

A Bibliometric Analysis of Knowledge Management: Applications, Price's Square Root and Pareto Principle on Research Trends

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Abstract: The study deals with the Bibliometric study on the publication of "Knowledge Management". The records are collected from Web of Science Databases for the period of 2003-2022. A total of 3068 papers were identified in Web of Science database. The study reveals that, most of the researchers chosen to publish their research results in journal and more numbers of articles were published in the year 2022. The authorship trend shows that, out of total 3068 literature published, Single Author 7.89% and Multiple author 92.11% of the publication published under the majority joint author. Three thousand and sixty eight authors have contributed the total of 33568 articles. Additional in this study also acknowledged to analyses coverage growth rates, most prolific authors, Degree of collaboration, Areas of research concentration, Price's Square Root Law and Pareto Principle and citation analysis is also noted in this study.

Keywords: Author Productivity, Citation, Knowledge Management, Bibliometrics, Price's square root Law, Pareto Principle.

I. Introduction

The Knowledge Management growth analysis of publication could produce some useful results regarding growth pattern of literature and scientific output of authors in that correction. The Bibliometric analysis of scientific publications is an important aspect of research effort in information science in recent years. Bibliometrics is now an accepted analytical tool and Pajec tool also, to the monitor and analyse the research performance of institutions, individuals etc. Aimed at various purposes and includes measureable and qualitative analysis of research papers.

The major focus of the study is to apply the Bibliometric analysis with a view to analyses the evaluation and growth and development of research output in Knowledge Management. This study related to authors and their productivity; collaborative patterns and other aspects is important and useful to understand the device underlying the growth of knowledge of a discipline. This study also to analyses the evaluation growth and development and of Knowledge Management research output in positions of its content and attention relative growth rates, doubling time, most prolific authors, Degree of collaboration, Areas of research concentration, Price's Square Root Law and Pareto Principle and citation analysis is also noted.

II. Literature Review

The study of the authorship pattern and collaboration is an important aspect of Scientometric analysis.

Azadeh and Abdolreza (2013)¹ studied Lotka's law on the literature of applied mathematics of Mysore University, taking data from Web of Science for the period 1975- 2011. They reported a very high value of $\lambda = -3.3488$, suggesting highly skewed author productivity distribution without confirming to Authors productivity.

Sivakumar et al., (2013)² tested the fitness of in this study on the biology literature of central universities in India from 1999-2012 on data taken from 'Science Citation Index-Expanded' and applied chi-square test and found that Price's Square Root Law was not able to explain the author productivity distribution in this study.

Chen, Yang and Yu (2011)³ applied Lotka's law on agent-based modeling literature taken from the Social Science Citation Index (SSCI) database. The value of parameters λ and c were -3.2 and 0.8573 respectively and K-S test confirmed the author productivity distribution.

Zafrunnisha and Pullareddy (2009)⁴ conducted the Studies related to authorship trend and collaborative researches that are considered as an important facet of modern science. Predominance of multi-authored papers over single authored papers is seen. The degree of collaboration in Psychology is 0.53. USA defenses' first by producing 42.28% of cited journals. Majority of the cited journals of Psychology (94.54%) are in English language.

Objectives

This article aims to identify author productivity in the research of Knowledge Management profit with the goals as following:

1. To identify Year wise Distribution of Cited Reference and Authors
2. To find out the Total Global Citation and Local global citation output
3. To find Country wise, State wise and Citation output
4. To find out the top most productive authors and authorship pattern

- 5 To Identify Co – authorship on Knowledge Management research
- 6 To know degree of collaborations among authors
- 7 To the applicability of Price's Square Root Law
- 8 To the applicability of Pareto Principle (80 X 20 Rules)

Data collection

For collection of the publication data, the source Web of Science (WoS) a bibliographic and citation database was used. The data was collected for the period 2003-2022. The full records were downloaded in the plain text format.

