RESEARCH PRODUCTIVITY OF THE DEPARTMENTS OF STATISTICS OF CENTRAL UNIVERSITIES IN INDIA: A BIBLIOMETRIC STUDY

A Thesis submitted to the Mizoram University
for the award of Degree of

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In
Library and Information Science
(School of Economics, Management and Information Science)

By

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DECLARATION

I Sangita Das Talukdar, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University / Institute.

This is being submitted to the Mizoram University for the Degree of Doctor of Philosophy in Library and Information Science.

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C E R T I F I C A T E

This is to certify that the thesis entitled, "**Research Productivity of the Departments of Statistics of Central Universities in India: a bibliometric study**", submitted by the **Mrs Sangita Das Talukdar** for the award of **Doctor of Philosophy** in **Library & Information Science**, is carried out under my guidance and incorporates the students bonafide research and this has not been submitted for award of any degree in this or any other university or institute of learning.

Place : Aizawl
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D E D I C A T I O N

To my father God bless his soul……

…….. I seek your blessing forever…….

I would like to dedicate this thesis to my father **Late Kabindra Kumar Das Talukdar** who unfortunately passed away on 14th May, 2013 but whose affectionate words, support and care will always enshrine in my mind. I miss him a lot, let this work be lasting evidence that can be accomplished. It gives me immense pleasure in being able to express my gratitude to him in commemorating his memory in this way.

Date : /07/2016 **Sangita Das Talukdar**

Place: Aizawl, Mizoram

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Sangita Das Talukdar

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ABBREVIATIONS

AU	Allahabad University
AMU	Aligarh Muslim University
ARP	Academic Research Productivity
ARWU	Academic Ranking of World Universities
BHU	Banaras Hindu University
DU	Delhi University
DST	Department of Science & Technology
HU	Hyderabad University
HRD	Human Resource Development
GU	Hemwati Bahuguna Nandan Garwal University
GER	Gross Enrollment Ratio
ISI	Institute of Scientific Information
IGNOU	Indira Gandhi National Open University
IT	Information Technology
ICT	Information and Communication Technology
JCR	Journal Citation Report
MU	Manipur University
M.Phil	Master of Philosophy
MSN	MathSciNet
NEHU	North Eastern Hill University
PU	Pondicherry University
Ph.D	Doctor of Philosophy

PG	Post Graduate
R & D	Research & Development
RU	Central University of Rajasthan
RUSA	Rashtriya Uchchatar Shiksha Abhiyan
SSA	Sarva Shiksha Abhiyan
UK	United Kingdom
UG	Under Graduate
UGC	University Grants Commission
UNESCO	United Nations Educational, Scientific and Cultural Organization
WS	Web of Science
WWW	World Wide Web

Chapter 1

Introduction

1.1 Rationale

University word is derived from the Latin word "Universitas," which means 'specialized associations between students and teachers'. This Latin word referred to Institutions of learning, which granted degrees to its students. The present day Universities are also following the rich tradition of the ancient Universities silently witnessing and accepting changes of time, space and technology. Universities today are much bigger in terms of the subjects taught, faculties and the students. An University is a place where new ideas germinate, strike roots and grow tall and sturdy. It is a unique space, which covers the entire universe of knowledge. It is a place where creative minds converge, interact with each other and construct visions of new realities. Universities are diverse in their design and organization, reflecting the unique historical and socio-cultural settings in which they have grown. Through research and teaching universities create, evaluate and bring about advances in knowledge and culture. The principle of moral and intellectual autonomy from political authority and economic power is ingrained in the very idea of a University. This autonomy ensures freedom in research and training and it is expected that the governments and the society would respect this fundamental principle. Teaching and research have to be inseparable, because the task of the University is not only to impart knowledge to young people but also to give them opportunities to create their own knowledge. University is a place where new ideas germinate, strike roots and grow tall and sturdy. It is a unique space, which covers the entire universe of knowledge. It is a place where creative minds converge, interact with each other and construct visions of new realities. Universities act as a bridge between elites and classes; rural and urban and between man and women. Higher education is perceived as a means to overcome caste and class hierarchy, patriarchy and other cultural prejudices and also a source of new knowledge and skills, a space for creativity and innovations. Higher education is considered as a national responsibility and the government has to make necessary provisions to realize its potentials.

The universities produce relevant research, which can compete with the best in the world through interdisciplinary work in which the sciences, social sciences and humanities work together. Universities act as a foundation of civic and democratic values for social cohesion and purpose. Knowledge created in the universities not only leads to economic growth but also helps to overcome racial and ethnic tensions, dogmatism and religious extremism. Universities should be developed in such a way that there is a better understanding of diverse values, policies, practices, traditions and resources. The students, Faculty and

communities who are not part of formal structures and excluded outside can come and become part of the university system .The higher education communities produce a large amount of research in a multifaceted direction. Research in a University increases the knowledge base through new ideas, innovations, artifacts, discoveries and inventions etc. Through research and teaching universities create, evaluate and bring about advances in knowledge and culture. In fact, teaching and research should go hand in hand, each providing fresh incentives to the other. Teaching and research have to be inseparable, because the task of the University cannot be confined only to impart knowledge to the young people but also to give them opportunities to create their own knowledge.

Higher education is the principal site at which our national goals, developmental priorities and civic values can be examine and refined. Higher education is decisive for developing a modern economy, knowledge society and a vibrant polity. It equips young people with skills relevant for the market and those who are already in employment with skills so that they can rapidly grow in career. It prepares all to be responsible citizens who value a democratic and pluralistic society. Thus the nation creates an intellectual repository of human capital to meet the country's needs and shapes its future.

1.2 Research in Universities

YashPal (2008) In the report he mentioned about the major responsibilities of academic staff in a modern University and they are teaching (transmission of knowledge), research (advancement of knowledge) and community service (application of knowledge). Active and constant engagement with young minds and hearts of the society implies that the universities are to serve the society as a whole and in order to achieve this considerable investment in continuing education is essential. Universities are supported in these endeavors by the government, as these Institutions of higher learning contribute to the solution of present technological and social problems.

Etzkowitz and Leydesdorff (2000) in their triple helix model, the TH model applied greater emphasis on the role of University-Industry-Government (U-I-G) relations as these relations are crucial for the creation and diffusion of knowledge and technological development of nations. The measurement of research productivity is a regular exercise across the universities, research laboratories and countries globally. Although controversial and often contested, such measurement is regarded as the most important indication of research productivity by academic staff. Assessments of academic Institutions are undertaken at different levels of aggregation (for the institution as a whole, by discipline, by Department or unit and at the level of the individual) with the outcomes used to support decisions of different kinds and different stakeholders.

Liang et al.(2012) This paper focussed the role of Chinese universities in enterprise–University research collaboration. This study focuses on a special aspect of the collaboration of co-authored articles. The two

cases analyzed are: (1) research collaboration between Baosteel Group Corporation and Chinese universities; (2) research collaboration between China Petroleum & Chemical Corporation and Chinese universities. The co-authorship data over the period 1998–2007 were searched from CNKI database, the largest Chinese publication and citation database. The main findings are as follows: the number of articles co-authored by enterprise and University scientists has been increasing rapidly; the share of co-authored articles has been growing; the authors from universities are more possible to be the first authors; as a whole, enterprise–University co-authored articles tend to receive more citations and get downloaded more frequently; a mathematical orientation emerges in the enterprise–University articles. To reveal and describe such a trend the methods of keywords analysis and co-occurrence analysis are applied. The Chinese government's various policy instruments and support for pushing and improving enterprise University research collaboration are introduced and analyzed.

Martin (1996) mentioned that in US, the Congress in 1993 passed the Results and Performance Act which requires the Federal agencies to establish indicators to assess output, service level and income. Measures of research productivity covering both quantity and quality at a national level support are done so that such information is useful to governments, heads of Departments, deans of faculties and students/scholars interested in their performance in relation to competitors.

1.3 Role of Research Productivity in Higher Education

Research productivity in higher education relates to both knowledge creation and knowledge dissemination through its various forms of research, teaching and outreach activities. Research productivity forms a very distinguishing part of the universities and as a consequence, the rankings of academic Institutions based on research productivity have become increasingly important. If Arts satisfy our emotional needs Science satisfies our intellectual needs and Technology augments the means for our survival. If innovation lies at the heart of a developed economy and we want higher education Institutions to have an impact on society at large, then we need to find assessment methods that recognize and encourage engagement as well as scholarship. Research covers a wide range of activities, from carefully designed studies by independent University researchers to analysis of data for particular administrative or political purposes. Rewarding the quality research productivity at higher education Institutions forms the basis for sustaining current research and promoting research and other knowledge output required to meet the national development needs. As research is a central function the University must evaluate its performance.

Data on research performance helps to inform strategic decisions about what areas of research to support or build. It also helps the University leaders understand the institution's position relative to global and domestic standards of research production. It answers to the questions such as how research is conducted, its impact, number of articles published in core journals by the faculty members in their respective fields, trend of the

publications whether it is increasing or decreasing, patents granted, technology transfer etc and analysis of the research problems both subject wise and discipline wise etc

Martin (1996) Evaluations and assessments of public funded research were first introduced in UK. In 1993 the Congress in US passed the Results and Performance Act which requires Federal agencies to establish strategic planning and performance measurement. This requires establishment of performance goals and performance indicators to assess productivity, service level and outcome.

In UK Higher Education Funding Council intend to reward the 'world class' research. The rising cost of research has always put pressure to the administrators for the maximum utilization of resources at a minimum price. This calls for evaluation and assessment of the existing infrastructure by the funding bodies. Research is one of the three missions of modern Universities and its evaluation is becoming stronger in worldwide universities. Developing countries are trying to develop world class universities through intense research fund increases and incentive policies. In many universities of US and UK there is a section/Department that performs the function of measuring research productivity of Departments, Faculty Members etc. The Centre for Measuring University Performance (MUP) of University of Florida, provide objective data and analyses research performance in traditional disciplinary subject areas and in interdisciplinary areas for the purpose of strengthening the quality and impact of research. It brings out the annual report titled *The Top American Research Universities.* In Australia the link between research funding and research productivity is already in place for decades. Research Quality Framework (RQF) Preferred Model is maintained by the University of Adelaide. The aim of the RQF initiative is to develop the basis for an improved assessment of the quality and impact of publicly funded research. Spanish scientists are supplemented with salary increment for increasing their productivity in English language international journals.

1.4 Indicators of Research Productivity

These days there is growing trend to rank academic Institutions, which has assigned significant value to research productivity as a measure of institutional standing, academic reward and budgets both at national and international fronts. The indicators are of great concern as a suitable unit of measurement for research productivity. Some of the widely used indicators of research productivity are given below:

Peer Review Process

Peer review is the oldest system of research evaluation of Institutions and individuals done by the panel of peers and experts in a particular discipline or field of study.

Meek and Lee (2005) According to them peer review is applied in a variety of settings including research funding applications, articles submitted for publication and job applicant selection. An advantage of the approach is that "a well informed insider will be able to spot trends far sooner than the impartial outsider".

In some disciplines peer review is the only performance indicator. The results of peer review are very relevant when the review is done by the disciplinary expert who is best to make judgments about quality in his/her area of research expertise. Peer review is a fundamental aspect of the academic process and the internal professionals judge and are responsible for the quality of the knowledge produced and managed. In spite of many merits of peer review, assessment depends on the judgment of peers and a matter of subjectivity is always present. As such peer review process is a partial indicator of contributions to scientific progress. However a blend of peer-review and bibliometrics method is successful for measuring performance. Many Institutions involved in performance evaluation use both the technique for measuring performance.

Bibliometric techniques

Here research productivity of Faculty Members can be measured in the form of citations received to the formal and informal publications such as books, journal articles, lectures notes, conference deliveries, licenses, patents, designs and trademarks, monographs, research reviews etc .

Reutors (2008) Bibliometrics is the application of quantitative analysis and statistics to publications such as journal articles and their accompanying citation counts. Quantitative evaluation of publication and citation data is now used in almost all nations around the globe. Bibliometrics is used for research performance evaluation in universities and government labs. Policymakers, research directors, administrators, information specialists, librarians and researchers can use the analysis at individual level. Analysts in many nations issue bibliometric reports at regular intervals called science indicators studies. National Science Foundation (United States), the European Commission, L'Observatoire des Sciences et des Techniques (France), National Institute for Informatics (Japan). Active bibliometrics groups include Argentina, Australia, Belgium, Brazil, Chile, China, Israel, Italy, New Zealand, Portugal, Spain, Sweden, Switzerland and Taiwan. The Netherlands is a world leader in the funding of national research by means of bibliometric measures.

Garfield (1998) In 1998, Garfield himself estimated that citation data and analysis were used in USA to evaluate 5,000 Departments at the leading universities. The Research Excellence Framework of UK conducted a study on the citation count on journal articles and looked up on the ISI Web of Science using

customised software developed by the research team. And resulted in a matching of 79.13% (112,201 from 141,789) of the journal articles included in the Web of Science.

Citations are the essence of science, in the last decade several database producers have came and successfully built up and maintained citation indexing and manually added cited references. The discipline-oriented databases Chemical Abstracts produced by the American Chemical Society, MathSciNet by the American Mathematical Society and PsycINFO by the American Psychological Association have introduced citation indexing to their bibliographic databases. Even though indexing of cited references is still a very laborious and expensive task various studies are done and found empirically that citation data analyses are used for assessment of individual contribution to their research work. These studies are further extended to assess between and across departments, Institutions, countries, gender etc.

Thomson Reutors (2008) In the report Eugene Garfield's mentioned the reasons for citing a paper and they are :

- Paying homage to pioneers.
- Giving credit for related work (homage to peers).
- Identifying methodology and equipment.
- Providing background reading.
- Correcting one's own work.
- Correcting the work of others.
- Criticizing previous work.
- Substantiating claims.
- Alerting researchers to forthcoming work.
- Providing leads to poorly disseminated, poorly indexed, or uncited work.
- Authenticating data and classes of fact (such as physical constants).
- Identifying original publications in which an idea or concept was discussed.
- Arguing against the work or ideas of others.
- Disputing the claims of others to have been first with their work.

Neuhaus and Daniel (2008) discussed the Information Communication and Technology revolution and the availability of scholarly documents as it is now possible to automate vast data resources at relatively low cost. Bibliographic databases were established that automatically extract bibliographic information and cited references from electronic documents retrieved from digital archives and repositories. Some databases offer sophisticated features for citation searching and provide detailed information on download frequencies, that serve as an additional basis for assessing the resonance and impact of publications.

In addition to citation indexing of traditional bibliographic databases some of the major sources of citation data are

1. Web of Science
2. CiteSeer
3. Scopus
4. Google Scholar
5. Scifinder Scholar
6. Faculty of 1000
7. SMEALSearch
8. RePEc

Teaching

Teaching is an important part of an University education system. Faculties are evaluated over a period on the basis of research supervisions such as PhD, MPhil, Associates, PG students. Faculty Members also guide to prepare the curriculum at UG level, provide consultation/technical guidance to many Public and Pvt. Institutions.

Research Projects

Research Projects or Grants can be used to determine the research quality of the Institutions. The number and value of research grants and contracts gained provides a better picture for understanding for research quality, as one must have good research capacity to win a research grant or contract. Research grants is an evidence about the quality of the Department for which granting bodies give funds, to high-quality researchers who have excellent track records in producing vital research. University Grants Commission (UGC) promotes teaching and research in emerging areas in Humanities, Social Sciences, Languages, Literature, Pure Sciences, Engineering & Technology, Pharmacy, Medical, Agriculture Science, etc. UGC released grant of Rs. 52.18 crore in Major (804) and Minor (110) projects in Engineering and Technology in 2009-10. UGC released grant of Rs. 20.77 crore in Major (500) and Minor (69) projects.

Martin (2006) mentioned in his work that Faculty Members in mathematical sciences can be evaluated on the basis of research projects undertaken and completed. Some more indicators that he suggested are :

Prizes, fellowships and awards, particularly those won in international competition;

Invited fully- or partly-funded visits to leading research centers and institutes;

Membership of editorial boards of international journals;

Membership of the organizing committee or advisory board of prestigious international conferences;

Scholarly activity such as reviewing and refereeing;

Assessing research theses and research grant applications,

and production of (documentable) widely-used software packages.

Number of Publications

The publications are the most valid, fair and direct measure for research performance. It is the total of publications by the scientists or researchers or Faculty Members of a country, institution, subject in the certain period under observation. The number of journal articles, books, conference papers, chapters of books etc published is most valued indicator. This indicator is used by all the Institutions for measurement of research performance.

Li (2012) mentioned that research performance is an important consideration for every ranking system, they're usually measured by different indicators. Times rankings use normalized average citations per paper to measure the research influence of Universities, while citations per Faculty were used in the QS rankings to indicate the research strength. ARWU rankings put more emphasis on the quantity of scientific research output like the number of papers published in Nature and Science and the number of papers indexed in Science Citation Index-expanded and Social Science Citation Index. In Chinese regional University rankings, research performance is mainly measured by research outputs such as the number of publications, the number of patents granted, etc. In his study he included six indicators indexed by Web of Science covering 11 years from 2000 to 2010 and they are

1. Number of papers P Number of articles
2. Number of ESI fields F
3. Total citation counts C
4. Citations per paper CPP C/P as shown in ESI
5. Normalized citation impact
6. Hirsch-index

Meek and Lee (2005) in their study discussed and mentioned that broadly there are two categories of performance indicators firstly quantitative (based on number of publications) and secondly qualitative (based on the importance of publications). In their study they used 7 indicators for performance evaluation and they are :

1. Bibliometric data;

2. Awards to individual researchers;

3. Research student data;

4. Research Faculty data;

5. Research income from external sources;

6. Research commercialization performance data; and

7. Outcomes from peer review processes.

Some other indicators for Faculty Members evaluation on the basis of literature studied are

- International exposure of the Faculty Members and students.
- Income generated from University –industry collaboration.
- NGO, Private sector funding.
- Contributions to the wider society.

1.5 Major Agencies for Evaluating Research Productivity

The last decade witnessed the emergence of many ranking systems for research evaluations. Due to globalization, countries as well as universities are open for all and the universities use the rankings for promotional events. Websites of the universities regularly display the rankings, some of the major agencies for evaluating research productivity are

1) Thomson Scientific promotes their Essential Science Indicator (ESI) product as an "in-depth analytical tool that offers data for ranking scientists, Institutions, countries, and journals". H-index is used to evaluate the quality of individual authors based on the citations to the papers.
2) Shanghai Jiao Tong University Higher Education Academic Ranking of World Universities (ARWU). Since 2003 the Academic Ranking of World Universities (ARWU) is published annually by the Institute of Higher Education, Shanghai Jiao Tong University (http://www.arwu.org). It is the first ranking with

an intended worldwide coverage that focuses in the academic or research performance of universities. The indicators include the alumni and staff winning Nobel or similar prestigious prizes,highly cited researchers in major research fields, articles published in selected top journals, articles indexed by the citation indexes produced by Thomson-ISI and performance per capita.

3) Times Higher Education rankings (THE-QS). The THE-QS World University Rankings (THE-QS) is the only world ranking produced by a private company, Quacquarelli Symonds Limited that started to publish the rankings in 2005. The ranking (http://www.topuniversities.com) is compiled based in six distinct indicators and they are academic prestige based on large number of respondents, results from an employer survey, the student Faculty ratio, citations per capita according to the Elsevier Scopus database and the proportions of international professors and international students. Before 2007, they derived the citation counts from the ISI Citation indexes.
4) Web Ranking of World Universities (WR) The Web Ranking of World Universities or Webometrics Ranking (WR) is done since 2004 (Aguillo et al. 2006, 2008) by the Cybermetrics Lab, a research group of the Spanish National Research Council (CSIC). They use web data extracted from commercial search engines, including the number of webpages, documents in rich formats (pdf, doc, ppt & ps), papers indexed by Google Scholar (indicator added in 2006) and the number of external in links as a measure of link visibility or impact (http://www.webometrics.info).
5) National Taiwan University Ranking (NTU Ranking) – The overall rankings of performance ranking of scientific papers for world universities started from 2007. It is also known as NTU Ranking. NTU Ranking provides overall rankings, rankings by the six fields and rankings by 14 selected subjects of the top 500 universities. The ranking was first published in 2007 by Higher Education Evaluation and Accreditation Council of Taiwan (HEEACT) and which utilized more objective methods and statistics to rank universities. This rankings system is designed to assess academic performance for research universities by using objective indicators to evaluate their achievements in scientific research. The ranking system evaluates the performance of scientific papers and the indicators are designed to compare both the quality and quantity of scientific papers in each University.
6) Many universities have a section or Department to measure the research productivity for Faculty Members, Departments and by discipline. The Centre for Measuring University Performance (MUP) of University of Florida, Research Quality Framework (RQF) Preferred Model maintained by the University of Adelaide and accepted by the Australian Government.

1.6 India's Research Productivity

Indian higher education system is one of the largest education systems in the world after US and China. After independence, government has taken various initiatives such as the Scientific Policy Resolution (1958), the Technology Policy Statement (1983) and Science and Technology Policy (2003). At the time of independence, there were only 20 Universities and 500 Colleges in the country with 2.1 lakhs students in higher education. Now in 2011-12 it has increased to 29 times in the case of the Universities, 71 times in the case of Colleges and has gone up to 97 times in the case of student's enrolment in the formal system of higher education.

As on 31.03.2012 the network includes Universities (Central, State, State Private, Deemed to be Universities and four Institutions established under State Legislation) and colleges in the Higher Education sector. So far the number of universities is concerned, Tamil Nadu tops the list with 55 universities, followed by Uttar Pradesh (54), Rajasthan (47), Andhra Pradesh (43), etc.

Central University: A University established or incorporated by a Central Act.

State University: A University established or incorporated by a Provincial Act or by a State Act. State universities are meant to be the responsibility of State Governments to maintain and develop. Although majority of students get enrolled here but state universities are treated very shabbily in the matters of allocation of funds or creation of facilities. Even though State Universities are primarily the responsibility of States but for the development of all young people, either in a state-run Institutions or in a central Institutions is a national responsibility and there cannot be any discrimination between the two.

Private University: A University established through a State/Central Act by a sponsoring body viz. A Society registered under the Societies Registration Act 1860, or any other corresponding law for the time being in force in a State or a Public Trust or a Company registered under Section 25 of the Companies Act, 1956.The absence of any significant expansion in different sectors of higher education by the State has created a space for the growth of private providers.

Deemed-to-be University: An Institution Deemed to be University, commonly known as Deemed University refers to a high-performing institution which has been so declared by Central Government under Section 3 of the University Grants Commission (UGC) Act, 1956.

Institution of National Importance: An Institution established by Act of Parliament and declared as Institution of National Importance.

Institution under State Legislature Act: An Institution established or incorporated by a State Legislature Act.

The category wise distribution of universities is given in the Table 1.1 below

Table 1.1 Distribution of Universities

Sl. No.	Type of Institutions	No. of Institutions (As on 31.03.2012)
1.	Central Universities	44
2.	State Universities	286
3.	State Private Universities	111
4.	Institutions estab. through State Legislation	4
5.	Institutions deemed to be universities	129
	Total	574

University Grants Commission (2012)

University Grants Commission (2012) in the report mentioned that plan grants (4721.43 crores) released during 2011-12, 46.84% had gone to Central Universities, 2.44% to Deemed Universities, 20.25% to state universities and 6.33% to Colleges of State Universities.

