

SCIENTOMETRIC ANALYSIS OF RESEARCH CONTRIBUTIONS OF MAHARSHI DAYANAND UNIVERSITY (ROHTAK) FROM 2011-2021

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ABSTRACT -

The present paper assesses the research growth and impact of Maharshi Dayanand University (MDU), Rohtak, concerning its academic research growth from 2011 to 2021 through the Scopus database. This study provides insight into the university's annual growth of publications, the impact of citations, national and international collaborations, distribution of documents within a subject area, preferred sources for research communication, the pattern of authorship, and highly cited papers during the period. The keywords co-occurrence entails the main themes of research among various disciplines. The study findings are helpful in understanding the knowledge structures and publication trends for the academicians and stakeholders.

Keywords : Maharshi Dayanand University, Research output, Research productivity, Scientometric analysis, Scopus.

INTRODUCTION

Universities have an important role in the transmitting of excellent education and the promotion of research and development activities. Quality education results in quality research output. There is a need to study the research output of various universities to enable policymakers and academicians to identify the success factors resulting in quality research communication. An analysis of an institution's publication provides a clear picture of its research output. Various methods and tools are available to identify the quality of research productivity. One such is the scientometric evaluation, a modern technique to study the quantitative aspects of literature yield. This method is adopted to study the literature growth of Maharshi Dayanand University, Rohtak. Many popular citation databases index the research outputs in different periodicals. Scopus is one of them that indexes the research output published in popular peer-reviewed journals.

Maharshi Dayanand University, popularly known as MDU, is one of the premier universities of Haryana state, located in Rohtak district, with 'A+' grade accredited by NAAC in 2019. MDU was established by in 1976 by Haryana Legislative Assembly, Act 25 (1975) to encourage higher education and research. Later in 1977, this university was retitled after the name of Maharshi Dayanand, a social activist and renowned thinker. This university has got 94th rank in the 2022 NIRF institutional ranking.

The University campus, which spans over more than six hundred acres, is carefully set out with cutting-edge structures that provide a sight of architectural harmony and natural beauty. Its 38 departments provide educational and research opportunities. Around 263 institutions and colleges are affiliated with this university situated in seven districts throughout the state.

This study seeks to examine the growth and development of the university's research production as indexed in Scopus in order to offer a more precise picture of the research patterns and understand how it evolved over time.

REVIEW OF LITERATURE

The literature review is essential to identifying new research topics and gaps. Many scholars have done evaluation studies throughout time to map an institute's research outputs, specifically in the higher education sector in India.

Batcha (2018) examined research contributions produced by six universities in Tamil Nadu. He found that Madras University made the maximum publications throughout the study period; chemistry and crystallography are significant research having international collaboration with

USA and South Korea. Bapte & Gedam (2018) presented a bibliometric profile of SGBAU Amravati for the last two decades using Scopus based on an affiliation search. The university has the highest international collaboration with United States and Brazil; two authors wrote maximum articles. Shettar and Hadagali (2020) performed a quantitative evaluation of the research output of newly founded NITs. Their analysis suggests that NIT Trichy and NIT Rourkela were the top institutes compared to all the NITs in publications and citations; sixteen NITs gained more than one hundred publications per year. Singh, Mahala, and Yadav (2021) did a study to determine the scientific research growth of the Delhi University using the Web of Science database. They discovered that the mass of documents was published in the form of articles. Chemistry and physics were the most productive subject areas. Delhi University authors collaborated globally with the United States and Switzerland. Siwach and Kumar (2015) assessed the academic papers published by MDU Rohtak, between 2000-2013, as indexed in Scopus. They found that MDU has a strong research collaboration with GJU Hisar; chemistry was the most researched area with maximum publications, and the most favoured source was the *Indian Journal of Heterocyclic Chemistry*. Dhawan et al. (2017) used bibliometric analysis to evaluate the science & technology research production of six state funded universities of Haryana from Scopus data. According to their findings, Kurukshetra University produced the most publications during their research period. Siwach & Parmar (2018) did a bibliometric analysis of Haryana Agricultural University to identify the research trends. They observed that over half of the articles were published in ten

different sources, with *Annals of Biology* being the most popular.

In the current study, the authors employed the scientometric method to examine the research growth and impact from 2011 to 2021, intending to offer a better insight into studies.