III. Methodology

All the Data from Web of Science. This study is conducted with a view to analyze the trend in the development of Knowledge Management in Bibliometric analysis. It is also focused to trace the past trends in the area of research output on Knowledge Management in Bibliometric analysis based on the sample data. The Development speeds of profit with respect to investigate productivity are analyzed from 2003-2022. The total data was 3068. The information has investigated analyzed and ordered into Bibexcel, HistCite and Pajek software tool it is likewise precise in nature in behind the trial truth in view of use of practical real instruments.

Analysis and Discussion

Year wise Distribution of Cited Reference and Authors

Table-1 shows that the values total Cited References and its average values, number of authors and its average authors per article values and its mean values are calculated by year wise Knowledge Management research publication output. It could be noticed that from the table-1 below totally 3068 records were produced by 3068 authors for 20 years from 2003 to 2022 on Knowledge management research in Library Field . Totally 994 times cited references measured by other scientists.

The year of 2022 records were cited by highest times cited references during period. Each year records were cited more than 35 times at every article of Knowledge Management . The year of 2021 had contributed the highest number of authors in 316 research publication and citation 1794 times. It is concluded from these analysis highest cited references of 4745 times cited by others in the year 2019. 2019 in this year author contributed 269 records and the citation high in others to all in 4745 times. Very Lowest contribution of only 20 in 2003 and cited reference 429 only.

Table 1: Year wise Distribution of Cited Reference and Authors

S.No	Publication Year	Record	Percentage	TLCS	TGCS
1	2003	20	0.7	5	429
2	2004	18	0.6	3	702
3	2005	24	0.8	4	1288
4	2006	28	0.9	12	1724
5	2007	38	1.2	14	1629
6	2008	42	1.4	12	1226
7	2009	81	2	14	1536
8	2010	177	2.5	27	2208
9	2011	127	4.1	49	3405
10	2012	125	4.1	41	4266
11	2013	130	4.2	33	3054
12	2014	146	4.8	48	4006
13	2015	172	5.6	33	3610
14	2016	190	6.2	61	3859
15	2017	223	7.3	49	5406
16	2018	222	7.2	33	4220

17	2019	269	8.8	30	4745
18	2020	307	10	41	4569
19	2021	316	10.3	22	2889
20	2022	413	13.5	8	1794

Country wise Overall Output of Knowledge Management

Table-2 presents data of Country wise contribution for total research output in Knowledge Management. It could be noted that in topes paper published in KM and the number went up to compare to other countries. However, its Country contribution was shown a declining trend. It is seen that it's Topes' country growth have decreased gradually on India. India was Published in 3044 papers in top one record in this article and the Total local Citation is 533 and Total global Citation is 56281 times in cited respectively. The USA is the second one of the record of KM in 428 and TLCS is 77 TGCS 16240 records.Uk is the third one of the most record in third place 267 records and TLCS 77 records and TGCS is 10394 citations .The most of the contribution in top 8 list in the table2 . Publication of all sources of Knowledge Management research output has increased from 2001 in 2020.The table explain to top 25 countries published in this study.

