A Review of research progress and projection of future publication trend amongst the science stream academics of University of Jaffna, Sri Lanka

U. Latha.[1], I. M. Lakshman[2]

Abstract

An increase in emphasis on research productivity evaluation can be discerned commonly in higher educational institutions world over. As far as the Faculty of Science, University of Jaffna is concerned such an in depth study had not been done. This bibliometric study analyzed the research publications produced by the academics of Faculty of Science, University of Jaffna. The objective of this study is to empirically measure the research output during the time period of 2003 to 2018 to find out the department wise output, year wise publication output, authorship pattern and degree of collaboration, media of research communication, relative growth rate, doubling time and to forecast future publication trend of academics. The year wise publication output shows an increasing pattern. But the output growth is not uniform. Findings revealed that Faculty of Science has produced 1359 publications with an annual average of 85 and with the maximum of 139 during the study period. The highest number of publications is from the Department of Zoology (22%). The Department of Botany shows second highest number with 21% of the publications. The lowest number is from the Department of Fisheries (4%). The research output from departments of Physics, Mathematics and Statistics, and Chemistry are more or less the same. Mean value of the degree of collaboration of authors during the overall sixteen years is found to be 0.84. Single author publications are less (15%) than collaborative effort (85%). Abstract form of publications is more in number 836 (61%). Journal article is 501 (37%) and Book form is 22 (2%).

[1] Senior Assistant Librarian, Library, University of Jaffna.
Email: ulathanki@gmail.com : https://orcid.org/0000-0002-9364-9014
[2] Senior Lecturer, Department of Sociology, University of Colombo.
Email: ireshalakshman@soc.cmb.ac.lk

A uniform dropping pattern was observed in the mean relative growth rate (RGR) from 0.439 to 0.122 considering four year blocks from 2003 to 2018. The mean doubling time showed an increasing tendency through each consecutive block of four year period. It ranged from 0.89 in the first block to 5.80 in the last block of a total of sixteen year time span. The forecast for 2025 based on least square estimate the number of publications should be 186 if status remains unchanged. Thus Faculty of Science has to endeavor and orient their research efforts more towards publishing journal articles than short communications and giving priority towards interdisciplinary research to obtain greater impacts with the vision of establishing excellence of the institution.

Introduction

In the present world research activity is part and partial of each and every systematic knowledge. Research in the field of science, as well as in all fields in general for that matter have to be carried out exhaustively. This has to be done with utmost thoroughness for the civil society at large to benefit from it and has to be improved in every aspect to cope with and keep pace with a surging planet. The universities have the collective responsibility to initiate on their innovative research and utilize intuitive ability and to manifest features which would enhance the academic status of each university. Higher education institutions around the world primarily provide intensive training to the emerging researchers in their specialized fields through postgraduate programmes and expertise training. According to Borse (2012) and Uyangoda (2011) research is an organized, systematic and institutionalized practice inculcated in the norms of higher educational institutions.

Bibliometric assessment is one of the popularly used tools of evaluating the research progress. To analyze the trend quality, quantity and variety a bibliometric study of the research output is critical (Ellegaard, 2018; Angammana & Jayatissa, 2015). Mostly in western countries the funding agencies used bibliometrics as an auxiliary tool while assessing the quality of research output of any higher educational institution is used for funding purpose.

The Faculty of Science is one of the pioneer faculties of University of Jaffna. It was setup in 1974 with the mission of "produce competent graduates who excel in learning and research in basic sciences and who could contribute to the development of the nation". The vision of the Faculty of Science is to attain an internationally recognizable level of teaching and research, and to disseminate scientific knowledge to the society. Aiming the Faculty of Science, University of Jaffna has been publishing their researches regularly from its inception. As far as Faculty of Science is concerned, an in depth study to access the research output has not been carried out so far. Publishing the findings of their research will help the academics of Faculty of Science to evaluate themselves and find out their strengths and weaknesses in relevant to their efforts and enable them to identify the core areas of research to be

focused in future. Thereby they would be able to improve their research output in quantity as well as in quality. Hence this bibliometric study was carried out to empirically measure the research output and forecast the future publication trend of academics of Faculty of Science, University of Jaffna based on their research publications from the year 2003 to 2018.