During the academic session 2011-2012, the total enrolment in all courses and levels in regular stream stood at 203.27 lakhs including 86.72 lakhs women students, constituting 42.66%. The maximum number of students had been enrolled in the state of Uttar Pradesh (29.11 lakhs), followed by Maharashtra (24.14 lakhs), Andhra Pradesh (19.98 lakhs), Tamil Nadu (18.55 lakhs), etc. and Sikkim State had the lowest enrolment of 12,757 amongst states. The student's enrolment in terms of percentages is given in the next page in Table 1.2

Table 1.2 : Students Enrolment in 2012

Level	UG	PG	Dip./Cert.	Research
Percentage of total enrolment	85.87	12.26	1.08	0.79

University Grants Commission (2012)

About 156.02 lakhs under-graduate students are in the affiliated colleges and 17.99 lakhs post-graduate students are in remaining University Departments and their constituent colleges. About 1.61 lakhs research students are in the universities.

Out of the total enrolment of students (203.27 lakhs), 37.09% students are in the Faculty of Arts, followed by Science 18.64% and Commerce 17.57% respectively. While the remaining 26.70% enrolment are in the professional courses. This uneven distribution is an indicator of policy change.

The number of research degrees Ph.D. and M.Phil. awarded during 2010-2011 are 16,093 and 12,549 respectively. Out of these, the Faculty of Science had the highest number with 5232 Ph.D. Degrees and 4451M.Phil. Degrees followed by the Faculty of Arts with 5037 Ph.D. Degrees and 4739 M.Phil. Degrees.

Funding for education and research is greater than before and in the 12th Five-year plan, there is a four-fold increase for education compared to the 11th plan. The vision of the 12th Five year plan for Indian higher education is to achieve further access to higher education through a mission mode national programme by creating new universities and increasing the intake capacity of the existing universities and colleges. Equity and inclusion is done by bridging regional imbalances and disparities across disciplines and tries to address spatial, economic, social and technological needs of the country. Enhancing quality and excellence in all spheres of higher education by increasing the student intake, Faculty enrichment, curricular and evaluation reform, revamping governance structures, greater emphasis on research and innovation by creating efficient regulatory framework.

Many policy changes are taken to fulfill the three E's (Expansion, Equity and Excellence) motives of 12th plan. For expansion, the target in XII plan is to create enrolment capacity by 10 million, with 1 million for distance learning. This would help an additional 3 million students of each age cohort (18-23) to enter the

higher education stream and raise GER by 27% by 2017. There is a scheme of open model colleges in educationally backward districts. The target is to set up 50 new universities, 500 new colleges and 30 new engineering colleges under this scheme. (University Grants Commission, 2008) GER is a gross measure that includes all enrolled in higher education proportionate to population in the relevant age group (18-23 years). Literacy rates are substituted by GER in higher education for identification of the Economically Backwards Districts for the purpose of planning and allocation of funds in the context of higher education. The following formula defines GER (higher education):

$$GER = \frac{\text{All Enrolled in Post Higher Secondary Classes}}{\text{Total Population in 18-23 age groups}} * 100$$

For equity, efforts include establishing 374 model colleges in educationally backward districts, improving enrolments in general, special efforts to deal with problems of geographically backward area, women and backward classes, central and state run schemes and scholarships. To provide equitable access and educational opportunities in higher education to the different social, religious, occupational and economic groups living both in rural and urban areas is a major challenge before the policy makers for nearly six decades since the independence.

Caste-based stratification of Indian society and the ways in which it permits (or prohibits) distribution of social goods, services and opportunities has posed a major area of concern in the process of educational development in India. There are differences before the planners due to the various religious groups, the agricultural and non-agricultural population, gender inequality is there as women in each category of population continue to be behind significantly in comparison to their male counterparts. The task of the planners and policy makers is to create enabling conditions so that all deprived social groups, religious and linguistic minorities, the landless and poor wage earners could be brought within the ambit of education in general and higher education.

Planning Commission. (2013) In the report the major criteria is to attain excellence in teaching (learning environment, student teacher ratio, curriculum quality), research (volume, technology transfer, income from research) and citation (research influence). Another parameter of judging quality is employability and employer satisfaction. The Table 1.3 below presents some of the aspects about the quality and gap in each University.

Table 1.3: Quality and Gap in each University

Parameters	Avg. Of all Universities	A Grade Universities	Quality Gap
Number of Departments Per University	29	34	5
Number of Sanctioned Faculty Positions per University	287	432	145
Number of filled up Faculty position per University	220	329	109
% of Faculty positions vacant	25%	0	0
Number of Faculty Members with PhD	158	432	274
Number of Teachers per Department per University	8	10	2
Number of Books in Library	288913	352886	63973

Planning Commission (2013)

Table 1.4 : Major inputs of Higher education

1.	India (Area)	3287 km
2.	India (Population)	1.2 billion
3.	No of Researchers	1,54,827
4.	Indian economy	1337 $
5	UGC grant (Research)	Rs 3439.95 crores(73.5 crores)
7.	Degree awarded	16,093 (M.Phil), 12,549 (Ph.D)
8.	Faculty	University-1.60 ,Colleges- 7.76 (lakhs)
9.	Expenditure per student on Higher Education	Rs 18600
10.	UGC Expenditure on infrastructural development	Rs. 5 crore each University
11.	Gross Enrollment Ratio	15%
12.	Gross expenditure on R&D in 2011-12	72,620.44 crores (0.87%)

Human Resource Development (2011) and Department of Science and Technology (2012)

Human Resource Development (2011) and Department of Science and Technology (2012) As per the reports the Table 1.4 and Table 1.5 below provide a numerical description of the Indian Higher education system. The input is in the form of manpower, funds, infrastructure and the corresponding output is in the form of publications, patents and journal impact at the world level.

India is considered as a sleeping giant and if the research capacity and experience are moved in a right direction it can compete with other nations in a brief period. According to Adams, King and Singh (2009)

in 1981, India accounted for just above 14,000 papers in the Thomson Reuters database. In the period of 2004-2009 , India produced 126,000 papers, constituting 2.75% of the world's papers published in journals indexed by Thomson Reuters. If this trajectory continues then India's productivity will be on a par with most G8 nations within 7-8 years and can overtake them between 2015-2020. India's strength lies on the subject areas of Chemistry followed by Agricultural Sciences, Pharmacology, Microbiology, Pharmacology & Toxicology, have accounted for notable high quality publications.

Ministry of Commerce (2011). Intellectual Property Rights (IPR) are considered to be the backbone of any economy and their creation and protection is essential for sustained growth of a nation. The Table 1.5 below shows in detail about the trend of Patents filed, examined and granted in India during the last 6 years.

Table 1.5: Patents Growth

Year-	2005-06	2006-07	2007-08	2008-09	2009-10	**2010-11**
Filed	24505	28940	35218	36812	34287	**39400**
Examined	11569	14119	11751	10296	6069	**11208**
Granted	4320	7539	5316	6061	6168	**7509**

Ministry of Commerce and Industry. (2011)

India's strength in patent lies in the fields of Information Technology, Drugs and Pharmaceutical, Space Research, Biotechnology, Entertainment and several other emerging fields.

Out of the total 16,093 Doctorates in the country, 8,302 (51.6%) Doctorates were from the S&T discipline during 2010-11. The national share of universities in scientific publications in the year 2010 has been estimated at 31%, which had been earlier assessed at 15% in 2003. Average citations per paper of publications from the Institutions supported by DST exceed the national average of 3.4.

Department of Science and Technology (2012) had commissioned Thomson Reuters to show, through objective analysis, India's strengths and weaknesses in science and technology, and key areas in which India can achieve tremendous progress. Thomson Reuters presented "Evidence" that report a large volume of data and trends in research outputs from India. Evidence is based on the scientific publications covered under the Science Citation Index SCI databases. The Table 1.6 below provides the important facts and figures about India's research output.

Table 1.6: Major Outputs of Higher Education

Sl No.		2010
1.	Total no. of publications	65,487 Scopus, 40,711 SCI
2.	India's share in global research publication	3.5%
3.	Total no. of patents	39400
4.	Citation impact	0.68%
5.	No. of Indian papers in top 1% impact making journals	4723
6.	India's share of GDP/R&D	0.87%

Department of Science and Technology (2012)

The current status of higher education in India is characterized by low enrolment, poor completion rates and high drop out. There are wide social and regional disparities in enrolment rates and availability of Institutions of higher education. India has made appreciable progress in this regard, particularly with reference to growth in the number of universities and colleges over the years, improving infrastructure such as teaching Faculty, hostels, housing for teachers, library, laboratories, and computer facilities etc. over the years.

The colleges and universities located in remote and backward areas are poor on all parameters of educational development. It is therefore necessary to consolidate the infrastructural provisions in existing universities and colleges besides strengthening the supply of colleges and Institutions of higher and vocational education in order to provide higher and better quality opportunities to eligible population to join higher education.

1.7 Statement of the problem

Universities conduct research worldwide to create, transfer and utilize knowledge to find solutions for the scientific, technological and social problems prevalent in the society. Research has a central place in

University education system and about one third of University budget goes for research funding. Research is one of the three missions of modern universities and its evaluation is becoming stronger in worldwide universities. As most world-class universities are Research universities (RU). Developing countries, are trying to develop world class RU through intense research fund increases and incentive policies. In many universities of US and UK there is a section/Department that performs the function of measuring research productivity of Departments, Faculty Members etc. The Centre for Measuring University Performance (MUP) of University of Florida, provide objective data and analyses research performance in traditional disciplinary subject areas and in interdisciplinary areas for the purpose of strengthening the quality and impact of research. It brings out the annual report titled *The Top American Research Universities*. In Australia the link between research funding and research productivity is already in place for decades. Research Quality Framework (RQF) Preferred Model maintained by the University of Adelaide. The aim of the RQF initiative is to develop the basis for an improved assessment of the quality and impact of publicly funded research.

Reutors (2008) Mentioned that counting, measuring, comparing quantities and quantitative analysis are the main tool of science. Scientific research, recording and communicating research results through publications, has become enormous and complex. It is so complex and specialized that personal knowledge and experience are no longer sufficient tools for understanding trends or for making decisions. Yet the need is to highlight significant or promising areas of research and to manage better investments in science. Universities, government offices and labs, boardrooms must decide what research should be supported and what should not, or which research projects and researchers should receive more support than others.

Bird (2005) The working committee report analysed the importance of performance indicators by the UK government. To assess the impact of Government policies on well performing or underperforming Institutions and public servants to play the role for public accountability of Ministers. A Performance Monitoring protocol cover objectives, the definition of performance indicators, design considerations, procedures for data collection, analysis, presentation of uncertainty and adjustment for context together with dissemination rules is explicitly defined. The Royal Statistical Society considers that attempts to educate the wider public and policy makers about the issues surrounding the use of performance indicators.

Universities can fetch up more finance from governments by increasing their research productivity hence forth evaluation of research performance is of paramount importance. More important is the evaluation of the research performance. Data on research performance helps to inform strategic decisions about the areas of research to uphold. Research performance evaluations are done by University administrators, Government offices and laboratories to rank the institution's standard to national and international level. The measurement of research productivity is crucial these days for career advancements, promotions, Departmental and institutional ranking, a measure for R&D, assess market-oriented innovations, economic

growth etc. On the basis of research productivity institution's strategic decisions are taken to set priorities, staff and fund allocation. Students use the rankings of Departments and Institutions for further education, learning and research.

Martin (1996) mentioned about the 4 reasons why there should be assessment of government funded research and they are:

Firstly due to the growing costs of scientific instruments, facilities and infrastructure, Secondly to manage the funds for research, Thirdly to balance between the new emerging areas and the declining areas of scientific research and finally public accountability so that the public money is well spent.

Statistics is the science of collecting and analyzing data, in order to base decisions on them. It is a branch of scientific method used in dealing with phenomena that can be described numerically either by counts or by measurements. The different stages for the organization of numerical data are collection, organization, presentation, analysis and interpretation. The methods by which statistical data are analysed are called statistical methods, the mathematical theory which is the basis of these methods is called the theory of statistics or mathematical statistics.

Statistical methods are applicable to wide variety of fields – from astrostatistics to econometrics, from business statistics to medicine, from social statistics to actuarial science for risk assessment, from agriculture to engineering statistics etc. Statistics is usually not studied for its own sake but it is employed as a tool for analysis of problems in natural, physical and social sciences. The subject statistics is widely used in practice, the various statistical methods are used to study various subjects such as economics, commerce, physics, astronomy, life science and all other branches of knowledge. Job opportunities in statistics are plentiful and projected to increase worldwide. Both the theoretical and applied aspects of statistics are used by Government, laboratories, scholars, policy makers and the common man. After IT, statistics is the only subject that is used as tool to study other subjects. This study is an attempt to know the departments which provide best teaching and research in the Central Universities, to know the number and growth of publications in the subject of statistics, projects completed, collaboration pattern among the authors, citations to the publications etc the topic *Research Productivity of the Departments of Statistics in the Central Universities in India: a bibliometric study* is taken as the study. Such kind of study can also be implemented in other kind of subjects to know the publication pattern in a particular subject.

1.8 Objectives of the study

The objectives of this study based on the scientific indicators are to:

1. To find out the research productivity of 11 departments among the 44 departments that exist in the 44 central universities in India.

2. To find the refereed research output of the Faculty Members engaged in the 11 departments of the 11 central universities covered under the study.

3. To find the publication pattern of Faculty Members with regard to projects completed in the 11 departments of the respective 11 central universities.

4. To find the correlation between faculty size and total publications, faculty size and referred publications.

5. To determine the trend of publications in the succeeding years.

1.9 Methodology of the study

The present study taken up by the scholar is an evaluator study. For the study the scholar have identified 44 central universities that have the department of statistics and it was found that in the initial stage there are 11 central universities that have the department of statistics.

The total population of 82 faculty members working in the 11 central universities spread all over the country were contacted at the first stage. The relevant information were collected through questionnaire, interview and respective webpages of the faculty members. The survey started from 20 July 2011 and ended by April 2013 and 74 variables were grouped under five broad categories. The five categories are basic details, departmental details, publication details, referred publications and research problems. An excel sheet was prepared for data entry. The scholar used various statistical tools like : Simple Mean, Correlation Coefficient and Least square method were used for data analysis.

1.10 Hypothesis

Following are the hypothesis of the study:

1. Research output is directly proportional to the length of service of the Faculty Members.

2. The focus area of research changes in the faculty's career graph and there is a gradual growth in the publication as the author gains more experience in his field.

Hypothesis 2 is a composite statement "The focus area of research changes n the faculty's career graph and there is a gradual growth in the publication as the author gains more experience in his field." The second composite statement has similarity with hypothesis 1. However, while working on the project the researcher focused in the first part of the composite statement only. In other words, the researcher studied the change in focus area of the faculties in chapter 4 section 4.3.3 and tested hypothesis 2.

The second part of the composite statement was not attended any further as it was already covered under hypothesis 1 and was taken care in Chapter 4 section 4.5.

1.11 Definition of Terms

Central University: Institutions set up by the Central Act of Government of India. Higher education Institutions that are organized and controlled by UGC. Although each University operates under a separate charter with some freedom. The Government through the Ministry of HRD and UGC holds ultimate authority over Central Universities.

Experts: A full-time academic lecturer who is mainly engaged in working in a high status position in the University. Experts will therefore include the President, Deans, Professors, Assistant Deans, Associate Professors.

Faculty Members/ Academic staffs : Full-time tenured University lecturers who are mainly responsible for teaching, research and academic service (advising students and performing professional duties). They can be Professors, Associate Professors, Assistant Professors. This does not include part-time lecturers, adjunct professor, visiting professor, temporary Faculty Members and teaching assistants.

Publication: Any activity that aims to make the products of academic research generally known to the public. It is only research published in refereed or non-refereed journals.

Research: Any scholarly research produced by academic Faculty Members that contributes to the knowledge base of a discipline. A research publication in refereed or non-refereed journal, research report for an agency or institution, a monograph and a academic book or book chapter.

Research activity: Any activity that academic lecturers perform when they conduct research such as defining a research problem, carrying out a literature review, collecting data, analyzing data or writing a report.

Research Output: The quantity of finished research works and publications produced by academic lecturers during 2000-2010.

Research Productivity: Total research output compared with inputs such as time and Faculty size during 2000-2010.

1.12 Overview of Chapters in the Theses

Chapter 1 This chapter serves as an introduction to the study, a foundational explanation for the importance of research, research productivity, various parameters for the measurement of research productivity in universities. The reputed agencies and the parameters used by the agencies to rank the universities on the basis of research productivity is also discussed. This chapter discuss about the role of research productivity in Institutions and its importance for the policy makers, administrators, Faculty Members, students, experts. To determine and strengthen the weak subject areas on the basis of research productivity is discussed, strategic decisions taken by government to set priorities, staff and fund allocation is also discussed. Students use the rankings of Departments and Institutions for further education, learning and research. This chapter also served with theoretical background of the study and it concluded with the statement of the problem, the objectives of the research and the significance of the study.

Chapter 2 This chapter acts a background for the development of various models for the evaluation of research performance. An attempt is made in this chapter to review the trends of productivity models in phases. The various indicators of research evaluation are also discussed in detail.

Chapter 3 Here in this chapter an overview of the Universities, Departments, Faculty Members under study are presented. This chapter also gives details about the research methodology, research questions, design and organization of the study. It gives details about the methodological procedures of selected subject, the design of the questionnaire, sampling techniques and the treatment of the data.

Chapter 4 In this chapter the researcher presented the analysis and findings of the study. The quantitative data obtained through questionnaires, interview methods and website about the Faculty Members under study are represented in tables and graphs.

Chapter 5 Here the findings and conclusions of the research study and some suggestions are also given for improving the research output of the Faculty Members.

1.13 Summary of the Chapter

This chapter has provided information that will assist in the planning, progress and formulation of institutional research policies by highlighting those factors that should be emphasized in order to further encourage academic staffs to increase their research productivity.

Nowadays universities are changing their roles. Universities put more emphasis on producing a higher quantity and quality of research productivity. Academic staffs are conducting research in order to enhance

their knowledge and improve the quality of teaching. Their teaching role and research should co-exist in a balance which is supported the Institution, Government, private organizations and the community.

It is a fact that there is still an unacceptably low level of research Productivity in the Universities of India. The current condition of higher education threatens the University's ability to sustain the condition that supports research achievements. In Indian Universities there are many obstacles that impact on low research productivity which need to be resolved and eliminated if research productivity is to be increased.

Chapter 2

Review of literature

Review of literature or Literature Search involves review of literature on the problem under study. It helps in understanding problem clearly and knowing what has already been done on the area under study including allied area. It helps in refining the ideas, specification of research procedure, clarity and understanding of things to be done. For reviewing of literature primary sources such as periodicals, reports, theses etc and secondary sources abstracts and indexes are used.

Harrods Librarian Glossary (2005) "An exhaustive search from published information on a subject conducted systematically using all available bibliography finding tools, aimed at locating as much existing material on the topic as possible, an important initial step in any serious research project".

2.1 Research

Research is a careful study of a subject especially in order to discover new facts or information about it. An efficient and effective approach to expand knowledge is to conduct a special, planned and structured investigation, which is known as the process of research. Research is considered as an important function of university together with teaching and community service. Research is a human activity based on intellectual investigation discovering and revising human knowledge on different aspects of the world. This research provides scientific information and theories for the explanation of the nature and the properties of humans. Research is a scientific undertaking, which by means of logical and systemized methods aims to discover new facts or verify old facts and to their sequences, interrelationship, casual explanation and the natural laws that govern them. Research is an intellectual act that starts with the asking of a question and progress through the critical and analytical study of evidence, and arrives at new conclusion or now knowledge.

Webster's International Dictionary (1986) defines research "As studious enquiry or examination, especially critical and exhaustive investigation, or experimentation having for its aim the discovery new facts and their correct interpretation, the revision of accepted conclusions theories or laws in the light of newly discovered facts, or practical application of new or revised conclusions, theories or laws."

With regard to the value or importance of research Meek and Lee (2005) mentioned that the relevance of the research problems is of utmost concern. Problems that exist at the time of the research and that are expected to occur in the future. Universities are expected to provide research that is nationally significant. Importance

of research would include the extent to which the research meets an identified need. So even though a piece of research may not meet an identified need at present, it might be critical in the longer term.

2.2 Productivity

Zamarripa (1993) stated that productivity is used in different connotations in different fields such as in manufacturing productivity involves quantity of products manufactured. The total number of products manufactured in a period can be known as the productivity level. In a service industry productivity can be measured by the number of existing and new customer's turnovers. In sales productivity measurses the sales performance of an employee or the entire company.

Print and Hattie (1997) Research productivity can be defined as the totality of research performed by academics in universities and related contexts within a given time period. Research performance indicators can then be devised to measure the performance and to provide a basis for making judgments about research quality.

Organization for Economic and Cooperation Development (2001) According to OECD the main objectives of productivity measurement includes:

Technology: A frequently stated objective of measuring productivity growth is to trace technical change which may be in documented form of new blueprints, scientific results, new organizational techniques or development of new products.

Efficiency: *P*roductivity measurement concerns the industry level, efficiency gains can either be due to improved efficiency in individual establishments that make up the industry or to a shift of production towards more efficient establishments.

Real cost savings: A pragmatic way to describe the essence of measured productivity change. In this sense, productivity measurement in practice could be seen as a quest to identify real cost savings in production.

Benchmarking production processes: In the field of business economics, comparisons of productivity measures for specific production processes can help to identify inefficiencies. Typically, the relevant productivity measures are expressed in physical units (e.g. cars per day, passenger-miles per person) and highly specific.

Living standards: Measurement of productivity is a key element towards assessing standards of living. A simple example is per capita income, probably the most common measure of living standards: income per

person in an economy varies directly with one measure of labour productivity and value added per hour worked.

Hornby (2010) wrote that the rate at which a worker, a company or a country produces goods and the amount produced, compared with how much time, work and money is needed to produce them. A productivity measurement is the only yardstick that can actually gauge the competence of management and allow comparison between the managements of different units within the enterprise, and of different enterprises.

