Research Performance of Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, India

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Abstract. This paper investigated about the research performance of Sri Siva Subramaniya Nadar College of Engineering is the one of the prominent technical institution in Chennai, Tamil Nadu, India. The objectives of the study are to analyze the various scientific research parameters of Sri Siva Subramaniya Nadar College of Engineering to plan for the future course of actions. This study analyzes and visualizes scholarly publications of Sri Siva Subramaniya Nadar College of Engineering using SCOPUS data from the period 2003. There are various qualitative and quantitative methods to measure research performance. This study adopted a number of Publications based on author, institution, country, and year, type of documents, subject area and number of citations. Relative Growth rate, Doubling Time, Coauthor Activity Index and analyzed by VOS Viewer and R Tool. Sri Siva Subramaniya Nadar College of Engineering leads in research productivity compared to other engineering colleges in Tamil Nadu during recent year. It also collaborated with Anna University, Chennai. United States is the predominant collaborative country for their research work. Moreover Department of Science and Technology has predominantly sponsored for the research activities of this institution. This analysis results indicate that publishing in top-ranked journals would improve the chance of getting more citations. The study considered only publications that are indexed in SCOPUS. It covered a limited set of sources as per the SCOPUS editorial policy. Most of the covered sources are journals and conference proceedings. Sri Siva Subramaniya Nadar College of Engineering is a technology based institution, and the majority of its academic departments fall in Engineering and Technology domains.

Keywords: Scientometrics, Research impact, Relative Growth Rate, VOS Viewer, Research performance, SSN College of Engineering, Chennai.

1 Introduction

Sri Siva Subramaniya Nadar College of Engineering, Chennai is one of the most prominent technical institutions in Tamil Nadu. Research productivity and citations are also significant factors in the ranking of institutions by various agencies. Hence, a study to analyze various aspects of Sri Sivasubramaniya Nadar College of Engineering research works and compare it with the peer institutions in the country is very significant to help the institution in formulating strategies for research planning and funding. This study has performed the scientometric analysis and visualization of the scholarly publications of Sri Siva Subramaniya Nadar College of Engineering, Chennai using SCOPUS, a citation database by Elsevier. The study used VOS Viewer for analyzing and visualizing citation networks. The findings of this study are expected to help Sri Siva Subramaniya Nadar College of Engineering have a thorough understanding of

the research impact of its publications and help to frame research policies to formulate strategies for increasing the visibility and citation impact of institution.

Vasistha (2011) has reported the research publication output of PEC University of Technology, Chandigarh and found that there is a increase in the output by 131.85% between 1996 and 2009. Savanur and Konnur (2012) have studied the research output of Bangalore University in the period of 1970 to 2010 and found that the growth rate of publications was highest during 1996 and 2000 and gradual decrease found after 2001. Maharana and Sethi have studied the publication output of Sambalpur University during 2007-2011 and analysed the various scientific parameters of the institution. Arumugam et.al (2019) analysed the Scholarly Research Output of Indian Institute of Management (IIMs) in India and found that significant contribution from the faculty of IIM Ahmedabad with 85.3% publications.

2 Aim and Objectives of the Study

The primary aim of this study was to analyze Sri Sivasubramaniya Nadar College of Engineering research output patterns and analyze area of growth to help the institution to formulate research planning to meet out the future requirements
.
The following are the objectives of the study

- ❖ To find out the chronological growth of research publication output
- ❖ To explore the various types of publication.
- ❖ To identify the most productive authors and authorship pattern.
- ❖ To find out major research areas of the university in terms of published works.
- ❖ To find out the impact of international collaborations and source of publications on received citations.

3 Methodology

Data on publication output of SSN College of Engineering were collected from the Scopus database for all the years from 2003 to 2020. Scopus, a product of Elsevier is covers nearly 30,000 titles from over 5,000 publishers and is the largest abstract and citation database of peer-reviewed literature covering science, technology, medicine, social sciences, arts and humanities. It also provides author profiles which cover affiliations, number of publications and their bibliographic data, references, and details on the number of citations each published document has received. It has a facility to calculate h-index of authors and institutions. The query: AF-ID (" Sri Sivasubramaniya Nadar College of Engineering, Kalavakkam" 60079728) AND (LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2003)) was used to retrieve details of research publications emanating from SSN College of Engineering. The study adopted VOS Viewer, a domain visualization tool to process data and make visualization graphs using SCOPUS data. VOS Viewer supports various bibliometric and citation analysis matrices and visualizes them using different network algorithms.

