A Bibliometric Study on Collaborative Research and Development Output of Statistical Quality Control and Operation Research (SQC & OR) Division of Indian Statistical Institute (ISI) during 2010-2014

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Abstract *- This study is a Bibliometric analysis of the research publication output of Statistical Quality Control and Operation Research (SQC & OR Unit) of Indian Statistical Unit (ISI). Data of this study have been collected from ISI Annual Report during the year 2010-2014. Year wise output of publication, type of publication, authorship pattern, degree of collaboration, distribution of length of article, distribution of reference per article and area of research for published output have considered for this study. Findings reveal that 265 publications have published during this period. Most of the publications of SQC & OR Division are collaborative in nature. The degree of collaboration clearly indicates dominance upon multi authored contribution. The faculties of SQC & OR Division mostly prefer 10-12 pages length for their publication. Maximum numbers of citations follow are 21-25 (31.59%), and Six Sigma Initiatives is the most popular area of research (30.87%).*

Keywords: Bibliometrics, Research publication, Publication output, ISI Annual Report, SQC & OR Unit, Indian Statistical Institute.

Introduction

Research is an important facet for the development of a nation. Research is human activity based on intellectual application in the investigation of matter. The main aim of discovering research is discovering and development of methods and systems for advancement of human knowledge. The outcome and the extent of the function of the academics in creating new knowledge and innovation are form of research output. Research output is a means by which academics contribute their own knowledge to the existing body of knowledge. This can be in the form of journal articles, technical reports, books, chapters in a book, supervision and training of students etc. The more research outcomes are published in all formats the probability of availability and access to information is assumed.

The main aim of any research institutions or organization is to increase the research productivity and research quality. Publication productivity, as a consequence of its measurability (namely, number of publications), is usually used as an indicator of research productivity. For the purposes of this study, publication productivity is used as an indicator of research productivity and is measured as self reported number of publications published over a five-year period. The research output of a nation is a yardstick to measure its Socio-economic and educational status. There is a number of ways to measure the quantity and

quality of the research output of the country and even the contributions of an individual (**Kalaiappan, Kaliyaperumal, & Rajasekar,** 2010). The measurement in the field of LIS is known as bibliometric analysis. Bibliometric study is a simple statistical method of counting to evaluate and quantify the growth of a subject.

Statistical Quality Control and Operation Research Division, ISI

In the context of Indian Statistical Institute (ISI), it is well known in the world for its contributions in research and education. Statistical Quality Control and Operation Research (SQC & OR) Division conducts research in the areas of Statistics and Operations Research and the research are often related to practical problems encountered in industry and elsewhere. The Institute pioneered the development of Statistical Quality Control (SQC) movement in India. As early as in 1935, the Institute had recommended that the Government should take appropriate measures to initiate SQC methods in Indian industries. The Institute initiated the use of Statistical Quality Control and Operations Research in India in the early fifties and started developing these fields through theoretical and applied research, practical training in industry and consultancy assignments. The Statistical Quality Control and Operations Research (SQC & OR) Division set up in 1953, now operates with 8 units located at Bangalore, Kolkata, Hyderabad, New Delhi, Mumbai, Coimbatore, Chennai and Pune.

