Biobibliometric portrait of B.K Sen: A librarian, information scientist and scientometrician

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ABSTRACT

This biobibliometric study highlights the major aspects of the career of the Indian librarian and information scientist, Bimal Kanti Sen. As a professional librarian, he took major initiatives toenhance practical scientometric programs in India. He has contributed 390 writings since 1964 to 2018, i.e. over 55 years,including his service and retirement period. He authored seven writings per year on an average. Of the 390 writings, 184 are research articles, which means he contributed about three papers per year consistently over hisentire career period. Other than research articles, his contributions include technical and popular articles (55, 14%), writings on terminology (48, 13%), course materials (37, 10%), books (12, 3%), letters (12, 3%), book reviews (9, 2.5%), catalogue (9, 2.5%), review articles (5, 1.3%), reports (5, 1.3%) and bibliographies (4, 1%). The year-wise distribution of authorship pattern, collaborative authors and degree of collaboration, author productivity, core journals and highly cited publications are identified in this paper. Different academic indicators of Bimal Kanti Sen are calculated on the basis of citation data available from Web of Science, Scopus and Google Scholar. His academic and research activitiessteadily increased with his age. His most notable research work was normalization of the Impact Factor and identifying Impact Factor of non-SCI journal. His other notable works include biobibliometric analysis, history of science, lexicography, etc. He is still academically active and continues to add to the knowledge repository.

Keywords: Biobibliometrics; Bibliometric profile; Bimal Kanti Sen; B K Sen;Impact Factor Normalization

INTRODUCTION

Scientometrics is a domain that is devoted to quantitative studies of science and technology. It aims at the advancement of knowledge in the course of science andtechnologydevelopment, emphasizingthe context of sociological and policy-related questions. A special weightage is giventothe role of quantitative analysis. Various other synonymous terms hover around the term *scientometrics, i.e.* bibliometrics, informetrics, webometrics, cybermetrics, etc. Scientific publications seem to have provided the best available basis for measuring the outputs of individual scientists as there is a good correlation between the eminence of scientists and their sustained scholarly publications (Hertzel and Price 1986; 1987). Scientometric studies are highly valued by historians of science, biographers of scientists, administrators of scientific establishments, science policy makers, research and development managers, educationalists, scientometricians, young scientists, documentalists, information scientists and science journalists (Stockley 1957).

Biobibliometrics deals with the biographical study of the individual careers of scientists and researchers and correlating bibliographic analysis of publications or academic and scientific achievements. Individuals create ideas. Institutions are built by individuals and grow around individuals,which are the basic foundations of any institution. The probable doyens of any subject domain may be predicted by studying the core individuals of the same. Biobibliometrics is a term that was first coined by Sen and Gan (1990) to mean the quantitative and analytical method for discovering and establishing functional relationships between biodata and biblio-data elements. There are many biobibliometric studies, but they have hardly used the term 'biobibliometrics' in the titles of the papers except for Sen and Gan (1990) and Tiew (1999).

Kalyane and Kalyane (1993) first used the phrase 'scientometric portrait' to carry out biobibliometric studies on scientists. In some of the papers, Kalyane and Devarai (1994) and Kalyane and Samanta (1995), used the term 'informetrics' in the titles of their papers on C. S. Vekata Ram and K. Ramiah respectively.However, there was a continuous use of the phrase 'scientometric portrait' (Kalyane and Kalyane 1993; Kalyane and Kalyane 1994; Kademani and Kalyane 1994; Kademani and Kalyane 1994; Kalyane 1995; Kalyane and Kademani 1995, Kalyane and Munnolli 1995; Kalyane and Sen 1996; Kademani, Kalyane and Kademani 1996; Kademani and Kalyane 1996; Kalyane and Kademani 1997; Kalyane and Sen 1998; Kademani and Kalyane 1998; Kademani, Kalyane and Jange 1999; Kademani, Kalyane and Kumar 2000; Kademani, Kalyane and Kumar 2001; Kalyane, Prakasan and Kumar 2001; Kalyane, Prakasan and Vijay Kumar 2002; , Kalyane and Kumar 2002; , Kalyane and Kumar 2002; Koganuraman et al. 2004; Angadi et al. 2004; Kademani et al. 2005) consistently.A comprehensive reference list on biobibliometric studies is provided by Koley and Sen(2018). The biobibliometric studies or scientometric portrait development carried out by Amsan, Angadi, Balakrishnan, Devarai, Hazarika, Kalyane, Kademani, Karanjai, Koganuramath, Koley, Kumar, Mallikarjun, Mohan, Munnolli, Muttayya, Narayana, Prakashan, Samanta, Sangam, Sarme, Savanur, Sen, Suresh, Vellaichamy and Tiew, illustrates scientists from different subject domains as listed in Table 1. Besides the group headed by Kalyane, some other biobibliometric studies were carried out by Sangam et al (2006, 2007, 2010). The first biobibliometric study on a film actress, Suchitra Sen, and on a biobibliometrician, Sambhu Nath De were carried out by Koley and Sen (2014a; 2016b), who also conducted a few other biobibliometric studies (Koley and Sen 2014b; 2016a). An inspection of Table 1 instantly reveals that the practical biobibliometrics works started in 1993, while the theoretical concept was introduced by Sen and Gan in 1990. In all, the scientometric portraits of 43 scientists were developed by Kalyane et al. Of the 43 scientists, 26 were of Indian scientists, followed by 4 scientists each from UK and USA, while another 2 were from Germany. The native countries of other scientists include Egypt, France, Hungary, Malaysia, Netherlands and Scotland (one scientist each). The scientists from Physics and Astrophysics top the list (13, Nobel-Laureate: 5) followed by Chemistry and Biology (7 each, Nobel-Laureate: 3 in Chemistry), Physiology/ Medicine (7, Nobel-Laureate: 2) and Scientometrics (4). The scientometric portraits developed for laureate scientists figures ten, with five from Physics. The Physics and Astrophysics areas are found to be the most favourable for the biobibliometricians. The distinguished scientometricians with biobibliometric studiesinclude Eugene Garfield, Tibor Braun and Mike Thelwall. Notably Tibor Braun was a chemist originally, while Eugene Garfield was proclaimed as a historian of science. The focal area of Mike Thelwall is altmetric studies rather than traditional scientometrics and bibliometrics.To date only one Indian scientometrician, V.L. Kalyane,biobibliometric portrait was developed. But Kalyane is better known as biobibliometrician rather than a general scientometrician or bibliometrician. This paper is the first attempt to present abiobibliometric study of a multifaceted Indian scholarBimal Kanti Sen or more well known as B.K. Sen, who was a

librarian atthe National Science Library of India over a substantive time, and proclaimed as aninformation scientist, ascientometrician and a lexicographer.