Research Objectives

The objective of this study are

1. to empirically measure the research output during the time period of 2003 to 2018.
2. to forecast the future publication trend of the academics attached to Faculty of Science, University of Jaffna.

Literature Review

Bibliometric study is a distinct branch of documentary research in the field of library and information science. According to Pritchard (1969), the one who coined the name bibiliometric, has defined it as "the application of mathematics and statistical methods to books and other media of communication". Further it has been described as a series of techniques that seek to quantify the process of written communication as "the quantification of bibliographical data" Powell, (2004) & Moed et al. (1995) used bibliometric analysis of groups or institutes at the micro or meso level as one of the indicator to measure the research productivity of bundle of whole groups within the particular subject of knowledge or specific university. Print (1997) revealed that refereed journal articles, peer reviewed books and competitive research grant are found to be the core indicators in the measurement of research productivity among the academics in educational institutes.

To measure the research output of various institutions, a lot of meaningful and diligent work has been carried out in many countries in the analysis of the relevant literature which is voluminous. Okafor (2011) in his research publication defining that research output could be measured in terms of the quantity of research publications within a stipulated time period. Further they have suggested that this can be measured by totalling the number of books and papers publishes within a definite period of time. The results of Satpathy

and Kumar Sa (2015) revealed that the journals were the most effective medium for the dissemination of research findings and that it constituted around 90% of the total communications. The results of (Duraipandi & Balasubramani, 2015) found it in alignment with Satpathy and Kumar Sa (2015). They also revealed that the present trend of more or less collaborative and interdisciplinary and multiple authors are the predominant feature. Aswathy and Gopikuttan (2015) also expressed the same conclusion in their research findings. They noted that the degree of collaboration was 0.97%.

Okafor (2011) pointed out that either totalling the number of articles or the citations could be considered for bibliometric studies. Meanwhile they also noted the inapplicability of the above bibliometric measurement by the researchers in the developing countries due to their inadequate access and representation to the most reputed international databases and Science Citation Index. Instead they have suggested counting the number of publications in order to overcome this shortcoming. In order to keep a track of the publications of an institution Jeevan and Gupta (2002) suggested that the annual report of the respective institution and the Science Citation Index (SCI) could be the most authentic and reliable source.

There were considerable amount of researches conducted in different context to find out the status of research output in Sri Lanka. Another study revealed that Sri Lankan medical research contribution during 2000-2009 was relatively small compared to global research output (Ranasinghe et al., 2012). Bibliometric studies conducted by the authors Pratheepan and Weerasooriya (2015) in the recent past pointed out that based on the number of publications, citations and h-index, the performance of the professors of Faculty of Science in the Sri Lankan university system were the first. As far as management faculties are concerned University of Jaffna manifested the highest average index of 7.75. When it comes to total research output of the academics of University of Jaffna, science stream contributed considerably (22%). The research output of the Faculty of Management was estimated around 12.5%. Latha (2015) has made the same conclusions about the University of Jaffna. Pratheepan (2012) conducted a study based on ISI WoS database to find out the ranking and performance of Universities in Sri

Lanka, revealed that University of Jaffna ranked fifth out of fifteen state universities in Sri Lanka. Also he pointed out in his findings that out of top ranked list of thirty scientists in Sri Lanka two researchers affiliated to University of Jaffna. Evaluating research output of individuals, faculty, institutions and countries has become the accepted yardstick worldwide. There is an increasing interest in the evaluation of academics using some important aspects, particularly research and scientific activities of the departments or faculty.

