



## RESEARCH ARTICLE

# BIBLIOMETRIC ANALYSIS OF INDUSTRIAL POLLUTION RESEARCH

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### ABSTRACT

This paper presents on Bibliometric analysis of industrial pollution research, the study aims to analysis; to find out year wise publications on industrial pollution research, to find out sources wise publications, to examine authorship pattern, to find out top twenty institutions, to find out top twenty countries contributed on industrial pollution research. The data have accessed from the Scopus database; the data have been collected during from 2006 to 2020, 1098 records were retrieved. The study revealed that, the year-wise industrial pollution research publications show an increase and decrease trend, in the last four years, the publications have increased. the top twenty authors contributed to in the industrial pollution research publications, among the authors Garc a-P rez, J occupies the first position with 8 contributions, Deshmukh, J.U, L pez-Abente, G, Ramis, R. has second and third place respectively. The language-wise publications on industrial pollution, among the fifteen languages, the majority of publications are in the English language. The top twenty countries contributed to industrial pollution research publications, among the twenty countries, out of 1098 papers China has first place with 28.05 per cent contributions, India has second place with 10.11 per cent contributions, Russian Federation has third place with 8.74 per cent.

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## INTRODUCTION

Industrial pollution is caused by particles especially waste gases like carbon monoxide, sulfur oxides, and nitrogen oxides which are the waste products of industry that ultimately end up in the air. Air pollution is now the world's largest single environmental health risks, and is fast becoming one of the leading causes of illness and death in developing countries (UNEA, 2014). Industrial emissions are the second largest pollutants of the atmosphere after automotive exhausts (Gull et al, 2013). Industries and factories give off various pollutants into the environment including the land, air, and waters. It is estimated that about 50% of all pollution is as a result of industrial and manufacturing activities. Global warming is among the most serious outcome of industrial pollution, Industrial toxic and chemical wastes that are disposed into water bodies or landfills are also responsible for cancers and human cell poisoning (EarthEclipse, 2021). The World Health Organisation (WHO) estimates that in 2016, some 58% of outdoor air pollution-related premature deaths were due to ischaemic heart disease and stroke, while 18% of deaths were due to chronic obstructive pulmonary disease and acute lower respiratory infections respectively, and 6% of deaths were due to lung cancer.

Industrial pollution has many adverse consequences on human health and may be a cause of death because of respiratory, lung and cardio-related diseases (Karimi B, Shokrinezhad B. 2020), (Anwar A, Ayub M, Khan N, Flahault A.2019).

## METHODOLOGY

In the present study, the data have accessed from the Scopus database; the keyword was used in search documents 'Industrial pollution' selected the search within field 'article title', and the time span field has been selected published from 2006 to 2020. A total of 1098 records were retrieved, the data downloaded and analyzed using MS office-Excel as per objectives of the present study.

**Relative Growth Rate (RGT) and Doubling Time (DT):** The relative growth rate is the increase in the number of publications/pages per unit of time. Here, one year is taken as the unit of time. The mean relative growth rate R (1-2) over a specified period of interval can be calculated from the following equation suggested by Mahapatra (1985).

$$R(1-2) = \frac{W2 - W1}{T2 - T1}$$

Where,

R = Mean relative growth rate over the specific period of interval;  
 $W1 = \log w1$  (Natural log of initial number of publications/  
 pages);

$W2 = \log w2$  (Natural log of initial number of publications/pages);  
 $T2-T1$  =Unit difference between the initial time and final time.

Therefore,

$R(a)$  =Relative growth rate per unit of publications per unit of  
 time (year)

$R(p)$  =Relative growth rate per unit of pages per unit of time  
 (year)

**Doubling Time (DT):** A direct equivalence exists between the  
 relative growth rate and doubling time. If the number of  
 publications/pages of a subject doubles during a given period, then  
 the difference between the logarithms of the numbers at the  
 beginning and at the end of the period must be the logarithms of  
 the number 2. This difference has a value of 0.693. Thus, the  
 corresponding doubling time for publication and pages can be  
 calculated by the following formula:

$$\text{Doubling time (Dt)} = \frac{0.693}{R}$$

Therefore,

$$\text{Doubling time for publications Dt (a)} = \frac{0.693}{R(a)}$$

**Objectives:** The following objectives are framed for the present  
 study;

- To find out year wise publications on industrial pollution  
 research
- To find out sources wise publications on industrial pollution  
 research
- To find out top ten authors on industrial pollution research
- To examine authorship pattern
- To find out top twenty institutions contributed on industrial  
 pollution research
- To find out top twenty sources contributions industrial  
 pollution research
- To find out top twenty countries contributed on industrial  
 pollution research