Table 1: List of Scientists with Biobibliometric and Scientometric Portraits

No.	Subject	Year	Name of the Scientist	Nationality
1	Physiology/ Medicine	1993	Vinodini Reddy	India
2	Mathematics	1994	C. S. Venkataraman	India
3	Physics	1994	P K Iyenger	India
4	Physics	1994	C. V. Raman (Nobel Laureate)	India
5	Biology/ Life Science	1994	M. S. Swaminathan	India
6	Physics-Nuclear	1995	R. Chidambaram	India
7	Chemistry	1995	T. S. West	Scottland
8	Biology/ Life Science	1995	P. M. Bhargava	India
9	Agricultural Science	1995	K Ramaiah	India
10	Astrophysics	1996	S. Chandrasekhar (Nobel Laureate)	India
11	Physics	1996	Pierre-Gilles de Gennes (Nobel Laureate)	France
12	Physics	1996	K. S. Krishnan	India
13	Physiology/ Medicine	1997	Barbara McClintock (Nobel Laureate)	USA
14	Biology-Genetics	1998	C. R. Bhatia	India
15	Chemistry	1999	Dorothy Crowfoot Hodgkin (Nobel Laureate)	UK
16	History-Malaysia	1999	K. K. Kim	Malaysia
17	Astrophysics	2000	Vikram Ambalal Sarabhai	India
18	Chemistry	2001	Ahmed Hassan Zewail (Nobel Laureate)	Egypt
19	Biology-Molecular Biology	2001	Ranjit Kumar Mitra	India
20	Chemistry	2002	Harold W Kroto (Nobel Laureate)	UK
21	Astrophysics	2003	R. G. Rastogi	India
22	Chemistry + Scientometrics	2003	Tibor Braun	Hungary
23	Chemistry-Physical	2003	Biman Bagchi	India
24	Physics	2004	Wolfgang Ketterle (Nobel Laureate)	Germany
25	Physics-Nuclear	2004	Homi J. Bhabha	India
26	Botany	2004	L. L. Narayana	India
27	Physiology/ Medicine	2004	H. Hartwell (Nobel Laureate)	USA
28	Mathematics	2006	N. Rudraiah	India
29	Physics	2006	Anthony J. Leggett (Nobel Laureate)	USA
30	Earth Science	2006	Peter John Wyllie	UK
31	Physiology/ Medicine	2006	B. N. Koley	India
32	Physics	2007	Sivaraj Ramaseshan	India
33	Chemistry-Polymer Science	2008	T. M. Aminabhavi	India
34	Physiology/ Medicine	2008	T. M. Aminabhavi	India
35	Scientometrics, History of Science	2010	Eugene Garfield	USA
36	Bio-meteorology	2010	Nayana Nandu Borthakur	India
37	Virology	2011	Harald Zur Hausen	Germany
38	Physiology/ Medicine	2014	Sambhunath De	India
39	Bengalee film actress	2014	Suchitra Sen	India
40	Scientometrics and Altmetrics	2016	Mike Thelwall	UK
41	Scientometrics, Biobibliometrics	2016	V. L. Kalyane	India
42	Physiology/ Medicine	2016	A. S. Paintal	India
43	Astrophysics	2018	J. H. Oort	Netherlands

This biobibliometric study includes productivity, collaboration and authorship pattern study and scientometric indicator analysis of Bimal Kanti Sen, a former scientist of the Indian National Scientific Documentation Centre or INSDOC (now called National Institute of Science Communication and Information Resources, NISCAIR). He also served at the University of Malaya, Malaysia for five years (1995-1999) as a Visiting Professor.

BRIEF BIOGRAPHICAL SKETCH

B.K. Sen was born 2nd August 1938, at Charmadhua, P.O. Chandrakona, Dist - Mymensingh, Bengal, India (now in Bangladesh). He is the fourth son of Mr. Benode Bihari Sen and Ms. Haima Bala Sen.He was admitted to Charmadhua Government Primary School where he studied up to Class IV and obtained a scholarship through a competitive examination. Thereafter, he joined Chandrakona Rajlakshmi High School and studied up to Class VI. Throughout his schooling, he was the top students of his class. While in Class VII, a riot broke out in East Pakistan which forced his family to leave their home practically empty handed to settle in a village called Hansdaha near Gulab Bag in the district ofPurnea in Bihar.Here he was admitted into Purnia Zila School which was four miles away from the village. Everyday he walked barefooted for eight miles to attend school. The distance of the school, the Hindi medium and lack of books due to utter poverty culminated in his becoming an academically average student. He passed his secondary examination in second division. For a short time he was admitted toRampurhat College to study Intermediate in Science. He had to leave the college again due to financial constraints. His education would have found a dead end here had his maternal uncle, Dhirendra Chandra Chanda, not come forward to provide him boarding and lodging in his house at Belgharia in Kolkata. In the City College of Amherst Street, Calcutta, Prof. Manoranjan Dasgupta (the then Vice Principal of the College) was kind enough to give him admission in Intermediate in Science after the date of admission was long over. He then completed his bachelor's degree in Science with Distinction. Hereafter, he joined the West Bengal Government Service in 1960 as a Lower Division Assistant. While working here he used to walk everyday along Bowbazar Street up to Writers Building to do his duty, and encountered the signboard of Bengal Library Association (BLA) located at Huzury Mall Lane, of Bowbazar Street, Calcutta. In his early childhood he has seen a small collection of books in his home belonging to his father. The books were used to primarily answer the various queries of the villagers, such as the auspicious day for a journey, the days of various festivals, full moon and new moon, and so on. This developed in him a love for books. Possibly, his love for books one day landed him in BLA's office where from he completed his Certificate Course in Library Science. He obtained his library science degree from the University of Calcutta. He was a Gold Medallist for the Master in Library and Information Science from University of Delhi. His PhD was awarded by Jadavpur University in 1995 for his thesis entitled *Indian Scientific Periodicals: A Study of the Origin and Development up to 1900* under the supervision of Prof. Prabir Roychowdhury. This study added yet another area, i.e. History of science, into his research career.

He started his professional career as aLibrary Assistant in the Finance Department Library, Government of West Bengal, in 1961. This duty he performed besides his duty as a Lower Division Assistant (LDA.) Then he joined as a Junior Documentation Assistant, at INSDOC, New Delhi in 1963, where he served upto 1995. During his career of 32 years he worked in various departments and headed successively the Russian Science Information Centre, National Centre on Bibliometrics, Education and Training Division, and finally National Science Library.   He left INSDOC in 1995 tojoin University of Malaya in Malaysia as visiting professor where he served upto 1999. Here he contributed substantially to the development

of the Master of Library and Information Science (MLIS) programme. He also was part of the team who initiated and contributed to the very first issue of the *Malaysian Journal of Library & Information Science,* an international journal. It may be noted that this was the first LIS journal from Asia to be indexed by Web of Science. In INSDOC, he shouldered the full responsibility of the Education and Training Division during 1988-1995. He taught for a period of 25 years, mainly in subjects relating to Information Sources, Classification, and Information and Society in the Associateship in Information Science (AISc) Course. He organized numerous courses of 4-week duration devoted to Computer Application in Library and Information Activities; and also organized four 10-day training courses on Bibliometrics to train librarians and information specialists from all over India, under the auspices of the National Centre on Bibliometrics, a NISSAT project.He organised three courses of one-week duration on CDS/ISIS to train about 70 INSDOC employees in June/July 1988. Heprepared around 30 course materials for BLIS, MLIS, M Phil/PhD courses in1989 at the School of Social Sciences, Indira Gandhi National Open University (IGNOU), New Delhi.

Prof. Sen is actively associated with the Delhi Library Association. He taught Reference Service to Diploma students for about five years during 1970s. He also taught Cataloguing (Theory) to the Certificate Course students for about 20 years during 1975 to 1995. He delivered numerous visiting lectures at the North Eastern Hill University, Shillong; Aligarh Muslim University, Aligarh; Dr. Hari Singh Gaur University, Sagar; Jamia Milia Islamia, New Delhi; Technical Teachers Training Institute, Chandigarh; State Council of Educational Research and Training, New Delhi; National Institute of Oceanography, Goa; Annamalai University, Regional Study Centre, New Delhi; University of Burdwan, Bardhaman; Jadavpur University, Kolkata; Vidyasagar University, Midnapore; and Mizoram University, Aizawl on diverse topics such as Reference Service, Abstracting and Indexing Services, Bibliometrics, Information Science, Information Centre Management and Universal Decimal Classification. He delivered several lectures on Energy Information Handling in Nepal in 1987, and in Pakistan in 1991 at the National Workshop on Energy Information Handling organised at Kathmandu and Islamabad respectively under the auspices of INNERTAP, UNESCO. Apart from teaching, he has been distinctly involved in several other areas such as, editing, compilation of reference sources; writing of course materials; compilation of scientific glossaries; research in bibliometrics and related areas; research in history of science; popular science writing; and writing of poems.

