Characterizing Elite Scholars of Library and Information Science: A Bibliometric Analysis

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Abstract

Publication metrics have become crucial to measure the productivity and impact of individuals and organizations for highlighting their influence upon the knowledge world. This study aims to present a bibliometric analysis of the top two percent highly cited Library and Information Science (LIS) researchers in the Stanford University list of the top two percent researchers of various disciplines published in 2021. We have used the bibliometric method to analyze 254 highly cited LIS researchers. The findings show male dominance and female underrepresentation in LIS research. Leydesdorff, Loet is the most highly cited researcher of the LIS field. The Amsterdam School of Communications Research, Netherlands, is the most highly cited organization of LIS based on the highly cited researchers affiliated with it. The majority of LIS researchers belong to USA and UK. There is a meager contribution of Asian, Australian, and African countries producing highly cited LIS researchers. Highly cited LIS researchers are more familiar with publishing research in information retrieval, information seeking, and bibliometrics.

Positions of researchers at different ranks by different measures depict their productivity, impact, h- index, and a composite score. A strong correlation exists between total publications and total citations. The study, in its nature, is unique and will provide an insight for young and emerging researchers for selection of research direction, persons for research collaboration, and a motivation to invest more efforts for impactful research.

Keywords: Highly cited scientists; two percent highly cited researchers; lis researchers; elite scientists; bibliometric study; library and information science

Introduction

Research is a studious examination for knowledge creation. According to Hillway (1964), research is "a method of study by which, through the careful and exhaustive investigation of all the ascertainable evidence bearing upon a definable problem, we reach a solution to that problem". Research plays an important role in the growth and development of professions (Siddique et al., 2021) and helps policymakers to make evidence-based policies keeping in view the recent research results. Public policymakers are perfectly informed by researchers to make timely and cost-effective solutions to the problems (Lavis et al., 2004). Researchers play a crucial role in conducting research on various phenomena and continue to work towards the exploration of satisfactory answers to important questions (Salkind & Rainwater, 2006). In recent years, research has been rapidly increasing in almost all disciplines. The role of institutional researchers is not merely limited to assembling, analyzing, interpreting, and disseminating information. Still, they have become change agents, information scientists, and advisors of choice within their institutions (Matier, 1994).

There are various methods to measure the quantity and quality of research. Throughout scientists' careers, assessments of their quality as scientists play a crucial role - for example, competitions for gaining fellowships, appointments, tenure decisions, promotions, and funding for research (Sonnert, 1995; Yang & Meho, 2006). One of the most common methods to assess the impact of research was publications count in early times and the number of published articles that cited them. Later on, several indicators emerged to measure the significance and impact of the research output of scientists (Farooq et al., 2017). The h-index presented by Hirsch (2005) defined by Mester (2016) as "A scientist has index *h* if *h* of his/her N_p papers have at least *h* citations each, and the other $N_p - h$ papers have no more than h citations each" and is globally used due to its

simplicity and usefulness (Alonso et al., 2009). It is used to compare scientific journals, authors, research teams, countries, and institutions. The h-index provides both quality and quantity indicators for published research. One of its drawbacks is that it does not consider the citations of top h-core publications when the highly-cited publication is different for two authors but has the same h-index (Farooq et al., 2017).

However, to overcome the limitation mentioned above of the h-index, the g-index was introduced to assess the global performance of citations of a set of articles (Egghe, 2006). The g-index also considers all h-core publications, not all publications, and the age of an author's research. The impact factor is also considered a qualitative indicator for assessing journals based on the citations and directly provided by ISI Web of Science. But one of its shortcomings is that it is manipulated by researchers using self-citations (Bordons et al., 2002). The citation counts are heavily used to assess the impact of publications of the scientific community produced by sole authors, institutions, or countries (Vieira & Gomes, 2010). These citations to the published research can be captured from the two most widely used indexing and abstracting databases, Scopus and Web of Science.

Web of Science is the oldest one where its content coverage goes back to, for Science Citation Index 1945, Social Sciences Citation Index 1956, and Arts & Humanities Citation Index 1975. Subject coverage of Web of Science includes all disciplines (*Web of Science database*, 2021; Yang & Meho, 2006). Similar to Web of Science, Scopus, a product of Elsevier, is also an abstract and citation database. Its content coverage goes back to 1966 and citation coverage from 1996 onwards. It covers 39743 journal titles, including 25000 active and 14558 inactive titles from more than 5000 international publishers worldwide (*About Scopus-Abstract and citation database*, 2021). Several research studies have been conducted based on Scopus data, including bibliometric analyses, citation analyses, and studies on collaboration networks. These studies have also been conducted to measure published research's quantity, quality, and structural aspects. The available literature tends to discuss various author ranking systems and methods, i.e. h-index, g-index, and citation analyses based on citations either from Web of Science, Scopus or Google Scholar.

