Chapter 2  
REVIEW OF LITERATURE

2.1 INTRODUCTION

The present chapter is intended to focus on the literature search on Bibliometrics and Scientometrics Studies, research productivity, authorship pattern and bibliometric laws etc.

The effective research is based upon past knowledge, this step helps to eliminate replication of research work and provides useful basis for the formulation of hypothesis provides a foundation for conceptual framework, deciding the methodology and also interprets the most important findings and conclusions of the study. (Singh, 2006) In a review of literature a brief summary of previous research is given, so that the researcher may be familiar with what is already known and with what is still unidentified and unproven. Further review of related literature avoids the repetition of work which has already been done in the specific subject discipline. It also helps the researcher to examine the different aspects of the problem which has been taken into consideration. It enables the researcher to identify the unexplored areas, in order to create new foundation for research. By considering this efficiency of various dimensions of bibliometric studies, a couple of studies based on India and Outside India reviewed pertaining to the present study has been presented conceptually from general to particular.

A retrospective search of literature has been carried out by using ETDs (Electronic Theses & Dissertations on INFLIBNET Websites); E-databases such as Shodhganga and Vidhyanidhi, Various consortiums based databases such as E-Shodhsindhu, JCCC@infonet, Emerald, Springer e-journals, online full-text databases, E- Repositories such as DOAR, E-Directories such as DOAJ and Open access full-text articles etc. Whereas, the relevant research papers and related documents such as Journal articles, encyclopedias, online dictionaries, conference papers, books, conference papers etc. has been also traced out to collect the relevant information regarding the study.

2.2 EXPLANATIONS OF THE CONCEPTS

2.2.1 Bibliometrics:

“Bibliometrics is the classification, organization and quantitative evaluation/appraisal of publication of pattern of all macro and communications along
with their authorship by mathematical and statistical calculation”. (Nichalas and Riche, 1978, p.156) Bibliometrics has also defined as the study of authorship pattern, patterns of publication, citations, productivity patterns, secondary journal coverage as well as analyze quantitatively the recorded knowledge in the form of books, periodicals, Doctoral thesis, Dissertations etc. (Roy, 2004; Vijay, 2005; Kamlan, 2002; Priya, 2002; Saiga, 2002)

2.2.2 Scientometrics:

Scientometrics is the quantitative study of the disciplines of science based on published literature and communication. This could include identifying emerging areas of systematic scientific research, examining the development of research over time, or geographic and organizational distributions of research. (Glossary of Thompson, 2008)

Scientometrics defined as "the study of the quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policy making. It involves quantitative studies of scientific activities, including, among others, publication, and so overlaps bibliometrics to some extent”. (Tague-Sutcliffe, 1992)

Scientometrics has been defined as “a complex of quantitative mathematical and statistical methods used to investigate such aspects as research team and to define evolutionary and prospectus of science” (Kumar, 2004; Bonitz, 1980). A large number of studies have been conducted on Scientometrics in different disciplines such as: (Voveriene & Trumpiene, 1994; Anand, 1997; Dhiman & Yashodarani, 2005; Kalyane & Devarai, 1994; Kaushik, 2003; Kumar, 2004, 2002; Kumar & Kumar, 2005; Munnoli & Kalyane, 2003; Negi, 2005; Rajan & Sen, 1986; Egghe, 2008; Ravichandra Rao & Sahoo, 2008; Wolfgang, 2008; Sarvanan & Ponnudurai, 2006; Tiwari, 2006)

2.2.3 Biographical bibliometrics:

Scientometric portrait, Informetic portrait and bio-bibliometrics are the synonymous terms. The phrase ‘Scientometric Portrait’ was first used by Kalyane and Kalyane (1994) to bring out bio-bibliometric studies on scientists rather than academicians or researchers from other disciplines such as arts, humanities and social studies. Later on Kademani and Kalyane (1997) have been using the phrase ‘Scientometric Portrait’ consistently in their publications since 1994.
Bio-bibliometrics is a well-known concept in social sciences among biographers, bibliographers and librarians. A bio-bibliography is a widespread listing, generally annotated, of all sorts of publications of a person together with listing of biographies and other resources published on any phase of life and work of that person. In brief, bio-bibliometrics aimed at defining correlation among bio-data and biblio-data profiles of a person or a group of persons. (Sen & Chatterjee, 1990)

2.2.4 Research Productivity:

According to Creswell (1986), “Research productivity is the certain level to which lecturers engage in their own research and publish scientific articles in refereed journals, conference proceedings, writing a book or a chapter, gathering and analyzing innovative facts, working with postgraduate students on dissertations and class projects, obtaining research grants, carrying out editorial duties, obtaining patents and licenses, writing monographs, developing experimental designs, producing works of an creative artistic or a creative nature, engaging in public debates and commentaries”.

2.2.5 Scientific Productivity:

The term ‘Scientometric Studies’ may be defined as “an analysis of literature with mathematical and statistical methods used in information use and seeking pattern approaches in a particular field of information products and services for knowledge indicators towards organizational development”. (Kasirao, 2012)

2.2.6 Author productivity:

The terms author productivity; scientific productivity and trends of publications are used synonymously. Regarding the author productivity one can say that, author productivity means “authors productiveness or author’s efficiency in publication production” In other words author productivity can be explained as the effectiveness of productive efforts to produce fruitful publication”. (Vijay, 2005; Adhe, 2008)

2.2.7 Journal productivity:

The most prolific journal means a journal, which publishes more articles than the other Journals. Kannappanvar and Nulvi (1991); Kumar and Kumar (2005); Maricic (1983); Osarch (2005); Parmeshwaram and Smitha (2001); Kademani
(2005a) and Gupta (1987) have analyzed year wise, article wise, editorial wise the most productive journals according to their productive rank list.

2.2.8 Impact factor:

Impact factor is to determine the frequency with which the average cited article in a journal has been cited in a particular year. (Kalyane & Sen, 2003; Kalyane, 1989; Arora & Sen, 1992; Bandyopadhyay, 2003; Devarajan, 1997; Kawatra, 2000; Mahapatra, 2000; Sen, 1999; Sen & Chatterjee, 1990; Tiwari, 2006; Patel, 1991)

The impact factor can be calculated with the formula:

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\text{Impact factor} = \frac{\text{Total number of citations received}}{\text{Total number of publications of an author}}
\]

Therefore, IF= the number of times a journal was cited/the number of citable items the journal published.

2.2.9 Productivity patterns:

The term productivity patterns replicate the author productivity, authorship pattern, channels of communication, impact factor of author as well as journals, etc. Productivity patterns means an excellent idea to produce (publish) research papers in respective subject. (Adhe, 2008)

2.2.10 Authorship patterns:

Authorship trend and collaborative research are important facets of informetrics/bibliometrics studies. The authorship pattern one of the main aspects of citation analysis mainly deals with the type of authors, degree of collaboration among them and collaborative trend of authors. It seems to be raising trend of multiple authorship & collaboration between researchers is leading indication of growing professionalism in different fields. (Joolae et al., 2015)

2.2.11 Collaboration:

Melin and Persson's (1996) defined as "collaboration is an extreme form of relations or interaction that permissible for effective communication as well as the allocation of competency and other resources". (Sengupta, 1990)

According to the Martin and Katz's (1997) definition "collaboration is working together of researchers to achieve the common goal of producing new scientific knowledge".
2.2.12 Research collaboration:

The meaning of collaborative research is termed as "mutual participation researchers in a coordinated effort to sort out the solution of a problem together." Collaborative relations are characterized by collective goals, proportion of formation, and a high degree of cooperation, negotiation, interactivity, and interdependence. (Lai, 2011)

2.3 THE PREVIOUS STUDIES: GROWTH OF LITERATURE

A large number of quantitative studies based on Bibliometric and Scientometric techniques have been taken out to evaluate the research productivity of individuals, scientists, institutions, R & D research institutions, Universities, Library science professionals, countries, etc. Studies are also reported to proven the fitness of classic laws of bibliometrics, authorship pattern & degree of collaborations, Relative growth rate and doubling time, factors influencing productivity and impact of research conducted in various countries. The pioneered work on the topic of Bibliometrics was carried out by various authors and these are available online.

However, studies devoted to the author productivity and publication trends have become topic in bibliometric studies. Bhatia (2005); Chaubey (1992); Kaur (1979); Datta (1983); Susila (1986); Gopi (2005); Gupta and Karisiddappa (1997); Gupta and Kumar (1994) have paid attention towards impact of funding on the productivity of scientists, productivity of individual inventors, while Gupta, (1990, 1986); Kalyane and Sen (1995); Kalyane and Devarai (1994); Kannappanavar and Vijaykumar (2001); Kannappanavar and Nulvi (1991) deals with the productivity trends, authorship trends, however, Kausik (2003); Kumar and Gupta (2003b); Magyar (1974); Munnoli and Kalyane (2003); Munshi (1996); Rai and Kumar (2005); Reddy (1999); Rowlands (2005); Sen and Chaterjee (1990a&b); Shridhar (2002); Kademani and Kumbar (2006); Kademani (2007); Egghe (2008); Vaishnav and Deo (1993); Khaparde and Pawar (2013); Suradkar and Khaparde (2012); Alhamdi and Khaparde (2015); Alhamdi, Khaparde & Kanekar (2013); Kanekar & Khaparde (2015); Shafiullah, Khaparde & Alhamdi (2015) dealt with measurement of author Productivity, research productivity, Productivity of faculty members, Lotka’s law and research Productivity, Collaboration, Co-authorship, relative growth rate, doubling time, degree of collaboration, etc.
Alghanim & Alhamali (2011) carried out a study to evaluate research productivity among faculty members at medical and health schools in Saudi Arabia and identified the prevalence, factors and obstacles affecting research productivity among academic staff and he also identified factors promoting research productivity. Individual factors included aspects such as researcher’s age, gender, salary, academic rank, number of years in the profession, teaching load and the faculty member’s confidence in writing refereed works. Institutional factors included the Institution size, funds allocated to research, presence of research groups, departmental support, subscriptions of journals, and the availability of information technology (Sax et al. (2002); Sypsa & Hatzakis (2009); Wager (2009). Furthermore, some of the authors focused on studies in different discipline such as management, Smith, et al. (2008); higher education, Toutkoushian, et al. (2003); information systems, Long, et al. (2009); agriculture, Kotrlík, et al. (2002); medical and health-related studies, Jelercic, et al. (2010); Dandona, et al. (2009); Gaym (2008); Glanville, et al. (2011).

