CHAPTER – I
INTRODUCTION

Education System

Perspective at the Global Level

Higher education occupies a significant position in the educational system of nation because it is the apex of entire educational structure and influences education at all levels. Higher education also influences any national activity. Through innovative ideas and innovations, it also influences the future of a country. It plays a crucial role in generating new knowledge and skills. Higher education is a process of empowerment and enlightenment, leading to harmonious development of the individual and sustainable development of the nation (Jakhar & Kumar, 2010).

Higher education, also called tertiary, third stage, or post secondary education, is the non-compulsory educational level that follows the completion of a school providing a secondary education. Tertiary education is normally taken to include undergraduate and postgraduate education, as well as vocational education and training. Colleges and universities are the main institutions that provide tertiary education. Collectively, these are sometimes known as tertiary institutions. Tertiary education generally results in the receipt of certificates, diplomas, or academic degrees (UNESCO, 2006).
Higher education includes teaching, research and social service activities of universities, and within the realm of teaching, it includes both the undergraduate level and the postgraduate level. Higher education generally involves work towards a degree-level or foundation degree qualification. In most developed countries a high proportion of the population (up to 50%) now enters higher education at some time in their lives. Higher education is therefore very important to national economies, both as a significant industry in its own right, and as a source of trained and educated personnel for the rest of the economy (Jhajharia, 2012).

**Perspective at the National Level**

Indian education has always been ranked as being among the best the world over. As India’s growth story and the boon in offshore research, software and business process outsourcing show an increasing trend, over the next five years Indian education is going to be under pressure to deliver to the large talent pool that is required to fuel this growth and ensure that India remains competitive (Surisetti, Sarkar, & Jain, 2012).

India however has also had a rich history of traditional education and this tradition spans over five thousand years. The arts, culture, theatre, spirituality and literature have for long been part of our education system that was developed using the method of “Guru - Shishya” or “teacher - student”, a one to one method for transfer of knowledge and learning under the Gurukul system where the
student lived with the teacher and learned all that he needed to learn to become a master in the profession (Cheney, Ruzzi, & Muralidharan, 2005).

In the post independence era new education methods were developed and the system of education was made more equitable and democratic. Thanks to several decades of intensive focus given by successive governments, India’s education system has created a rich and large pool of skilled and knowledgeable talent that India has been able to reap rich harvest from during the growth and globalization decades of the 1990s and 2000s (Cheney, et al., 2005).

Status of Higher Education

India has around 520 universities and 26,000 colleges enrolling 12.37 million students. It is ranked third globally, after the U.S and China, in terms of absolute number of student enrolled in higher education institutions (Gupta & Gupta, 2012). Despite the presence of a large number of institutions, higher education penetration is only 12 per cent. The Union Government aims to increase this to 15 percent by 2012.

Higher education institutions play a major role in improving the environment preserving natural resources and making an economic and social impact. Graduates are entering a volatile world and higher education needs to respond to challenging, rapidly changing socio-economic and environmental conditions (Kapur & Mehta, 2004). Through their roles as educators and
researchers, institutions can contribute to securing a safer and more sustainable future against recognized poverty.

Our choices now will influence whether current and future generations will live with a changed climate, depleted resources and without the open space and biodiversity, adversely affecting standard of living and quality of life. Higher education can help in promoting new and sustainable ways of living, working, producing and travelling that will help achieve wider benefits to human health and wellbeing.

It is appropriate to quote the words of the President of the Club of Rome, who said that “Education must not only be adapted to the needs of our age, it must also make real effort to look ahead some twenty five years” (Razak & Mohamed).

“Higher education institutions play a strategic role in finding solutions to today’s leading challenges in the fields of health, science, education, renewable energies, water management, food security and the environment,” said UNESCO’s Director – General (Matsuura, 2008).