OBJECTIVES OF THE STUDY

The major focus of this study is to evaluate the research efficiency of MDU Rohtak from 2011 to 2021 in terms of its publication production. The following objectives are being pursued by this study:

1. To explore the annual growth of publications (journal article).
2. To identify the preferred sources for research communication.
3. To analyse the trend in authorship patterns and identify most productive authors.
4. To identify the areas that have contributed most to research.
5. To identify which publications have received the most citations.
6. To determine the impact of research through citations received for the publications
7. To study the co-occurrence of keywords of the subject.

METHODOLOGY

In the present study, scientometric analysis was used as the research method to execute an in-depth assessment of the Maharshi Dayanand

University's research efficiency. On May 21, 2022, citation data was taken in a comma-separated value file format from the Scopus database and then analysed to discover relevant findings. This database has a unique feature that we can search by institution name, and every institution has a unique identifier.

The search string “(AF-ID (Maharshi Dayanand University 60004880) AND (LIMIT-TO (PUBYEAR, 2011-2021)))” was entered in the advanced search tab, and 3598 publications associated with MDU were found. Again, the search term (DOCTYPE='ar') was used, and 2596 documents were identified that were examined for this study. The R-Bibliometrix package was used to process the data. The VOSviewer tool is also used to create visualisation graphs of citations and data analysis findings.

DATA ANALYSIS

Year-wise contributions

The year-wise journal articles of Maharshi Dayanand University from 2011 to 2021 are shown in Table 1. The university authors published 2596 publications that received 22891 citations during this period. The most papers were appeared in 2020, with 350, followed by 324 and 320 in 2021 and 2019. In the year 2011, a minimum of 147 articles were distributed and in the same year, the average citation per item was the most (18.56), followed by 2012 (15.26).

Table 1 : MDU annual contributions

Year	No. of Articles	Article (%)	Citation Received	Citation per Paper (CPP)
2011	147	5.66	2728	18.56
2012	185	7.13	2824	15.26

2013	205	7.90	3123	15.23
2014	205	7.90	2382	11.62
2015	183	7.05	1888	10.32
2016	207	7.97	2413	11.66
2017	219	8.44	2238	10.22
2018	251	9.67	2017	8.04
2019	320	12.33	1768	5.53
2020	350	13.48	1112	3.18
2021	324	12.48	398	1.23
	2596	100	22891	8.82

A citation review of published data revealed that MDU has an h -index of 56 and a CPP of 8.82. Figure 1 depicts a graph showing the annual growth in intensity of research and impact.