Methodology

Methodology described the methods the researcher adopted in studying the research publication output of academics belongs to the Faculty of Science, University of Jaffna. This section mainly comprises and defines the target population, study area, data collection tools, and research design and data analysis. The methodological frame work of this study is primarily combining the guidelines and suggestions given by (Gujarati, 2003; Powell, 2004) and bibliometric tools.
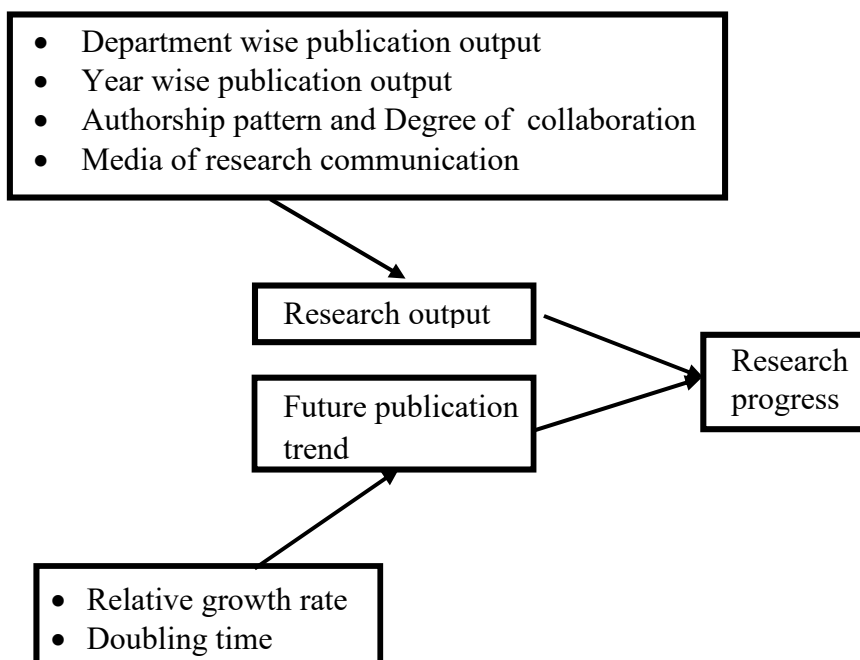

Figure 01. Conceptual frame work

Figure 1 describes the conceptual frame work of the research. Research Progress of the academics basically characterized by research output and future publication trend. The research progress was measured in terms of department wise research output, year wise publication output, authorship pattern and degree of collaboration and media of research communication. The future publication trend was predicted by estimating the relative growth rate, and doubling time.

Sampling and Data collection

The entire permanent academics belongs to seven disciplines namely Zoology, Botany, Physics, Chemistry, Mathematics and Statistics, Computer science and Fisheries of Faculty of Science were considered for this study. The research effort was aimed at the total number of articles published during the period of 2003 to 2018. The secondary data corresponding to the year 2003 to 2018 pertaining to the number of publications were collected from the annual reports of University of Jaffna published from the year 2004 to 2019. This study considered the journal articles, short communications published in the symposiums, abstracts in conference proceedings and books. A total of 1359 publications were analyzed in multiple dimensions to find out the department wise output, year wise publication output, authorship pattern and degree of collaboration, media of research communications, relative growth rate, doubling time, and future publication trend.

Data analysis

Data gathered were orderly organized and tabulated in an Excel spread sheet and processed. Data were analyzed by using the descriptive statistics such as mean, standard deviation, percentage, and the bibliometric indicators namely department wise research output, year wise publication output, authorship pattern and degree of collaboration, media of research communication, relative growth rate, and doubling time,. Finally, the least square estimate was used to predict the future publication trend.

Department wise publication output

Department wise research output information was obtained by counting the number of publications which included books, journal articles and short communications produced by academics attached to seven departments.

Year wise publication output

Annual publication data of faculty of science was elicited from the University annual reports published with effect from the year 2004 to 2019.

Degree of collaboration

The Degree of collaboration was estimated based on the methodology used by (Subramanyam, 1983; Jiban & Prabir Kumar Das, 2012; Maharana & Bihari Sethi, 2013; Satpathy & Kumar Sa, 2015).

$$C = \frac{Nm}{Nm + Ns}$$

Where,   C   = Degree of collaboration

                 Nm   = Number of multiple authors

                 Ns   = Number of single authors

Relative Growth Rate (RGR)

The Relative Growth Rate (RGR) is defined as 'the increase in number of articles or pages per unit of time'. The research adopted the following formula as per the reference from Aswathy and Gopikuttan (2015) in estimating the relative growth rate.

$$\text{Relative Growth Rate (RGR)} = \frac{\text{Loge 2W} - \text{Loge1W}}{2T - 1T}$$

The mean relative growth rate over the specific period of interval was calculated from the following equation;

$$\frac{1 - 2R + \text{LogeW2} - \text{LogeW1}}{T2 - T1}$$

Where,

1-2R   - Mean relative growth rate over the specific period of interval

$Log_e W1$ - log of initial number of articles

$Log_e W2$ - log of final number of articles after a specific period of interval

T2-T1   - Unit difference between the initial time and the final time.