4 Limitations Of The Study

The study considered only publications that are indexed in SCOPUS. It covered a limited set of sources as per the SCOPUS editorial policy. Most of the covered sources are journals and conference proceedings. Books' data coverage in Citation Index is comparatively low, and the majority of the academic departments fall in engineering and technology domains.

Analysis

Type of Resources

The below figure clearly shows that there are good number of articles published in subscribes resources compared to open access platforms which clearly indicated , there is a lack of awareness among the faculty about open access publishing in the technical institutions.
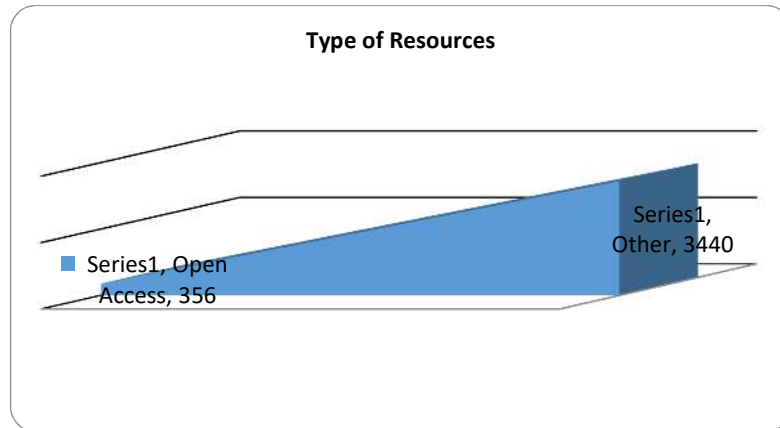
Figure 1. Type of Publishing Resources

Chronological Growth of Publications

Table 1 shows significant increase in publication started from 2003 with 6 publications and 2019 is the most productive year with 595 (15.67%) publications followed by 2018 and 2017 with 524 (13.8%) and 421 (11.09%) publications respectively. The publication output of last ten years, i.e. from 2011 to 2020 contributes 3394 (89.40%) publications of the total of 3796 in 18 years (2003 to 2020).

Year Range	Year		Total Publication
	No of Publication	Percentage	
2003-2010	402	10.59009	3796
2011-2020	3394	89.40991	

Table 1. Year-wise Output of Publications

Relative Growth Rate [R(a)]

The relative growth rate is the increase in the number of publications per unit of time i.e. one year. The mean relative growth rate R(1-2) over a specified period of interval can be calculated from the following equation suggested by Mahapatra

where,

R(1-2) = Mean relative growth rate over a specific period of interval;

W1 = Log W1 (Natural log of initial number of publications at beginning);

W2 = Log W2 (Natural log of initial number of publications at end);

T2 -T1 = Unit difference between the beginning time and end time.

Therefore, R(a) = Relative growth rate per unit of publications per unit of time (year).

The Relative Growth Rate R(a) and Doubling Time D(t) of publication output of SSN College of Engineering are derived and presented in Table 2 and the results show that till 2008 there was not good number of publications when compare with the last 10 years. The relative growth rate ranges between 1.79 to 0.88. The mean relative growth rate is 0.46.

Doubling Time (DT)

A direct equivalence exists between the relative growth rate and doubling time. The doubling time for publication can be calculated by the following formula suggested by Mahapatra. Therefore, The doubling time for publication output of SSN College of Engineering increased from 2007(1.07) onwards till 2020 to 20.87 in 2020. The doubling time for publications at the aggregate level has been computed as 1.2 years. There is a progressive growth in the number of publications of research output of SSN College of Engineering but its Doubling time is showing a increasing trend, since the rate of increase is high.