Stanford University has recently published a list that signifies the top two percent of the most-cited scientists in several disciplines based on the citations from Scopus. It was released in 2017 for the first time. The report was prepared by a team of scientists led by Professor John Ioannidis, a

distinguished Professor at Stanford University. The analysis was performed using research publications upto 2020 end and was published in a peer-reviewed scientific journal PLOS Biology on October 19, 2021 (Baas et al., 2021). According to the composite citation index, the data comprises all scientists who are amongst the top 1,00,000 across all disciplines, both with self-citations and without self-citations. Scientists have been classified into 22 scientific disciplines and 176 sub-fields, and a minimum number of publications of any author is limited to five. Field and subfield discipline categories are divided keeping in view the Science-Matrix classification. Each author has a single affiliation in the database, although they have worked in more than one organization. There is one most common scientific discipline and two sub-disciplines for each scientist based on his/her publications along with relative percentage for each (Ioannidis et al., 2019; Ioannidis et al., 2020).

The availability of a field-annotated standardized database of the top two percent scientists provided by Stanford University offers an opportunity to perform evaluations of individuals based on their research areas, institutions, disciplines, countries, and regions. Library and Information Science (LIS) is one of those 176 subfields under major field Social Sciences, and 254 scientists are classified under this subject category in the latest released Stanford University list of top two percent scientists. However, by reviewing the available literature and to the best of our knowledge, there has not been found any single study in general and particularly in Library and Information Science research which tends to discuss the analysis of these elite scientists of Library and Information Science as well as their publications, citation densities, gender-wise distribution, affiliations, and countries. The present study is designed to fill this knowledge gap and provide a comprehensive analysis of the top two percent scientists of LIS across 176 sub-disciplines of the world of science. The study will also explore the correlation between the research age of the authors and their scientific productivity, total publications (TP) and total citations (TC), and analysis of variance (ANOVA) within continents and quartiles.

Literature Review

Publication statistics have been ubiquitous for the assessments of scientific achievement of scholars, along with citation counts. Moreover, citation statistics are used to quantify the career achievements of scholars both at the level of single publication and over the entire career (Petersen et al., 2010). Highly cited researchers across various disciplines have been considered elite

scholars, and assessment of their productivity and impact on the scientific community is enormously discussed across multiple research studies. Jones (2021) conducted a scientometric analysis of highly cited scientists in forensic science and legal medicine. This study used the lists of two percent highly cited scientists provided by Stanford University in 2019 and 2020. There were 30 names under the list provided in 2019, which increased to 215 forensic practitioners in the 2020 list. The author reported that among these 30 scientists, the majority belongs to Germany (n=9), followed by the USA (n=5) and Australia (n=4). The average number of published papers by this elite class remained 297. The increased number of scientists in the later list to 215 produced an average number of 145 documents. The rank of countries against productivity changed, and highly cited scientists from the USA were (n=46) followed by Germany (n=32), UK (n=10), Australia (n=19), Canada (n=11), and Japan (n=10). The study also highlighted the top ten scientists who remained on the lists all the time. The most productive author was Kintz, P. from the University of Strasbourg, France, with 500 research publications.

Another study by Chan and Torgler (2020) on gender differences among 94000 top-cited scientists by their discipline and country based on the Stanford University released list in 2019, reported that men scientists dominate and female representation (15%) among highly cited scientists fluctuates between countries as well as scientific disciplines. Among these top-cited scientists, the highest representation of women scientists belongs to Finland (20.45%), while the lowest is from Saudi Arabia (2.08%). The share of female scientists by discipline remained highest in Public Health and Services (36.1%) and the lowest in Physics and Astronomy (7.7%). The study also revealed that despite the minimum share of female scientists in a few disciplines, they have contributed by publishing more impactful research in those areas than their male scientists. The authors of the study (Mayer & Rathmann, 2018) also discussed the female under-representation in the research productivity of professors of Psychology in Germany. The study also highlighted that women conduct research but distinct publication patterns. They mostly seem to be satisfied publishing their research in less prestigious venues instead of peer-reviewed, highly ranked academic journals. It becomes disadvantageous because publications in competitive journals are considered important and get more recognition.

Parker et al. (2013) analyzed the relationship between the number of articles and the portion of highly cited papers published by 28,078,476 researchers between 1980-2013 by extracting data

from Web of Science, an abstract and citation database. This study concluded that the higher the number of articles a researcher publishes, the higher citations these papers attract. This relationship is more robust for established researchers, while, on the contrary, such a pattern is not observed for younger researchers but only in Natural Sciences. According to Sandstrom and van den Besselaar (2016), there is a strong correlation between production and citation, and it strengthens the statement "more papers, the more high impact papers". From the perspective of being an old or classic researcher to get more cited, Kulczycki et al. (2021) pointed out that when it had become necessary in the governance of the Communist Party (Polish United Worker's Party) to cite classics (Karl Marx, Friedrich Engels, Vladimir Lenin, and Joseph Stalin) to get the work published, the citations to classics (*N=296*) only contributed 0.49% of the total citations.

An exhaustive literature review depicts that a few studies have been conducted on the top two percent highly cited researchers in the lists released by Stanford University since 2017. The researchers of this study have not found any single research study in general and specific on the top two percent highly cited LIS researchers included in that lists. Therefore, there is a need to conduct a comprehensive analysis of 254 researchers under the category of Library and Information Science in the latest list of the top two percent highly cited researchers released by Stanford University in 2021. This study will provide a state-of-the-art bibliometric analysis of 254 LIS researchers based on different aspects and indicators of their publications and citations densities.

