

Nanomaterials for Photocatalytic dye degradation: A Scientometric Assessment

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Abstract:

This study analyses the application of the Nano materials in the field of photo catalytic dye degradation research output in the form of literature records retrieved from web of science data base for the period 2006-2019(14 years). The analysis is focused on the annual growth of publication belonging to document categories, authorship patterns, degree of collaboration, contribution by institution and journal productivity in Nano materials for photo catalytic dye degradation. The finding of the results revealed that out of 810 records, single author contributed 1.23% of the article which 98.77% of the articles showed multiple authorships. So collaborative authorship pattern dominated compared to single contribution. The average degree of collaboration focused to be 0.99. The most productive journal is journal of Nano materials.

Keywords: Nanomaterials for Photocatalytic dye degradation, Scientometric Study, Degree of Collaboration, Hitecite, VoS Viewer.

1. Introduction:

Industrial development is one of the reasons behind the economic status of each country because lot of products have been manufacturing in industries which are very important in the day-to-day life. Even though providing a lot of benefits to the society but also few drawbacks are there with the industries to the environment. . Nowadays, the synthetic dyes are extensively used in products like clothes, leather accessories, furniture, and plastic products. However, during the dyeing process, nearly 12% of these dyes exclude as waste, and ~ 20% of this wastage enters to the environment. Dyes are one of the major pollutants to create environmental hazardness to the hydrosphere, living organism and human beings. The soil and water are having pollutants due to

contamination of soil and water by the discharged effluents and solid waste from the cosmetics, textiles, drug, foods and paper industries throughout the world. A lot of investigations have been done to remove these dyes from effluents by photocatalytic dye degradation with the help of nanomaterials can provide complete elimination of pollutants from the environment.

Scientometric is an important Research tool for understanding the subjects which aims in measuring the utility of documents and relationship between documents and fields. Here the investigation have been employed this methodology for studying authorship pattern and collaboration research in Nano materials for photocatalytic dye degradation research productivity the related research article were download from the data base in web of science during the period from 2006 to 2019 for the data was tabulated using hitecite software and interpretation of results can be carried out using VOS viewer,

2. Review of Literature:

Khalaj M (2020) analyzed the research output on green synthesis of nanomaterials published in Web of Science during the 24 period 1991 – 2019 is analyzed. Overall, 9 scientometric indicators are employed to 25 interpret the results retrieved from the 8761 documents collected. It is found that 107 countries and nearly 22400 authors have contributed to this subject, hence highlighting the relevance of this topic. The type of documents, countries and author contribution were also analyzed.

Yogendra Singh (2010) identified a historical background of the development of this subjectNanoscience and technology field in the world in general and India in particular. Presents a brief literature survey of the scientific productivity. Reasons why data have been taken from Web of Science is given in brief. Analyses the data in order to find a quantitative spread in this field over last twenty years (1988-2007). The analysis of data reveals that there has been a fast growth in Nanoscience and technology research in India. The increase in the last five years (2003-2007) has been quite phenomenal as 75 % of the articles have been published during these 5 years.

Anuja E (2020) examined the Research output of Thin Film for Solar cell Fabrication analyzed patterns of authorship, author productivity, documents as well as language analysis covered in the paper over the period 1991-2019. It was found that 5365 Papers were published during the study period of the study. The maximum numbers of articles were collaborative in nature. The highest contributed in the year 2017. It was an analysis Degree of Collaboration 0.98.

Rajeshwari S(2012) identified Research contribution of Arts faculties of Annamalai University. Studies the impact of research under different existing Social Science &Arts departments of the University and analyses the strong and weak areas of University research, collaborative nature of research in terms of the authorship pattern. The results shows that there is significant growth of research productivity in the faculty of Arts during the period of study with less collaboration.

Ramesh K(2020) analyzed Scientometrics include identifying emerging areas of scientific research, examining the development of research over time, geographic and organizational distribution of research. Present study explored the scientometric analysis of IoT in Network Security for the period between 2009 to 2019. The study revealed that the highest numbers of papers were contributed by multi authors, whereas the remaining papers were produced by a single author. In the study period research publication are in increased trends

3. Objectives

- To identify the research contribution of Nanomaterials for Photocatalytic dye degradation.
- To measures the authorship pattern and Degree of Collaboration.
- To examine Document wise, Language wise and Keyword wise contribution of Nanomaterials for Photocatalytic dye degradation.
- To determine the geographical contribution of country wise and institution wise.

4. Methodology

This study was based on the data downloaded from Web of Science database for the period 2006 – 2019. The data have covered the research output of 14 years. The downloaded data were analyzed by using Hitecite and VOS Viewer software applications. The data analyzed in depth of web of science database.

**Table 1 Data Sample of Nanomaterials for Photocatalytic dye degradation
During 2006-2019**

S.No.	Details about Sample	Observed Values
1	Duration	2006- 2019
2	Time Span	14 Years
3	Total No. of Records	810
4	Total No. of Authors	3343
5	Contributed Journals	250
6	Document Types	4
7	Languages	3
8	Frequently Used Words	1746
9	Contributing Countries	72
10	Contributing Institutions	1032
11	Local Citation Score	334
12	Global Citation Score	18483