RESEARCH CONTRIBUTIONS

During his tenure in INSDOC (now NISCAIR), and as visiting Professor in universities around India and abroad, most of his research activities were confined to bibliometric studies, scientific periodicals, scientific societies and lexicography. More specifically the research domains may be categorised as:
   (a) History of Indian Science and Technology (S& T) periodicals
   (b) History of Indian scientific societies
   (c) Determination of impact factors of journals not covered by *Science Citation Index*
   (d) Development of the concept of normalized impact factor of S & T periodicals
   (e) Evaluation of recent scientific output of laboratories using bibliometric methods
   (f) Coverage of Indian S & T literature by international abstracting and indexingServices
   (g) S & T terminology in Bengali and lexicography

The research output of the Council of Scientific and Industrial Research (CSIR) is being analyzed using the method of evaluation developed by Prof. Sen since 1986. Scientists are

being ranked for the award of prestigious prizes and fellowships based on this analysis. The analysis has generated numerous useful indicators for science management and attracted the attention of many top ranking scientists of India. Dr Eugene Garfield termed the method of determination of the impact factor of non-SCI journals as an effective method. In INSDOC, Prof. Sen established The *National Centre on Bibliometrics* through the financial support of NISSAT (National Information System on Science and Technology), Government of India. The Centre is the first of its kind in Asia. He prepared the research project proposal, along with acquiring of funds, selection of people, planning of the services etc. to run the Centre.The Centre is operational since 1988. Under the auspices of the centre, a publication titled *In Search of Knowledge* was published in six volumes, incorporating significant contributions of CSIR scientists published since 1942. *CSIR Research Output - a Bibliometric Analysis* for the years 1986, 1987, 1988, 1989, 1990, 1991 were also publishedby the Centre under Prof. Sen's supervision. This publication created a great impact in CSIR since it became a mirror of the achievements of various CSIR laboratories. Another big contribution of the Centre is the evaluation of the contributions of a scientist based on the citations received by his papers. The method developed by the Centre has found wide application in India for the purpose of awarding a scientist or electing him/her as a fellow of a prestigious academy of science. Citation analysis has become a common term among the Indian scientists today. Prof. Sen may be reckoned as the Father of citation analysis in India. He carried out bibliometric evaluation of some 20 departments of Indian universities at the behest of the University Grants Commission, India. He is a veteran editor during the last forty years of various primary and secondary journals, directories, monographs, reports, etc. Some of the publications edited by him are listed below:

(a) *Indian Educational Material - an Annotated Quarterly Bibliography*. [Associate Editor 1966-1970]
(b) *Contents List of Soviet Scientific Periodicals* [Editor 1971-1980]
(c) i*Russian Scientific and Technical Publications - An Accession List* [Editor 1971-1980]
(d) *Annals of Library Science and Documentation* [Associate Editor 1981-1987; Editor 1988-1989]
(e) *Malaysian Journal of Computer Science* [Editorial board 1995-1999]
(f) *Malaysian Journal of Library & Information Science* [Editor 1995-1999]
(g) *ILA Bulletin* [Editor 2000-2001]
(h) *Information Today and Tomorrow* [Editor 1999 -2002]
(i) *Directory of Scientific Research Institutions in India.* 2nd edition.
(j) *Open Access to Knowledge and Information – Scholarly Literature and Digital Library Initiatives – The South Asian Scenario*/ Anup Kumar Das(UNESCO publication);
(k) *Digital Archiving of Audio Content* (UNESCO publication)
(l) *Report of the National Forest Commission*
(m) *Voices from the Field. 2011.* (ICFRE Publication)
(n) *Organizing knowledge: then and now*. Bidyarthi Dutta; (New Delhi: Ess Ess Pub. 2015.)

He played the leading role in setting up of the Russian Science Information Centre in INSDOC in 1971. The overall organisation, planning, and management of the Centre was conducted by him for about ten years. The two serials producedby him for disseminating information on Russian books and periodical articles on science and technology are: *Russian Scientific & Technical Publication- an Accession List;* and *Contents List of Soviet Scientific Periodicals.* Every detail of the serials including their contents, organisation of inside matter, index etc. was worked out by him as the Editor of the two serials. The Express Information Service was introduced in India for the first time by him in 1973 when a serial publication on metallurgy providing long digests of articles was published. The Information Letter Service,

a novel current awareness service, was also introduced by him for the first time in India soon after the establishment of the Centre.

Prof. Sen is also actively involved in developing subject dictionaries and glossaries during the last fifty years. He compiled many subject glossaries on Physics, Chemistry, Library & Information Science etc. He published over 160 research articles in various national and international journals.He received many distinguished awards, i.e. Prof. S Dasgupta Memorial Gold Medal from University of Delhi in 1983; Dr. T M Das Foundation Award for the Best Science Writing in Jnan Bichitra in 1994; Tincori Dutt Award for Best Writing in Library and Information Science published in *Granthagar* from Bengal Library Association in 1998 and Distinguished Leadership Award by American Biographical Institute in 1997.

Scope
Scientometric portrait study is a quantitative analysis of the publications of an author or a scientist, either living or dead. It concludes all publications during one's life time. The present study is confined to 380 publication contributions of B.K. Senthat include research articles published in various national and international journals, conference proceedings, books, technical and popular articles, review articles, bibliographies, course materials, reports, letters and catalogues, etc. during 1964-2018.

OBJECTIVES

The main objectives of the study are:
    (a) To ascertain the growth pattern of research and other contributions of B K Sen;
    (b) Toidentify the year-wise distribution of authorship pattern;
    (c) To identify the collaborative authors and degree of collaboration;
    (d) To calculate author productivity;
    (e) To identify core journals;
    (f) To identify highlycited publications;
    (g) Toidentifydifferent academic indicators of B K Sen

METHOD

Publications count and analysis is one of the bibliometric/scientometric analytic technique. It involves studying the number of publications of a single author, or productivity of literature in the field, with the purpose to compare the amount of research in different countries, and the amount produced during different periods or in different subdivisions of the field (Hertzel 1987). Using the same technique, thisstudy reports on a single author study of'B. K. Sen'. Scientific publications seem to provide the best available basis for measuring the research output. The citation data for this study was obtained from Scopus, Web of Science and Google Scholar databases to extract relevant data on B. K. Sen over the period of fifty four years (1964-2018). In total, 380 publication contributions of B. K. Senwere identified for this study. The collected data were transferred into Microsoft Excel 2010, and subjected to further analysis to meet the objectives of the study.

DATA ANALYSIS

Growth of Publications

The yearwise variations of cumulative number of research article publications and authorship pattern analysis are presented in Table 2. The single-authored journal articles by B K Sen are 73, while multi-authored articles are 111. Of the 111 multi-authored publications, Sen was the first author in 29 articles, second author in 55 articles and third author in 25 articles. The CAPC varies with PPA in accordance with the equation: $y=0.0189*x^{2.298}$, where, X=PPA and Y=CAPC (Figure 1). This is a non-linear polynomial equation where 'y' represents nearly parabolic pattern. The growth of publications other than journal articles are presented in Table 3.
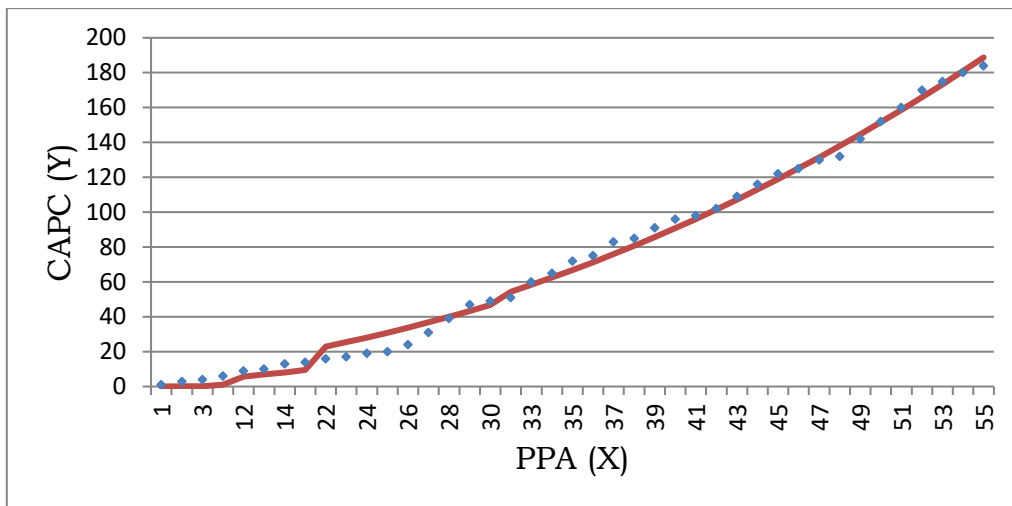
Figure 1: Variation of CAPC with PPA for Journal Articles