Doubling Time

Doubling time is the period of time required for a quantity to become double in size or value. Doubling time and Relative growth rate has direct relationship between them. The doubling time for each specific period of interval and for articles were calculated by using the formula used by (Aswathy & Gopikuttan, 2015).

Doubling Time (DT) $= \dfrac{0.693}{R}$

Future Publication Trend

Future publication trend was estimated by calculating the least square estimate of the available annual publication data. The method of ordinary least square was estimated based on Gujarati (2003). Under certain assumptions the method of least squares has some valuable striking statistical properties that have made it one of the most powerful and popular method for prediction in statistics.

Population Regression Function: $Y_i = \beta_1 + \beta_2 X_i + u_i$

The population regression function is not directly observable. Hence it was estimated from the sample regression function: $Y_i = \hat{\beta}_1 + \hat{\beta}_2 X_i + \hat{u}_i = \hat{Y}_i + \hat{u}_i$
Where $\hat{Y}_i$ is the estimated (conditional mean) value of Y_i. But how is the SRF itself determined. First express as $\hat{u}_i = Y_i - \hat{Y}_i = Y_i - \hat{\beta}_1 - \hat{\beta}_2 x_i$

Which shows that the $\hat{u}_i$ are simply the differences between the actual and estimated *Y* values. With the given *n* pair of observations on *Y* and *X*, to determine the sample regression function in such a manner that it is as close as possible to the actual *Y*. To this end, the following criterion was adopted. Sample regression function is chosen in such a way that the sum of the residuals is as small as possible, where u_i^2 are the squared residuals.

$\Sigma \hat{u}_i = \Sigma (Y_i - \hat{Y}_i)$
$\Sigma U_i^2 = \Sigma (y_i - \hat{y}_i)^2 = \Sigma (y_i - \hat{\beta}_1 - \hat{\beta}_2 X_i)^2$

By squaring $\hat{u}_i$ this method gives more weight to residuals. A further justification for the least squares method lies in the fact that the estimators obtained by it have some very desirable statistical properties. $\Sigma \hat{u}_i^2 = f(\hat{\beta}_1, \hat{\beta}_2)$. It is obvious from this is that, the sum of the squared residuals is some function of the estimators $\hat{\beta}_1$ *and* $\hat{\beta}_2$. For any given set of data, choosing different values for $\hat{\beta}_1$ *and* $\hat{\beta}_2$ will give different $\hat{u}$'s and hence different values of Σu_i^2

Results and Discussion

Department wise Publication Output

The inference from Table 1 is the total number of publications of all seven departments were 1359. It is observed that in 2016 and 2017 the outcome of publications is highest at 139 and 138 respectively. The highest number of publications are from the Department of Zoology. Next to that Department of Botany is at second place, recording a 21% of the total publications. The lowest number is from the Department of Fisheries. This may be due to the fact that it is a newly established department under the Faculty of Science. The research output from the Departments of Physics, Mathematics and Statistics, and Chemistry are more or less the same.

Table 01. Department and Year wise publication output

Year	Botany	Computer	Maths & Stats	Chemistry	Physics	Zoology	Fisheries	Total
2003	7	3	4	3	5	11	0	33
2004	9	2	6	2	1	8	0	28
2005	12	7	0	3	19	8	0	49
2006	17	6	1	3	22	32	0	81
2007	2	9	6	1	16	12	1	47
2008	20	2	4	17	20	25	0	88
2009	20	13	6	10	8	9	0	66
2010	9	13	8	14	5	12	0	61
2011	17	17	6	9	7	19	0	75
2012	18	7	9	20	12	29	11	106
2013	14	4	18	5	14	33	6	94
2014	28	10	29	18	9	7	6	107
2015	21	6	23	31	10	25	5	121
2016	29	14	23	33	8	21	11	139
2017	32	9	28	22	9	28	10	138
2018	31	14	23	27	7	15	9	126
Total	**286**	**136**	**194**	**218**	**172**	**294**	**59**	**1359**
Percentage	**21**	**10**	**14**	**16**	**13**	**22**	**4**	