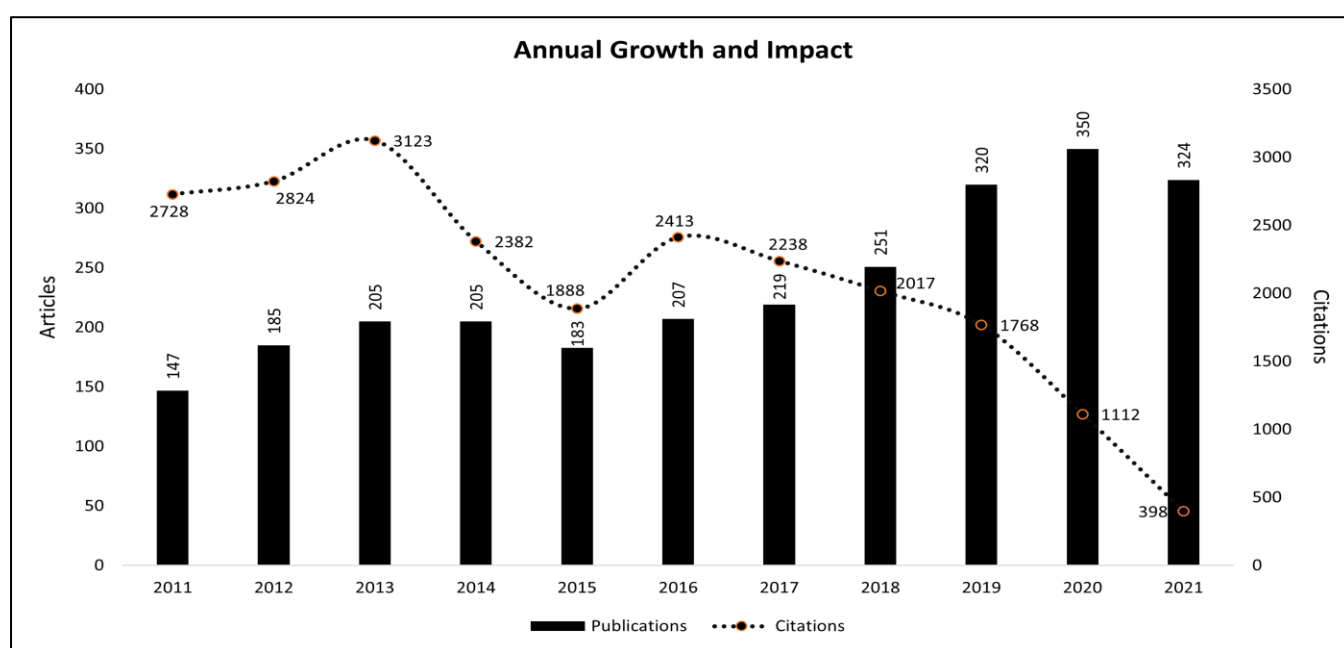


Figure 1: Annual Growth and Impact

Discipline-wise Contributions

The distribution of MDU publications by discipline-wise is shown in Table 2. With the most publications published throughout the research period, university authors contributed the most to Biochemistry, Genetics, and Molecular Biology ($N=587$). The next subject category is Engineering ($N=512$), followed by

Chemistry ($N=467$) and Pharmacology, Toxicology, and Pharmaceutics ($N=439$). The mean citation per paper is highest for Chemical Engineering (13.44), followed by Biochemistry, Genetics and Molecular Biology (12.88) and Materials Science (12.52). The h -index is highest for Biochemistry, Genetics & Molecular Biology ($h=45$), followed by Chemistry ($h=38$) and Engineering ($h=36$).

The number of articles is much more, as Table 2 depicts only the ten subject categories. Other categories have less number of publications, so they are not included in the top ten list.

Table 2: Research Disciplines

Subject	No. of Articles	Citations Received	CPP	<i>h</i> -index
Biochemistry, Genetics and Molecular Biology	587	7560	12.88	45
Engineering	512	4694	9.17	36
Chemistry	467	5940	12.72	38
Pharmacology, Toxicology and Pharmaceutics	439	3101	7.06	26
Agricultural and Biological Sciences	354	2555	7.22	24
Materials Science	311	3894	12.52	32
Physics and Astronomy	307	3006	9.79	28
Mathematics	251	934	3.72	14
Chemical Engineering	250	3361	13.44	32
Medicine	246	2036	8.28	24

Form of Publications

Table 3 shows the different types of publications between 2011 to 2021. 2596 (72.15%) of the total 3598 publications are articles, 476 (13.23%) are review papers, 254 (7.06%) are conference papers, 163 (4.53%) are book chapters, and 32 (0.89%) are editorials. The highest Citations Per

Paper (*CPP*) is for review papers (21.53), receiving 10248 citations in terms of citations. Moreover, books (*CPP*=9.17) received 275 citations. A total of 2596 articles have a *CPP* of 8.82 and received 22891 citations. As a result, articles and review papers received more citations than other types of publications.

Table 3 : Publications Forms

Form	Publication	Citation	<i>h</i> -index	CPP
Article	2596	22891	56	8.82
Review Paper	476	10248	54	21.53
Conference Paper	254	822	15	3.24
Book Chapter	163	640	14	3.93
Editorial	32	49	4	1.53
Book	30	275	10	9.17
Letter	13	51	4	3.92
Data Paper	12	21	2	1.75
Erratum	8	5	1	0.63
Note	8	41	3	5.13
Short Survey	5	0	0	0.00
Undefined	1	7	1	7.00
Total	3598			9.74

Rate of Relative Growth and Doubling Time

The observed values of growth rate (RGR) and doubling time (T_d) from 2011 to 2021 are shown in Table 4. The relative growth rate refers to the rate of growth of scientific publications over time, which can be calculated by dividing the difference between the final publication count and the initial publication count by the initial publication count, and then dividing the result by the time elapsed.

$$\text{Relative Growth Rate (RGR)} = \frac{\log_e W_1 - \log_e W_2}{T_2 - T_1}$$

Where,

$\log_e W_1$ = log of the primary number of articles

$\log_e W_2$ = log of the ending number of articles

$T_2 - T_1$ = the unit difference between the primary and ending time.

Doubling Time (T_d) refers to the time it takes for the number of scientific publications in a field or by a particular author to double in size. It can be calculated by taking the natural logarithm of 2 (approximately 0.693) and dividing it by the relative growth rate.

$$\text{Doubling Time (} T_d \text{)} = \frac{0.693}{\text{RGR}}$$

The highest 0.243 RGR was procured in 2019, and ($T_d=12.297$) was in 2017 throughout the study phase. The mean ($\bar{x}$) was noted for RGR (0.072) and for doubling time (2.570), respectively.

