Original Research Article

EXPLORING AUTHORSHIP DISTRIBUTION AND COLLABORATIVE TRENDS IN DATA VISUALIZATION PUBLICATIONS 2001-2020 INDEXED IN LISA

*** Ms. Pradnya K. Kivande & ** Dr. Shashank S. Sonwane***

*Research Scholar & **Professor, Dept. of Library & Information Science, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar, M.S. India

Abstract:

The study examines the authorship patterns and collaboration coefficients of publications on data visualization indexed in the Library and Information Science Abstracts (LISA) database between 2001 to2020. A total of 7,144 articles published during this period were analyzed using scientometric methods. The analysis explored the trends in authorship, identifying the proportion of single-authored and multi-authored papers, and assessed the degree of collaboration among researchers in the field. The study also calculated the collaboration coefficient to quantify the extent of collaborative efforts in data visualization research. The findings provide valuable insights into the evolving nature of research collaboration, authorship trends, and the dynamics of knowledge production in the domain of data visualization within library and information science. These insights contribute to a better understanding of how researchers in this field engage and collaborate over two decades, offering implications for fostering interdisciplinary and collaborative approaches in future research.

Keywords: *Data Visualization, Collaboration Index, Collaboration Coefficient, Modified Collaboration Coefficient, Relative Growth Rate, Co-authorship Index.*

Introduction:

Data visualization has emerged as a critical area of study, enabling researchers and professionals to represent complex data sets in an accessible and visually interpretable manner. With the exponential growth of data across diverse fields, the role of data visualization in simplifying, analyzing, and communicating information has become indispensable. In the context of library and information science, data visualization facilitates the representation of bibliometric trends, citation networks, and research output, thereby aiding decision-making and scholarly communication.

The Library and Information Science Abstracts (LISA) database serves as a premier indexing platform for research in library and information science, including the domain of data visualization. Publications indexed in LISA reflect advancements, trends, and patterns in scholarly output, making it an ideal resource for bibliometric studies.

Authorship patterns and collaboration dynamics are significant indicators of the progress and maturity of a research domain. They provide insights into the level of individual and collective contributions, interdisciplinary engagement, and the overall research culture. The study of collaboration coefficients further quantifies the degree of teamwork and cooperative efforts among researchers.

This paper investigates the authorship patterns and collaboration coefficients of data visualization research articles indexed in LISA during the period 2001–2020. The study aims to analyze the distribution of single and multi-authored papers, calculate the collaboration coefficient, and identify trends in research

collaboration over the two decades. By applying scientometric tools, this research sheds light on the collaborative behavior and authorship trends in the field, providing valuable insights for researchers, institutions, and policymakers to foster collaborative research ecosystems.

Literature Review:

The Collaboration Coefficient is a metric designed to evaluate the extent of collaborative efforts in research. Unlike solely relying on the average number of authors per publication or the percentage of jointly authored works, this coefficient integrates the strengths of both approaches. It offers a more holistic perspective on collaboration patterns within a specific field (Ajiferuke et al., 1988; Savanur & Srikanth, 2009).

The Collaboration Coefficient (CC) is a quantitative measure used to assess the level of collaboration in research. It accounts for both the average number of authors per publication and the percentage of collaboratively authored papers. The CC value ranges from 0 to 1, where 0 represents exclusively single-authored works, and 1 denotes maximum collaboration. To address limitations in specific scenarios, such as when all papers are co-authored by all authors, a Modified Collaboration Coefficient (MCC) has been introduced. The MCC enhances the accuracy of the measure by incorporating both the number of authors per paper and the proportion of multi-authored papers, offering a more precise evaluation of research collaboration (Manoj Kumar Verma et al., 2019).

The Modified Collaborative Coefficient (MCC) was introduced to enhance the original Collaboration Coefficient (CC) by addressing its limitations. Specifically, the MCC ensures that the value reaches 1 in cases where all papers in a collection are authored by the maximum possible number of contributors, thereby providing a more refined measure of collaboration (Savanur & Srikanth, 2009).

Collaborative consumption (CC) refers to a multidimensional concept that focuses on shared use and cooperation among consumers, emphasizing their roles, the intensity of collaboration, and the involvement of various stakeholders in these exchanges. A triadic framework for CC categorizes the motives, activities, and resources or capabilities of participants, illustrating the intricate and dynamic nature of collaboration in consumer contexts (Ertz et al., 2018; Benoit et al., 2017).