The CAPC varies with PPA in accordance with the equation: $y = 3.95*x-4.54$, (Figure 2), where, x=PPA and y=CAPC. This is a linear equation with the values of slope and intercept are 3.95 and (-4.54) respectively. The growth of all publications is shown in Table 4. The CAPC varies with PPA in accordance with the equation: $y = 1.638*x^{1.361}$, where, x=PPA and y=CAPC. This is a non-linear polynomial equation (Figure 3).

Figure 2: Variation of CAPC with PPA for publications other than journal articles

Table 2: B.K.Sen's Growth of Research Articles and Authorship Pattern

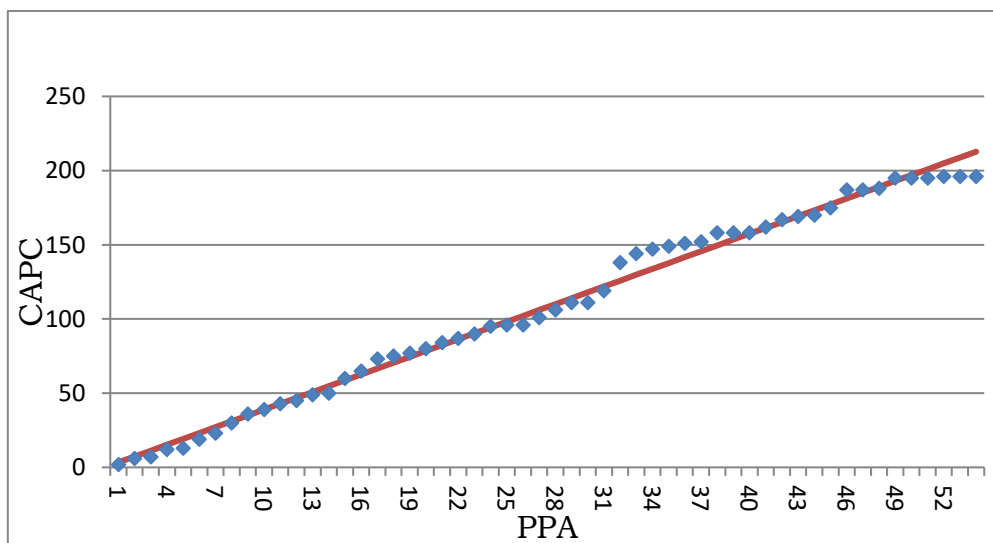| Year	APC	CAPC (Observed)	CAPC (Calculated)	AA	PPA	SAP	MAP	1st Author	2nd Author	3rd Author	> 3rd Author	No. of Co-Authors	DC = MAP/APC
1964	1	1	2.04	26	1		1		1			1	1.00
1965	2	3	2.38	27	2		2		2			3	1.00
1966	1	4	2.77	28	3		1	1				1	1.00
1969	2	6	4.19	31	6	2							0.00
1975	3	9	8.65	37	12		3	1	2			4	1.00
1976	1	10	9.65	38	13		1				1	3	1.00
1977	3	13	10.73	39	14		3		3			2	1.00
1978	1	14	11.91	40	15	1							0.00
1985	2	16	23.04	47	22	1	1	1	1			1	0.50
1986	1	17	25.11	48	23		1		1			1	1.00
1987	2	19	27.32	49	24	2							0.00
1988	1	20	29.68	50	25	1							0.00
1989	4	24	32.18	51	26		4	4				3	1.00
1990	7	31	34.84	52	27	2	5	4	1			3	0.71
1991	8	39	37.67	53	28	5	3		2	1		4	0.38
1992	8	47	40.66	54	29	1	7	4	1	2		6	0.88
1993	2	49	43.83	55	30		2	2				2	1.00
1995	2	51	50.74	57	32		2	1	1			2	1.00
1996	9	60	54.48	58	33	3	6	3	1	2		7	0.67
1997	5	65	58.43	59	34	3	2		1		1	4	0.40
1998	7	72	62.59	60	35	3	4	3	1			9	0.57
1999	3	75	66.97	61	36	2	1		1			1	0.33
2000	8	83	71.58	62	37	3	5		5			2	0.63
2001	2	85	76.42	63	38		2	1		1		3	1.00
2002	6	91	81.51	64	39		6	3	1	2		3	1.00
2003	5	96	86.85	65	40		5	2	2	1		5	1.00
2004	2	98	92.45	66	41	2							0.00
2005	4	102	98.32	67	42		4		3	1		5	1.00
2006	7	109	104.47	68	43	2	5		3	2		5	0.71
2007	7	116	110.90	69	44	3	4		1	3		6	0.57
2008	6	122	117.63	70	45	3	3		2	1		5	0.50
2009	3	125	124.66	71	46	2	1			1		2	0.33
2010	5	130	132.00	72	47	3	2			2		4	0.40
2011	2	132	139.67	73	48	1	1	1				1	0.50
2012	10	142	147.67	74	49	5	5		3	2		4	0.50
2013	10	152	156.01	75	50	6	4		3	1		6	0.40
2014	8	160	164.70	76	51	4	4		3	1		4	0.50
2015	10	170	173.75	77	52	5	5		3	2		8	0.50
2016	5	175	183.17	78	53	1	4		4			3	0.80
2017	5	180	192.98	79	54	4	1		1			1	0.20
2018	4	184	203.17	80	55	3	1		1			1	0.25
All	184					73	111	29	55	25	2	125	

[APC=Annual Publication Count; CAPC=Cumulative Annual Publication Count; AA=Author's Age; PPA=Publication Productivity Age; DC=Degree of Collaboration; MAP=Multi-Authored Publications; SAP=Single-Authored Publications]

Table 3: Growth of Publications other than Research Articles

Year	BK	RVA	TA	WT	BR	LT	BL	CT	CM	RP	APC	AA	PPA	CAPC [Observed]	CAPC [Calculated]
1965		1						1			2	27	2	2	2.65
1966			1				1	2			4	28	3	6	6.6
1967								1			1	29	4	7	10.6
1968			1			1		3			5	30	5	12	14.5
1969								1			1	31	6	13	18.5
1970			5				1				6	32	7	19	22.4
1971			2	1				1			4	33	8	23	26.4
1972			5	1			1				7	34	9	30	30.3
1973		1	2	1	1					1	6	35	10	36	34.3
1974			2		1						3	36	11	39	38.2
1975			2						2		4	37	12	43	42.2
1976			1	1							2	38	13	45	46.1
1977				2	2						4	39	14	49	50.1
1978				1							1	40	15	50	54
1979			5	3	2						10	41	16	60	58
1980			3			2					5	42	17	65	61.9
1981		1	1	2		3	1				8	43	18	73	65.9
1982			2								2	44	19	75	69.8
1983			1							1	2	45	20	77	73.8
1984			2	1							3	46	21	80	77.7
1985	2			1	1						4	47	22	84	81.7
1986		1	2								3	48	23	87	85.6
1987			1						1	1	3	49	24	90	89.6
1988	2		1						2		5	50	25	95	93.5
1989	1										1	51	26	96	97.5
1990											0	52	27	96	101
1991		1				2			1	1	5	53	28	101	105
1992			1	1					3		5	54	29	106	109
1993					1				3	1	5	55	30	111	113
1994											0	56	31	111	117
1995			1	7							8	57	32	119	121
1996			2	17							19	58	33	138	125
1997			5			1					6	59	34	144	129
1998				3							3	60	35	147	133
1999				1		1					2	61	36	149	137
2000			2								2	62	37	151	141
2001			1								1	63	38	152	145
2002	1		5								6	64	39	158	149
2003											0	65	40	158	153
2004											0	66	41	158	157
2005	2								2		4	67	42	162	161
2006					1	1			3		5	68	43	167	165
2007									2		2	69	44	169	169