Research Questions

Our study is designed to address the following research questions.

1. What is the gender wise distribution of top two percent highly cited LIS researchers?
2. Who are the top highly cited ones among highly cited LIS researchers?
3. What is the contribution of organizations/affiliations, countries and continents by producing top two percent highly cited LIS researchers?
4. What are the research interest areas of top two percent highly cited LIS researchers?
5. What are the positions of highly cited researchers at different ranks by TP, TC, h20, and CS?
6. Is there any significant difference between productivity and impact of male and female highly cited LIS researchers?

7. Is there any correlation between total publications (TP) and research period (RP) with total citations (TC)?
8. Is there a significant impact of total publications (TP) on total citations (TC)?
9. Is there any significant difference of total citations (TC) within quartiles of total publications (TP) and the continents?

Materials and Methods

The current study analyzes different aspects of the top two percent LIS researchers using the bibliometric method. Bibliometric methods are gaining more popularity across various disciplines of the world of scientific knowledge (Aria & Cuccurullo, 2017; Song et al., 2019). Bibliometric and its allied techniques are heavily used by LIS researchers (Naseer & Mahmood, 2009). The researchers of this study extracted data from Stanford University's list of the top two percent highly researchers prepared by a team of experts in the leadership of Professor John Ioannidis, an eminent Professor at Stanford University in 2021 (Baas et al., 2021). The database stipulates standardized information on citations, co-authorship-adjusted, h-index, citations to publications in different authorship positions, and a composite score. Initially, we kept apart 254 researchers under Library and Information Science subfield. We updated this data by adding additional information on gender, qualification, last degree, institution type in affiliation, and research areas of LIS researchers by searching Google Scholar, LinkedIn, ResearchGate, and researchers' own institutional websites.

These highly cited researchers were divided into active and non-active groups. Those who published any publication in the last five years were considered active, and others who had not published in the previous five years or after 2015 were deemed non-active researchers. We made four quartiles of researchers (Q1, Q2, Q3, Q4) based on the number of publications to analyze the mean difference by performing ANOVA. These quartiles include publications as Q4 (5-50), Q3 (50-100), Q2 (100-150) Q1 (150 to onwards). We also calculated the research age of each researcher from the year of their first publication till the last publication. These researchers were assigned different ranks based on total publications (TP), total citations (TC), h-index (h20), and composite score (SC). After carefully preparing the data, the analysis was performed using MS Access, VOSviewer, Biblioshiny (An R application), and an online visualization platform

(https://flourish.studio/). Statistical Package for Social Sciences (SPSS v.26) was used for the Analysis of Variance (ANOVA), Correlation, Regression and T-Tests in this study.

Results

The dataset for this study is derived from Stanford University's released list of highly cited scientists in 2021. Out of 1,00,000 highly cited researchers, 254 researchers fall under the subject category of Library and Information Science. Figure 1 shows an overview of the analysis performed at these 254 highly cited researchers. The data comprises 160 male and 94 female researchers. These researchers are divided into active and non-active researchers. The researchers who have published their research in the last five years are considered active (*n=208*), while those who had not published any study in the last five years are considered non-active (*n=48*). These researchers belong to different types of affiliated institutions, which include school (n=1), college (*n=1*), library (*n=2*), corporate institutions (*n=32*), and with universities (*n=128*). According to qualification, researchers with PhD are (*n=240*), MS (*n=12*) and BS (*n=2*). Out of these LIS researchers, 137 are closely engaged with the LIS field, while 76 have diverse research interests.

Figure-1 *Overview of results*

Gender wise distribution

Table 1 represents the gender-wise results among highly cited LIS researchers. The table depicts 160 male and 94 female researchers. Male researchers contributed by publishing 15389 publications, which received 455971 citations, while female researchers produced 5956 publications with 179918 citations. The average number of publications among males remained 96.18, while among females, 63.36.

Likewise, the male scientists got 2849.82 average citations, and female scientists received an average of 1914.02 citations per publication. The minimum years of research between female highly cited researchers were eight years and a maximum of 63 years. The male researchers' minimum research period was 11 years and a maximum of 65 years.

Gender	Q-G	TP	TC	H20-Max	H20-Min	RP-Min	RP-Max	Avg-TP	Avg-TC
Female	94	5956	179918	50	8	8	63	63.36	1914.02
Male	160	15389	455971	72	5	11	65	96.18	2849.82

Table-1 *Gender wise distribution (Q-G=Quantity of Gender, TP=total publications, TC=total citations, H-20Max=H-index maximum, H-20Min=H-index minimum, RP-Max=Research period maximum, RP-Min=Research period minimum, Avg-TP=Average of total publications, Avg-TC=Average of total citations)*

Top 20 highly cited LIS researchers

Table 2 lists the top 20 highly cited authors among 254 LIS researchers in the Stanford University list of top two percent researchers. The most highly cited author was Leydesdorff, Loet from The Amsterdam School of Communications Research, the Netherlands, with 20736 citations over 412 research publications and ranked first by citations but second by productivity. He started his research in 1980, and his last year of publication is 2021. Thelwall, Mike from University of Wolverhampton, UK remained second with 17283 citations according to citation rank but stood first by productivity and produced 453 publications during 2000-2021. Seventeen researchers are among active researchers, while three are non-active in research and publishing. Among these top 20 researchers, a maximum is computer science degree holders, followed by Library and

Information Science and Information Science. Lefebvre, Carol from Lefebvre Associates Ltd, UK, stood at bottom of the list by getting 5919 citations against only 35 research publications.

