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Original Research

Authorship Pattern on Multiple Disabilities during 2006-2020: A Scientometric Analysis

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ABSTRACT

The study highlights the research collaboration and growth rate in multiple disabilities using social network analysis based on 27708 scholarly communications from 2006-2020. It analyses the types and trends of authorship patterns through various indices and employs social network analysis. The study aims to construct a Co-authorship network at the micro and macro levels to disclose the intellectual structure of prolific authors. The study exemplifies the growth rate with mean average growth rate (0.09), relative growth rate (0.23) and doubling time (3.52), which specifies that there is no constant rate of augmentation found in the research field and authors tend to work collaboratively. While comparing the prolific authors' Scientometric measures with social network measures, the author Kappos L has secured the highest position in production (255), with the utmost H-Index (67), G-index (154), M-Index (3.914) and citation (24478). He is the best collaborator with the highest cluster level of 354, degree centrality (84) and close to other authors (0.847).

Keywords: Multiple Disabilities, Relative Growth Rate, Doubling Time, Authorship Pattern, Collaborative Indexes and Social Network Analysis.

Introduction

Authorship pattern describes the characteristics and collaboration between authors in a particular field. It is a measure of the interactive study utilized in Scientometric to shed- light on contributors' intellectual and technical knowledge, a significant and recent progression in the metric study. It reveals the number of authors in a publication, their dedication, reputation, professional accomplishment, and production cognoscibility in a specific field. Hence this study aims to determine the authors' contribution in the multiple disciplinary field. It also aids in acknowledging the author's contribution, which supports the upsurge in their further productivity in this field. Lotka's law of scientific productivity can verify the authorship pattern and fit of goodness can be tested by K-S Test (Rajgoli & Laxminarsaiah, 2015), (Kasa, Izah, Soyemi & Opeke, 2020).

Multiple disabilities is a term for an individual with two or more combinations of disabilities; There are four types of multiple significant disabilities they are physical, developmental, behavioural or emotional and sensory impaired. It also includes imperfect hearing or visual impairment. According to the World Health Organization statistics report. 12.6% of people aged between 15- 45 are affected by multiple disabilities. The prevalence of multiple disabilities is seen at the household level more than in individuals. It ranges from 9.4% - 68.3%. The median household level in dissemination is 27.8%, i.e., in four families, one or more people are affected by multiple disabilities. Most probably, people living in rural areas are affected by multiple disabilities more than in cities. It affects aged people; women are affected by seeing or walking more than other prevalent difficulties like hearing, understanding, self-care or communiqué difficulties.

The WHO and WHS reports portray that multiple disabilities are a significant national health issue. Still, no scientometric study using social network analysis has been conducted to enumerate the research production. The structural methodology is based on the study of interface and association among scientists is called social network analysis. An analysis of collaborative behaviour between the scientists in the field can be verified through collaborative measures along with centrality measures consisting of authors or nodes and their relationships, aiming to recognize and interpret the pattern of a link among them and help to envisage the social structure of any entities. It also aids in exploring the research efforts taken by the scientists and prolific authors who are concentrating on and discourse the problem society faces. These can be explained by employing social network analysis. It can be a cluster of people, organizations, regions, nations and communities which broadcast information and performances (De Nooy, Mrvar & Batagelj, 2018).

Micro-network measures are employed to identify prolific authors through the central node. It aids in examining the appropriate non-directional network and their relationships by co-occurrence network (Wasserman & Faust, 1994). In the Co-authorship network, degree centrality specifies the number of times an author worked with others to publish a research article through ties. It aids in calculating both non-directional and directional networks, such as citation networks. Closeness centrality depends on the distance between authors; it also focuses on the prolific author's connectivity with other neighbouring authors with the help of vertices. A considerable distance depicts lower or fragile closeness, and a shorter distance depicts higher or stronger closeness (De Nooy et al., 2018). Betweenness centrality gauges the number of times a node associates with other nodes in the shortest way (Wasserman & Faust, 1994). Meso network is indicated through clustering techniques, which analyze the performances of documents, authors, or institutions. Components can compute the utmost clustering technique; if one component in a graph is connected, it specifies the strongest association; if more than one component is available in the graph, it specifies the weakest connection (Kleinberg, 1999). Macro network measures aid in measuring the density, connectedness, average distance, and correlation between layout and Geodesic path can be verified. The study's limitations are considered as only the top 100 authors have been selected for the Co-authorship network. The top 20 prolific authors' Scientometric and social network measures were identified and compared.