**Internationalization**

Education is becoming increasingly international. Not only are the materials becoming more influenced by the rich international environment, but exchanges among students at all levels are also playing an increasingly important role (Pretty, I. 2010).
**Education in the Developing World**

In developing countries, the number and seriousness of the problems faced are naturally greater. People in more remote or agrarian areas are sometimes unaware of the importance of education. However, many countries have an active Ministry of Education, and in many subjects, such as foreign language learning, the degree of education is actually much higher than in industrialized countries.

**University and Higher Education**

India has one of the largest Higher Education systems in the world (UNESCO, 2007). Central Government is responsible for major policy relating to higher education in the country. It provides grants to University Grants Commission (UGC) and establishes Central Universities in the country. The Central Government is also responsible for declaration of Education Institutions as ‘Deemed to be University’ on the recommendations of the UGC.

State Governments are responsible for establishment of State Universities and colleges and provide plan grants for their development and non-plan grants for their maintenance. The coordination and cooperation between the Union and the States is brought about in the field of education through the Central Advisory Board of Education (CABE).
India is now developing technologies that will skip land based phone and internet lines. Instead, India launched EDUSAT, an education satellite that can cover most parts of the country at a greatly reduced cost. There is also an initiative started by the One Laptop Per Child (OLPC) foundation, a group out of Massachusetts Institute of Technology (MIT) Media Lab and supported by several major corporations to develop a $100 laptop to deliver educational software. The laptops are widely available as of 2008. The laptops are sold at cost or given away based on donations. These will enable developing countries to give their children a digital education, and help close the digital divide across the world (Elton, 2000).

**Quality Enhancement**

Quality Enhancement (QE) in higher education is a deliberate process of change that leads to improvement. The word “Quality” has been borrowed from the industry. In academic parlance, two terms are often used namely, ‘Quality Assessment’ and ‘Quality Assurance’. They are like two sides of a coin. The former refers to the national and external evaluations used to assess the overall teaching and research performance of the institution. The latter refers to the concern of different stakeholders regarding the continuous process of adopting various mechanisms and procedures to monitor performance and to take up remedial measures to improve academic standards and to increase the overall effectiveness of the organization (Bergan, 2004).
Higher Education and Accreditation Agencies

The expansion of higher education without maintaining quality is not desirable. The quality is the first essential requirement for any institution. It is more so in case of higher education institutions because it is where the future of the youth is shaped. To fulfill this need the National Assessment and Accreditation Council (NAAC) was established at Bangalore in 1994 by the UGC to assess and accredit institutions of higher education in the country. It is an external Quality Assurance Agency like the Higher Education Quality Control Council of the UK and is a member of the International Network of Quality Assurance Agencies in Higher Education (INQAAHE). UGC is responsible for coordination, determination and maintenance of standards and release of grants. Professional councils are responsible for recognition of courses, promotion of professional institutions and providing grants to undergraduate programmes and various awards. The statutory professional councils are:

- All India Council of Technical Education (AICTE)
- Medical Council of India (MCI)
- Indian Council for Agricultural Research (ICAR)
- National Council for Teacher Education (NCTE)
- Dental Council of India (DCI)
- Pharmacy Council of India (PCI)
- Indian Nursing Council (INC)
- Bar Council of India (BCI)
- Central Council of Homeopathy (CCH)
- Central Council for Indian Medicine (CCIM)
- Council of Architecture
- Distance Education Council
- Rehabilitation Council
- State Councils of Higher Education

**NAAC - An Overview**

The National Assessment and Accreditation Council (NAAC) is an autonomous body established by the UGC of India to assess and accredit institutions of higher education in the country. It is an outcome of the recommendations of the National Policy on Education (NPE-1986) which laid special emphasis on upholding the quality of higher education in India (India, 2009). To address the issues of quality, the National Policy on Education and the Plan of Action (POA-1992) advocated the establishment of an independent national accreditation body. Consequently, the NAAC was established in 1994 with its headquarters at Bangalore.