Author	Gender	Institution	F-L Year	RP	Last degree	R-TP	R-TC
Leydesdorff, Loet	Male	The Amsterdam School of Communications Research, Netherlands	1980-2021	42	Sociology	R_2(412)	R_1(20736)
Thelwall, Mike	Male	University of Wolverhampton, UK	2000-2021	22	Mathematics	R_1(453)	R_2(17283)
Salton, Gerard	Male	Cornell University, USA	1959-1997	39	Applied Mathematics	R_35(142)	R_3(15012)
Booth, Andrew	Male	The University of Sheffield, UK	1990-2021	32	Library and Information Science	R_8(250)	R_4(12755)
Bornmann, Lutz	Male	Administrative Headquarters of the Max Planck Society, Germany	2004-2021	18	Sociology of Science	R_3(349)	R_5(11048)
Buckley, Chris	Male	Sabir Research, Inc, USA	1983-2009	27	Computer Science	R_185(43)	R-6(10670)
Jansen, Bernard J.	Male	Qatar Computing Research Institute, Qatar	1997-2021	25	Computer Science	R_7(276)	R_7(10425)
Rowley, Jennifer	Female	Manchester Metropolitan University, UK	1979-2021	43	Journalism	R_5(311)	R_8(10218)

Waltman, Ludo	Male	Leiden University, Netherlands	2005-2021	17	Computational Economics	R_62(102)	R_9(10189)
Garfield, Eugene	Male	Universitat de Barcelona, Spain	1952-2016	65	Linguistics	R_9(248)	R_10(9479)
Chen, Chaomei	Male	Drexel University, USA	1992-2021	30	Computer Science	R_25(174)	R_11(8384)
Robertson, Stephen	Male	University College London, UK	1969-2019	51	Computer Science	R_43(133)	R_12(8359)
van Eck, Nees Jan	Male	Leiden University, Netherlands	2005-2021	17	Computer Science	R_82(90)	R_13(8317)
Spink, Amanda	Female	Pennsylvania State University, USA	1992-2013	22	Information Science	R_15(208)	R_14(8270)
Wilbur, W. John	Male	National Library of Medicine, USA	1967-2019	53	Computational Biology	R_31(158)	R_15(7885)
Lariviere, Vincent	Male	University of Montreal, Canada	2003-2021	19	Information Science	R_26(172)	R_16(7302)
Rousseau, Ronald	Male	Universiteit Antwerpen, Belgium	1985-2021	37	Library and Information Science	R_6(310)	R_17(6787)
Jaeger, Paul T.	Male	University of Maryland, USA	2002-2021	20	Law	R_24(180)	R_18(6715)
Jarvelin, Kalervo	Male	Tampereen Yliopisto, Finland	1982-2021	40	Information Science; Work environment; Intelligence;	R_34(144)	R_19(6711)

Lefebvre, Carol	Female	Lefebvre Associates Ltd, UK	1992-2021	30	Criminology, Library and Information Science	R_210(35)	R_20(5919)

Table-2 *Top 20 highly cited LIS authors (F-L year=First year-Last year, RP=Research period, R-TP=Rank by publications, R-TC=Rank by citations)*

Top 20 Highly cited organizations

Table 3 shows the highly cited organizations based on the highly cited researchers affiliated with them. The Amsterdam School of Communications Research, UK is the most highly cited organization with 20736 citations over 412 publications and 380 cited publications, followed by the University of Wolverhampton, Netherlands, with 17283 citations over 453 research publications. The University of Wolverhampton is the most productive organization with 453 research publications and 417 cited publications. Universitat de Barcelona, USA, had a maximum of not cited publications (TP=98). Interestingly, Lefebvre Associates Ltd, USA, got the bottom position and produced a limited number of publications (TP=35), but all publications received citations and a total of 5919 citations.