2.3.1 Bibliometrics & Scientometrics in General

Bibliometrics and Scientometrics techniques have became tools to assess the productivity of research institutes and individual researchers. From long decades in India and abroad, research productivity in higher education is gaining magnitude importance. Universities and other equivalent R & D Institutes are the centers of research however, these higher education bodies considered as very important parts for scientific studies and with overwhelming progress of a nation. Evaluation of such productivities of institutional research and developmental activities highlights the contribution of the institution and the individual scientists engaged in research. A well acknowledged productivity sign is the number of publications produced by academic faculties, scientists, higher institutions or R & D research groups (Chikate & Wadhwana, 2014). These kinds of bibliometric studies based on the field of research performance, evaluation has been already undertaken by a good number of researchers and in this section some of the relatively good studies are highlighted and tried out to cover general to particular sub-discipline (Martin, 1996). This particular study has been undertaken to evaluate the growth of research publications in a state university among various disciplines by using various bibliometric indicators or parameters in the form of simple publication count of the academic faculty members.
2.3.1.1 Research productivity of Universities

Research is very essential for academic work in the universities and it forms one of the major functions of the academic staff of any university. The primary functions of universities are teaching, research, public services and the conservation of knowledge and ideas. The primary goal of any university is to create knowledge and serve its public. (Edifon, 1985) The productivity of an academic institution can be calculated by counting the number of publications produced by its faculty over a time period. (Bottle et.al. 1994) Supporting to this the individual faculty member’s scholarly productivity can be counted and used as a unit of analysis while evaluating higher education. (Hattie et.al. 1994)

An individual faculty member’s repartition, visibility, innovation and advancement in the academic reward structure is strongly associated with and evaluated through their research work hence, faculty research productivity is regularly used as an index of departmental and intuitional prestige. The research outputs of the university faculty in the form of research papers in scholarly journals, conference proceedings and books are being considered as one of the main criterion for assessing the performance of the faculty.

Akakandelwa (2009) analyzed 220 papers which were published by the academic faculty of the University of Zambia from 2002 to 2007. The papers were downloaded from the Thomson Scientific database and the attempt was made to analyze authorship patterns and research collaboration among the faculties. Wang, et al. (2011) examined the scientific research performance of the faculties of National Taiwan University and Peking University. The data was downloaded from Web of Science databases (WoS) from 2000 to 2009; the analysis based on mainly two indicators i.e. citations per publication and h-index of the faculties. Jeyshankar, et al. (2011) analyzed bibliographical details of 1282 research articles published by the scientists of CECRI from the period 2000-2009 and reported that 2009 was the most productive year among the other sand collaborative research was dominant on single authorship. The study further investigated authorship pattern, co-authorship pattern, highly prolific authors and highly preferred journals by the scientists of CECRI.

Jung (2012) pointed out that research productivity was influenced by a number of factors and he also described some of the major factors and models which influenced
the research productivity. This study examined the research productivity of faculties of Hong Kong across academic discipline and found that research activities across Hong Kong academics are highly internationalized. The Similar studies were also carried out by Allison & Long (1990); Baird (1991); Shin & Cummings (2010); Zhou & Volkwein (2004); Sheehn & Welch (1996).

Okiki (2013) carried out a study and examined the level of research productivity of teaching faculty members in Nigerian federal universities. The result of the study showed that the research productivity of the teaching faculty members in Nigerian federal universities is high in journal publications, technical reports, conference papers, working papers, and occasional papers. The research productivity is higher in Northeast with Mean= 22.53; SD= 25.73 and Southwest with Mean= 21.74; SD= 87.28 and North Central with Mean= 20.69; SD= 31.24 Nigeria. Ogbomo (2010) examined the publication Output of Librarians in Tertiary Institutions of Delta State University at Abraka, Nigeria. In the same vein, studies on Nigeria conducted by Uzun (2002); Aina and Mabawonku (1998); Arnachallam (1992); Nwagwu (2007); Chiemeke et al. (2009); Braimoh (1999); Agboola and Oduwole (2005); Ramsden (1994); Athey and Plotnicki (2000); Okafor and Dike (2010)

Nagarkar (2014) analyzed 811 papers from 258 journals with 8948 citations collected from the Web of Science (WoS) databases of the total 30 faculty members during 1999-2012 of the Department of Chemistry at University of Pune. The bibliometric analysis of the present study reveals that International journals were most preferred by the faculty members and overall H-index of the department is 43 during the study period. The various bibliometric parameters used to carry out the analysis of the research contributions made by the faculty members including number of papers, number of citations received, institutional collaborations, productivity of journals, subject categories and authorship pattern. Kumar; Dora and Desai (2015) reported the bibliometric analysis of the total 760 research publications made by the authors affiliated to Gujarat University during the year 2004-2013, similarly Kumbar et al. (2008) carried out the study to analyze the growth and impact of research output of University of Mysore during 1996-2006. Chikate & Waddhwana (2014) analyzed the scientometric study of 71 research publications of LIS Professionals of SNDT Women’s University, Mumbai from 2003 to 2012. In this study year wise, subject
wise, gender wise, language wise productivity of publications, authorship pattern and channels of communication has been studied.

**Khaparde (2013)** analyzed 774 research articles from 144 journals generated by Department of Chemistry, Dr. Babasaheb Ambedkar Marathwada University during 1975 to 2012 and it examines year-wise distribution of papers, authorship pattern, journal wise productivity, productivity of faculty and discipline-wise distribution etc. **Veer & Kale (2014)** studied the total 1059 publication output of the Science faculty members of the S.R.T.M. University, Nanded for the year 1994-2011. The research productivity shows a steady growth during the period of study and it stated that the faculties of Science taken under the study are successful in carrying out research activities during the study period. It reveals that out of 1059 total publications maximum 338 (31.92%) are single authored and predominant on multi-authored publications. The study also reported the Degree of Collaboration of publications of the Science faculty of the SRTM University with 0.680.

**Siwach and Kumar (2015)** studied the total no. of 1247 research contributions in the form of journal articles, reviews and articles in press as reflected through Scopus database of Maharshi Dayanand University, Rohtak during 2000-2013. **Aswathy & Gopikuttan (2013)** analyzed the publication pattern of faculty members of three universities in Kerala viz., University of Kerala, Mahatma Gandhi University and University of Calicut during 2005 to 2009. The study revealed 966 journal articles contributions from UoK, while 635 and 734 journal articles from MGU and UoC. Wherein, authorship pattern, Degree of Collaboration, the suitability of Lotka’s Inverse Square Law and year-wise and designation-wise distributions has been studied. **Vasishta Seema (2011)** undertook a study with publication data of 177 research output reflected in Scopus International database and analyzed the research productivity, publication growth, national and international collaboration, etc. of PEC University of Technology, Chandigarh from 1996-2009. The study examined the broad characteristics of research publications, its growth, format, media of communication, national and international collaboration pattern and overall citation impact, distribution of research output and impact under wide range of subjects and under different subject disciplines, most productive authors during the study period and highly cited papers. **Ponomariov & Boardman (2010)** aimed to study the
research productivity of university research centers and collaboration patterns of university faculty members and measured the productivity and collaboration patterns of university researchers.

**Kumbar; Gupta and Dhawan (2008)** examined total 1518 research papers and represented the growth, contribution and impact of research carried out by the scientists of University of Mysore in science and technology during 1999-2006. Wherein, their growth rate, impact generated in terms of average citations received and the collaboration pattern in different disciplines of science and technology accumulated from the Scopus international database. **Kandalkar (2014)** studied Research performance of Social science faculty members working in affiliated colleges and department of Sant Gadge Baba Amravati University, Amravati during 2008-2010. The study covers the research productivity of the faculties and reported bibliometric analysis using various parameters viz. authorwise, subjectwise, yearwise, journal wise etc. The distribution of 266 articles reveals the highest no. of contribution is 139 articles in the year 2010. **Khandare (2014)** carried out a Scientometrics study to analyze research Productivity of academic librarians affiliated to North Maharashtra University, Jalgaon from 2008 to 2012. This study covers Gender wise, types of research contribution, Language wise, rank list of Author, book publication/research project Status, authorship pattern and barriers in carry out the research and productivity pattern among the faculty members, etc.

**Kumar; Dora & Desai (2015)** carried out the study to analyze the total number of 760 research publications of Gujarat University during the ten-year period between 2004 and 2013. The data was analyzed and it depicts that majority i.e. 83% research publications are journal articles, whereas a steady growth in publication trend increased from 2008 onwards and the collaboration among the authors was found to be the highest in the year 2012 with 0.70. **Baskaran (2013)** examined research contribution of Alagappa University during 1999-2011 and the author productivity, discipline-wise and institution-wise collaboration and ranking of authors has been analyzed. It revealed that during the study period Relative growth rate (RGR) was found to be fluctuating trend and the doubling time (DT) was found to be increased and decreased trend. While, Degree of collaboration and its’ mean value is found to be 0.963.
2.3.1.2 Research productivity of Institutions:

It is necessary to accelerate with the global competitions and to face the challenges of the future applying the invention to build sustainable research success. A key factor is investment in research and development, building for the future. Technology delivers new products and services. R & D plays a vital role in enabling the institution to release the potential of the world class research base to tackle technological, social and economic challenges. The research activities in the various forms of publications of the higher institutions are reflected through its research publications made by the scientists. (Chikate & Wadhwana, 2014)

Devi and Lekshmi (2014) carried out the Scientometric evaluation of publication productivity of Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Thiruvananthapuram from 2001-2010. An annual reports of this institution is the major source to collect the data for the present study it depicts that the JNTBGRI scientists prefer mostly Indian journals to publish their research articles and Collaboration coefficient of journal article during the year 2010 is found to be 0.7541. Kar; Ghosh and Mondal (2014) analyzed the total of 265 research publications of UGC-DAE Consortium for Scientific Research, Kolkata Centre during the period of 2006-2010. The bibliometric analysis of the study shows that out of 25 publications there were 145 journal publications and the remaining 120 was published Conferences and seminars proceedings.

Sevukan; Nagarajan and Sharma (2007) conducted a bibliometric study on Research output of faculties of Plant Sciences in Central universities of India. A total of 348 bibliographic records of Plant sciences retrieved from ISI Science Citation Index extended (SCIE) for a period of 10 years from 1997 to 2006. The study focused on research literature in plant sciences of the faculties in central universities of India by analyzing year, document type, authorship pattern, and collaboration pattern at different levels, i.e. international, national, and local level has been analyzed and laws of Bradford and Lotka have also been tested. Kademi et al. (2006) presented a scientometrics analysis of papers published by the analytical chemistry division of Bhabha Atomic Research Centre (BARC) in India during. Vellaichamy and Jeyshankar (2015) conducted a Scientometric analysis of publication productivity of Pondicherry University seen through Scopus international database over a period of

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twenty seven years from 1987-2013. The study depicts that collaboration in research among faculties are much popular as majority of the researchers preferred to publish their research work as joint or Co-authorship and the degree of collaboration ranges varies from 0.61 to 0.96 and its mean value 0.88. A study on Scientometrics conducted by Lee (2003) highlighted research performance of the Institute of Molecular and Cell Biology (IMCB) for the ten years since its establishment. The results of the study showed that IMCB produced 395 research papers. Similar studies on Scientometrics conducted by Thirumagal (2002); Fakhree et.al (2011)

Mahbuba; Rousseau and Srivastava (2010) made a scientometric assessment and comparison between two health and population research organizations, viz. the International Centre for Diarrheal Research in Bangladesh (ICDDR) and National Institute of Cholera and Enteric Diseases (NICED) in India during the period 1979-2008. Kumar and Dora (2012) analyzed the research productivity of IIMA faculties and identified the research output during the period 1999-2010 that includes types of publications, most preferred journals, most prolific authors from (Indian Institute of Technology (IIMA), authorship pattern, and the journals most cited by the researchers from IIMA. The present study aims to evaluate the research performance of IIMA based on the papers published in journals that had indexed in Web of Science and Scopus for period of twelve years. Koganuramath, et al. (2002) done similar study on collaboration pattern, identified prolific authors and core journals by analyzed 663 papers published by the scientists of TISS during 1990-2000.