Assessment and Accreditation is broadly used for understanding the “Quality Status” of an institution. In the context of Higher Education, the accreditation status indicates that the particular Higher Educational Institutions
(HEI) – a College, a University, or any other recognised unit therein, meets the standards of quality as set by the Accreditation Agency, in terms of its performance, related to the educational processes and outcomes, covering the curriculum, teaching-learning, evaluation, faculty, research, infrastructure, learning resources, organisation, governance, financial well being and student services.

**Process**

NAAC’s process of assessment is towards holistic, systematic, objective, data-based, transparent and shared experience for institutional improvement. NAAC has formulated a four stage process for assessment and accreditation as given below:

1. In the first step of Assessment and Accreditation, ‘Institutional Eligibility for Quality Assessment’ (IEQA) is required to be obtained by an applicant institution at the beginning, while it is still in the planning stage for assessment. The benefits of this step for an applicant institution are:
   - To get recognized as eligible to apply for the second step comprehensive assessment and accreditation process.
   - To get feedback from NAAC if it does not qualify in the first step, about specific improvements to be made for reaching the required quality level.
To receive assistance and suitable mentoring from NAAC in the latter case, for enabling it to qualify for IEQA in due course of time.

2. Preparation of the Self-Study Report by the institution, its submission to NAAC and in-house analysis of the report by NAAC.

3. Peer Team visit to the institution for validation of the Self-Study Report followed by a presentation of the comprehensive assessment report to the institution.

4. Grading, Certification and Accreditation based on the evaluation report of the peer team.

Benefits of Accreditation

Accreditation facilitates

- institution to know its strengths, weaknesses, and opportunities through an informed review process.
- identification of internal areas of planning and resource allocation.
- collegiality on the campus.
- funding agencies look for objective data for performance funding.
- institutions to initiate innovative and modern methods of pedagogy.
- new sense of direction and identity for institutions.
- the society look for reliable information on quality education offered.
• employers look for reliable information on the quality of education offered to the prospective recruits.

• intra and inter-institutional interactions (http://www.ugc.ac.in/page/NAAC.aspx).

**Academic Research**

Research is an important academic activity and is expected of every faculty member. The assessment of research may take the form of an input-output process. The input constitute three major resources namely,

a) Manpower

b) Institutional Resources

c) Financial Resources

The output of research is more complex comprising intangible outcomes such as new scientific knowledge and awareness of new methodologies, in the form of theories and empirical findings. The tangible outputs are research findings, which are published in the form of research reports or publications in refereed journals, which is of national or international recognition or communicated in the form of presentation at conferences, and finished products like patented inventions of trained and qualified researchers (Zainab, 1999).
Research Output

Research output takes the form of publications that include journal articles, reviews, letters, book and chapter in book etc. A strong and well designed university research profile contributes the creation of new knowledge, maintains and strengthens the quality of a university’s programmes, increases funding from external sources and enhances the institution’s leadership role.

The Role of Universities in Research

Research, as the most important source of knowledge generation, occupies a critical position in promoting a nation’s prosperity and its citizens’ well-being. Research not only helps solve practical problems and brings about material improvements via high-tech products, it also provides insights and new ideas that enrich human understanding of various social, economic and cultural phenomena. Research is also regarded as an important indicator of a nation’s economic competitiveness for the present and the future. Although government and private institutions have set up their own research centres and started their own research in recent years, universities continue to play a prominent role in knowledge production, particularly in the research fields. Research has become an important component of a university’s mission and a key indicator of its performance. In most countries, higher education is primarily government funded, so it is essential that university research fulfils the nation’s research objectives. book The Idea of a university advocates that a
university’s primary function is knowledge dissemination instead of knowledge

Emphasis on research in higher education institutions is a product of the
combined forces operating nationally and institutionally. Nationally, university
research as a key indicator of the overall national capacity and educational
well-being has been given significant attention. Institutionally, higher education
institutions and departments are motivated by the desire to win international
and national recognition, which are closely associated with the research
performance of their academic staff. This recognition elicits further benefits for
building research capacity, including securing grants for higher degree students.
Higher education institutions and departments establish reward structures and
enhance research management to encourage and reward research among
academics.