In research, comparative studies of collaboration measures, such as the Collaboration Coefficient (CC), indicate that revised indices like the degree of collaboration and modified collaboration coefficient are more effective for bibliometric analyses, offering insights into research productivity and impact (Liao & Yen, 2012). Additionally, newly developed indices, including the RC-Index and CC-Index, evaluate collaboration networks by considering factors like the number of partnerships, co-author productivity, and the structure of collaborative activities within scientific communities (Abbasi et al., 2009).

Objectives:

- ➢ To examine the yearly distribution of publications
- ➢ To determine the authorship distribution of the publications
- ➢ To evaluate the Collaboration Index among authors
- ➢ To assess the Collaboration Coefficient and Modified Collaboration Coefficient
- ➢ To analyze the Co-authorship Index
- ➢ To calculate the Relative Growth Rate and Doubling Time of publications

Scope & Limitations:

This research focuses on analyzing data visualization publications indexed in the Library and Information Science Abstracts (LISA) database from 2001 to 2020. The study covers a broad range of aspects, including

year-wise distribution of publications, authorship patterns, collaboration indices, and co-authorship trends. The scope also extends to measuring the collaboration coefficient and modified collaboration coefficient to provide insights into research collaboration dynamics. Additionally, the study includes an evaluation of the relative growth rate and doubling time of publications in the field of data visualization, aiming to uncover trends in research productivity and collaboration within library and information science.

Data Analysis:

The results of the calculations are analyzed to identify trends, patterns, and shifts in authorship and productivity. The Collaboration Index, CC, and MCC are compared across years to assess changes in collaboration levels. The RGR and Dt are analyzed to determine the growth rate and maturation of the journal's literature.

Methodology:

The study employs a quantitative approach, utilizing data to analyse the Collaboration Co-efficient and Modified Collaboration Coefficient, Co-authorship Index, Relative Growth Rate and Double Time of publications, a particular formula was used and these formulae are given with appropriate tables in the analysis part. The data were analysed and tabulated with the use of MS-Excel application software.

Table no. 1 year wise growth of Publication

Sr.No.	Year	Articles	Percentage
1	2001	83	1.16
2	2002	91	1.27
3	2003	86	1.20
4	2004	120	1.68
5	2005	144	2.02
6	2006	387	5.42
7	2007	356	4.98
8	2008	467	6.54
9	2009	426	5.96
10	2010	439	6.15
11	2011	487	6.82
12	2012	427	5.98
13	2013	496	6.94
14	2014	421	5.89
15	2015	491	6.87
16	2016	483	6.76
17	2017	467	6.54
18	2018	403	5.64
19	2019	414	5.80
20	2020	456	6.38
		7144	100.00

Table No. 1 presents a year-wise distribution of article productivity, highlighting trends in research output over a 20-year period from 2001 to 2020. The data shows a gradual increase in article publications, with early years like 2001 and 2002 contributing only 1.16% and 1.27%, respectively. From 2006 onward, there is a marked rise in productivity,

with the peak year being 2013, which accounts for 6.94% of total articles, closely followed by 2011 and 2015 at 6.82% and 6.87%, respectively. This heightened activity persists through subsequent years, with 2020 contributing 6.38%, reflecting sustained research interest and output. The consistent productivity from 2008 to 2020 indicates a stable commitment to research, with each year contributing around 5-7% of the total articles, demonstrating a steady growth in academic engagement within the field.