Year	BK	RVA	TA	WT	BR	LT	BL	CT	CM	RP	APC	AA	PPA	CAPC	CAPC
2008	1										1	70	45	170	173
2009		1								4	5	71	46	175	176
2010	1			1						10	12	72	47	187	180
2011											0	73	48	187	184
2012										1	1	74	49	188	188
2013	1	1	2							3	7	75	50	195	192
2014											0	76	51	195	196
2015											0	77	52	195	200
2016	1										1	78	53	196	204
2017											0	79	54	196	208
2018											0	80	55	196	212
All Total	12	5	55	48	9	12	4	9	37	5	196				

[BK=Book; RVA=Review Articles;TA=Technical & Popular Articles; WT=Writings on Terminology; BR=Book Reviews; LT=Letters; BL=Bibliography;CT=Catalogue;CM=Course Materials; RP=Reports; APC=Annual Publication Count; AA=Author's Age; PPA=Publication Productivity Age; CAPC=Cumulative Annual Publication Count]

Table 4: Growth of All Publications

| Year	APC	AA	PPA	CAPC (Observed) (X)	CAPC (Calculated) (Y)
1964	1	26	1	1	1.64
1965	4	27	2	5	4.21
1966	5	28	3	10	7.31
1967	1	29	4	11	10.81
1968	5	30	5	16	14.64
1969	3	31	6	19	18.77
1970	6	32	7	25	23.15
1971	4	33	8	29	27.76
1972	7	34	9	36	32.59
1973	6	35	10	42	37.61
1974	3	36	11	45	42.82
1975	7	37	12	52	48.20
1976	3	38	13	55	53.75
1977	7	39	14	62	59.46
1978	2	40	15	64	65.31
1979	10	41	16	74	71.31
1980	5	42	17	79	77.44
1981	8	43	18	87	83.70
1982	2	44	19	89	90.09
1983	2	45	20	91	96.61
1984	3	46	21	94	103.24
1985	6	47	22	100	109.99
1986	4	48	23	104	116.85
1987	5	49	24	109	123.82
1988	6	50	25	115	130.89
1989	5	51	26	120	138.07
1990	7	52	27	127	145.34
1991	13	53	28	140	152.72
1992	13	54	29	153	160.19
1993	7	55	30	160	167.76
1995	10	57	32	170	183.16
1996	28	58	33	198	190.99
1997	11	59	34	209	198.91

1998	10	60	35	219	206.91
1999	5	61	36	224	215.00
2000	10	62	37	234	223.17
2001	3	63	38	237	231.42
2002	12	64	39	249	239.75
2003	5	65	40	254	248.15
2004	2	66	41	256	256.63
2005	8	67	42	264	265.19
2006	12	68	43	276	273.82
2007	9	69	44	285	282.52
2008	7	70	45	292	291.30
2009	8	71	46	300	300.14
2010	17	72	47	317	309.06
2011	2	73	48	319	318.04
2012	11	74	49	330	327.09
2013	17	75	50	347	336.21
2014	8	76	51	355	345.40
2015	10	77	52	365	354.65
2016	6	78	53	371	363.96
2017	5	79	54	376	373.34
2018	4	80	55	380	382.78

[APC=Annual Publication Count; AA=Author's Age; PPA=Publication Productivity Age; CAPC=Cumulative Annual Publication Count]
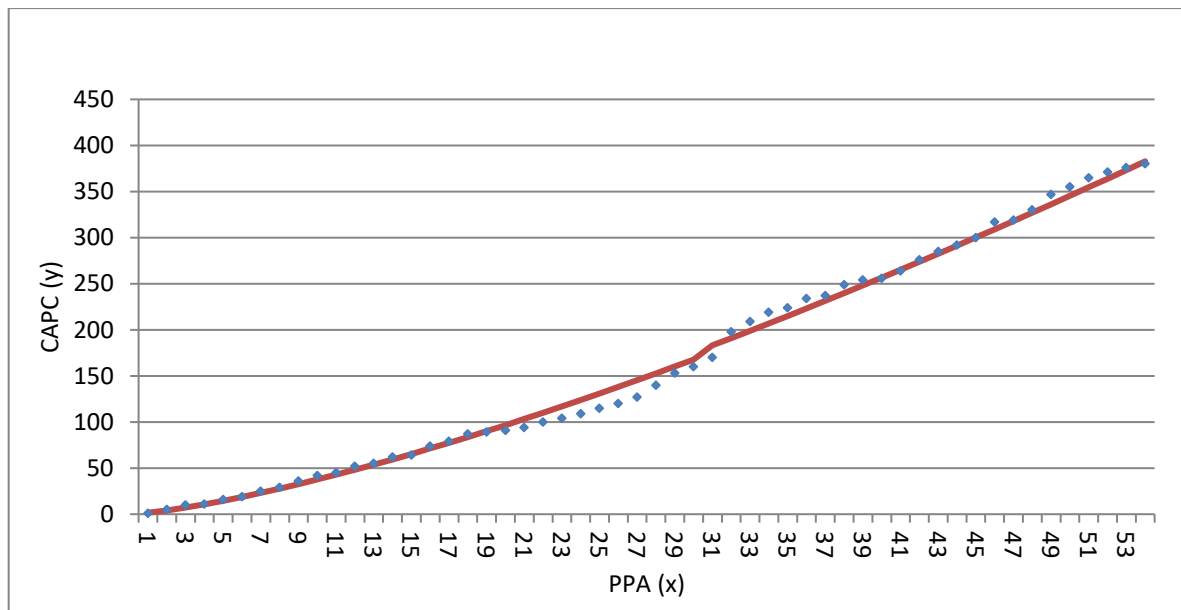
Figure 3: Variation of CAPC with PPA for All Publications
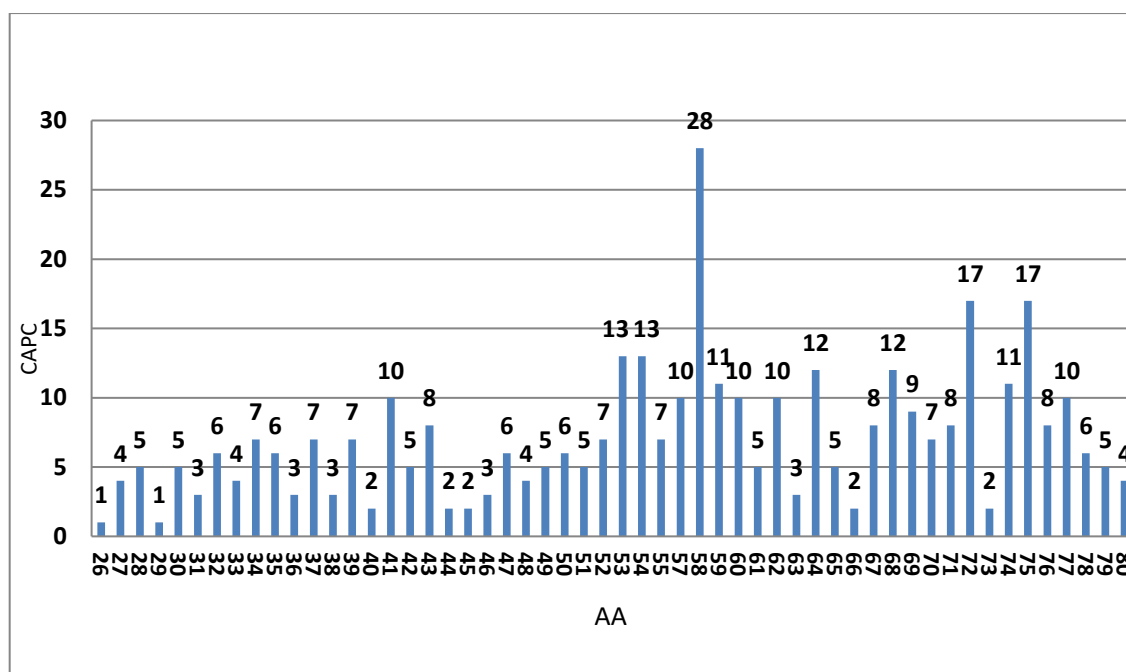
Figure 4: Variation of Number of All Publications (CAPC) with AA