Rank	Institutions	NCP	CP	TP	TC	F-L years
1	The Amsterdam School of Communications Research, UK	32	380	412	20736	1980-2021
2	University of Wolverhampton, Netherlands	36	417	453	17283	2000-2021
3	Cornell University, UK	49	93	142	15012	1959-1997
4	The University of Sheffield, UK	16	234	250	12755	1990-2021
5	Administrative Headquarters of the Max Planck Society, UK	26	323	349	11048	2004-2021
6	Sabir Research, Inc. USA	2	41	43	10670	1983-2009
7	Qatar Computing Research Institute, USA	38	238	276	10425	1997-2021

8	Manchester Metropolitan University, USA	44	267	311	10218	1979-2021
9	Leiden University, Canada	15	87	102	10189	2005-2021
10	Universitat de Barcelona, USA	98	150	248	9479	1952-2016
11	Drexel University, Belgium	25	149	174	8384	1992-2021
12	University College London, Denmark	23	110	133	8359	1969-2019
13	Leiden University, Italy	15	75	90	8317	2005-2021
14	Pennsylvania State University, Netherlands	28	180	208	8270	1992-2013
15	National Library of Medicine, USA	12	146	158	7885	1967-2019
16	University of Montreal, Denmark	23	149	172	7302	2003-2021
17	Universiteit Antwerpen, Spain	29	281	310	6787	1985-2021
18	University of Maryland, USA	40	140	180	6715	2002-2021
19	Tampereen Yliopisto, Finland	8	136	144	6711	1982-2021
20	Lefebvre Associates Ltd, USA	0	35	35	5919	1992-2021

Table-3 Highly cited organizations based on highly cited researchers affiliated with them (NCP=Not-cited publications, CP= Cited publications, TP=Total publications, TC=Total citations, F-L years=First year-Last year)

Research Areas

Figure 2 demonstrates research interests in which highly cited researchers conducted their research. Information Retrieval is at the top of the list and is used by 39 researchers among 254 LIS researchers. The use of Information Retrieval started in 1955 till 2021. Bibliometrics stands second and is used by 33 researchers. Its use began in 1952 and is increasing day by day in almost all disciplines. Information Science is also a trending research topic among LIS researchers and has been used by 23 researchers. Scientometrics, altmetrics, informetrics, and research evaluation are allied methods of bibliometrics. The use of these methods also prevails among LIS highly cited researchers. Interactive Information Retrieval, Open Access, and Human-Computer Interaction remained the less used research areas.

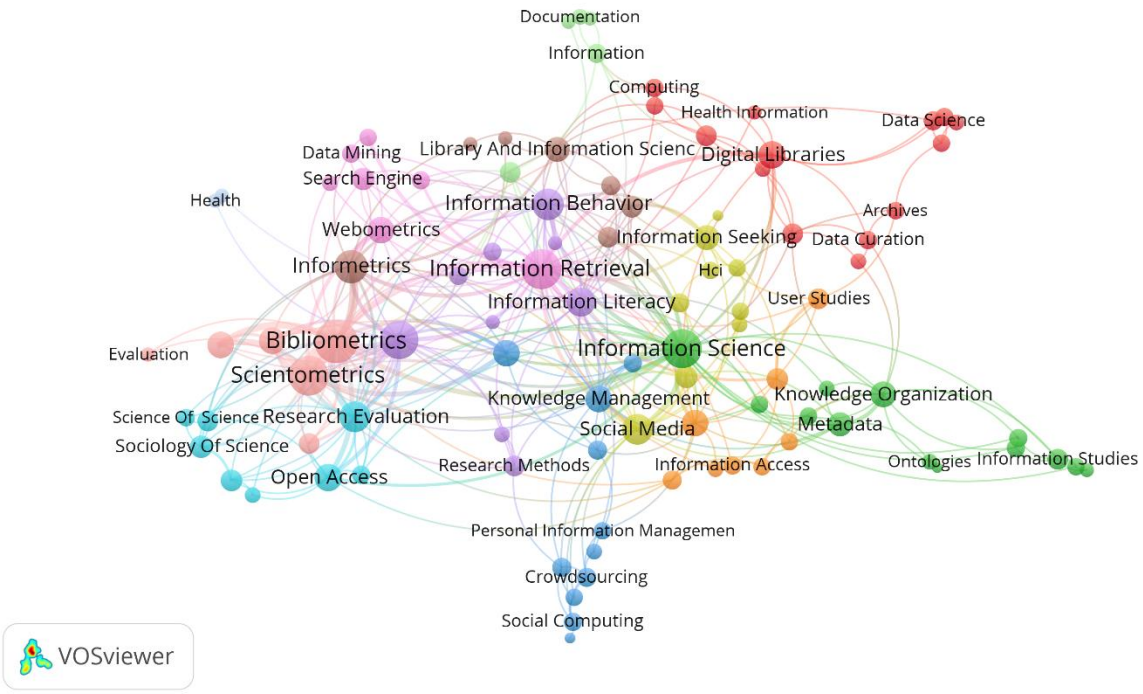

Figure-2 Research areas of top two percent highly cited researchers

Countries and Continents

Figure 3 portrays affiliated countries of highly cited researchers with the number of researchers of each country and shows the total number of researchers from each continent. The highest number, 143 highly cited researchers, belong to North America, where the USA leads by producing 121 LIS researchers. Europe secured the second position with 80 two percent highly cited LIS researchers. United Kingdom leads the European world with 32 highly cited LIS researchers. The Asia continent remained at the third position having 19 highly cited researchers, where Taiwan, South Korea, Singapore, and Israel produced more highly cited researchers than other Asian countries. Australian continent contributed by producing 11 highly cited researchers, and Africa produced only one highly cited LIS researcher from South Africa.

