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Scientometric Analysis of the Research Productivity of Savitribai Phule Pune University

Santosh Chaturbhuj[#] and Nandkishor Ramrao Motewar[$,*]

[#]*VPM's Maharshi Parshuram College of Engineering, Velneshwar, Ratnagiri - 415 729, India*
[$]*Knowledge Resource Centre, Gondwana University, Gadchiroli - 442 605, India*
[*]*E-mail: motewar.nankishor@gmail.com*

ABSTRACT

The study is about the Scientometric analysis of published articles under the Savitribai Phule Pune University, Pune since 2001 to 2019. Total of 6449 documents were studied. Specialisation Index and the Research Priority Index have been used for analysing the subjects and their sub-subjects Chemistry, Physics, Biology, and Engineering. The study provides an overview of research conducted by the University and tries to show the weaker and stronger areas in four major subjects. The study measures and illustrates the research efforts taken by the Savitribai Phule Pune University in comparison with research efforts taken by the Nation and the World in the same subjects. The study found 'Physics' as a specialised subject in the University which obtained 1.455 SI Index Value. The study also reveals that 'Medical Chemistry' with 333.2 PI Value in Chemistry, 'Polymer Science' with 757.87 PI Value in Physics, 'Microbiology' with 1090.51 PI Value in Biology, and 'Biotechnology Applied Microbiology' with 936.9 PI Value in Engineering have received the highest research priority and corresponds to the Nation's research productivity efforts in the same Sub-subjects. The study provides different ranking such as author's productivity, most cited authors, author's impact (h-index, g-index, m-index), most-cited journals and most contributed journals.

Keywords: Specialisation index; Priority index; h- index; g-index; m-index; University of Pune; Chemistry; Physics; Biology; Engineering

1. INTRODUCTION

Bibliometrics and Scientometrics are used to evaluate scholarly communication. These are the tools to calculate research progress quantitatively and qualitatively. Scientometric indicators have varied use to assess the research performance of authors, institutions, universities and nations. With the help of Scientometric indicators, one can easily measure the performance and growth of an institution. It is easy to understand the nature of growth in a variety of disciplines. Accordingly, an institution or government has to make its research policy. It means these indicators are "monitoring devices". There are many indices used to evaluate the performance of authors and their impact on the research field. h-index, g-index, and m-index are some of them. Some indicators that measure the performance of research productivity of a particular discipline and one can compare it at the institute level, national level, or with the world's productivity in the same discipline. The specialisation Index and Priority index are used for this purpose. In short, each institution should use these indicators to assess its own progress and nature of research activities. It helps them to understand which fields they have to focus on. In the present study, the Savitribai Phule Pune University is taken as a case study. Hereinafter SPPU stands for "Savitribai Phule Pune University".

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The Savitribai Phule Pune University, Pune (SPPU) is one of the oldest educational centres of Maharashtra and one of the premier universities in India. It was established on 10th February 1949. The University has 46 academic departments and 307 recognised research institutions. The present study evaluates the research activity conducted by this University since 2001 to 2019. The study provides an assessment of research activity in general as well as Chemistry, Physics, Biology and Engineering in particular.

2. LITERATURE REVIEW

There are many research scholars who conducted Scientometrics research on different Universities from India. Some of those well-known studies are referred to for the present study.

Maharana, Rabindra K. (2013)[1] published paper entitled "A bibliometric analysis of research output of Sambalpur University's publication in ISI Web of Science during 2007-2011'. The study revealed that 29.41 per cent of the publications are four authored publications, and it is the highest in the University. 'Chemistry' is the most productive subject with 27.65 per cent contribution. The highest research articles published in 'Astrophysics and Space Science Journal'. B.K. Mishra is the most productive author with 16.47 per cent publications to the whole published literature from the University.

Singh, Monika and Kumar, Amit (2019)[2] studied, "Measuring the research output of the University of Delhi: A Bibliometric Study." This study deals with the research productivity of the University of Delhi from 1989 to 2018. The study shows that in 2017 the highest output with 1494 publications was published by the University of Delhi. The Council of Scientific Industrial Research (CSIR) India has the highest publications with 8.080 per cent in a total publication. 'USA' is the most collaborative country with the University of Delhi. 'Chemistry' is the most productive subject at the University. This study gives the rank of productive authors. It also reflects the highest cited papers with its ranks.

Nagarajan, M. (2016)[3] studied the research output in Science from Tamil Nadu Universities. The study compared 12 Universities' research output published since 1991 to 2015. It gives year-wise output as well as subject-wise output. According to the study, the most productive subject is 'Chemistry' and 'Anna University published the highest publications i.e., 1660 in Chemistry. The study shows that the highest collaboration is with the USA with 24.60 per cent of publications. The doubling time for publication in Tamil Nadu Universities is 7.7.

Swain, Dilip K., Rautaray, Bijaylaxmi, and Swain Chandrakanta (2013)[4], Studied the Scientometrics dimension of research productivity of the KIIT University, Odisha. The study examined the degree of collaboration and it is found to be 0.93. In the year-wise analysis of research productivity, it is found that the highest productivity was found in 2017 with 107 published articles. Veena Goswami received the highest citations 77 and the highest h-index i.e., 5. The United States is the highest collaborative country with the University.