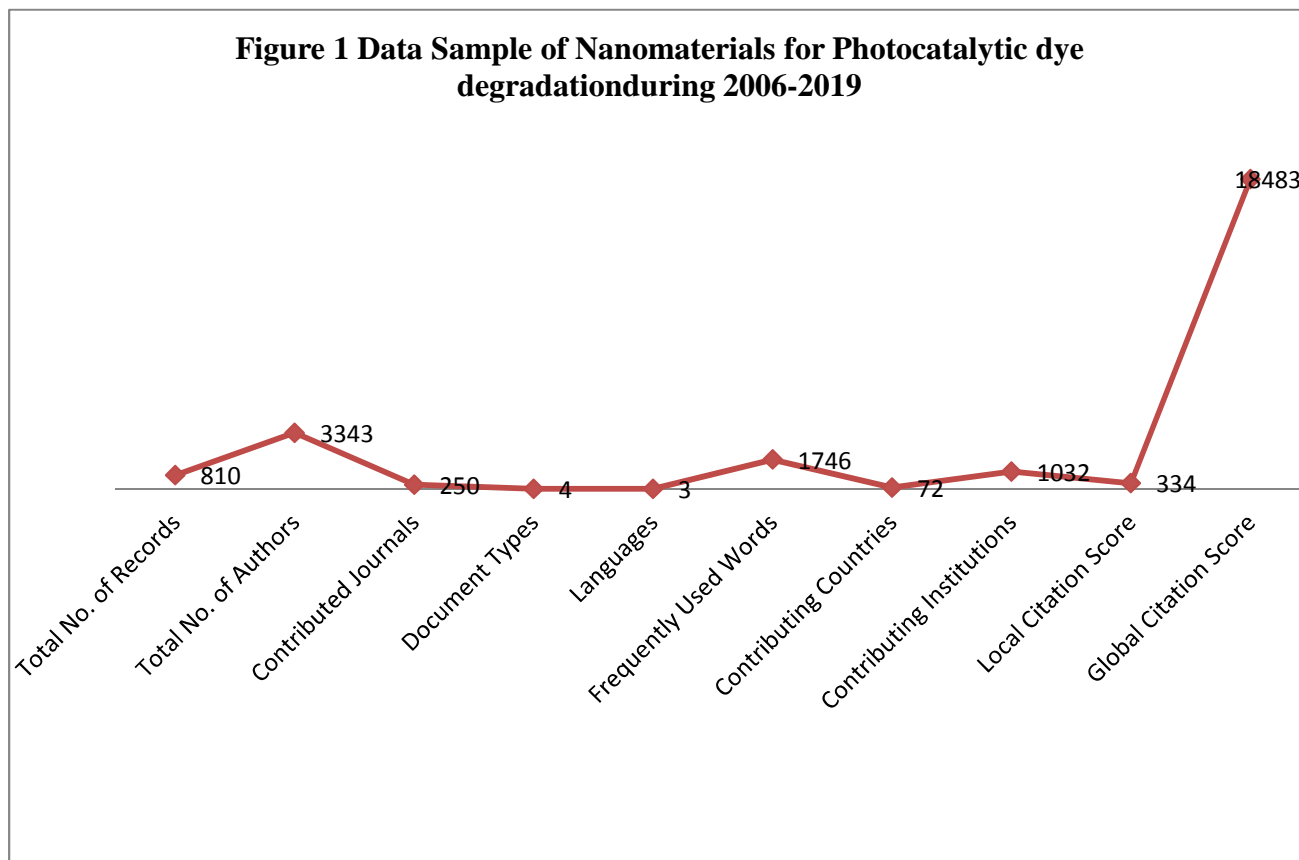


Table 1 and Figure1 show that the brief description on Nanomaterials for Photocatalytic dye degradation research output during the sample period from the Web of Science Database. The total span is 14 years. They were 810 records downloaded. Among the records were earning 3343 authors, 250 journals, 4 Documents, 3 Languages, 1746 words, 72 countries, 1032 Institutions, 334 Total Local Citation Scores(TLCS) and 18483 Total Global Citation Scores(TGCS).

Table 2 Growth of year wise literature of Nanomaterials for Photocatalytic dye degradation

S.No	Year	Records	%	TLCS	TGCS
1	2006	1	0.1	0	117
2	2007	5	0.6	14	612
3	2008	5	0.6	0	219
4	2009	6	0.7	21	1018
5	2010	12	1.5	26	721
6	2011	18	2.2	16	828
7	2012	26	3.2	37	3440
8	2013	38	4.7	21	1925
9	2014	57	7.0	24	1480
10	2015	73	9.0	49	1920
11	2016	103	12.8	37	2285
12	2017	135	16.8	56	2050
13	2018	137	16.9	29	1249
14	2019	194	23.9	4	619
		810	100	334	18483

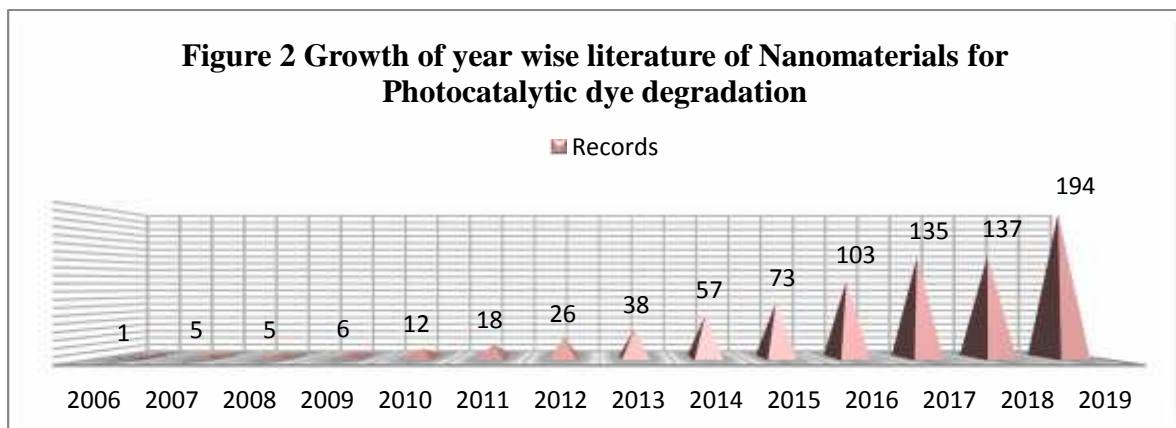


Table 2 and Figure 2 reveals that Annual contribution on Nanomaterials for Photocatalytic dye degradation during the study period. Total contribution were 810 Records. This record was collected for 14 years (2006-2019). The research contribution was highest in the year 2019 and least in the year 2006. The maximum contribution is 194 records (23.9%) and minimum contribution is 1(0.1%) record in the study period. Annual contribution was increased trend in the period 2006-2019. Nowadays, recent research work was focused on synthesis of Nanomaterials for photo catalytic dye degradation.