Table 4 : Rate of Relative Growth (RGR) and Doubling Time (T_d)

Year	No. of Articles	Cumulative	$\log_e W_1$	$\log_e W_2$	RGR	RGR ($\bar{x}$)	T_d	$T_d (\bar{x})$
2011	147	147	0.00	4.99	0	0.072	0	2.570
2012	185	332	4.99	5.22	0.230		3.014	
2013	205	537	5.22	5.32	0.103		6.751	
2014	205	742	5.32	5.32	0.000		0.000	
2015	183	925	5.32	5.21	-0.114		-6.104	
2016	207	1132	5.21	5.33	0.123		5.624	
2017	219	1351	5.33	5.39	0.056		12.297	
2018	251	1602	5.39	5.53	0.136		5.081	
2019	320	1922	5.53	5.77	0.243		2.853	
2020	350	2272	5.77	5.86	0.090		7.733	
2021	324	2596	5.86	5.78	-0.077		-8.978	

Collaboration between Institutions and Countries

For research publications, authors collaborated with many institutions across the country and the globe. Table 5 lists the top ten institutions that

have collaborated with MDU authors. With 97 publications, 1178 citations, and an *h*-index of 20, the university has a prominent research collaboration with Guru Jambheshwar University. The Delhi University has the second-highest collaboration with MDU, which has 94 papers

that received 755 citations with a 16 *h*-index; Amity University has 93 shared articles with 1072 citations with a 19 *h*-index. The Scientific and Industrial Research Council has the highest average citation per publication, 27.93.

Table 5 : Institutional Collaboration

Sr. No.	Name of Institutions	No. of Articles	Citations Received	CPP	<i>h</i> -index
1	Guru Jambheshwar University of Science and Technology	97	1178	12.14	20
2	University of Delhi	94	755	8.03	16
3	Amity University	93	1072	11.53	19
4	Deenbandhu Chhotu Ram University of Science and Technology	74	502	6.78	14
5	Kurukshetra University	59	406	6.88	13
6	Pandit Bhagwat Dayal Sharma University of Health Sciences	56	312	5.57	11
7	B. D. Sharma PGIMS, Rohtak	48	409	8.52	10
8	Universiti Teknologi MARA	44	509	11.57	13
9	Council of Scientific and Industrial Research India	44	1229	27.93	16
10	Central University of Haryana	39	178	4.56	9

As shown in Table 6, the university has the most worldwide collaborative papers with Malaysia ($N=64$), followed by Saudi Arabia ($N=61$) and the United States ($N=47$). The university has the highest *h*-index of fifteen in collaboration with the United States.

Table 6: Country Collaboration

Sr. No.	Country	No. of Articles	Citations Received	<i>h</i> -index
1	Malaysia	64	646	14
2	Saudi Arabia	61	593	13
3	United States	47	477	15
4	Spain	39	400	10
5	Australia	27	150	8
6	Portugal	26	648	12
7	United Kingdom	25	251	8
8	China	16	129	8
9	South Korea	15	513	6
10	Oman	10	89	5

Preferred Sources for Publication

For publishing research, the author preferred many scholarly communication channels like journals, proceedings, etc. The 2596 publications have appeared in many periodicals. Table 7 lists the top ten journals chosen for publication by MDU researchers. These journals accounted for 9.74 per cent of total publishing. The most chosen journal by the authors of MDU for scholarly

communication is “*Journal of Materials Science: Materials in Electronics*”, in which forty-one papers were published. The “*International Journal of Biological Macromolecules*” published thirty-four articles. The following most preferred journals are “*International Journal of Pharmacy and Pharmaceutical Sciences*” (N=29), “*Annals of Biology*” (N=26), “*Medicinal Chemistry Research*” (N=23), and “*BMC Chemistry*” (N=21).

Table 7 : Preferred Sources for Publication

Sr. No.	Source	No. of Articles	Citations Received	CPP	CiteScore (2021)	h-index
1	Journal of Materials Science: Materials in Electronics	41	414	10.10	4.2	13
2	International Journal of Biological Macromolecules	34	686	20.18	11.6	17
3	Int. Jour. of Pharmacy & Pharmaceutical Sciences	29	234	8.07	-	9
4	Annals of Biology	26	6	0.23	0.5	2
5	Medicinal Chemistry Research	23	425	18.48	3.8	11
6	BMC Chemistry	21	131	6.24	4.4	7
7	Der Pharma Chemica	20	23	1.15	-	2
8	International Journal of Agricultural and Statistical Sciences	20	5	0.25	1.2	1
9	Journal of Molecular Liquids	20	227	11.35	9.0	8
10	3 Biotech	19	77	4.05	4.3	7

The highest citation per paper rate (20.18) was seen for the International Journal of Biological Macromolecules papers and followed by Medicinal Chemistry Research (CPP=18.48) and Journal of Molecular Liquids (CPP=11.35). It was also discovered that documents submitted to the International Journal of Biological Macromolecules have the uppermost h-index

(h=17), followed by the Journal of Materials Science: Materials in Electronics (h-index=13).