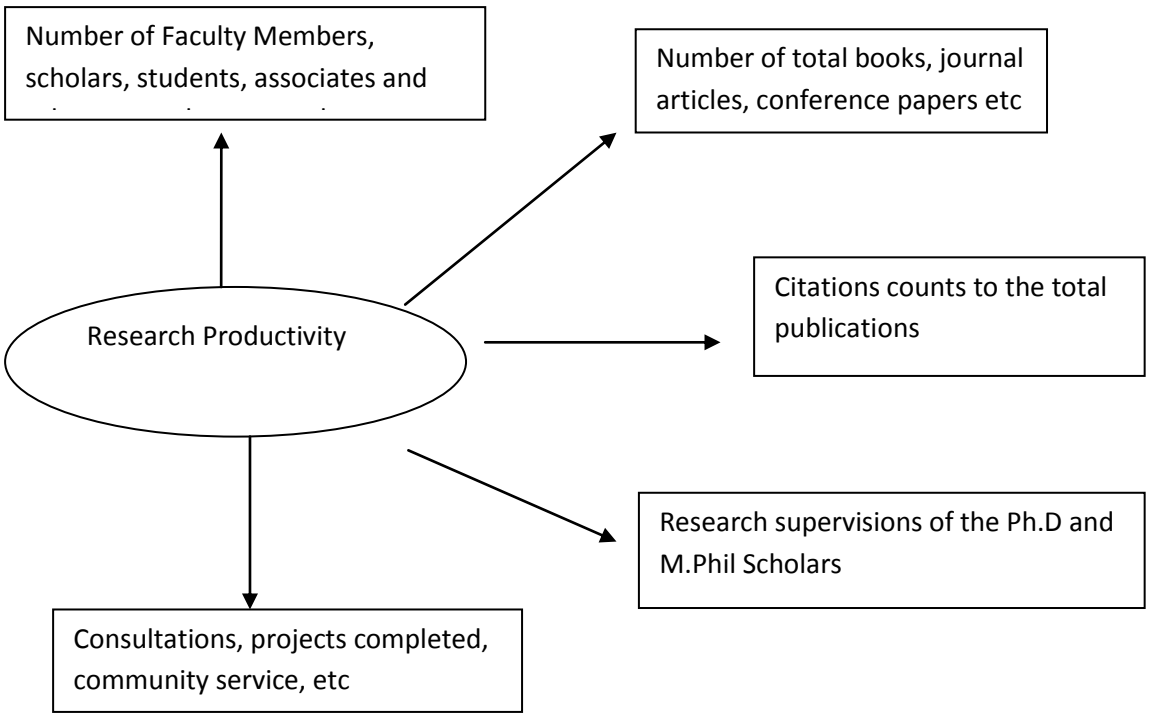
Oxford Advance Learners Dictionary (2010) The rate at which a worker, a company, or a country produces goods and the amount produced compared with how much time, work and money is needed to produce them.

Broadly, productivity measures can be classified as single factor productivity measures (relating a measure of output to a single measure of input) or multifactor productivity measures (relating a measure of output to a bundle of inputs). The choice between them depends on the purpose of productivity measurement and in many instances on the availability of data.

2.3 Academic Research Productivity (ARP)

In academics, productivity is outcome in terms of students, trained researchers, scientific and technological advances, publications, consultancy for public and private organizations and community service of various kinds in a time frame. Research productivity can be defined as the totality of research performed by academics in universities and related contexts within a given time period. The different components of research productivity are given in the Fig. 2.1. Research performance indicators can then be devised to measure that performance and to provide a basis for making judgments about research quality.

Fig. 2.1: Research Productivity Model



(Tafreshi, Heidari Imani and Ghashlag (2013) This study is an applied-mixed one which aims to evaluate research productivity of Faculty of district 2 of Islamic Azad University. Present study was conducted in two qualitative and quantitative parts. In qualitative part of study, researcher used Delphi method to converge opinions of experts and in quantitative part, correlation and advanced multi-variable analyses (exploratory factor analysis, confirmatory factor analysis and structural equation model) were used for data analysis. In ranking organizational factors, motivation obtained the first rank and employees and colleagues' attitudes had the least importance. Another important tangible outcome is the satisfaction of the people who work in universities, on whom the quality and quantity of research, service and scholarship finally depends. They suggested peer review process to evaluate the academic productivity. Also results of exploratory factor analysis and confirmatory factor analysis showed that individual factors can be divided in to three groups: (1) job satisfaction, (2) learning and teaching process and (3) specialized job ability. Also organizational factors divided into six groups: (1) organizational support, (2) organizational culture, (3) organizational purpose (4) motivational factors, (5) students characteristics and (6) industrial relationship.

2.4 Previous Studies on Research Productivity

Various studies have done from time to time to study the factors that impact research productivity such as Finkelstein suggested seven critical variables : Faculty researchers having a research orientation, the highest terminal degree within a field, early publication habits, previous publication activity, communication with disciplinary colleagues, subscriptions to a large number of journals, and sufficient time allocated to research.

Ramsden(1994) This article describes results from a study of academic productivity in Australian higher education. It estimates the output (in terms of quantity of publications) of individuals and academic Departments across the different subject areas and types of institution. Several potential correlates of productivity, including level of research activity, subject area, institution, gender, age, early interest in research, and satisfaction with the promotion system, re examined. A model linking Departmental context to personal research performance through Departmental and personal research activity is developed and tested. An index of research productivity is defined as the five year sum of (3*number of single or multi author books)+(number of papers in referred journals)+(number of edited books)+number of chapters in referred books).

Dundar (1998) in his study mentioned about the various studies done by scholars to find the various component of academic research productivity which he classified in three broad attributes and they are Individual Attributes that consists of gender, age, experience, personality, training, freedom at workplace, Departmental and Institutional Attributes that consists of Faculty and organization size, quality researchers, equipment, supplies, institutional and travel funds, library collections, etc

Bland etal. (2002) model suggested that Faculty research productivity is highest when a Faculty member has specific individual qualities, works in an institution that is highly conducive to research, and is led by someone who possesses essential leadership qualities and uses an assertive–participatory management approach. Exploring the relationship between inputs and outputs of research is a straightforward way of measuring research productivity. A combination of cost-benefit analysis and evaluation of research results has therefore been used by several scholars. A social-scientific approach is used to address the question of the impact of knowledge management on research productivity instead of directly measuring knowledge productivity of research groups by a comparison of inputs and outputs.

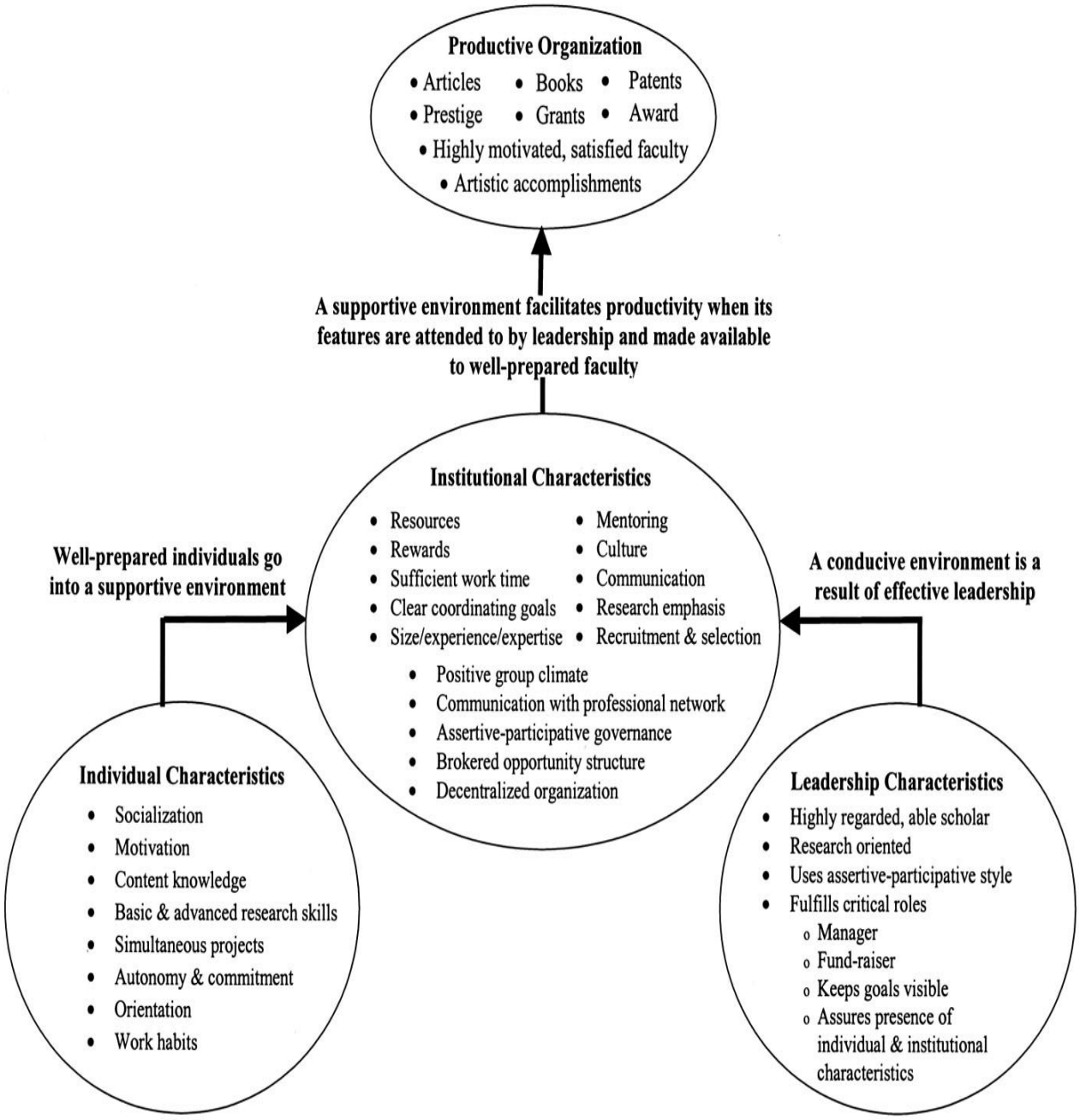
Toutkoushian (2003) Here it is shown how readily available data on publication from the ISI may be used to estimate the number of scholarly articles written by and institution's Faculty member. A standard measure of

research output is calculated by dividing total publication by the number of fulltime Faculty Members at the institution. The articles with one or more authors of the institution are identified.

Bland et al (2005) One of the best works in measuring research productivity was done by Bland et al. Here the authors summarized the previous research productivity model of earlier scholars very succinctly and presented his model. Creswell' model suggested successful researchers with senior professorial rank, spend at least one-third of their time on research activities, publish early in their careers, receive positive feedback from peers, have close contact with colleagues, Faculty researchers are more productive when they are employed in a major University that rewards research and assigns ample time for Faculty to conduct research. They mentioned that Dundar and Lewis proposed a model in which Faculty research productivity is primarily associated with two attributes: firstly individual attributes that relate to personal traits and environmental experiences and secondly institutional and departmental attributes that entail variables related to leadership, culture, structure, and policies. They mentioned that Teodorescu's model asserted that individual achievement variables and institutional characteristic variables would predict Faculty research productivity across national boundaries. They mentioned that Brocato proposed that Faculty research productivity in the context of medical school family practice departments is related primarily to factors such as socialization, individual Faculty's psychological demographic characteristics, institutional and departmental research environments.

They found that individual Faculty's characteristics such as motivation, professional networks, research training, were highly correlated to research productivity. To explain individual and group (Department) research productivity within the context of a large medical school. This study used data from a University of Minnesota Medical School—Twin Cities vitality survey conducted in 2000 that had a response rate of 76% (*n* _ 465 Faculty). A statistical software package was used to conduct *t* tests, logistic regressions, and multiple regressions on these data. The validity of Faculty, Department, and leadership characteristics identified in the Bland et al. model were confirmed as necessary for high levels of research productivity. Faculty productivity was influenced more by individual and institutional characteristics and proposed the following model for research productivity as mentioned in Fig 2.2 below.

Fig. 2.2 Bland's Research Productivity Model



Wang, Peters and Guan (2006) The goal of the paper is to identify factors that contribute to high knowledge productivity based on the findings of a study of German research group. A total of 15 in-depth face-to-face interviews with heads of German academic research groups in the field of physics were conducted. The questions referred to the current practices of knowledge creation and knowledge management and to the subjective assessments of these practices. The study identified human resource management as the weakness

of the German knowledge management practice. There seems to be an inherent contradiction between the goals of attracting promising students to a career in science and securing mobility.

Bland etal. (2005) In the model, Faculty research productivity is highest when a Faculty member has specific individual qualities, works in an institution that is highly conducive to research, and is led by someone who possesses essential leadership qualities and uses an assertive–participatory management approach. Exploring the relationship between inputs and outputs of research is a straightforward way of measuring research productivity. A combination of cost-benefit analysis and evaluation of research results has therefore been used by several scholars. A social-scientific approach is used to address the question of the impact of knowledge management on research productivity instead of directly measuring knowledge productivity of research groups by a comparison of inputs and outputs.

Moed (2006) The study presented in this paper provides a series of bibliometric indicators of the research performance of universities, derived from the Web of Science, published by Thomson Scientific. Papers were selected with the name of a University (and its major Departments) mentioned explicitly in the address. Name variations were taken into account. Additional papers were selected from affiliated, teaching hospitals on the basis of an author analysis. This round added to a particular University's article output selected in the first round papers from affiliated hospitals, published by authors who did not explicitly mention this University's name in their institutional affiliation, but who showed strong collaboration links with that University, as its name appeared in the address lists of at least half of their papers. The first and most important one is the set of universities that published more than 5,000 articles in WOS journals during 1997–2004, or on average more than 625 papers per year during this time period. The first indicator, denoted *as article output, disciplinary specialisation Index,* Normalised citation impact (also denoted as citation impact per paper), % Internationally co-authored articles and the % Articles with private sector.

Qiu, Ma and Cheng (2008) In this paper a new method – Paper Quality Index (*PQI*) to evaluate the output of a researcher is developed. The main purpose of our method is to solve two problems that consist in the method of *h*-index: one is that the *h*-index can't compare the outputs of researchers in different fields; the other is that it is unsuitable for evaluating the outputs of young researchers. On the basis of the thoughts, we advance a method named "paper quality index" (*PQI*). Its mathematical expression is given below:

$$PQI_{ij} = \frac{IF}{IF_m} \times \frac{TC}{TC_m}$$

In this mathematical expression, "*i*" stands for a paper. "*j*" stands for the publication year of the paper *i*. "*m*" stands for the field to which the paper *i* belongs. *IF* stands for the impact factor of the journal in which paper *i* published. *IF* stands for the journal's average *IF* in recent three years. *IFm* stands for the impact factor of

the field *m*. *IFm* stands for the average *IFm* in recent three years. *TC* stands for the total number of citations of the paper after its publication. *TCm* stands for the total citations of the articles published in the year *j* in the field *m*. *TCm* stands for the average citations of per paper published in the year *j* in the field *m*. The calculation is the total number of citations to the articles published in the year *j* in the field *m* / number of papers published in the year *j* in the field *m*. The citations in 2007 was taken out because the JCR has not supplied the corresponding data.

Tatavarti, Sridevi and Kothari (2010) For the determination of research output and quality a new metric called as Research Turnover (RT) is defined to indicate the research value of the University. RT which may be assessed based on an empirical relation is proposed in this paper by considering the following parameters and criteria.

- Number and quality of publications in peer-reviewed and refereed journals
- Number of patents filed/published in national and international patent offices
- Number of sponsored research projects procured for the University
- Number of consultancy projects completed and revenue generated for the University
- Number of books published
- Number of Ph Ds supervised

$$RT = RTpb + RTpt + RTsr + RTcp + RTbk + RTph .$$

RTpt is the research turnover with respect to patents, RTcp is the research turnover with respect to consultancy Projects, RTph is the research turnover with respect to Ph Ds supervised, RTpb is the RT with respect to refereed paper publications. The computed RT value will give a comprehensive metric for determining the quality of research. The higher the RT value, better the research quality.

Abramo (2011) mentioned about an assessment system which is designed to evaluate research and development carried out by public research organizations , including both universities and research organizations. Here universities were asked to submit research outputs to the panels, outputs acceptable were limited to articles, books, and book chapters; proceedings of national and international congresses; patents and designs; performances, exhibitions and art works. Thus the model was designed as an ex-post evaluation exercise focused on the best outputs produced by Italian research Institutions.

Duffy et al (2011) In his study he mentioned about the various studies about the research productivity assessment like author-weighted publication formula, individual productivity measurements from the publicly available data. The research productivity of academic psychologists: assessment, trends, and best practice recommendations.

Dominigo (2011) To evaluate the performance of whole University systems by Shanghai Jiao Tong Academic Ranking of World Universities the author dealt with system aggregates by means of averaging scores taken over a number of Institutions from each higher education system according to the Gross Domestic Product of its country. He treats the set of indicators (measures) at the country level as a scale, and investigates its reliability and dimensionality using appropriate statistical tools. After a Principal Component Analysis is performed, a clear picture emerges: at the aggregate level ARWU seems to be a very reliable one-dimensional scale, with a first component that explains more than 72% of the variance of the sample under analysis. The percentages of variance of the indicators explained by the first component do shed light on the fact that ARWU is in fact measuring the research quality (both at the individual and collective levels) of a University system. The indicators used are :

Individual indicators

1. Alumni Total number of graduates from an institution winning Nobel Prizes in the sciences or Fields Medals in Mathematics.
2. Award Total number of the staff working at an institution at the time of winning Nobel prizes in the sciences, or Fields Medals in Mathematics.
3. HiCi Total number of highly cited researchers in broad subject categories found at the web site of the Institute of Scientific Information.

Collective indicators

1. N&S Total number of articles published in Science and Nature in the past five years.
2. PUB Total number of articles indexed by Science Citation Index-Expanded and Social Science Citation Index in the previous year.
3. PCP Total scores of the previous five indicators divided by the number of full-time equivalent academic staff.

The ARWU ranking data thus rely on the history of universities in the past and current centuries (indicators Alumni and Award), in the last ten to twenty years, reflected in the number of Highly Cited Authors, and in the previous five years, as measured by the indicator N&S. It also measures the current performance in quantity of publications by means of the indicator PUB.

Wang, et. al (2011) This study reports research on analyzing the impact of government funding on research output. 500,807 SCI papers published in 2009 in 10 countries are collected and analyzed. The results show that, in China, 70.34% of SCI papers are supported by some research funding, among which 89.57% are supported by National Natural Science Foundation of China (NSFC). Average grants per funding-supported paper in China is 2.95, when in the USA the number is 2.93 and in Japan it is 2.40. The results of funding agency analysis show that, China, Germany and Spain are single funding agency dominated countries, while

USA, Japan, Canada and Australia are double funding agencies dominated countries and the source of funding in UK, France and Italy is diversified.

Abrizah and Wee (2011) There study is based on 1662 computer science researchers and focused on the research productivity of universities of Malaysia. Bibliometric methods are employed to conduct the research during the period 2000-2010 and the field includes journals, conference proceedings, lecture notes. In the 11 year period 903 records were noted. Time series analysis of Institutional productivity based on the publications counts of 5 sub domains of computer science was analysed.

Kumar and Dora (2012) This study measured the research output of IIMA in the 12 years (1999-2010). To review the impact of research in terms of published papers, Web of Science from Thompson Reutors and Scopus from Elsevier were used. The study revealed that IIMA has 172 publications in Web of Science and 284 in Scopus. The results were tabulated in MS Excel and the duplicates (138) were removed from 456.The final list included 318 unique entries for IIMA from both Web of Science and Scopus.

Ranasingh (2012) This study is based on the Sri Lanka publication data, retrieved from Sciverse Scopus database for 10 years from 01/01/2000 to 31/12/2009. Conference Proceedings books, trade publications and book series are excluded. Articles identified are classified according to subject area life and health sciences.

Matthews (2013) Publication productivity during 2009–2011 was studied for physicists who teach in South African universities, using data from Departmental websites and Thomson Reuters' Web of Science. The objective was to find typical ranges of two measures of individual productivity: number of papers and sum of author share, where author share per n-author paper is 1/n author units. The lowest 10 % did not publish, and the top 10 % produced above four papers and above 1 AU. Productivity varied with rank, ranging from medians of 0.67 papers and 0.2 AU for lecturers to 1.67 papers and 0.4 AU for full professors.

Choudhry (2013) Here the research publications in the field of Veterinary Animal Sciences by Indian researchers was downloaded from VETCD-COMS and 2000-2006 tabulated through MS EXCEL. Articles are broadly classified in two disciplines and various subjects are included in the disciplines. Data is computed to record and analyze the number of publication discipline-wise and subject wise for each of 7 years (2000-06) .Two core journals are selected to study the pattern of articles .Subject wise article productivity and geographical distribution by the author and institutes are noted.

Chen, Hu and Yang (2013) This paper aims to compare R&D productivity change across countries by providing the empirical evidence: First, although existing studies have measured R&D productivity change at the firm and industry level. Secondly utilizing the concepts of directional distance function, this study develops the Luenberger R&D productivity change index (LRC) to addresses the estimating methodology

and describes the dataset. They follow the concept of Luenberger productivity index to construct the R&D productivity change and decompose it into efficiency change and technical change. Utilizing a panel dataset of 29 countries over the 1998–2005 period to implement the empirical estimation, the results show that the R&D productivity growth is mainly attributed to the innovation effect.

Vinluan (2012) used objective assessment using bibliometric indicators or research productivity in Education and Psychology in Philippins using the journal article as unit of analysis at the individual, institutional and national levels using the SSCI data and ISI Web of Knowledge citation database service of Thomson Reutors for a period of 1966 to 2009.

Lehman (2008) Here authors employ Bayesian statistics to analyze several different indicators of scientific performance. They categorize each author by some tentative indicator based on their total citation record. Once assigned, it can empirically construct the prior distribution, p(_), that an author is in author bin _ and the probability P(N|_) that an author in bin _ has a total of N publications. They also construct the conditional probability P (i|_) that a paper written by an author in bin _ will lay in citation bin i. Studies performed on the first 25, first 50 and all papers of authors in a given bin reveal no signs of additional temporal correlations in the lifetime citation distributions of individual authors. They bin papers into L bins according to the number of citations. The binning of papers is approximately logarithmic.

2.5 Indicators for Academic Research Productivity.

Various performance indicators which are used for measuring academic research productivity have been mentioned in the literature.

Martin (1996) discussed what the various indicators of basic research measure scientific activity; production and progress; publications; citations; quality; importance; impact of publications and peer evaluation. It provides a measurement for weighing the quantitative performance of a system.

Martin (1996) The indicators should measure scientific activity (scientists and other supporting staff, funding and scientific equipment) ; production (scientific results from the various input resources); progress (scientific knowledge form various scientific activities); publications (contributions in the form of journal articles institution wise, country wise, subject wise) and Citations (scientific progress by various publications through increased quality, importance and impact of publications).

Print and Hattie (1997) studied the education discipline and mentioned that within the context of higher education Institutions, performance indicators can be used for comparison purposes. Comparison may be over time, within a Department, between Departments within a University, or across universities. There are 14 different indicators used under 3 broad categories and they are research grants, research students and publications.

Toutkoushian et.al (2003) Here it is shown how readily available data, a publication from the ISI may be used to estimate the number of scholarly articles written by an Institutions Faculty. A standard measure of research output is calculated by dividing total publication by the number of fulltime Faculty Members at the institution. The journal article with one or more authors of the institution is identified.