It is observed from Figure 4 that B K Sen contributed a maximum number (28) of scholarly output at the age of fifty eight, i.e. in the year 1996, followed by 17 contributions at the age of 72 and 75 in the years 2010 and 2013. In the years,1991 and 1992 (age 53 and 54) and 2002 and 2006 (age 64 and 68), he contributed 13 papers and 12 papers each respectively. Least number of papers (only one) were contributed in the years 1964 and 1967 (Age 26 and 29). The Quinquennium publication data of B K Sen is presented in Table 5 and Figure 5. The highest contribution figured 59 during 1994 to 1998, at the age-range of 56 to 60 followed by 55 contributions during 2009 to 2013 (age-range 71 to 75) and 45 contributions during 1989 to 1993 (age range 51 to 55). The author was thus most active during the age of 51 to 60, i.e. since 1989 to 1998. It is worth mentioning that he was a visiting Professor at the University of Malaya, Malaysia during this period. Also, he was potentially active during the age range of 71 to 75, i.e. since 2009 to 13. The contribution of B K Sen was least during the age-range of 26 to 30, i.e. since 1964 to 1968 followed by 22 contributions during the age-range of 31 to 35, i.e. since 1969 to 1973. It is observed that the author's productivity increased with age.

Table 5: Quinquennium Publications

| Year	AA	PPA	APC
1964-68	26-30	1-5	16
1969-73	31-35	6-10	26
1974-78	36-40	11-15	22
1979-83	41-45	16-20	27
1984-88	46-50	21-25	24
1989-93	51-55	26-30	45
1994-98	56-60	31-35	59
1999-03	61-65	36-40	35
2004-08	66-70	41-45	38
2009-13	71-75	46-50	55
2014-18	76-80	51-55	33
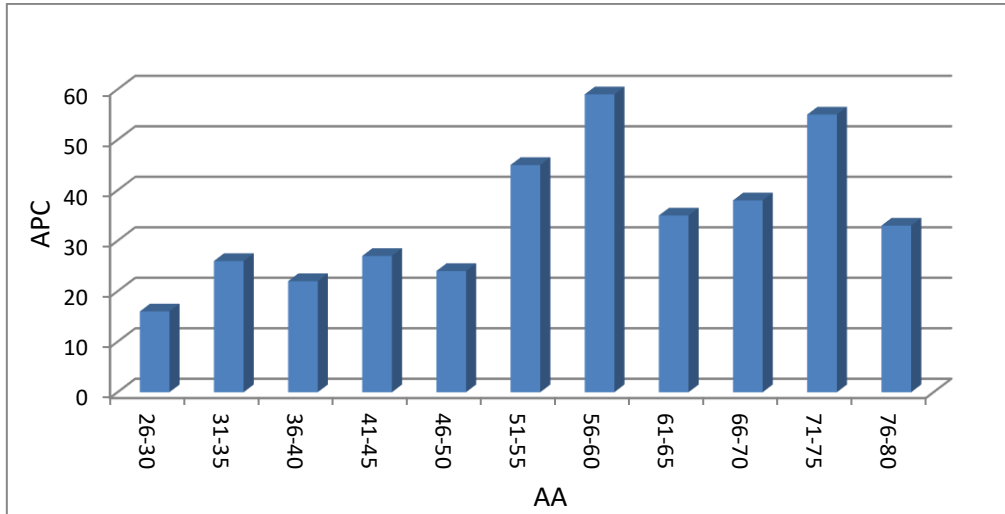
Figure 5: Quinquennium Publications

The total number of publications contributed by B K Sen up to June, 2018 figures 380, of which research articles amount 184 (48%), followed by technical and popular articles (55, 14%), writings on terminology (48, 13%) and course materials (37, 10%). The remaining 15% contributions include, books (12, 3%), letters (12, 3%), book reviews (9, 2.5%), catalogue (9, 2.5%), review articles (5, 1.3%), reports (5, 1.3%) and bibliography (4, 1%) (Figure 6).
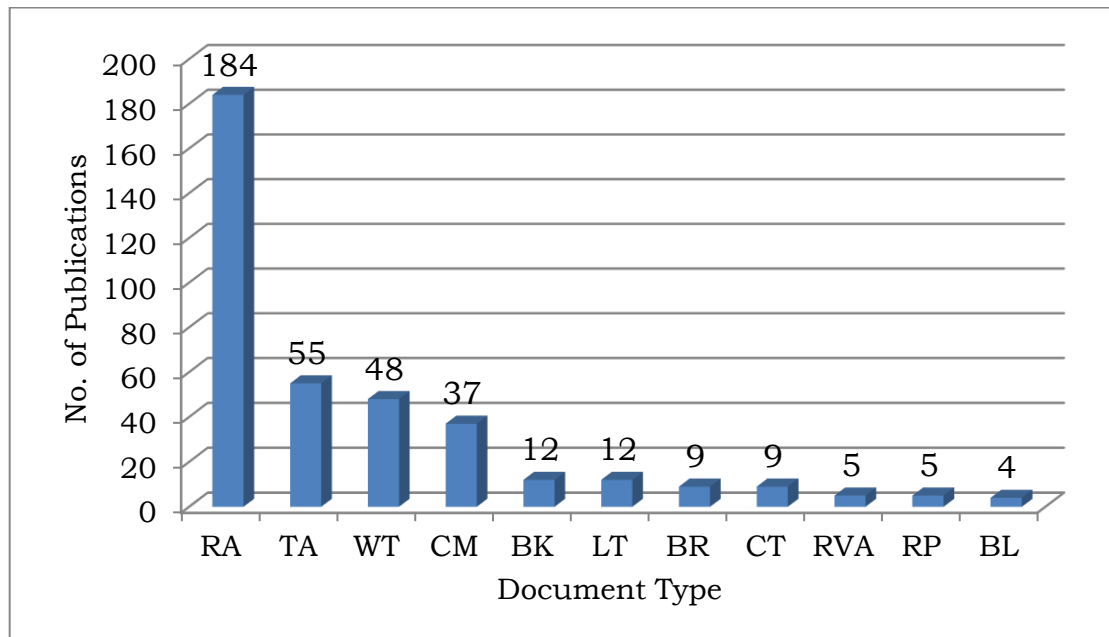
[*RA=Research Articles; TA=Technical & Popular Articles;WT=Writings on Terminology;CM=Course Materials; BK=Book; LT=Letters;BR=Book Reviews;CT=Catalogue; RVA=Review Articles; RP=Reports;BL=Bibliography*]

Figure 6: Variation of number of Publications with Document Type

Authorship Analysis

The name of the first authors and the co-authors are enumerated in Table 6. The ranked list of the co-authors is enumerated in Table 7. The top-ranked co-author of B K Sen is A Karanjai

(co-authored 6 papers in 12 years) followed by B Dutta and S Koley who co-authored 11 papers each over 11 and 17 years. The third and fourth ranked co-authors are A. K. Das and P. P. Ray who contributed 8 and 7 papers respectively during 7 years each.