Figure-3 *Countries having highly cited researchers of LIS*

Rankings

In figure 4, the ranks of highly cited LIS researchers based on their publications, citations count, h20, and composite score are presented. The analysis shows that Thelwall, Mike is the most producive author with publication (TP=453), but he secured the second rank in citations count, h20, and the composite score. Leydesdorff, Loet got the second rank in productivity with (TP=412) publications but secured the highest position in other rankings. Interestingly, the productivity and citation rank fluctuate between these two researchers. Bornmann, Lutz secured the third position in productivity and h20 ranking; however, Salton, Gerald stood third in citation rank and Rowley,

Jennifer in h20 ranking. Booth, Andrew received the fourth rank in both citations and h20 rank while he remained at eighth rank by productivity and at 14 rank by composite score. Spink, Amanda also secured ranks in all rankings as 15 by productivity, 14 by impact, six by h20, and 11 by composite score. Jansen, Bernard J. also stood at different ranks in all four types of rankings. Ding, Ying is at the bottom rank by productivity, Lefebvre, Carol by impact, Tenopir, Carol by h-20, and Jaeger, Paul T by composite score.

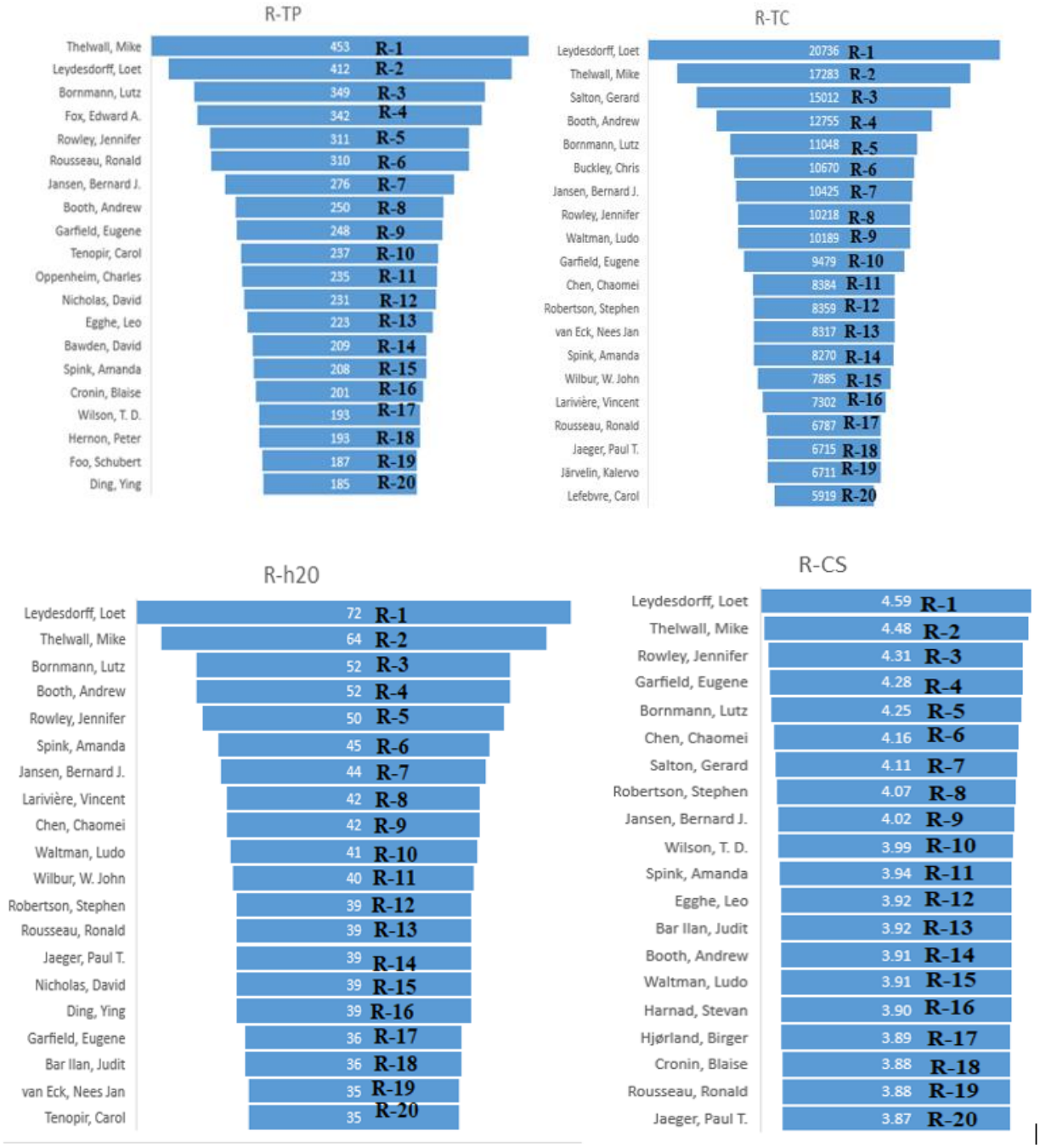

Figure-4 Rankings highly cited researchers based on productivity (TP), impact (TC), h20 and composite score (SC).