The interactions that social network analysts study are typically those that tie individual human beings. Network analysts frequently scrutinize links between groups, organizations, institutions, states, nations, or international groupings. The following topic review of the

literature lights up the usefulness of the social network analysis measures at various levels. The next topic describes the methodology and limitations of the study to analyze the data and sketches social network analysis measures.

Literature Review

Several scientometric studies have been carried out to analyze research productivity. Among them, few are reviewed for this study. The growth pattern of chemical papers and elements is verified through the exponential growth of literature (Schummer, 2004). Mutschke and Mayr (2015) explored the applicability and usefulness of two particular science models for re-ranking search results with Bradfordizing and author centrality. Similarly, collaboration networks were structured to study diseases and disorders like chromosomal disorders and other abandoned diseases (Nishavathi & Jeyshankar, 2018). Nishavathi & Jeyshankar (2020) determined a study on meso metrics, such as clustering techniques, hubs, and authorities were also employed to scrutinize the citation networks. Baskaran (2020) analyzed the production of faculty members of Alagappa University by computing their citations and h-Index based on both WoS and GSM during 1989-2018, which accomplished the maximum output in 2018 with the greatest h-index of 7, which is mainly published by Central Electrochemical Research Institute researchers (Jeyshankar, Babu & Rajendran, 2011). Nishavathi, Jeyshankar and *Dong-Geun* (2022) persistent about Co-authorship network analysis to map the research productivity and collaborative pattern of Alagappa University authors as replicated through Scopus and Web of Science database for 10 years from 2009 to 2018. Research on the structural and conceptual network of the authors aids in comparing with other authors through network analysis. The temporal evolution of network analysis revealed more insights into the authors' productivity and found inadequate literature published on social networks. Liu, Bollen, Nelson, & Van de Sompel, (2005) introduced a weighted directional network model, Author Rank, to signify the impact of an individual author in the network. The results also emphasized that PageRank and AuthorRank divulge degree, closeness and betweenness centrality metrics which is significant for Co-authorship networks. Waila, Singh and Singh (2016) presented analytical outcomes of Recommender Systems progressed to evaluate the importance of budding areas of research with total output, growth of output, authorship and country-level collaboration patterns, major contributors, top publication sources, thematic trends and emerging topics in the field to elaborate a scientometric mapping of research. Various social network analyses have been scrutinized to appraise the conceptual and social network structure, such as the bibliographic data's co-occurrence, impact and Co-authorship pattern (Giannakis & Croom, 2001, Newman, 2001). Three types of metric analysis can be employed to verify the social network analysis of a particular field in that the citation network can be represented through the links, nodes and edges between the documents. Combining the number of documents with prolific institutions, journals, authors, and countries at the local and global level can be appraised with the help of centrality measures like closeness, betweenness, and page rank algorithms, which is considered as micro – level metrics (Breznik & Skrbinjek, 2017; Waltman, Yan & van Eck, 2011). Another metric is a meso-level metric which can be utilized to appraise clustering, hubs and authority for various groups, institutions and organizations (Batagelj, Doreian, Ferligoj & Kejzar, 2014; Nishavathi & Jeyshankar, 2020) Baskaran (2020) persistent citations and h-Index for the research output of faculty members in Alagappa University based on the database retrieved

from both WoS and GSM from 1989 to 2018. The outcome revealed that Central Electrochemical Research Institute researchers had contributed more documents.

Considering a literature review, it is determined that centrality measures can be evaluated through micro, macro and meso-level metrics. This study envisioned exploring the knowledge dissemination pattern, social collaborations, and productive authors by constructing citation and Co-authorship networks for the research output from 2006-2020. The principal intention of this study is to scrutinize collaboration between authors through various indexes, micro, meso and macro level metrics to explore–the authorship network on research output. The outcomes will support the authorities in formulating policies regarding multiple disabilities, fortifying research accomplishments, and constructing innovative scientific methodologies for collaborative research. The following topic identifies the objectives of the article drawn from the previous studies.

Objectives

Objectives of the study are deliberated according to the exploration of the Co-authorship network to generate enhanced results for the study

- To measure the scientific research output on multiple disabilities during 2006-2020;
- To determine the degree of collaboration by employing various indexes;
- To find out the collaboration and centrality measures for co–authorship network and
- To compare the Scientometric measures with social network measures of prolific authors.