Year-Wise Authorship Distribution of the Publication

Table no. 2 Authorship pattern year wise

Sr.No.	Year	Single Author	Two Author	Three Author	Four Author	More Than Four Author	Total	Percentage
1	2001	1	20	12	24	26	83	1.16
2	2002	1	26	19	18	27	91	1.27
3	2003	7	11	26	23	19	86	1.20
4	2004	3	25	32	41	19	120	1.68
5	2005	2	28	40	38	36	144	2.02
6	2006	6	67	69	79	166	387	5.42
7	2007	5	69	87	94	101	356	4.98
8	2008	13	79	76	87	212	467	6.54
9	2009	6	73	84	106	157	426	5.96
10	2010	3	97	79	111	149	439	6.15
11	2011	9	102	107	89	180	487	6.82
12	2012	11	66	164	95	91	427	5.98
13	2013	10	83	167	86	150	496	6.94
14	2014	6	95	83	147	90	421	5.89
15	2015	13	67	83	46	282	491	6.87
16	2016	**12**	110	59	82	220	483	6.76
17	2017	16	67	92	79	213	467	6.54
18	2018	9	122	106	83	83	403	5.64
19	2019	14	93	49	83	175	414	5.80
20	2020	7	116	108	131	94	456	6.38
Total		154	1416	1542	1542	2490	7144	100
Percentage		2.16	19.82	21.58	21.58	34.85	100	

Table 2 presents a detailed analysis of authorship patterns in the field of data visualization from 2001 to 2020, highlighting significant trends in publication collaboration. The data reveals that the year with the highest total publication output was 2006, with 387 articles, while the lowest output occurred in 2001, with only 83 articles. Throughout the two decades, single-author contributions represented a mere 2.16% of the total, indicating a strong preference for collaboration, particularly among multi-author papers, which accounted for 34.85% of the total publications. The findings reflect a marked shift towards collaborative research, with notable peaks in publication rates during certain years, underscoring the collective effort to advance knowledge and innovation in data visualization practices.

Collaboration Index:

Collaboration Index is a mean number of authors per joint paper. For this analysis, the single authored papers which are equal to one always are omitted. The mean number of authors per joint authored paper means collaboration index is shown in table no. 4.30.

Table no. 3 Collaboration Index

Sr.No.	Year	No of paper y	No.of auther x	Colaboration Index=NA/NP
1	2001	83	867	0.10
2	2002	91	1034	0.09
3	2003	86	1245	0.07
4	2004	120	1257	0.10
5	2005	144	1678	0.09
6	2006	387	1647	0.23
7	2007	356	1243	0.29
8	2008	467	1126	0.41
9	2009	426	1173	0.36
10	2010	439	1324	0.33
11	2011	487	1234	0.39
12	2012	427	1238	0.34
13	2013	496	2346	0.21
14	2014	421	1162	0.36
15	2015	491	1024	0.48
16	2016	483	1246	0.39
17	2017	467	1345	0.35
18	2018	403	1672	0.24
19	2019	414	1734	0.24
20	2020	456	1523	0.30

It is observed from the table no. 3 that, The collaboration index for the analyzed period reveals significant trends in research cooperation within the field. Between 2001 and 2005, collaboration remained relatively low, with values ranging from 0.07 to 0.10, suggesting a moderate level of individual research contributions or limited team-based work. However, beginning in 2006, there is a notable increase in the collaboration index, which peaks in 2015 at 0.48, indicating a shift towards more collaborative efforts. This upward trend highlights a consistent growth in team-based research, with higher collaboration levels from 2007 onward, reaching above 0.30 for several years. These findings imply a growing recognition of the value of co-authored works, likely driven by interdisciplinary research demands and a global push for more comprehensive studies, particularly in fields requiring diverse expertise. The steady incline in collaboration index over time emphasizes the evolving landscape of academic research, with collaboration becoming a more integral part of scientific advancement.

Collaboration Coefficient and Modified Collaboration Coefficient:

According to Ajiferuke et al. (1988) who have shown the mean number of author per paper, the proportion of multiple authorship as a measure of degree of collaboration in a discipline, is inadequate. There for, they have proposed an measure combining some of the merits of both measure into what is known as collaborative coefficient.

Suppose if a paper has a single author, the author receives one credit; if two each receives ½ credits. In ferneral, if we have 'n' author each receive 1/n credits. Hence, the average credit awarded to each author of a random paper is E[1/n], a value which lies between 0 and 1, if '0' is to correspond to single authorship, than the CC is defined as:

CC = 1-E [1/n]

= 1- (1/j) p (N=j)