Most Productive Authors

Table 8 lists the top fifteen highly productive authors. Out of these authors, five are associated with the department of chemistry, three each are from the department of biochemistry and the department of pharmaceutical sciences, and one each from the department of electronics and

communication, genetics, mathematics, and microbiology. With 139 publications, Chandra Shekhar Pundir is the most prolific author, followed by Narasimhan B. (N=112) and

Satyender Pal Khatkar (N=111). C. S. Pundir has the utmost h-index (40), followed by S. P. Khatkar and V. B. Taxak (h-index=24 each).

Table 8 : Productive Authors

Name of Authors	Department	No. of Articles	Citations Received	CPP	h-index
Chandra Shekhar Pundir	Biochemistry	139	4147	29.83	40
Narasimhan B.	Pharmaceutical Sciences	112	1328	11.86	22
Satyender Pal Khatkar	Chemistry	111	1379	12.42	24
Vinod Bala Taxak	Chemistry	105	1363	12.98	24
Pratyosh Shukla	Microbiology	67	1131	16.88	21
Renu Chugh	Mathematics	65	238	3.66	9
Devender Singh	Chemistry	62	393	6.34	13
Jaya Parkash Yadav	Genetics	62	865	13.95	16
Harish Dureja	Pharmaceutical Sciences	55	352	6.40	12
Jagriti Narang	Biochemistry	54	1252	23.19	21
Rajesh Punia	Chemistry	52	494	9.50	14
Nidhi Chauhan	Biochemistry	48	1439	29.98	21
Avni Khatkar	Electronics and Communication	43	703	16.35	18
Rajesh Kumar Malik	Chemistry	42	529	12.60	18
Arun Nanda	Pharmaceutical Sciences	41	428	10.44	12

Collaborative Measures and Authorship Pattern

The yearly distribution of the authorship displays in Table 9 as well as various collaboration metrics that have been thoroughly examined.

Degree of Collaboration

Subramanyam (1983) devised a method for calculating the level of teamwork. DC's formula is as follows:

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

Using data in Table 9, in the year 2021;

$$\frac{321}{321+3} = \frac{321}{324} = 0.991$$

According to the current analysis, the highest value for degree 0.991 was recorded in 2021, followed by 2016 (0.976), 2015 (0.973), and 0.966 in 2019 and 2014, respectively.

Collaboration Index

Lawani (1980) proposed the Collaborative Index approach, which involves averaging the number of authors for each publication. The equation is as follows:

$$CI = \frac{\sum_{j=1}^k j(f_j)}{N}$$

Using data in Table 9, during 2021;

$$CI = \frac{(3+72 \times 2 + 60 \times 3 + 48 \times 4 + 48 \times 5 + 93 \times 6)}{324} = 4.065$$

According to Table 9, the rate of collaboration index is highest (4.065) in 2021 and lowest (3.400) in 2019.

Collaborative Coefficient

The collaborative coefficient is suggested by Ajiferuke et al. (1988). It intends to eliminate the limitations related to collaboration index and degree. The formula is following:

$$CC = 1 - \frac{\sum_{j=1}^k (1/j)(f_j)}{N}$$

The year 2021 has the highest CC value of 0.703, up from 0.675 in 2016 and 0.674 in 2020. The lowest figure recorded in 2019 was 0.640.

Table 9: Collaborative Measures and Authorship Pattern

Year	Authors						Total	CC	CI	DC
	One	Two	Three	Four	Five	≥ Six				
2011	6	28	47	25	23	18	147	0.663	3.578	0.959
2012	9	41	39	45	24	27	185	0.659	3.622	0.951
2013	12	43	56	46	20	28	205	0.647	3.502	0.941
2014	7	42	57	43	27	29	205	0.668	3.624	0.966
2015	5	45	39	35	27	32	183	0.672	3.710	0.973
2016	5	45	58	33	33	33	207	0.675	3.691	0.976
2017	9	59	57	39	12	43	219	0.649	3.525	0.959
2018	9	63	65	36	30	48	251	0.661	3.633	0.964
2019	11	102	85	45	24	53	320	0.640	3.400	0.966
2020	17	71	70	64	33	95	350	0.674	3.886	0.951
2021	3	72	60	48	48	93	324	0.703	4.065	0.991

Mapping of Author Collaboration

The authors visualised mapping of the university author's collaboration with other researchers. These visuals were drawn by the VOSviewer application. Figure 2 depicts author collaboration in terms of maximum Publications, and it was found that Kumar S. has the highest credit in

collaborative research in 169 publications. Figure 3 visualises the collaboration network of the highest obtained citations. It was noted that Pundir C. S. (N=132), Kumar A (N=113), and Narasimhan B. (N=112) have research collaboration with 4167, 897, and 1400 citations, respectively.