Khanna, Sunaina[5], *et.al.*, investigated the Scientometric analysis of the research output of Guru Nanak Dev University during 2006-15 in Physics and Astronomy. The study gives an overview of the research productivity of all Indian universities and Guru Nanak Dev University, Amritsar is in the 23rd rank. The study reveals a 9.6 per cent annual growth rate. Out of 652 publications during the study period, 108 means 16.56 per cent of publications are from the Physics and Astronomy Subject.

Sunil Kumar Yadav, Manoj Kumar Verma, and S.N. Singh (2020)[6] studied the research productivity of Mizoram University based on the data collected from the Indian Citation Index for 14 years from 2004-2017. The study reveals that the average research output is 18.93 articles per year. The most productive author was U. K. Sahoo from the department of Forestry with 25 publications. The highest-ranking publication was Current Science with 16 publications. The highest publications have been given by Biological Science subject which are 54 and the most preferred documents are 230 by the scientists of Mizoram University during 2004-2017

R. Santhakumar, K. Kaliyaperumal, and S. Louies (2020)[7] published a paper entitled "Scientometric Profile of the University of Madras: The Mother of South Indian Universities" The research paper presented the research productivity of the Madras University for a period of ten years, i.e., from 2009 to 2018. The result of the study shows that the h-index of the University was 65 during the study period. The major findings of the study report that the university produces a greater number of papers in the field of chemistry and the researchers preferred to publish their research output in UK journals.

3. OBJECTIVES OF THE STUDY

The main objective is to analyse the research output of Savitribai Phule University of Pune from 2001 to 2019 with the help of Scientometrics indicators. In particular, the study focuses on

- To analysis the year-wise productivity of the SPPU
- To compare the SPPU's productivity with India's productivity as a whole
- To understand the research priority of different sub-subjects within the University
- To compare the research priority of the University with India's research priority
- To compare the status of the subject's specialisation of the University with India and India's specialisation with World
- To know the ranks related to authors, relevant journals.

4. RESEARCH METHODOLOGY

The data is collected from the Web of Science database. For the data collection, three search terms, i.e., "The University of Pune" OR "Univ. Pune" OR "Savitribai Phule Pune University" are used. The data is derived from the 'Organisation Enhanced' option. Duration is selected from 2001 to 2019. In short, the present study is limited to all the publications published and indexed in Web of Science in the name of SPPU only. The data is downloaded in plain text format. Bibexcel and Excel software are used to extract data from the plain text for further analysis. R-programming software is also used during the study.

Following are the important Scientometrics indicators used for quantitative and qualitative analysis of research productivity of Savitribai Phule Pune University.

4.1 Specialisation Index

Specialisation Index[8-9] indicator is used to understand the specialised discipline or subject in which a region, a country is having greater research output than in all other disciplines. The specialisation index stated that an aggregate is said to be specialised when it produces more in a specific discipline than in all other disciplines. SI is obtained with the following formula

$$SI=(Xa/Xt)/(Ya/Yt)$$

Where, Xa=Number of publications by group 'X' in discipline 'a'. Ya= Number of articles published by group Y in discipline 'a'. Xt= Total number of articles published by reference group 'X'. Yt= Total number of articles published by reference group 'Y'.

In the above formula group, 'X' is always a subset of group 'Y'. If the answer of the indicator is higher than 1.0, it indicates that 'X' is specialised in relation to 'Y' and if the answer is lower than 1.0, it means group 'X' has not specialised in the discipline 'a'.

In the present study, this indicator was used in two paired groups. One is the publication of Savitribai Phule Pune University considered as 'X' and the publication of India

considered as 'Y'. In the second pair, the publication of India is considered as 'X' and the publication of World in same discipline is considered 'Y'. 'a' include disciplines such as 'Chemistry', 'Physics', 'Biology' and 'Engineering'.

Table 1. Document wise distribution of published materials

Document Type	Records	% of 6449	Citation	% of 141833
Article	5722	88.73	125249	88.31
Review	240	3.72	13147	9.27
Proceedings Paper	213	3.30	2924	2.06
Meeting Abstract	94	1.46	6	0.00
Editorial Material	68	1.05	224	0.16
Letter	46	0.71	260	0.18
Correction	27	0.42	16	0.01
Book Review	21	0.33	1	0.00
Biographical-Item	8	0.12	0	0.00
News Item	5	0.08	5	0.00
Poetry	3	0.05	0	0.00
Film Review	1	0.02	1	0.00
Retraction	1	0.02	0	0.00
	6449	100	141833	100

4.2 Priority Index

The Priority Index[10] is similar to the Specialisation index. It provides the research priority of a country, an institution, or a university to emphasise the efforts on given sub-fields. The priority index was obtained with the help of the following formula:

PI=(nij/nio)/(noj/noo) X 100

Where nij= the number of publications of the country 'i' in subject field 'j'. nio= the number of publications of the country 'i' in all sub-fields. noj = the number of publications of all countries in the sub-field 'j'. noo= the number of publications of all countries in all sub-fields.