Table 2: Country wise Publication and Citation

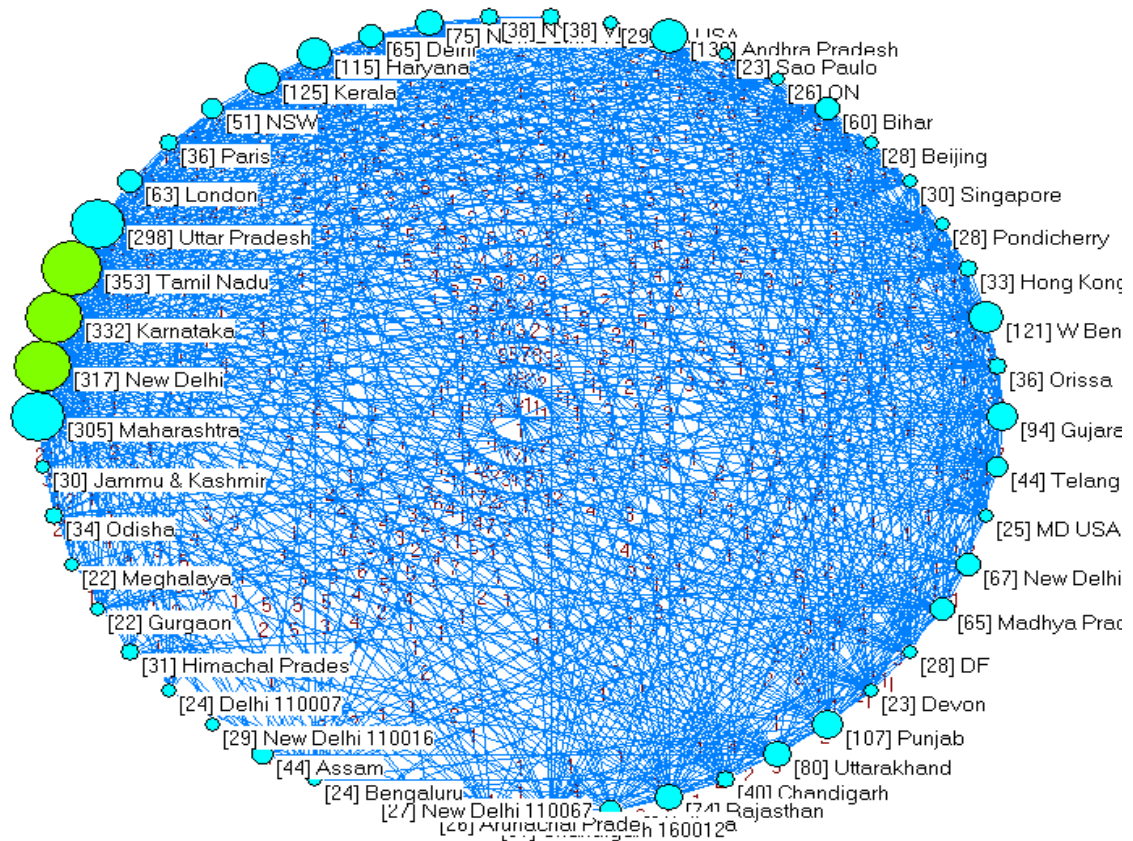
S.No	Country	Record	TLCS	TGCS
1	India	3044	533	56281
2	USA	428	77	16240
3	UK	267	48	10394
4	Australia	172	34	7944
5	Peoples R China	121	19	5981
6	France	107	18	6512
7	Germany	107	18	6148
8	Italy	106	7	4202
9	Canada	99	14	5239
10	Netherlands	95	12	5935
11	Brazil	72	2	4878
12	Switzerland	68	10	3356
13	South Africa	66	11	3042
14	Spain	65	5	4424
15	Japan	63	4	4453
16	Sweden	50	14	3794
17	Malaysia	49	1	1780
18	Singapore	46	3	2285
19	Saudi Arabia	45	3	1339
20	Belgium	43	5	2769
21	South Korea	42	4	2047
22	Denmark	40	8	3642
23	Turkey	39	2	2363
24	Pakistan	36	5	1005
25	Thailand	34	2	1428

State wise Overall Output of Knowledge Management

Table-3 presents data of Country wise contribution for total research output in Knowledge Management . It could be noted that in topest paper published in KM and the number went up to compare to other countries. However, its Country contribution was shown a declining trend. It is seen that its Topes country growth have decreased gradually on Tamilnadu 353. Karnataka was Published in 332 papers in top two. New Delhi is third position in the 317 record. Maharashtra is the fourth place and produced in 305 papers. Uthrapradhesh was fifth place in 298. State wise Publication of all sources of Knowledge Management research output has increased from 2001 in 2020.The table explain to top 25 countries published in this study. In the output explain Map 1 and this chat also.