Guan and Wang (2004) They proposed a model to evaluate the efficiency of research groups in the area of information science in PR China. By taking the research groups as Decision Making Units (DMUs), the budget of the projects and size of the groups as inputs and the quantity and quality of publications produced by the groups as outputs of the model, the relative efficiencies of 21 research projects are evaluated. The output indicators, including both quantity and quality of research projects are:

1. Number of papers published in international journals;
2. Number of papers indexed by SCI;
3. Cumulative citation counts minus self-citations of each publication ,
4. Measurement of overall level of all the publications,
5. Average citation counts per paper, citations per paper,
6. Ratio of the number of papers having independent citations to the number of papers indexed by SCI,
7. Percentage cited by others versus uncited and number of papers that received more than 5 citations.

Vaan (2005) in his study found that for the decision regarding matters of scientific activities advanced bibliometric indicators have to be used in parallel to a peer-based evaluation procedure. The major technical and methodological problems in the application of publication and citation data in the context of evaluation and citing-cited matching process are to be reduced.

Meek , Lee and Der (2005) in their work stated the various aspects of indicators such as the indicators should be

1. They are expressed numerically;
2. They relate inputs to outputs (ie they measure efficiency of resource use);
3. They are linked to the overall goals of the organization (i.e. they are concerned with effectiveness in meeting desired outcomes);
4. They allow users to determine how the performance of the individual or organization under study has changed over time and/or how it compares with the performance of other individuals or organizations and
5. They may be used as incentives to influence the activities in socially desired ways.

Overcoming the debate and controversy over performance indicators some holistic approach towards the features of performance indicators are

1. The performance indicators should be objective and clear.

2. The indicators can be presented numerically (ordinal or cardinal) so that at least they can help in decision making.

3. The indicators are mission oriented so as to serve the purpose of institution for which the performance is measured.

4. The indicators should be time bound such that it should measure performance in present context.

Carey (2007) Due to the variability of the sub disciplines of mathematics and statistics only bibliometric data cannot be used to understand the culture of the sub disciplines and it is suggested to use other indicators other than publications. Citations to articles in mathematical sciences are less compared to other sciences eg. A paper may be cited as the result contained therein may be used. The study further suggested that due to time lag impact of the article may be measured over decades rather than years. The study further discussed the various pros and cons of bibliometric indicators used in various rankings of world universities and provided five indicators to measure productivity such as article output, disciplinary specialization index, normalized citation impact, % internationally co-authored articles and % articles with private sector.

Hendrix (2008) The objective of this study was to analyze bibliometric data from ISI, National Institutes of Health (NIH)–funding data and Faculty size information for Association of American Medical Colleges (AAMC) member schools during 1997 to 2007 to assess research productivity and impact. This study gathered and synthesized 10 metrics for almost all AAMC medical schools (n=5123): (1) total number of published articles per medical school, (2) total number of citations to published articles per medical school, (3) average number of citations per article, (4) institutional impact indices, (5) institutional percentages of articles with zero citations, (6) annual average number of Faculty per medical school, (7) total amount of NIH funding per medical school, (8) average amount of NIH grant money awarded per Faculty member, (9) average number of articles per Faculty member and (10) average number of citations per Faculty member. Using principal components analysis, the author calculated the relationships.

Nicolini (2008) In their study assessed the activity of each single scientist and each institution during the time interval (1990–2006) in Science Citation Index the number of publications and their impact factors in international SCI journals were properly ranked properly weighted for their position, number of coauthors and discipline using deciles. The database is a well-known multidisciplinary and multinational index to the journal literature of science and technology. SCISEARCH indexes the contents of 90% of the world's most

significant scientific and technical literature with 3,322 source issues and 620,000 authored source items. In addition the number of patents registered in various countries and the number of inventions produced by each industry, institution, or country has been obtained using the World Patents Index database of the Derwent Publications, Ltd. of London, through the Dialog Information Services. This database contains about seven million patents, corresponding to over 29 national and international offices. The resulting different indicators utilized in this evaluation are based on the total number of publications differently weighted in relation with the number of co-authors and with the fraction as first author.

Rodrigo (2010) in his work studied the factors that contribute to the assessment of the research performance of scientists (evaluative purposes) as well as the different aspects of their behaviour (descriptive purposes). They believed that the combination of bibliometric indicators and personal data of researchers (i.e.,age, tenure, professional status, years of experience, etc.) can provide a rich picture of the performance of scientists from a micro-level perspective.

Franceschini and Maisano (2011) mentioned that bibliometric indicators are the most practicable instrument in case of large-scale evaluations (in opposition to peer review methods) that takes into account two important aspects: overall productivity—generally measured in terms of publications—and overall diffusion/impact—generally measured in terms of received citations. They developed tools to perform qualitative/quantitative evaluations on the regularity of one scientist's output in a simple and organic way. Input data consist of the distribution of Py values, namely the total number of publications for each year of one researcher's career and the distribution of Cy values, namely the total number of citations accumulated by the (Py) publications of each year, up to the moment of the analysis.

2.6 ARP in Higher Education Institutions in India

India home of more than 1.2 billion population of which 0.672 billion population are in age group 15-64 years. This age group is considered as the "working age population" that provides the necessary invaluable human resource which should be engrossed, attached and nurtured with skills so that they can live a purposeful life and contribute to nations development. There has been a tremendous improvement in the number of foreign R&D Centers and universities in India. Most of these R&D centers relate to Information and Communication Technologies (ICTs), automobile and pharmaceutical industries.

Adams, King and Singh (2009) As per Global Innovation Index, India was placed at 54th rank in 2008. India has become the world's largest exporter of IT services since 2005 and exports of aerospace products have been increasing at a rate of 74% per year. In higher education government is seeking to raise the gross

enrolment ratio from 11% in 2007 to about 15% by 2012 and 21% by 2017. One-quarter of the student body is now enrolled in Science &Technology fields.

Department of Science & Technology R&D Report (2011-12). India's per capita R&D expenditure has increased to Rs. 451/- (US$ 9.5) in 2009-10 from Rs. 217/- (US$ 4.8) in 2004-05. Gross Expenditure on R&D (GERD) in Higher Education is 4.1%. Academic sector received 64% of the total extramural R&D support during the year 2009 -10. Out of the total 16,093 Doctorates in the country, 8,302 (51.6%) Doctorates were from the S&T discipline during 2010-11.

India spent 0.87% of its GDP on R&D in 2009-10 whereas the developed countries spent more than 2% of their Gross Domestic Product (GDP) on R&D.

India's scientific publication output has shown a rising trend during the last decade. In 2010 as per the SCOPUS database, research output was 65,487 and 40,711 as per the SCI database. During 2010-11 a total of 39,400 patents were filed in India. Out of which 8,312 (21.1%) patents were filed by Indians. Patent applications filed in India are dominated by Computer/Electronics, Mechanical and Chemical fields

Indian publications are on a steep rise India's publication record will be on par with most G8 nations within 7–8 years. India could even overtake them between 2015 and 2020. The most recent data confirms that India's strength truly lies in the basic sciences such as chemistry, physics, pharmacology and toxicology. India is self-sufficient in food grain production; we have space program that has enabled satellite launches and a moon mission; we have atomic energy program; we have developed indigenous technology for missiles and aircraft; we do exports in biotechnology, pharmaceuticals, and information-technology services. But India lags behind in research investment and output when compared with other countries. In this direction government has made efforts by creating facilities such as the 5 Indian Institutes of Science Education and Research at Pune, Kolkata, Bhopal, Mohali and Thiruvananthapuram dedicated to the international standards of scientific research and science education.

2.7 Bibliometrics: a Tool to Study RP

The term 'Bibliometrics' was first coined by Alan Pritchard in 1969. He defined it as the application of mathematical and statistical methods to books and other media of communication. Earlier it was known as 'Statistical Bibliography' by Hulme in 1923, 'Librametry' by S.R. Ranganathan in 1948. The later terms are 'Scientometrics', 'Informetrics' and 'Webometrics'.

Scientometics is the application of complex mathematical and statistical methods used to analyse the quantitative characteristics of science as an enterprise. Informetrics is the application of mathematical and statistical methods to investigate scientific and technical information. The information may in the form of

Print, NonPrint or in Electronic Form. Finally Webometrics is application of all mathematical and statistical methods to analyze the WebPages of the Web.

Bibliometrics is the quantitative evaluation of publication and citation data and it is used for the objective research performance evaluation. It is used by University and government labs, policymakers, research directors, administrators, information specialists, librarians and researchers. Using citation bibliometrics,University can assess the performance of its research units, gauge its contribution to the creation of knowledge and technology and make decisions based on objective and quantitative data.

Vaan (2005) mentioned that bibliometric indicators can be used to support peer review process for objective and transparent evaluation purpose. This can be done by reducing the technical and methodological errors associated with bibliometrics. The technical problems are 1) mismatch of cited and citing publications 2) Variations and errors in author names especially when publications are written by many authors, authors from non-English speaking countries 3) Errors in journal volume numbers, errors in initial page numbers, dual volume-numbering systems or combined volumes. 4) Missing names of University as only a section or Department are mentioned .eg in case of medical research the hospital's name is mentioned and the University name is not indicated. The Methodological problems are 1) ISI database coverage is low in the disciplines of Engineering, Social and Behaviour science and Humanities. 2) Only the core journals of selected disciplines are covered. Many other forms of communications are not covered. 3) The authors and journals from US are given a preference.

Thomson Reutors (2008) In the report Eugene Garfield's mentioned that bibliometric data is used for a number of purposes, that a University must have for evaluating its research performance. Each purpose calls for particular kinds of information such as citation metrics can help to answer important questions of University's research performance, competitiveness, forecast growth of a university , university's centres of excellence, citation ranking and the influence of a university research. The different sections or citation indices are

Productivity: Counts of papers or Paper counts which measure productivity are the most basic bibliometric measure and provide the raw data for all citation analysis. Ranking Institutions in terms of paper counts helps to compare the productivity and volume of research output among various Institutions. The number of researchers at an institution should be taken into account when comparing publication counts across Institutions. Characteristics of the papers, such as document type, publication year, and categorization method, should also be considered.

Total recognition/influence: Citations measure impact and influence. Citations to papers are summed over some time period to create an aggregate citation count. Aggregate citation counts of Institutions or researchers over the same time period can be useful in comparing and ranking their research impact.

Indirect recognition/influence: Second-generation citation counts are the sum of the citation counts of all the papers citing a target paper. This is a measure of the long-term impact of a paper which is similar in effect to the Google PageRank Efficiency.

Average citations per paper: Citations per paper (sometimes called "impact") is computed by dividing the sum of citations to some set of papers for a defined time period by the number of papers (paper count). The citations per paper score is an attempt to weight impact in respect to output, since a greater number of publications tends to produce a greater number of citations. Citations per paper is a useful statistic when comparing large with small producers; however, some minimum number of publications, a threshold, ensures that one or a few highly cited papers do not skew the results.

H-index: The Hirsch index, or H-index, is a distribution-based indicator that corresponds to the number of papers at or above a given citation level equal to the value of the citation threshold. This statistic reflects the number of papers (N) in a given dataset having N or more citations. For example an H Index of 77, indicates that 77 papers in the given set were cited at least 77 times each.

The H-index of a subset of papers is always less than the H index of the entire set and hence cannot be normalized in a ratio manner. This measure attempts to reflect both productivity (number of papers) and impact (number of citations) in one number.

Percent cited/uncited papers : Relative Percent cited/uncited papers can be considered relative to the field of research, a country, institution, etc. This method provides further context to percent cited/ uncited. For example, the rates of citedness vary across disciplines. The measure enables you to judge the influence of the papers in light of the norm in their field, or the norm in their country or institution Field baselines and relative impact

Field baselines: These are average citations per paper for papers in a field (usually a journal set) defined for a specific time period. Since different fields exhibit different average rates of citation, the mean for the field should be used to gauge the relative impact of one or a group of papers. By dividing the actual number of citations by the average, a ratio is obtained.

Research fronts: A research front is a group of highly cited papers referred to as core papers in a specialized topic defined by a cluster analysis. A measure of association between highly cited papers is used

to form the clusters. That measure is the number of times pairs of papers have been co-cited that is the number of later papers that have cited both of them. Clusters are formed by selecting all papers that can be linked together by a specified cocitation threshold.

Collaboration indicators: Metrics for collaboration include rates of co-authorship for pairs of authors, Institutions, countries, etc. They can include standard series such as the percentage of papers with 1, 2, 3, etc. authors over time, as well as the computation of impact and relative impact indicators for specific country or institutional collaboration pairs. These metrics can help identify where collaboration has and has not taken place.

Disciplinarily index: This metric indicates the concentration or dispersion of a group of papers over a set of field categories. This can be expressed as the sum of squared fractions of papers over some set of categories (disciplinarily index). A value of 1 indicates total concentration in a single field category. This metric helps to view multi- or interdisciplinary research output. It represents a response to the problem of field definition (a set of journals defining a field or category), which sometimes poses difficulties due to the constantly changing nature of science.

Time Series: Time series are powerful depictions of citation data. Whereas single period statistics provide a snapshot of research performance, time-series provide insight into the change in output and impact over time.

Abramo (2011) The recent development of bibliometric techniques has led various governments to introduce bibliometrics, in support or substitution for more traditional peer review. In the United Kingdom the Research Excellence Framework taking place in 2014, is an informed peer-review exercise, here the assessment outcomes will be a product of expert review informed by citation information and other quantitative indicators. It will substitute the previous Research Assessment Exercise series which was pure peer-review. The REF will be undertaken by the four UK higher education funding bodies. In Italy, the Quality of Research Assessment (VQR), expected in 2012, substitutes the previous pure peer-review Triennial Evaluation Exercise (VTR 2006). It can be considered a hybrid, as the panels of experts can choose one or both of two methodologies for evaluating any particular output: (i) citation analysis; and/or (ii) peer-review by external experts.

Citations act as a referral point for scholars to show earlier studies from where they have started their investigations. Tracking citations and understanding their trends in context is a key to evaluate the influence and impact of research.

2.8 Chapter Summary

This literature review has presented a number of views on the meaning of Research,
Productivity, Research Productivity, Academic Research Productivity (ARP), Bibliometrics and the various Indicators by individuals and Institutions to measure Research Productivity. Productivity is the relationship between the outputs generated by a system and the inputs provided to create those outputs. Research productivity can be measured by both quantity and quality the most frequently used method is to count research productivity based on a weighting system. The literature review indicates that there have been numerous studies investigating academic research productivity, and there are a range of different theories. Each evaluation technique has its own sets of indicators. The present study is based on the Indicators that are the most desired one for evaluations of research performance.

Chapter 3

Methodology of the study

The purpose of this chapter is to explain the research methodology that will be used in this study. This chapter describes about the research design, data collection methods, instrumentation, sampling procedures, scope and coverage, population, sample and data analysis involved with the study. In addition, this chapter also gives a brief description of the departments involved in the study. Many factors are taken into consideration for the measurements of qualitative attitudes. Academic output of Faculty Members depends on their individual, institutional, environmental and psychological factors. This study aims to measure and rank the research productivity of the Faculty Members on the basis of the publications.

3.1 Data collection method

The research study is based on survey method. The literature is reviewed at depth so that there is a better understanding of the subject and data gathering instruments. It is very important that the data must be acquired accurately, methodically, under the right conditions and with minimum interruption . A structured questionnaire having both close ended and open ended questions was designed to collect data. In some situations when it was not possible to be filled by Faculty Members the information was gathered from their respective websites. Emails were also sent to Faculty Members although it was found that the response from emails is less as compared to direct observation. The data collected is tabulated and presented in the next chapter of data analysis and interpretation. If the researcher needs information available in existing manuals, then interviewing is unnecessary except where the manual is not up to date. If additional information is needed, on-site observation or a questionnaire may be considered. As such various data collection tools are used for this study. Each tool has a special function and depends on the information needed. A mixture of questionnaire, interview methods and websites were appropriate instruments for the study. The questionnaire content was based on the research objectives listed in Chapter 1. The questionnaire included different types of question such as dichotomous question (Yes \ No), multiple choice question and opinion questions. Every question is framed that it should be easy to understand and take little time of the Faculty Members to provide the needed information. Latest technology affords to solve problems of conventional data collection for survey research. The web pages, emails and telephonic survey are detailed and economic .

3.2 Main instruments for data collection

Questionnaire

Questionnaires are the most common instruments for data collection. In this method a list of relevant questions pertaining to the survey is prepared and sent to the respondents. The questionnaire contains questions and provides space for answers. Request is made to the informants through a covering letter to fill up the questionnaire and send it back within a specified time.

Following principles are considered while framing the questionnaire:

1. Covering letter: The scholar conducting the survey introduces and state the objective of the survey.
2. Number of questions in the questionnaire are small.
3. The questions in the questionnaire are arranged logically.
4. Questions are short and simple to understand.
5. Personal questions are avoided.
6. Includes both open-ended and close ended questions.

The questionnaire in the present study incorporates questions on the following sections and they are:

- Personal Information about the Faculty Members.
- Departmental details of the Departments under study.
- Publication details
- Research problems

Personal Interview

In this method of collecting data, there is a face-to-face interpersonal role situation in which a person called the interviewer asks a person being interviewed and questions are designed to gather information about a problem area. The interview is the oldest and most often used device for gathering information. Awad (2007) It is used for main two purposes 1) as an exploratory device to identify relations or verify information and 2) to capture information as it exists. The interviewer asks questions pertaining to the survey and collects the desired information. Here the response is more as people are willing to supply more information when approached personally. Information collected by this method is more accurate as the interviewer can clear the doubts of the informants and above all supplementary information about the informants personal

characteristics and environment are also covered as such information is very useful while interpreting results. Then the interview proceeds with asking questions properly, obtaining reliable responses and recording them accurately and completely. Regarding the arrangement of interview, it should be arranged so that the physical location, time of the interview and order of interviewing assure privacy and minimal interruption. Appointments are made well in advance and a fixed time period adhered to as closely as possible.

Websites

Internet is a worldwide network of networks connecting millions of users, spread across continents, exchanging terabytes of information that covers everything from sports to space, all at a very low cost. The internet is connected via the computer users all over the world. Each computer is connected to the internet using its own unique identification called as address. This addressing system is called the Internet Protocol (IP) addressing system.

Websites are internet based navigational system, an information distribution and management system. A website is a system for organizing, linking and providing point-and-click access among related internet files, resources and services. The point-and-click access is due to the underlying hypertext or hypermedia approach of the web search engine. Hypertext refers to computer-based documents in which cross-references are embedded within documents and other entries. Each cross-reference is a pointer to another document or to other actions, lists or menus. This approach enables a user to move from one place in a document to another in a non-sequential manner. The documents are not just text but it involves multimedia options like graphics, photographs, audio and video or the combination of all. Bajaj and Nag (2012) mentioned that there are more than 1 Billion websites today on internet. Websites can be divided into two broad categories – static and interactive. Interactive sites are part of the Web 2.0 community of sites and allow for interactivity between the site owner and site visitors. Static sites serve or capture information but do not allow engagement with the audience directly.

Oxford advance dictionary (2010) A place connected to the internet, where a company or an organization or an individual puts information.

In this study websites is one of the main instruments for data collection. After collection of the preliminary data from the Faculty Members, some information were missing as it was not possible for the Faculty Members to remember all the publications in the period 2000-10. Moreover they were busy with their other academic works so the researcher went 3-4 times to collect the questionnaire from the Faculty Members. In

such a situation Departmental websites were of great help and provided the relevant information. The websites of the respective departments included in the study is given in the Table 3.1 below.

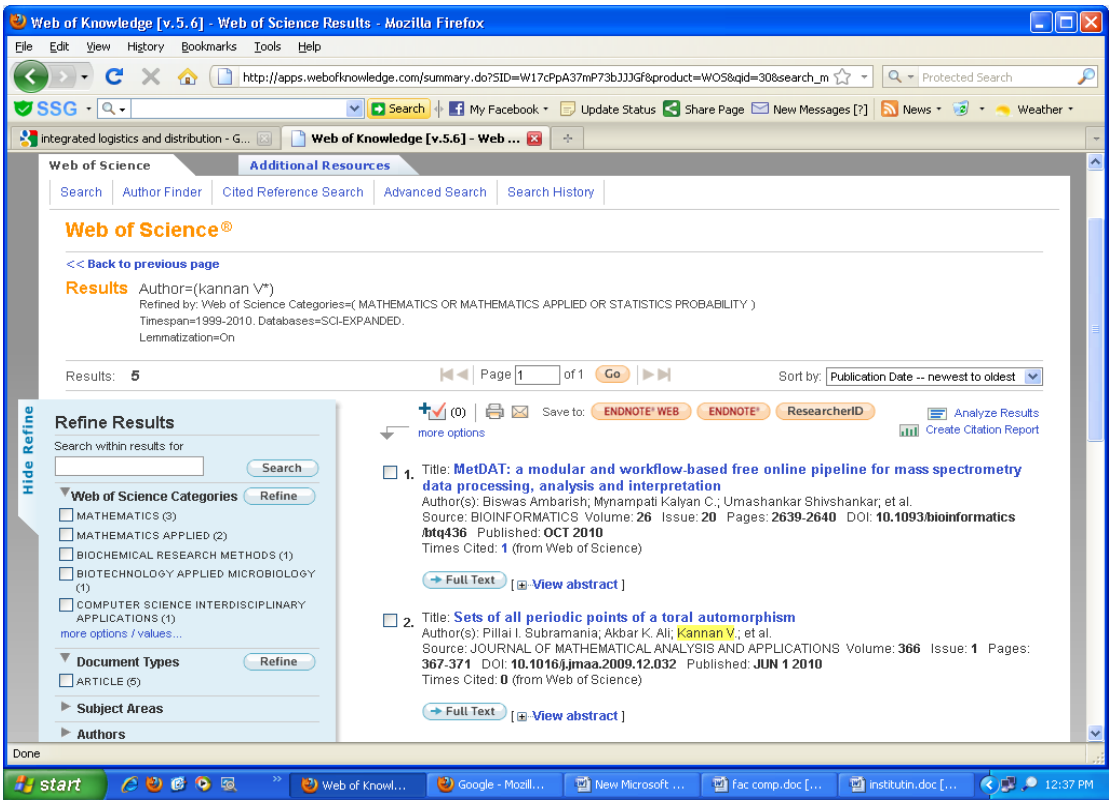
Table 3.1: Websites of the Departments

Sl. No.	Name of Department	Website
1.	Department of Statistics, Allahabad University	http://www.allduniv.ac.in
2.	Department of Statistics and Operation Research, Aligarh Muslim University	www.amu.ac.in/science/statistics
3.	Department of the statistics, Banares Hindu University	www.bhu.ac.in/science/statistics
4.	Department of Mathematical Statistics, Delhi University	www.du.ac.in/index/statistics
5.	Department of Statistics, Hemvati Nandan Bahuguna Garwal University	www.hnbgu.ac.in
6.	School of Mathematics and Statistics, Hyderabad University	http://mathstat.uohyd.ernet.in/people/Faculty
7.	Department of Statistics, Indira Gandhi National Open University	www.ignou.ac.in
8.	Department of Statistics , Manipur University	www.maniuniv.ac.in/Department
9.	Department of Statistics, North Eastern Hill University	www.nehu.ac.in/Department
10.	Department of Statistics, Pondicherry University	www.pondiuniv.edu.in/Department
11.	Department of Statistics, Central University of Rajasthan	www.curaj.ac.in

Websites were most useful to fulfill the other important objective of the study. To find the impact of the publications, published by the Faculty Members. Impact of publications is the referred publication which are indexed in the citation databases of Web of Science(WS) and MathSciNet (MSN).