Bhatia (2010) undertook the study to evaluate quantitatively research publications published by the scientists of National Institute of Occupational Health (ICMR) Ahmedabad, India, during 2000–2006. The result depicts that maximum number of publications are observed in journals dealing in occupational health and occupational medicine, which is related to institutional research field. Multiple-author articles are predominant on single-author articles because research format in occupational health is multi-disciplinary. While, to carry out research in multiple disciplines/parameter one requires more scientists and core subject in occupational health and occupational medicine.

Sharma (2009) assessed a total of 2603 research articles published by the scientists of Central Potato Research Institute (CPRI) during 1991-2007. The data for the present
study were collected by scanning of annual reports of CPRI and *Journal of the Indian Potato Association*. The analysis shows that majority of the scientists preferred to publish research papers in joint authorship (82.67 %) having 0.82 degree of collaboration. Further the study shows there was no consistent pattern of literature growth but factors like fund availability, scientists’ recruitment and their availability, and years that had special occasions like conferences, seminars, etc., have impact over scientific productivity of the scientists during the study period.

**Rani and Jinju (2009)** assessed the total number of 632 publications of scientists of Rajiv Gandhi Centre for Biotechnology during 1995-2006 using various forms included such as journal articles, conference papers, patents, book chapters and PhD guided. The year 2005-2006 was the most productive year with 112 articles (25.87 %) published in the case of journal articles. The productivity of the scientists of RGCB reflects significant growth quantitatively and qualitatively with the development of the institution. **Baby and Kumaravel (2002)** examined the growth of research and the relative growth rate and doubling time is 0.45 and 2.27 respectively and three-authored publications predominate amongst the pattern of authorship. **Lee, et al. (2012)** focused on the impact of collaborating patterns on the R&D research performance of public research institutions (PRIs) in Korea's science and engineering fields. The data of 127 institutions reflected in Scopus international database was considering for the construction of R&D collaborating networks based on the co-authorship pattern. In this study they proposed four types of collaborations by categorizing network analyses into two dimensions: structural positions (density, efficiency, and betweens centrality) and the relational characteristics of individual nodes.

**Montoya, et al. (2014)** described the features of the research contributions made by the Spanish institutions to the specialized literature in the energy field in the period 1957-2012. **Falagas; Papastamataki and Bliziotis (2006)** assessed the research productivity of different world regions in the field of Parasitology using the PubMed database and collected information for the period of 1995–2003. **Luo and Lu (2009)** studied that biological incursion is an important obstacle for biodiversity protection and sustainable development of global agriculture and forestry. The present study expressed bibliometric analysis of biological invasion literature indexed by the Web of Science in the period of 1991-2006. **Hasselback et al. (2000)** studied the research
productivity of 3878 accounting faculty from 1971 to 1993 thus; it elaborated the benchmarks for evaluating research performance of these faculties. A similar study was undertaken by Singh, et al. (2005) considering the Science Citation Index (SCI) to extract research contribution and impact of Indian Institute of Technology, Roorkee from 1993-2001.

Sahu; Goswami and Choudhary (2011) carried out a study to analyze R & D publications growth, its characteristics, research impact, quality, citation value, category of journals, core research areas, characteristics of productive authors of National Metallurgical Laboratory (NML) Jamshedpur during, a constituent unit of CSIR, India based on data obtained from the Science Citation Index (SCI). The data shows that the average number of publications per year was 88.1 for the study period and the average citation per paper was 5.02. It also revealed that the majority of the authors of NML published their research work in joint authorship (96.48%) rather than single authorship. The authors mostly prefer to publish their research findings in reputed International journals rather than Indian journals further, it shows that 72.95% citing authors are from foreign countries and only 27.05% are Indians. Thus the R & D contributions made by scientists of CSIR-NML had a global impact in the field of metallurgy and materials science.


Pillai & Priyalakashmi (2013) analyzed the Bibliographic details of total 1076 research articles of Central Tuber Crops Research Institute (CTCRI) during the
study depicts that the year 2006 was the most productive year among the others as highest number of 169 papers was published in this year and result shows that the average number of publications per year was 97.82. It also revealed from the study that maximum number of the contributions were multi authored (87.68%) rather than single authored while, the C= degree of collaboration of scientist of CTCRI was found to be 0.87 and the majority of the articles published by the scientists were in the foreign journals (51.89%). Viswanathan & Tamizhchelvan (2015) analyzed the 8599 research publications downloaded from the Scopus international database. The study analyses and discusses on the yearly publications, authorship pattern, co-authorship index, citation pattern, highly contributed authors, ranking of authors by using various indices, top ranked Institutions for the productivity of publications and journals which published the maximum number of research works on the area of study. The highest numbers of citations were received by Singh R.P with 820 citations and published 62 publications. The author Singh R.P. and Roy P.S. has highest ‘h’ index and the value found to be 17.

Sooryamoorthy (2010) studied scientometric analysis using South African publications on medical field for the period of 1975–2005. Gupta and Bala (2011) undertook the study to examine India's performance in S&T on several quantitative measures including India's global publication share, rank and growth rate, its publication share in various subjects in terms of national and global context using 15 years publications data (1996-2010) downloaded from the Scopus database. Dutt and Nikam (2013) examined solar cell research in India as revealed by the publications indexed in Web of Science (WoS) for a period of 20 years from 1991 to 2010. Ramakrishnan and Ramesh Babu (2007) studied the literature output from three bibliographic databases, namely MEDLINE, CINAHL and IPA in the field of hepatitis and depicts that collaboration in authorship pattern is widespread, averaging 0.85. Ram (2011) analyzed data in the PubMed database for the period of 1996-2010 to study the growth of research on Artemisia, including research distribution by country, type of publications, journal authorship patterns, and Indian publication activity on Artemisia. Bala and Gupta (2009) analyzed 16 years (1992–2007) research activities of the Government Medical College & Hospital, Chandigarh (GMCH), covered in Scopus international multidisciplinary bibliographical database. The study resulted that GMCH stands at 9th rank in research output, 13th in average
citation per paper and 12th in h-index among the top 15 medical colleges of the country.

Raut; Sahu and Ganguly (2008) highlights the distribution of various forms of publication, authorship trends, most frequently cited periodicals and geographical distribution of the literature in the area of strategic management. The study revealed that journals are mostly used than other form of documents and authorship pattern determined mainly on single and joint authors in books than in journals. The study also found that the Strategic management journal, Academy of Management Journal, Administrative Science Quarterly etc., were most important journals in the field of strategic management. Vijay (2005) aimed to identify the pattern of productivity of the authors in the field of food science and Technology in India. Braun, et al. (2001) studied patterns of 58400 neuroscience journals. Newman (2004); Karisiddappa (1998) studied co-authorship in the field of Genetics. Ranganathan (2014) studied scientometric analysis of the Mapping of Oceanography Research Productivity in India from 2008 to 2013. He analyzed the research output of Researchers in the field of Oceanography thus this study encompassing outputs on Science from Aquatic Science and Fisheries Abstract (ASFA) data base. The growth rates of output in terms of research productivity are analyzed for the period of study and authorship pattern and author productivity is examined to found out the pattern of research contribution in the field of Oceanography.

2.3.2 Authorship trend and collaborative research

Collaboration in research means two or more scientists work together on a scientific problem or project and contribute their, physical & mental efforts. It is observed that multi-authored decline in single authored papers. (Price, 1963) In recent period, there is a trend towards collaboration in research in almost all pure & applied sciences and it is different from one subject to another. (Arora & Pawan, 1995) It has been also found that a large number of collaborative studies have been reported in the field of Science & technology than in Social Sciences & humanities. (Pillai, 2007) Collaboration among the researchers also increases quality of work, but less effort for each co author. The Collaboration & team work are among the most important necessities of scientific & technological work today. (Joolae, et.al, 2015)
Many researchers have also studied the relation between productivity and co-authorship, some research also resulted that co-authorship cause more citations. They also studied a comparison of co-authorship patterns in agriculture and life sciences in both Scopus and ISC databases during 2002-2011 (Joolae et al., 2015). Georghiou (1998) believed that immigration of researchers to other countries play an important role in collaboration. The extent of collaboration and their growth rate is observed to vary from one subject to another (Gupta and Karisiddappa, 1998); Glanzel & De Lang (1997) opined that there are economic and political reasons are also reflected in collaboration among the researchers. Amsaveni and Vasanthi (2013) found out the trend in authorship patterns and collaborative research in network security. Patterns of productivity of scientists, authors or writers are analyzed by Gupta and Kumar (1994); Kalyane and Sen (2003); Munnoli and Kalyane (2003); Kumar (2002); Kumar and Kumar (2004); Mishra (2010) and Surendra Kumar (2010).

Pradhan; Panda & Chandrakar (2011) analyzed a sample of 53,977 articles downloaded from SCI –Extended database in Web of Science during the period 2000-2009 and also highlighted the trends in authorship pattern and collaborative research in Indian chemistry literature. Rajendran; RameshBabu and Gopalakrishnan (2005) analyzed the overall output of fiber optics research and try to identify the year wise and country wise Growth of literature, authorship pattern, bibliographic forms, ranking of core journals and nature of research have been analyzed. Arya (2012) carried out bibliometric analysis based on the data collected from ‘Indian Journal of Veterinary Medicine’ published during the period 1999-2007 wherein, authorship pattern and collaborative research trends in the field of veterinary medicine has been analyzed.

Zafrunnisha and Pullareddy (2009) studied total 141 Ph.D. theses in the field of Psychology submitted to three universities during the period 1963–2003. Within that total of 22,565 citations appended to these theses, among them 14,374 journal citations came out and were used for the study wherein, authorship pattern and collaborative research has been analyzed based on the data. The study depicts that Multi-authored papers predominate with 52.87% of the total cited papers and the degree of collaboration in Psychology is 0.53. It is also observed that USA ranks first by producing 42.28% of cited journals. India got second rank with 21.38% of total cited journals, followed by UK (15.44%) and Canada (1.75%).
**Rao and Raghavan (2003)** done a study on collaboration in superconductivity research in India indicate an increased interaction between countries, institutions, and disciplines, leading to “global research networks”. **Kim (2006)** attaining knowledge and techniques through collaboration and ultimately writing of a co authored article. He incorporates getting more citations, higher prestige; motivate some researchers to co authored in writing papers. Co authorship eases transmission of information and technology between researchers, organizations and countries. **Sengar (2014)** focused on the collaborative strength and patterns of authorship and strength of authors among the CSIR-IMTECH scientists/researchers for a period of 20 years. The study exposed that maximum number of scientists preferred to publish research papers in collaboration with joint authorship rather than single authorship. The study resulted that out of 902 articles 753 (83.48%) were joint works, while only 149 (16.51%) were single-author works. The degree of author’s collaboration was also calculated to be 0.83, while the mean numbers of single-author and joint authored articles were 7.45 and 37.65, respectively.

