	8
Etzkowitz	International Triple Helix Institute Palo Alto VA, International Triple Helix Institute, Palo Alto	United States	8	0.4	7	4922	615.25	703.14	6	8
Brown	University of Bath, Department of Social and Policy Sciences, Bath	United Kingdom	7	0.4	7	427	61.00	61.00	5	7
Fuglsang	Roskilde Universitet, Department of Social Sciences and Business, Roskilde	Denmark	7	0.4	4	20	2.86	5.00	3	4
Kattel	UCL Institute for Innovation and Public Purpose	United Kingdom	7	0.4	7	113	16.14	16.14	4	7
Misuraca	Politecnico di Milano, Department of Design, Milan	Italy	7	0.4	5	41	5.86	8.20	3	6
Walker	City University of Hong Kong, Kowloon	Hong Kong	7	0.4	7	296	42.29	42.29	4	7
Arundel	Tasmanian School of Business and Economics, Sandy Bay, Australia Universiteit Maastricht, Maastricht	Netherlands	6	0.37	6	261	43.50	43.50	6	6
Lewis	School of Social and Political Sciences, Melbourne	Australia	6	0.3	5	201	33.50	40.20	5	6
Mergel	Universität Konstanz, Department of Politics and Public Administration, Konstanz	Germany	6	0.37	6	335	55.83	55.83	4	6
Torfing	Roskilde Universitet, Roskilde	Denmark	6	0.37	6	581	96.83	96.83	5	6
Desouza	QUT Business School, School of Management, Brisbane, Australia Queensland University of Technology, Centre for Future Enterprise, Brisbane	Australia	5	0.30	5	200	40.00	40.00	3	5
Gallouj	Université de Lille, Lille	France	5	0.30	3	114	22.80	38.00	2	5
Zanfei	Universita degli Studi di Urbino Carlo Bo, Urbino	Italy	5	0.30	5	97	19.40	19.40	4	5
Al Marri	British University in Dubai, Faculty of Engineering and IT, Dubai	United Arab Emirates	4	0.24	0	4	0	0	0	0

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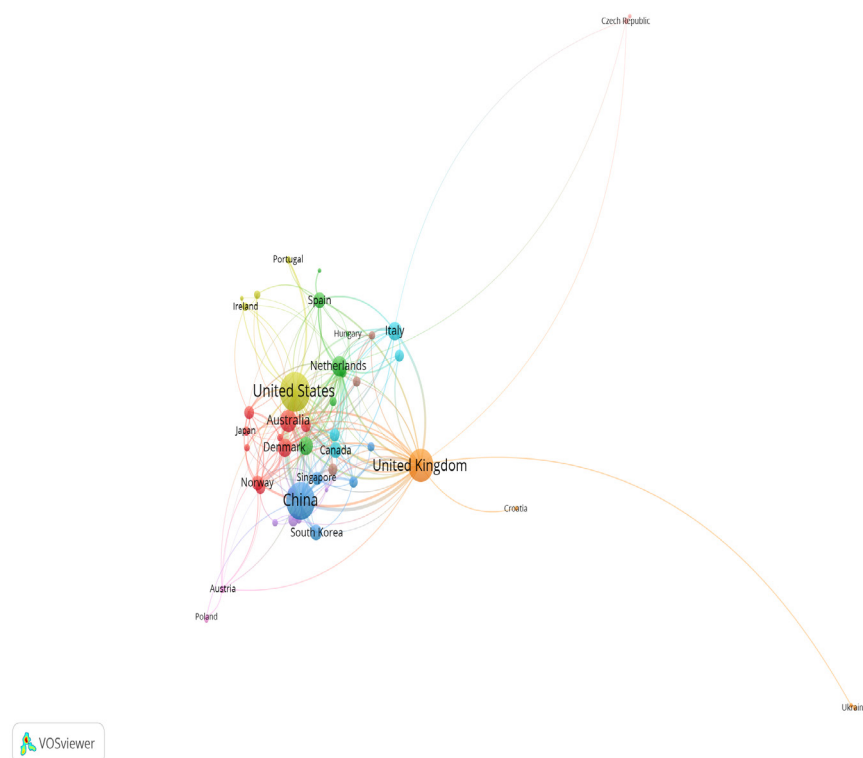
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Author Name	Affiliation	Country	TP	%	NCP	TC	C/P	C/CP	h	g
Ashford	Massachusetts Institute of Technology, Sociotechnical Systems Research Center, Cambridge, United States	United States	4	0.24	4	109	27.25	27.25	3	4
Borins	University of Toronto, Department of Management, Toronto	Canada	4	0.24	3	353	88.25	117.67	3	4
Chatfield	University of Wollongong, Wollongong	Australia	4	0.24	4	41	10.25	10.25	4	4