Table 3: State wise Overall Output of Knowledge Management

Rank	State Wise	Record
1	Tamil Nadu	353
2	Karnataka	332
3	New Delhi	317
4	Maharashtra	305
5	Uttar Pradesh	298
6	Andhra Pradesh	138
7	Kerala	125
8	W Bengal	121
9	Haryana	115
10	Punjab	107
11	Gujarat	94
12	Uttarakhand	80
13	New Delhi 110029	75
14	Rajasthan	74
15	New Delhi 110012	67
16	Madhya Pradesh	65
17	Delhi	65
18	London	63
19	Bihar	60
20	NSW	51
21	Kolkata	49
22	Telangana	44
23	Assam	44
24	Chandigarh	40
25	NY USA	38



Ranking of Authors Productivity Based on Publications

Table 4 indicates ranking of authors by number of publications. Authors ‘Kumar A’ published highest number of articles for the study period with 74 records and also had highest citation score of 1139. The following authors ‘Kumar S’ published next highest number of articles for the study period with 58 records and also had next highest citation score of 864 . Then ‘Singh A’ published in third position of 41 records and citation score of 583. Explain in this table top 25 Authors productivity proof that. Thus, the most-cited authors are distinguished from the most-published ones. It is found from the analysis that Lotka’s law may be applicable with regard to author productivity in proliferation of research in Knowledge Management as the research papers.

Table 4: Author Productivity of Top 25 Most Productive Authors

S.No	Author	Record	TLCS	TLCS/t	TLCSx	TGCS/t	TLCR	TGCS/t	TLCR	TLCSb	TLCSb
1	Kumar A	74	2.4	13	1.83	6	1139	153.71	22	8	
2	Kumar S	58	1.9	8	1.15	3	864	159.66	8	1	
3	Singh A	41	1.3	15	1.83	9	583	96.08	18	5	
4	Kumar R	39	1.3	4	0.4	2	676	123.35	11	0	
5	Singh R	36	1.2	14	1.53	6	600	93.45	12	9	
6	Gupta S	29	0.9	4	0.99	2	297	61.55	10	0	
7	Sharma S	29	0.9	3	0.21	3	438	50.95	3	1	
8	Kumar P	28	0.9	2	0.3	0	454	92.81	6	0	
9	Sharma A	27	0.9	2	0.22	1	408	88.85	3	0	

10	Kumar V	26	0.8	4	0.46	2	605	74.28	4	0	
11	Singh RK	26	0.8	26	2.75	11	373	35.9	16	10	2
12	Kumar M	21	0.7	5	1.25	3	487	109.23	2	0	
13	Sharma R	21	0.7	0	0	0	252	27.97	4	0	
14	Singh AK	21	0.7	7	0.87	3	247	27.27	12	6	
15	Gupta N	19	0.6	7	0.85	2	155	32.19	4	3	
16	Singh SK	19	0.6	7	1.49	4	361	65.33	8	1	
17	Singh M	18	0.6	2	0.26	1	214	38.21	3	0	
18	Gupta A	17	0.6	3	0.19	2	409	60.62	0	0	
19	Singh S	17	0.6	0	0	0	170	38.54	4	0	
20	Das AK	16	0.5	0	0	0	151	31.89	3	0	
21	Singh P	16	0.5	3	0.58	1	152	29.26	3	0	
22	Singh V	16	0.5	1	0.33	0	172	22.47	0	0	
23	Gupta R	15	0.5	5	0.53	2	692	93.8	3	1	
24	Srivastava A	15	0.5	2	0.25	0	141	27.33	7	2	
25	Das S	14	0.5	2	0.25	1	146	23.62	1	1	

Authorship Pattern of Knowledge Management

The study of authorship pattern is a significant angle in bibliometric analysis. It target at studying the performance of researchers in donating research output both individually and jointly. Later, there is a need to analyze the equal with the end goal of current study.

Table-5 specifies the authorship pattern in Knowledge Management research output. It could be practical that three author donated papers conquers the first position 436 (14.21%), followed by two authors and four authors underwritten papers occupies the second position 407 (13.27%) in respect to total number of papers published during the period of examination. From this study the multi-author publication is the highest compare to single-author publication. In the twenty years analysis, year 2020 has recorded highest publication of 413 record, followed by the year 2019 has recorded 316 publications to the year authors involvement.