The webpage of the citation database Web of Science is given in the Figure 3.1 below

Figure 3.1 : Webpage of Web of Science



The webpage of the citation database MathSciNet is given in the Figure 3.2 below

Figure 3.2: Webpage of MathSciNet

3.3 Scope and Coverage

Central Universities of India

In India, "University" means a University established or incorporated by or under a Central Act, a Provincial Act or a State Act and includes any such institution as may, in consultation with the University concerned, be recognized by the University Grants Commission (UGC) in accordance with the regulations made in this regard under this Act. Central universities are established by the act of Parliament. Currently there are 39 central universities in India and the list is given in the appendix II.

A University established or incorporated by a Central Act. The Central Government provides grants to UGC and establishes Central Universities in the country. The Central Government is also responsible for declaring educational Institutions as "deemed-to-be University" on the recommendation of the UGC.

Role of Central University

Universities in India played a very important role for vibrant society and also for the continuation of its rich democratic tradition. The higher education system in India is one of the largest system in the world, the responsibility rests on the Central Government to devise policies with a view to improving the quality of higher education in India. Improving the quality and access of higher education and research in India has become all the more important keeping in view the growing need of qualified human resource in various

sectors of the economy. The central government lays special emphasis on research and development carried out in technical and other academic Institutions.

Central government is responsible for major policy changes relating to higher education. One of the most important tasks is the establishment of central universities across the length and breadth of the country through the acts of legislations posed by the education system. The central universities admit students and provide job opportunities in the field of both teaching and non-teaching on all India level. The central universities have always reflected a national diverse character in the composition of the students, teaching and non-teaching staff.

The Central government is responsible for arranging, allocating and distribution grants for the growth and maintenance of the Central Universities in India. The Government of India initiated a planned development of higher education in the country with the establishment of University Grants Commission (UGC). In 1953 the UGC became a statutory organization by an act of Parliament 1956 for the coordination, determination and maintenance of standards of higher education. The UGC Act 1956 empowers the commission to allocate and disburse grants to the higher education institution in India. The UGC provides grant for both plan and non-plan schemes to the Central Universities. Currently there are 39 Central Universities in India and the list is given in Appendix II.

3.4 Population of the Study

Out of the 39 central universities, 14 central universities have the Department of statistics. Out of the 14 Departments, 11 Departments were used for conducting the detailed survey, as the other 3 Departments were approved by the University but not operational during the time of study. The population of the study included the publications of the Faculty Members engaged at the Eleven Central Universities of India during the period 2000-2010 is given in the Table 3.2.

Table 3.2: List of Statistics Departments

Sl.No.	Name of Department
1.	Allahabad University
2.	Aligarh Muslim University
3.	Banaras Hindu University
4.	Delhi University
5.	Hemvati Nandan Bahuguna Garhwal University
6.	Hyderabad University
7.	Indira Gandhi National Open University
8.	Manipur University
9.	North Eastern Hill University
10.	Pondicherry University
11.	Central University of Rajasthan

3.5 Department Profiles

A brief profile of all the 11 Departments will be covered in this sub section.

1. Department of Statistics, Allahbad University

Figure 3.3: Department Webpage of Allahabad University (AU)

The statistics unit was started as Department of Mathematics and Statistics in 1968. On August 21, 2000, the Department was separated from Mathematics and become Department of Statistics. It provides research programmes in all branches of statistics.

The Department conducts the following programmes in

i) UG ii) PG and iii) D.Phil in statistics

The Department has 3 Faculty Members, 2 are Professors and 1 is Assistant Professor.

2. Department of Statistics and Operation Research, Aligarh Muslim University

Figure 3.4: Department Webpage of Aligarh Muslim University (AMU)

The Department was started in 1953 and the teaching of statistics at PG level started in 1958. The Department publishes the journal 'The Aligarh Journal of Statistics' yearly that has a high academic repute. The Department changed its name and become Department of Statistics and Operation Research in 1989. The Department receives special assistance programme from UGC since 2009. The Department has a computing laboratory for research scholars and a smart class for PG students.

The Department conducts the following programmes in i) M.Sc and ii) M.Phil/Ph.D in Statistics.

There are 14 Faculty Members in the Department out which 11 are Professors and 3 are Assistant Professor.

3. Department of Statistics, Banaras Hindu University

Figure 3.5: Department Webpage of Banaras Hindu University (BHU)

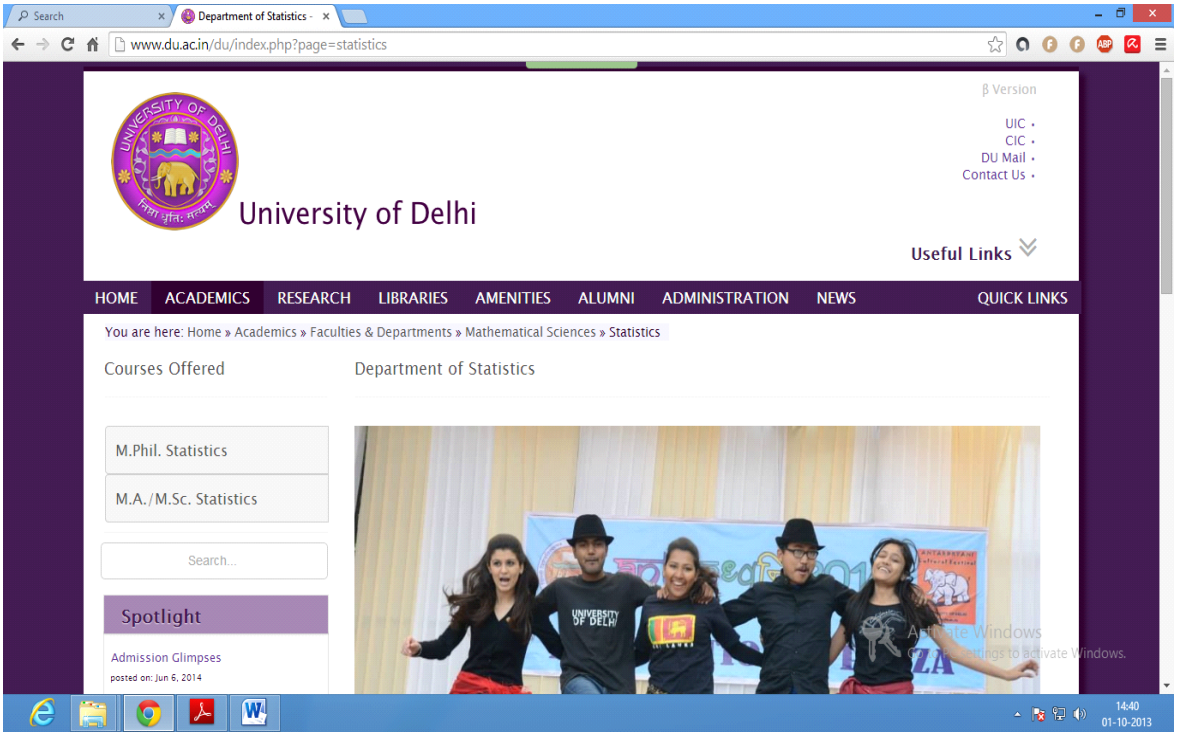
The Department of the statistics was established in the year 1950 and the teaching of statistics at post graduate level was started in 1962. The Department is under Faculty of Science. The University Grants Commission supported the Department in the form of Special Assistance Programme (2009-14) and Department of Science and Technology, New Delhi helped it under its FIST Programme (2004-09). Besides, there is a Centre of Population Studies functioning under the Department created by population Council, USA in 1969. The present building of the Department is situated at the ground, first floor and second floor of the old Three Year Degree Course (T.D.C.) building in the Faculty of Science complex which is now popularly known in the University as Sankhyiki Bhawan.

Currently the Department offers courses in i) M.Sc. Statistics and ii) Ph.D Programmes.

Presently, the Department consists has 11 Professors and 3 Assistant Professors.

4. **Department of Mathematical Statistics, Delhi University**

Figure 3.6: Department Webpage of Delhi University (DU)



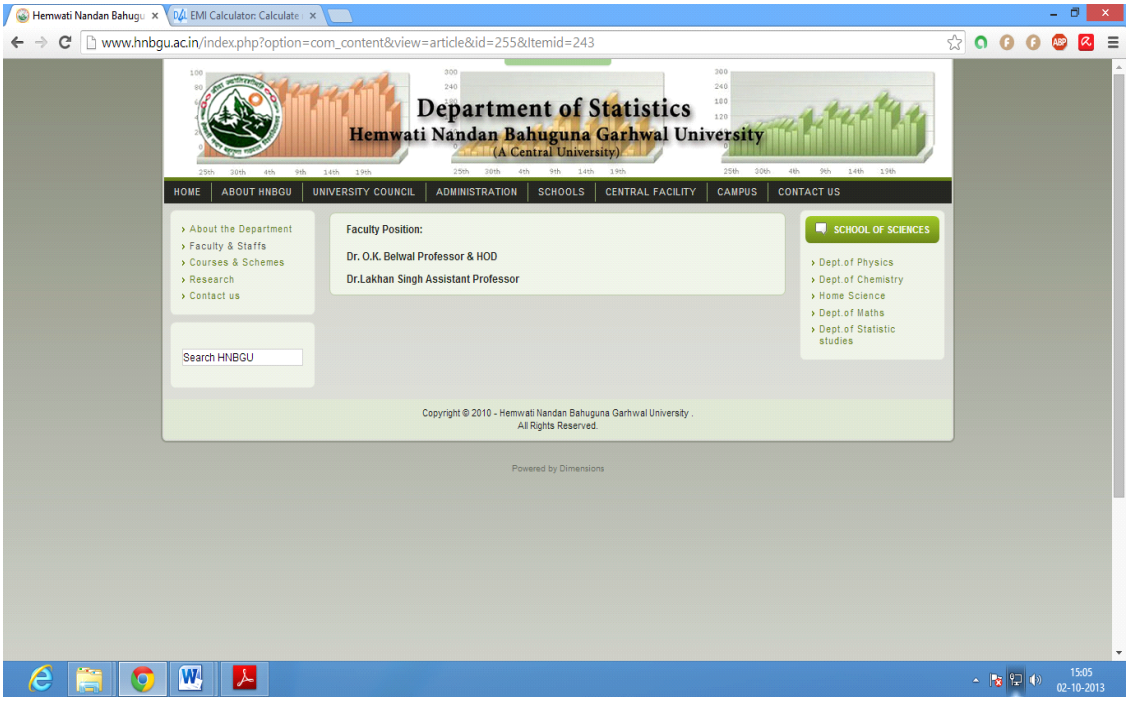
The Department of Mathematical Statistics was established in July 1957. In 1987, the Department of Mathematical Statistics was re-named as the Department of Statistics. The Department imparts rigorous training and exposure to the students by introducing the latest state-of-the-art in the programming language and computer software to enable the students to perform statistical data analysis. There is a good collection of books in the Departmental library with latest titles in various areas of statistics. Two computer laboratories with latest computing systems and related equipment have been setup in the Department for the use of students, research scholars and teachers. The Department has its own placement cell operating since academic year 2005-06 to look after the job opportunities of the alumni.

The Department is running the post-graduate (M.A./M.Sc.), M.Phil. and Ph.D. Programmes in Statistics.

There are 4 permanent Faculty Members, 1 is Professor and 3 are Associate Professors.

5. Department of Statistics, Hemvati Bahuguna Nandan Garwal University

Figure 3.7: Department Webpage of Hemvati Bahuguna Nandan Garwal University (GU)



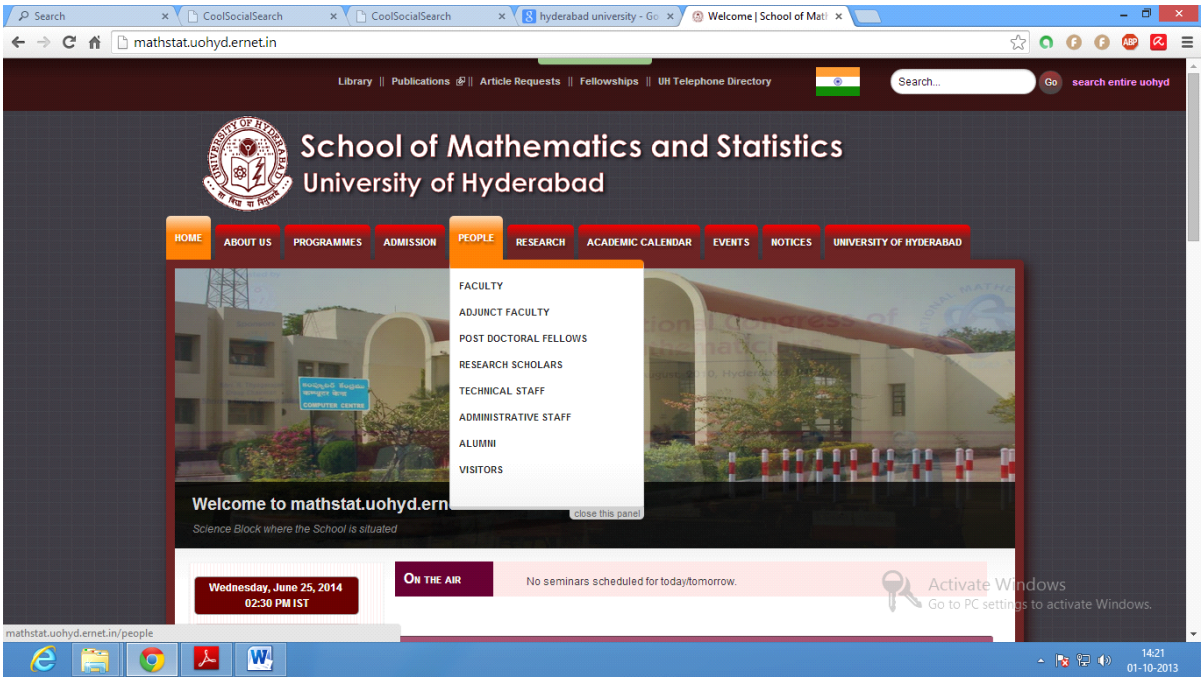
The Department of Statistics of H.N.B. Garhwal University established at Srinagar and Tehri campus in 1978 with the teaching of undergraduate classes. In 2000 Statistics was also introduced at Master's level. Later on teaching of statistics was also introduced at undergraduate level at the other campus of Pauri. The Department since inception has been actively engaged in research in the field of Operations Research and Demography. The Department has also completed two major Research Projects sponsored by U.G.C. and C.S.O. At present Department is also running a project of DST Sponsored (Women Scientist Scheme (WOS) for Research in Basic/Applied Science. The Department specializes in the field of Operations Research and Demography.

The Department offers programmes in i) B.A/B.Sc Statistics ii) M.A/M.Sc. Statistics and iii) Doctor of Philosophy (D. Phil).

There are 2 Faculty Members one Associate Professor and one Assistant Professor.

6. School of Mathematics and Statistics, Hyderabad University

Figure 3.8: Department Webpage Hyderabad University (HU)



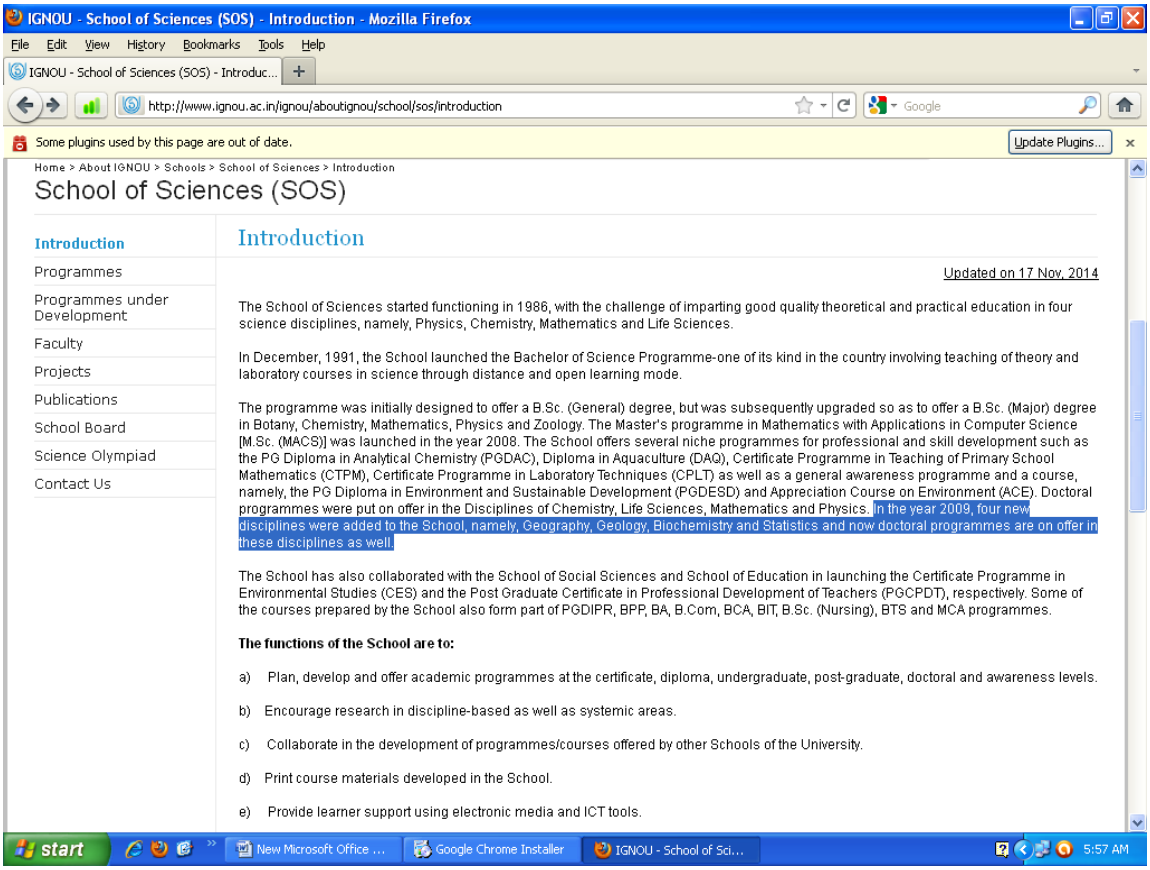
The Department of statistics and mathematics was established in the year 1978. The Department was renamed as School of Mathematics and Statistics in 2013. The school receives recognition from various funding agencies. DST has selected this school under its FIST (Funds for Infrastructure in Science and Technology) (Level ll) scheme. This grant is to support research in areas under Cryptology, Modeling & Simulation and Dynamical Systems. The school is also chosen by the UGC for support under COSIST (Committee for Strengthening Infrastructure in Science & Technology) programme. It is also a recipient of the Special Assistance Programme (SAP) of the UGC. The National Board of Higher Mathematics, (NBHM) has recognized the Departmental library as a regional library of the NBHM. And thus provides library grant each year for subscribing journals in Mathematics and Mathematical Statistics.

The Department offers MSc. and PhD programmes in statistics.

Presently the Department has 18 Faculty Members out of which 6 are Professors, 6 are Associate Professors and 6 are Assistant Professors.

7. Department of Statistics, Indira Gandhi National Open University

Figure 3.9: Department Webpage of IGNOU



The Department was started in the year 2009.

Currently the programme of Post Graduate Diploma in Applied Statistics is conducted.

There are 4 Faculty Members in the Department, 1 is Associate Professor and 3 are Assistant Professor.

8. Department of Statistics, Manipur University

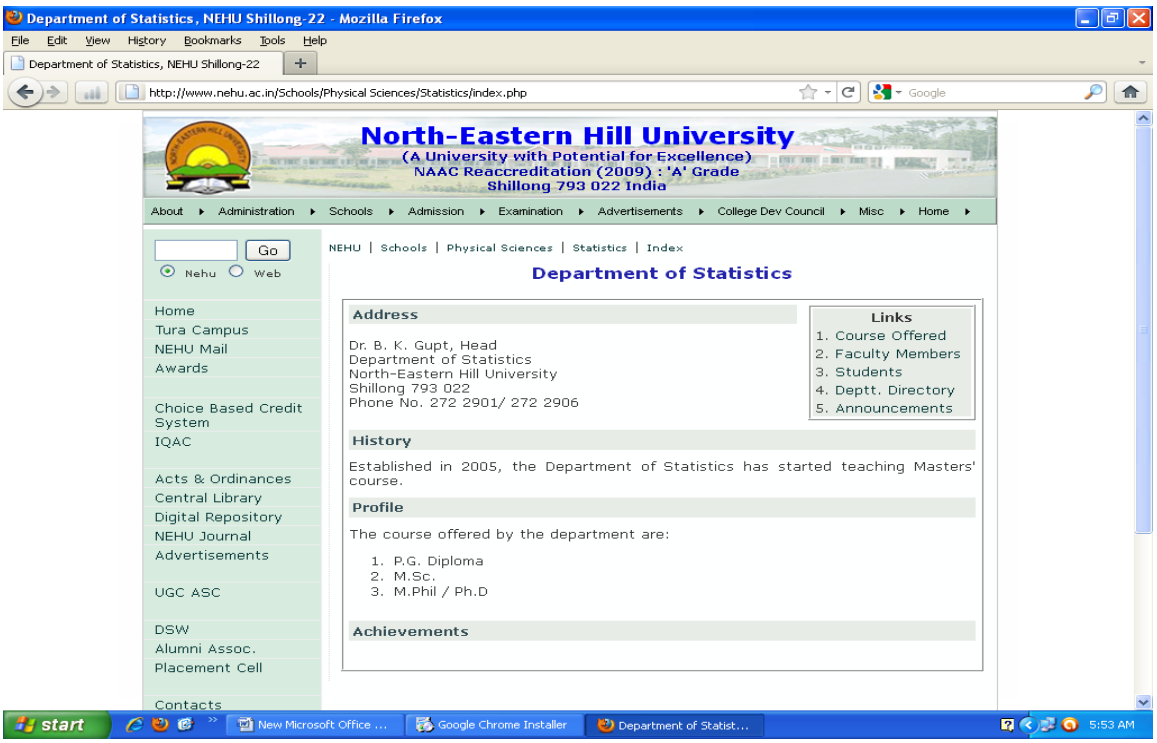
Figure 3.10: Department Webpage of Manipur University (MU)

The Department provides progammes in Ph.D and MSc. in Statistics

There are 3 Faculty Members in the Department, 1 is Associate Professor and 2 are Assistant Professor.

9.Department of Statistics, North Eastern Hill University

Figure 3.11: Department Webpage of North Eastern Hill University (NEHU)



The Department of statistics was established in 2005.

The course offered by the Department are i) P.G. Diploma ii) M.Sc. iii) M.Phil / Ph.D. in statistics

The Department has 6 Faculty Members 1 is Professor, 2 are Associate Professors and 3 are Assistant Professors.

10. Department of Statistics, Pondicherry University

Figure 3.12: Department Webpage of Pondicherry University (PU)

The Department of statistics was established in the year 2006. The Department is located in a well built building with all the modern facilities. It has a seminar room, Departmental library and one computer laboratory.