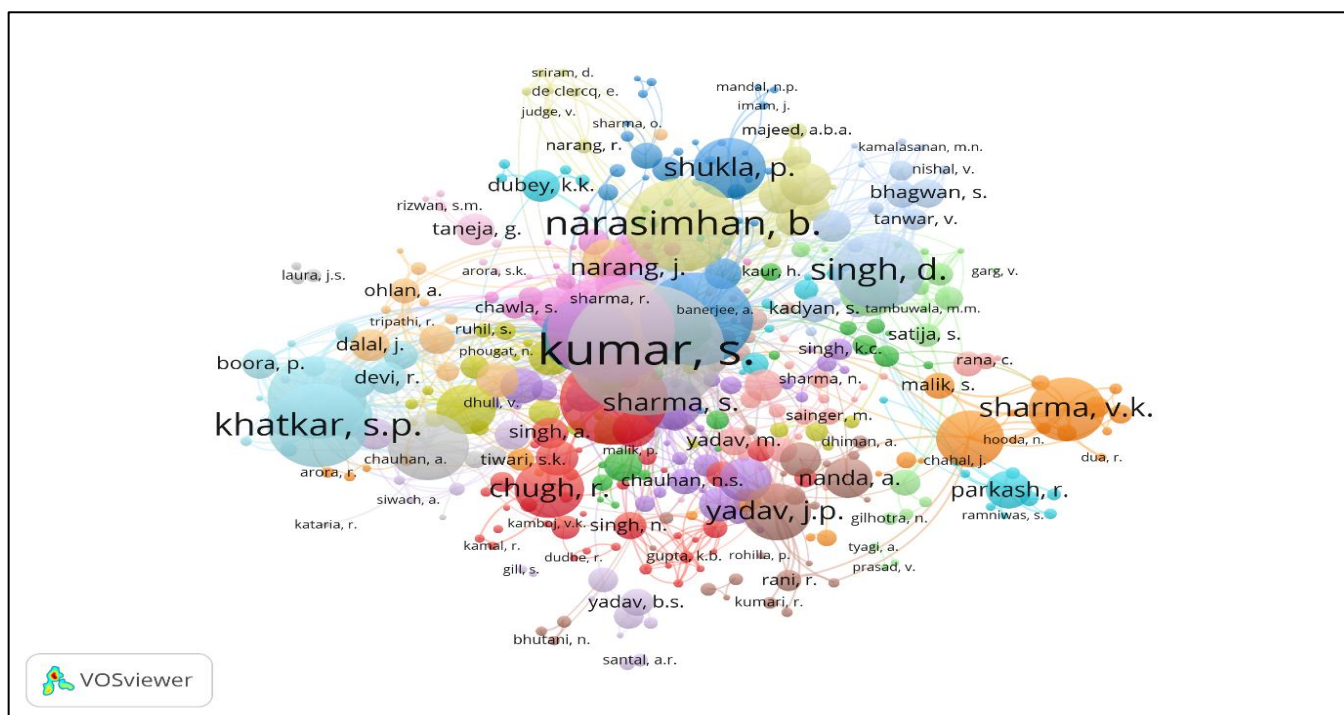


Figure 2: Author Collaboration (Publications)