Table 3 Document wise contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Document type	Records	%	TLCS	TGCS
1	Article	750	92.6	257	14096
2	Review	34	4.2	71	4081
3	Proceedings Paper	23	2.8	6	306
4	Early Access	3	0.4	0	0
		810	100	334	18483

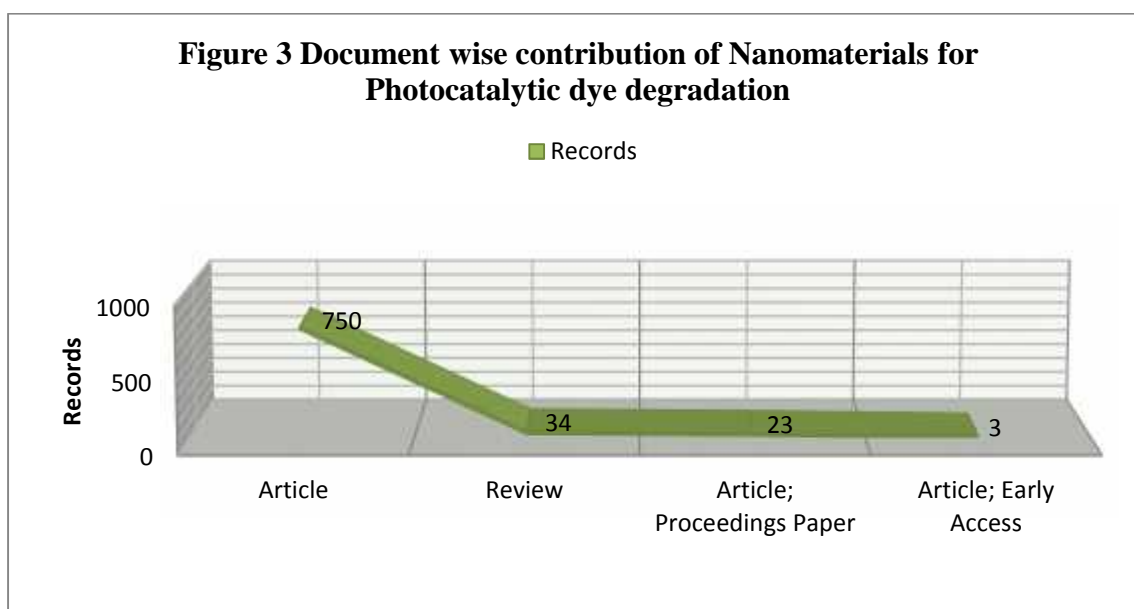


Table 3 and Figure 3 represent the document wise contribution of Nanomaterials for Photocatalytic dye degradation. The Documents are classified into four divisions. The Article possess (92.6%) has been taken in the first place followed by Review (4.2%), Proceeding (2.8%), Early Access (0.4%). Out of 810 records, Articles possess 750 records.

Table 4 Language wise contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Document type	Records	%	TLCS	TGCS
1	English	806	99.6	334	18463
2	Chinese	2	0.2	0	17
3	Portuguese	2	0.2	0	3
		810	100	334	18483

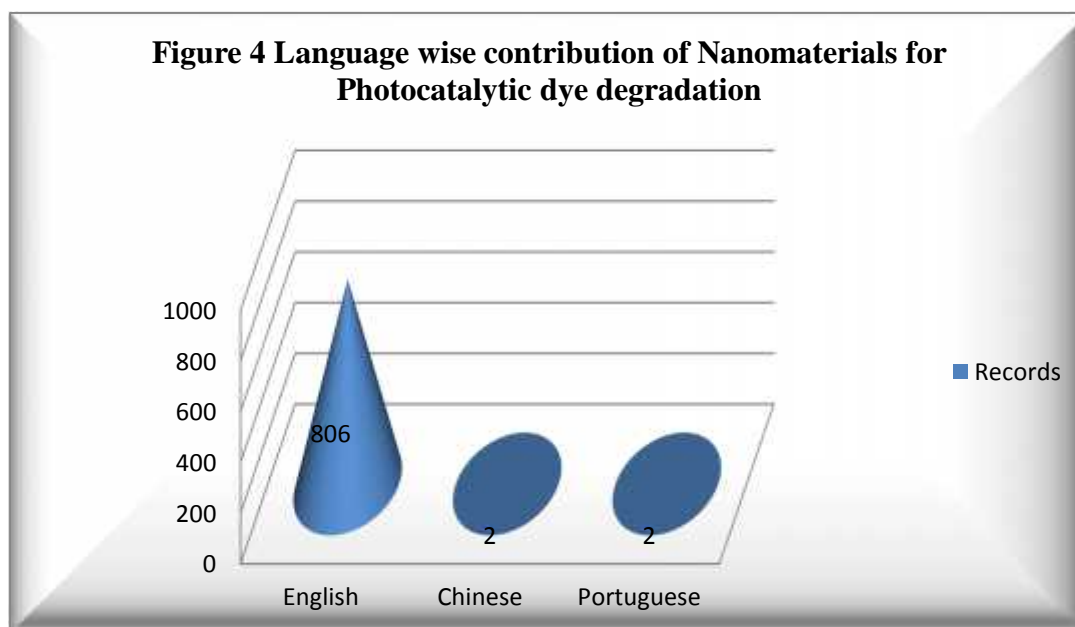


Table 4 and Figure 4 shows that Language wise contribution of Nanomaterials for Photocatalytic dye degradation. The maximum records are in the form of English Language 806 (99.6%) records.

Table 5 Authorship Pattern of Nanomaterials for Photocatalytic dye degradation

S.No	Authors	Records	Percentage
1	Single	10	1.23
2	Double	66	8.15
3	Three	128	15.80
4	Four	167	20.62
5	Five	122	15.06
6	Six	140	17.28
7	Seven	75	9.26
8	Eight	39	4.81
9	Nine	29	3.58
10	Ten & Above	34	4.21
	Total	810	100