Material and Methods

The data has been retrieved from the Web of Science (WoS) database with 27708 records for 15 years (2006-2020). Bibexcel, MS-excel and Pajek software were used to analyze the data. Growth consistency can be evaluated through growth rate and doubling time. Doubling time is utilized to compute the required time to double the existing quantity of publications, citations, etc. It has a close association with the relative growth rate. Whereas to quantify the level of collaborative practices was scrutinized through various indexes like Degree of Collaboration, Collaborative Index, CAI, Collaborative Coefficient and Modified Collaborative Coefficient are used to study the trend of Co-authorship in any field or discipline. Collaborative Index (CI) represents the average number of authors per paper intense by Lawani(1980), and the degree of collaboration (DC) represents the percentage of multi-authored papers efforts, which is established by Subramanian (1983). Ajiferuke, Burell and Tague (1988) recognized the shortcomings of the Collaborative index and degree of collaboration, framed the collaborative coefficient (CC), incorporated some merits to the earlier indexes, and formulated a collaborative co-efficient, which resolved the shortages of both collaborative measures.CC lies the values between 0 and 1. The value 0specifiesdomination of a single author and value 1 specifies the domination of multiple authors. CC discriminates single and collaborating authors, but it flops to convey about 1 for extreme collaboration of authors apart from the infinite of authors. It was resolved by Savanur and Srikanth (2010) by the factor (1 – 1/A) with CC and articulated a new theory of Modified Collaborative Coefficient (MCC). Co – Authorship Index (CAI) was expressed by Schubert and Braun (1986) for the first time, and Garg and Padhi (1999) recommended a formula to compute CAI. It is acquired by calculating the production of correspondingly single or more authored papers.

If CAI = 100, the number of productions is equal to are average within a Co-authorship pattern.

If CAI >100, the number of productions is more significant than the average

CAI <100, the number of productions is inferior to the average

For appraising the prolific author's accumulative impact on output and performance and to measure the quantity with quality by comparing publications to citations, H-index, G-index and M-index were utilized.G-index, which allows highly-cited papers to reinforce low-cited papers and gauge the m- index value, researchers H-index is divided by the number of years since their first publication.

Results

Table 1 and Figure 1 depict the inverse relationship between relative growth rate and doubling time. RGR and Dt are employed to determine the performance and efficiency of growth of literature for the period of 2006-2020 have displayed a mean relative growth rate of 0.23 and doubling time of 3.52. The lowest RGR is observed in 2019 as 0.11, with the highest doubling time of 6.09 in the same year. It is observed that the average annual growth rate of productivity for the study period is 0.09. Even though the growth rate of literature increases spontaneously, the average growth ratio shows that the growth speed is not constant.

Table 1

Growth Rate and Doubling time of Research Output on Multiple disabilities

S.No	Year	Records	Cum.	ARoG	AGR	W1	W2	RGR	Dt
1	2006	901	901	0.00	0.00	0	6.80		
2	2007	995	1896	1.10	0.10	6.80	7.55	0.74	0.93
3	2008	1070	2966	1.08	0.08	7.55	7.99	0.45	1.55
4	2009	1245	4211	1.16	0.16	7.99	8.35	0.35	1.98
5	2010	1307	5518	1.05	0.05	8.35	8.62	0.27	2.56
6	2011	1533	7051	1.17	0.17	8.62	8.86	0.25	2.83
7	2012	1715	8766	1.12	0.12	8.86	9.08	0.22	3.18
8	2013	1889	10655	1.10	0.10	9.08	9.27	0.20	3.55
9	2014	2025	12680	1.07	0.07	9.27	9.45	0.17	3.98
10	2015	2105	14785	1.04	0.04	9.45	9.60	0.15	4.51
11	2016	2250	17035	1.07	0.07	9.60	9.74	0.14	4.89
12	2017	2337	19372	1.04	0.04	9.74	9.87	0.13	5.39
13	2018	2549	21921	1.09	0.09	9.87	10.00	0.12	5.61
14	2019	2641	24562	1.04	0.04	10.00	10.11	0.11	6.09
15	2020	3146	27708	1.19	0.19	10.11	10.23	0.12	5.75
Total		**27708**		**Mean AGR 0.09**		**Mean RGR &Dt**		**0.23**	**3.52**

ARoG- Average ratio of growth**, AGR-**Average Growth Rate, **RGR-** Relative Growth Rate **and Dt-** Doubling time