Year	No. of Records	Cumulative	log W1	log W2	RGR	Doubling Time
2003	6	6	0.00	1.79	1.79	0.39
2004	4	10	1.79	2.30	0.51	1.36
2005	10	20	2.30	3.00	0.69	1.00
2006	28	48	3.00	3.87	0.88	0.79
2007	44	92	3.87	4.52	0.65	1.07
2008	70	162	4.52	5.09	0.57	1.22
2009	108	270	5.09	5.60	0.51	1.36
2010	132	402	5.60	6.00	0.40	1.74
2011	203	605	6.00	6.41	0.41	1.70
2012	220	825	6.41	6.72	0.31	2.23
2013	246	1071	6.72	6.98	0.26	2.66
2014	311	1382	6.98	7.23	0.25	2.72
2015	396	1778	7.23	7.48	0.25	2.75
2016	354	2132	7.48	7.66	0.18	3.82
2017	421	2553	7.66	7.85	0.18	3.85

2018	524	3077	7.85	8.03	0.19	3.71
2019	595	3672	8.03	8.21	0.18	3.92
2020	124	3796	8.21	8.24	0.03	20.87

Table 2 Relative Growth Rate and Doubling Time

Annual Growth Rate (AGR)

This is one of the indicators of Annual Growth Rate (AGR) for each year. The formula for AGR is: **AGR = (Ending Value Beginning Value) / Beginning value**

The formula for AAGR is: **AAGR = (Growth Rate in Period A + Growth Rate in Period B + Growth Rate in Period C + ...Growth Rate in Period X) / Number of Periods**

S.No	Year	No of Publications	ARoG	AGR
1.	2003	6		
2.	2004	4	0.667	-0.333
3.	2005	10	2.500	1.500
4.	2006	28	2.800	1.800
5.	2007	44	1.571	0.571
6.	2008	70	1.591	0.591
7.	2009	108	1.543	0.543
8.	2010	132	1.222	0.222
9.	2011	203	1.538	0.538
10.	2012	220	1.084	0.084
11.	2013	246	1.118	0.118
12.	2014	311	1.264	0.264
13.	2015	396	1.273	0.273
14.	2016	354	0.894	-0.106
15.	2017	421	1.189	0.189
16.	2018	524	1.245	0.245
17.	2019	595	1.135	0.135
18.	2020	124	0.208	-0.792

Table 3 Annual Ratio of Growth and Annual Growth Rate

The AGR is the highest in 2006 (1.800) followed by 2005(1.500) and 2008(0.591). The AGR is the lowest in 2012 (0.084). As far as negative growth rate is concerned, the year 2016 has the AGR -0.106 of followed by -0.333 in 2004. There is a fluctuation in the AGR of SSN College of Engineering research output during the study period.

5 Document Type Distribution

Tables 4 shows that the faculty of SSN College of Engineering mostly published their research findings in the form of journal articles (2192 with 57.74%) as the preferred channel for their publications. They have also presented their papers in 1437 (37.85%) conferences. They have published 39 (1.03%) review papers as well. Other types like book chapter 97(2.55%), books (4 of 0.104%) are also the source of publications. Remaining forms like short survey, editorial and so on.

S.No	Document Type	No of Publications	Percentage (%)
1	Article	2192	57.74
2	Conference Paper	1437	37.85
3	Book Chapter	97	2.55
4	Review	39	1.02
5	Editorial	8	0.21
6	Erratum	6	0.15
7	Book	4	0.10
8	Letter	3	0.07
9	Data Paper	2	0.05
10	Note	2	0.05
11	Short Survey	1	0.02
12	Undefined	5	0.13

Table 4. Type of Documents

Predominant Authors of the Institution

Table 5 reveals that Ramasamy, P is the most productive author with 417 (10.98%) publications followed by Radha, S..with 134 (3.53%) publications. Below table represents the top 20 ranking of authors based on the publications.