And its sum ∑ rate = 1-f1+(1/2)f2+(1/2)f3+…(1/k)fk N

Table No. 4 The Collaborative co-efficient of publications

Sr.No.	Year	Single Author	Two Author	Three Author	Four Author	More Than Four Author	Total	CC
1	2001	1	20	12	24	26	83	0.68
2	2002	1	26	19	18	27	91	0.67
3	2003	7	11	26	23	19	86	0.64
4	2004	3	25	32	41	19	120	0.66
5	2005	2	28	40	38	36	144	0.68
6	2006	6	67	69	79	166	387	0.70
7	2007	5	69	87	94	101	356	0.68
8	2008	13	79	76	87	212	467	0.70
9	2009	6	73	84	106	157	426	0.70
10	2010	3	97	79	111	149	439	0.69
11	2011	9	102	107	89	180	487	0.68
12	2012	11	66	164	95	91	427	0.67
13	2013	10	83	167	86	150	496	0.68
14	2014	6	95	83	147	90	421	0.68
15	2015	13	67	83	46	282	491	0.71
16	2016	**12**	110	59	82	220	483	0.69
17	2017	16	67	92	79	213	467	0.69
18	2018	9	122	106	83	83	403	0.65
19	2019	14	93	49	83	175	414	0.68
20	2020	7	116	108	131	94	456	0.67
Total		154	1416	1542	1542	2490	7144	0.68
Percentage		2.16	19.82	21.58	21.58	34.85	100	

Table 4. shows that The table provides an overview of the Collaborative Coefficient (CC) in publication patterns over two decades, from 2001 to 2020, showing authorship distribution by single, two, three, four, and more-than-four author groups. The CC value, a measure of collaboration within the research community, consistently hovers around 0.68, indicating a high level of collaborative activity across years. The data shows that multi-author publications (especially those with more than four authors) dominate, accounting for 34.85% of the total authorship. Notably, the CC reaches its peak in 2015 with a value of 0.71, reflecting a particularly strong collaborative effort that year. This trend underscores the importance of collaborative research in advancing data visualization studies, as reflected in the high cumulative CC of 0.68, emphasizing that collaboration remains a core aspect of publication productivity in this field.

The Modified Collaborative co-efficient of publication:

The modified collaboration coefficient (MCC) counted by the formula which is suggested by Savanur and Srikanth (2010) as given below:

$$\text{MCC} = \left(\frac{N}{N-1}\right)\left\{1 - \frac{\sum_{j=1}^{A}\left(\frac{1}{j}\right)fj\ A\ j=1}{N}\right\}$$

Table No.- 5 Modified Collaboration Coefficient

	Year	Single Author	Two Author	Three Author	Four Author	More Than Four Author	Total	MCC
1	2001	1	20	12	24	26	83	0.69
2	2002	1	26	19	18	27	91	0.68
3	2003	7	11	26	23	19	86	0.65
4	2004	3	25	32	41	19	120	0.67
5	2005	2	28	40	38	36	144	0.69
6	2006	6	67	69	79	166	387	0.70
7	2007	5	69	87	94	101	356	0.69
8	2008	13	79	76	87	212	467	0.70
9	2009	6	73	84	106	157	426	0.70
10	2010	3	97	79	111	149	439	0.69
11	2011	9	102	107	89	180	487	0.69
12	2012	11	66	164	95	91	427	0.67
13	2013	10	83	167	86	150	496	0.68
14	2014	6	95	83	147	90	421	0.68
15	2015	13	67	83	46	282	491	0.71
16	2016	**12**	110	59	82	220	483	0.69
17	2017	16	67	92	79	213	467	0.70
18	2018	9	122	106	83	83	403	0.65
19	2019	14	93	49	83	175	414	0.68
20	2020	7	116	108	131	94	456	0.67
	Total	**154**	**1416**	**1542**	**1542**	**2490**	**7144**	

Table no. 5 The table presents an analysis of the Modified Collaboration Coefficient (MCC) for research publications over a 20-year period, tracking changes in authorship patterns and collaborative tendencies. The MCC, which slightly adjusts the traditional Collaboration Coefficient (CC) for enhanced accuracy in reflecting collaborative efforts, reveals a steady high level of collaboration, ranging from 0.65 to 0.71 across the years. Multi-author publications (particularly with three or more authors) consistently dominate, suggesting a strong preference for collaborative work within the research community. Peaks in MCC values, such as 0.71 in 2015, highlight years of especially intensive collaboration. Overall, the sustained high MCC underscores the prominence of collaborative authorship as a core element in advancing research, reflecting the collective contributions of diverse author groups over time.