The Department provides programmes in i) M.Sc. Statistics ii) M.Sc. Five year Intergrated Statisitics iii) Post Graduate Diploma in Statistical and Research Methods and iv) Ph. D progamme in statistics.

There are 8 Faculty Members in the Department. 1 is Professor, 2 are Associate Professors and 5 are Assistant Professors.

11. Department of Statistics, Central University of Rajasthan

Figure 3.13: Department Webpage of Central University of Rajasthan (RU)

The Central University of Rajasthan has been established in February 2009 by an Act of Parliament, the Central Universities Act 2009.

The University started working temporarily from Jaipur and introduced PG programmes in 2009-10 namely M.Sc./M.A. Statistics(Actuarial) in collaboration with Malaviya National Institute of Technology(MNIT), Jaipur.

There are 5 Faculty Members in the Department, 1 is Professor, 2 are Associate Professor and 2 are Assistant Professor.

3.6 Citation Database

Citation databases are used to know the importance and assess the publications of the Faculty Members. Two databases Web of Science of Thomson Reutors which is multidisciplinary in nature and the other one is MathSciNet by American Mathemathical Society that is in Mathematics discipline.

Web of Science

From the last 50 years, Thomson Reuters (http: //apps.webofknowledge.com)) has comprehensively collected data across academic fields, from natural sciences to social sciences and humanities. The policy of indexing and storing of data is very consistent and reliable. A citation index for science was first described in 1955 by Eugene Garfield, the founder and chairman emeritus of ISI, in the journal Science. The result of the publication was the production of the Science Citation Index in 1961. The operating principle of a citation index is: If a researcher knows of a publication important to his or her work, a citation index would allow the researcher to identify journal articles published subsequent to that work which have cited it. Due to the enormous growth of publication, citation, communications, power and software applications, all has made bibliometrics a practical and even cost-effective pursuit. Web of Science includes the Science Citation Index, the Social Science Citation Index, the Arts and Humanities Citation Index, Index Chemicus, and Current Chemical Reactions, resulting in a truly multidisciplinary citation resource. Web of Science, covers9,300 high-quality, core journals from every field, used by over 3,400 organizations and universities in more than 90 countries around the world,

- 100 years of abstract
- 54 million records covering 5,294 social science publications in 55 disciplines
- 760 million+ cited references
- 6.5 million records across 160,000 conference proceedings
- Multidisciplinary citation index
- All items such as articles, reviews, editorials, letters, book review etc

One can limit a bibliometric analysis to only articles and reviews, or choose to include the more marginal document types.

(Whitepaper 2008) Analysts in many nations issue bibliometric reports at regular intervals called science indicators studies. National Science Foundation (United States),the European Commission, L'Observatoire des Sciences et des Techniques (France), National Institute for Informatics (Japan) .Other nations with active bibliometrics groups include Argentina, Australia, Belgium, Brazil, Chile, China, Israel, Italy, New Zealand, Portugal, Spain, Sweden, Switzerland and Taiwan. In almost all cases the citation and publication data of Thomson Reuters form the basis of their bibliometric analysis. As the data collection method is massive and systematic the citation analysis results are statistically significant. This is the reason that Thomson Reuters' citation index, accessible via *Web of Science*, is used as the worldwide standard for bibliometrics.

The following steps are used to retrieve the relevant data

1. Using Advanced search feature, the country field tag India (CU= (India) was used as the query command and the period of analysis covered (time span) was from 2000 to 2010. The citation database "Science Citation Index Expanded "(SCI-EXPANDED)" was checked.

2. From the search results, the Web of Science Categories = (MATHEMATICS OR MATHEMATICS APPLIED OR STATISTICS PROBABILITY) were chosen to refine the search.

3. The analysis was further limited to only journal articles and conference proceedings and books.

4. Author search option was used eg. 'Distinct Author Sets: chaturvedi ajit*'

MathSciNet

MathSciNet (www.ams.org/mathscinet) is an electronic publication offering access to well maintained and easily searchable database of reviews, abstracts and bibliographic information for the mathematical sciences literature. Over 100,000 new items are added each year, most of them classified according to the http:// www.ams.org/msc/ Mathematics Subject Classification. Authors are uniquely identified (by their MR Author ID), enabling a search for publications by individual author rather than by name string. MathSciNet contains almost 3 million items and over 1.7 million direct links to original articles. Bibliographic data from retro digitized articles dates back to the early 1800s. Reference lists are collected and matched internally from approximately 550 journals, and citation data for journals, authors, articles and reviews is provided. This web of citations allows users to track the history and

influence of research publications in the mathematical sciences. MathSciNet contains bibliographic data and direct links for Ph.D. theses published in Mathematics, Applied Mathematics and Statistics from the ProQuest Dissertations & Theses database, the most comprehensive collection of dissertations and theses in the world.

The following steps to retrieve the relevant data

1. Publication results for Institutions eg. "(Institution Code=(6-HYDR-DMS)) AND Pub year in [2000-2010]"

2. Publication results for Authors eg. "(Author =(chaturvedi, ajit)) AND Pub year in[2000-2010]"

3.8 Administration of Questionnaire

A letter detailing the study and its purpose was given to the Faculty Members by the researcher personally. Personal contacts were also used for the Faculty Members working in the different universities of India. As direct access to the Departments was difficult due to time and space constraints, a contact in each University was identified by the researcher to act as a liaison between researcher and Faculty Members. That information which was not able to be collected by the researcher personally, then with the help of web pages

and telephonic interviews data were gathered. The date for launch of the survey was 20 July 2011 and ended by April 2013.

3.9 Limitations of the study.

The study as has been mentioned will be limited to the Central Universities and no other central organizations nor any research institutes having the Department of Statistics neither any state or deemed universities been included under the purview of the study. Further, the study will be confined only to the publications such as articles in the peer-reviewed journals, books, etc and other research output like patent filling, editorials, research reviews etc will be excluded the study. Moreover, the publications of the faculties working exclusively in the Department of Statistics in the colleges affiliated to the Central University will be excluded from the study. Further limitation of the study is it is restricted to one decade i.e, 2000 to 2010.

Chapter 4

Data analysis and interpretation

4.1 Introduction

Measurement of research performance is a very difficult task and it depends on many aspects. Various intrinsic and extrinsic factors are considered for research evaluation. This study is designed to be exploratory in nature and aimed to reflect a clear picture of the current situation of research productivity of the Faculty Members.

The questionnaire collected general information of Faculty Members, departmental information, publication information, referred publication, authorship pattern and the citations. Analysis about the productivity of the Faculty Members with regard to projects completed, publications, and referred publication for each Department is calculated and divided by the respective Faculty size. As mentioned in earlier chapter research productivity is the totality of research performed by academics in universities and related contexts within a given time period.

Data analysis is an intermediary stage of work between data collection and data interpretation. The data gathered in the form of questionnaires /interviews/direct observations is mostly in the form of research variables. The research variables recognized is a result of preliminary research plan, which also sets out the data processing methods beforehand. Analysis of data requires advance planning and this planning may cover such aspects as identification of variables, hypothetical relationship among the variables and the tentative research hypothesis.

The various steps in analysis of data may be stated as:

(a) Identifying the variables – The different aspects of research questions are the variables. Eg, age, sex , experience , number of articles published.

(b) Editing the data – Editing is a process of checking to detect and correct errors and omissions. Data editing happens at two stages, one at the time of recoding the data and second at the time of analysis of data. The editing step checks for the completeness, accuracy and uniformity of the data set created by the researcher.

(c) Coding and Classification – The edited data are then subject to codification and classification. Coding process assigns numerals or other symbols to the several responses of the data set. It is therefore a pre-requisite to prepare a coding scheme for the data set. The recording of data is done on the basis of this

coding scheme. The first coding done to primary data sets are the individual observations. This response sheet coding gives a benefit to the research as the verification and editing of recordings and further contact with respondents can be achieved without any difficulty. The codification can be done at the time of distribution of the primary data sheets itself. The coding can be numeric or alphabetic or alphanumeric. Classification is required to code the open-ended responses. Publications are an open-ended questions from all responses, a suitable classification can be arrived. Classification should be linked to the theory and the aim of the particular study. The scheme of classification should be exhaustive. There must be a category for every response. The classifications of the designation of Faculty Members are 'Professors', 'Associate Professors' and 'Assistant Professors'.

(d) Transcriptions of data: The main aim of transcription is to minimize the shuffling process between several responses and several observations. This process requires the preparation of the data sheets where observations are the rows of the database and the responses are the columns of the data sheet. Each research question is given a level so that long question can be covered under the label names. The label names are links to the research questions.

(e) Tabulation of data: Tabulation is a process of summarizing raw data and displaying them on compact statistical table for further analysis. Tabulation can be done manually or through the computer. The choice depends on the size and type of study, cost considerations, time pressures and the availability of software packages.

(f) Construction of frequency table: Frequency tables provide 'shorthand' summery of data. The table facilitates comprehending masses of data at a glance, they conserve space and reduce explanation and description to a minimum. They give a visual picture of relationships between variables and categories. They facilitate summation of items and the detection of errors and omissions and they provide a basis for computations.

(g) Graphs / Charts/ Diagrams: In presenting the data of frequency distributions and statistical computations it is often desirable to use appropriate forms of graphic presentation. In addition to tables graphic presentations involves use of graphics charts and other pictorial devices such as diagrams. These forms and devices reduce large masses of statistical data to a form that can be quickly understood at a glance. Graphic presentation emphasize new and significant relationships and are useful in discovering new facts in developing hypotheses.

Here in this study results of data analysis will start with the general information of the Faculty Members and proceed to provide answers to research questions in the order they were listed in the questionnaire.

Significant results will be displayed along with tables and figures. Further, the data is analyzed to find the correlation between the variables under study, the degree of correlation helps us to examine that we have we have moved in correct path. A positive correlation between two variables is an indication that there is a direct relation between the two variables. If one variable increase the other variable will also increase and vice versa. Eg If the strength of Faculty Members increase in a Department then the publications of the Department will also increase. Further, the least square method is used to analyze the data for determining the number of expected publications by the Faculty Members. The publications in the succeeding years and they are the publications after the period 2000-2010 is also estimated.

4.2 Distribution and response rate of questionnaires

The Faculty Members are all around the country and there are 82 Faculty Members in the various Departments. 82 questionnaires were distributed to all the Faculty Members, 49 (60%) questionnaires were collected. And the remaining questionnaires were filled up from the information about the Faculty Members available from the websites of the respective Departments. In case of Departments which do not provide any information in their websites, over phone information about Faculty Members was collected.

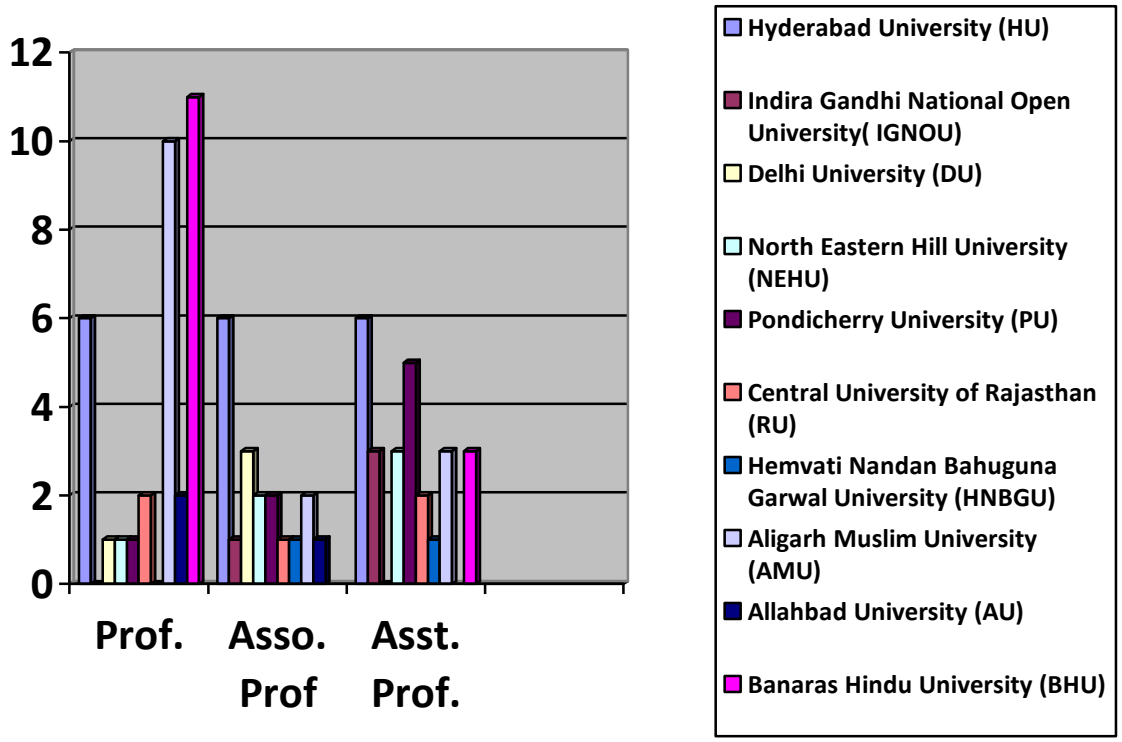
4.3 Personal Details of Faculty Members

The general information of Faculty Members is characterized by six unique variables and they are year of establishment, qualification, specialization and designation that are analyzed in the later part of this section. There are in total 11 Departments under study and the basic details were collected and presented in Table 4.1 on next page.

Table 4.1 Basic details of the Departments

Sl. No.	Departments	Break-up of Faculty	Faculty size	Year of East.
1.	Allahabad University (AU)	Professor-2 Asso. Prof.-1 Asst. Prof.-0	3	1968
2.	Aligarh Muslim Unversity (AMU)	Professor-10 Asso. Prof.-2 Asst. Prof.-3	15	1953
3.	Banaras Hindu University (BHU)	Professor-11 Asso. Prof.-0 Asst. Prof.-3	14	1950
4.	Delhi University (DU)	Professor-1 Asso. Prof.-3 Asst. Prof.- 0	4	1957
5.	Hemvati Nandan Bahuguna Garwal University (HNBGU)	Professor-0 Asso. Prof.-1 Asst. Prof.-1	2	1978
6.	Hyderabad University (HU)	Professor-6 Asso. Prof.-6 Asst. Prof.-6	18	1978
7.	Indira Gandhi National Open University (IGNOU)	Professor-0 Asso. Prof.-1 Asst. Prof.-3	4	2009
8.	Manipur University (MU)	Professor-0 Asso. Prof.-1 Asst. Prof.-2	3	2008
9.	North Eastern Hill University (NEHU)	Professor-1 Asso. Prof.-2 Asst. Prof.-3	6	2005
10.	Pondicherry University (PU)	Professor-1 Asso. Prof.-2 Asst. Prof.-5	8	2006
11.	Central University of Rajasthan (RU)	Professor-2 Asso. Prof.-1 Asst. Prof.-2	5	2009
		Total	82	

Figure 4.1: Representation of the Faculty Members



4.3.1 Designation

Out of the 82 Faculty Members 34 are Professors, 20 are Associate Professors and 28 are Assistant Professors. From the above figure we can see that, the Department of BHU has the maximum number of Professors followed by the Department of AMU. For Associate Professors the Department of HU leads followed by the Department of DU. Finally in case of Assistant Professors the Department of HU leads followed by the Department of PU.

4.3.2 Qualification

Regarding the highest qualification of the Faculty Members, during the study it is found that out of 82 Faculty Members, 75 Faculty Members have Ph.D as their highest qualification, 3 Faculty Members have M.Phil and 4 Faculty Members have Masters as their highest qualification.

4.3.3 Specialization

Specialization of Faculty Members refers to the research and teaching conducted in the field of a subject that is of interest to the Faculty Members

The major specialized areas of the discipline statistics are

1). Statistical Inference 2). Demography

3). Sampling 4). Reliability Theory

5). Bayesian Applications 6). Stochastic Process

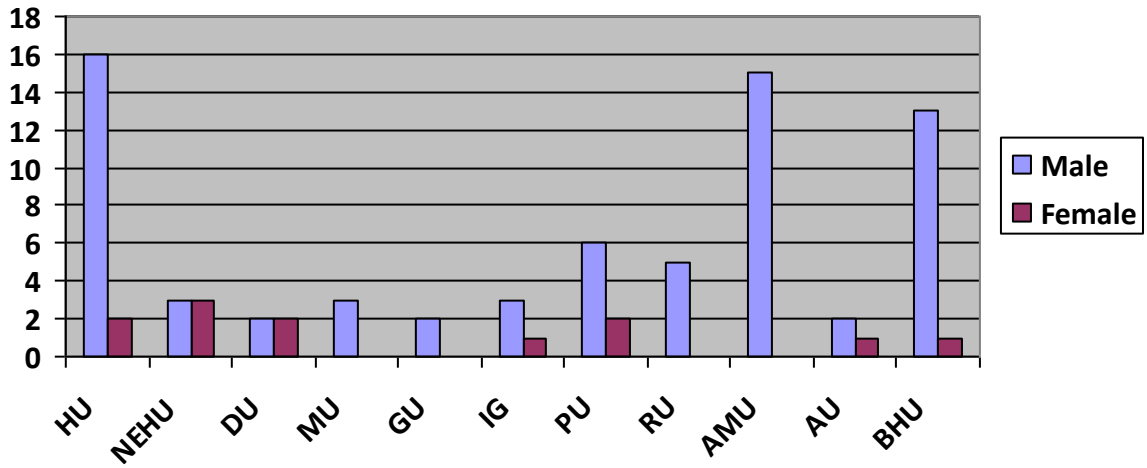
7). Operation Research 8). Differential Equations

4.3.3.1 A question was asked that whether the research area of the Faculty Members has changed over time as one gain more experience. The response was 70 (80%) out of 82 Faculty Members mentioned that there is no change in the research area in their full career.

4.3.4 Gender

Out of the total 82 Faculty Members from 11 Departments, 12 (14%) Faculty Members are female and rest 70 are male Faculty Members. The diagrammatic representation of gender in the 11 Departments is given in the Figure 4.2 below

Figure 4.2: Gender wise distribution of Faculty Members



From the above figure we can find that there is a gender disparity among the Faculty Members in the Department of AMU, BHU, HU, PU and RU. In case of the Departments of NEHU, DU there is no gender disparity.

4.4 Department Details

4.4.1 Courses Conducted

The courses conducted by the 11 Departments are categorised as 1). M.Phill/Ph.D in Statistics 2). PG in Statistics and 3). PG Diploma in Statistical Methods. Among all the 11 Departments, 9 Departments conduct the M.Phil/Ph.D programmes except the Departments of IGNOU and Rajasthan University.

All of the 11 Departments conduct the PG courses in Statistics. The 2 Departments of Pondicherry University and NEHU conduct the PG Diploma in Statistical Methods.

4.4.2 Projects Completed

Regarding the number of major projects completed by the Faculty Members, only 32 (26%) of the Faculty Members mentioned that they have worked in a project. Out of the 11 Departments 5 Departments of Delhi University, HU, AMU, GU and BHU had worked and completed research projects in the period 2000-10. The number of Projects completed by the Departments is given in Table 4.2 below

Table 4.2: Department wise Projects completed

Sl. No.	Departments	Major Projects completed (in No.)
1.	Banaras Hindu University (BHU)	9
2.	Hyderabad University (HU)	5
3.	Delhi University (DU)	3
4.	Aligarh Muslim University (AMU)	2
5.	Pondicherry University (PU)	1
6.	Hemvati Bahuguna Garwal University (GU)	1

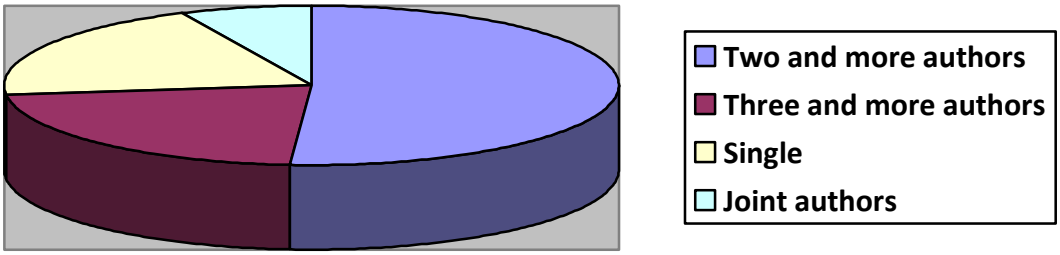
Thus on the basis on the Number of Projects completed it is found that the Department of BHU leads other Departments. HY and DU holds the 2nd and 3rd position respectively.

4.4.3 Collaboration Pattern

Regarding the collaboration pattern it is found that during the period 2000-10 , 51% (304) of the publications are published by two and more authors, 22% (131) of the publications are published by three and more authors, 20 % (119) of the publications are published by single author and rest 7% (43) of the

publications are published by joint authors. It must be mentioned that during the study it was found only Faculty Members of Hyderabad University have the pattern of publishing single. The figures above can be diagrammatically represented in the Fig. 4.3 below

Fig 4.3: Representation of the collaboration pattern.



4.4.4 Authors Productivity using Lotka's Law

In 1926, Alfred J. Lotka, a statistician of the Maropolitan Life Insurance Company used the index of Chemical Abstracts and derived the equation., $x^a y = c$ where x stands for the number of contributions, y for the number of authors and (a and c) are constant. This finding finally became known as Lotka' s law or the inverse square law of scientific productivity. Lotka's Law indicate that " … the number of authors making n contributions is about $1/n^2$ of those making one; and the proportion of all contributors, that make a single contribution is about 60 %". That means out of all authors in a given field, 60% will have one publication, 15% will have two publications, 7 % of the authors will have three publications and so on.

The scholar checked whether the publications of the faculty members is in compliance with Lotka's Law, which is applicable to author's productivity. The equation to represent Lotka's inverse square law which is mathematically expressed as:

$$x^a y = c \quad \text{…….. (Equation 1)}$$

where x stands for the author's contribution, y stands for the number of authors and c is a constant .The value of c was determined by putting in the value of the pair of data in Equation 1. Considering the fact that 16 authors have produced one article each, the value of constant c can be obtained :

$1^a y = c$ ($1^a = 1$) ……. (Equation 2)

$y = c$, $c = 16$

The value of a can be determined by using the pair of data in Equation 2 :

$2^a y = c$

$2^a = 16/6 = 2.67$

$a = \log 2.67/\log 2 =$

$a = .4265/.3010 = 1.417$

Comparing the data set ('a'=1.414 and the observed values of 'y') to calculate the expected values, it may be said the data sets do not follow Lotka's Law (the difference between observed values and the expected values is wide for x =2). Lotka's law holds true when applied to large bodies of literature over a quite long period of time. Here the observed values of authors contribution is 16 authors contributed one paper, 6 authors contributed two paper, 42 authors contributed three papers and 18 contributed 4 papers and as such Lotka's Law does not hold true. Even in the study it is found that the faculty members of Hyderabad University publish single. Carey (2007) In the subject areas like mathematics and statistics the publications are published less and citations are few as because a paper is cited for a result and due to infrequent publication, time-lag etc.