S.No	Author	No of Publications	Percentage (%)
1	Ramasamy, P.	417	10.98
2	Radha, S.	134	3.53
3	Senthil Kumar, P.	101	2.66
4	Amutha, R.	75	1.97
5	Ramaprabha, R.	74	1.94
6	Rajini, V.	70	1.84
7	Srinivasan, R.	65	1.71
8	Sreeja, B.S.	62	1.63
9	Kumar, P.S.	60	1.58
10	Vishvaksenan, K.S.	59	1.55
11	Kamaraj, V.	55	1.44
12	Rajesh, N.P.	53	1.39
13	Pandian, M.S.	52	1.36

Table 5: Ranking of Authors

14	Vijayalakshmi, P.	52	1.36
15	Muthu, R.	50	1.31
16	Nagarajan, T.	50	1.31
17	Rajesh, P.	50	1.31
18	Senthil Pandian, M.	49	1.29
19	Seyezhai, R.	48	1.26
20	Kanagasabai, M.	46	1.21

Authorship Pattern

Table 6 shows that 3678 papers are collaborative publications. Two author papers (1260 with CAI 239.12) and followed by more than two author's collaborative papers (2418 with CAI 85.03). 118 papers (CAI 27.75) were contributed by single authors.

Co-Authorship Index

Year	Single Author	CAI	Two Authors	CAI	More than Two Authors	CAI	Total
2003	0	0.00	3	360.20	3	66.74	6
2004	1	223.15	0	0.00	3	100.11	4
2005	1	89.26	2	144.08	7	93.44	10
2006	0	0.00	6	154.37	22	104.88	28
2007	3	60.86	9	147.35	32	97.08	44
2008	4	51.01	26	267.57	40	76.28	70
2009	5	41.32	42	280.15	61	75.39	108
2010	9	60.86	51	278.33	72	72.81	132
2011	5	21.99	89	315.84	109	71.67	203
2012	11	44.63	85	278.33	124	75.24	220
2013	5	18.14	99	289.91	142	77.05	246
2014	12	34.44	110	254.80	189	81.12	311
2015	12	27.05	154	280.15	230	77.53	396
2016	17	42.87	117	238.10	220	82.96	354
2017	11	23.32	130	222.45	280	88.78	421
2018	9	15.33	139	191.10	376	95.78	524
2019	12	18.00	162	196.14	421	94.45	595
2020	1	7.20	36	209.15	87	93.65	124
Total	118	27.75	1260	239.12	2418	85.03	3796

Table 6. Authorship Pattern

Degree of Collaboration

Collaborative co-efficient is used to measure the extent of collaboration. The measure of the degree of collaboration in a discipline lies between 0 and 1 according to the formula of Subramanyam

$C = Nm/Nm+Ns$.

C: Degree of Collaboration

Nm: Number of multi-authored publications

Ns: Number of single authored publications

Hence C = 0.95 Hence, it is found that the degree of collaboration of publications of SSN College of Engineering faculty is 0.95.

Pattern of Co-Authorship

In order to assess the Pattern of Co-Authorship (CAI), the following formula suggested by Garg and Padhi has been employed.

$$CAI = \frac{Nij/Nio}{Noj/N\infty}$$

Where, Nij = Number of papers having authors in block i

Nio = Total output of block i

Noj = Number of papers having j authors for all blocks

N∞ = Total number of papers for all authors and all blocks

Hence CAI= 27.75 for single author, 239.12 for two authors, 85.03 for multiple author.
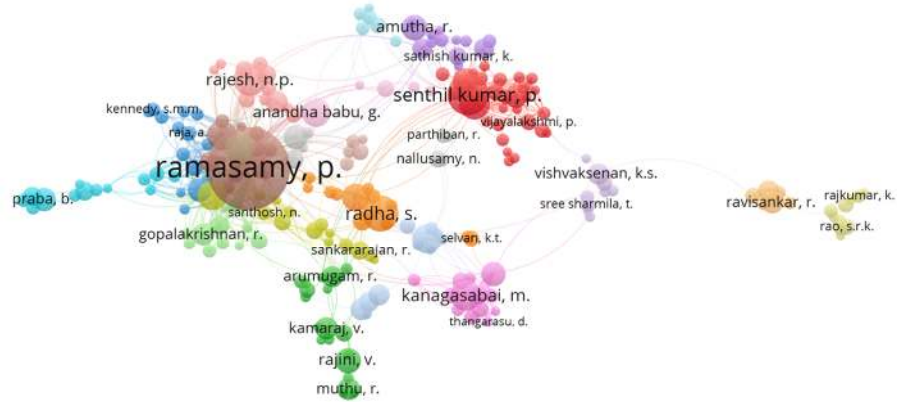
Figure 2. Pattern of Co-Authorship

Source wise Distribution

Table 7 shows that the distribution of journals based on publications on which the papers appeared indicates a high degree of scatter in terms of number of journals. The top 20 journals accounted for less than 20% of all publications output.