If the priority index denotes PI= 100, it means the research priority of a country for a given sub-fields, corresponds to the average of all countries. If PI>100 it means higher than average and If PI<100, it means lower than average. The nation has to emphasise its research efforts to lower the Priority Index. No country has a higher priority in all sub-fields of a discipline. In the present study, the priority index of sub-subjects studied at the University and National levels.

5. DATA ANALYSIS

5.1 The Document Wise Distribution of the Publications

The Savitribai Phule Pune University (SPPU) published 6449 different types of documents since 2001 to 2019. Table 1

Table 2. Year-wise distribution of publications

Publication years	Records	% of 6449	Citations	141833%	ACPI	ACPCY	Citation received in published year	Immediacy index
2001	126	1.95	2854	2.01	0.04	150.21	22	0.17
2002	135	2.09	4683	3.30	0.03	260.17	20	0.15
2003	136	2.11	6052	4.27	0.02	356.00	29	0.21
2004	150	2.33	4690	3.31	0.03	293.13	42	0.28
2005	189	2.93	5671	4.00	0.03	378.07	37	0.20
2006	250	3.88	8165	5.76	0.03	583.21	102	0.41
2007	261	4.05	6997	4.93	0.04	538.23	72	0.28
2008	288	4.47	7463	5.26	0.04	621.92	65	0.23
2009	297	4.61	8372	5.90	0.04	761.09	100	0.34
2010	348	5.40	10090	7.11	0.03	1009.00	162	0.47
2011	339	5.26	7030	4.96	0.05	781.11	105	0.31
2012	355	5.50	7076	4.99	0.05	884.50	173	0.49
2013	363	5.63	7216	5.09	0.05	1030.86	181	0.50
2014	393	6.09	7778	5.48	0.05	1296.33	442	1.12
2015	413	6.40	7151	5.04	0.06	1430.20	212	0.51
2016	600	9.30	18673	13.17	0.03	4668.25	1754	2.92
2017	578	8.96	8500	5.99	0.07	2833.33	376	0.65
2018	564	8.75	9593	6.76	0.06	4796.50	430	0.76
2019	664	10.30	3779	2.66	0.18	3779.00	515	0.78
Total	6449	100	141833	100	0.05	7464.89	NIL	NIL

expressed the fact that the most prominent publications are in the form of articles. SPPU has published 5722 research articles, which is 88.73 per cent of the total publications. These research articles have received 125249 citations within a 19-year span. The second preferred type of document is review articles. SPPU has published 240 review articles. Though review articles are less in number, they have received 13147 citations, which is 9.27 per cent of the total citations. It means that the contents of review articles are highly recognised by research scholars. The proceeding paper is one more important form of a document published by SPPU. It has 213 publications in the form of proceeding papers with 3.30 per cent of the total.

5.2 Year-wise Distribution of Publications

SPPU has published total 6449 documents in different forms from 2001 to 2019. The year-wise distribution is given in Table 2. It depicts the chronological development of research conducted by SPPU. As the Table 2 shows, the number of publications is continuously increasing. It started with 126 documents in 2001 and reached 664 papers in 2019. It means SPPU has an increasing pattern of research productivity.

Citation conveys the value and quality of any research documents. The usefulness depends on the citations received by the documents. SPPU has received 141833 citations for 6449 documents during 19 years. It means articles of SPPU have received 0.05 average citations per article and 7464.89 average citations per year.

SPPU has received the highest number of citations in 2016, which is 18673 citations. It is a 13.17 per cent contribution to the total citations received by SPPU. The numerical data of citations clearly indicates that the research activity of SPPU is continuously recognised by the world with some fluctuations. The highest citations per document are found in 2019 with a 0.1 2019 with 0.18 ACPI value and the lowest found in 2003 with 0.02 ACPI value. The ACPCY means average citations per citable year. It means the citable year is different for every year. The documents published in 2001 has 19 years of opportunity to receive citations. So, they have 19 years citable years span. On the contrary, the articles published in 2019 have only a one-year citable span. So, the column of the table ACPCY evaluates how many average citations received by documents per year within the citable span. Accordingly, the highest citations per citable year received in 2018 with 4796.50 ACPCY values. It means these articles have received citations on a large scale within two years of the citation span. The articles published in 2016 have received 4668.25 ACPCY values, which means every citable year, they have received 4668.25 citations. It shows the high quality of research published during this year.

Table 2 represents the data, how fast the publications are visible by the scholarly community. This visibility is measured by the citations received in the publication year. The highest visibility is shown by the publications published in the year 2016 with 1754 citations and 2.92 Immediacy Index values. It means that SPPU has published 600 publications in 2016 and within the same year, these 600 articles received 1754 citations and the ratio between the two is 2.92 which is called the Immediacy Index. Higher the Immediacy Index, the higher the visibility of research publications. The publications from 2014 have 1.12 Immediacy index values, which is notable. It is observed that SPPU publications have shown an increasing pattern of immediacy index with some fluctuations.