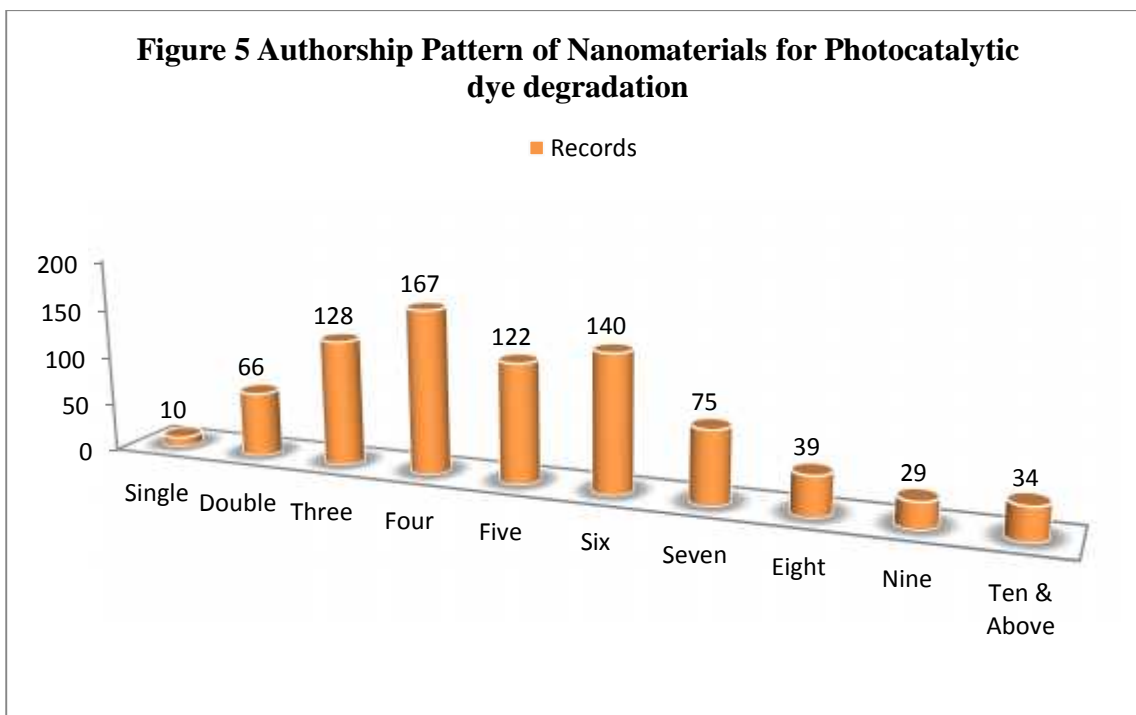


Table 5 and Figure 5 shows that the authorship pattern is analyzed for Nanomaterials application in Photocatalytic dye degradation. It is observed that 1.23% of the contribution by

Single Author and 98.77% of the contribution by Multiple Authors. The maximum contribution is four authors with 20.62%.

5. Degree of Collaboration

The data from the above table 6 indicates the degree of collaboration in research output of Nanomaterials for Photocatalytic dye degradation. The degree of collaboration reveals that single Vs. multi-authored paper on Nano materials applications research productivity during the period 2006 to 2019. Out of the total 810 papers published 800 are from multiple authors which 98.77% of total output and 10 papers are published by single author which is 1.23% of total output. It can be calculated using this formula (K.Subramanyam, 1982)

$$C = \frac{N_m}{N_m + N_s}$$

Where,

C = Degree of collaboration in a discipline

N_m = Number of multiple authored papers

N_s = Number of single authored papers

Based on the study the result of the degree of collaboration $c=0.99$ i.e., 99% of collaborative author's articles published during the study periods. The study found that single author papers maintained a low profile among Nano materials research scientists.

Table 6 Authorship Pattern Degree of Collaboration

Year	Single	Multiple	Total	Degree of Collaboration
2006	-	1	1	1.00
2007	-	5	5	1.00
2008	-	5	5	1.00
2009	-	6	6	1.00
2010	-	12	12	1.00
2011	-	18	18	1.00
2012	2	24	26	0.92
2013	1	37	38	0.97
2014	-	57	57	1.00
2015	2	71	73	0.97
2016	-	103	103	1.00
2017	-	135	135	1.00
2018	2	135	137	0.99
2019	3	191	194	0.98
	10	800	810	0.99

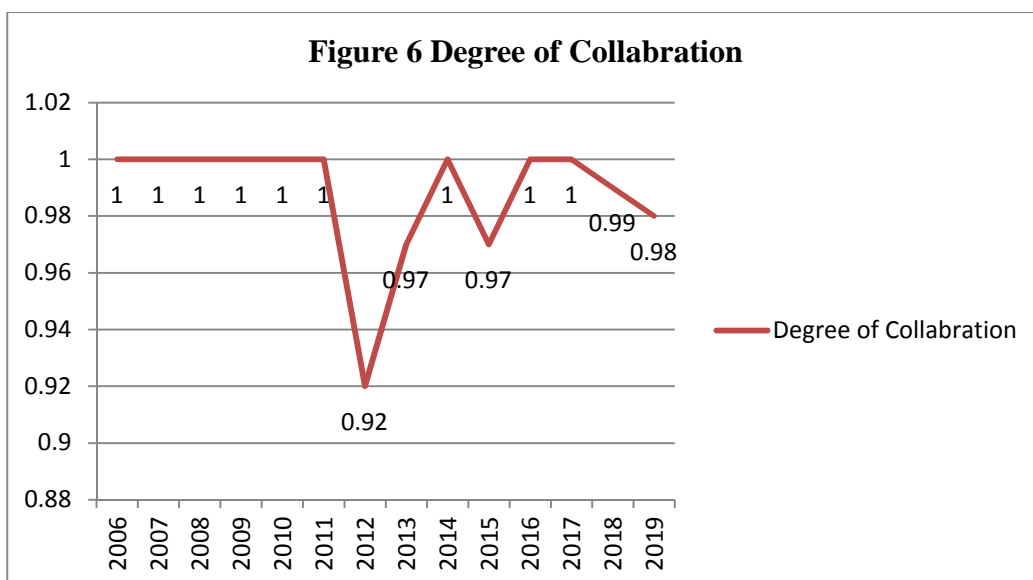
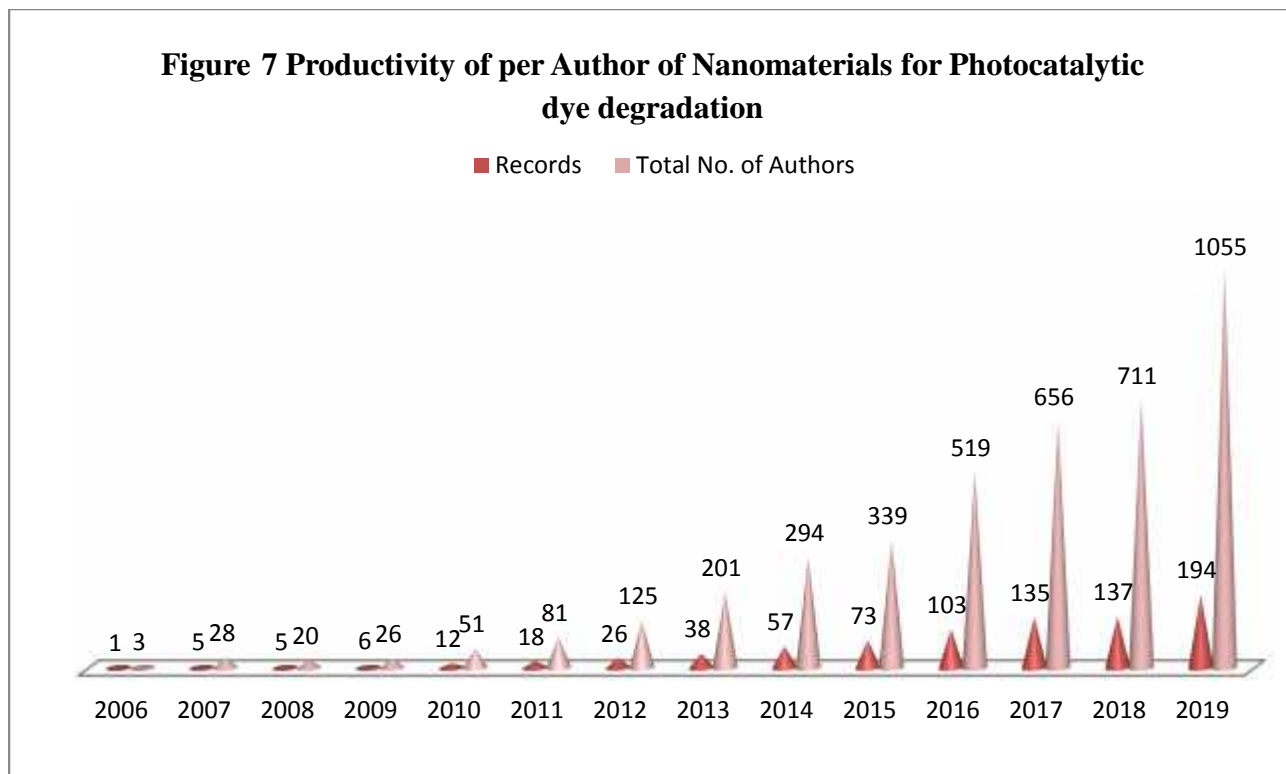