S.No	Name of the Source	No of Publications	Percentage (%)
1	Aip Conference Proceedings	125	3.29
2	Journal Of Crystal Growth	93	2.44

3	International Journal Of Applied Engineering Research	88	2.31
4	Advances In Intelligent Systems And Computing	62	1.63
5	IEEE Region 10 Annual International Conference Proceedings TENCON	42	1.10
6	Desalination And Water Treatment	40	1.05
7	European Journal Of Scientific Research	36	0.94
8	Lecture Notes In Mechanical Engineering	35	0.92
9	Spectrochimica Acta Part A Molecular And Biomolecular Spectroscopy	35	0.92
10	Materials Today Proceedings	32	0.84
11	Arpn Journal Of Engineering And Applied Sciences	31	0.81
12	Advanced Materials Research	30	0.79
13	Communications In Computer And Information Science	30	0.79
14	International Conference On Communication And Signal Processing Iccsp 2014 Proceedings	29	0.76
15	Multimedia Tools And Applications	27	0.71
16	Materials Letters	26	0.68
17	Optik	26	0.68
18	Cluster Computing	24	0.63
19	International Journal Of Recent Technology And Engineering	23	0.60
20	Journal Of Materials Science Materials In Electronics	23	0.60

Table 7. Ranking of Journals based on Publications

Collaborative Country

Figure 3 shows that the faculty of SSN College of Engineering collaborated most with researchers of India (3793) followed by United States 83 publications.
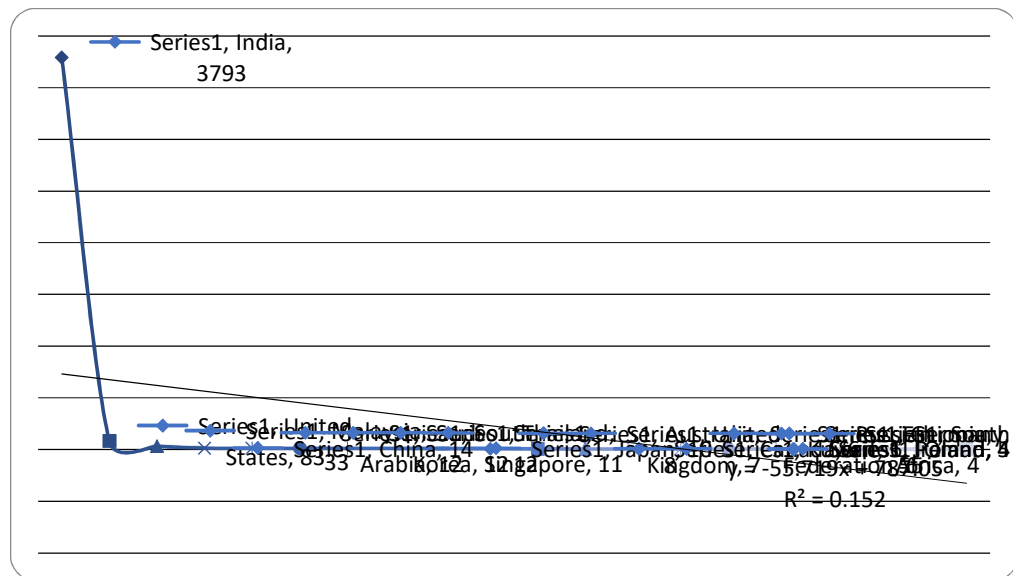
Series1, India, 3793

Series1, United States, 833
Series1, China, 14
Series1, Saudi Arabia, 12
Series1, South Korea, 12
Series1, Singapore, 11
Series1, Japan, 8
Series1, United Kingdom, 7
Series1, Germany, 5
Series1, Australia, 5
Series1, Malaysia, 5
Series1, France, 5
Series1, Canada, 4
Series1, Poland, 4
Series1, Russia, 4

$y = -556.69x + 4785.5$
$R^2 = 0.152$

Figure 3. Collaborative Countries

Collaborative Institutions

Table 8 shows that researchers from 20 institutions collaborated with the faculty of SSN College Of Engineering for more than 20 publications. Among them, Anna University stands first with 537 publications.