Bibliometrics

The term bibliometrics was derived from “biblion” meaning book and
“metron” meaning measure. This term was introduced by Pritchard in 1969. He
stated, “The term (Statistical bibliography) is clumsy, not very descriptive, and can
be confused with statistics itself or bibliographies on statistics”. In the same issue
of Journal of Documentation appeared Fairthorne’s 1969, classic article
“Empirical Hyperbolic Distributions (Bradford-Zipf-Mandelbrot) for Bibliometric
Description and Prediction”, in which the author used the word “bibliometric” and acknowledged Alan Pritchard as the donor of the term (Fairthorne, 1969).

“Bibliography” was derived from two roots: biblion, book; graphos from graphein, to write. Webster (1956) defined it as a “history of books, an account of manuscripts… and information illustrating the history of literature, as well as a list of an author’s writings; or the literature dealing with a certain subject or author” (Hertzel).

In post-classical Greek times, Monks, in copying manuscripts, also made lists of the books being copied; these listed, catalogues or inventories, are considered early bibliographies. Modern bibliography began in 1564 when George Willer of Augsburg published his catalogue of books, a listing for sale by him at the Frankfurt fair. Schneider as cited in Hertzel, 1987, describes, by the 18th century in France, bibliography was “writing about books”; later it was called “the science that deals with literary production”, and finally, “the science of books” (Osareh, 1996).

Current bibliography may be said to be the result of demands of research, development of numerous journals, and the formation of many societies, literary and scientific. The most important change in the meaning of bibliography was caused by change in its purpose, which at first was to preserve or record past items whereas it’s primary purpose now is to aid in dispensing knowledge.
Statistics was derived from the German “Statistik” which came from the Medieval Latin “statisticus” which in turn was derived from the Latin “status” meaning state, position, standing (Webster, 1960). Levinson defines statistics as “The science of collecting or selecting facts, sorting and classifying them, and drawing from them whatever conclusions may lie buried among them” (Osareh, 1996).

The Two Divisions of Statistics

Descriptive statistics- Descriptive statistics is really a description or compilation of data in a form that is clear and usable.

Inferential (Inductive) statistics - in Inductive statistics, data pertaining to a sample of a population are used to arrive at a probable conclusion or prediction concerning the whole.

Originating as the mathematical tool of the gambler, the science of probability has become fundamental in the knowledge of the physicist, the biologist, the technologist, the industrialist, the businessman, and the philosopher. It seemed logical that the science of probability and statistics would also have been used by the librarian or the bibliographer and eventually applied to the field of bibliography. So, statistics, employing the theory of probability (counting, analyzing, interpreting) combined with bibliography (knowledge dispensers) became statistical bibliography.
Alan Pritchard 1969, who first used the term “bibliometrics,” described it as the “application of mathematics and statistical methods to books and other media of communication”. In a later article, Pritchard explained bibliometrics as the “metrology of the information transfer process and its purpose is analysis and control of the process” (Pritchard, 1969).

**Types of Bibliometrics**

Bibliometrics, called quantitative science, is divided into two areas: descriptive and evaluative. These two areas may also be divided as follows:

1. Productivity Count (Descriptive)
   - Geographic (Countries)
   - Time periods (years)
   - Disciplines (Subjects)

2. Literature Usage Count (Evaluative)
   a. Reference
   b. Citation

Descriptive bibliometrics study includes the study of the number of publications in a given field, or productivity of literature in the field for the purpose of comparing the amount of research in different countries, the amount produced during different periods, or the amount produced in different subdivisions of the field. This kind of study is made by a count of the papers,
books and other writings in the field, or often by a count of those writings which have been abstracted in a specialized abstracting journal. Evaluative bibliometrics study includes the “study of the literature used by research workers in a given field”. Such a study is often made by counting the references cited by a large number of research workers in their paper (Pritchard, 1969).