Source: Annual Reports (2004 -2019), University of Jaffna

Year wise Publication Output

Figure 2 shows year wise publication output. In a general sense the diagram indicates an increasing tendency in the number of publications. Annual average publications is 85 in overall. But the output growth is however not uniform. In comparison between 2003 and 2008, there is a spike in the number of researches in 2018. It may be that the numerical increase of the staff and the individual performance of the numbers could have resulted in the quantum increase of publications. In the years of 2004, 2007 and 2010 net publication output shows a drop.

The cause for this effect could be attributed to the closure of the University due to the civil unrest and limited internet facility. Though the years 2011 to 2017 the uniform increase in publication output is observed. This observation may be due to improvement of internet facilities in the year of 2010, availability and accessibility of electronic resources especially of reputed journal databases from the University library through Consortium of Sri Lankan Academic Libraries (CONSAL) in the year 2014.

The synergistic effect of these remarkable research supportive measures on the research output of the academics was also supported by Wijetunge (2019). On top of it the provision made through the amended Sri Lankan higher education policies such as entitlement for the research allowance, incentives for publication of articles in reputed journals and research grants encouraged and motivated the academics to engage more in research activities could be another factor. The same conclusions were also proposed by (Okafor, 2011). He suggested that to achieve prosperity in Nigeria in harmony with other countries which depend on research and development, the government should sponsor on subsidized publishing in national journals and increase the allowances that would help and support academics to publish in international journals. Besides, after 2016 there appears a period of relative stagnation in the number of publications.
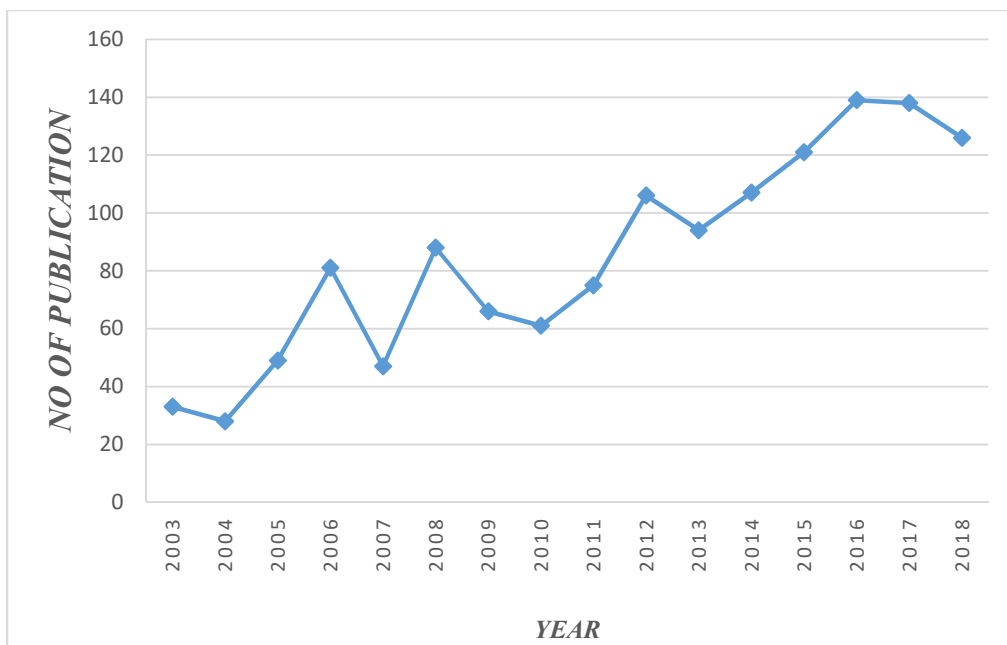
Figure 02. Year wise publication output