S.No	Collaborative Institutions	No of Publication	Percentage (%)
1	Anna University	537	14.14
2	Vellore Institute of Technology, Chennai	100	2.63
3	Sathyabama Institute of Science and Technology	71	1.87
4	Vellore Institute of Technology, Vellore	70	1.84
5	College of Engineering, Guindy	69	1.81
6	Rajalakshmi Engineering College	68	1.79
7	Indian Institute of Technology Madras	65	1.71
8	National Physical Laboratory India	56	1.47
9	Indira Gandhi Centre for Atomic Research	50	1.31
10	Sri Venkateswara College of Engineering, Sriperumbudur	44	1.15
11	St. Joseph's College of Engineering	41	1.08
12	SRM Institute of Science and Technology, Ramapuram Campus	36	0.94
13	Sri Sai Ram Engineering College, Chennai	34	0.89
14	SRM Institute of Science and Technology	31	0.81

15	KCG College of Technology	24	0.63
16	SASTRA Deemed University	23	0.60
17	Alagappa College of Technology	22	0.57
18	Anand Institute of Higher Technology	21	0.55
19	Madras Institute of Technology	20	0.52
20	Tagore Engineering College	20	0.52

Table 8. Ranking of Collaborative Institutions

Subject wise Distribution

Table 9 shows that 1930 papers were published in the broad area of 'Engineering' followed by Computer Science (1478) and Physics and Astronomy (834).

S.No	Subject Category	No. of Publications	Percentage (%)
1	Engineering	1930	50.84
2	Computer Science	1478	38.93
3	Physics and Astronomy	834	21.97
4	Materials Science	782	20.60
5	Mathematics	396	10.43
6	Chemistry	395	10.40
7	Chemical Engineering	261	6.87
8	Energy	261	6.87
9	Environmental Science	218	5.74
10	Biochemistry, Genetics and Molecular Biology	125	3.29
11	Medicine	117	3.08
12	Earth and Planetary Sciences	80	2.10
13	Business, Management and Accounting	72	1.89
14	Agricultural and Biological Sciences	70	1.84
15	Pharmacology, Toxicology and Pharmaceutics	63	1.65
16	Multidisciplinary	58	1.52
17	Decision Sciences	54	1.42
18	Social Sciences	48	1.26
19	Immunology and Microbiology	19	0.50
20	Neuroscience	14	0.36
21	Health Professions	12	0.31
22	Arts and Humanities	10	0.26
23	Psychology	5	0.13
24	Economics, Econometrics and Finance	4	0.10
25	Dentistry	1	0.02
26	Nursing	1	0.02

Table 9. Broad Areas of Publication

Keyword Distribution

Figure 4: Distribution of Keywords

Figure 4 shows the most predominant keyword used by the faculty of the institution. It also identifies proximity of the relevance keywords used in the publications.

Top Cited Papers

Table 10 shows that top 20 cited papers based on the citations received from the overall period of the study. It is evident that 2338 papers have received below 100 citations and 18 papers have received more than 100 citations. 1440 papers have not received single citations.

S.No	Authors	Title	Year	Source Title	Citation
1	Senthil Kumar P., Ramalingam S., Senthamarai C., Niranjanaa M., Vijayalakshmi P., Sivanesan S.	Adsorption of dye from aqueous solution by cashew nut shell: Studies on equilibrium isotherm, kinetics and thermodynamics of interactions	2010	Desalination	460
2	Carolin C.F., Kumar P.S., Saravanan A., Joshiba G.J., Naushad M.	Efficient techniques for the removal of toxic heavy metals from aquatic environment: A review	2017	Journal of Environmental Chemical Engineering	270
3	Panchatcharam M., Miriyala S., Gayathri V.S., Suguna L.	Curcumin improves wound healing by modulating collagen and decreasing reactive oxygen species	2006	Molecular and Cellular Biochemistry	210