Literature Review

Gunasekaran, Sadikbatcha and Sivaraman(2016) in their study found out from their study that Indian researchers published 6186 papers from 569 journals and 12 non journal sources. More than 45 percent of these papers appeared in journals with an impact factor less than 1000. He found that 26 percent of papers published by Indians were in US journals. Mandhirasalam (2015) analyzed the publication output of PSG College of technology (PSGCT), Coimbatore and reported that 2112 papers (89.6percentage) were published during the last ten years among the 2357 papers published in the span of 44 years i.e. from 1971 to 2014. **Meera and Sahu (2014)** have studied the research output of University college of Medical Science (UCMS), University of Delhi and found that among the total of 2557 papers published by the faculties of UCMS, 82.19 percent could be traced in Medicine 25.6 percent was produced by three author system. **Singh, Jain and Babbar (2013**) in analyzed the research publication for a period of ten years from 1922 to 2002 to access the trend in the publication patterns of DESIDOC Bulletin of Information Technology by library and information professionals. Volume wise distribution of contributors, authorship pattern of contributors, institution wise etc. has been clearly described. The study revealed that 60 issues of the journal published 145 articles. Out of 145, 66.9 percentage articles were published by single author. The study also identified that 128 articles (88 percentage) were from India and rest 17 (12 percent) were contributed from rest of the countries. **Esmail and Jothi (2011)** attempted the authorship trend and collaborative research in the field of agricultural extension. Required data had been collected from the 'Journal of extension system ' published during the period of 2000-2009. It revealed that multi authored papers contribution was more in number compared to single authored paper. **Kumber and Kumar (2011)** investigated to identify the authorship trend and collaborative research in Genetics and Plant breeding. The data was collected from Indian Journal of Genetics and plant breeding published during 1998-2002. It highlighted that two author papers were maximum 215 (44.24 percentages). The degree of author collaboration was 0.87. **Thanuskodi (2010)** analysed the research output performance of Social scientists on social science subjects and highlighted that the analysis covered mainly

the number of articles, authorship pattern, subject wise distribution of articles, average number of references per articles, forms of document cited, year wise distribution of cited journal etc**.**
Krishnamurthy et. al. in the year 2009 aimed to analyze the Diabetes literature indexed in the MEDLINE databases for the period 1995-2005. It was found that the maximum number of records (13244) was during 2003, followed by 12960 in 2002 and 11061 in 2001. Relative Literature Growth was decreasing year wise in their study.

Objectives

The main objectives of the study are the following:

- To find out the year wise research publication output of SQC & OR Unit, ISI
- To identify the types of publication
- To determine the authorship pattern
- To examine the degree of collaboration among authors
- To present reference wise distribution of publication
- To point out the length of the publication
- To find out the top ranked area of research.

Coverage and Methodology

The methodology will be applicable in this study is Bibliometrics scrutiny. The study is based on the publications data collected from ISI Annual Report **(2010-2014**). Only the journal articles, reviews, conference papers, edited volumes and articles in press were considered for this study. For each publication, name of authors, number of authorship, number of references, author's institutional affiliation, area of the study, page length were noted down. All the necessary information were compiled, recorded, tabulated and analyzed for making observation as indicated in the objectives of the study. A database was created using Microsoft excel to accommodate and manage the data needed for analysis and used to generate such data as frequency distribution, mean, year wise distribution of publication, type of publication, authorship pattern (single, double, three and multiple), author collaboration, author productivity, centre wise distribution of authors, ranking of contributors, length of articles, reference per publications, area of research of published output and geographical distribution of published output.

Data Analysis and Results

Output of Publications

Table 1 represents year wise distribution of research output/ Publications of SQC & OR Unit of ISI during the year 2010-2014. It shows that the division has published 265 publications during these periods. The maximum research outputs are published in the year 2014 with 72 publications (27%) followed by the year 2011 with 61 publications (23%) and 2010 with 48 publications respectively. The lowest number of research outputs are 39 publications (15%) in the year 2013 followed by 45 publications (17%) in the year 2012. There is no steady growth rate from the year 2012 onwards. The growth does not show any specific pattern.
Table 1: Distribution of the year wise output

Sl. No.	Year	Number of Papers	Percentage (%)
1	2010	48	18

2	2011	61	23
3	2012	45	17
4	2013	39	15
5	2014	72	27
	Total	265	100

To understand this study, I have brought out the year wise growth pattern of the publications in the following figure.