Collaboration pattern of authorship in research

Single author publications are less (15%) than collaborative effort (85%). This result was found to be consistent with (Duraipandi & Balasubramani, 2015) also found to be in line with the authors (Jeevan & Gupta, 2002). It is to be noted however that multi author publications (3-4) are greater in number. Sevukan et al. (2007) also found that the contribution of faculties are fairly collaborative in nature mostly at local level. Table 2 depicts that the degree of collaboration of authors is in increasing trend along with the increase of years. The highest collaboration is observed in the years 2016 and 2018. The mean degree of collaboration is 0.84. It is notable that with respect to Wijetunge et al. (2020) University of Peradeniya is having the highest number of academic collaboration which was expressed by the number 2.2. Based on the cumulative research output of the departments corresponding to the degree of collaboration particularly after the year 2015 it can be inferred that when degree of collaboration is increasing it seems to be fostering the total number of publications.

Table 02. Collaboration pattern of authorship in research

| Year	Single (1)	Double (2)	Multi (3-4)	Mega (>4)	Total	DC
2003	17	8	4	4	33	0.48
2004	20	5	1	2	28	0.64
2005	22	8	4	15	49	0.55
2006	32	20	17	12	81	0.60
2007	12	5	21	9	47	0.74
2008	9	25	34	20	88	0.90
2009	8	24	25	9	66	0.88
2010	5	18	26	12	61	0.92
2011	7	24	35	9	75	0.91
2012	9	33	55	9	106	0.92
2013	18	17	44	15	94	0.81
2014	12	32	56	7	107	0.89
2015	9	33	54	25	121	0.93
2016	8	49	58	24	139	0.94
2017	11	51	49	27	138	0.92
2018	7	42	55	22	126	0.94
Total	**206**	**394**	**538**	**221**	**1359**	**0.84**
In percentage (%)	**15**	**29**	**40**	**16**		
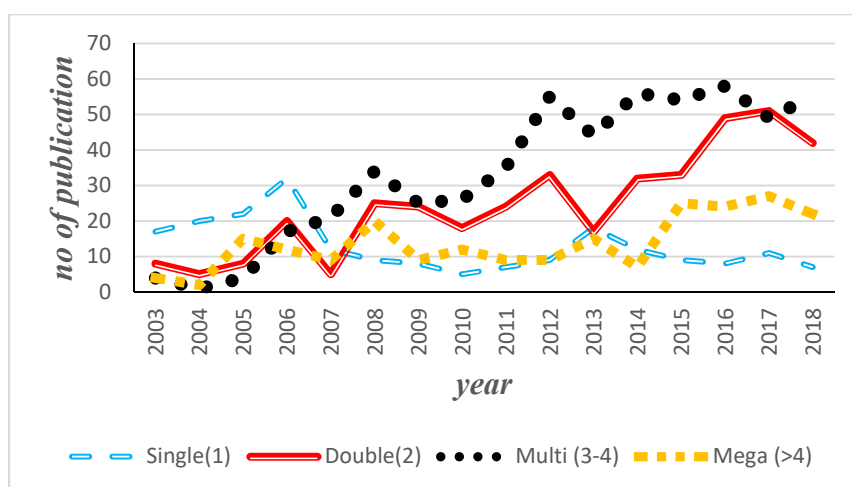
Figure 03. Collaborative pattern of authorship in research

Media of research communication

Table 03. Media of research communication

Document type	Journal article	Abstract	Books	Total
Number of publications	501	836	22	1359
In percentage (%)	37%	61%	2%	

As shown in the Table 3, Abstract form of publication is more in number 836 (61%). Journal article is 501 (37%) during the sixteen years. However, after 2006 there is an increase in journal articles as publications; 46 in 2018 and 5 in 2006. The trend therefore is towards journal article publications along with time. Number of books published by the academics is comparatively very low only 2% of the total publications.

Future publication trend

Table 4 shows the relative growth rate (RGR) of the publications from the year 2003 to 2018. Estimated mean Relative growth rate (RGR) for a block of four years manifests a declining trend in the publication along with the years. Considering four year blocks from 2003 to 2018 the mean relative growth rates (RGR) were 0.439, 0.216, 0.153 and 0.122 respectively. But the estimated mean doubling time for a block of four years highlights an increasing trend with years. It is 0.89, 3.476, 4.594 and 5.797 respectively. The forecast for 2025 the publication would be 186 if the status remains unchanged.