**Applications of Bibliometric Analysis**

Bibliometric analyses result in indicators of research quantity and performance. They can also provide measurements of connections between researchers and research areas through statistical analysis of co-publications and citations (Mattsson, 2011).

**Quantity Indicators: Number of Publications and Citations**

- Number of publications and citations, the two most basic bibliometric indicators describe the number of publications and citations attributed to a group of authors (a research group, a department, a university or a country) during a specified time period (Mattsson, 2011).

- Number of publications and citations per researcher is a relative measure. It compensates for the size of the studied unit and therefore indicates scientific output in relation to invested resources.
Performance Indicators: Normalized Citation Counts

- The crown indicator measures the research impact of a group of authors. It compares the average number of citations to the group’s publications to the average number of citations to international publications from the same year, in the same subject area and of the same document type.
- Top five per cent shows the share of publications attributed to a group of authors that belong to the five per cent most cited publications in the world from the same year, in the same subject area and of the same document type.

Journal Performance Indicators: Impact Indicator

- An impact indicator for a scientific journal is a mean value that describes how many times an average article published in the journal is cited.

Structural Indicators: Publication Patterns

- Publication and citation analysis can also identify connections between publications, authors and areas of research.

Performance of Bibliometric Analysis

Most bibliometric analyses use data originating from one or more of the three ISI citation indices supplied by Thomson Scientific. (ISI – the Institute for Scientific Information – founded by Eugene Garfield in 1958 and now a part of Thomson Scientific.)
The most important citation index for medicine, life science and the natural sciences is the Science Citation Index Expanded (SCIE). This contains references to articles from more than 5,900 scientific journals ("Thomson Scientific: Citation Products"). There is also a Social Sciences Citation Index and an Arts and Humanities Citation Index.

Including all three indices, Thomson Scientific indexes about 8,500 of an estimated number of more than 22,000 active, refereed scientific journals (Ulrichsweb.com). Since Thomson Scientific uses the reference lists from publications in their own indices to select what journals to include, it is reasonable to assume that the Thomson citation indices contain the most cited and the most important academic journals.

Subscribers to the Thomson citation indices can, for example, access them through the web based service ‘Web of Science’. This is a relatively easy-to-use search interface that provides the opportunity to create lists of publications and citations attributed to researchers, research groups, departments, universities or countries. It’s however not suited for more complex bibliometric analyses, including the calculation of mean values or connection mapping. For this, data have to be purchased or downloaded from the Thomson citation indices and locally developed applications shall be used for the calculations.
As a consequence of the strong bibliometric focus on data from the Thomson citation indices, most bibliometric indicators are reliable only in research areas where publishing in scientific journals is the main mode of communication. This is often the case in natural sciences, technology and medicine, but analyses of areas within the humanities or social sciences must apply other methods as well.

The UK government is considering using bibliometrics in its Research Excellence Framework, a process which will assess the quality of the research output of UK universities and on the basis of the assessment results, allocate research funding.

The three most commonly used laws in bibliometrics are:

1. Lotka's law of scientific productivity
2. Bradford's law of scatter
3. Zipf's law of word occurrence

**Lotka's Law**

Lotka's Law describes the frequency of publication by authors in a given field. It states that "... the number (of authors) making contributions is about 1/n² of those making one; and the proportion of all contributors, that make a single contribution, is about 60 per cent" (Lotka 1926, cited in Potter 1988). This means that out of all the authors in a given field, 60 per cent will have just one
publication, and 15 per cent will have two publications \((1/2^2 \times .60)\). 7 per cent of authors will have three publications \((1/3^2 \times .60)\), and so on. According to Lotka's Law of scientific productivity, only six percent of the authors in a field will produce more than 10 articles. Lotka's Law, when applied to large bodies of literature over a fairly long period of time, can be accurate in general, but not statistically exact. It is often used to estimate the frequency with which authors will appear in an online catalogue (Potter, 1981).