4	Ravikumar K., Krishnan S., Ramalingam S., Balu K.	Optimization of process variables by the application of response surface methodology for dye removal using a novel adsorbent	2007	Dyes and Pigments	180
5	Kumar P.S., Ramalingam S., Kirupha S.D., Murugesan A., Vidhyadevi T., Sivanesan S.	Adsorption behavior of nickel(II) onto cashew nut shell: Equilibrium, thermodynamics, kinetics, mechanism and process design	2011	Chemical Engineering Journal	174
6	Pandiarajan N., Muthu R.	Mathematical modeling of photovoltaic module with Simulink	2011	2011 1st International Conference on Electrical Energy Systems, ICEES 2011	164
7	Poornachandra S.	Wavelet-based denoising using subband dependent threshold for ECG signals	2008	Digital Signal Processing: A Review Journal	164
8	Selvaraj V., Alagar M., Kumar K.S.	Synthesis and characterization of metal nanoparticles-decorated PPY-CNT composite and their electrocatalytic oxidation of formic acid and formaldehyde for fuel cell applications	2007	Applied Catalysis B: Environmental	144
9	Ravilumar K., Ramalingam S., Krishnan S., Balu K.	Application of response surface methodology to optimize the process variables for Reactive Red and Acid Brown dye removal using a novel adsorbent	2006	Dyes and Pigments	144
10	Subbaraj P., Rengaraj R., Salivahanan S.	Enhancement of combined heat and power economic dispatch using self adaptive real-coded genetic algorithm	2009	Applied Energy	132

Table 10. Top Cited Papers

Funding Sponsors

Below table represented the top 20 funding agencies for SSN College of Engineering. Table 11 is evident that Department of Science and Technology, Government of Kerala have sponsored for (86) publications followed by Department of Science and Technology, Ministry of Science and Technology, India (45), Science and Engineering Research Board (41) and so on.

S.No	Funding Sponsor	No of Publications
1	Department of Science and Technology, Government of Kerala	86
2	Department of Science and Technology, Ministry of Science and Technology, India	45
3	Science and Engineering Research Board	41
4	SSN Educational and Charitable Trust	31
5	SSN College of Engineering	28
6	Ministry of New and Renewable Energy India	17
7	All India Council for Technical Education	15
8	Bangladesh Council of Scientific and Industrial Research	14
9	Defence Research and Development Organisation	12
10	Board of Research in Nuclear Sciences	10
11	University Grants Commission	10
12	Department of Atomic Energy, Government of India	9
13	Singapore Eye Research Institute	5
14	VIT University	5
15	Department of Science and Technology, Ministry of Science and Technology	4
16	National Natural Science Foundation of China	4
17	Universiti Malaya	4
18	University Grants Committee	4
19	Council Â of Â Scientific and Industrial Research, India	3
20	Department of Science and Technology, Government of West Bengal	3

Table 11 Predominant Funding Sponsors

6 Findings

- ❖ 3796 papers were published by the faculty of SSN College of Engineering in the span of 24 years from 2003 to 2020.
- ❖ Journals are the most preferred channels followed by conference proceedings.
- ❖ The relative growth rate ranges between 1.79 to 0.88.
- ❖ The paper entitled 'Adsorption of dye from aqueous solution by cashew nut shell: Studies on equilibrium isotherm, kinetics and thermodynamics of interactions' by Senthil Kumar P., Ramalingam S., Senthamarai C., Niranjanaa M., Vijayalakshmi P., Sivanesan S. in the 'Journal of Desalination' in 2010 is the most cited paper of SSN College of Engineering and has received 460 citations as of now;
- ❖ 18 papers have received more than 100 citations and 2338 papers have received 01 to 99 citations. 1440 papers have not received single citation.

7 Conclusion

Nowadays reputation of every institution is measured based on the research output and innovation. This qualitative research work is essential to the technical institution in order to identify the areas of research need to be improved and the current position of technical advancement along with the competitive institutions in the future course of action. This qualitative work brings out the scientific productivity of the institution with respect to various parameters and to promote the weaker section of the institution. This study covers only the data existed in the Scopus database where as other citation databases for the scientific productivity can also be explored for the other quality measures. Moreover It's a prime duty of the Library Science community to explore the scientometric research for every institution and enlighten with the upcoming research areas.

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