**Pillai (2007)** studied the doctoral theses submitted at Indian Institute of Science, Bangalore during 1999-2003 and analyzed the authorship trend and the degree of collaboration of journal articles and books cited by the physicists. The study resulted that team research is preferred rather than solo research in the field of physics while, the average number of authors per journal article was 3 and for books it was 1.69. For this study the degree of collaboration in different years was calculated and the average value of it for journals was 0.08 and 0.44 for books, it may be revealed that the authorship collaboration is more in journal articles than in books. The study concluded that authorship pattern, the degree of collaboration and the average number of authors were different in journals and in books. **Navaneethakrishnan (2014)** analyzed a total of 1795 records of publications of Sri Lanka in humanities and social science research authored by 3521 authors during the period 1960 – 2012 derived from SCOPUS database. He tried to found out the authorship patterns and degree of collaboration among the authors. **Goyal, et al. (2013)** studied Indian Journal of Chemistry Section-B (IJCB) published during the 2002-2011 and the authorship trends and collaborative research are studied in the field of Chemical Sciences based on the collected data. It resulted that majority of the articles with 97.24% are multi
authored and 2.75% articles are single authored. Wherein, the degree of collaboration in the field of chemical sciences is found to be 0.97.

Khaparde and Pawar (2013) analyzed a sample of 17917 articles collected from LISA during 2000-2009 and studied the authorship pattern and collaborative research among the authors in the field of Information Technology. The study resulted that the average number of authors per article is 1.80 and the degree of collaboration (C) during the 10 years is 0.71. This study further revealed that the multi-authorship articles are higher and predominant on single authorship. The similar study was done by Bhedekar & Sonawane (2014) analyzed the trends in authorship pattern and collaborative research in Library and information science research found in LISA during 2008-2012. Suradkar and Khaparde (2012) assessed a sample of 12263 articles from Journal of Library management during the period 2000-2009 and tried to found out the trends in authorship pattern and authors collaborative research in the particular journal. The study depicts that Single authored articles are dominant i.e. 8327 (67.90%) and the mean value of the overall degree of collaboration during 2000-2009 is found to be 0.277. Mani (2014) also studied authorship patterns and collaborative research in Malaysian Journal of Library and Information Science during 1996-2012.

A huge number of studies have been carried out to analyze and interpret the trends in collaborative authorship in different disciplines. Some of these are defined as follows:

Alhamdi and Khaparde (2015) tried to found out the authorship Pattern in Cloud Computing Research in Library, Information Science & Technology abstracts (LISTA). This study intended to identify and analyses the growth rate of scholarly publications, analyses the authorship pattern, to identify the standard length of title, also to know the popularity mail domain used by authors and to examine the rank of journals in cloud computing research. Harsanyi (1993); Joshi & Maheswarappa (1994) have made systematic review of the literature on multi-authorship studies and Udofia (2002) evaluated African Trypanosomiasis research literature and has made a review on authorship pattern and collaborative research. As similar to this number of studies done in different disciplines, Kumbar; Harinarayana & Tejaswini (2004); Krishna & Kumar (2004) and Farhat (2002) have studied the authorship trend in the field of Agriculture Science. Bandopahyay (2001, 2004) analyzed the research
collaboration and authorship pattern of different disciplines such as: Mathematics, Physics, Mechanical engineering, Philosophy & Political science. *Vimala & Reddy (1996)* investigated the authorship trend in Zoology. *Sangam (2000)* studied trend in collaborative research in Psychology. *Vijay (2005)* studied collaborative trend in the Indian food Science & technology literature. *Rana & Agarwal (1994)* analyzed Indian wild life & fisheries literature. *Visakhi & Srivastava (2002)* studied the collaborative authorship in Statistical science. *Bird* has studied the authorship pattern in Marine Mammal Science. *Cunningham and Dillon* have analyzed the authorship pattern in Information Systems. *Khaparde & Pawar (2013)* studied authorship Pattern and Degree of Collaboration in Information Technology. *Begum and Rajendra* studied research collaboration in Zoological Sciences and analyzed 7854 publications published during 1975-1984. 67.02% of the literature was by multiple authors. *Vinayagamoorthy, et al. (2009)* investigated the authorship pattern and collaborative research in Herbal literature from the perspectives of medicinal plants. *Mujoo-Munshi; Vashishth and Gautam (1993)* studied research collaboration in Agricultural Sciences and analyzed about 9500 papers published during 1982-1986 by six agricultural universities in India. 15.36% of the articles were single-authored. The degree of collaboration is found to be 5.51 in Agricultural Sciences.

* Arya & Sharma (2011)* analyzed the data collected from ‘CABI abstracts’ for the period of 2006-2010 and highlighted the collaboration in research and authorship trend in the area of veterinary sciences all over the world with special reference to India. The study revealed that collaborative research has been preferred by the scientists over that of solitary research and for this study Average degree of collaboration was found to be 0.84, which also indicates dominance of collaborative research over solo research. Thus, subject analysis of the study shows a good research in the area of animal nutrition and veterinary physiology. *Amsaveni, et al. (2013)* examined authorship Pattern and Collaborative Research in Bioinformatics discipline and for this data was collected from International Journal of Computer Science and Mobile Computing.

### 2.3.3 Analysis of subject specific Journals

An article published in a refereed journal is assessed and certified as a contribution to knowledge because refereed journals are putatively ‘prestige’ journals, supervising the review of manuscript by experts in the field. Thus, articles published
in refereed journals may be assessed higher than articles in non-refereed journals (Miller & Serzan 1984). However, there are also unpublished research outcomes that are recognized as a form of productivity. For example, papers presented at professional meetings and the final reports of funded research are significant types of unpublished research For instance, a paper presented at the national association conference may have more prestige than the one presented at a regional meeting (Creswell 1986).


Velmurugan (2012) studied the Bibliometric analysis with special reference to Authorship Pattern and Collaborative Research Output of Annals of Library and Information Studies for the Year 2007 – 2012. The study on the same journal by Verma; Rajnish and Priyanka (2007) tried to find out journal’s year, institutions, and contributions by state, authorship patterns, citation analysis and length of the contributions. Pandita (2013) presented bibliometric study aimed to identify the latest publication distribution pattern of the articles published in Annals of Library and Information Studies (ALIS) journal during the last decade. Wherein, the areas like article distribution pattern, authorship pattern, reference, and geographical distribution of authors etc. has been studied. The analysis of the same journal was also made by Mete & Deshmukh (1996) evaluated 202 articles of Annals of Library Science and Documentation published during the period 1984-1993, having 1824 citations and it revealed that source journal is the most cited publication with 8 to 12 years as half life for books and journals respectively. Thavamani and Velmurugan (2013) examined the pattern of authorship and degree of collaboration in the same journal during 2002 – 2012.
Thavamanis (2013) analyzed the source journal *DESIDOC Journal of Library & Information Technology* during 2007-2011 and identified the growth rate and authorship pattern of productivity of articles. The study found out that productive year was 2008 during the study period and the Relative Growth Rate (RGR) was high in terms of literature productivity and Degree Collaboration (DC) was also high in terms authorship pattern i.e., 108 out of 194 (0.556). Kumar and Moorthy (2011) studied the publication pattern of *DESIDOC Journal of Library and Information Technology* from 2001 to 2010. Suradkar and Khaparde (2012) studied overall 5521 citations appended to 532 articles based on 5 volumes, 30 issues of the *Journal of Documentation* during 2007-2011. The mean of relative growth and Doubling Time for the first five year was 0.278 and 1.813. Swain, et al. (2013) studied the *Library Review* from 2007 to 2011 and found that the DC in the publications of Library Review was 0.36 and the journal had accommodated over 22 citations per article. Lipetz (1999) studied the Aspects of JASIS Journal of Authorship by examining the volume of five decades from 1955 to 1995.

Park (2010) studied the literature of *D-Lib Magazine* by extracting the issues during July 1995 to May/June 2008 which covered a period of thirteen years and the findings of the study proven that two and more author’s contribution was highest with a ratio of 57% and most of the authors had a single contribution. It depicts that multi-authorship is predominant on single authorship. Pareek (2013) in the article A bibliometric analysis of the literature of IFLA Journal during 2001-2010 studied the various aspects of the Journal, such as its distribution of article by year, authorship patterns, distribution of contributions by institution, subject distributions, citation patterns, length of article, rank of cited authors, and geographical distributions of authors. Rani & Nagaraju (2013) examined the nine volumes containing 26 issues of an online journal *Webology* during 2004 to 2012 attempted to analyze the scholarly communications in the respective and tried to cover mainly the number of articles, authorship pattern, country wide contribution of articles, etc.

Bakri and Willett (2008) analyzed the *Malaysian Journal of Library and Information Science* from 2001 to 2006 and tried found out the range of articles published per volume, average number of references per article, average length per article page; percentage of multi-authored papers, and geographical affiliation. Tiew; Abdullah and Kaur (2002) explored the same journal for a five year period from
1996 to 2000. Singh (2013) conducted a bibliometric analysis of the Chinese Librarianship: an International Electronic Journal during 2009-2012 using various bibliometric parameters. The study revealed the quantitative growth of articles by number and year, distribution of citations by number and year, range of citations per article, authorship patterns, authorship productivity, most prolific authors, and authors by country of the 55 articles published in the journal. Fatima; Warraich and Ahmad (2011) traced the Pakistan journal of library and information science’s author productivity, extent of authors’ collaboration, authors’ institutional affiliation, authors’ geographic affiliation, type of publication, language of papers, and number of citations used per article, length of papers, and yearly distribution of papers. Young (2006) explored a bibliometric study on Library Quarterly (LQ) covering for a period of 48 years from 1956 to 2004 with 4226 articles. The author found that more than 50 percent of the top thirty contributors had served on the editorial board of LQ and a large majority of authors were either from the University of Chicago (doctoral graduates or faculty or both).

Thanuskodi (2011) analyzed bibliographical aspects of the journal titled Library Herald for the period between 2006 and 2010. This study aimed to find out the number of articles, authorship pattern, subject wise distribution of articles, average number of references per articles, forms of documents cited, year wise distribution of cited journals etc. Dutt; Garg and Bali (2003) analyzed 1317 papers published in the volumes of the International Journal Scientometrics during 1978 to 2001 and noticed that single authored papers dominated the Scientometrics output, but multi-authorial papers were gaining momentum.

A great number of studies have been conducted to analyze the ranking of the subject specific research journals and interpret the trends in collaborative authorship in different disciplines such as: Swain, et al. (2014) examined the patterns of publications in the Journal of Educational Media and Library Science (JoEMLS) from 2008 to 2012 and it revealed that publications of JoEMLS are led by two-author papers, followed by single-author papers and three-author papers and the degree of collaboration in JoEMLS publications is found to be 0.63. Thus, Taiwan occupies the top position in the country-wise ranking of publications, followed by China and Malaysia. Tsay & Yueh (2011) conducted the study to identify the Journal of Information Science (JIS) and the subject relationship with other disciplines by
citation analysis and further it explores the bibliometric characteristics of the respective journal. The citation data for present study was collected from references of each article of JIS during 1998 and 2008. Furthermore, the databases like Ulrich’s Periodical Directory, Library of Congress Subject Heading was retrieved from the WorldCat and LISA database were used to identify the main class, subclass and subject of cited journals and books for the particular study.