5.3 Specialisation Index

The study evaluates the comparison between the research productivity of the Savitribai Phule Pune University with the research productivity of India with four main disciplines, i.e., Chemistry, Physics, Biology and Engineering. The study also deals with the comparison between India's research productivity with the world's productivity. The highest specialisation index value found in the Biology subject is 1.662 SI Values. It implies that Biology is the highest research-productive department in which research efforts correspond with India's research efforts in the subject. SPPU has 1.318 SI values in Engineering subjects, which is more than 1. It indicates that SPPU has corresponded its research efforts with India. Table 3 represents that Physics and Chemistry have 0.980 and 0.686 specialisation index values respectively, which is less than 1. This means the research efforts taken by the Savitribai Phule Pune University in Physics and Chemistry subjects are not specialised as compared to the nation's research effort in the same subjects. The University has to take enough effort to increase productivity in these disciplines.

Table 3 shows that India has found correspond in research efforts with the World in Physics and Chemistry subjects as these subjects have 1.295 and 1.235 SI values. It's clear from the data that SPPU has a corresponding SI value in Biology in comparison with India, but in comparison with the World, India does not represent itself in the research of Biology because it has only a 0.452 SI value. So that India has to take many efforts in this field. The research in Engineering at the national level does not correspond with the World as it has only 0.860 SI Values. Specialisation Index talks about the general development of research in a particular field. To understand the research development in sub-subjects of a particular field one has to think about the priority index. This index helps to understand the weaker and stronger areas of a particular subject.

Table 3. Specialisation index of main subjects

Name of main subject	No. paper published (2001-2019)				
	SPPU	India	SI of SPPU	World	SI of India
Chemistry	2028	259083	0.686	3711911	1.235
Physics	2737	244736	0.980	3343300	1.295
Biology	1317	69433	1.662	2718689	0.452
Engineering	1903	126492	1.318	2602771	0.860
Total	7985	699744	NIL	12376671	NIL

Note: - The total publication count of SPPU in this table is increased because some research papers belong to more than one subject.

5.4 Priority Index Distribution Found in the Sub-subjects of Chemistry

There are 7 sub-subjects on which the priority index is applied. The data from Table 4 shows that the highest priority

Table 4. Priority index distribution found in the sub-subjects of chemistry

Name of sub-subjects in Chemistry	No. paper published (2001-2019)				
	SPPU	India	PI of SPPU	World	PI of India
Chemistry Physical	674	67420	127.715	977777	98.789
Chemistry Multidisciplinary	528	65062	103.676	1363170	68.381
Chemistry Organic	331	50379	83.936	370811	194.651
Chemistry Medical	156	5981	333.213	90644	94.535
Chemistry Analytical	117	24480	61.058	418245	83.857
Chemistry Inorganic Nuclear	147	25925	72.439	241295	153.932
Chemistry Applied	75	19836	48.303	249969	113.691
Total	2028	259083	NIL	3711911	NIL

Table 5. Priority index distribution found in the sub-subjects of Physics

Name of sub-subjects in Physics	No. paper published (2001-2019)				
	SPPU	India	PI of SPPU	World	PI of India
Physics Applied	642	45660	125.725	1026891	60.742
Physics Condensed Matter	440	31942	123.172	553539	78.830
Astronomy and Astrophysics	367	7063	464.622	104055	92.726
Physics Atomic Molecular Chemical	302	15169	178.022	298901	69.328
Nanoscience Nanotechnology	292	88117	29.631	212503	566.464
Physics Multidisciplinary	154	19521	70.541	427846	62.329
Optics	113	5568	181.469	150066	50.687
Physics Particles Fields	107	12933	73.979	221484	79.769
Polymer Science	89	1050	757.921	25107	57.131
Physics Fluids Plasmas	67	7501	79.869	155983	65.693
Physics Nuclear	65	8382	69.341	138902	82.436
Crystallography	59	1280	412.159	18709	93.462
Thermodynamics	40	550	650.310	9314	80.668
Total	2737	244736	NIL	3343300	NIL

index found in Medical Chemistry with 333.21 PI Value. It means SPPU is one of the leading universities in the research of Medical Chemistry in India. There are sub-fields of Chemistry like Physical Chemistry and Multidisciplinary Chemistry that correspond to the nation in terms of research productivity with 127.72 and 103.68 PI values respectively. The lowest research efforts were found in Applied Chemistry with 48.30 PI Values. SPPU has to take many efforts in Applied Chemistry (48.30), Analytical Chemistry (61.06), Inorganic Nuclear Chemistry (72.44), and Organic Chemistry (83.94). These are the sub-fields of chemistry that have PI values less than 100. It means research in these sub-fields does not correspond with the nation.

Table 4 enumerates the research status of India in comparison with the World. It's clear from the data that India corresponds with the World's research efforts in Organic Chemistry (194.65), Inorganic Nuclear Chemistry (153.93), and Applied Chemistry (113.69). It provides the information that India is one of the prominent countries in these sub-fields of Chemistry. India has to take much effort to promote the research efforts in the weaker sub-fields of Chemistry like Multi-disciplinary Chemistry (68.38), Analytical Chemistry (83.86), and Medical Chemistry (94.54).