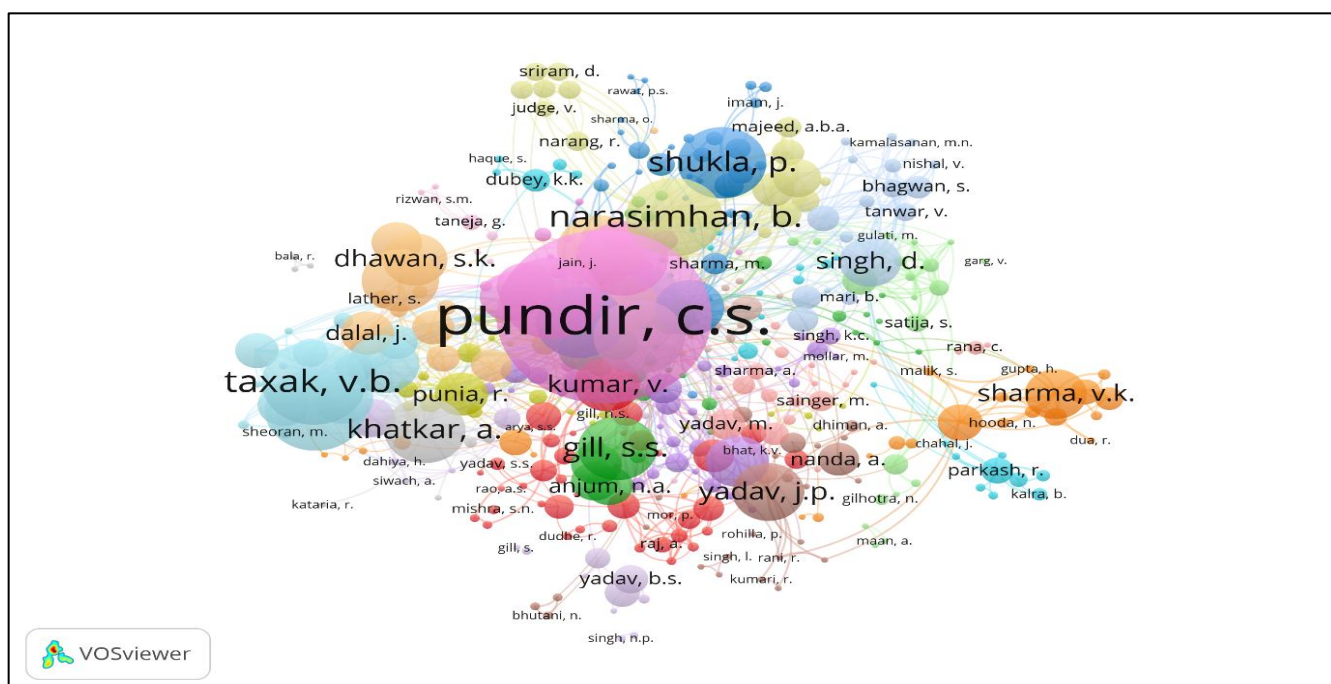


Figure 3: Author Collaboration (Citations)

Citation Outline and Most Cited Papers

From 2011-2021, Table 10 shows the citation profile of academic articles. It was understood that others cited 99.73% of all publications. Furthermore, 14 publications earned more than

one hundred citations, 67 publications received between 51 to 100 citations, 46 publications received 41 to 50 citations, and 1771 publications (68.22%) received 1 to 10 citations.

Table 10: Citation Profile of Publications

Citation Range	Article	Article (%)	Citation	Citation (%)
Not cited	7	0.27	0	0.00
1-10	1771	68.22	7145	24.50
11-20	433	16.68	6211	21.29
21-30	170	6.55	4233	14.51
31-40	88	3.39	3068	10.52
41-50	46	1.77	2051	7.03
51-100	67	2.58	4414	15.13
>100	14	0.54	2047	7.02
Total	2596		29169	

Table 11 lists the highest ten most cited documents. These highly cited publications were published in nine distinct journals. These ten papers earned 1633 citations, with an average of

163 for each. The article entitled “Nanostructured graphene/Fe₃O₄ incorporated polyaniline as a high performance shield against electromagnetic pollution” by Singh et al. (2013) received 433 citations and was published in Nanoscale.

Table 11 : Highly Cited Articles

Article	DOIs	Total Citation	Citation per Year
Singh, 2013	10.1039/c3nr33962a	433	43.30
Bhateria, 2016	10.1007/s40899-015-0014-7	169	24.14
Anjum, 2015	10.1007/s11356-014-3917-1	165	20.63
Chauhan, 2011	10.1016/j.aca.2011.06.014	163	13.58
Anjum, 2016	10.1007/s11356-016-7309-6	133	19.00
Gandhi, 2011	10.1016/j.compscitech.2011.08.010	133	11.08
Chauhan, 2012	10.1016/j.electacta.2012.02.012	117	10.64
Chauhan, 2017	10.1016/j.bios.2016.06.047	107	17.83
Banerjee, 2013	10.1016/j.carbpol.2012.09.022	107	10.70
Mehta, 2012	10.1111/j.1574-695X.2012.00987.x	106	9.64
Total Citations of Highly Cited Papers		1633	

Mapping of Keywords Occurrence

Figure 4 represents the network map of the commonly used author keywords.