**Panda; Maharana & Chhatar (2013)** analyzed publication and citation patterns in the *Journal of Information Literacy (JIL)* an open access journal from 2007-2012 and revealed that the number of research articles (51.9%) is highest among other types of publications such as book reviews (27.49), conference papers (20.61%), etc. **Biradar (2006)** examined the articles published in *Indian Journal of Environmental Protection* during the years 1994, 1999 and 2004. It depicts from the study that team or collaborative research is preferred in the field of environmental science rather than solo research and reported that the degree of collaboration varies from year to year and is found to be 0.78–0.95. The overall degree of collaboration for the study period was calculated and found to be 0.85. It further revealed that the proportion of single authored papers have decreased from 20.290% in the year 1994 to 4.762% in 2004. **Garg and Kumar (2010)** investigated the sample of citations of the articles published in 46 Indian Science Journals indexed by SCIE in the year 2006 and cited during 2006 to 2009. The study observed that collaborative papers had the highest rate of citation
Paper. The Indian Journal of Medical Research published by Indian Council of Medical Research, New Delhi had the highest citation impact and it further analyzed that highest number of papers was cited in the discipline of medicine. **Sharma & Singh (2012)** explored the Bibliometric analysis of total 2490 articles contributed by Indian authors and published in *New England journal of Medicine* during the period of 2006-2010. The study further analyzed the distribution of articles, year wise authorship pattern, year wise Impact factor of articles, year wise distribution of length of articles, Gender wise distribution of articles, year wise distribution of references of articles, contribution according to thrust areas and state wise distribution of articles.

### 2.3.4 Applicability of Lotka’s & Bradford’s law

The Lotka’s distribution is based on an inverse square law where the number of authors writing \( n \) papers is \( 1/n^2 \) of the number of authors writing one paper. Each subject area can have associated with it an exponent representing its specific rate of author productivity. The Bradford’s distribution (or Law of Scatter) groups journals and articles to identify the number of periodicals relevant to a particular subject. Its computation is based on the total number of articles published by the journals in a particular subject area.

Many studies have been conducted on these bibliometrics laws and its applicability to identify the subject matter. Some of these are stated such as **Sudhier (2013)** analyzed authorship distribution in physics literature and examined the validity of Lotka’s law of scientific publication productivity; K-S statistical test and Chi-square test were applied to verify the applicability of Lotka’s law. The first issue of the journal *Scientometrics* appeared Lotka’s law and related statistical regularities. **Nazim and Ahmad (2008)** examines total of 2675 scientific output for the period of 1991-2006 were collected from Web of Science (WoS), especially via the Science Citation Index in the field of ‘nanotechnology’. Wherein, Authorship pattern and core journals were examined using Lotka’s law and Bradford’s law of scattering respectively.

**Barik and Jena (2014)** analyzed a total of 385 article indexed by Scopus database during the period of 2004-2013 and further the study examined the growth of Library and Information Science (LIS) research articles in India. The attempt was made to analyze the annual growth of LIS research publications in India and to found out the authorship pattern, authors’ productivity and degree of collaboration. The bibliometric
law such as Lotka’s inverse square law has been applied to identify the productivity of authors and Bradford's law has been applied to identify the scattering of core journals in the particular subject discipline. **Kumar (2010)** examined two data-sets of the research papers (6076 and 17681) contributed by CSIR’s scientists during the period of 1988-1992 and 2004-2008 were collected from SCI-CD-ROM and Web of Science respectively. In this study the authors have tried to find out the applicability of Lotka’s Law to research productivity of Council of Scientific and Industrial Research (CSIR) India.

**Naseer & Mahmood (2014)** analyzed 5195 publications out of which 2609 authors contributed to Pakistani literature during 1947-2008 and presented Bibliometric analysis to find out authorship pattern of LIS literature produced in Pakistan during 62 years period under study. The study also applied the Kohnogorov-Snimov (K-S) test, using Lotka software, to determine goodness of fit and found that data failed the test at all levels (1%, 5% and 10% levels). The study further tested the applicability of Lotka's law to Pakistani LIS authors and it concluded that Lotka’s law was not applicable to Pakistani LIS authors. **Bailon- Moreno et al. (2005)** analyzed the Bibliometric laws and their empirical flaws to prove the goodness of fit at all levels.

While, empirical distributions of Lotka’s distribution and Bradford’s distribution has been tested by many authors; Schorr (1975); Coile (1977); Bellis (2009); Pao (1986); Nicholls (1986); Nicholls (1989); Lemoline (1992); Rousseau (1993); Sen, Taib & Hassan (1996); Gupta (1996); Gupta and Kumar (1998); Kawamura (1999); Gupta et.al. (1999); Gupta et.al. (1999); Rousseau & Rousseau (2000); Kumar (2003); Pulgarin & Gil-Leiva (2004); Rai & Kumar (2005); Sobrino et.al. (2008); Petek (2008); Askew (2008); Larsen et.al. (2008); Pavlykevich et.al. (2009); Ahmed & Rahman (2009); Kumar (2010); Sen (2010); Sudhier (2010); Sevukan, Nagarajan and Sharma (2007) Aswathy & Gopikuttan (2013).

### 2.3.5 Biographical Bibliometrics

According to **Kademani, Kumbar & Surwase (2008)** Bio-bibliometrics deals with the biographical study of the individual careers of scientists and researchers and correlating bibliographic analysis of publications or academic and scientific achievements. Bio-bibliometric study is also carried out to assess the research outputs or performance of an individual author or a scientist or a set of authors or scientists.
with contributions generated throughout the life time (Koely & Sen, 2006). However, most Bio-bibliometric studies are single-author studies, the author may be living or dead. This kind of study is also called as “Biographical bibliometrics” (Prakasan et.al. 2013). Most of the studies in this area have been conducted by Kalyane, Kademani and others. Kalyane & Sen (1996); Koganuramath, et al. (2004); Kademani, et al. (2002); Kalyane, et al. (2001); Kalyane (1995); Kademani, et al. (1996); Kademani, et al. (1996); Kalyane & Kademani (1997); Devarai & Ramesh (1998); Sen & Sarkar (2012); Sen & Sarkar (1990).


Koley & Sen (2014) has done a biographical bibliometric analysis of Sambhu Nath De, a medical scientists & a recognized as a pioneer in Cholera research. De’s total 47 research publication during 1944-1980 was analyzed with the author productivity, degree of collaboration and publication productivity age. However, out of the 47 papers, De is the first author in 24 papers, second author in 6 papers, and third author in 4 papers. Overall, he has published 34 papers as co-author. Mukherjee (2013) examined the bio-bibliometrics analysis of of Prof. Lalji Singh, an eminent Indian Scientist in the field of Genome analysis, DNA finger printing, etc. and presented the bibliometric analysis based on the publication data indexed in Web of Science and Scopus, wherein authorship pattern, citations received and relative performance.
Diem and Wolter (2013) carried out the study and investigate the research performance of individual researchers in the field of education sciences in Switzerland. He used the fitness-for-purpose and soundness of bibliometric parameters for measuring and elucidating the research performance.


2.4 DETERMINANTS OF RESEARCH PRODUCTIVITY

One of the strategies for determining research productivity is to assess the quantity of publications which researchers communicated through primary or other sources. Research productivity and research activity are interrelated. Research involves collecting and analyzing data. Productivity of the academic faculties reflected through writing, reading, and publishing research reports in professional refereed journals, and displaying it on the web, or to making it known to the public through any other means. Academic faculty’s research productivity primarily evaluated by published works, externally funded grants, and the number of citations the published works received. The most common productivity measures look at publications that are submitted, accepted (in press), or published. The published works could be journal articles (refereed and non-refereed), books (including edited books and textbooks), book chapters, monographs, conference papers, and research proposals written to receive external and internal grants. (Middaugh, 2001)

2.4.1 Measurement of Research productivity

The most persistent issue regarding the measurement of research productivity is the confusion of quantity of publications with quality of publications, either in the publication itself or the publication outlet (Lawrence & Green 1980). Indeed, it has
been noted that the debate over the most appropriate measure of productivity revolves around these two fundamental dimensions of quantity and quality (McGuire et al 1988). Furthermore, whilst research productivity can be measured at the individual level, there is also a need to develop hierarchical measures at the sub-department, department and university levels (Lertputtarak, 2011).

Measuring the research productivity of faculty is a complex issue, with many contributing factors. Productivity has been measured at a variety of levels, including at the level of individual faculty, at the department level and at the institutional level. (Dundar and Lewis, 1998) Research productivity has been measured as the quantity and/or quality of the artifacts produced by faculty scholarship. (Athey & Plotnicki, 2000; Brocato & Mavis, 2005; Dennis et al., 2006; Dundar & Lewis, 1998; Meho & Spurgin, 2005; Park & Riggs, 1993) The criteria that have been used in measuring productivity vary by institution and discipline, and faculty promotion and tenure is typically based in part on those criteria. Previous studies have found that both productivity criteria and promotion and tenure requirements also change over time, as disciplines and institutions change, grow, or mature. (Bunton & Mallon, 2007; Dennis et al., 2006; Youn & Price, 2009) Economic conditions can also have a profound impact on faculty research productivity, and institutional support for scholarship can be restricted or eliminated during difficult economic times. (Petry & Kenney, 1991) Other studies have shown that age, gender, socioeconomic status, experience, and educational background can impact faculty productivity, with the combination of age and experience showing a particularly strong correlation with research productivity. (Dundar & Lewis, 1998)

2.4.1.1 Quantity Measurement:

The most frequently used measure of the quantity or amount of research productivity is a numerical publication count or the journal article count over a certain time period. The activities included in measuring productivity range from a narrow perspective of ‘number of research articles published’ to a broad interpretation which consists of presentations, both formal and informal, number of graduate students that a staff member is advising, publications of any type and proposals submitted for funding. Moreover, it also includes counts of the number of editorial duties, conference deliveries, licenses, patents, monographs, books, experimental designs, and works of an artistic or creative nature, public debates and commentaries.
(Creswell, 1986). Rotten (1990) stated that ‘a common approach to measuring research productivity was to count the number of books, articles, technical reports, bulletins, and book reviews published, as well as presentations given and grants received through reviewing curriculum vitae or other print materials’. Fielden and Gibbons (1991) pointed out that within the business faculty, many lecturers emphasize articles published in refereed journals and trivialize all other measures of productivity. Clement and Stevens (1989) found that management administrators put greater weight on scholarly research and less on trade and newspapers articles than their non-management business peers.