Inferential Analysis

An independent T-Test was performed to examine the difference between male and female LIS researchers in productivity and citations gained against their publications. The results show a significant difference between male and female LIS researchers in productivity (F=13.310, Sig.=000) and citations (F=12.427, Sig.=001). It is obvious from the mean values that male LIS researchers published more documents and gained more citations than female LIS researchers. A significant correlation has been observed between total publications (TP) and total citations (TC) of highly cited LIS researchers in our analysis. The value of Pearson Correlation (r=.713**) illustrates a strong correlation between total publications and total citations. It can be concluded that the number of citations increases with the increase in publications. Another correlation between the research period (RP) and total citations (TC) was analyzed. The value of Pearson Correlation (r=.211**) depicts a weak correlation between the research period and total citations. It can be assumed that citations increase with the increase in the age of publication.

We applied a linear regression test by considering total publications as independent variable and total citations as dependent variable to analyze the impact of total publications on total citations. The p-value of the linear regression in this analysis shows a significant impact of total citations on total publications. The positive value of understandarised coefficients demonstrates that the number of citations increase with an increase in number of publications.

The below table portrays the analysis of variance (ANOVA) results for the means of the total citations (TC) within the continents. The results show a significant difference in total citations gained by continents (F=4.697, Sig.=003). The LSD multiple comparisons describe that North America and Europe significantly differ from other continents against citations gained. An analysis of variance (ANOVA) was performed on quartiles of research publications to analyze the mean of total citations within quartiles. The results depict a significant difference between quartiles (F=7.904, Sig.=0.000). The LSD multiple comparisons show that Q1 significantly differ from Q3 and Q4 and Q2 from Q1 and Q4, Q3 from Q1 and Q2 and Q4 from Q1 and Q2. The mean difference of Q1 is significantly high than others which shows that publications more than 150 received highest number of citations as compared to other groups.

Variables	Mean values	F-value	Sig
Gender/NP/independent sample T-Test		F= -4.230	.000
Female	63.36		
Male	96.09		
Gender/NC/independent sample T-Test		F= -3.086	.001
Female	1914.02		
Male	2861.18		
Continent/NC/ ANOVA		F= 4.679	.003
North America	2156.99		
Europe	3416.61		
Asia	1993.74		
Australia	1380.55		
Group subfield/NC/ ANOVA		F= 7.904	.000
Q1	1333.73		
Q2	2130.94		
Q3	3125.52		
Q4	3364.26		
Correlation		Pearson correlation (r=.713**)	.000
TP	83.93		
TC	2509.27		
Correlation		Pearson Correlation (r=.211**)	.001
Research period	28.31		
TC	2509.27		
Regression		R =.711a	
		R square =.506	.000
TP		Standard coefficient Beta =.711	

TC	Unstandardized Coefficients = 28.830 t =16.056

Table-4 *Statistical analysis results NP(Number of Publications), NC(Number of Citations), Q1, Q2, Q3, Q4 quartiles as mentioned in methodology.*

Discussion

This study performed a bibliometric analysis on 254 LIS researchers included in the list of top two percent highly cited researchers published by Stanford University in 2021. The gender-wise production and citation show less contribution of female LIS researchers. They contributed by publishing about one-third of total publications compared with male researchers and also received less citations. This result shows female underrepresentation in research and publishing in the LIS field as mentioned by Alemna and Badu (1994), Alemna (1996), Chan and Torgler (2020), Mayer and Rathmann (2018), Siddique et al. (2021) and Thelwall et al. (2019) in their studies. This might be due to difference in social setup, gender-based allocation of resources, professional opportunities, and family circumstances and commitments (Chan & Torgler, 2020; Siddique et al., 2021). More active employer support such as day-care on campus and incentives to manage workload can lead females to career progression and high-impact research improvement (Zakaib, 2011).

Leydesdorff, Loet from The Amsterdam School of Communications Research, the Netherlands, is the most highly cited LIS researcher in the top two percent highly cited researchers. At the same time, he remained at second rank by productivity. Thelwall, Mike from the University of Wolverhampton, UK, is the most productive author while at second rank by impact. Buckley, Chris from Sabir Research, Inc, USA, secured the sixth rank by citation while he stood at 185 rank by productivity. He published only 43 publications but gained more citations over them. Lefebvre, Carol from Lefebvre Associates Ltd, UK, is at the bottom of the list by citations. Still, she contributed only 35 publications that received enough citations to help her stand among the top 20 highly cited LIS researchers. Out of the top 20 highly cited researchers, only three female researchers are. It is also noteworthy that most of the LIS researchers among the list of top 20 belong to the UK, followed by the USA, while the USA was also the top contributing country in

the findings of Jones (2021) by producing the majority of top two percent highly cited Forensic Science and Legal Medicine scientists. Only one researcher from the Asian continent has secured a position in the top 20 highly cited LIS researchers. There is no representation of Australia and Africa among them. According to our analysis, seventeen researchers are active, while three are non-active. Most of the top 20 researchers have computer science degrees with LIS degrees.