## ANALYSIS AND INTERPRETATION

**Table 1. Year wise publications on industrial pollution research**

Sl. No.	Year	No. of Records	Percentages
1	2006	42	3.83
2	2007	44	4.01
3	2008	52	4.74
4	2009	68	6.19
5	2010	49	4.46
6	2011	61	5.56
7	2012	54	4.92
8	2013	60	5.46
9	2014	67	6.10
10	2015	77	7.01
11	2016	70	6.38
12	2017	80	7.29
13	2018	102	9.29
14	2019	116	10.56
15	2020	156	14.21
	Total	1098	100.00

Table 1 shows that year wise publications on industrial pollution  
 research, during the study period year 2020 more contribute with  
 14.21 per cent publications, the year 2019 have published 10.56  
 percent, the year 2018 have published 9.29 percent publications,  
 the year 2017 have published 7.29 percent publications, the year  
 2015 have published 7.01 percent publications, the year 2016

have published 6.38 percent publications, and followed by, the  
 year 2009 have published 6.19 percent, the year 2014 have  
 published 6.10 percent, the year 2009 have published 6.19  
 percent, the year 2011 have published 5.56 percent, the year 2013  
 have published 5.46 percent, the year 2012 have published 4.92  
 percent, the year 2008 have published 4.74 percent, the year 2007  
 have published 4.01 percent, the starting year 2006 have  
 published with least percent publications. The year-wise  
 industrial pollution research publications show an increase and  
 decrease trend. Table 2 shows that Relative Growth Rate and  
 Doubling Time of industrial pollution research, the publications  
 Doubling Time mean value is 3.12. In 2006, the industrial  
 pollution research publication was 42; gradually the research  
 publications were raised to 156 in the year 2020, the relative  
 growth rate mean value is 0.09. The industrial pollution research  
 publications are increasing more than three times from starting  
 year to end of the study period year. Table 3 shows that  
 document type wise research publications on industrial pollution,  
 thirteen document types are contributed in this research, among  
 the document types Article has first position with 76.59 per cent,  
 Conference Paper contributed 13.93 with second place, Book  
 Chapter has third place with 4.01 per cent, Review has 2.64 per  
 cent, Book and Erratum has 0.73 per cent respectively, Note has  
 0.46 per cent, Retracted has 0.27 per cent, Editorial and Short  
 Survey has 0.18 per cent respectively, Data Paper, Letter and  
 Undefined have 0.09 per cent contributions.

The study found that document type wise research publications on  
 industrial pollution, articles are more contributed to document  
 types. Table 4 shows that the sources type wise research  
 publications on industrial pollution, among the five sources  
 Journal has contributed on 81.06 per cent, Conference Proceeding  
 has 11.84 per cent, Book has 4.10 per cent, Book Series has 2.46  
 per cent, and Trade Journal has fifth place with 0.64 per cent. It  
 found the sources type wise research publications on industrial  
 pollution, among the five sources Journal has occupies first  
 position with more than 80 per cent contributions. Table 5 shows  
 that top twenty authors contributed on industrial pollution research  
 publications, among the authors Garca-Perez, J occupies first  
 position with 8 contributions, Deshmukh, J.U, Lopez-Abente, G,  
 Ramis, R. . has second, third, and fourth position with 7  
 contributions respectively, Ambore, N.E., Da vydova, Y.A.  
 Fernandez-Navarro, P., Vorobeichik, E.L. has 5 records with  
 fifth, sixth, seventh and eighth position with respectively,  
 Aragones, N., Boldo, E., He, C., Huang, Z., Kozlov, M.V.,  
 Lope, V., Ma, W Palle, J.S, Suleimanov, I.F, Tilt, B , Yi, P. and  
 Yu, Q. has ninth, tenth, eleventh, twelfth thirteenth, fourteenth,  
 fourteenth, fifteenth, sixteenth, seventeenth, eighteenth,  
 nineteenth and twenty position respectively. Table 6 indicates that  
 authorship pattern on industrial pollution research, Six and above  
 author collaborative contributions are 33.88 per cent publications,  
 five author collaborative contributions are 23.13 per cent  
 publications, four author collaborative contributions are 18.49 per  
 cent publications, three author collaborative contributions are  
 11.29 per cent publications, double author collaborative  
 contributions are 3.83 per cent publications, single author  
 contributions are 3.83 per cent publications. It found that, the  
 authorship pattern on industrial pollution research, the  
 collaborative authors is more compared to the single-author  
 publications. Table 6 shows that language wise research  
 publication on industrial pollution, 1098 papers are published in  
 fifteen languages, among the fifteen languages, the majority of  
 publications are in the English language, 5.19 per cent papers were  
 published in German language, 2.46 per cent papers published are  
 in Russian language, 1.09 per cent papers are published in French,  
 followed by in Spanish language 0.64 per cent, in Polish language  
 0.46 per cent publications, in German language 0.36 per cent