5.5 Priority Index Distribution found in the Sub-subjects of Physics

There are 13 sub-subjects of Physics on which a priority index is applied. Polymer Science is a sub-field of Physics in which SPPU corresponds the research output with the nation. It has 757.92 PI values. Actually, the productivity of SPPU in Polymer Science is 89 publications only. But the productivity of the Nation is 1050 publications in 19 years. That's why it corresponds with the Nation's productivity. The same nature is found in Thermodynamics (40 publications and 650.31 PI Value) and Crystallography (59 publications and 412.16 PI value). The prominent research areas in SPPU are Optics (154 publications and 181.47 PI value), Astronomy, and Astrophysics (367 Publications and 464.622 PI value), Applied Physics (642 publications and 125.73 PI value), and Physics-Condensed Matter (440 publications and 125.73 PI value). Nanoscience and Nanotechnology have very few publications by SPPU. So, the University has to take many efforts to enhance research activity in this sub-field.

While comparing the productivity of sub-fields of Physics between India and the world, it comes to know that India's research efforts correspond to the world only in Nanoscience Nanotechnology (88117 publication and 566.46 PI value). It means that India is one of the leading countries that conduct research in this sub-field of Physics. The other 12 sub-fields of Physics are having less PI values than 100. It means India is lacking behind the World in these sub-fields of Physics. The lowest PI value found in Polymer Science (1050 publications and 57.13 PI value). India has to take major steps to enhance the research culture in different sub-fields of Physics.

5.6 Priority Index Distribution found in the sub-Subjects of Biology

There are 7 sub-fields of Biology on which the Priority Index is applied. SPPU has found the highest PI value in

Table 6. Priority index distribution found in the sub-subjects of biology

Name of sub-subjects in Biology	No. paper published (2001-2019)				
	SPPU	India	PI of SPPU	World	PI of India
Biochemistry Molecular Biology	391	39593	52.064	1329904	116.571
Biotechnology Applied Microbiology	317	4983	335.389	128823	151.458
Plant Science	147	2828	274.043	66499	166.517
Microbiology	145	701	1090.511	31395	87.428
Biophysics	138	7957	91.434	172057	181.080
Cell Biology	95	11601	43.173	775931	58.542
Biology	84	1770	250.199	214080	32.374
Total	1317	69433	NIL	2718689	NIL

Table 7. Priority index distribution found in the sub-subjects of engineering

Name of sub-subjects in Engineering	No. paper published (2001-2019)				
	SPPU	India	PI of SPPU	World	PI of India
Material Science Multidisciplinary	857	22793	249.921	361535	129.725
Biotechnology Applied Microbiology	317	2249	936.902	27269	169.704
Engineering Electrical Electronics	200	41147	32.308	935712	90.483
Environmental Science	188	7055	177.127	161286	90.006
Instruments Instrumentation	122	3618	224.138	114063	65.267
Engineering Chemical	91	26801	22.569	559386	98.585
Engineering Environmental	52	9551	36.189	213150	92.201
Food Science Technology	48	653	488.599	11493	116.910
Engineering Multidisciplinary	28	12625	14.742	218877	118.687
Total	1903	126492	NIL	2602771	NIL

Microbiology (145 publications and 1090.51 PI values). It again finds out that both SPPU and India have very few publications in this sub-field, that's why the PI value of SPPU is shown much higher than others. But it is true that SPPU has one of the prominent institutes where research in Microbiology is done. Other prominent sub-fields of Biology in which SPPU corresponds to the Nation are Biotechnology Applied Microbiology (317 publications and 335.39 PI value), Plant Science (147 publications and 274.04 PI value), and Biology in general (84 publication and 250.20 PI value). SPPU has the lowest PI value in Cell Biology (95 publications and 43.17 PI value). Biophysics (138 publications and 91.43 PI value) is also one of the weaker sub-subjects in which SPPU has to take initiative to develop a research culture.

Comparing India's output with the world's output in the sub-subjects of Biology, it is found that the highest PI value is obtained by Biophysics (7957 publications and 181.08 PI value). It means that India is one of the leading countries that have produced higher publications in Biophysics. Other sub-fields in Biology like Plant Science (2828 publications and 166.52 PI value), Biotechnology and Applied Microbiology (4983 publications and 151.46 PI value), and Biochemistry Molecular Biology (39593 publications and 116.57 PI value). India has very less research done in Cell Biology (11601 publications and 58.542 PI value) and Biology in general (1770 publications and 32.374 PI value). The data concluded the fact that SPPU is much similar to India in nature of productivity and research efforts. It is much better in position only in terms of Microbiology and biology in general

5.7 Priority Index Distribution found in the Sub-subjects of Engineering

There are 9 sub-subjects in Engineering on which the Priority Index is used to evaluate the research efforts undertaken by SPPU and India. Table 7 shows that the highest PI value obtained by Biotechnology Applied Microbiology (317 publications and 936.90 PI value). It means in the field of Technology, SPPU is one of the dominant institutions in the research of Biotechnology Applied Microbiology. Food Science Technology is the second highest sub-field with 488.60 PI value. SPPU published only 48 documents in 19 years. It shows that the productivity of India is also very low in Food Science Technology. Other sub-fields in Engineering which have PI value higher than 100 are Material Science Multidisciplinary (857 publications and 249.92 PI value), Instruments Instrumentation (122 publications and 224.14 PI value) and Environmental Science (188 publications and 177.13 PI value). Engineering multidisciplinary (28 publications and 14.74 PI value) has obtained the lowest PI value. It means SPPU is lacking in multidisciplinary Engineering subjects like Mechatronics, Artificial Intelligence etc.