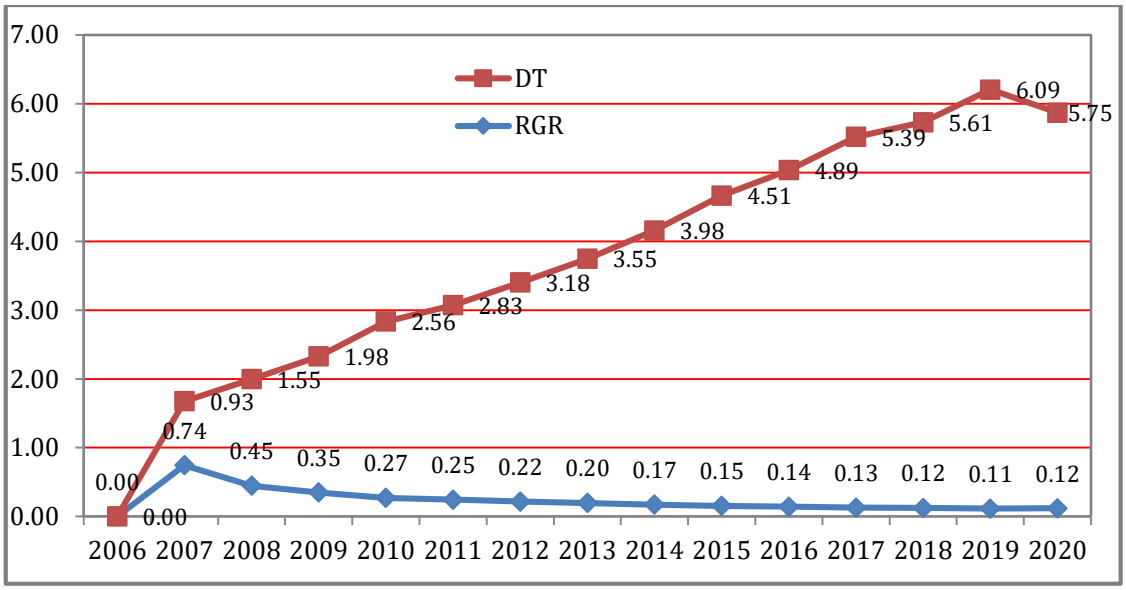

Figure 1: Relative Growth Rate (RGR) and Doubling Time (Dt) of Research Output

Table 2 represents the collaboration and impact of publication through MCC, CI, TA, and ACPP. The research output on multiple disabilities and DC for the study period is 0.90-0.97, close to 1, indicating the dominance of multi-authored documents. Even though the multi-authorship pattern increases throughout the year, their collaboration has been varied, and CI for the research output fluctuates from the initiating year, indicating that the mean value of author per paper is not in proportion.CC illustrates the higher collaboration of multi-authors but fails to depict the performance of collaboration among authors, but MCC calculated the performance level of authors is also great. To evaluate the impact of authorship pattern, total citation and average citation per paper have been calculated, providing the consequences as 2012 received the highest citation of 78700, which is tailed by 2006(63799) and 2010(63684) citations, earlier periods of publications received more citations. Even though 2012 established more citations, average citation per paper reached its peak in 2006 with 70.81 and has been unceasingly reduced in the subsequent years.

Table 2
Chronological Distribution of Collaboration Indexes of Research Output

Year	Records	Single	Multiple	DC	RSA	CI	CC	MCC	Total Citation	ACPP
2006	901	94	807	0.90	0.10	2.10	0.72	0.72	63799	70.81
2007	995	90	905	0.91	0.09	2.03	0.74	0.73	48823	49.07
2008	1070	93	977	0.91	0.09	2.10	0.75	0.74	57848	54.06
2009	1245	99	1146	0.92	0.08	1.95	0.75	0.75	52415	42.10
2010	1307	81	1226	0.94	0.06	1.95	0.77	0.76	63684	48.73
2011	1533	96	1437	0.94	0.06	1.89	0.77	0.77	59551	38.85
2012	1715	94	1621	0.95	0.05	1.93	0.79	0.78	78700	45.89
2013	1889	108	1781	0.94	0.06	1.82	0.79	0.79	54580	28.89
2014	2025	113	1912	0.94	0.06	1.75	0.80	0.79	53875	26.60
2015	2105	93	2012	0.96	0.04	1.81	0.81	0.8	54453	25.87

Year	Records	Single	Multiple	DC	RSA	CI	CC	MCC	Total Citation	ACPP
2016	2250	81	2169	0.96	0.04	1.70	0.82	0.82	48850	21.71
2017	2337	101	2236	0.96	0.04	1.69	0.82	0.82	48618	20.80
2018	2549	103	2446	0.96	0.04	1.65	0.83	0.82	41124	16.13
2019	2641	78	2563	0.97	0.03	1.62	0.84	0.84	25752	9.75
2020	3146	93	3053	0.97	0.03	1.58	0.84	0.84	14308	4.55
Total	**27708**	**1417**	**26291**						**766380**	

DC: Degree of Collaboration; RSA**:** Rate of Single Authorship; **CI**: Collaborative Index; **CC:** Collaborative Coefficient; **MCC**: Modified Collaborative Coefficient; **TA:** Total Authors; **ACPP:** Average Citation Per Paper.