Table 5: Authorship Pattern of Papers Published

Year	Single	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten and above	Total
2001	4	2	1	4	4	3	2				20
2002	3	4	5		2	2	1	1			18
2003	3	7	9	1	2	1	1				24
2004	6	4	2	5	3	2	5	1			28
2005	8	12	2	5	4	3	4				38
2006	9	5	6	10	5	4	3				42
2007	7	10	6	9	9	3	11	15	6	5	81
2008	31	24	30	26	24	16	12	3	5	6	177
2009	4	19	30	20	14	16	3	3	5	13	127
2010	6	28	25	25	8	8	3	5	4	13	125
2011	7	20	20	26	12	11	3	2	10	19	130
2012	6	17	25	29	11	10	11	12	13	12	146
2013	18	27	30	27	19	19	15	3	13	1	172

2014	20	20	20	23	25	18	14	10	15	25	190
2015	19	41	31	31	16	17	14	16	16	22	223
2016	18	19	33	23	23	22	16	18	26	24	222
2017	15	30	27	36	26	25	16	26	31	37	269
2018	12	45	34	40	33	30	36	24	26	27	307
2019	19	32	47	26	36	31	35	29	25	36	316
2020	27	41	53	41	41	30	31	48	50	51	413
Total	242	407	436	407	317	271	236	216	245	291	3068
%	7.89	13.27	14.21	13.27	10.33	8.83	7.69	7.04	7.99	9.49	

Single Vs Multiple-Authored Research Output and Degree of Collaboration

The single type multi-author research output during the period 2001-2020 is experiential. It is experiential that from the above table shows, the single-author donated papers constitute 7.89% of the total publications where-as the enduring majority 92.11% of the papers are contributed by multi-authorship. In order to regulate the collaboration in numerical terms, the formula apply in this study was tested and analysis the research . It is conditional from Table 5 that at the total level, the degree of collaboration during the study period 2001–2020. Out of total 3068 literature published, 92.11 % of them were published under the joint authors of publications in Knowledge Management research output. The period wise analysis shows that its level is rather less in the first (2001-2007) period in single Author and it has shown. An reducing trend during the period (2008-2020). Based on this study, the result of the degree of teamwork $C=0.079$ percent of collaboration authors articles published during the study periods.

Table - 6: Single Vs Multiple Authored Research output and Degree of Collaboration

Year	Single Author		Multiple Author		Total	%	Degree Collaboration
	Output	%	Output	%			
2001	4	20	16	80	20	0.65	0.2
2002	3	16.67	15	83.33	18	0.59	0.167
2003	3	12.50	21	87.50	24	0.78	0.125
2004	6	21.43	22	78.57	28	0.91	0.214
2005	8	21.05	30	78.95	38	1.24	0.211
2006	9	21.43	33	78.57	42	1.37	0.214
2007	7	8.64	74	91.36	81	2.64	0.086
2008	31	17.51	146	82.49	177	5.77	0.175
2009	4	3.15	123	96.85	127	4.14	0.031
2010	6	4.80	119	95.20	125	4.07	0.048
2011	7	5.38	123	94.62	130	4.24	0.054
2012	6	4.11	140	95.89	146	4.76	0.041
2013	18	10.47	154	89.53	172	5.61	0.105
2014	20	10.53	170	89.47	190	6.19	0.105
2015	19	8.52	204	91.48	223	7.27	0.085
2016	18	8.11	204	91.89	222	7.24	0.081
2017	15	5.58	254	94.42	269	8.77	0.056
2018	12	3.91	295	96.09	307	10.01	0.039
2019	19	6.01	297	93.99	316	10.30	0.060

2020	27	6.54	386	93.46	413	13.46	0.065
Total	242	7.89	2826	92.11	3068	100.00	0.079

Author Pattern of h- Index (h-core)

It is observed from below table-6 the Author pattern Index for single authors is declined fortopy twenty five in 2001 -2020 . Kumar A published in 75 articles then h-index is 16 , h-core of 898 and 1151 citations .Second one is Kumar S 58 articles are published , h-index is 15 ,h-core 898 and 864 citations also.