The Amsterdam School of Communications Research, UK, is the most highly cited organization of LIS covering a research period 1980-2021 and received second rank by productivity. The University of Wolverhampton, Netherlands, is the most productive organization but ranks second in the highly cited list. The highly cited researchers and their publications among these two universities reveal a novel finding; the researchers from later one started their research 20 years late than the researchers from The Amsterdam School of Communications Research, UK but produced more impactful publications and stood second by citations rank. Cornell University, UK is at third rank by citations, and its only 93 publications got 15012 citations. According to our findings, this may be due to the maximum age of its publications, which cover 1959-1997 to provide more visibility to attract more citations.

Furthermore, according to our analysis, researchers from Cornell University, UK, Sabir Research, Inc. USA, and Pennsylvania State University, Netherlands, have not published any research in the last five years, so these are non-active organizations in high impact LIS research. Lefebvre Associates Ltd, USA, is at the bottom of the list and published only 35 publications during 1992-2021. However, all publications received citations to secure a position among the top 20 highly cited organizations.

The top two percent highly cited LIS researchers have published their research in diverse areas of LIS. Information retrieval is the most used research area among LIS researchers during 1955-2021 and is used by 39 highly cited LIS researchers. This result is in-line with the findings of Han (2020) stating that Information retrieval is the most used research area by LIS researchers. Bibliometrics received the second rank due to its rapid use by LIS researchers from 1952 to onwards. Bibliometrics and its allied methods, scientometrics, altmetrics, research evaluation, and informetrics are also frequently used in LIS research and the findings of Anna et al. (2021) and Hussain and Yar (2021) also pictured bibliometrics, scientometrics, altmetrics, research

evaluation, and informetrics as the most frequently used research areas. Open access and human-computer interaction are less used research areas.

Our analysis depicts that North America contributed by producing a maximum of two percent of highly cited LIS researchers from the USA, confirming the findings (Jones, 2021) that USA leads by producing a maximum of highly cited researchers in Forensic Science and Legal Medicine. The UK leads in European countries having maximum LIS researchers than others. Asian, Australian, and African countries have a low number of highly cited LIS researchers. Several reasons might be considered for the low contribution of these countries for producing high-impact LIS research, which include lack of English proficiency, lack of research training and funding, and lack of interest and commitment (Ameen, 2013; Lund et al., 2021).

The rankings of highly cited LIS researchers against four indicators reveal that a few researchers, including the top two highly cited LIS researchers, have secured different ranks in all four rankings. Our findings observed that some youngest researchers like Waltman, Ludo, and van Eck, Nees Jan have secured top ranks even though they started publishing their research very late than others. This might be due to their high-quality research publications, which attracted more citations. It is also notable that Garfield, Eugene, a pioneer of bibliometrics and scientometrics, secured the ninth rank by productivity, the tenth rank by impact, got seventeenth rank by h20, and the fourth rank by overall composite score (SC). One of the renowned researchers in information-seeking behavior, Wilson, T.D., ranked at the seventeenth number by productivity and stood at the tenth position by composite score. He did not receive enough citations to secure any position among the top 20 highly cited researchers. It strengthens the findings of Kulczycki et al. (2021) that being the oldest or classic researcher does not mean to get more cited.

In statistical analysis, there has been a strong correlation between publications and citations, which displays that citations increase with an increase in publications. Our findings are similar to that of Sandstrom and van den Besselaar (2016) and Parker et al. (2013) that increase in the number of publications attracts more citations. The the p-value of pearson correlation between the research period and total citations shows a weak correlation. However, it can be inferred that citations increase as publications get older. This result confirms the findings of Kulczycki et al. (2021) that old research publications got fewer citations. One of the reasons to get more citations might be the quality and worth of publications for the scientific community for a long time. Looking at the

results, it is evident that North America and Europe have received more citations than other continents. This can be due to more high-impact publications from these two continents by highly cited researchers living there.

Conclusion

This investigation aims to analyze the different aspects of the most influential scholars in the world of Library and Information research. The data for this analysis was derived from Stanford University's list of the top two percent highly cited researchers recently released in 2021. The number of LIS researchers included in this list were 254 who were considered suitable for this study. Male researchers dominate in the research and publishing in the LIS field. Women empowerment in academia needs more attention of concerned authorities to produce more opportunities and incentives for females. The highly cited researchers and institutions from the USA and the UK are actively involved in the research productivity of LIS. A less representation of Asian, African, and Australian countries has been witnessed by producing the highly cited LIS researchers. They need to invest more tremendous efforts to increase their LIS research and impact. The majority of highly cited researchers are affiliated with universities that means academicians and practitioners in universities have contributed more than those associated with other organizations. Moreover, some neglected areas of research in LIS like data science, computing, research methods, crowdsourcing, and archives need more attention from highly cited researchers to publish quality research in these areas. Overall, our study may help and motivate young researchers to choose their research direction, supervisors, peers for international research collaboration and produce impactful research in the field of Library and Information Science.

Authors declarations

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