Table 3 evidenced that the collaborative authorship index for the output of multiple disabilities for the entire study period was diverse, with higher and lesser than the average. From 2006 to 2013, the collaboration of dual, three, four, and five authors was high and average in 2014 and declined in the latest years. But the CAI of more than five authors augmented in the latest years pronounces enhanced research relevance, effectiveness, quality and validity in multiple disabilities productivities.

Table 3
Co-authorship Index for Authorship Pattern of Research Output

Year	Single Author	Two Author	Three Author	Four Author	Five Author	More than Five Authors	Total
2006	204.00	143.85	105.36	103.33	112.08	74.57	901
2007	176.87	136.42	117.42	113.68	93.10	77.83	995
2008	169.96	113.50	109.19	112.18	117.78	79.61	1070
2009	155.49	130.34	106.88	110.01	95.86	84.40	1245
2010	121.18	128.84	127.26	97.14	100.25	85.52	1307
2011	122.45	129.15	107.44	104.40	96.36	89.43	1533
2012	107.18	111.87	97.93	109.47	112.90	91.53	1715
2013	111.80	109.67	89.77	100.61	107.80	97.28	1889
2014	109.12	100.80	104.17	97.27	94.79	99.85	2025
2015	86.39	94.54	98.67	109.66	101.10	100.03	2105
2016	70.39	88.90	99.89	95.75	100.15	106.61	2250
2017	84.51	84.28	97.90	96.47	97.85	106.94	2337
2018	79.01	82.88	93.26	87.24	103.46	110.11	2549
2019	57.75	81.15	86.94	99.35	95.12	113.01	2641
2020	57.80	73.31	95.68	91.96	89.67	115.90	3146
Mean	**114.26**	**107.30**	**102.52**	**101.90**	**101.22**	**95.51**	**27708**

Table 4 represents the top 20 prolific authors in the research field of multiple disabilities. The authors were ranked according to their publication count. Kappos L, acknowledged as the utmost prolific author in terms of efficiency and citation impact with his publications, started to appear in the year 2006, followed by Motl RW with 219 publications from the year

2006onwards but received a minimum citation of 7710 representing excellence of his work need to be improved. Similarly, Comi G ranked 3rd position with 205 publications from 2006 onwards. He secured 61 as his H-index, 133 as his G-index and 3.588 as his M-index secured the second position with the highest citation of 18549 scores, and secured good author-level metrics. Montalban X received the 3rd highest citations of 16781 with a minimum of 172 publications which depicts the premier quality of his work. It clearly states that the most prolific author need not be influential or highly productive. According to the prolific authors, Kappos L received the highest M-index, and further 14 authors recognized the highest M-index as 2.118 to 3.941, which analyses the functional performance of authors. However, the publication counts were the nearer for authors; their impact values have greatly differed according to their author-level metrics.

Table 4
Top 20 Prolific Authors in the field of Research output

Authors	h-index	g-index	m-index	TC	NP	PY
Kappos L	67	154	3.941	24478	255	2006
Motl RW	46	77	2.706	7710	219	2006
Comi G	61	133	3.588	18549	205	2006
Filippi M	57	89	2.672	9693	189	2006
Lancioni GE	26	42	1.562	3046	182	2006
Barkhof F	55	105	2.582	11958	174	2006
Montalban X	58	128	3.566	16781	172	2006
Sigafoos J	25	38	1.324	2674	170	2006
O'reilly MF	24	37	1.326	2535	168	2006
Singh NN	23	36	1.346	2348	161	2006
Zivadinov R	40	64	2.353	5029	158	2006
Weinstock-Guttman B	45	80	2.647	6981	151	2006
Miller DH	52	116	3.059	13727	139	2006
Giovannoni G	44	114	2.588	13126	130	2006
Rocca MA	43	72	2.116	5850	126	2006
Havrdova E	44	102	2.588	10570	123	2006
Trojano M	41	75	2.412	5977	121	2006
Sormani MP	36	69	2.118	5148	116	2006
Amato MP	44	73	2.588	5730	112	2006
Butzkueven H	36	76	2.118	6003	103	2006