**Bradford's Law**

Bradford's Law serves as a general guideline to librarians in determining the number of core journals in any given field. It states that journals in a single field can be divided into three parts, each containing the same number of articles:

1. a core of journals on the subject, relatively few in number, that produces approximately one-third of all the articles
2. a second zone, containing the same number of articles as the first, but a greater number of journals
3. a third zone, containing the same number of articles as the second, but a still greater number of journals.

The mathematical relationship of the number of journals in the core to the first zone is a constant ‘n’ and to the second zone the relationship is ‘\(n^2\)’. Bradford expressed this relationship as ‘1:n:n^2’. Bradford formulated his law after studying
a bibliography of geophysics, covering 326 journals in the field. He discovered that 9 journals contained 429 articles, 59 contained 499 articles, and 258 contained 404 articles. So it took 9 journals to contribute one-third of the articles, 5 times 9, or 45, to produce the next third, and 5 times 5 times 9, or 225, to produce the last third. As may be seen, Bradford's Law is not statistically accurate, strictly speaking. But it is still commonly used as a general rule of thumb (Potter 1981).

**Zipf's Law**

Zipf's Law is often used to predict the frequency of words within a text. The Law states that in a relatively lengthy text, if you "list the words occurring within that text in order of decreasing frequency, the rank of a word on that list multiplied by its frequency will equal a constant. The equation for this relationship is \( r \times f = k \) where ‘\( r \)’ is the rank of the word, ‘\( f \)’ is the frequency, and ‘\( k \)’ is the constant (Potter 1988). Zipf illustrated his law with an analysis of James Joyce's Ulysses. "He showed that the tenth most frequent word occurred 2,653 times, the hundredth most frequent word occurred 265 times, the two hundredth word occurred 133 times, and so on. Zipf found, then that the rank of the word multiplied by the frequency of the word equals a constant that is approximately 26,500" (Potter 1981). Zipf's Law, again, is not statistically perfect, but it is very useful for indexers (Fedorowicz, 1982).
Citation Analysis

Another major area of bibliometric research uses various methods of citation analysis in order to establish relationships between authors or their work. When one author cites another author, a relationship is established. Citation analysis uses citations in scholarly works to establish links. Many different links can be ascertained, such as links between authors, between scholarly works, between journals, between fields, or even between countries. Citations both from and to a certain document may be studied. One very common use of citation analysis is to determine the impact of a single author on a given field by counting the number of times the author has been cited by others. One possible drawback of this approach is that authors may be citing the single author in a negative context (saying that the author doesn't know what s/he's talking about, for instance) (Osareh,1996).

Co-citation Coupling

Co-citation coupling is a method used to establish a subject similarity between two documents. If papers ‘A’ and ‘B’ are both cited by paper ‘C’, they may be said to be related to one another, even though they don’t directly cite each other. If papers ‘A’ and ‘B’ are both cited by many other papers, they have a stronger relationship. The more papers they are cited by, the stronger their relationship is (Osareh,1996).
**Bibliographic Coupling**

Bibliographic coupling in a way is the mirror image of co-citation coupling. Bibliographic coupling links two papers that cite the same articles, so that if papers ‘A’ and ‘B’ both cite paper ‘C’, they may be said to be related, even though they don’t directly cite each other. The more papers they both cite, the stronger their relationship is (Osareh, 1996).

**Web Applications of Bibliometrics**

Recently, a new growth area in bibliometrics field of webmetrics, or cybermetrics has been in the emerging. Webmetrics can be defined as using of bibliometric techniques in order to study the relationship of different sites on the World Wide Web. Such techniques may also be used to map out (called "scientific mapping" in traditional bibliometric research) areas of the Web that appear to be most useful or influential, based on the number of times they are hyperlinked to other Web sites.