Table 7 Productivity of per Author of Nanomaterials for Photocatalytic dye degradation

Year	Records	Total No. of Authors	Average Author per Paper	Productivity per Authors
2006	1	3	3	0.33
2007	5	28	5.60	0.17
2008	5	20	4	0.25
2009	6	26	4.33	0.23
2010	12	51	4.25	0.23
2011	18	81	4.50	0.22
2012	26	125	4.81	0.21
2013	38	201	5.29	0.19
2014	57	294	5.16	0.19
2015	73	339	4.64	0.21
2016	103	519	5.04	0.20
2017	135	656	4.86	0.21
2018	137	711	5.19	0.19
2019	194	1055	5.44	0.18
	810	4109	5.07	0.20



The data pertaining to author productivity in the Table7. The table shows that the total average number of authors per paper is 5.07 for the 810 articles. The average productivity per author is 0.20 during the year 2006 to 2019.

Productivity has been calculated with the following formula

$$\text{Average authors per paper} = \text{No. of Authors} / \text{No. of Papers}$$

$$\text{Productivity per Author} = \text{No. of Papers} / \text{No. of Authors}$$

Table 8 Top 10 Institution wise contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Institution	Records	TLCS	TGCS
1	Univ Johannesburg	27	16	368
2	Chinese Acad Sci	25	7	645
3	Najran Univ	16	23	460
4	Chonbuk Natl Univ	15	22	541
5	King Abdulaziz Univ	12	3	243
6	Panjab Univ	12	5	185
7	Islamic Azad Univ	11	1	104
8	Chiang Mai Univ	10	0	49
9	Natl Inst Technol	9	4	166
10	Yeungnam Univ	9	6	415

Figure 8 Institution wise contributions of Nanomaterials for Photocatalytic dye degradation