Table 6: List of First Authors and Co-Authors for Research Articles since 1964 to 2018

Year	1st Authors' Names	Co-Authors' Names
1964	T. S. Rajagopalan	T. S. Rajagopalan
1965	T. S. Rajagopalan	T. S. Rajagopalan, S. Roy, K. L. Gogia
1966		J. C. Gera
1975	B. Guha	R. N. Neogi, S. K. Gupta, S. B. Ghosh, B. Guha
1976	B. S. Kesavan	B. Guha, K. Ramaswami, B. S. Kesavan
1977	B. Guha	B. Guha, R. N. Neogi
1985	H. Bhattacharyya	H. Bhattacharyya
1986	T. N. Rajan	T. N. Rajan
1989		T. A. Pandalai, A. Karanjai, U. M. Munshi
1990	S. B. Ghosh, U. M. Munshi, Narendra Kumar	S. B. Ghosh, U. M. Munshi, Narendra Kumar
1991	K. Arora, U. M. Munshi	Narendra Kumar, K. Arora, U. M. Munshi, A. Karanjai
1992	A. Karanjai, Narendra Kumar	A. Karanjai, U. M. Munshi, R. Arora, V. V. Lakshmi, Narendra Kumar, K.V.S. Prasad
1993	--	T. A. Pandalai, A. Karanjai
1995	V. L. Kalyane	V. L. Kalyane, A. Mukhopadhyay
1996	T. A. Pandalai, V. L. Kalyane	T. A. Pandalai, A. Karanjai, V. L. Kalyane, A. N. Zainab, Che Azlan bin Taib, Mohd. Faris, Yaacob M
1997	U. M. Munshi, Kiran Kaur	U. M. Munshi, Kiran Kaur, Lily Lee, Tiew Wai Sin,
1998	V. L. Kalyane	Khong Wye Keen, Lee Soo Hoon, Lim Bee Ling, Md Rafae Abdullah, Ting Chang Nguam, Wee Siu Hang, V. L. Kalyane, T. A. Pandalai, A. Karanjai
1999	W. S. Tiew	W. S. Tiew
2000	A. K. Das, B. Dutta	A. K. Das, B. Dutta
2001	B. Dutta	B. Dutta, A. K. Das, U. M. Munshi
2002	B. Dutta, V. L. Kalyane	B. Dutta, A. K. Das, V. L. Kalyane
2003	B. C. Biswas, V. L. Kalyane, S. Koley	B. C. Biswas, V. L. Kalyane, S. Koley, K. Chatterjee, A. Karanjai
2005	A. K. Das, B. Dutta, P. P. Ray	A. K. Das, B. Dutta, P. P. Ray, C. Dutta, B. C. Biswas
2006	S. Chakraborty, S. Koley, B. C. Biswas	S. Chakraborty, S. Koley, B. C. Biswas, A. K. Das, C. Saha
2007	A. K. Das, B. C. Biswas, P. P. Ray, V. K. J. Jeevan	A. K. Das, B. C. Biswas, P. P. Ray, V. K. J. Jeevan, C. Dutta, A. Roy
2008	S. Mallik, B. Dutta, A. K. Das	S. Mallik, B. Dutta, A. K. Das, K. P. Majumder, C. Dutta
2009	B. Dutta	B. Dutta, K. P. Majumder
2010	Tilak Hazarika, B. Dutta	Tilak Hazarika, B. Dutta, K. P. Majumder, Deepak Sharma
2011	B. Dutta	B. Dutta
2012	P. P. Ray, R. Giri	P. P. Ray, R. Giri, B. C. Biswas, P. Chand
2013	B. Dutta, R. Giri, Sangeeta Narang, S. Koley	B. Dutta, R. Giri, Sangeeta Narang, S. Koley, K. P. Majumder, Archana Shukla
2014	S. Koley, Sarmistha Mitra, B. Dutta	S. Koley, Sarmistha Mitra, B. Dutta, Archana Shukla
2015	S. Koley, P. P. Ray, B. Dutta, S. Narang, R. Giri	S. Koley, P. P. Ray, B. Dutta, S. Narang, R. Giri, K. P. Majumder, Archana Shukla, G. mahesh
2016	P. P. Ray, H. K. Tripathi, S. Koley	P. P. Ray, H. K. Tripathi, S. Koley,
2017	V. K. J. Jeevan	V. K. J. Jeevan
2018	S. Koley	S. Koley

Table 7: Ranking of Co-Authors

Rank	No. of Papers Contributed with B. K. Sen (P)	Co-Authors' Names	No. of Contributing Years (Y)	P/Y
1	12	A. Karanjai	6	2
2	11	B. Dutta, S. Koley	11, 17	1, 0.65
3	8	A. K. Das	7	1.14
4	7	P. P. Ray	7	1
5	6	B. C. Biswas, B. Guha, R. N. Neogi, T. A. Pandalai, U. M. Munshi	5, 3, 2, 3, 6	1.2, 2, 3, 2, 1
6	5	K. P. Majumder, V. L. Kalyane	5, 4	1, 1.3
7	3	Archana Shukla, C. Dutta, N. Kumar, R. Giri, T. S. Rajagopalan	3, 3, 3, 3, 2	1, 1, 1, 1, 1.5
8	2	S. B. Ghosh, S. Narang, V. K. J. Jeevan	2, 2, 2	1, 1, 1
9	1	A. Mukhopadhyay, A. N. Zainab, A. Roy, B. S. Kesavan, C. Saha, Che A. B. Taib, D. Sharma, G. Mahesh, H. Bhattacharyya, H. K. Tripathi, J. C. Gera, K. Arora, K. Chatterjee, K. L. Gogia, K. Ramaswami, K.V.S. Prasad, Khong W. Keen, K. Kaur, L. S. Hoon, Lily Lee, L. B. Ling, Md R. Abdullah, Mohd. Faris, P. Chand, R. Arora, S. Chakraborty, S. K. Gupta, S. Mallik, S. Roy, S. Mitra, T. N. Rajan, Tiew W. Sin, T. Hazarika, T. Chang, V. V. Lakshmi, W. S. Tiew, Yaacob M	1 each	1 (For all authors)

Co-authorship and Lotka's Law

Lotka's law describes the publication-frequency of authors in a given subject field. It states that the number of authors making contributions is about $1/n^2$ of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent. This means that out of all the authors in a given field, 60 percent will have just one publication, and 15 percent will have two publications ($1/2^2$ times of 60). Seven percent authors will have three publications ($1/3^2$ times of 60), and so on. According to Lotka's law of scientific productivity, only six percent of the authors in a field will produce more than 10 articles. Lotka's law, when applied to large bodies of literature over a fairly long period of time, can be accurate in general, but not statistically exact. The general form of Lotka's law can be expressed as $y = c/x^n$ where y=percentage of authors, x=number of articles published by an author, c=constant and $-n$=slope of the log-log plot. In this co-authorship analysis, there are 61 co-authors of Sen, of which 39 co-authors (63%) were associated with single article, 3 co-authors were (5%), were associated with two articles, 5 co-authors were (8.2%) were associated with three articles and so on. The co-authorship data thus nearly tallies Lotka's Law. The Lotka's equation for this co-authorship data is found as: $Y = 45/(X)^{0.9}$, where Y = Cumulative no. of co-authors and X = Cumulative no. of articles.