**Bibliometric indicators**

Among many definitions of bibliometrics one definition is that bibliometrics is a quantitative assessments of man’s cultural progress including science and technology as may be revealed through bibliographic data. Bibliographic data are those which can be collected, derived or deciphered from different parameters as can be assigned to a document. A document can provide two types of information –one is tropical information or the so called thought
content for which a reader studies a document. The other is the set of peripheral information which may be used for document description or which may be derived from the document or which may be assigned to the document from some authoritative source to describe or designate the document. These may include the name(s) of the author(s), number of pages, number of words in a part of the document, the subject classification number, the bibliographic references, citation etc.

Bibliometric indicators are based on bibliographic parameters or bibliographic features as some authors have said. They are a set of bibliometric parameters. They are the results of the need for objective and easily manipulable measures of scientific and technological activities and output. But there are now bibliometric indicators for the social sciences and the humanities also.

Most of the bibliometric indicators are arbitrary and artificially provided. They have little connection with any theoretical background or understanding of the underlying process. Not all the bibliometric indicators can be applied universally. They are contextual and some time highly specific (Okubo, 1997).

**Direct Bibliometric Indicators**

Direct indicators are those which use the bibliographic data available in a straightforward way from the document (Vinkler, 1996). These are:

- The number of authors per paper or the collaborators.
• The number of pages or number of lines in a paper or a document.

• The proportion of the text matter and the supporting matters and the illustrative matters. In the text matter we can consider the written text from introduction to the conclusions. In the peripheral or supporting matter we consider the abstract or acknowledgement, the appendices and the list of references. In the illustrative matter we consider the tables, graphs, charts etc.

• The number of references or the reference size.

• References age distribution.

All such quantitative data are directly available from the document.

Derived Indicators

Derived indicators are those which cannot be calculated directly from the documents but are to be prepared or calculated after some manipulation using the features and items implicit in the documents (Vinkler, 1996). These include:

1. Citation counts and all the indicators derived from citation data together with co-citational indicators.

2. Indicators calculated from the word frequency counts in the documents and their derivatives together with indicator based on co-word analysis.

3. Subject categorization of the micro-documents.
4. All the indicators based on ranking procedure of journals, countries, authors, etc., based on productivity counts, reference count, citation counts, etc.

**Assigned Indicators**

Such indicators are somewhat extraneous and are attributed by other based on bibliographic features or assessment of thought contents of so called qualities of the documents or bibliographic items (Vinkler, 1993).

*Some of these are:*

1. Indicators based on peer judgment.
2. Indicators based on use of documents (these may be calculated from library lending data, document copying and supplying data, number of references, etc.,).
3. Indicators based on analysis of scattering.
4. Subject classification of the documents.

**Non-bibliometric Indicators**

Such indicators are based on data which are not available or cannot be derived from the document description or the documents. They are not at all bibliographic items as such. They are not also assigned characteristics based on some features or aspects of the documents. Library use of documents, records of documents delivery from a documentation center, number of journals published in
a country, technology transfer, per-capita-expenditure on research, gross expenditure on research are some of the items which are non-bibliometric but can be used to produce science and technology indicators.

**Mixed Indicators**

There can be indicators which are produced by composing both bibliographic and non-bibliographic items. Vinkler made a survey of bibliometric indicators and attempted to classify them. He primarily categorized the indicators as publication indicators and citation indicators. He also considered the possible types as simple (single characteristic data without any standard), specific (characteristic data projected to other characteristics data), balance (one type of characteristic data related to another type of characteristic data), distribution (based on distribution or share or proportion of a set of characteristic data in a class of the same type of data sets), relative (characteristic data against a background of some absolute standard). Each of these five can represent either quantity or impact or quantity and impact. Thus, Vinkler’s (1993) typology has 15 types of indicators.