4.5 Publication Details

When the Faculty Members were asked that whether their publications are included in the Indexing / abstracting journals / citation databases. The response rate is low, as only 25 (30%) of the Faculty Members mentioned that their publications are cited in the major Indexing / Abstracting / citation databases.

The year wise distribution of research outputs that are the publications from the 11 Departments and all the different forms of publications such as Books, Journal Articles and Conference Proceedings by the 82 Faculty Members from the 11 Departments is given in Table 4.3 and Table 4.4 on next page

Table 4.3: Breakup of the Publications

Dept.	Articles	Conf. Procee.	Books.	Total Pub.
AU	Prof.- 16 Asso Prof.- 6] 22 Astt. Prof- 0	Prof.-4 Asso Prof.- 2]6 Astt. Prof-0	Prof.- 2 Asso Prof.- 0]2 Astt. Prof-0	**30**
AMU	Prof.- 130 Asso.Prof.-35] 181 Astt. Prof- 16	Prof.- 5 AssoProf.-3]13 Astt. Prof -5	Prof.- 4 Asso Prof.-1]5 Astt. Prof-0	**197**
BHU	Prof.- 132 Asso Prof.-0] 161 Astt. Prof- 29	Prof.- 7 Asso Prof.-0]10 Astt. Prof-3	Prof.- 14 AssoProf.-0] 14 Astt. Prof-0	**185**
DU	Prof.- 21 Asso Prof.-53] 74 Astt. Prof- 0	Prof.- Asso Prof.-]0 Astt. Prof		**74**
GU	Prof.- Asso Prof.- 5]8 Astt. Prof-3	Prof.- Asso Prof.-] 0 Astt. Prof		**8**
HU	Prof.- 51 Asso Prof.- 9] 62 Astt. Prof- 2	Prof.- Asso Prof.-] 0 Astt. Prof		**62**
IGNOU	Prof.- Asso Prof.- 0] 0 Astt. Prof-	Prof.- Asso Prof.-]0 Astt. Prof		**0**
MU	Prof.- 0 Asso Prof.- 3] 5 Astt. Prof- 2	Prof.- Asso Prof.-]0 Astt. Prof		**5**
NEHU	Prof.- 4 Asso Prof.- 2]6 Astt. Prof-	Prof.- Asso Prof.-]0 Astt. Prof		**6**
PU	Prof.- 7 Asso Prof.- 3] 12 Astt. Prof- 2	Prof.- 3 Asso.Prof.- 7]13 Astt. Prof-3	Prof.- 0 Asso Prof.- 4]5 Astt. Prof-1	**30**
RU	Prof.- Asso Prof.- 0]0 Astt. Prof-	Prof.- Asso Prof.-]0 Astt. Prof		**0**
Total	**529**	**42**	**26**	**597**

Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University-HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University- NEHU, Pondicherry University- PU, Central University of Rajasthan- RU

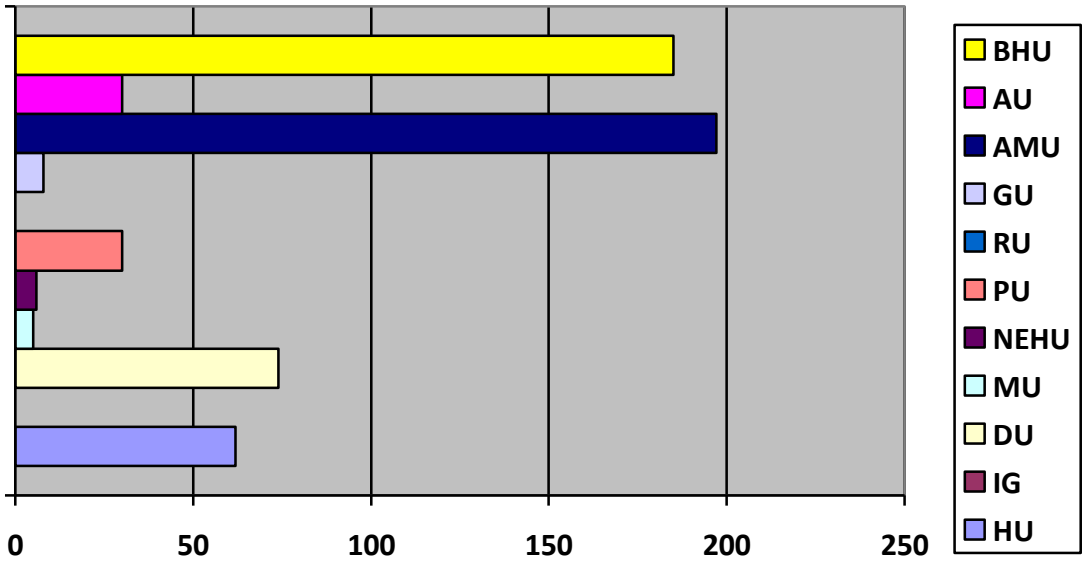
Table 4.4: Year wise Distribution of Publications

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Pub.
AU	2	2	2	3	2	2	2	3	4	3	5	**30**
AMU	8	11	7	12	12	15	14	26`	21	40	31	**197**
BHU	16	13	20	12	11	17	19	14	22	23	18	**185**
DU	2	1	4	6	8	7	8	5	8	10	15	**74**
GU	-	1	1	-	2	-	2	1	-	-	1	**8**
HU	4	7	5	7	12	1	4	8	5	1	8	**62**
IGN	-	-	0	-	-	-	-	-	-	-	-	**0**
MU	-	-	-	-	-	1	-	1	-	2	1	**5**
NEHU	-	-	-	-	-	-	-	1	2	-	3	**6**
PU	-	-	-	--	-	-	-	-	-	12	18	**30**
RU	-	-		-	-	-	-	-	-	-	-	-
	30	**35**	**39**	**40**	**43**	**47**	**49**	**59**	**62**	**91**	**100**	**597**

Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University-NEHU, Pondicherry University- PU, Central University of Rajasthan- RU

From the above Tables we find that in terms of publications the Department of AMU has the highest number of publications followed by the Department of BHU and DU respectively which is well displayed in the Fig.4.4 below

Fig 4.4: Research output of Faculty Members

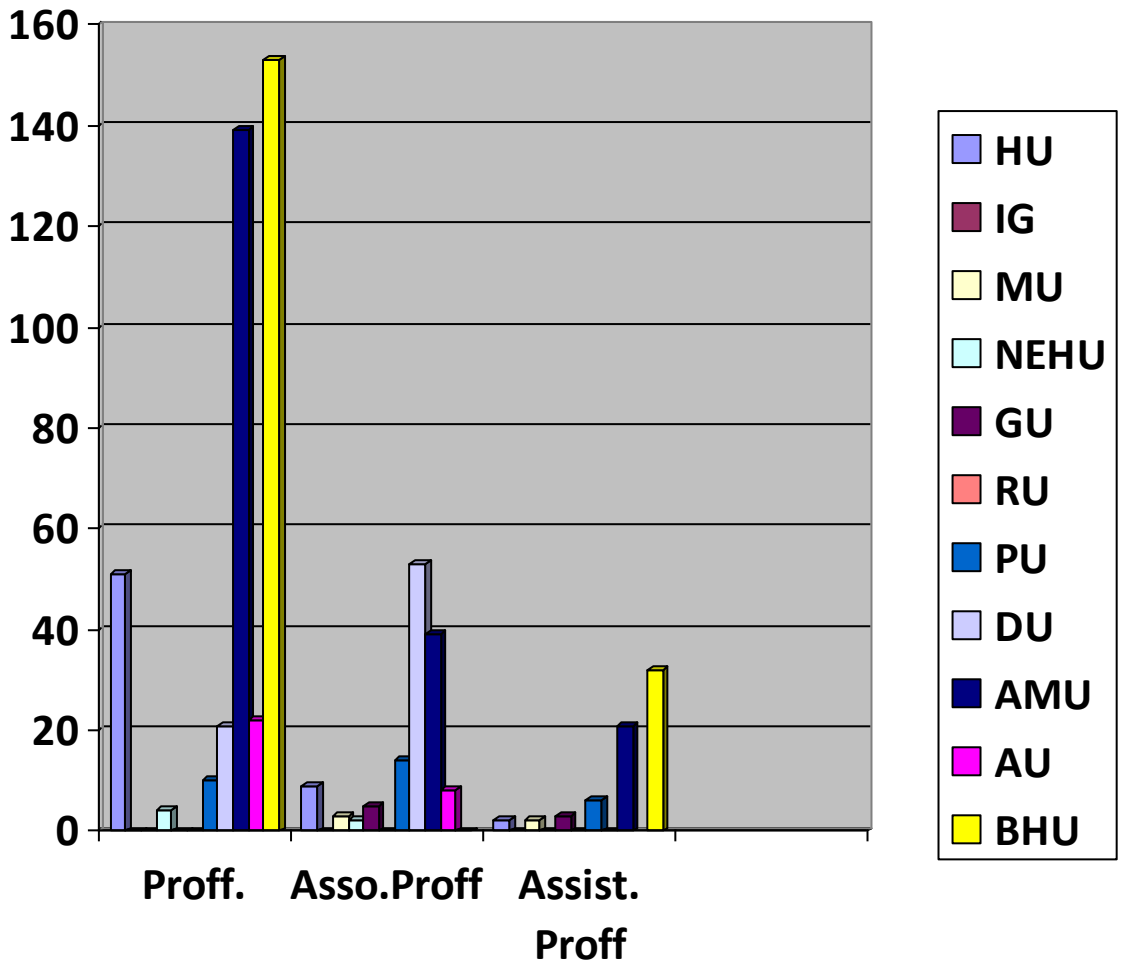


Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University- NEHU, Pondicherry University- PU, Central University of Rajasthan- RU

4.5.1 Publication Pattern

Among the Professors, Associate Professors and Assistant Professors, Professors are contributing most publications. The Fig. 4.5 below describes the publications from each Department along with the publication pattern by the Professors, Associate Professors and Assistant Professors.

Figure 4.5: Designation wise Publication pattern



Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University- NEHU,Pondicherry University- PU, Central University of Rajasthan- RU

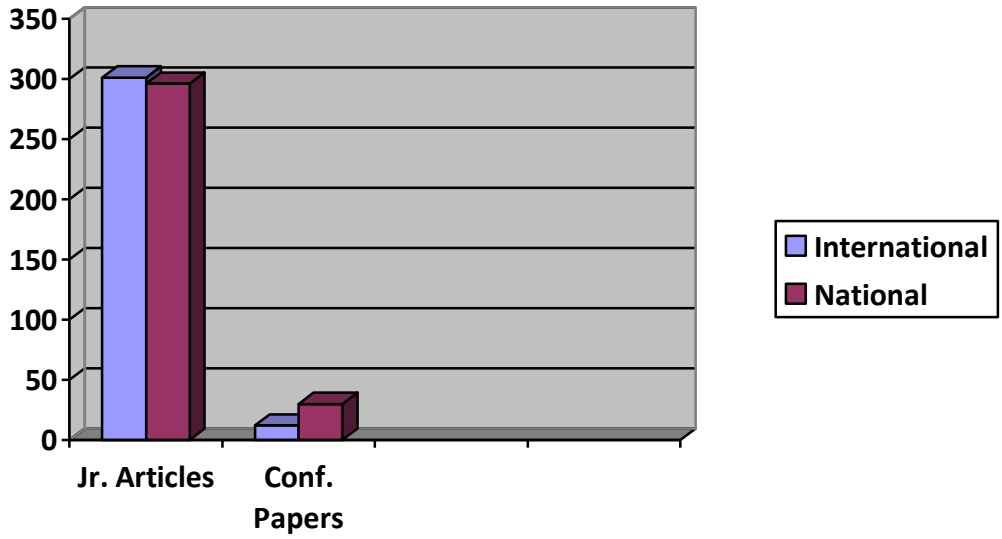
From the Figure 4.5 we can see that among the Professors, the Professors of the Department of BHU are leading followed by the Professors of the Departments AMU and HU respectively.

Among the Associate Professors, the Associate Professors of the Department of Delhi University are leading followed by the Associate Professors of the Departments of AMU and Pondicherry University and lastly among the Assistant Professors, the Assistant Professors of BHU are leading followed by the Assistant Professors of AMU and Pondicherry University. Thus we find that in case of total publications the Departments of BHU and AMU are most active.

4.5.2 Scope of Journal Articles

It is found that out of 529 Journal articles, published by the Faculty Members in 200-2010. The number of articles at International journals are 301 (57%) and the number of journal articles at national level is 296 (43%). Out of the 42 conference papers published by the Faculty Members in 2000-2010, 12 papers are presented in International level conferences and rest 30 papers are presented at National/Regional level. The scope of the papers is given below in Fig 4.6

Fig. 4.6: Scope of Research Papers



4.5.3 Identification of Core Journals

The literature in Statistics covered in the present study (2000-2010) comprises a total of 529 articles published in 120 journals. The core journals are the journals that publish four or more articles each. The largest number of papers were published in the Journals mentioned in the Table 4.5 on next page

Table 4.5: Identification of Core Journals

Sl. No.	Name of Journal
1.	International Journal of Operation Research
2.	Aligarh Journal of Statistics
3.	International Journal of Applied Mathematics
4.	International Journal of Computer Science & Engineering
5.	Pakistan Journal of Statistics
6.	Journal of Applied Probability and Statistics
7.	Fluids Dynamics Research
8.	Proceedings of Indian Academy of Sciences
9.	Environment and Ecology
10.	Journal of Algebra
11.	Indian Journal of Horticulture
12.	Journal of Safety & Reliability
13.	Archives of Mechanics
14.	Mechanics Research Communications
15.	Indian Journal of Pure and Applied Mathematics
16.	Journal of Mathematics & Physical Science
17.	Archives of Mechanics
18.	Journal of Mathematics
19.	ZAMM

4.5.4 Referred Publication

Referred publications are the publications that are indexed in the citation database of Web of Science and MathSciNet. The research productivity of the Faculty Members in the 11 Departments for the period 2000-2010 is given in the Table 4.6 and Table 4.7. The publications are grouped in two blocks firstly the referred publications cited by Web of Science and MathSciNet and secondly the Total publications by the Faculty Members in the specified period.

Table 4.6: Referred publications

Dept. (1)	Faculty size (2)	Web of Science (WS) (3)	Math Sci Net (MSN) (4)	WS+MSN (5)	Total Publications (6)
AU	**3**	0	19	**19**	**30**
BHU	**14**	5	24	**29**	**185**
AMU	**15**	4	8	**12**	**197**
DU	**4**	6	43	**49**	**74**
GU	**2**	0	0	**0**	**8**
HU	**18**	26	48	**74**	**62**
IGNOU	**4**	0	0	**0**	**0**
MU	**3**	1	0	**1**	**5**
NEHU	**6**	0	0	**0**	**6**
PU	**8**	2	0	**2**	**30**
RU	**5**	0	0	**0**	**0**
Total	82	**44**	**142**	**186**	**597**

Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University-HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University- NEHU,Pondicherry University- PU, Central University of Rajasthan- RU

Table 4.7: Year wise Distribution of referred articles

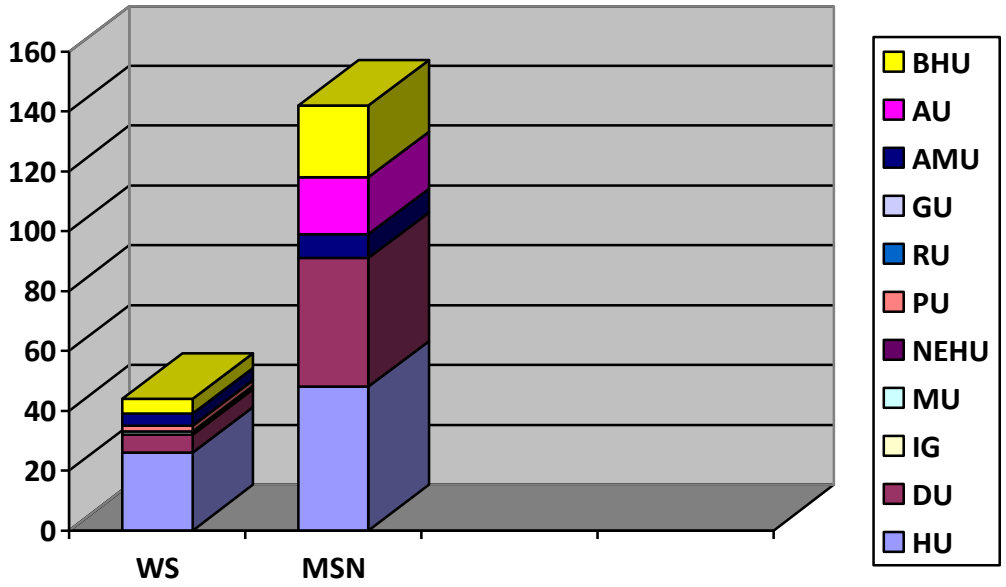
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Pub.
AU	1	1	2	2	1	1	1	2	2	3	3	**19**
AMU	1	1	1	1	1	1	1	1	1	2	1	**12**
BHU	1	1	2	2	3	2	2	3	3	5	4	**28**
DU	1	1	3	4	5	3	4	5	6	7	10	**49**
GU	0	0	0	0	0	0	0	0	0	0	0	**0**
HU	6	7	6	8	10	6	5	10	5	0	11	**74**
IGN	0	0	0	0	0	0	0	0	0	0	0	**0**
MU	0	0	0	0	0	0	0	0	0	0	1	**1**
NEHU	0	0	0	0	0	0	0	0	0	0	0	**0**
PU	0	0	0	0	0	0	0	0	0	2	0	**2**
RU	0	0	0	0	0	0	0	0	0	0	0	**0**
	10	**11**	**14**	**17**	**20**	**13**	**13**	**21**	**17**	**19**	**30**	**186**

Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University- NEHU,Pondicherry University- PU, Central University of Rajasthan- RU

From the above tables it can be said that in case of referred publications, Hyderabad University followed by Delhi University has the highest number of referred publications. The Departments of AMU followed by BHU have the highest number of Total publications.

From the above Table 4.4 that is about the referred publications of the 82 Faculty Members from the 11 Departments the graphical representation is given below in the figure 4.7 on next page

Figure 4.7: Referred publications



Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University-NEHU,Pondicherry University- PU, Central University of Rajasthan- RU, Web of Science -WS, MathSciNet - MSN

From the above Figure 4.7, we find that the citation database of MSN cites more publications of Faculty Members as compared to the database of WS. The selection and coverage procedure of publications in MSN is wider as it covers reviews, abstracts, journals, conference proceedings, letters, editorials, books, PH. D Theses and bibliographic information for the mathematical sciences literature. WS has coverage of high impact Journals, highly cited books and conference proceedings.

4.6 Correlation Analysis

The degree of relationship between the variables under consideration is measured through the correlation analysis. The measure of correlation called the correlation coefficient or correlation index summarizes in one figure the direction and degree of correlation. Thus correlation is a statistical device which helps us in the analysis of the co variation of two or more variables. The Karl Pearson coefficient of correlation is used in practice for measuring correlation. It is denoted by the symbol *r*. The formula for describing the correlation between two series is:

$r = \sum xy / \sqrt{(\sum x^2 * \sum y^2)}$,

Here $x = (X - \bar{X})$; $y = (Y - \bar{Y})$

$\sum x^2$ = sum of squares of series X,

$\sum y^2_y$ = sum of squares of series y,

N = Number of pairs of observation .

The value of r lies between ± 1

1. When *r* = +1, it means that there is a perfect positive relationship between the variables.
2. When *r* = -1, it means there is perfect negative relationship between the variables. When *r*= 0, it means there is no relationship between the variables, the variables are uncorrelated.
3. The closer *r* is to +1 or -1 , the closer the relationship between the variables and the closer r is to 0, the less close the relationship .

Karl Pearson coefficient of correlation is used in Library & Information Science to know the cause and effect relation between the two variables under consideration. If the two variables are plotted on a scatter diagram a straight line will be formed and by joining the points of the variables, straight lines can be formed that can be used to know the development of library over a period of time. The correlation coefficient can be used by the librarian for comparison between previous and current activities, services and library collection. It can also be used for the evaluation of staff performance. It summarizes in one value the degree of correlation and direction of correlation. The information about the variables can be collected from the Gate register, reports, written documents of library and library software.eg library users and library usage.

In this study the Correlation between the variables 1) Faculty size (x) and total publication(y) and the Correlation between 2) Faculty size (x) and referred publication (z) are studied and presented in the Table 4.8 below

Table 4.8: Karl Pearson's coefficient of correlation

Dept	Faculty size (x)	Total Pub. (y)	Referred Pub. (z)	X^2	Y^2	Z^2	xy	xz
AU	3	30	19	9	900	361	90	57
AMU	15	197	12	225	38809	144	2955	180
BHU	14	185	28	196	34225	784	2590	392
DU	4	74	49	16	5476	2401	296	196
GU	2	8	0	4	64	0	16	0
HU	18	62	74	324	3844	5476	1116	1332
IG	4	0	0	16	0	0	0	0
MU	3	5	1	9	25	1	15	3
NEHU	6	6	0	36	36	0	36	0
PU	8	30	2	64	900	4	240	16
RU	5	0	0	25	0	0	0	0
	82	**597**	**185**	**924**	**84279**		**7354**	**2194**

Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open University- IGNOU, Manipur University- MU, North Eastern Hill University-NEHU, Pondicherry University- PU, Central University of Rajasthan- RU

$$r_{xy} = \frac{N\sum XY-\sum X\sum Y}{\sqrt{(N\sum X^2-(\sum X)^2)}\sqrt{(N\sum Y^2-(\sum Y)}}$$

$$= + 0.72$$

Thus, there is a high degree of positive Correlation between Faculty size and Total Publication.

$$r_{xz} = \frac{N\sum XZ-\sum X\sum Z}{\sqrt{(N\sum X^2-(\sum X)^2)}\sqrt{(N\sum Z^2-(\sum Z)}}$$

$$= + 0.58$$

Thus, there is a positive correlation between Faculty size and Referred Publication.

To determine the trend of the Publications growth in the succeeding years, the Least Square method is used. This method is most widely used in practice. It is a mathematical method and with its help a trend line is fitted to the data in such a manner that the following two conditions are satisfied:

1. $\sum (Y-Y_c) = 0$ i.e sum of deviations of the actual values of Y and the computed values of Y is zero.
2. $\sum(Y-Y_c)^2$ is least. i.e, the sum of squares of the deviations of the actual and computed values is least from this line and hence the name of method of least squares. The line obtained by this method is known as 'as the line of best fit'.

The straight line trend is represented by the equation $Y_c = a+bX$

In order to determine the values of the constants a and b the following two normal equations are solved:

$$\sum Y = Na + b \sum X \quad \text{and} \quad \sum XY = a\sum X + b\sum X^2$$

Where, N represents number of years (months or any other any period) for which data is taken.