**Table 2. Relative Growth Rate and Doubling Time of industrial pollution research**

Sl. No.	Year	No. of Records	Cumulative	W1	W2	W2 – W1 (Ra)	Mean (Ra) W2-W1	Doubling Time	Mean Dt (a)
1	2006	42	42		3.73		0.04		4.6
2	2007	44	86	3.73	3.78	0.05		13.86	
3	2008	52	138	3.78	3.95	0.17		4.08	
4	2009	68	206	3.95	4.22	0.27		2.57	
5	2010	49	255	4.22	3.89	-0.33		-2.10	
6	2011	61	316	3.89	4.11	0.22	0.09	3.15	3.07
7	2012	54	370	4.11	3.98	-0.13		-5.33	
8	2013	60	430	3.98	4.09	0.11		6.30	
9	2014	67	497	4.09	4.2	0.11		6.30	
10	2015	77	574	4.2	4.34	0.14		4.95	
11	2016	70	644	4.34	4.24	-0.1	0.14	-6.93	1.71
12	2017	80	724	4.24	4.38	0.14		4.95	
13	2018	102	826	4.38	4.62	0.24		2.89	
14	2019	116	942	4.62	4.75	0.13		5.33	
15	2020	156	1098	4.75	5.05	0.3		2.31	
	Total	1098					0.09		3.12

**Table 3. Document type wise research publications on industrial pollution research**

Sl. No.	Document types	No. of Records	Percentages
1	Article	841	76.59
2	Conference Paper	153	13.93
3	Book Chapter	44	4.01
4	Review	29	2.64
5	Book	8	0.73
6	Erratum	8	0.73
7	Note	5	0.46
8	Retracted	3	0.27
9	Editorial	2	0.18
10	Short Survey	2	0.18
11	Data Paper	1	0.09
12	Letter	1	0.09
13	Undefined	1	0.09
	Total	1098	100.00

**Table 4. Sources type wise research publications on industrial pollution research**

Sl. No.	Source type	No. of Records	Percentages
1	Journal	890	81.06
2	Conference Proceeding	130	11.84
3	Book	44	4.01
4	Book Series	27	2.46
5	Trade Journal	7	0.64
	Total	1098	100.00

**Table 5. Top twenty authors contributed on industrial pollution research**

Sl. No.	Authors name	No. of Records	% of 1098
1	Garc�a-P�rez, J.	8	0.73
2	Deshmukh, J.U.	7	0.64
3	L�pez-Abente, G.	7	0.64
4	Ramis, R.	7	0.64
5	Ambore, N.E.	5	0.46
6	Davydova, Y.A.	5	0.46
7	Fern�ndez-Navarro, P.	5	0.46
8	Vorobeichik, E.L.	5	0.46
9	Arago�s, N.	4	0.36
10	Boldo, E.	4	0.36
11	He, C.	4	0.36
12	Huang, Z.	4	0.36
13	Kozlov, M.V.	4	0.36
14	Lope, V.	4	0.36
15	Ma, W.	4	0.36
16	Pulle, J.S.	4	0.36
17	Suleimanov, I.F.	4	0.36
18	Tilt, B.	4	0.36
19	Yi, P.	4	0.36
20	Yu, Q.	4	0.36

publications, in Italian and Portuguese language 0.18 per cent papers respectively, in Greek, Hungarian, Moldavian, Moldovan, Romanian and Turkish languages 0.09 per cent publications were published respectively on industrial pollution research during the study period.