Degree of Collaboration

The Degree of Collaboration (DC) is defined as the ratio between multi-authored publications (MAP) to annual publication count (APC). If no single-authored publication comes in any year, then APC will be equal to MAP. It is observed that, during 54 years of writing span of the author, the DC had its maximum value (1) only in 13 numbers of years, i.e. no single-authored publications of the Author came out in these 13 years (Table 8). The DC values lied between 0.5 and 1 for 8 years, the same was equal to 0.5 for 6 years and less than 0.5 for 8 years. The Degree of Collaboration was zero for 5 years, i.e. in these 5 years only single-authored publications of the Author came out.

Table 8: Variation of Degree of Collaboration over the Years

DC Values	Years	No. of years
=1	'65, '66, '75, '76, '77, '86, '89, '93, '95, '01, '02, '03 & '05	13
>0.5 &<1	'90, '92, '96, '98, '2K, '06, '07, '16	8
=0.5	'85, '08, '11, '12, '14, '15	6
<0.5	'91, '97, '99, '09, '10, '13, '17, '18	8
=0	'69, '78, '87, '88, '04	5

Communication Channels and Ranking of Articles

The distribution of research articles over journals show highly skewed pattern as evident from Table 9, which shows that 33 percent of all articles (61) were published in *Annals of Library and Information Studies* followed by *Malaysian journal of Library and Information Science* (17 articles, 9%) and *Library Herald* (10 articles, 5.4%). Other remarkable journals that published Sen's articles are, *Journal of Documentation*, *Scientometrics*, *Current Science*, and *SRELS Journal of Information Management.* The article entitled "*Documentation note: Normalized Impact Factor*" ranked one at per Web of Science (47 citations), Scopus (41 citations) and Google Scholar (91 citations) (Table 10). The rankings of top 10 articles at per Web of Science, Scopus and Google Scholar are furnished in Table 10. The Citation Growth Rate of these 27 articles, i.e. times cited per unit age of the articles are also listed here.

Table 9: Communication Channels (Journals) of B K Sen

Journal Name with Abbreviation	Frequency of Publication with %
Annals of Library and Information Studies (ALIS)	61 (33.2%)
Malaysian Journal of Library & Information Science (MJLIS)	17 (9.2%)
Library Herald (LH)	10 (5.4%)
ILA Bulletin (ILA)	9 (4.9%)
IASLIC Bulletin (IASLIC), SRELS Journal of Information Management (SRELS)	6 (3.3%)
Indian Journal of History of Science (IJHS)	5 (2.7%)
Journal of Documentation (JDOC)	4 (2.2%)
Current Science (CS), Jnan Bichitra (JB), Scientometrics (SCI), DESIDOC Journal of Library and Information Technology (DJLIT)	2 (1.1%)
Other Journals (OTH)	19 (10.3%)
Papers presented in National and International Seminars and Conferences along with published in Proceedings (Sem/ Conf)	39 (21.2%)

Core Journals and Bradford's Law

The total number of research articles contributed by Sen figured 184, of which 61 (33.2%, i.e. one-third) articles were published by *Annals of Library and Information Studies.* This is the core communication channel of Sen. In the allied zone, 57 articles were published in 7 journals and in the alien zone there are 23 journals and around 25 Seminars and Conferences, which figures 48. The ratio of number of communication channels is figured out as, 1:7:48, $(1:n:n)^2$. The distribution of journals is thus in well tune with Bradford's Law.

Scientometric Indicators

The scientometric indicators of Sen are calculated on the basis of citation data available from Web of Science, Scopus and Google Scholar. The number of citations received by Sen is 1183 (Google Scholar), 291 (Web of Science) and 185 (Scopus). The Google Scholar statistics outshines other two database statistics. The values of h-index are 8 (Scopus and Web of

Science) and 19 (Google Scholar). The Recency Index of Sen is nearly 0.4 at per the three databases, i.e. nearly 40 percent of the total number of citations received by Sen was appended during last five years (2013-18). The relevance of Sen's research has been found increasing with time (Table 11). The citation pattern indicates trifle chance of obsolescence of Sen's works in near future.

Table 10: Ranking of Papers by Number of Citations Received

Title of the Paper	Source and Year of Publication	Times Cited (TC) at per			Rank at per			Age of the Paper in 2018	Citation Growth Rate (CGR) at per (TC/A)		
		Web of Science	Scopus	Google Scholar	Web of Science	Scopus	Google Scholar		Web of Science	Scopus	Google Scholar
1) Documentation note: Normalized Impact Factor	JDOC/ 1992	47	41	91	1	1	1	26	1.8	1.6	3.5
2) A method for determining the Impact Factor of a non-SCI journal	JDOC/19 89	19	---	34	2	---	11	29	0.66	---	1.2
3) Acknowledgement patterns in research articles:	MJLIS/ 2002	16	10	26	3	7	14	16	1	0.63	1.63
4) Economic botany: a bibliometric study	MJLIS/ 2007	10	17	43	4	3	8	11	0.91	1.55	3.91
5) Scientometric portrait of Nobel laureate Pierre-Gilles de Gennes	MJLIS/ 1996	10	18	65	4	2	3	22	0.45	0.82	2.95
6) Indian periodicals in the Science-Citation-Index	SCI/ 1992	9	12	26	5	6	14	26	0.35	0.46	1
7) Evaluation of recent scientific-research output by a bibliometric method	SCI/ 1992	9	13	36	5	5	10	26	0.35	0.5	1.38
8) Scientometric portrait of C R Bhatia, an Indian geneticist and plant breeder	MJLIS/ 1998	8	---	58	6	---	5	20	0.4	---	2.9
9) Symbols and formulas for a few bibliometric concepts	JDOC/ 1999	8	12	26	6	6	14	19	0.42	0.63	1.37
10) Library and Information science literature and Lotka's law	MJLIS/ 1996	7	16	27	7	4	13	22	0.32	0.73	1.23

Table 11: Different Scientometric Indicators of B. K. Sen

Citation Databases	Total no. of citations received till date [C(Tot)]	Total no. of citations received during last 5 years [C(5)]	$C(5)/C(Tot)$ = Recency	h-index	Excess Citation (EC) [C(Tot)-h^2]	i-10 index	g-index	g-h Ratio (g/h)	e-index $(EC)^{1/2}$	e-h Ratio (e/h)	a-index [(h+e^2/h)]	R-index [h^2+e^2]$^{1/2}$
Scopus	185	66	0.36	8	121	8	12	1.5	11	1.4	23.1	13.6
Web of Science	291	104	0.36	8	227	5	12	1.5	15	1.9	36.1	17.0
Google Scholar	1183	445	0.38	19	822	29	31	1.6	28.7	1.5	62.4	34.4

CONCLUSION

This study highlights the major aspects of the career of the Indianinformation scientistBimal Kanti Sen. Similar studies on prominent scientometricians include Eugene Garfield, Tibor Braun, Mike Thelwall and V.L. Kalyane, have been obvious in the literature. The scholar, Dr. Bimal Kanti Sen is the second Indian figure to be considered for a biobioliometric study besides Kalyane. He contributed 390 writings since 1964 to 2018, i.e. during 55 years ofhis service periodplus retirement period. He authored seven writings per year on an average. Of the 390 writings, he contributed about three research articles per year consistently over the entire career period. His academic and research activity steadily increased with his age. His most notable research works wasnormalization of Impact Factor and finding Impact Factor of non-SCI journal. His other notable works include biobibliometrics analysis, history of science, lexicography etc. He is still academically very active and continuously adding research contributions.Biobibliometric studies help to analyse profiles of individual scientists over the years that enables identification of the knowledge generation and development cycle at different phases. Also, consolidated studies of numbers of individual contemporaries and individuals of different era are necessary to find out impact analysis of a subject at times. This study extends similar attempts for both global and Indian LISand scientometric domains.

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