Centrality Measures for Co–Authorship Network Analysis

Co-authorship network is evaluated for the research output of multiple disabilities from 2006 -2020. The features of co – the authorship network is given below. The network excludes the production from solo authors. The Co-authorship pattern has been evaluated by selecting top 100 authors and their collaboration with other authors in that the following consequences have revealed

Total No of Nodes - 100

Total No of links - 2092
Density –0.402
Average Degree –39.800
All degree Centrality – 0.455
Betweenness centrality- 0.0249
Closeness centrality - cannot be computed since the network is strongly connected

- The association of a network can be deliberate by its density value. The density value of theco–authorship network 0.402 networks is designated to be very strongly connected, so only closeness centrality cannot be calculated.
- The average degree centrality (39.800) specifies the mean value of collaborators per node in the network. Kappos L has a high degree of centrality and collaborates with 354 collaborators, which depicts that Kappos L is a vital collaborator of the whole network.
- Comi G has the maximum betweenness (0.0297), which point out that he is the most dominant author in the network linking different group of collaborators and controlling the flow of information between other authors.
- Kappos L (0.8471) is an excellent broadcaster who again has the maximum closeness with other authors. He specifies that he is rapidly interrelating and linking with others without intermediaries to find the best individuals to influence the entire network quickly. Moreover, the linked authors have similar scores and depict the authors' influence in the cluster. While analyzing the closeness centrality measure, the association of co-workers of an article was also identified.
- The network has 2 components. The author Filippi M collaborated with many authors. Lancioni GE is often connected with four authors and joined in the Co-authorship pattern. Sigafoos J, O'Reilly M F, Lancioni GE, Singh NN and Olivia D articulated a distinct component consisting of five nodes which denote that neither these authors nor their co–authors are not collaborating with others. They are considered an independent group of researchers and experts in this field of multiple disabilities research.
- Kappos L, with the highest cluster value of 354, leads the topper among the top 20 authors in the multiple disabilities research output. He also secured first rank in degree centrality (84) and closeness centrality (0.8471), showing his collaborative trend with other authors. The author Comi G secured second place in cluster level and closeness centrality with 0.7708. Sormani MP (0.7505) also secured third place in closeness centrality by producing 205 documents.
- Comi G has attained first place in betweenness centrality (0.0317), indicating that most of the research in the multiple disabilities field is conducted through his peer research groups. Hence he controls the flow of information. It also shows that he demeanour more research with his contemporaries and collaborated with the superior research community.

Table 5 and figure 2 depict that the degree of centrality depends upon the connectivity between authors. The prolific author Kappos L has the highest productivity (255), Degree centrality (84), and closeness centrality (0.847) and has been closely connected with several authors. Hence he secured a prolific position in the Co-authorship pattern. The author Cutter G, whose vertex is bigger, depicts that many authors are connected with him. But the highest value of his connectivity is 23, and he has collaborated with Marie A. The closest vertices are determined with the value of 0.00356 associated with the authors Cocco E and Soresaen PSvery

closely related. The vertices with the smallest angles are Ghezzi A, Zipp F and Martinelli V, with a value of 0.0042. Hillert J and Pelliter J are connected with the shortest line (0.01562), and Grand Maison F and Ghezzi A are associated with the most extended lines (0.83605). Totally 291565 crossing lines have been calculated. Maes B and Vlaskamp C are isolated because they are not connected with other authors; they are only associated with each other. The individual vertex adjoining to line can be measured as 0.00002, with the authors Weindl H, Marrie RA, and Zippf being the vertex associated by other authors. The correlation between layout and Geodesic paths illustrates that 93 vertices are connected with a value of 0.3915, and five vertices have 0.0000 component correlation. Even though these authors are not presented in the top 20, their relationship is depicted in the figure.

Table 5
Centrality Measures for Top 20 Prolific Authors in Multiple Disabilities Research output

S.No	Authors	Cluster	Rank	Degree	Closeness	Betweeness
1	Kappos L	354	1	84	0.8471	0.0297
2	Comi G	273	2	47	0.7708	0.0317
3	Filippi M	239	3	56	0.6633	0.0109
4	Motl RW	228	4	10	0.4834	0.0191
5	Montalban X	218	5	73	0.7639	0.0141
6	Barkhof F	206	6	58	0.6737	0.0106
7	Lancioni GE	189	7	4	0.0500	0.0000
8	Giovannoni G	184	8	61	0.6900	0.0061
9	Zivadinov R	184	9	14	0.5281	0.0079
10	Havrdova E	178	10	65	0.7130	0.0125
11	Sigafoos J	177	11	4	0.0500	0.0000
12	Weinstock-Guttman B	176	12	60	0.6900	0.0179
13	O'Reilly MF	174	13	4	0.0500	0.0000
14	Singh NN	168	14	4	0.0500	0.0000
15	Trojano M	166	15	69	0.7376	0.0106
16	Butzkueven H	163	16	61	0.6900	0.0060
17	Miller DH	159	17	29	0.6385	0.0047
18	Rocca MA	152	18	56	0.6828	0.0097
19	Sormani MP	148	19	71	0.7505	0.0192
20	Amato MP	137	20	56	0.6633	0.0065