Comparing India's output with the World's, it is found that India has the highest PI value in Biotechnology Applied Microbiology (2249 publications and 169.70 PI value). Other prominent research areas in Engineering at National level are Material Science Multidisciplinary (22793 publications and 129.73 PI value), Engineering Multidisciplinary (12625 publications and 118.69 PI value) and Food Science Technology (653 publications and 116.91 PI value). To conclude, it is found that both SPPU and India have followed the same pattern of development in research. The exceptions between two are found in Engineering Multidisciplinary (SPPU- 14.74 and India-118.69 PI value), Instruments Instrumentation (SPPU-224.14 and India-65.27 PI value) and Environmental Science (SPPU-177.13 and India-90.01 PI value).

5.8 Ranking of Authors as per Productivity

Total 9996 authors contributed 6449 publications in SPPU. Among these authors, Table 8 shows the 50

Table 8. Ranking of authors as per productivity

Name of author	Publication	% of 6449	Citations	% of 141833	Rank
More MA	180	2.79	3950	2.78	1
Gejji SP	131	2.03	1549	1.09	2
Dhavale DD	117	1.81	2665	1.88	3
Dhole SD	116	1.80	1349	0.95	4
Bhoraskar VN	112	1.74	1230	0.87	5
Padhye S	105	1.63	3678	2.59	6
Bhoraskar SV	101	1.57	2435	1.72	7
Mathe Vl	95	1.47	1723	1.21	8
Gosavi SW	93	1.44	2396	1.69	9
Kulkarni SK	90	1.40	4668	3.29	10
Shouche YS	87	1.35	2240	1.58	11
Gadre SR	83	1.29	3326	2.35	12
Joag DS	82	1.27	2702	1.91	13
Late DJ	81	1.26	2705	1.91	14
Kanhere DG	75	1.16	2080	1.47	15
Chopade BA	72	1.12	3285	2.32	16
Aiyer RC	70	1.09	1314	0.93	17
Singh S	69	1.07	1578	1.11	18
Jadkar SR	69	1.07	1366	0.96	18
Chakraborty S	68	1.05	1137	0.80	19
Kale BB	68	1.05	1776	1.25	19
Patwardhan B	68	1.05	2414	1.70	19
Padmanabhan T	64	0.99	4285	3.02	20
Pathan HM	64	0.99	610	0.43	20
Mahamuni S	63	0.98	1664	1.17	21
Kumar A	62	0.96	1311	0.92	22
Athawale AA	60	0.93	1617	1.14	23
Zinjarde S	59	0.91	1980	1.40	24
Chaure NB	52	0.81	663	0.47	25
Ghosh S	51	0.79	2966	2.09	26
Patil SI	51	0.79	1086	0.77	26
Kumar AR	50	0.78	2050	1.45	27
Salunke-Gawali S	50	0.78	551	0.39	27
Kodam KM	49	0.76	1035	0.73	28
Daftardar-Gejji V	48	0.74	2441	1.72	29
Sangode SJ	48	0.74	436	0.31	29
Joshi K	47	0.73	1406	0.99	30
Kumbhar AS	47	0.73	872	0.61	30
Nikam TD	47	0.73	677	0.48	30
Patole MS	47	0.73	1167	0.82	30
Haram SK	45	0.70	1002	0.71	31
Lokhande PD	42	0.65	698	0.49	32
Mitra S	42	0.65	11803	8.32	32
Puranik VG	42	0.65	1073	0.76	32
Patil S	41	0.64	1049	0.74	33
Bhargava S	41	0.64	796	0.56	33
Gosavi S	41	0.64	490	0.35	33
Kolekar YD	41	0.64	1267	0.89	33
Deobagkar DD	40	0.62	582	0.41	34
Joshi R	40	0.62	1069	0.75	34

most productive authors with the highest to lowest contribution in research. According to the data, More, M.A. has the highest contribution with 182 research papers from SPPU, which is 2.79 per cent contribution of the total. He received 3950 citations for 180 papers. This author is from the Department of Physics at SPPU. He has the highest three co-authorship papers with Joag DS (68 Publications), Late DJ (64 Publications), and Suryawanshi SR (35 publications). He contributed to the applied Physics with 83 Publications. The second and third-ranked authors are Genjji SP (131 publications and 1549 citations), and Dhavale DD (117 publications and 2665 citations). Genjji SP has the three highest co-authored authors are Lande DN (25 publications), Pinjari (20 publications), and Dhumal NR (19 publications). He is from the Department of Chemistry at SPPU. He has the highest contribution in Physical Chemistry with 99 publications. Dhavale DD, the third-highest contributed author is from the Department of Chemistry at SPPU. He has the three highest co-authored authors are Chopade BA (16 publications), Puranik VG (15 publications), and Sabharwal (14 publications). He has the highest contribution in Organic Chemistry with 86 publications.