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index.

Additionally, Figure 7 depicts the authors' network visualization map based on their affiliated countries. Only countries with a minimum of five documents and five citations were considered for this study. By utilising the fractional counting method, it was apparent that authors from the United States had a significant contribution in cooperating with authors from other nations in terms of

public sector innovation research. United States authors collaborated closely with other professionals from (a) the United Kingdom, (b) China, (c) Italy, (d) Spain, (e) Mexico, and (f) Portugal. Authors from the UK, China, the Netherlands, Italy, Spain, Austria, Australia, Denmark, Norway, and Sweden have launched several joint projects with colleagues in other countries.



Note: Unit of analysis = Countries; Counting method: Fractional counting; Minimum number of documents of a country = 5; Minimum number of citations of a country = 5

FIGURE 7. Network visualisation map of the co-authorship by countries

CITATION ANALYSIS

Table 12 shows the citation metrics of the papers gathered from the Scopus database. There were 27,550 citations reported in 53 years (1968 – 2021) for 1,643 articles, with an average of 519.81 citation every year.

Table 13 summarizes the 30 documents on public sector innovation, depending on how many times each was mentioned, it was found that the documents most often cited was “The dynamics of innovation: From National Systems and “mode 2” to a Triple Helix of university-industry-government relations” by author Etzkowitz and Leydesdorff (2000). Other document most often cited were related to e-government by Carter and Bélanger (2005), innovation collaboration by Wallsten (2000); Sørensen and Torfing (2011) and Damanpour and Schneider (2009).

TABLE 12. Public sector innovation research citations metrics

Metrics	Data
Total papers	1,643
Total citations	27,550
Number of years	53
Citations per year	519.81
Citations per paper	16.77
Citation per author	16,387
Papers per author	977.16
Authors per paper	2.25
h-index	69
g-index	137

TABLE 13. Top 30 Highly cited articles

No	Authors	Title	Year	Cites	Cites Per Year
1	Etzkowitz and Leydesdorff	The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university-industry-government relations	2000	3320	158.1
2	Carter and Bélanger	The utilization of e-government services: Citizen trust, innovation and acceptance factors	2005	1281	80.06
3	Etzkowitz	The triple helix: University-industry-government innovation in action	2008	683	52.54
4	Etzkowitz	Innovation in innovation: The Triple Helix of university-industry-government relations	2003	607	33.72
5	Wallsten	The effects of government-industry R&D programs on private R&D: The case of the small business innovation research program	2000	512	24.38
6	Hartley	Innovation in governance and public services: Past and present	2005	478	29.88
7	Damanpour and Schneider	Characteristics of innovation and innovation adoption in public organizations: Assessing the role of managers	2009	387	32.25
8	Sørensen and Torfing	Enhancing collaborative innovation in the public sector	2011	322	32.2
9	De Vries, Bekkers, and Tummers	Innovation in the public sector: A systematic review and future research agenda	2016	310	62
10	Cavalluzzo and Ittner	Implementing performance measurement innovations: Evidence from government	2004	272	16
11	Criado, Sandoval-Almazan, and Gil-Garcia	Government innovation through social media	2013	258	32.25
12	C. Bason	Leading public sector innovation: Co-creating for a better society	2010	250	22.73
13	Demirel and Kesidou	Stimulating different types of eco-innovation in the UK: Government policies and firm motivations	2011	221	22.1

continue ...