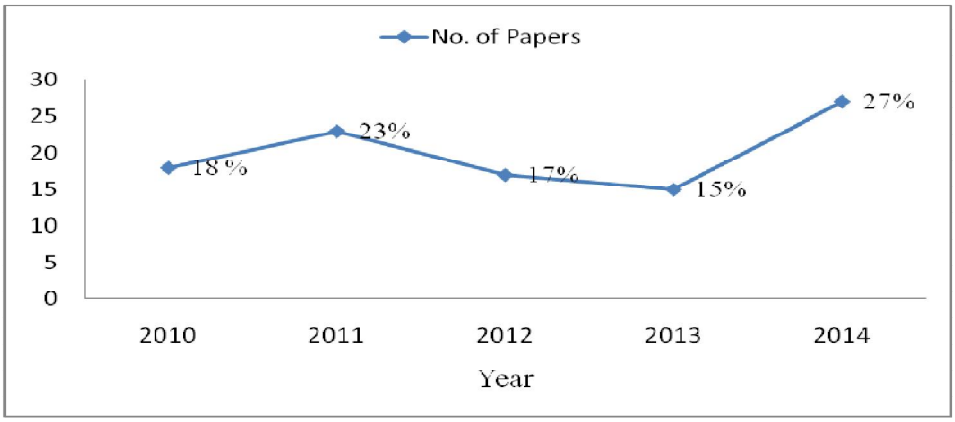

Figure 1. Distribution of the year wise output of Publication

Table 2: Distribution of the type of Publication

Sl. No.	Type of Publication	No. of Papers	Percentage (%)
1	Article (Journal)	170	64
2	Conference Paper	55	21
3	Edited Volume	25	9
4	Others	15	6
	Total	**265**	**100**

Table 2 shows that the faculties and research scholars of SQC & OR Unit of ISI mostly published their research findings in the form of Journal Article with 170 publications (64%) out of 265 as the medium of publication. They have also presented their papers in conferences and contributed 55 papers (21%) in the proceedings. They have published 25 edited volumes (9%) as well. Other types of publication including reviews, trade publication and article in press are very less with only 15 publications (6%).

Table 3: Distribution of the authorship pattern of publications

Year	Authorship Pattern				Total Article
	Single	Two	Three	More Than Three	
2010	16	13	14	6	48
2011	20	23	16	2	61
2012	12	9	18	6	45
2013	13	11	12	3	39
2014	28	22	18	4	72
Total	89	77	78	21	265
Percentage (%)	**33**	**29**	**30**	**8**	**100**

From the above table 3 it is clear that 176 publications (67%) are collaborative in nature. Only 89 papers (33%) are contributed by single author. Three authored papers are highest in number with 78 publications (30%) among the collaborative papers followed by two authored with 77 publications (29%) and more than three authors with 21 publications (8%). It is well known that now a day's research is carried out by group of researchers rather than by single researcher.

Degree of Collaboration

To determine the degree of collaboration on quantitative terms, the following formula by K. Subramanyam (1972) have used.

The formula is **C = NM/ (NM + NS)**

Where C = Degree of Collaboration
NM = Number of multi authored papers
NS = Number of single authored papers

Table 4: Distribution of the year Wise Degree of Collaboration

Year	Single Authored Papers (Ns)	Multi Authored Papers(Nm)	Total (Ns+Nm)	Degree of Collaboration
2010	12	36	48	0.75
2011	20	41	61	0.67
2012	17	28	45	0.62
2013	15	24	39	0.61
2014	25	47	72	0.65
Total	**89**	**176**	**265**	**0.66**

From the **table 4** it is observed that in the present study the value of C is

C = 176/ (176+89)
= 176/258
= 0.66

The degree of collaboration clearly indicates its dominance upon multi authored contribution.

Figure 4. Trend of year wise Degree of Collaboration of Publications The above table shows that the degrees of collaboration of publications are moving from 0.65 to 0.75 during the study period 2010-2014. The maximum collaboration trend is shown in the year 2010 with 0.75 followed by the year 2011 with 0.67 and 0.65 in the year 2014. The lowest collaboration of authors for the publication is in the year 2013 with 0.61 followed by the year 2012 with 0.62.