5.9 Author's Impact on Research

The publications of authors are referred by different research scholars for their study. This is called the citation received by the referred author. The value of the published document depends upon the citations received by an author or a document. The higher the citation, the higher the impact of an author. But many things like duration of publication, number of publications, affect the citation, that's why there are many indicators available to assess the impact of an author over the field. The impact of authors' research activity on the world's research culture can be assessed with three important Scientometrics Indicators which are h-Index, g-Index, and m-Index. In the present study, Table 9 shows that the highest two authors have received 34 h-index. h-index is calculated by arranging all publications of an author in descending order and the highest number of publications that received equal or more than equal citations has the h-index of that author. The author Padhye S. and Kulkarni SK have 34 h-index, which means both have 34 publications with at least 34 citations received by each paper. Table 9 provides the information that out of 30 authors, 28 authors have 30 h-index. It means they have published minimum 30 publications each and have received 30 citations to each paper.

Table 9 shows that 'Kulkarni S.K.' is the author who has the highest g-index (64) and 'Padmanabhan, T.' has received the second rank with 62 g-index scores. As the g-index is more dependent on citation score, it has shown precisely the research impact of that author on the research field. m-index is the higher version of the h-index. It is the average of low and high citations received during a long period of the career. It includes

Table 9. Author impact: h-index, g-index and m-index

Name of author	h-index	Rank	Name of author	g-index	Rank	Name of Author	m-index	Rank
Padhye S	34	1	Kulkarni SK	67	1	Calabrese E	4.67	1
Kulkarni SK	34	1	Padmanabhan T	64	2	Ducout A	4.67	1
More MA	33	2	Padhye S	58	3	Elsner F	4.67	1
Aumont J	33	2	Gadre SR	56	4	Levrier F	4.67	1
Baccigalupi C	33	2	Chopade BA	56	4	Pettorino V	4.67	1
Banday AJ	33	2	More MA	52	5	Savelainen M	4.67	1
Benabed K	33	2	Ghosh S	51	6	Harrison DL	4.67	1
Bersanelli M	33	2	Joag DS	49	7	Lattanzi M	4.50	2
Burigana C	33	2	Late DJ	49	7	Wehus Ik	4.50	2
Colombo LPL	33	2	Patwardhan B	48	8	Galli S	4.33	3
De Bernardis P	33	2	Daftardar-Gejji V	48	8	Maggio G	4.17	4
De Zotti G	33	2	Bhoraskar SV	46	9	Fraisse AA	4.17	4
Dupac X	33	2	Gosavi SW	46	9	Combet C	4.17	4
Ensslin TA	33	2	Kumar AR	45	10	Curto A	4.00	5
Eriksen HK	33	2	Dhavale DD	44	11	Gonzalez-Nuevo J	4.00	5
Finelli F	33	2	Shouche YS	44	11	Herranz D	4.00	5
Frailis M	33	2	Zinjarde S	43	12	Jaffe Ah	4.00	5
Galeotta S	33	2	Mitra S	42	13	Keskitalo R	4.00	5
Gorski KM	33	2	Kanhere DG	41	14	Pagano L	4.00	5
Gruppuso A	33	2	Kale BB	40	15	Remazeilles M	4.00	5
Kurki-Suonio H	33	2	Mahamuni S	39	16	Roudier G	4.00	5
Lamarre JM	33	2	Athawale AA	39	16	Benoit-Levy A	4.00	5
Lasenby A	33	2	Aumont J	39	16	Mortlock D	4.00	5
Lilje PB	33	2	Baccigalupi C	39	16	Pasian F	4.00	5
Lopez-Caniego M	33	2	Banday AJ	39	16	Stolyarov V	4.00	5
Macias-Perez JF	33	2	Benabed K	39	16	Davies Rd	4.00	5
Mandolesi N	33	2	Bersanelli M	39	16	Bielewicz P	3.88	6
Matarrese S	33	2	Burigana C	39	16	Kisner Ts	3.88	6
Montier L	33	2	Colombo LPL	39	16	Migliaccio M	3.88	6
Morgante G	33	2	De Bernardis P	39	16	Keihanen E	3.88	6

a total year of research as a third variable. So that it indicates the author's impact more precisely. As per the data indicated in Table 9, the first seven authors received 4.67 m-index scores. They are 'Calabrese, E.', 'Ducout, A.', 'Elsner, F.', 'Leverier, F.', 'Pettorino, V.', 'Savelainen, M.', 'Hrrison, D.L.

5.10 Most Relevant Journals for Publication used by Authors of SPPU

Table 10 shows the data of journals in which authors of the Savitribai Phule Pune University published their articles. According to the data given in Table 10, the most preferred journal by the authors is 'Current Science' with 118 articles. Similarly, 'Monthly Notices of the Royal Astronomical Society' have the same number of articles published. So, both have received the first rank. The second-rank journal is 'RSC Advances' with 88 articles. Table 10 represents the first 30 journals with the first 22 ranks.