Radhakrishma and Jackson (1993) in view that publication in refereed journals ranked foremost important factor in research productivity while, publications in refereed journals and considering paper presentations at national, international or regional level conferences etc. also to be very important component of research productivity of faculties reported by Yoder and Scanlon (1994, p.17). This statement was supported by Kotrlik, et al. (2002) quoted William Cooper as stating that ‘publications in research conference proceedings, books and other publications are meaningless or insignificant without publishing in refereed journals’(p.3). Furthermore, Creswell (1986) seriously pointed out that counts of publication require some form of weighting system, particularly for instance, the comparisons between journal articles and books. Books express a problem because there are several types of books that cannot be used to measure research performance, such as original scholarly books, theoretical or research monographs, edited books and textbooks. A chapter in a book for readings may also be classified as a book form. Further problems also could arise when equal weight is given to many of the peer-reviewed publications in newer journals whose review standard may be less rigorous than the longer established journals. Several weighting systems have developed to make comparisons among types of research productivity.

Braxton and Toombs (1982) used weighting procedure and it showed that original scholarly books and monographs receive higher weights than do journal articles. Textbooks are also weighted higher than edited books, whereas edited books are weighted equally with articles published in high-quality journals but higher than articles published in journals of lower perceived quality. (Creswell 1986) The simple counting of published and unpublished research outcomes does not allow any
comment upon the quality of work. For examination of quality, peer review rating and citation analysis are emerging as relatively new tools to assess. Lastly, service as a reviewer of grants proposals is another pertinent measure. (Pellino, Blackburn & Boberg, 1984)

2.4.1.2 Quality Measurement:

A process of professionally reviewing some other person’s research work by one or more qualified professionals refers to peer review process, usually for publication in a scholarly journal or book (Upali; Hebert & Nigel 2001). External reviewers for academic journals typically do not know the names of the authors of manuscripts that they are asked to review. However, the case of assessing grant proposals may be different, because the peer review process in grant proposals has considerable interest in what are the particular characteristics of the researcher e.g. age, gender, rank, potential conflicts of interest (Chubin, 1994). Kirkpatrick and Locke (1992) found a statistically significant positive correlation between individual peer rating and measures based on article counts and citation counts. However, peer ratings are not without their limitations, for example, it can be influenced by the personality of the scholar being judged and/or by the reputation of the institution of affiliation (Folger, Astin & Bayer, 1970).

Similarly, peer review has several other limitations (Nelson; Buss and Katzko, 1983) as follows:

(i) The quality of the personal work is not being measured in peer reviews,
(ii) Journals different in scope of articles published because some journals may concentrate on contribution to knowledge while others may focus on more creative contributions, and
(iii) Peer rating is affected by rapid changes of editorial staff and publishing policies.

2.4.1.3 Citation measurement:

Citation measurements carried out to measure faculty research productivity (Braskamp & Ory, 1994; Creamer, 1998). Indeed, Centra (1981) claimed that citation data better reflects the impact of faculty work. One way of gathering citation data is by obtaining curriculum vitae from faculty and verifying listed citations via citation abstracts and databases (Brocato, 2001). Published works are cited as building blocks
for ideas, concepts, findings, methods or information on instrumentation. Nevertheless, in a cited article, not everything is read and found useful. A publication is property, and citing practice is a social device for coping with problems of property rights and priority claims (Kaplan, 1965; Cole & Cole, 1967; Wanner, Lewis & Gregorio, 1981).

However, citation counts have some important limitations (Creswell, 1986; Brocato, 2001).

- There are substantial differences in citation rates among various disciplines because of the rates of publication and the acceptance rates of journals.
- Significant researches may not be recognized for a considerable period of time, Citation rates decay substantially (Line, 1984) thus staff who work for a longer period of time generally have more publications and more opportunity to be cited.
- A scholar who is a junior author of a piece, and therefore not first named, would be missed in simple counts.
- Some surnames are subject to common misspelling by citing authors, and these errors are preserved in the citation indexes.
- Citations may be for criticisms and rejections of research rather than its merit and utility. Sixth, several critics of citation tools have noted that self-citations and citation of friends’ work may distort realistic measurement.
- Citation counts do not distinguish between positive and negative comments about the work.

2.4.1.4 Research & Teaching:

Faculty research productivity measured by teaching and research carried out by the academic faculty members. Teaching usually quantified as courses taught, work load and class size (Boyer, 1990). Faculty productivity in the research university is frequently assessed as scholarly publications and presentations in conferences and seminars, sometimes including grants for minor or major research projects (Braskamp & Ory, 1994; Wong & Tierney, 2001). However, in the research university, scholarly publications in the form of peer-reviewed research articles in reputed professional journals considered as primary productivity of faculties which are measured in the granting of promotion and tenure in the respective academic career of those faculties (Braskamp & Ory, 1994; Lazear, 1998; Pellino et al., 1981; Wong & Tierney, 2001).
A widespread research in the relationship between research and teaching has produced mixed results, based on the variables of interest and how they are measured while minimum relationship has been found between teaching evaluations and research productivity, but (Ovington, et al. 2003; Bailey, 1999; Colbeck, 1997; Feldman, 1987), but faculty research productivity and teaching load are unconstructively related with each other (Buchheit, Collins & Collins, 2001; Chen, Gupta & Hoshower, 2006; Hardré et al. 2007; Hattie & Marsh, 1996). Hence, overlap exists between research and teaching in seminars/conferences and research advising/supervising more than in traditional classroom teaching (Altbach & Lewis, 1997; Colbeek, 1997).

2.5 FACTORS AFFECTING RESEARCH PRODUCTIVITY

A great emphasis given to research, teaching and service of most faculty members in large number of research-extensive universities and are expected to be productive (Blackburn & Lawrence, 1995; Fairweather, 2002). Similarly, an extensive focus is placed on scholarly research in the wide-spread form of conference presentations and publications such as refereed journal articles, books, and book chapters (Bentley & Blackburn, 1991; Hearn, 1999). The impact of such scholarly work exists due to such productivity of the faculties contributes large to the scientific and professional literature and brings credibility, integrity and has significant both to the individual scholar and to the institution (Plucker, 1988; Tien & Blackburn, 1996). It is considered as important facets for research and it determining how the nature and priorities of tasks in the professoriate are differentiated by type of institution and by discipline (Fairweather, 1999; Levin & Stephan, 1992). Bay & Clerigo (2013) reported that much confidence in research writing and organizational support toward research activities are two vital factors that may influence research performance of the faculties among higher educational institutions.

Furthermore, they summarize in their article Some Intrinsic and Extrinsic Factors affecting Research Productivity as mentioned below:

2.5.1 Research Skills and Competence

Research productivity is affected by the research skills and technique under research competency. Experience in doing research and training in research resulted better influence on research output. Somehow utilization of that research
communication skills, networking, sharing of knowledge, collaboration and teamwork also have an effect on research productivity (Wichian, et al., 2009). However, there are significant differences in research productivity among sort of knowledge, not only in the form of publication counts and citations but also in the productivity sequence. (Brambila; Veloso & Morgan, 2007) Self-motivation, essential skills and experience are the influential factors that encourage faculties to do research in an effective manner. (Lertputtarak, 2008) Researcher’s unique characteristics and research competency are closely interrelated with research productivity as they have more influence on individual productivity. (Nuqui & Cruz, 2012)

2.5.2 Tenure and Promotion Requirements

Faculty research productivity is significantly influenced by the extent of research promotion of institutions in terms of promotion of the research environment and in providing mentor’s assistance. (Nuqui & Cruz, 2012) Moreover, completing research projects funded by the various agencies is an important factor in order to receive high merit on annual evaluations in the institutions opined by the faculties having more than ten years rated research experience higher than those with fewer years of experience and with more experience (Nichols, 2004). Faculty members are being classified using criteria including professional growth of which they are evaluated in requisites of professional practice in related field of specialization, non-degree training program such seminars, symposia, workshops, etc. and published creative and scholarly works. (LPU-B Manual)

2.5.3 Organizational Support

For doing an effective and innovative research work there is a need for substantial financial and technology resources, strict cost management, closer ties between public and private sector research, multidisciplinary and international research teams and the funding skills and research management (Wichian, et al., 2009). Institutional research objective, goals, agenda and priorities, network and linkages influence research output dissemination and utilization. (Alim & Diocolano, 2011)

Furthermore, there is possibility of the reward structure of the research institution responds to initiatives and researchers prefer to allocate time to those activities that maximize future rewards. (Brambila, et al., 2007) Similarly, with the
incorporation of accountability features including formalized progress reports writing and mentorship feedback in fellowship training such programs can be increases research productivity. Some of the independent factors associated with research productivity may be these are, facilitating the identification of a mentor and providing an additional year of research (Cohen; Sherman; Kiet; Kapp; Osann; Chen; O’Sullivan & Chan, 2012). However, universities and other higher institutes assist, motivate and provide supportive factors and lecturers that have ample of compliance to do research then it resulted in better outputs and then significant research outcomes will be produced. (Lertputtarak, 2008) if the University can,

2.5.4 Availability of Resources and Productivity

There are two kinds of resources useful in increasing the research productivity i.e. financial support for research and research assistance/human resources such as PhD students, research associates, project fellows and other technicians. Many studies reported that scientists with high research experience and enrolled with much more PhD scholars/Post graduate students/project fellows will be more productive in publishing scholarly research work than others having less number of experience and having less number of research students enrolled with them. (Kyvik, 1991)

2.5.5 Organizational Context

Several previous studies have reported that the productivity of scientists influenced by the environment and it is generally assumed that good scientific environments motivate the research. Organizational environment can also influence on whether a person has possibilities to turn into a productive scientists or whether a research group will prosper or not.

2.5.6 Contextual Factors

The contextual factors to be most essential and greatest impact on the indicator that is considered when appraising research performance; published scientific artists. Furthermore Department climate, age structure, as well as proportion of faculty member’s with PhD’s have considerable impact on research output of the faculties (Smeby & Try, 2005). Research performance of any institution has garnered support for departmental prestige as important, less recognized about how prestigious departments and units promote, and less prestigious discourage, publications (Fox, 1983).
2.5.7 Size of the Institution

The size of the institution in which the faculty member works has considered as the crucial factor related to faculty research productivity. Behymer (1974) studied research productivity of faculty in four-year colleges and major research universities and reported that faculty in major research institutions publish more than faculty at four-year colleges. As similar to this study Bailey (1992) found out that research productivity increases from Liberal Arts II Colleges through Research I Universities. Dundar and Lewis (1998); Gorman and Scruggs (1984); Vasil (1992) also reported in their studies that institutional size was related to research productivity.

2.5.8 Other Individual Factors

Individual productivity may be affected by personal research motivation and creativity, abilities and IQ, educational background to be important in some studies. Graduates from top schools, with research assistance experiences and employed in research universities, are more productive than other researchers (Buckmueller, Dominitz & Hansen, 1999). While, Brian (2009) examined relatively different approaches for nurturing research productivity, such as recruitment and incentives and focused six promising unconventional approaches such as regular writing, tools for creativity, good luck, happiness, good health ad crowd wisdom, however these options challenged to conventional ideas about the research management.