Table 5: Distributions of the length of articles

Sl. No.	No. of Pages	2010	2011	2012	2013	2014	Total	Percentage	Mean
1	1-3	2	4	-	-	3	9	3.39	**10.70**
2	4-6	8	18	4	5	13	48	18.11	
3	7-9	-	6	18	8	19	51	19.25	
4	10-12	14	12	9	14	7	56	21.13	
5	13-15	10	16	5	7	17	55	20.75	
6	16-18	14	5	9	5	13	46	17.36	
		48	61	45	39	72	265	100	

The **table 5** depicts the length of the article of publications during 2010-2014. The larger number of publications i.e 21.13 percent are written in the range of 10-12 pages, followed by 20.75 percent of publications in the 13-15 range, 19.25 percent of publications are in the 7-9 range, 18.11 percent of publications are written in the range of 4-6 pages. The other smaller number of publications i.e 17.36 percent are written in the range of 16-18 pages and 3.39 percent of publications are the range of in 1-3 pages.

Distributions of references per articles

The study of distribution of references per articles of research output of SQC & OR Division of ISI is the other factor to be discussed for bringing out fruitful facts. The following table presents the distributions of references per publications.

Table 6: Distributions of references per articles

No. of References	Articles	Percentage	Cumulative
1-5	12	4.5	4.5
6-10	13	4.9	9.4
11-15	43	16.23	25.63
16-20	13	4.9	30.52
21-25	89	33.59	64.1
26-30	62	23.41	87.6
31-35	19	7.18	94.68
>>35	12	4.53	99.2
Nil	2	0.76	100
Total	**265**	**100**	**100**

Table 6 reveals number of references appended on each publication. It has clearly shows that variation i.e. nil to more than 35 references appended on publications. 0.76 Percent of publications have been not appended any references. 33.59 percent of publications appended 21-25 numbers of references each and 26-30 numbers of references has been given on 23.41 percent of publication each. 26-30 numbers of references has been given on 23.41 percent of publications each and so on. The highest >>35 references and second highest 31-35 numbers of references have been appeared on 4.53 and 7.18 percent of publications respectively. On the other hand the lowest with 1-5 number of references and second lowest with 6-10 number of references have been appeared on 4.5 and 9.4 percent of publication respectively. It has been agreed on research community that research article should contain a good numbers of references append on it.

Table 7: Subject wise distribution of research for Published Output (Top 10 ranked areas)

Sl. No.	Area/Subject	No. of articles	Percentage	Cumulative Percentage
1	Six Sigma Initiatives	82	30.87	30.87
2	Lean Six sigma	40	15.09	45.96
3	Process Control ,Reliability & Software Reliability	33	12.45	58.41
4	Process Capability	21	7.92	66.33
5	Statistical Quality Control	20	7.54	73.87
6	Matrix Theory	18	6.59	80.46

7	Optimization Model	13	4.9	85.36
8	Stochastic Games	9	3.4	88.76
9	Taguchi Method	7	2.86	91.62
10	Miscellaneous	22	8.38	100
Total		**245**	**100**	**100**

Table 7 ravels the area wise distribution of publication output. It shows that 30.87 percent of publication output has been appeared on 'Six Sigma Initiatives' and possess number one position in comparative to other subject area. 'Lean Six Sigma' is the next area as appears with 15.09 percent of total publication output. 'Process Control, Reliability & Software Reliability' is another area of research output with 12.45 percent of publication output and place third. 'Process Capability' and 'Statistical Quality control' are another area of research output with 7.92 and 7.54 percent of publication respectively and possess fourth and fifth position. 'Matrix Theory' is the next area as appears with 6.59 percent of total publication output. 'Optimization Model' is the next are with 4.9 percent of publication output and possess seventh position in the areas of published output. 8.53 percent of total publication output is on miscellaneous topic of Statistical quality Control and Operation research areas.

Conclusion

From the analysis of the study it can be concluded that there is no steady growth of publications during the study period 2010-2014. The faculties and research scholars of SQC & OR Division of ISI prefer journal articles to publish their research findings. The faculties and research scholars of SQC & OR Division of ISI prefer journal articles to publish their research findings. Most of the publications of SQC & OR Division are collaborative in nature. Multi authored contributions have dominance over solo authored contributions during the whole study period 2010-2014. The faculties of SQC & OR Division mostly prefer 10-12 pages length for their publication. The quality of teaching and learning process and reputation of any institution can be measured on the basis of the R&D and publication output. The findings show that SQC & OR Division of ISI have largely contributed to the research in the field of Statistical quality Control and Operation Research.

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