Table 10. Most relevant journals for publication used by authors of SPPU

Published Sources	Articles	Rank
Current Science	118	1
Monthly Notices of The Royal Astronomical Society	118	1
RSC Advances	88	2
Journal of Materials Science-Materials in Electronics	81	3
Journal of Physical Chemistry A	66	4
Astronomy & Astrophysics	63	5
PLOS One	51	6
Applied Surface Science	50	7
Journal of Chemical Physics	48	8
Tetrahedron Letters	48	8
Journal of the Geological Society of India	47	9
Scientific Reports	46	10
Physical Review B	45	11
Materials Letters	42	12
Journal of Physical Chemistry C	40	13
Journal of Alloys and Compounds	39	14
Physical Review D	39	14
Bioorganic & Medicinal Chemistry Letters	38	15
Applied Physics Letters	37	16
Chemistry Select	36	17
Nuclear instruments & methods in Physics research Section B-Beam interactions with materials and atoms	36	17
Journal of Applied Physics	35	18
Journal of Nanoscience and Nanotechnology	35	18
Journal of Molecular Structure	34	19
Materials Research Express	34	19
New Journal of Chemistry	34	19
Astrophysical Journal	33	20
Physical Review E	32	21
Synthetic Communications	32	21
Journal of Biosciences	30	22

6. CONCLUSIONS

The study reveals the strength and weaknesses of research policies and efforts taken by the Savitribai Phule Pune University. It is also focusing on the comparison of Indian productivity with the World's research productivity in selected disciplines. Following are the major finding discovered in the study.

- The study reveals that the SPPU has published 5722 articles from 2001 to 2019, which is 88.31 per cent of the total contribution
- SPPU has shown continuous year-wise productivity in publications and the highest found in 2019 with 664 publications
- Total 141833 citations received by the SPPU publications and the highest average citations per item found in 2019 with 0.18 ACPI value
- The highest citations received in 2016 with 18673 and the highest average citations per citable year received in 2018 with 4796.50 ACPCY value
- SPPU publications have shown an increasing pattern of immediacy index with some fluctuations and the highest 2.92 immediacy index found in 2016
- SPPU has published the highest number of papers in Physics with 2737 publications. But Biology is the highest subject which obtained 1.66 SI value. It means research efforts taken by SPPU corresponds to India in Biology and Engineering subjects
- Priority index in sub-subjects of Chemistry reveals the fact that Medical Chemistry is the most prominent sub-field with a 333.21 PI value. It reveals that SPPU has corresponded its research productivity with India in the sub-subjects of Chemistry like Medical Chemistry, Physical Chemistry, and Multidisciplinary Chemistry
- SPPU has the highest publications in Applied Physics with 642 Publications. SPPU has corresponded with India in the sub-subjects like Polymer Science (757.92 PI value), Thermodynamics (650.31 PI Value), Astronomy, and Astrophysics (464.62 PI value), Crystallography (412.16 PI value)
- The highest publications in the sub-subjects of Biology found in Biochemistry Molecular Biology with 391 publications. SPPU has prominent sub-subjects like Microbiology (1090.51 PI Value), Biotechnology Applied Microbiology (335.39 PI Value), Cell Biology (250.20 PI Value), and Plant Science (274.04 PI Value) in Biology in which it corresponds to India
- The sub-subjects in Engineering like Biotechnology Applied Microbiology (936.90 PI value), Food Science Technology (488.50 PI Value), Instruments Instrumentation (224.14 PI Value), Material Science Multidisciplinary (249.92 PI Value), and Environmental Science (177.127 PI Value) have prominent research areas in SPPU and it corresponds to India in research productivity
- India is one of the prominent countries in Physics (1.30 SI Value) and Chemistry (1.24 SI value). In the sub-subject analysis, it is found that India corresponds to the World in Organic Chemistry (194.65 PI value), Nanoscience and Nanotechnology (566.46 PI value), Biophysics (181.08 PI value), and Biotechnology Applied Microbiology (169.70 PI value)
- More MA is the most productive author in SPPU who has 180 publications and received 3950 citations. Padhye S and Kulkarni SK have the highest h-index (34). Kulkarni SK and Padmanabhan T. have received 67 and 64 g-index accordingly
- Current Science is the highest preferred journal by SPPU authors with 118 articles published in it.

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CONTRIBUTORS

Mr Santosh Chaturbhuj is currently working as a College Librarian at VPM's Maharshi Parshuram College of Engineering, Velneshwar, Maharashtra. His area of interest is Bibliometrics and Scientometrics Analysis, Library automation with KOHA, and Digital Library Software Dspace.
He has contributed to the study by data collection and data analysis.

Mr Nandkishor Ramrao Motewar is currently working as the Director, Knowledge Resource Centre, Gondwana University, Gadchiroli, Maharashtra. His area of interest is E-Resource Management, Library Automation, Reference Management Tools, and Academic Library Management.
He has contributed to the study by review of literature and interpretation of results and discussions.