2.5.8.1 Age

Age has been considered one of the crucial factors which included in several studies with overwhelming conflicting results. Bland and Berquist (1997) reported most of the senior faculty members remain fairly active in research activities comparatively to those of younger faculty members. Thus the average productivity of faculty seems to drop with age and senior faculty member’s products are high impact than comparable to others. They also observed that there is no significant indication that age determines a drop in productivity of scholarly work, but increased workloads and shifting emphasis is another issue to blame. Blackburn, et al. (1991) stated that the relationship between age and research productivity had been addressed in many studies and sometimes contradictory, correlations have been found.
2.5.8.2 Professional Experience

Some of the studies reported that a huge number of years of professional experience was related to high research productivity by the faculty members Gorman & Scruggs (1984); Vasil (1992). Pfeffer and Langton (1993) stated that total professional experience in the years had a foremost impact on total number of research outputs, but it has an insignificant effect on recent research productivity. Further Blackburn, et al. (1991) traced that the connection between educational experience and research productivity had been addressed in many studies and sometimes conflicting, correlations have been found with each other.

2.5.8.3 Gender

Gender is another influential factor related to research productivity and have been studied by many researchers with mixed results. Bailey (1992) found out a higher level of research productivity by male faculty members in his study while, other researchers have noted that female faculty members produce less number of research outputs and they are lagging behind experienced male faculty members in research productivity (Gmelch; Lovrich & Wilke, 1984; Smith; Lovrich, & Nicholas, 1995; Sax, et al., 1996). Blackburn, et al. (1991) reported the relationship between gender and research productivity had been addressed in many studies and sometimes contradictory, correlations have been found.

2.5.8.4 Confidence

The high impacted research outputs reflected faculty members’ confidence in their research abilities and is much related to increases the h-index of faculties. Bean’s (1982) model of faculty research productivity included the perceived level of authenticity in one’s research as an instructive factor. Whereas, Vasil (1992, 1996) explored that increases in ability and self-efficacy were also related with increased research productivity of faculties.

2.5.8.5 Salary/Wages

Several studies reported the relationship between research productivity and salary since wages often reflects research productivity levels (Jacobsen, 1992; Pfeffer & Langton, 1993; Rebne, 1989; Tornquist & Kallsen, 1992). Paying attractive salaries in return for performance may serve as an incentive for higher productivity from faculty members. Higher salaries may also attract productive faculty while at the same
time minimizing the possibility of losing active faculty to other institutions (Pfeffer & Langton, 1993).

2.5.8.6 Freedom

The freedom to doing research work increases research performance of the faculties and results in increased research productivity (Bland & Berquist, 1997). Landry et al. (1996) found that collaboration in the research activities of all kinds may increases researchers' productivity. While, Pfeffer and Langton (1993) found that collaboration was condensed by wage dispersion.

2.5.8.7 Rank

Bailey (1992); Vasil (1992) traced out that rank is a significant predictor of research productivity. Dundar and Lewis (1998) opined that departments with higher ranked faculty had higher research productivity with overwhelming outputs.

2.5.8.8 Institutional support

Kelly and Warmbrod (1986) stated that “received an institutional and departmental support for research is seen as the most important factor to research productivity” (p. 31). Dundar and Lewis (1998) found that the percentage of graduate students hired as research assistants interrelated highly with research production by the faculties.

2.5.8.9 Faculty size

Only one study among all could be found that addressed faculty size (Dundar & Lewis, 1998). They reported that programs with smaller numbers of faculty cannot compete in the area of research productivity with larger universities, hence it can be noted that faculty size is also a determining factor concerned with the research productivity.

2.5.8.10 Promotion

Some scholars believe that promotion has a motivating effect on research productivity. For instance, Fox (1985) suggests that higher education institutions can influence faculty research behavior through the exploitation of the reward structure for promotion. Other researchers, however, insist that faculty publish not for external rewards but because they enjoy the process of inquiry and interested in careful investigation of the facts (McKeachie, 1979).
2.5.8.11 Stress

Stress is becoming an emerging influential factor in research productivity as well as in all areas of life, and one study found five areas of stress among faculty members: i) reward and recognition, ii) time constraints, iii) departmental influence, iv) professional identity, and v) student interactions (Gmelch; Wilke & Lovrich, 1986). While two (reward and recognition and professional identity) of these major stressors, are closely related to research activities, and another (student interactions) is directly connected to the teaching role. It may be stated that the other two (time constraints and departmental influence) are associated with the both research and teaching, as well as to the service role of faculty. Time is related to research and teaching since these responsibilities consume much of a professor’s time and effort.

2.5.9 Motivational Factors

Prior studies identified two categories of personal motivational factors that drive academic research:

(1) Investment factors or extrinsic rewards (e.g., salary raises, tenure, and promotion) and

(2) Consumption factors or intrinsic rewards (e.g., an individual’s personal satisfaction from solving research puzzles, contributing to the discipline, and achieving peer recognition).

In addition to personal motivation, other factors also have a substantial influence on faculties research productivity. One well-established research productivity theory, Life-Cycle theory, suggests that in general the research productivity of a researcher rises sharply in the initial stages of a career, peaks at the time of tenure review, and then begins a decline. (Diamond 1986; Goodwin and Sauer 1995; Hu and Gill, 2000)

2.5.10 Other Factors

Some of the studies have identified that the following factors influence research productivity (Buchheit, et al. (2001); Cargile and Bublit (1986); Chow and Harrison (1998); Tien (2000); Levitan and Ray (1992); Hancock, et. al (1992) :

(1) Tenure status,

(2) The allocation of working time to research activities,

(3) Length of the tenure probationary period,

(4) Teaching loads, and

(5) Financial research support
However, other similar studies have looked on other variables and factors; Long & McGinnis (1981); Stankiewicz (1979); Ramsden (1994); Fox (1983); Grunning (1977); Kyvik (1995); Dundar & Lewis (1998)

2.6 FACTORS THAT INFLUENCE RESEARCH PRODUCTIVITY

The influence factors for research productivity were rearranged into 5 factors, grouping’s social knowledge and environmental condition/response into environment factors and institutional factors (Blackburn and Lawrence, 1995).

2.6.1 Demographic factors

Demographic factors relate to the personal characteristics of academic members, and for this study they will be taken as age, gender and marital status, and each will be justified, in turn, for inclusion in this work. Demographic factors were derived from socio-demographic factors. These factors include age, gender and marital status, and these were included in order to see if they carry any associated intrinsic problems that interfere with an academic staff member’s ability to carry out research (Blackburn and Lawrence, 1995).

2.6.2 Social contingency factors

Social contingency factors are those that have direct effects on academic staff abilities to carry out research because they typically place constraints on the time and energy that individuals have to engage in work activities. Those social constraints include the faculty member’s health, extent to obligations to others such as spouse, children and parents, financial strains and pregnancy.

2.6.3 Environmental factors

Environmental factors are those factors that relate to the work environment and cultural climate within which the academic lecturers have to deal with everyday, such as their colleagues’ commitment to research, the relationship between the academic lecturers and their supervisors, academic honesty, academic integrity, academic freedom, leadership and faculty collaboration toward a community of scholars. Academic environments and cultures or climates generally provide both socializing and reinforcing organizational messages about norms, values and expectations concerning research (Kuh & Whitt, 1998).
2.6.4 Institutional Factors

Faculty behavior, salary, research activity, time Institutional factors are those factors that directly emerge from the institution’s structure, such as the type of institution, institution policy for promotion, research policy, workload, salary and resources, and material supports.

2.6.5 Personal Career Development Factors

The Personal career development factors were derived from grouping self knowledge and career in Blackburn and Lawrence (1995)’s model. Personal career development factors are come from the academic and personal qualifications of academic lecturers themselves, such as an individual’s ability and interest, attitude toward conducting research, academic origin, advanced degree earned, research experience, skills and training, and rank and tenure status.

![Diagram](image)

**Figure No. 2.1:** Factors influencing research productivity by Blackburn and Lawrence (1995)

2.7 THE ROLE OF MOTIVATION

A large number of studies and vigorous research literature regarding the faculty productivity featuring external and organizational characteristics were available to quantify the predictors; however a small number of studies about motivation theories to conducting the research have been shown. (Goodwin & Sauer,
Rather some of the studies of factors influencing research productivity incorporated effects of personal and institutional characteristics. (Levitan & Ray, 1992) Therefore, necessarily it is needed to integrate these motivation theories, models and personal investment as contextual and individual differences to improve the research performance of the academic faculties or scientists hence these motivation theories can build up the personal and social dynamics to strengthen the quality of research productivity in other words it influenced the faculty research productivity. (Hardré, et al, 2007) The present study focused on three motivation theory as follow:

a. intrinsic versus extrinsic motivation  
b. self-determination and social support and  
c. self-efficacy

2.7.1 Intrinsic and extrinsic motivation

Intrinsic motivation is a fundamental part when an individual make engaged him in a movement or action due interest, enjoyment and satisfaction in that activity itself. While, extrinsic motivation is that which leads to forcefully engaged in the activity due to external pressure. (Reeve, 1995; Sansone & Harackiewicz, 2000) intrinsic motivation predicts effort in the learning environments and work-based studies, engagement, enjoyment and achievement.

Extrinsic motivation predicts minimal effort, lack of enjoyment and minimal performance often with a hesitancy to take risks or innovate (Deci & Ryan, 1987; Pintrich & Schunk, 1996; Reeve, 1995) besides this theoretical perspective merit was relatively inconsequential and that incentives perceived as external pressures did not productively motivate faculty members to do good research work. (Colbeck, 1992) Leadership positions and contingencies influenced the motivation to communicate with more power (Bland, et al, 2006; Ryan & Deci, 2000), as well as by the explicit or implicit social norms of the group (Deci & Ryan, 2002; Lazear, 1998).