Table 7 : Author Pattern of h- Index (h-core)

S.No	Author	h-index	Citation sum within h-core	All citations	All articles
1	Kumar A	16	898	1151	75
2	Kumar S	15	693	864	58
3	Singh R	14	549	600	36
4	Singh A	12	463	583	41
5	Kumar M	10	445	487	21
6	Maikhuri RK	10	258	279	14
7	Gupta S	9	234	297	29
8	Kumar V	9	564	605	26
9	Singh SK	8	332	361	19
10	Das AK	8	126	151	16
11	Singh AK	8	213	247	21
12	Jain V	8	310	315	10
13	Sharma S	8	393	438	29
14	Gunasekaran A	8	670	670	8
15	Singh RK	8	311	373	26
16	Gupta N	8	117	155	19
17	Kumar P	8	404	454	28
18	Kumar R	8	608	676	39
19	Rao KS	7	222	233	11
20	Mangla SK	7	468	480	10
21	Sharma N	7	96	107	12
22	Sharma A	7	351	408	27
23	Joshi R	7	92	97	8
24	Singh M	7	195	226	19
25	Singh N	7	147	155	13

Price's Square Root Law

Price' square root law is used to validate the distribution status of authors' productivity in the subject field. The calculation is based on the below formula and the status of authors calculation based on .

$PSQ = \sqrt{N} = 110.635$. Where, $N = 6495$.Based on Price's square root law, the only one contributor produced and 75,58,41,39,36,29,28,27,26 numbers of articles by single contributor are given publications.

Table: 8 Price's Square Root Law for Knowledge Management Research Productivity

No of Contribution A	No of Contributors B	% of 3068	A*B	6495 % of	Cumulated value of A*B %	Cumulated value of A*B
75	1	0.033	75	1.155	1.15	75
58	1	0.033	58	0.893	0.89	133
41	1	0.033	41	0.631	0.63	174
39	1	0.033	39	0.600	0.60	213
36	1	0.033	36	0.554	0.55	249
29	2	0.065	58	0.893	0.89	307
28	1	0.033	28	0.431	0.43	335
27	1	0.033	27	0.416	0.42	362
26	2	0.065	52	0.801	0.80	414
21	3	0.098	63	0.970	0.97	477
19	3	0.098	57	0.878	0.88	534
17	2	0.065	34	0.523	0.52	568
16	3	0.098	48	0.739	0.74	616
15	2	0.065	30	0.462	0.46	646
14	2	0.065	28	0.431	0.43	674
13	5	0.163	65	1.001	1.00	739
12	4	0.130	48	0.739	0.74	787
11	6	0.196	66	1.016	1.02	853
10	10	0.326	100	1.540	1.54	953
9	11	0.359	99	1.524	1.52	1052
8	18	0.587	144	2.217	2.22	1196
7	21	0.684	147	2.263	2.26	1343
6	38	1.239	228	3.510	3.51	1571
5	62	2.021	310	4.773	4.77	1881
4	148	4.824	592	9.115	9.11	2473
3	448	14.602	1344	20.693	20.69	3817
2	407	13.266	814	12.533	12.53	4631
1	1864	60.756	1864	28.699	28.70	6495
Total	3068	100.000	6495	100.000	100.00	33568

Created on the Price's square root law, 50% of the literature on a focus must contributed by the Price's square root of n contributors. PSQ value is located in the above table as underscored. It means that the square root value of contributors (58) was contributed only 0.89% of total publications. So the value is very far away from 50% (half of the literature on a given subject). Later, it concluded that the result is nearest fit with Price's square root law.

Pareto Principle (80 X 20 Rules)

Table 9 shows the applicability of Pareto's principle and test whether the dataset is validate to the Pareot's principle. He concluded that 80% of the contributions have come from 20% of contributors. Since total number of authors is 3068, that mean the 20% of total number of authors is 613.6 9721. Total number of publications is 33568 and its 80% of publications is 26854.4.