The author's term "*photoluminescence*" placed first ($N=51$) with 96 total link strength (TLS), as shown in the figure, while the phrase

"*antimicrobial*" ranked second with 49 occurrences and ($TLS=95$). The phrases "*antibacterial*", "*antioxidant*", and "*qsar*" occurred with ($TLS=45, 40, 38$) respectively.

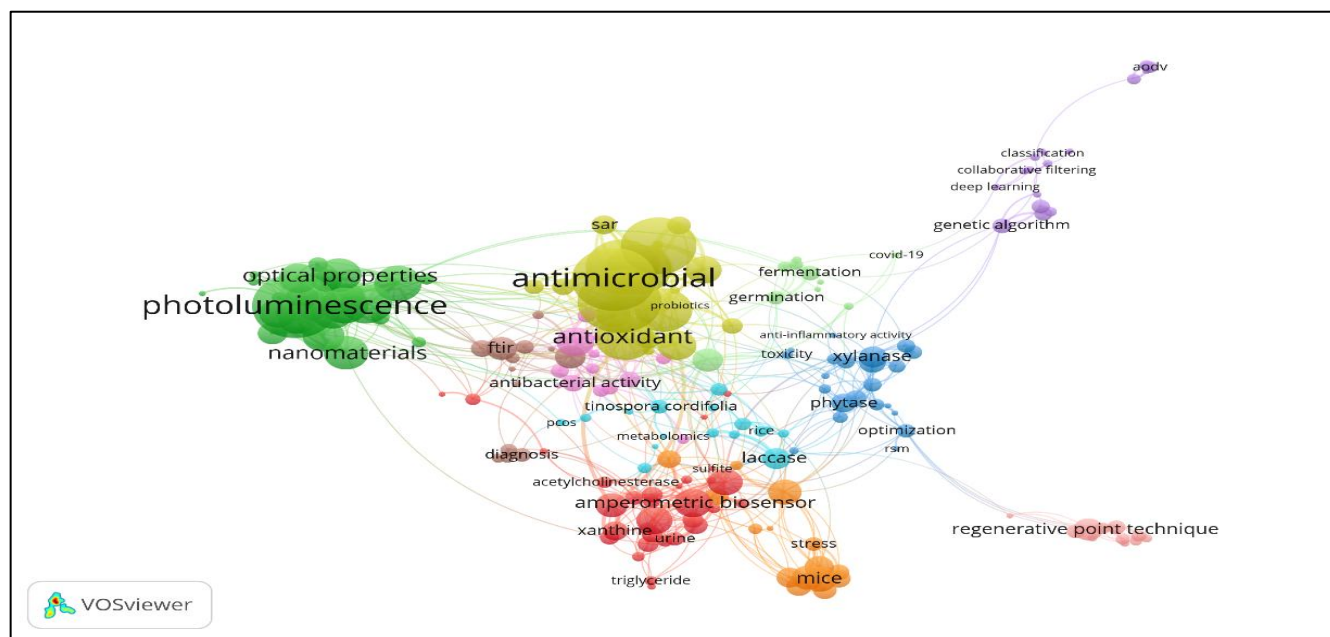


Figure 4: Map of Author's Keywords Co-occurrence

DISCUSSION

The analysis explained that MDU scholars published 2596 publications in journal articles. According to the report, the university's publications under study increased markedly by obtaining 22891 citations, with 8.82 citations per item. Biochemistry, genetics, and molecular biology are the key areas of university research output. The university collaborated with many other domestic and global institutions to conduct research and development. Guru Jambheshwar University has the most collaborative research with MDU at the domestic and international

levels; Malaysia has a strong collaboration network. Most of the papers appeared in the '*Journal of Materials Science: Materials in Electronics*'. In terms of publications, Prof. Chandra Shekhar Pundir of the department of biochemistry was the most prolific author.

Among the various forms of research contributions, the article and review gained the highest citations. In the authorship pattern of collaboration, three authors contributed a maximum number of publications, and the highest collaborative coefficient was 0.703 in 2021. Others cited 99% of publications of MDU

in their articles. A paper received the highest citations by Singh et al., published in *Nanoscale* in 2013. Out of the 2596 papers, fourteen were cited more than a hundred times.

CONCLUSION

This study intends to analyse the research documents Maharshi Dayanand University's researchers published as seen through the Scopus database between 2011 and 2021. This analysis provides a good sign of the research activities' research pattern. More efforts should be made up by the university administration to develop a professional research environment and pay more additional attention to the interdisciplinary research discipline

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