Table 04. Relative growth rates of science research performance

Year	No. of Publications	Cumulative total	LogeW1	LogeW2	RGR	Mean RGR	DT	Mean DT
2003	33	33		3.497		0.439		0.890
2004	28	61	3.497	4.111	0.614		1.13	
2005	49	110	4.111	4.700	0.590		1.18	
2006	81	191	4.700	5.252	0.552		1.26	
2007	47	238	5.252	5.472	0.220	0.216	3.15	3.476
2008	88	326	5.472	5.787	0.315		2.20	
2009	66	392	5.787	5.971	0.184		3.76	

2010	61	453	5.971	6.116	0.145		4.79	
2011	75	528	6.116	6.269	0.153	0.153	4.52	4.594
2012	106	634	6.269	6.452	0.183		3.79	
2013	94	728	6.452	6.590	0.138		5.01	
2014	107	835	6.590	6.727	0.137		5.05	
2015	121	956	6.727	6.863	0.135	0.122	5.12	5.797
2016	139	1095	6.863	6.999	0.136		5.10	
2017	138	1233	6.999	7.117	0.119		5.84	
2018	126	1359	7.117	7.215	0.097		7.12	

Conclusion and Recommendations

This research portrays a complete scenario of research output of academics attached to the Faculty of science, University of Jaffna. From 2003 to 2016 there was an overall growth observed in research publication output. Abstracts (61%) are the dominant media for dissemination of research findings. Next to that is journal article (37%). The availability of funds, access to technological resources, recruitment of academic afresh and refinement of higher education policy by the Ministry of Education may have been the causes for this ascend. But the output growth is not uniform. Department of Zoology produced the highest number of publications while the department of fisheries has the lowest number of publications.

This may be due to the fact that the Department of Fisheries was established recently under the Faculty of Science. Though an overall growth of research publications was observed, the relative growth manifests a declining trend along with year. Single author publications are less in number compared to collaborative research effort. The estimated mean degree of collaboration is 0.84. Though this number manifests a fair amount of collaborative research of Faculty of Science locally and internationally, still there is a possibility of pushing the number further by encouraging interdisciplinary collaborations.
In conclusion it could be stated that net publication number has to increase with an increase in frequency of publications while ensuring the quality of the publications are maintained or even improved. It should be taken into consideration that provision should be adequately made for fundamental and original research facility in the form of increased funds, equipment and enhanced access to most reputed international databases. In concurrent with the leading academic institutions academics of the Faculty of Science,

University of Jaffna have to be encouraged in publishing more journal articles than short communications.

After 2016 however stagnation in the output of research publication was observed. Cause for this could be attributed to constraints on academic researchers due to routine teaching hours and workload. This could be addressed by reducing the hours spent in teaching. So that research activities of academics may not be hindered. This again cannot be lasting solution as the fundamental duty of academics is to teach. Reducing the teaching hours could not be allowed to inhibit the learning process of students which can eventually affect quality of higher education.

A comprehensive solution is to establish a distinct research unit within the university sphere where full time researchers are appointed. Such an arrangements would surely increase research and intern publication output. Numerical increase of research publication output alone cannot be a yardstick to measure progress. It has to be proved that the suggested recommendation help the progress of higher educational system and the country as a whole when implemented. If a technique could be devised to access this feature it would be a remarkable advantage.

References

Angammana, A.M.S., & Jayatissa L.A. (2015). A bibliometric study of postgraduate thesis in library and information science with special reference to University of Kelaniya and University of Colombo, Sri Lanka. *Journal of University Librarians Association*, 19(1), 32-53.

Aswathy S., & Gopikuttan A. (2015). Bibliometric observation of publication output of university teachers. A study with special reference to physics. *Journal of science Research*. 4(1), 14-19.

Borse, M.N. (2012). Handbook of research methodology: Modern methods and new techniques. 2nd ed. *Jaipur*: Shree Niwas publications.