**Table 6. Authorship pattern on industrial pollution research**

Sl. No.	Authorship pattern	No. of papers	percentages
1	Single	42	3.83
2	Double	98	8.93
3	Three	124	11.29
4	Four	208	18.94
5	Five	254	23.13
6	Six and above	372	33.88
	Total	1098	100.00

**Table 7. Language wise research performance on industrial pollution**

Sl. No.	Languages	No. of Records	% of 1098
1	English	980	89.25
2	Chinese	57	5.19
3	Russian	27	2.46
4	French	12	1.09
5	Spanish	7	0.64
6	Polish	5	0.46
7	German	4	0.36
8	Italian	2	0.18
9	Portuguese	2	0.18
10	Greek	1	0.09
11	Hungarian	1	0.09
12	Moldavian	1	0.09
13	Moldovan	1	0.09
14	Romanian	1	0.09
15	Turkish	1	0.09
	Total	1098	100.00

**Table 8. Top twenty institutions contributed on industrial pollution research**

Sl. No.	Institutions (author affiliations)	No. of Records	% of 1098
1	Russian Academy of Sciences	38	3.46
2	Chinese Academy of Sciences	36	3.28
3	University of Chinese Academy of Sciences	17	1.55
4	Ministry of Education China	16	1.46
5	Institute of Plant and Animal Ecology	15	1.37
6	Siberian Branch, Russian Academy of Sciences	12	1.09
7	Tsinghua University	12	1.09
8	Instituto de Salud Carlos III	11	1.00
9	Centro Nacional de Epidemiologia	11	1.00
10	Peking University	11	1.00
11	Beijing Normal University	11	1.00
12	Zhejiang University	10	0.91
13	Consiglio Nazionale delle Ricerche	10	0.91
14	Nanjing Institute of Geography and Limnology Chinese Academy of Sciences	9	0.82
15	CNRS Centre National de la Recherche Scientifique	8	0.73
16	Nanjing University	8	0.73
17	Sichuan University	7	0.64
18	University of Science and Technology Beijing	7	0.64
19	University of Science and Technology of China	7	0.64
20	CIBER EpidemiologÅa Y Salud PÅblica	7	0.64

Table 8 shows that top twenty institutions contributed to industrial pollution research; among the Institutions, the Russian Academy of Sciences has the first position with 38 contributions, the Chinese Academy of Sciences has the second position with 36 contributions, University of Chinese Academy of Sciences has the third position with 17 contributions, followed by Ministry of Education China have fourth place with 16 contributions, Institute of Plant and Animal Ecology have fifth place with 15 publications, Siberian Branch, Russian Academy of Sciences and

Tsinghua University have sixth and seventh place with 12 contributions respectively, Instituto de Salud Carlos III, Centro Nacional de Epidemiologia, Peking University, have eight, ninth, tenth and eleventh position with 11 contributions respectively, Zhejiang University and Consiglio Nazionale delle Ricerche have twelfth and thirteen position with 10 contributions, Nanjing Institute of Geography and Limnology Chinese Academy of Sciences have fourteenth place with 9 contributions, CNRS Centre National de la Recherche Scientifique and Nanjing University have fifteenth and sixteenth position with 8 contributions, Sichuan University, University of Science and Technology Beijing, University of Science and Technology of China and CIBER EpidemiologÅa Y Salud PÅblica have seventeenth, eighteenth, nineteenth, and twentieth position with 7 papers.

**Table 9. Top twenty sources contributed on industrial pollution**

Sl. No.	Sources Name	No. of Records	% of 1098
1	Journal of Cleaner Production	28	2.55
2	Science of The Total Environment	26	2.37
3	Environmental Science and Pollution Research	25	2.28
4	IOP Conference Series Earth and Environmental Science	22	2.00
5	Environmental Pollution	20	1.82
6	International Journal of Environmental Research and Public Health	19	1.73
7	Environmental Monitoring and Assessment	18	1.64
8	Russian Journal of Ecology	15	1.37
9	IOP Conference Series Materials Science and Engineering	14	1.28
10	Nature Environment and Pollution Technology	13	1.18
11	Sustainability Switzerland	12	1.09
12	Water Air and Soil Pollution	12	1.09
13	Indian Journal of Environmental Protection	11	1.00
14	Journal of Industrial Pollution Control	11	1.00
15	Zhongguo Huanjing Kexue China Environmental Science	11	1.00
16	Huanjing Kexue Environmental Science	10	0.91
17	Pollution Research	9	0.82
18	Chemosphere	8	0.73
19	Contemporary Problems of Ecology	8	0.73
20	Atmospheric Environment	7	0.64