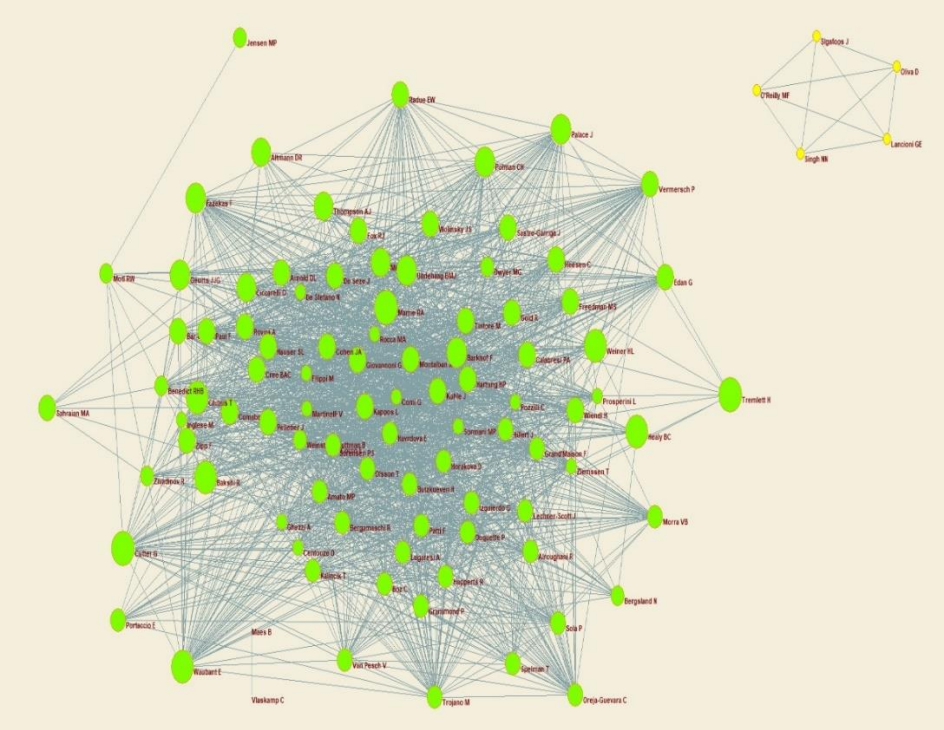

Figure 2: Collaboration network of top 100 authors in the research field

Comparison between Scientometric measures and social network measures represents that both the measures are correlated with each other such as the highest productivity, indices, degree centrality, closeness centrality and betweenness author Kappos L secured utmost H-Index (67), G-Index (154), M-Index (3.941), citations (24478)with the highest productivity of documents with (255), he has also associated with many numbers of authors with highest cluster level (354), degree centrality and closer to other authors with 0.8471closeness centrality measures. Prolific authors' scientometric measures are highly linked with social network measures. The author Comi G who secured third place in productivity with 205 documents, accomplished second position in H-Index (61), G-Index (133), M-Index (3.588), and total citation (18549) also mostly linked with SN measures like he secured second place in the cluster (273), closeness (0.7708), betweenness (0.0317), but significantly less degree centrality (47). It depicts that he is connected many times to the closest authors, not connected with some authors. Through his connectivity, more authors are associated. Hence his betweenness is augmented.