Table 9 : Pareto Principle (80 X 20 Rule) Law for Research Productivity

No of Contribution A	No of Contributors B	% of 3068	A*B	6495 % of	Cumulated value of A*B %	Cumulated value of A*B
75	1	0.033	75	1.155	1.15	75
58	1	0.033	58	0.893	0.89	133
41	1	0.033	41	0.631	0.63	174
39	1	0.033	39	0.600	0.60	213
36	1	0.033	36	0.554	0.55	249
29	2	0.065	58	0.893	0.89	307
28	1	0.033	28	0.431	0.43	335
27	1	0.033	27	0.416	0.42	362
26	2	0.065	52	0.801	0.80	414
21	3	0.098	63	0.970	0.97	477
19	3	0.098	57	0.878	0.88	534
17	2	0.065	34	0.523	0.52	568
16	3	0.098	48	0.739	0.74	616
15	2	0.065	30	0.462	0.46	646
14	2	0.065	28	0.431	0.43	674
13	5	0.163	65	1.001	1.00	739
12	4	0.130	48	0.739	0.74	787
11	6	0.196	66	1.016	1.02	853
10	10	0.326	100	1.540	1.54	953
9	11	0.359	99	1.524	1.52	1052
8	18	0.587	144	2.217	2.22	1196
7	21	0.684	147	2.263	2.26	1343
6	38	1.239	228	3.510	3.51	1571
5	62	2.021	310	4.773	4.77	1881
4	148	4.824	592	9.115	9.11	2473
3	448	14.602	1344	20.693	20.69	3817
2	407	13.266	814	12.533	12.53	4631
1	1864	60.756	1864	28.699	28.70	6495
Total	3068	100.00	6495	100.00	100.00	33568

Based on the analysis, the value of cumulated % of A*B is 9.11% (2473) of authors were contributed, but 20% of authors is 148. In 80x20 rule view, the value is not close to 20%. Hence, it concluded that this result is not fit to the Pareto's Principle.

IV. Major Findings:

- Totally 3068 records were produced for 20 years from 2001 to 2020 on Knowledge Management research. Totally 56565 times cited references measured by other researchers. The year of 2020 records were cited by highest times cited references during period. Each year records were cited more than 56565 times at every article of Knowledge Management. The year of 2020 had contributed the highest number of authors in 413 research publication. It is concluded from these analysis highest cited references of 5406 times cited by others in the year 2015.

- To find out author 'Kumar A' published highest number of articles for the study period with 74 records and also had highest citation score of 1151. The following authors 'Kumar S' published next highest number of articles for the study period with 58 records and also had next highest citation score of 864.
- From the outcome of this study, we come to realize that the multi-author distribution is the most elevated contrast with single-author distribution. In twenty years analysis, year 2020 has recorded the most noteworthy distribution appropriation of 413 followed continuously 2019, 2018 recorded next highest records.
- It is observed from this study the Co-Authorship Index for single authors is declined from 7.89% in the year 2001 to 2020. On the other hand, the Co-Authorship Index for Multiple authors is enhanced from 92.11% in the year 2001 to 2020, which indicates the pattern of co-authorship is increasing among the contributions of the journal.
- The findings of degree of collaboration analysis reveal the following facts that the case of single author contributed papers is less. It brings out clearly the high level prevalence of collaborative research in Knowledge Management. Based on this study, the result of the degree of collaboration $C=0.079$ articles published during the study periods.
- The findings of the square root value located at just 0.89% percent of publications. Most of the 50 % authors are contributed very less number of times in Knowledge Management.
- The contribution percentage of 110.635 (Nearly closed are root value of 6495) contributors is located at 0.89 percent of publications. The value is very far away from 50 % (half of the literature on a subject) so this result is not in compliance with Price's Square Root Law.
- It is found that the total number of authors is 3068, that mean the 20 percent of total authors number is 613.6% and its 80 percent of publications value is 26854.4. The finding of this study does not fit for Pareto Principle (80 X 20 Rule) for author contribution.
- This study investigated the outputs of Country wise Citation research publications is India contributed more records and TLCS 533 , TGCS 56281. The results
- showed that the highest number in India 3044 publications was published .State wise highly published in Tamilnadu majority contribution in 353. The majority of the research outputs was published highest language in English.

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