2.7.2 Self-determination and Social Support

Self-determination theory explains the perceptions of individual to themselves as an independent choice and liberty in their work forecasting their security, well-being, work exertion and performance about the research. (Deci & Ryan, 2002) As similar to this, individual’s self determination of themselves as capable in their relative work is cause them to put forth effort and engage fully in work-related tasks
Relatedness predicts job performance and satisfaction of the faculty to which faculties personally supported by the supervisors and other higher authorities. While relatedness, as third foremost important element self determination refer to the degree with supportiveness from others. (Deci & Ryan, 2002) Task-oriented self-efficacy predicts confident motivational and self realization outcomes across contexts, including determination and presentation of research. (Bandura, 1997)

### 2.7.3 Self-efficacy

Self-efficacy is the most competent which determines individual’s perception of capability to retain and complete entire tasks and achieve goals rather take it as challenge. (Bandura, 1997; Reeve, 1995) In the sphere of higher education self-efficacy accounted as a major variation in faculty research productivity. (Blackburn, et al, 1991) Faculty research efficacy within universities specifically, efforts invested in research activities in the form of research publications in various forms of information as well as in their presentations. (Hardré, Miller, Beesley, Pace, Maxwell, & Xie, 2007) Further, supportive and helpful culture in any organization predicted faculty motivation for teaching activity (Feldman & Paulsen, 1999), and wide-ranging happiness is strongly related with overall faculty success. (Walker, 2002)

Intrinsic motivation, self-determination, and self-efficacy are most important motivational characteristics that have been established to lead to workplace success across many contexts. There is little research applying these variables to studies of faculty motivation, excepting an infrequent study focused on a specific discipline or subset of related disciplines and later a handful of studies sampling across institutions and disciplines (Chen, Gupta & Hoshower, 2006; Hardré, et al, 2007; Bailey, 1999; Blackburn et al., 1991)

### 2.8 MOTIVATION THEORY

According to Greenberg (1999) motivation has been defined in science as the process of moving and maintaining goal directed behavior. Motivation is key in the establishment and further development of quality in higher education (Rowley, 1996). According to Greenberg, 1999 motivation theory can be classified in two main ways:

a. Content theories and

b. Process theories
2.8.1 Content Theories

It mainly emphasizes the basic human needs and drives that cause humans to perform or cease behaviors. Within the work environment, content theories focus on the needs, motives, or desires that cause employees to produce desired outcomes, as well as their relationships to the incentives or rewards that affect on personal performance (Greenberg, 1999). Some of the well known content theories of motivation (Greenberg, 1999) are described below:

2.8.1.1 Maslow’s Hierarchy of Needs Theory

Maslow’s hierarchy of needs is based on the idea that motivation comes from human needs. Maslow (1954) stated that to understand motivation at work, one must understand that human motivation arises from needs that can be placed on a hierarchy of importance. Once one set of needs can be satisfied, people begin to be motivated by higher stages of needs. Maslow’s theory contains five priorities of needs. These needs are: basic physiological needs, safety from external danger, love or affection and social activity, esteem and self-respect, and lastly self realization and accomplishment. Maslow’s theory has been widely accepted and recognized by learners for more than 50 years (John & Saks, 2005).

2.8.1.2 McGregor’s Theory X and Theory Y

In 1982, McGregor studied two different sets of managers’ attitudes, which he termed Theory X and Theory Y. A Theory X approach means managers allow workers little responsibility, authority, or flexibility. It views workers as needing to be trained and carefully watched to see how they perform. (Bobic & Davis, 2003) In contrast to Theory X, Theory Y suggests that managers need to develop the potential in employees and help them release their potential toward common goals. Workers are likely to perform their tasks and therefore, it is seen by managers as unnecessary to control and punish. Generally, people commit to their goals as they perceive rewards as their achievements (McGregor, 1985). Theory Y emphasizes a relaxed managerial atmosphere in which workers are free to imagine, be creative and ingenious in setting goals. From the perspective of Theory Y, managers are only consultants in the decision-making process (Merriden 1998).
2.8.1.3 Herzberg’s Two Factors Motivation Theory

Herzberg and his team published ‘The Motivation to Work’ in 1959. This publication explored the impact of fourteen factors on job satisfaction and dissatisfaction in terms of their frequency and duration of impact. Herzberg’s theory was a departure from Maslow’s hierarchy of needs (1954). Herzberg’s motivation-hygiene theory identified two sets of factors dealing with job satisfaction and dissatisfaction. (Herzberg; Mausner & Snyderman, 1959) They related dissatisfaction in the work environment to hygiene factors and satisfaction or psychological growth to motivation factors. Herzberg identified hygiene factors into working condition, salary, status, security, and interpersonal relations (such as relations with policies and administration or style of supervision). Motivation factors are based on what employees actually do and plan to get through achievement recognition, responsibility, advancement and growth.

2.8.1.4 McClelland’s Achievement Theory

McCleland (1961) has been a key researcher in the field of achievement motivation. He developed methods for counting the frequency of thoughts, actions, and feelings of individuals related to attaining excellence. His theory has been viewed as a measure of the strength of achievement motivation. (Alschuler; Tabor & McIntyre, 1970) McCleland’s theory indicates that workers with high achievement motivation are more interested in motivators (achievements, achievement recognition, responsibility, advancement, and growth) and desire feedback on how well they are doing their job.

2.8.1.5 Alderfer’s ERG Theory

Beside the five levels of needs suggested by Maslow, Alderfer’s E.R.G. theory addressed three basic sets of needs: Existence (E), Relatedness (R), and Growth (G). Elderfer (1969) described existence needs as follow: It can be summarized that existence needs are a physiological desire for material and physical well being. These needs are satisfied with food, water, air, shelter, working conditions, pay, and fringe benefits. People have to share material resources. The existence needs are the most concrete, related needs fall in the moderate range, and growth needs are least concrete. E.R.G. theory is similar to Maslow’s theory as the process of need fulfillment consisted of moving along the continuum in relation to satisfaction progression. But the difference lies in the content and process terms (Landy &
Trumbo, 1980). Maslow’s theory has five needs, while Alderfer’s theory has three needs. Maslow’s theory is one of fulfillment-progression, while Alderfer’s theory contains both fulfillment-progression and frustration-regression. Growth needs are related to: For growth needs, it is the desire to be creative, to make useful and productive contributions and to have opportunities for personal development that are the key factors. Alderfer (1969) pointed that existence, relatedness, and growth vary on a continuum of concreteness.

### 2.8.2 Process Theories

These are concerned with how behavior originates and operate in the work environment in order to achieve desired outcomes. (Auth, 1999) Some well-known process theories (Greenberg, 1999) are included:

#### 2.8.2.1 Adams’s Equity Theory

Adams (1963; 1965) is recognized as the person who developed equity theory. Equity theory focuses on people’s perception. Motivation stems from attempts to reduce unfairness or inequity in personal relationships. (Wilkens & Timm, 1978) Equity theory hinges on inputs in exchange relationship with outputs. Inputs represent the investment in the exchange relationship for which the contributor expects some reciprocal return. Equity theory has been applied to investigate the power structure in marital relationship (Webster & Rice, 1996), satisfaction with bargaining (Darke & Dahl, 2003) the relationship between friends (Roberto & Jean 1986), and perceptions of fairness of reward allocation in teams (Wilke; Rutter & Kinppenberg, 2000).

#### 2.8.2.2 Vroom’s Expectancy Theory

Vroom’s expectancy theory is a process theory. Vroom’s (1964) model of work motivation applied an expectancy perspective to the workplace. Expectancy Theory, as related to cognitive motivation, helps a researcher understand how individuals make decisions regarding various behavioral alternatives. Expectancy theory consists of Effort-Performance expectancy, Performance-Outcome expectancy and Valence. Effort-performance expectancy (EP) relates to how people evaluate their ability and how they consider the adequacy of contextual factors such as resource availability. (Bateman & Zeithaml, 1993) Expectancy is the belief that one’s effort (E) will result in attainment of desired performance (P) goals.
2.8.2.3 Reinforcement Theory

Reinforcement theory was developed by Skinner (1953). In reinforcement theory, behavior can be explained by environmental consequences. (Luthans & Kreitner, 1975) The theory relies on the concept of the ‘law of effect’, which demonstrates that positive or pleasant behaviors are more likely to be repeated. (Thorndike, 1911) There are four types of reinforcement: positive reinforcement, negative reinforcement, extinction and punishment. Positive and negative reinforcement are purpose to increase behavior, while extinction and punishment aims to decrease behavior.

2.8.2.4 Goal Setting Theory

In the mid-1960s, Locke began to examine and continued researching goal setting for thirty years in order to understand the impact of goals on individual. (Wikimedia Foundation Inc, 2007) Goal setting theory predicts a linear relationship between motivation and performance. Goals have a direct effect on motivation by directing attention, mobilizing effort, increasing persistence, and motivating the search for appropriate performance (Locke et al., 1981). Goals can affect performance in three ways; (1) goals have direct efforts to goal relevant activities, (2) Goals lead to more effort, (3) goals influence persistence (Wikimedia Foundation Inc, 2007).

2.9 MODELS FOR FACTORS INFLUENCING PRODUCTIVITY

Research productivity of faculty members has gain importance from several decades in India and abroad and factors which associated with or influencing research productivity have studied by various researchers while most of these studies are derived from the general models. These models are beneficial for promotion of faculty members and being applied in various organizations or institutions to study the effects of factors. In this section some of the models have been described as follows:

a. Conceptual models
b. Composite model

2.9.1 Conceptual Models

The conceptual model explains valuable elements which are useful for detecting the efforts of faculties in research area. This model clarify these elements and developed a path which potentially helpful in assessment of research productivity of faculty members. It can also prepare the suitable climate for decision making and
planning of make quality improvement and encouragement based on related data or information. (Tafreshi, et al., 2013)

2.9.1.1 Bland Model

The Bland model has three main elements these are; individual characteristics, Leadership characteristics and environmental (managerial) characteristics. (Bland, et al. 2002)

2.9.1.2 Finkelstein Model

This model illustrates seven variables initiated to calculate coverage of faculty members publications including 1) curiosity and attention of faculty towards research activity (2) having uppermost higher level educational degrees of faculties, (3) the way of primary publishing (4) earlier research performances (5) correlation with other authors from the same discipline, (6) maximum number of membership in journals, (7) eagerness in sufficient time commitment to do research. (Finkelstein, 1984)

2.9.1.3 Creswell Model

This model explained the significance of organizational factors as well as research culture influenced individual productivity of faculty members. In this model Creswell (1985) tried to identify organizational factors influencing research productivity of faculty members and described to promote their scientific status, devote at least one third of their time to research activities, publish papers in their specific field, receive positive feedback from their colleagues and/or have a continuous and close relationship with their colleagues involving in similar research plans inside and outside of university. (Creswell, 1985)

2.9.1.4 Dundar and Lewis Model

The present model was primarily characterized in two aspects, i.e. a) personal behavior and ecological experience mostly connected with individual characteristics of faculties and the other one is b) leadership, civilization, formation and strategy related with Organizational and department characteristics including variables. Thus, he elaborated faculty size is the most crucial and important factor for research productivity as stated by Dundar and Lewis (1998)
2.9.1.5 Teodorescu Model

An International model for productivity established by Teodorescu (2000) and in this model more focus was given on the individual success variables and organizational features.

2.9.1.6 Brocato Model

Brocato (2001) attempted to describe various factors pointed out various factors useful in research productivity of faculty members. The present model explained psychological factors, individual characteristics and organizational and group environment for conducting research. He establishes the correlation among motivation, professional networks and research training and bounded with research productivity of faculty members. Further, it was depicted that organizational, educational group (department/school) and disciplines these factors are least influenced on research productivity as compared to individual characteristics. Brocato (2001)

Figure No. 2.2: Conceptual models by Blackburn and Lawrence (1995)

2.9.2 Composite model

Jung (2012) has proposed a Composite model of productivity that is based on crucial individual attributes and institutional characteristics.
2.10 CONCLUSION

In recent years, research productivity is the most crucial and efficient factor which impact on the development of a nation. The researchers and policy makers have more interest in publishing trend in scholarly publications. One of the foremost measures is Research productivity of university faculty performance and therefore it is also used as a core indicator for evaluation of university rankings. The quality and quantity of research publications generated by the individual academic faculty members, communicated in form of journal articles, books, technical reports, and other types of publications recognized by the universities and hopefully it will help them to granting promotion and rewards.

This chapter will be followed by Chapter No. 3: Bibliometrics study: an Overview