Table 9 shows that top twenty sources contributed to industrial pollution research publications, among the top twenty sources, Journal of Cleaner Production occupies first place with 2.55 percent of papers, Science of The Total Environment has second place with 2.37 per cent papers, Environmental Science and Pollution Research has third place with 2.28 per cent papers, followed by IOP Conference Series Earth and Environmental Science has fourth place with 2.00 per cent papers, Environmental Pollution has fifth place with 1.82 per cent papers, International Journal of Environmental Research and Public Health has sixth place with 1.73 per cent papers, Environmental Monitoring and Assessment has seventh place with 1.64 per cent papers, Russian Journal of Ecology has eighth place with 1.37 per cent papers, IOP Conference Series Materials Science and Engineering has ninth place with 1.28 papers, Nature Environment and Pollution Technology has tenth place with 1.18 per cent papers, Sustainability Switzerland, Water Air and Soil Pollution has eleventh and twelfth place with 1.09 per cent papers respectively, Indian Journal of Environmental Protection, Journal of Industrial Pollution Control, and Zhongguo Huanjing Kexue China Environmental Science has thirteenth, fourteenth, fifteenth place with 1.00 per cent papers respectively. Huanjing Kexue Environmental Science has sixteenth place with 0.91 per cent papers, Pollution Research has seventeenth place with 0.82 papers, Chemosphere, Contemporary Problems of Ecology has eighteenth, and nineteenth place with 0.73 per cent papers respectively, Atmospheric Environment has twentieth place with 0.64 per cent papers.

**Table 10. Top twenty countries contributed on industrial pollution**

Sl. No.	Countries Name	No. of Records	% of 1098
1	China	308	28.05
2	India	111	10.11
3	Russian Federation	96	8.74
4	United States of America	90	8.20
5	France	41	3.73
6	United Kingdom	40	3.64
7	Italy	38	3.46
8	Poland	27	2.46
9	Canada	26	2.37
10	Spain	25	2.28
11	Germany	24	2.19
12	Romania	23	2.09
13	Australia	20	1.82
14	Japan	20	1.82
15	Nigeria	20	1.82
16	South Korea	20	1.82
17	Iran	18	1.64
18	Turkey	18	1.64
19	Greece	17	1.55
20	Pakistan	14	1.28

Table 10 shows that the top twenty countries contributed to industrial pollution research publications, among the twenty countries, out of 1098 papers China has a first place with 28.05 per cent contributions, India has second place with 10.11 per cent contributions, Russian Federation has third place with 8.74 per cent contributions, followed by United States of America has fourth place with 8.20 per cent contributions, France has fifth place with 3.73 per cent contributions, United Kingdom has sixth place with 3.64 per cent contributions, Italy has seventh place with 3.46 per cent contributions, Poland has eighth place with 2.46 per cent contributions, Canada has ninth place with 2.37 per cent contributions, Spain has tenth place with 2.28 per cent contributions, Germany has eleventh place with 2.19 per cent contributions, Romania has twelfth place with 2.09 per cent contributions, Australia, Japan, Nigeria, and South Korea has thirteenth, fourteenth, fifteenth, sixteenth place with 31.82 per cent contributions, Iran, Turkey has seventeenth and eighteenth place with 1.64 per cent contributions respectively, Greece has nineteenth place with 1.55 per cent contributions, and Pakistan has twentieth place with 1.28 per cent contributions. Out of 1098 papers China has the first place with 28.05 per cent contributions, India has second place with 10.11 per cent contributions, Russian Federation has a third place with 8.74 per cent contributions.

## CONCLUSION

Conclude from the study, the document type-wise research publications on industrial pollution, articles are more contributed to compared other document types, the source wise publications, Journal has occupied the first position with more than 80 percent contributions, the top twenty authors contributed to in the industrial pollution research publications, among the authors

García-Pérez, J occupies the first position with 8 contributions, Deshmukh, J.U, López-Abente, G, Ramis, R. has second and third place respectively. The authorship patterns on Industrial pollution research, the collaborative authors are more compared to the single-author publications, the language-wise publications on industrial pollution, among the fifteen languages, the majority of publications are in the English language. The top twenty institutions contributed to industrial pollution research; among the Institutions, the Russian Academy of Sciences has the first position with 38 contributions, the Chinese Academy of Sciences has the second position with 36 contributions, University of Chinese Academy of Sciences has the third position with 17 contributions, the top twenty sources contributed to industrial pollution research publications, Journal of Cleaner Production occupies first place with 2.55 percent of papers, Science of the total Environment has second place with 2.37 per cent papers, Environmental Science and Pollution Research has third place with 2.28 per cent papers.

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