Duraipandi, R., & Balasubramani, R. (2015). Mapping the research productivity of Jawaharlal Nehru University: A bibliometric analysis based on Scopus database. *Star international Journal* , 3 2(5), 18-24.

Ellegaard, O. (2018). The application of bibliometric analysis: disciplinary and user aspects. *Scientometrics*, 116,181-202.

Gujarati, Damodar N. (2003). Basic Econometrics. 4th ed. New York: Mc Graw Hill.

Jeevan, V.K.J., & Gupta, B.M. (2002). A scientometric analysis of research output from   Indian Institute of Technology, Kharagpur. *Scientometrics*, 53(1), 165-168.

Jiban K.P., & Prabir Kumar Das (2012). Quantitative Assessment of Research Contributions of the Indian Statistical Institute: 1991-2010. Conference Paper. Retrieved from www.isical.ac.lk.in/-

Latha U. (2015). A comparative analysis of the faculties of the University of Jaffna in the field of research and development in their differential pursuits. *Indian journal of information science and services. 9 (1&2), 96-99.*

Maharana Rabindra K., & Bihari sethi Bipin (2013). A bibliometric analysis of the research output of Sambalpur University's publication in ISI Web of Science during 2007 -11. Library Philosophy and Practice, 11-2013. (e-journal). Retrieved from www.webpage.uidaho.edu/mbolin/okafor.htm

Moed, H. F., Bruin, R.E. & Van Leeuwen, T.N. (1995). New bibliometric tool for the assessment of national research performance: database description, overview of indicators, and first applications. *Scientometrics*, 33(3), 381-422.

Okafor, V.N. (2011). Comparative analysis of research output of Federal Universities in Southern Nigeria. Library Philosophy and Practice, 4-2011. (e-journal). Retrieved from www.webpage.uidaho.edu/mbolin/okafor.htm

Powell, Ronald R. (2004). Basic research methods for librarians. 4th ed. Westport: Librarians unlimited.

Pratheepan, T., & Weerasooria, W. A. (2015). The publication output and impact of various faculties in Sri Lankan universities: a scientometric assessment and policy implications. *Journal of the University Librarian's Association of Sri Lanka,* 19 (1), 54-66.

Pratheepan, T.   (2012). Research productivity of Sri Lankan Universities during 1999 -2010 based on the ISI Web of Science Database: A

Scientometric study. *SSRN* (e-journal). Retrieved from DOI: 10.2139 /ssrn.1992372

Hattie, J. (1997). Measuring quality in universities: An approach to weighting research productivity. *Higher Education*, 33(4), 453-469.

Pritchard, A. (1969). Statistical bibliography or bibliometric?. *Journal of Documentation*, 25 (4), 348-349.

Ranasinghe, P., Jayawardena, R. & Katulanda, P. (2012). Sri Lanka in global medical research a scientific analysis of the Sri Lankan research output during 2000-2009. *BMC Research Notes* 5:121. Retrieved from http://www.biomedcentral.com/1756-0500/5/121

Satpathy, S. K. & Kumar Sa M. (2015). Research Outputs of State Government Universities of Odisha: A bibliometric study. *Library Philosophy and Practice*, 15(4), (e-journal). Retrieved from https://digitalcommons.unl.edu/libphilprac/1309/

Sevukan, R., Nagarajan, M. & Sharma,Jaideep. (2007). Research output of faculties of plant sciences in central universities of India: A bibliometric study. *Annals of Library and Information Studies,* 54, 129-139.

Subramanyam , K. (1983). Bibliometric studies of research in collaboration: a review. Journal of University of Jaffna. (2004 -2019). *Annual Reports. University of Jaffna.*

Uyangoda, J. (2011). Writing research proposals in the social sciences and humanities: A theoretical and practical guide. Colombo: Social scientists association.

Wijetunge, P. (2019). Access to scholarly publications through consortium in Sri Lanka: A case study. *Journal of Library and Information Technology*, 39(1), 10-16.

Wijetunge, P., Silva, A. & Manatunga, P.K.S. (2020). Research productivity of the state universities of Sri Lanka, a case based on SciVal and the contribution of libraries towards excellence. *Journal of University Librarians Association of Sri Lanka,* 23(1), 91-118.