Relative Growth Rate and Double Time of publication:

The growth of literature of Applied and Environmental Microbiology journal research is being measured with the Scientometric indicators Relative Growth Rate (RGR) and Doubling Time (Dt). The RGR is obtained with the following formula used by Karpagam R, et.al. (2011);

$$R(P) = \frac{\text{Loge}2p - Loge1p}{2T - 1T}$$

Here R (P) = Relative Growth Rate of articles over the specific period of time.

Log_e 1P = Log of initial number of articles.

Log_e 2P = log of final number of articles

2T – 1T = the unit difference between the initial time and final times.

The Dt. is obtained with the following formula;

$$Dt = \frac{0.693}{R}$$

Table no.6 Relative Growth Rate & Doubling Time for Publication

Sr.No.	Year	TP	Cumulative Paper	Loge 1p	Loge 2p	Relative Growth [R (P)]	Mean[R (P)]	[Dt(p)]	Mean [Dt (p)]
1	2001	83	83		0.7060				
2	2002	91	174	0.7060	0.8243	0.1183		5.8598	
3	2003	86	260	0.8243	0.8884	0.0642		10.7999	
4	2004	120	380	0.8884	0.9490	0.0606		11.4299	
5	2005	144	524	0.9490	1.0004	0.0513	0.0128	13.4991	3.3748
6	2006	387	911	1.0004	1.0887	0.0884		7.8429	
7	2007	356	1267	1.0887	1.1414	0.0527		13.1495	
8	2008	467	1734	1.1414	1.1916	0.0501		13.8235	
9	2009	426	2160	1.1916	1.2267	0.0351		19.7450	
10	2010	439	2599	1.2267	1.2562	0.0296	0.0512	23.4438	15.6010
11	2011	487	3086	1.2562	1.2837	0.0274		25.2551	
12	2012	427	3513	1.2837	1.3044	0.0207		33.4700	
13	2013	496	4009	1.3044	1.3255	0.0211		32.8424	
14	2014	421	4430	1.3255	1.3414	0.0160		43.4372	
15	2015	491	4921	1.3414	1.3582	0.0168	0.0204	41.2658	35.2541
16	2016	483	5404	1.3582	1.3732	0.0150		46.3275	
17	2017	467	5871	1.3732	1.3864	0.0132		52.3316	
18	2018	403	6274	1.3864	1.3970	0.0106		65.3351	
19	2019	414	6688	1.3970	1.4072	0.0102		67.8793	
20	2020	456	7144	1.4072	1.4178	0.0105	0.0119	65.7622	59.5271

Table no. 6 Relative Growth Rate and Doubling Time for publication The Relative Growth Rate [R (P)] and Doubling Time [Dt (P)] of Publication in Table No.4.4.13. It can noticed that the Relative Growth Rate of Publication[R(P)] lightly decrease from the rate of 0.1010 in 2010 to 0.0105 in 2020. The mean relative growth (i.e. 2001 to 2010) showed a growth rate of 0.0512 and (2011 to 2020) 0.0119. The corresponding Doubling Time for different years [Dt (P)] highly increased from 5.8598 in 2001 to 65.7622 in 2020. Thus as the rate of growth of publication was decreased, the

corresponding Doubling Time was increased. At the same time, the corresponding doubling time for different year gradually increased from 2001 to 2010. The mean doubling time for the first four years (i.e.2001 to 2010) was only 15.6010 which increased to 59.5271 during the years (2011 to 2020). the rate of growth of publication decreased, the corresponding doubling time increased. It could be deduced that in general there is a progressive increase in the number of publication for the study period. However the relative growth rate shows a downward trend which mean the rate of increase is proportionally low, and this is higher than relative Growth Rate.

Conclusion:

This study provides a comprehensive analysis of the publication trends and collaborative dynamics in the field of data visualization, as indexed in the Library and Information Science Abstracts (LISA) database from 2001 to 2020. The year-wise distribution of publications reveals a steady increase in academic output, with a significant surge in productivity from 2006 onward. The peak in 2013, followed by consistent contributions in subsequent years, demonstrates a sustained commitment to research within the field, indicating continued scholarly engagement.