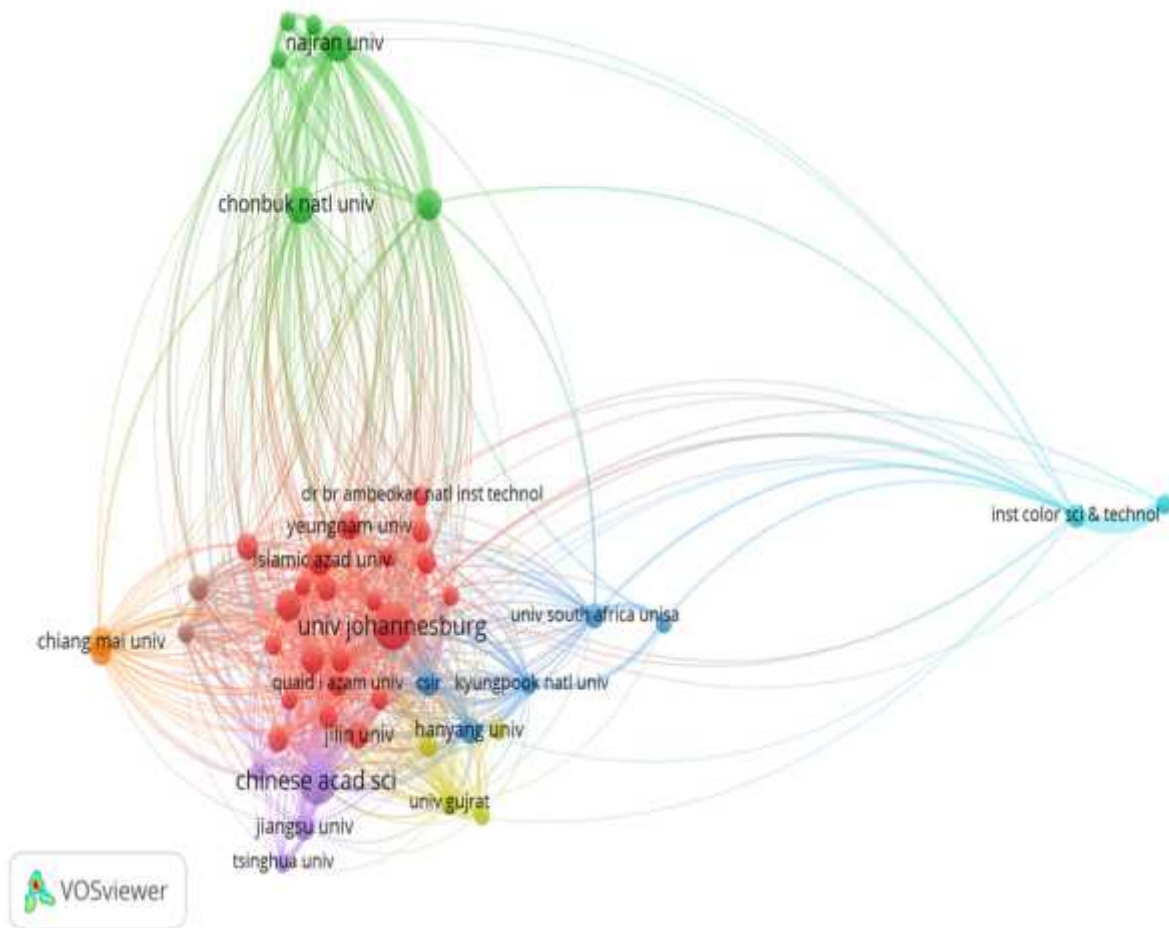


Table 8 and Figure 8 shows that Institution wise contribution of Nanomaterials for Photocatalytic dye degradation. It is found that total 1032 institution published 810 research papers during 2006-2019. The result shows that top 10 Institution contributing the recent research out of which the most prolific institution is University of Johannesburg published 27 research papers in this field.

Table 9 Top 10 Country wise contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Country	Records	TLCS	TGCS
1	Peoples R China	236	45	4812
2	India	206	106	3860
3	South Korea	60	38	1939
4	Saudi Arabia	55	31	924
5	USA	50	28	2823
6	Iran	47	55	3146
7	South Africa	46	30	774
8	Pakistan	37	5	195
9	Egypt	34	10	460
10	Australia	21	28	1414

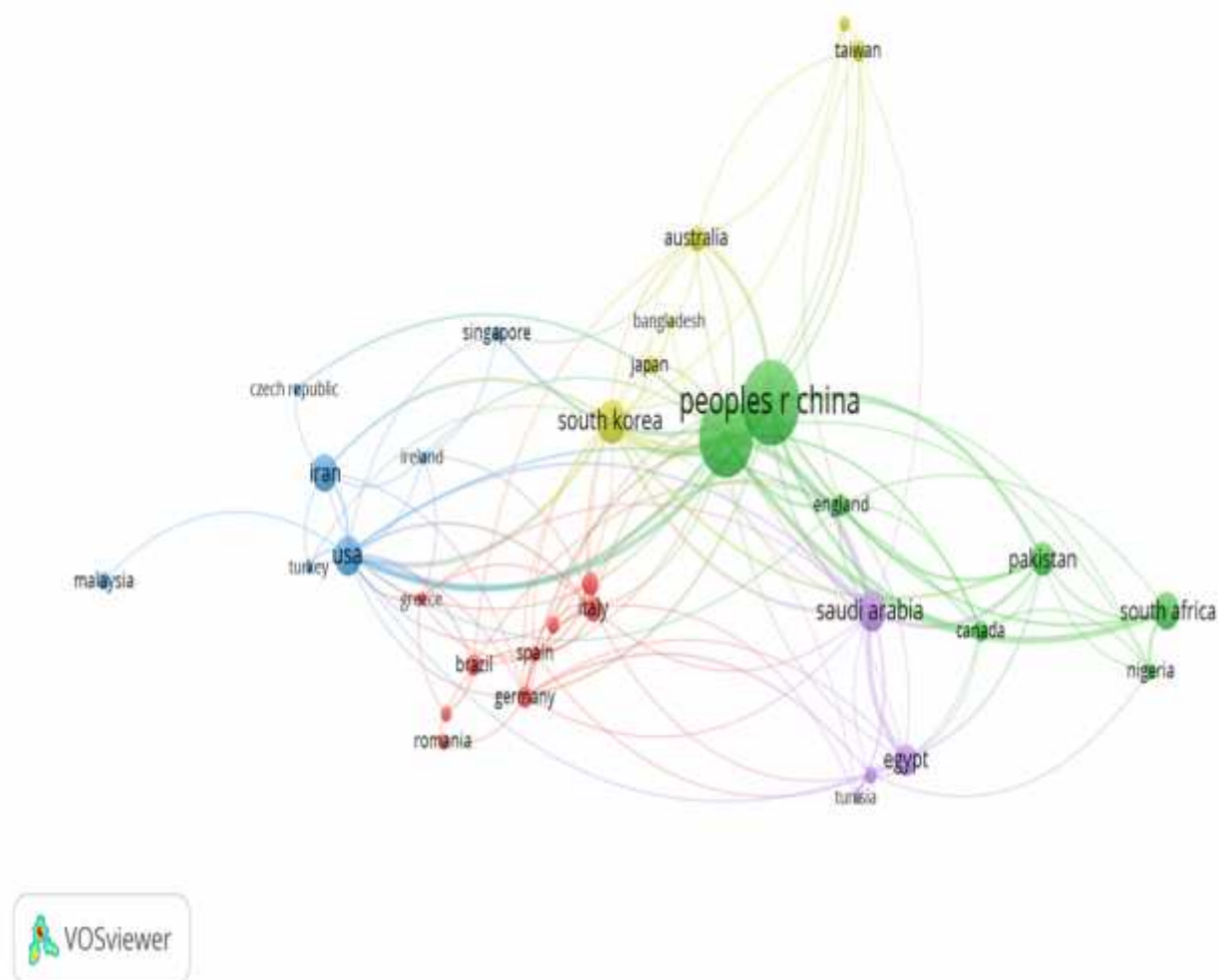
Figure 9 Country wise contributions of Nanomaterials for Photocatalytic dye degradation

Table 9 and Figure 9 reveals that Country wise contribution of Nanomaterials for Photocatalytic dye degradation. It also shows that research Publications of Top 10 countries. Totally 72 countries published 810 research papers during 2006-2019. At the time of study period the first place occupies by Peoples R China with 236 records and followed by South Korea, Saudi Arabia, USA, Iran, South Africa, Pakistan, Egypt and Australia etc. India is in second position with 206 records.