The values of a and b can be determined from

$$a = \sum Y/N \text{ or } \bar{Y} \quad \text{and} \quad b = \sum XY/\sum X^2$$

To determine the expected number of publications in the year 2011, 2012, 2013 and 2014 the following Table 4.9 is prepared

Table 4.9: Publication Estimation by Least Squares

Year (x)	Publication (y)	Deviation from 2005 (X)	Xy	X^2	Y_e
2000	32	-5	-160	25	23.52 ≈ 24
2001	35	-4	-140	16	29.67 ≈ 30
2002	39	-3	-117	9	35.82 ≈ 36
2003	40	-2	-80	4	41.97 ≈ 42
2004	43	-1	-43	1	48.12 ≈ 48
2005	47	0	0	0	54.27 ≈ 54
2006	49	1	49	1	60.15 ≈ 60
2007	59	2	118	4	66.57 ≈ 67
2008	62	3	186	9	72.72 ≈ 73
2009	91	4	364	16	78.87 ≈ 79
2010	100	5	500	25	85.02 ≈ 85
2011		6			91.17 ≈ 91
2012		7			97.32 ≈ 97
2013		8			103.47 ≈ 103
2014		9			109.62 ≈ 110

The equation is $Y_e = a + b X$

$a = \sum y/N = 597/11 = 54.27$, $b = \sum Xy/\sum X^2 = 677/110 = 6.15$

Thus, $Y_e = 54.27 + 6.15X$

When X = 6 then $Y_{2011} = 91.17 \approx 91$
X = 7 then $Y_{2012} = 97.32 \approx 97$
X = 8 then $Y_{2013} = 103.47 \approx 103$
X =9 then $Y_{2014} = 109.62 \approx 110$

Using the values of the constants 'a' and 'b' the values of Y_e are estimated, Y_e is the expected number of publications.

To determine the expected number of referred publications in the year 2011, 2012, 2013 and 2014 the following Table 4.10 is prepared and given below

Table 4.10: Referred Publications Estimation by Least Squares

Year(x)	Referred pub (y)	Deviations from 2005 (X)	Xy	X^2	Y_e
2000	10	-5	-50	25	10.82 ≈ 11
2001	11	-4	-44	16	12.02≈ 12
2002	14	-3	-52	9	13.22≈ 13
2003	17	-2	-34	4	14.42≈ 14
2004	20	-1	-20	1	15.62≈ 16
2005	13	0	0	0	16.82≈ 17
2006	13	1	13	1	18.02≈ 18
2007	21	2	42	4	19.22≈ 19
2008	17	3	51	9	20.42≈ 20
2009	19	4	76	16	21.62≈ 22
2010	30	5	150	25	22.82≈ 23
2011		6			24.02≈ 24
2012		7			25.22≈ 25
2013		8			26.42≈ 26
2014		9			27.62≈ 28

$Y = a+bx$

$a = \sum y/N$ $\quad$ $b = \sum xy / \sum x^2$

$=16.82$ $\quad$ $=132/110=1.2$

Thus, $Y=16.82+1.2x$

When $X = 6$ then $Y_{2011} = 24.02 \approx 24$
$X = 7$ then $Y_{2012} = 25.22 \approx 25$
$X = 8$ then $Y_{2013} = 26.42 \approx 26$
$X = 9$ then $Y_{2014} = 27.62 \approx 28$

Using the values of the constants 'a' and 'b' the values of Y_e are estimated, Y_e is the expected number of referred publications.

To determine the relationship between the variables, Estimated Total publication and Estimated Referred publications in the succeeding years the correlation is studied and presented in the Table 4.11

Table 4.11: Karl Pearson's Coefficient of Correlation for Estimated Publications

Year(x)	Referred pub. Y_{Re} (X)	Total pub. Y_{Te} (Y)	XY	X^2	Y^2
2000	10.82	23.52	254	117	553
2001	12.02	29.67	356	144	880
2002	13.22	35.82	473	174	1283
2003	14.42	41.97	605	207	1761
2004	15.62	48.12	751	243	2315
2005	16.82	54.27	912	282	2945
2006	18.02	60.15	1083	324	3618
2007	19.22	66.57	1279	369	4431
2008	20.42	72.72	1484	416	5288
2009	21.62	78.87	1705	467	6220
2010	22.82	85.02	1940	520	7228
2011	24.02	91.17	2189	576	8311
2012	25.22	97.32	2454	636	9471
2013	26.42	103.47	2733	698	10706
2014	27.62	109.62	3027	762	12016
			21245	5935	77026

Thus, $r = \dfrac{N\sum XY-\sum X\sum Y}{\sqrt{(N\sum X^2-(\sum X)^2)}\sqrt{(N\sum Y^2-(\sum Y)^2}}$

$$= \frac{15(21245)-(998)(288)}{\sqrt{6081}\ \sqrt{159386}} = \frac{318675-287424}{77.98 * 399.23}$$

$$= 1.003 \approx 1$$

As r =1 we can say that there is a strong positive relationship between the estimated total publications and estimated referred publications.

To find the research productivity of each department based on the publication output the Table 4.12 is prepared and presented below

Table 4.12: Department wise Research Productivity

Dept. (1)	Faculty size (2)	WS+ MSN (C) (3)	Pub. (P) (4)	Avg. Ref. Pub (C) (3)/(2) =(5)	Avg. Pub.(P) (4)/(2)=(6)	Resh. Output (3)+(4) = (7)	Resh. Prod. (RP) (5)+(6)=(8)
AU	**3**	19	30	**6.3**	**7.3**	49	**13.6**
AMU	**15**	12	199	**0.8**	**12.7**	211	**13.5**
BHU	**14**	29	185	**2.1**	**12**	214	**14.1**
DU	**4**	49	74	**12.25**	**18.5**	123	**30.75**
GU	**2**	0	8	**0**	**4**	8	**4**
HU	**18**	74	62	**4.1**	**3.4**	136	**7.5**
IGNOU	**4**	0	0	**0**	**0**	o	**0**
MU	**3**	1	5	**0.3**	**1.6**	6	**1.9**
NEHU	**6**	0	6	**0**	**1**	6	**1**
PU	**8**	2	30	**0.5**	**3**	32	**3.5**
RU	**5**	0	0	**0**	**0**	0	**0**

Here C = Citations per Department, P = Total Publications per Department, Allahabad University-AU, Aligarh Muslim University- AMU, Banaras Hindu University-BHU, Delhi University- DU, Hemvati Nandan Bahuguna Garwal University- GU, Hyderabad University- HU, Indira Gandhi National Open

University- IGNOU, Manipur University- MU, North Eastern Hill University- NEHU,Pondicherry University- PU, Central University of Rajasthan- RU, Web of Science –WS, MathSciNet-MSN, RP = Research Productivity per Department

The publications are grouped in two blocks firstly the referred publications cited by Web of Science and MathSciNet and secondly the total publications by the faculty members in the specified period. Average of each of the blocks is obtained and respectively divided by the faculty size of each department. Research productivity is obtained by adding the Avg. of Referred publications and Avg. of Total publications. Thus looking at figures in the above Table 4.12 we can conclude that the Department of Delhi University leads the other Departments.
The Department of BHU is Second and the Department of AU is Third.

The Departments of HU, DU and AU have a good coverage in Total Publications and Citations.

4.7 Hypothesis Testing

After due analysis of data obtained from the Faculty Members through the questionnaire and interview to find inferences relating to each facet. It came up that the academic staffs are very concerned about the low quality of research in Indian Universities. The two hypotheses formulated earlier for the purpose of testing the hypotheses by the research findings. The hypotheses, which are drawn for the proposed study, are stated below:

H 1) **Research output is directly proportional to the length of service of the Faculty Members.**
Out of the total 82 Faculty Members, 34 are Professors, 20 are Associate Professors and rest 28 are Assistant Professors. The publications among the Professors (Mean = 36.36) is on the top compared to Associate Professors (Mean=12.09) and Assistant Professors (Mean=5.818). As Professors have a more service tenure thus from the above it is revealed that research output is highest in Faculty Members with a long length of service and hence the hypothesis presupposed by the scholar is tested true.

H 2) **The focus area of research changes in the Faculty's career graph and there is a gradual growth in the publication as the author gains more experience in his field.**
During the interview with the Faculty Members it came out that the focus area of research remains the same in the career graph. As 70 (80%) out of 82 Faculty Members mentioned they would like to teach and research in their specialized field. Thus the hypothesis presupposed by the scholar tested is not true.

4.8 Research Problems

India is working hard with reference to growth in the number of universities and colleges over the years, even then the rural-urban and regional difference, in availability of infrastructure such as teaching Faculty,

hostels, housing for teachers, library, laboratories, and computer facilities etc. have widened over the years. The importance of research is well accepted in the universities but even than there is a low level of research productivity. Lack of scholars, gaps in universities and laboratories, deficit R & D budget, pressure from undergraduate programs, infrastructure problems have degraded the research culture in universities which has lower the research productivity of Indian Universities and so none of the Indian Universities are in the top 300 world University rankings.

A research work is always associated with hurdles or problems so a question was asked in this study to find the major problems that the Faculty Members are encountered with while conducting research. Based on the responses from Faculty Members it is found that the major problems can be divided into 2 broad categories of theoretical and practical problems is given in Table 4.13.

Table 4.13: Research Problems

Theoretical
Paucity of journals and research books
Lack of funds
Non access to many full text databases
Inadequate Faculty size
Practical
Lack of funds
Infrastructure
Manpower for Xeroxing
Pressure from Non-Academic Jobs
Irregular Power Supply

On the basis of analysis given in the above Table 4.13 it can be concluded that availability of funds and weak infrastructure is a major problem for the Faculty Members. The Faculty Members also face problems of not having enough journals and books in their specialized fields. Irregular power supply, pressure from non-academic jobs, official delays are the major problems faced by them. The Faculty Members mentioned that inadequate Faculty size, deficit budget, pressure from undergraduate programs, infrastructure problems etc are also problems faced by them.

Chapter 5

Findings, Conclusions and Suggestions

This chapter is divided into three sections: the findings of the study; the conclusions made from the findings and the researcher's suggestions for improving the research productivity in the universities of India.

5.1 Findings

- A total of 82 Faculty Members and 11 Departments are covered in the study. Out of the total 82 Faculty Members 12 (14%) are Females and rest 70 (84%) are Male Faculty Members. This difference shows gender disparity.

- Out of the total 82 Faculty Members, 34 (41%) Faculty Members are Professors, 20 (24%) are Associate Professors and 28 (34%) are Assistant Professors.
- Out of the 14 Departments approved by the universities 3 Departments are not operational.
- By year of establishment BHU is the oldest Department started in 1950 and the Department of Central University of Rajasthan was recently started in 2009.
- Out of the 14 Departments all the 11 Departments conduct PG courses, Ph.D Programmes are conducted by all Departments except the Departments of IGNOU and University of Rajasthan. The 2 Departments of Pondicherry University and NEHU conduct the PG Diploma in Statistical Methods.
- Out of the 11 Departments 6 Departments of Delhi University, AMU, GU,PU,HU and BHU had worked and completed research projects in the period 2000-10. It is found that only 32 out of 82 Faculty Members mentioned that they have worked in a Project and each Project ended with publishing a Journal article.
- The Faculty Members are specialized in the following areas of the discipline statistics are

    1). Statistical Inference

    2). Demography

    3). Sampling

    4). Reliability Theory

    5). Bayesian Applications

    6). Stochastic Process

7). Operation Research

8). Differential Equations

- Out of 82 Faculty Members, 75 Faculty Members have Ph.D as their highest qualification.
- It is found that out of 597 publications 51% (304) of the publications are published by three authors, 22% (131) of the publications are published by four and more authors, 20 % (119) of the publications are published by single author and rest 7% (43) of the publications are published by joint authors. It must be mentioned that during the study it was found only Faculty Members of Hyderabad University have the pattern of publishing single.
- Regarding the research output i.e the publications by the 11 Departments. Journal articles, Books and Conference Proceedings are the main research output of the Faculty Members .
- There are 597 publications by all the Departments in the period 2000-10.
- Journal articles mostly published, as 529 (88%) of the total publications are the Journal articles.
- After Journal Articles, Conference Papers are published and 42 papers were published in 2000-2010. As Mathematical and Statistical science in Natural science are not influenced much by technology so the upcoming research areas are less.
- Regarding books 26 books were published in the period and it is found that books are published by the senior Faculty Members.
- On an average each Faculty member publishes 7 publications in a 10 year period.
- Average publications of each Department are the total publications divided by the Faculty size of the respective Departments.
- AMU has the highest number of Total publications followed by BHU and DU.
- It is found that out of 529 Journal articles, published by the Faculty Members in 200-2010. The number of articles at International journals are 301 (57%) and the number of journal articles at national level is 296 (43%). Out of the 42 conference papers published by the Faculty Members in 2000-2010, 12 papers are presented in International level conferences and rest 30 papers are presented at National/Regional level.
- In case of Avg. Publications we can see that DU has the highest publications followed by AMU and BHU.
- The referred research output i.e the publications of Faculty Members cited by any of the two citation database.
- We find that a total of 186 (31%) out of 597 publications were cited by WS and MSN.
- On an average each Faculty member has 2 citations in a 10 year period.

- The publications are more cited by MSN (76%) as compared to WS (24%). It is clear that WS only includes highest impact peer reviewed journals in their database and has less coverage of preprints, journals, books, etc.
- There is a positive correlation between Faculty Size and Number of Publications.
- There is a growth of publications in the succeeding years estimated through the method of Least Square
- Average referred publications of each Department are the Total referred publications divided by the Faculty size of the respective Departments.
- In case of Avg. Referred publications we can see that DU has the highest referred publications followed by AU and HU.
- The research productivity is calculated from the Avg. Total Publications and Avg. Total Referred Publications.
- With regard to research productivity the Department of DU is First, Second is the Department of BHU and Third is the Department of AU.
- Thus on the basis of total publications and referred publications we can conclude that Delhi University has the highest research productivity followed by Banaras Hindu University and Allahabad University respectively in Statistics discipline in the period 2000-2010.

And the annual publication rate is growing by 11 % and the annual publication rate of expected number of publications is growing at the rate 10%.

5.2 Suggestions

The research productivity of the Faculty Members are not at par with other developed countries. The research productivity of Indian universities is low and so none of the Indian universities are in the top 300 world University rankings and it is highly recommended that Authorities must note the problems and try to solve them.

On the basis of discussion with the Faculty Members and literature studied about the low research productivity the related suggestions can be grouped into 3 sections given below

5.2.1 Faculty related Suggestions

1. The research facilities should be developed for improving research productivity such as having a well equipped Laboratory, Language laboratories, Libraries and archival collections.
2. Faculty Members with high performance and output in research should be given reimbursement of travel, accommodation and other related expenses on duty.
3. The pressure from all academic and non-academic has to be reduced by the recruitment of Research Associates, Teaching Assistants and Post-doctoral Fellows for universities. The supporting staffs are also required to do the other non academic jobs.

4. The Faculty Members should be given royalty income from the technology transfer, software development and consultancy provided to the government or private sector.

5. For the Faculty promotions the criteria should be set like the number of research publications, impact factor of journals, citations.

5.2.2 Department related Suggestions

1. The Departments should link their teaching and research initiatives with manpower training program, innovation and community service.

2. The post-graduate and doctoral students must go through a detailed course on how to conduct research ethically by promoting original thinking, analysis and writing. The course should also review all the cases of scientific misconduct that have occurred over the last few decades to understand the associated problems in research.

3. Continuously updating the syllabus with periodic revision to make the teaching and learning fascinating for the teachers , students and at the same time trying to meet the local, state and national needs.

4. Students should be encouraged for original writing and analysis. Awards should be given for student for publishing in quality journal articles, book chapters etc.

5. Research funds not only from the University Grants Commission but from other funding agencies also should be extended to the Departments.

6. The leading Departments in specialized discipline should become networking centers in different parts of the country to promote collaborative research, access to advanced facilities and training in frontier areas.

7. Strong linkage between the Universities and Research laboratories of CSIR DRDO, Indian Statistical Institutes etc should be built up and promoted through joint research projects and training.

8. Setting up of Internal Quality Assessment Cell to assess the performance of the institution.

5.2.3 Government related Suggestions

1. To enhance the quality of teaching, learning and research the higher education Institutions offering postgraduate and research programmes should be identified and encouraged with research grants, internet and digital resources. Postgraduate and research Departments should be encouraged to do more research and their workload should be considerably reduced.

2. Priority should be taken for the maximum access to research journals.

3. To reduce the workload on Faculty Members the recruitment of Research Associates, Teaching Assistants and Post-doctoral Fellows for universities should be done without any delay.

4. There are a large number of vacant sanctioned Faculty positions in universities which needs to be filled transparently.

5. The number of PhDs from Indian Universities should be increased with proper standards.

6. Encouragement should be given to interdisciplinary movement between Science & Technology streams and industrial R&D.

5.3 Conclusions

It is found that the publications of the faculty members is increasing over the years. The various facets of publication pattern are found and analysed in the study. Collaboration by two or more authors is growing, journal articles are the main source of communication, the articles that are published in journals are in international in scope, the number of referred articles cited by major database is also growing. Research productivity is calculated on the basis of total publications and referred publications in relation to faculty size of the respective departments. There are demographic factors and institutional factors such as age, gender, and marital status that hindrance low research output. During the study it is found that demographic factors have only a slight affect on research productivity because the respondents said that the outcomes depend on the enthusiasm and willingness of Faculty Members rather than the barriers of age, gender or marital status.

Governments expect universities to become more competent and successful in teaching and research. Academic staff in universities are developing their research performance as new knowledge is generated and that place the basis for academic support. Research productivity in Universities has become a most important criterion for making promotion and tenure decisions. There is clear evidence that administrators at many Institutions together with the academic staff realize the important of research within the University structure. Many barriers to research productivity which require resolution and abolition must be eliminated in order that Faculty Members can increase their research output. In India many academicians lack the knowledge, skills, experience and resources to do research. The academic staffs face the problems of teaching work load, lack of research facilities and complicated financial regulation/policies.

Planning Commission (2009) The report strongly recommended that the base of sciences in the University needs to be rebuilt and strengthened by taking newer initiatives in the frontier areas. The Committee is of the view that utility of social sciences to our society, polity, economy, etc. cannot be overlooked as they add value to one's life. The Committee is of the opinion that this imbalance needs to be corrected immediately by making the study of Social Sciences scientific, interesting and relevant to present situation. The resource funding allocation in the case of university is not effective and some faculties have a lower level of supporting facilities than they request. In this context the science faculties needs special care for research funding allocation.

The various suggestions found during the study must be taken by the faculties, administrators and government, priority wise, to improve the research productivity of universities in India.

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APPENDIX I

QUESTIONNAIRE

Respected Sir/Madam,

Sub: Request for filling up the Questionnaire.

I have under taken a research work leading to Ph.D degree in the Department of Library & Information science, Mizoram University, Aizwal, Mizoram. The title of my research is **Research productivity of Faculty Members in the Department of Statistics in the Central Universities of India.**

I shall be grateful if you kindly spare your valuable time to fill up the questionnaire and provide me the relevant data required for the study. I would like to mention that without your kind cooperation this task would not have been completed.

I assure you that the data provided by would be kept confidential it would be used for academic purpose only.

Thanking you in anticipation for your kind cooperation.

Yours sincerely,

Sangita Das Talukdar

Ph. No. : 9435619256

Email ID : sangitatalukdar83@gmail.com

I. Personal Information

1. Name of Department

2. Year of Estb.

3. Name of Faculty member

4. Qualification

5. Specialization

6. Desig.

Professor _____

Asso. Professor _____

Asst. Professor _____

II. Departmental Information

7 .Courses Conducted: PG _____ Research _____Others _____

8. Have you worked in any research project? Yes_____ No_____

If yes, kindly mention the number of major projects undertaken by you during 2000-2010?

9. Kindly mention the pattern of collaboration for the publications published by you in the period 2000-10? (Mention in numbers.)

Single_____ Two_____ Two and more_____ Three and more _____

III. Publication Information

10. Has your focus area of research changed as you gained more experience in your work.

Yes No

11. Are your publications indexed in any citation databases.

Yes_____ No ____

12. Kindly mention in numbers the research output by you during 2000-10.

	Articles		Conference papers		Books
	National	International	National	International	
2000					
2001					
2002					
2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					

IV. Research Problems

13. Kindly mention the problems faced by you while doing research.

_____

_____

_____

_____

14. What suggestions would you like to give to improve the research productivity.

_____

_____

_____

APPENDIX II

List of Central Universities in India

Sl. No	Name of University	Year of Estd.	url
1.	Allahabad University	1887	www.allduniv.ac.in
2.	Baneras Hindu University	1916	www.bhu.ac.in
3.	Aligarh Muslim University	1920	www.amu.ac.in
4.	Visva Bharati	1921	www.visva-bharati.ac.in
5.	University of Delhi	1922	www.du.ac.in
6.	Jamia Millia Islamia	1962	www.jmi.nic.in
7.	Jawaharlal Nehru University	1969	www.jnu.ac.in
8.	North Eastern Hill University	1973	www.nehu.ac.in
9.	Hyderabad University	1974	www.uohyd.ernet.in
10.	Pondicherry University	1985	www.pondiuni.edu.in
11.	Indira Gandhi National Open University (ignou)	1985	www.ignou.ac.in
12.	Assam University	1994	www.aus.nic.in
13.	Tezpur University	1994	www.tezu.ernet.in
14.	Nagaland University	1994	www.nagauniv.org.in
15.	Babasaheb Bhimrao Ambedkar University	1996	www.bbau.ac.in
16.	Mahatma Gandhi Antarrashtriya Hindi Vishwavidyalaya	1997	www.manuu.ac.in
17.	Maulana Azad National Urdu University	1998	www.manuu.ac.in
18.	Mizoram University	2000	www.mzu.edu.in
19.	Manipur University	2005	www.manipuruniv.ac.in

20.	Rajiv Gandhi University	2007	www.rguhs.ac.in
21.	Tripura University	2007	www.tripurauniv.in
22.	Sikkim University	2007	www.sikkimUniversity.in
23..	English and Foreign Languages University	2007	http://www.eflUniversity.ac.in
24.	Indira Gandhi National Tribal University	2007	http://igntu.nic.in
25.	Central University of Bihar	2009	www.cub.ac.in
26.	Guru Ghasidas Vishwavidyalaya	2009	http://ggu.ac.in
27.	Central University of Gujarat	2009	www.cug.ac.in
28.	Central University of Haryana	2009	
29.	Central University of Himachal Pradesh	2009	www.cuhimachal.ac.in
30.	Central University of Kashmir	2009	www.cukashmir.ac.in
31.	Central University of Jharkhand	2009	www.cuj.ac.in
32.	Central University of Karnataka	2009	www.cuk.ac.in
33.	Central University of Kerala	2009	www.cukerala.ac.in
34.	Harisingh Gour Vishwavidyalaya	2009	www.dhsgsu.ac.in
35.	Central University of Orissa	2009	www.cuo.org
36.	Central University of Rajasthan	2009	www.curaj.ac.in
37.	Central University of Tamil Nadu	2009	www.tiruvarur.tn.nic.in
38.	Hemwati Nandan Bahuguna Garwal university	2009	www.hnbgu.ac.in
39.	Central University of Rajasthan	2009	www.curaj.ac.in