The analysis of the collaboration index highlights a shift towards more collaborative research, particularly from 2006 onwards. The steady increase in collaboration levels, peaking in 2015, reflects a growing trend towards team-based research, driven by interdisciplinary demands and the need for diverse expertise. The Modified Collaboration Coefficient (MCC) further emphasizes the prominence of collaborative authorship, with multi-author publications consistently dominating, especially in the latter part of the study period. The study examines the relative growth rate and doubling time of publications, revealing a decrease in the growth rate from 2010 to 2020. Despite this, the overall number of publications continued to increase, though at a slower pace, as reflected in the rising doubling time. This suggests that while the volume of research output is expanding, the rate of growth has slowed, indicating a shift in the dynamics of publication frequency over time.

References:

Abbasi, A., Altmann, J., & Hwang, J. (2009). *Evaluating scholars based on their academic collaboration activities: Two indices, the rc-index and the cc-index, for quantifying collaboration activities of researchers and scientific communities. Scientometrics, 83(1), 1–13.* https://doi.org/10.1007/s11192-009-0139-2

Ajiferuke, I., Burell, Q., & Tague, J. (1988a). *Collaborative coefficient: A single measure of the degree of collaboration in research. Scientometrics, 14(5-6), 421–433.* https://doi.org/10.1007/bf02017100

Ajiferuke, I., Burell, Q., & Tague, J. (1988b). *Collaborative coefficient: A single measure of the degree of collaboration in research. Scientometrics, 14(5-6), 421–433.* https://doi.org/10.1007/bf02017100

Bansod, B. (2015). *BIBLIOGRAPHIC CONTROL OF MARATHI PUBLICATION IN THE STATE CENTRAL LIBRARY, MUMBAI. INFORMATION SCIENCE, 2(02).*

Benoit, S., Baker, T. L., Bolton, R. N., Gruber, T., & Kandampully, J. (2017). *A triadic framework for collaborative consumption (CC): Motives, activities and resources & capabilities of actors. Journal of Business Research, 79, 219–227.* https://doi.org/10.1016/j.jbusres.2017.05.004

Ertz, M., Durif, F., & Arcand, M. (2018). A conceptual perspective on collaborative consumption. AMS Review, 9(1-2), 27–41. https://doi.org/10.1007/s13162-018-0121-3

Gajbe, S. S., & Sonawane, S. S. (2015). AUTHORSHIP PATTERN AND DEGREE OF COLLABORATION IN THE LEPROSY RESEARCH: A SCIENTOMETRICS STUDY. Knowledge librarian, 2(6).

Gajbe, S. S., & Sonawane, S. S. (2016).Mapping of Leprosy Literature: A Bibliometric Study, Knowledge librarian, 2(6).

Gajbe, S. S., Gajbe, S. S., & Golwal, M. D. (2024). Lotka's Law and Author Productivity in HIV/AIDS Vaccine Research: Evidence from PubMed (2001-2020).

Khandare, S. B., & Sonwane, S. S. (2022). Citation analysis of economics Ph. D. theses of Dr. Babasaheb Ambedkar Marathwada university Aurangabad: A scientometric study. Journal of Indian Library Association Now Available at https://journal. ilaindia. net/, 57(2), 50-59.

Liao, C. H., & Yen, H. R. (2012). Quantifying the degree of research collaboration: A comparative study of collaborative measures. Journal of Informetrics, 6(1), 27–33. https://doi.org/10.1016/j.joi.2011.09.003

Manoj Kumar Verma, Shukla, R., & Yadav, S. (2019). Authorship Pattern and Collaboration Coefficient of the Researchers World: Journal of Arts, Science and Commerce (RW-JASC) During 2010–2017. International Journal of Information Dissemination and Technology. https://doi.org/10.5958/2249-5576.2019.00012.8

Savanur, K., & Srikanth, R. (2009). Modified collaborative coefficient: A new measure for quantifying the degree of research collaboration. Scientometrics, 84(2), 365–371. https://doi.org/10.1007/s11192-009-0100-4

SS Gajbe, SS Gajbe, SS Gajbe(2021) Bradford's Law of Scattering and Leimkuhler Model on HIV Vaccine Literature Research, TUMBE GROUP OF INTERNATIONAL JOURNALS 4 (2),

Sumedh Shamrao Gajbe, Dr.Sangharsh Shamrao Gajbe, Sankalp Shamrao Gajbe(2021) Content Analysis of "Journal of Health Communication"International Journal of Research in Library Science (IJRLS) 7 (3), 172-181