Table 10 Author contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Country	Records	TLCS	TGCS
1	Umar A	16	23	460
2	Kumar R	11	17	299
3	Arotiba OA	9	9	189
4	Govender PP	9	3	58
5	Kumar S	9	7	244
6	Thongtem S	9	0	46
7	Thongtem T	9	0	46
8	Akhtar MS	8	19	441
9	Mamba BB	7	4	56
10	Phuruangrat A	7	0	29

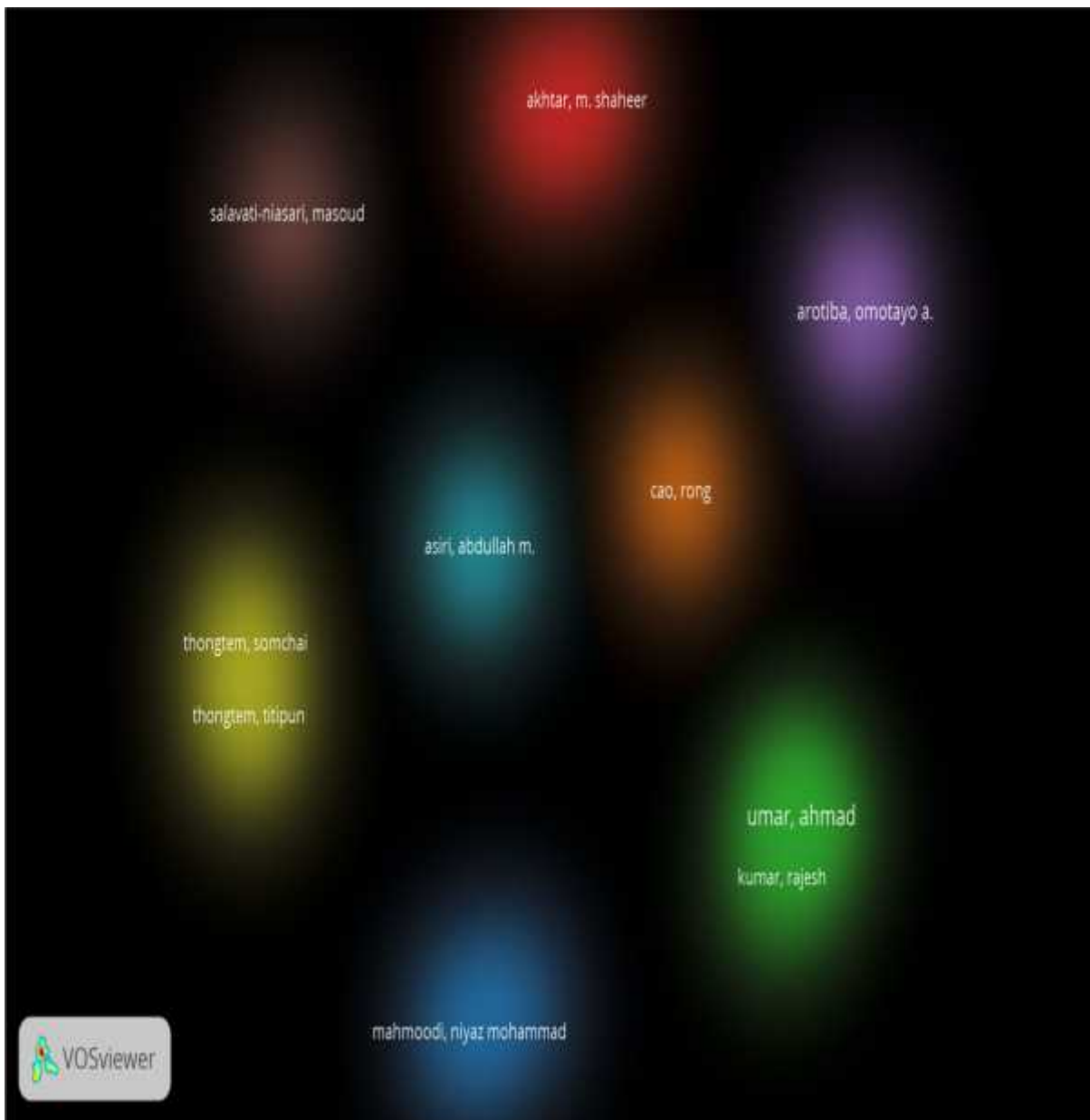
Figure 10 Author contributions of Nanomaterials for Photocatalytic dye degradation

Table 10 and Figure 10 shows that the Author contribution of Nanomaterials for Photocatalytic dye degradation. Total number of Authors is 3343. Top most author is 'Umar A' 16 Records.

Table 11 Journal contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Journal	Records	TLCS	TGCS
1	Journal Of Nanomaterials	58	0	367
2	Nanomaterials	34	0	320
3	Rsc Advances	31	12	387
4	Digest Journal Of Nanomaterials And Bio structures	28	3	125
5	Journal Of Materials Science-Materials In Electronics	27	8	162
6	Applied Surface Science	19	4	339
7	Applied Catalysis B-Environmental	18	37	3002
8	Journal Of Colloid And Interface Science	17	13	487
9	Journal Of Nanoscience And Nanotechnology	16	10	395
10	Journal Of Alloys And Compounds	13	9	281

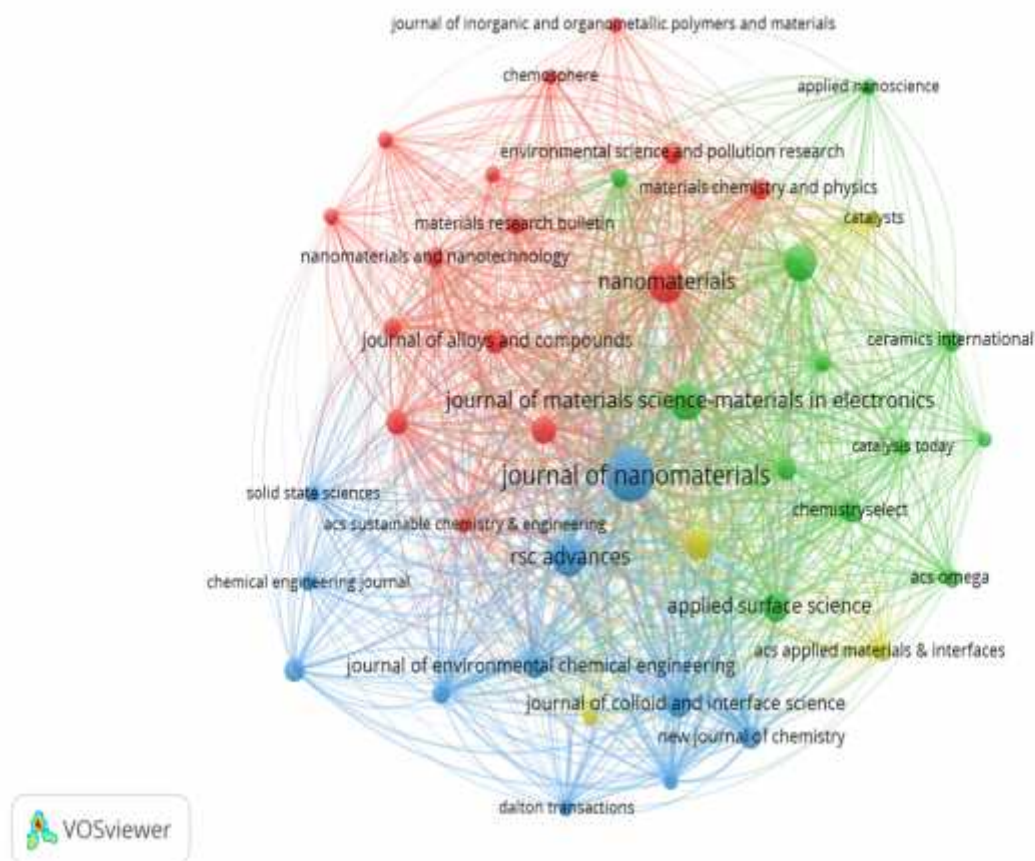
Figure 11 Journal contributions of Nanomaterials for Photocatalytic dye degradation