... cont.

14	Tolbert, Mossberger, and McNeal	Institutions, policy innovation, and e-government in the American States	2008	216	16.62
15	D. Breznitz, M. Murphree	Run of the red queen: Government, innovation, globalization, and economic growth in China	2011	210	21
16	Etzkowitz	Incubation of incubators: Innovation as a triple helix of university-industry-government networks	2002	195	10.26
17	Kang and Park	Influence of government R&D support and inter-firm collaborations on innovation in Korean biotechnology SMEs	2012	188	20.89
18	Osborne and Brown	Innovation, public policy and public services delivery in the UK. The word that would be king?	2011	188	18.8
19	Kamal	IT innovation adoption in the government sector: Identifying the critical success factors	2006	180	12
20	Walker	Innovation type and diffusion: An empirical analysis of local government	2006	179	11.93
21	Borins	Leadership and innovation in the public sector	2002	178	9.37
22	Lee, Hwang, and Choi	Open innovation in the public sector of leading countries	2012	172	19.11
23	Albury	Fostering innovation in public services	2005	168	10.5
24	Borins	Encouraging innovation in the public sector	2001	166	8.3
25	Khademian, Mergel, and Desouza	Implementing open innovation in the public sector: The case of Challenge.gov	2013	160	20
26	Lapsley and Wright	The diffusion of management accounting innovations in the public sector: A research agenda	2004	157	9.24
27	Cumming	Government policy towards entrepreneurial finance: Innovation investment funds	2007	153	10.93
28	Guo, Guo, and Jiang	Government-subsidized R&D and firm innovation: Evidence from China	2016	144	28.8
29	Doh and Kim	Government support for SME innovations in the regional industries: The case of government financial support program in South Korea	2014	135	19.29
30	Mahmood and Rufin	Government's dilemma: The role of government in imitation and innovation	2005	133	8.31

Notes: TC=total citations; CPY=citation per year; CPA=citation per author

The citation mapping for documents having at least 30 citations is shown in Figure 8. It depicts the most influential writers in the field and how their thoughts

intertwined. Figure 9 shows the countries of origin in further detail.

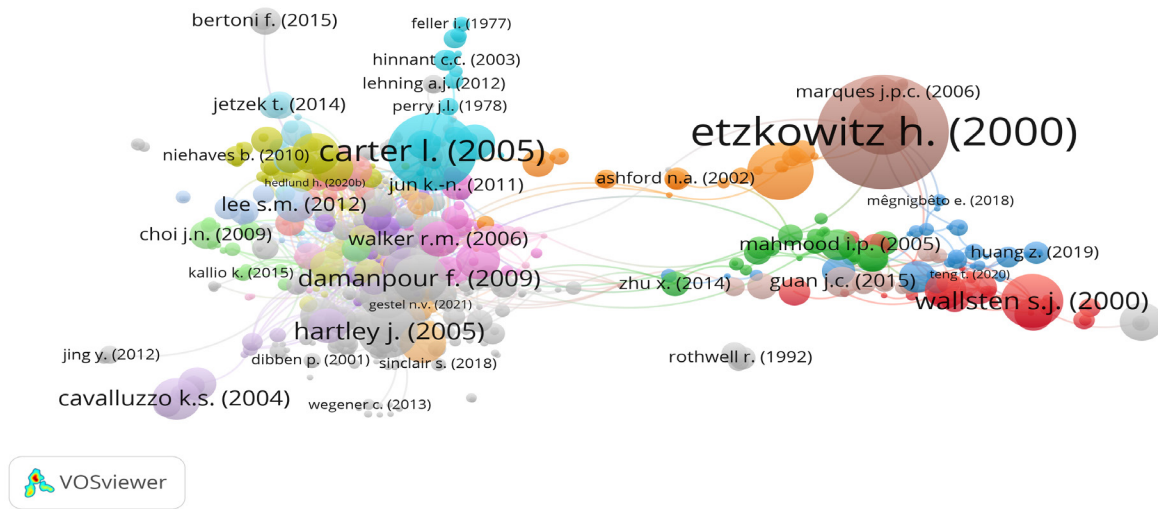


FIGURE 8. Network visualisation map of the citation of public sector innovation documents.