Discussion

An effort has been made to evaluate the research productivity and authorship pattern of multiple disabilities by applying scientometric and social network measures. The overall productivity of this study is 27708, with an average growth rate of 0.09 for the period of 2006-2020, as reflected in the WoS database. Even though the growth of literature is increasing every year, it is not at a stable rate. Applying scientometrics to the study's Co-authorship delves into the attribute's statistical features. Still, centrality measures clarify the association and connection between the authors, which helps find the most productive, dominant authors and their social interactions. Kumar (2015) analyzed a study on Co-authorship, a substitute for research collaboration; it is a significant way to determine the association of different sets of aptitudes to construct a research output. It can be viewed from the standpoint of social networks,

which also depict the scientific community. In this study, also authors desired to work collaboratively, and the form of community tends to be large. Abbasi, Altmann and Hossain (2011) Scrutinized a research presentation of scholars (*g*-index) is wholly associated with four SNA measures, excluding the normalized betweenness centrality and the normalized closeness centrality measures. In multiple disabilities research, prolific authors' efforts are significantly linked with SNA measures of Co-authorship pattern. Sanjeevaraja, C. was still renowned as the most prolific author of Alagappa University. A single author named Kappos L accomplished the first position in the research field (Nishavathi et al., 2022). Benckendorff (2010) employed network analysis to indicate that the network metrics are accessible to recognize the most productive and collaborative authors and institutions, and the inferences of these measures are explored.

The association between productivity, citations and collaboration is also discussed. It is also discussed in considerable disability research and found that the most productive author Kappos L is associated with productivity, citation and collaboration. But to the controversy, Comi G an additional author Sormani MP (0.7708), also secured the second position in closeness centrality with the minimum production of 205 documents. Zare-Farashbandi, Geraei and Siamaki (2014) explored that the network leaders can control the flow of information in the network evaluated with the other members based on the shortest paths. Likewise, Comi G has accomplished first place in betweenness centrality (0.0317), which points out that most of the research is conducted through his contemporary research groups. Hence he controls the flow of information. It also demonstrates the collaboration with the greater research community.

Conclusion

The study aims to identify the research collaboration and growth rate in multiple disabilities by employing social network analysis based on 27708 publications from the Web of Science that appeared from 2006-2020. It scrutinizes the trends of authorship patterns through numerous indices like Degree of Collaboration. Collaborative Indices and impact are measured through citation. The consequences of growth rate determine the presentation and effectiveness of the growth of literature with mean average growth rate (0.09) and average RGR (0.23), and doubling time (3.52). Even though there is a continuous augmentation in the growth of literature, a constant growth rate is absent. The study period evinces a 0.90-0.97 degree of collaboration, representing the dominance of collaboration in publications but varied and fluctuating in the collaboration index.

Total citation and average citation per paper have been calculated to appraise the impact. Results showed that 2012 acknowledged the highest citation of 78700, followed by 2006(63799) and 2010(63684) citations; former publications received more citations than the latest, which shows the recent publications yet to be cited. Even though 2012 recognized higher citations, the average citation per paper was accomplished in 2006 at 70.81, and it has been constantly condensed in the following years. CAI of research output portrayed that more than five authors' collaboration increased throughout the year articulating greater significance, efficiency and excellence in research of multiple disabilities productivities. Collaborating with professional experts allows for expanding and improving the research with new strategies. Kappos L has been acknowledged as a prolific author with his highest publication (255) and utmost citation (24478). He also secured the highest H-Index (67), G-Index (154) and M-Index (3.941), which shows his excellence in work.

The centrality measures describe that the density value of Co-authorship is 0.042 with a strong connection; hence closeness cannot be calculated. The prolific author Kappos L secures a high degree of centrality and is a good broadcaster with 0.8471 maximum closeness with other authors. Comi G is the most dominant author in linking different groups of collaborators and controls the flow of information. SigafoosJ, O'Reilly M F, Lancioni GE, Singh NN and Olivia D expressed a separate component consisting of five nodes that do not collaborate with others. They are deliberated as an autonomous group of researchers and experts in this field of multiple disabilities research.

The closest vertices with the value of 0.00356 determine the connection of authors Cocco E and Soresaen PS are very closely correlated. The vertices with the tiniest angles are Ghezzi A, Zipp F and Martinelli V, with a value of 0.0042. Hillert J and Pelliter J are connected with the shortest line (0.01562), and Grand Maison F and Ghezzi A are associated with the lengthiest lines (0.83605). Totally 291565 crossing lines have been calculated, in that Maes B and Vlaskamp C are quarantined because they are not linked with any other authors; they are only connected. Comparison between Scientometric and social network measures represents that both the measures are correlated with each other such as the highest productivity, indices, degree centrality, closeness centrality and betweenness. The effects of multiple disabilities create more societal issues for an individual, but the research published in the field oscillates. Hence, this study determines the prolific authors may be fortified to conduct more research in the field. The authors not contributing to the specific field can be motivated to research by providing more funds and scholarships. It also assists Research and Development centres, organizations, and authors in making some effort to publicize the issues to promote the nation's health and wealth.

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