Table 11 and Figure 11 shows that 810 articles were published by 250 journals out of 250 journals only 10 most productive journals were taken for analysis. From the data obtained the top most journal is Journal of Nanomaterials with 58 records and followed by journal of nanomaterial having 34 records and RSC advances with 31 records.

Table 12 Keywords contribution of Nanomaterials for Photocatalytic dye degradation

S.No	Journal	Records	TLCS	TGCS
1	Photocatalytic	443	54.7	189
2	Degradation	231	28.5	148
3	Synthesis	216	26.7	75
4	Tio2	203	25.1	59
5	Light	171	21.1	93
6	Activity	157	19.4	51
7	Visible	151	18.6	77
8	Dye	131	16.2	69
9	Nanoparticles	127	15.7	35
10	Zno	111	13.7	66

Figure 12 Keywords contribution of Nanomaterials for Photocatalytic dye degradation

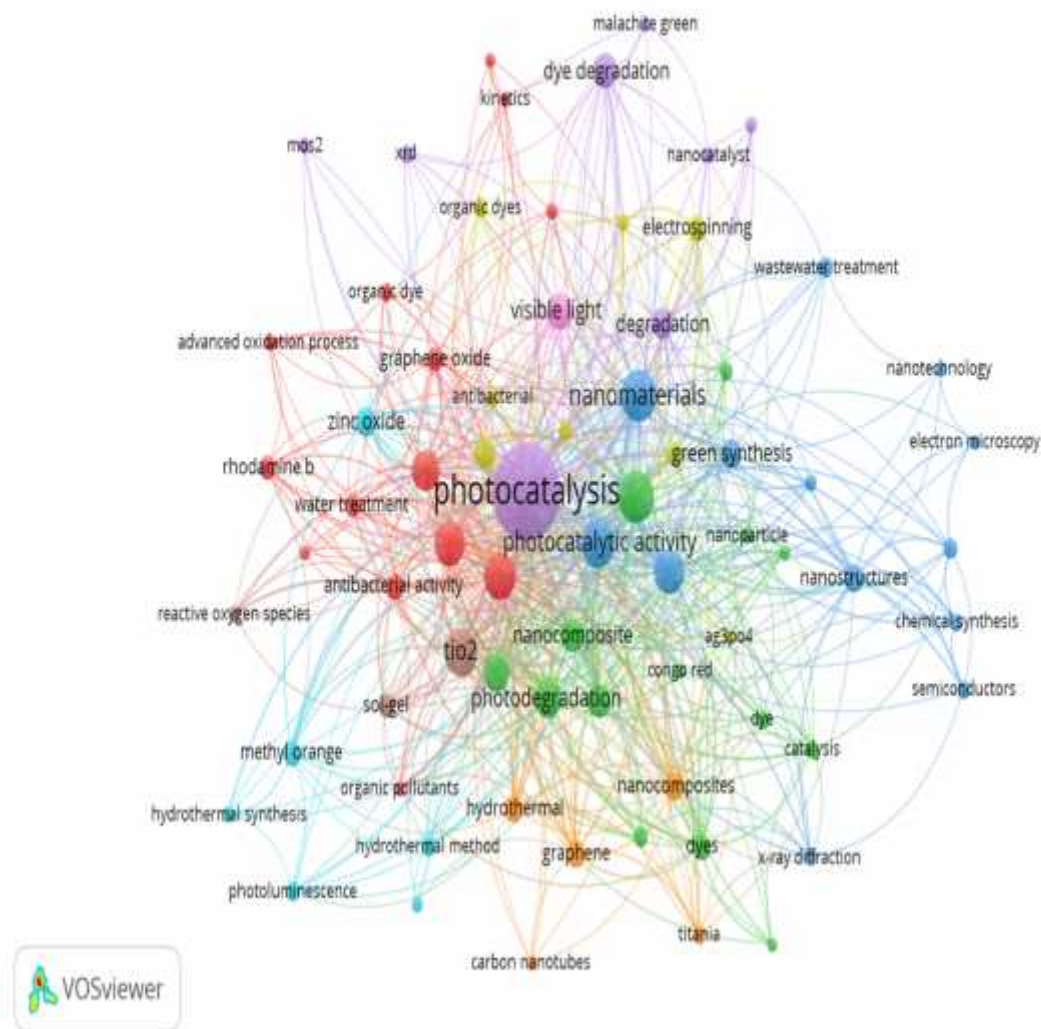


Table 12 and Figure 12 shows that Top 10 Keywords contribution of Nanomaterials for Photocatalytic dye degradation. Total number of keywords is 1746. The top most keyword is photocatalytic with 443 records.

Findings

- The findings of the growth rate of Nanomaterials for Photocatalytic dye degradation research output during the study period are increasing trends.
- The finding of the annual contribution of Nanomaterials for Photocatalytic dye degradation is highest in the year of 2019.
- The finding of the author productivity is multiple authors.
- The finding of the Document wise maximum contribution is articles.
- The finding of the Language wise maximum contribution is English Language.

Conclusion

Scientometrics include identifying emerging the development of research on Nanomaterials for Photocatalytic dye degradation. The study revealed that the highest number of papers was contributed by multiple authors, whereas the remaining papers were produced by a single author. Nanomaterials for Photocatalytic dye degradation research is beginning in the year 2006. It is the first article published in the year 2006. During the last 14 years span global contribution in terms of research output is significantly increased shows that the positive growth trend in future.

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