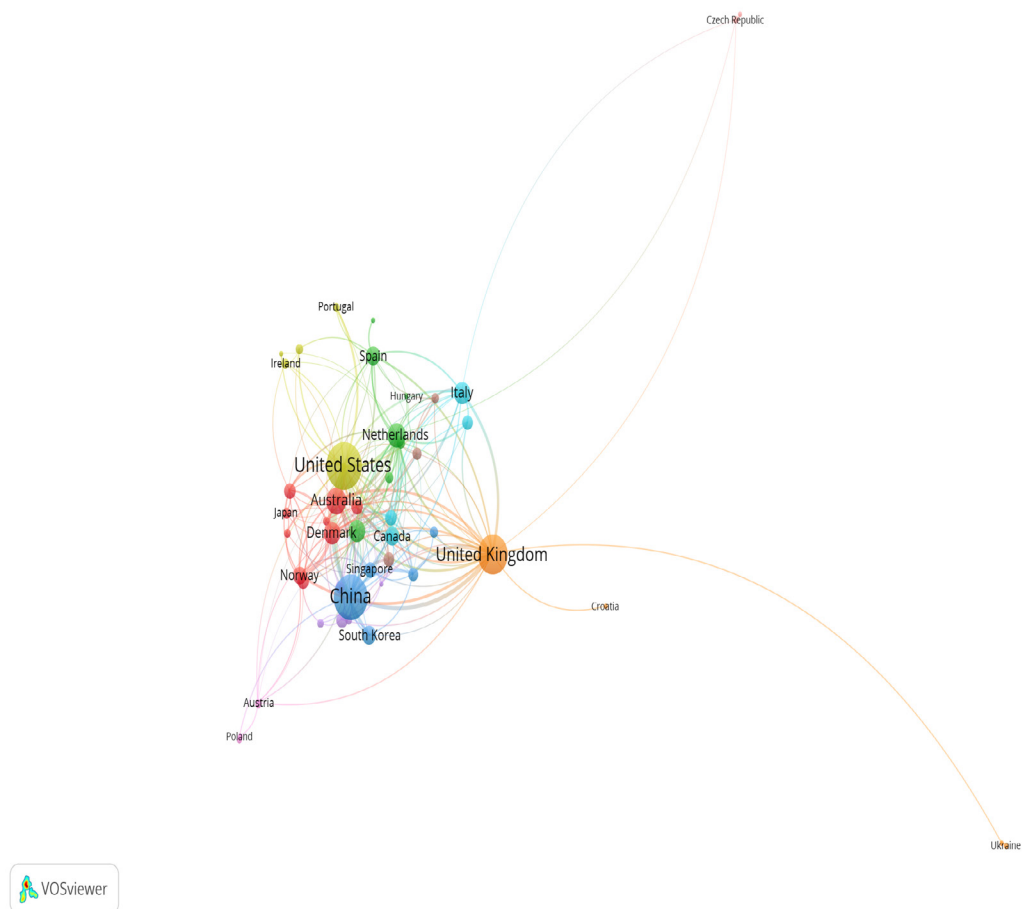


FIGURE 9. Network visualization map of citations of public sector innovation documents by country, with a minimum of five documents per country and a minimum of five citations per country.

DISCUSSION

This section expands on the preceding findings by revisiting the research questions. Regarding the first research questions on public sector innovation, the field of research has grown and been disseminated. These bibliometrics analysed 53 years of papers published between 1968 and August 2021. Our results indicate that documents on PSI research began appearing in early 1968 and progressively increased in later years. Likewise, it emerged throughout the public sector's transformation from the Old Public Administration era to the New Public Management and New Public Service eras. According to the analysis, public sector innovation areas are gaining increased attention each year, as indicated by the many practitioners, researchers and scholars. Most researchers prefer journal articles compared to other publications because journals are established platforms for sharing ideas, findings and recommendations for future research. Based on the analysis, top journals and publishers contributed the majority of total publishing and citation.

Moreover, the analysis successfully indicated a modification in the level of involvement of developing countries in PSI studies. PSI research was dominated by the United States, China and the United Kingdom. This study demonstrated that research outputs from developing countries are gaining momentum, increasing the number of varied scholars conducting PSI research. According to the data in the preceding sections' tables and figures, the public sector's trend toward innovation seems to be the one that many will embrace in the future. This tendency is expected to expand as raising the attention to improving the productivity of public service delivery, service digitization and public sector agency performance increases. In addition, the present Covid 19 pandemic has compelled the public sector to think and act innovatively when formulating and executing policies.

In response to the third objective, our analysis of areas of study, keywords, and titles revealed that PSI research primarily focused on domain innovation. According to the data, social sciences are the most frequent subject area in PSI research. The most frequently encountered theme in PSI research is 'innovation'. The key points of this field can be observed in the results of VOSviewer's keyword, title and summary analyses. For instance, while reviewing Table 7, we discovered that, in contrast to synonyms for the public sector, "government data processing," "e-government," "open innovation," and "innovation performance" were among the most often used phrases in the collected documents.

Regarding the third research question, which were concerned with the major players in PSI research and their

collaborative efforts. Our research looked at countries, institutions, authors and citations, and there seems to be a good scientific collaboration on PSI research globally. The United States, China, and the United Kingdom ranked first through third in scholarly articles on public sector innovation. The United States had the most papers on PSI research, indicating that it was a pioneer in the global and may have focused funding into it. This is reinforced further by the fact that the United States boasts of the world's largest concentration of top-ranked universities. The significant disparity between PSI research conducted in these countries and the rest of the globe should be a cause for concern, as one of the primary purposes of public sector innovation is to improve public sector delivery services. The relevance of PSI publications can be explained through the explanation of citation metrics in this research. One thousand six hundred forty-three articles and over 27,550 citations have been published due to 53 years of publications in the PSI field (1968 – 2021). In aggregate, PSI research documents retrieved from the Scopus database are mentioned 519.81 times every year, averaging 16.77 citations per paper and 2.25 authors per paper.

LIMITATIONS AND FUTURE RESEARCH

The objective of this research was to comprehensively review the publications related to public sector innovation research from 1968 to 2021 using bibliometric analysis. Evolutionary mapping of public sector innovation, key topic areas and collaborations across various categories are the number of published studies per year, sources, languages, subject areas, keywords, document titles, contributing countries, main institutions, authorship, etc. citation. The findings indicated that Eastern and Western scholars conducted the early researches on PSI.

However, it should be noted that no search query is 100% ideal; hence, false positive and negative results are to be expected (Sweileh et al. 2017). The current analysis relies entirely on the Scopus database for document retrieval. Even though Scopus is one of the most comprehensive databases for academic research preservation., it cannot possibly include all published sources (Sweileh et al. 2017; Ahmi & Mohamad 2019). Additional databases, such as Web of Science, Google Scholar, Dimensions and others, may be utilised in future research. Integrating all of these databases can contribute to the creation of innovative and valuable results. Despite these limitations, the current study contributes to knowledge by highlighting recent research trends in the public sector. Additionally, this research contributes by

utilising the bibliometric method to enhance public sector innovation knowledge.

The research's objective is to demonstrate that most academic studies employed the title as a catchphrase, the authors as key references, and the institutions as the focal point of information. Subsequently, some researchers may concentrate on search terms contained in the abstract or keyword field. Additional research is required to investigate and assist in bridging the gap that may exist in the context of public sector innovation development. While this analysis focuses on innovation in the public sector, future research may examine innovation development within businesses, non-governmental organisations, and small and medium-sized enterprises (SMEs).

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DECLARATION OF COMPETING INTEREST

None

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