**Purpose of Bibliometric Indicators**

Many of the bibliometric indicators are just intellectual exercises. They can’t be used purposefully. Some of the indicators based on Shannon’s information entropy are of this nature. Many of bibliometric indicators are contextual. The ratio of articles published in national journals and the foreign
journals may give an idea of internationally or islandness of research activities of a
developing country. One reason for the interest in bibliometric indicators is to
lessen or to overcome the subjective diversion and unreliability of assessment by
individual peers and experts. Such assessments are required at the individual level,
at the institutional level, at the national level and at the level of supporting or non-
supporting a research front. These assessments are needed in case of an individual
for employment, promotion for project funding, for awards and rewards, for
knowing about the status of a scholar whose expert coinciding may be important
towards a social or economic goal, etc.

At the institutional level one needs to know the Research and Development
capabilities and performance standards already in existence for an institution. It is
also important to know the different foci of research areas, degree of inter
disciplinarily or subject specificity.

At the national level the need is to have an information base and indication
for the guidance to policy matter. Whether to give support and spend money for a
particular research area, say, super-conductivity, or cold-fusion or inter-galactic
space rockets. The international bodies, the national government, the Science and
Technology leaders and even the journalists and tax payers are interested in
knowing the status of performance in science and technology and in other spheres.
Over the last fifteen years, there has been an increased interest in the evaluation of scientific research, be it at the level of programmes or institutions. Whereas in period of economic growth it was easy to justify new programmes of research, budgetary cuts, or at best steady state funding despite a growing number of applicants, have forced administrators of research, as well as researchers, more than ever before, not only to justify their projects, but also to find ways to phase out existing ones. There has also been a growing awareness of the importance of having a global evaluation of the effects of funded research on the development of knowledge.

In these circumstances, performance indicators and evaluation methods have been looked at as a way of assisting the taking of informed decisions. This conjuncture led to the development of a variety of tools designed to circumscribe the multidimensional nature of scientific research. Among them, bibliometric methods, that are statistical analysis of published papers, have become an important tool for measuring the dynamic of scientific research (Okubo, 1997).

**Bibliometric Analysis of Research Performance**

Peer review undoubtedly has to remain the principal procedure of quality judgment. But peer review and other related expert-based judgments have serious shortcomings and disadvantages (Horrobin 1990; Moxham and Anderson 1992). Opinions of experts may be influenced by subjective elements, narrow-mindedness and limited cognitive horizons. Subjectivity, i.e., dependence of the
outcomes on the choice of individual committee members, is a major problem. This dependence may result in conflicts of interests, unawareness of quality, or a negative bias against younger people or newcomers to the field. (Vann Rann, A.F. 2003)

“We absolutely do not plead for a replacement of peer review by bibliometric analysis. Subjective aspects are not merely negative. In any judgment there must be room for the intuitive insights of experts. We claim however that for a substantial improvement of decision-making our bibliometric method has to be used in parallel to a peer-based evaluation procedure” (Rinia, Van Leeuwen, Van Vuren, & Van Raan, 2001).

The most crucial parameter in the assessment of research performance is international scientific influence. International influence is considered as an important, measurable aspect of scientific quality and therefore there developed standardized, bibliometric procedures to assess research performance within the framework of international influence or impact. Undoubtedly, the bibliometric approach is not an ideal instrument, working perfectly in all fields under all circumstances. But the approach works very well in the large majority of the natural, the medical, the applied sciences, and in several fields within the social and behavioral sciences. One of the most important features of the method is that it provides more than just "nice additional data". It forces the experts to re-think their judgments and it provides challenging new insights. Thus they form,
particularly at the level of research programmes, an indispensable tool for
decision-making in science policy, particularly in priority setting.

Bibliometric analyses performed at the macro-level (e.g., a whole country)
yield at best general assessments of fields as a whole, for instance, how good a
country's performance is in physics, chemistry, psychology or immunology,
without a reliable breakdown to the individual research groups or programmes.
Therefore, research performance should be analysed systematically on the meso-
level of larger institutions, such as universities or major parts of universities, like
faculties or institutes. After an overall assessment of these larger institutions,
performance analysis can be narrowed down to the most important level:
the micro-level, that is, the real "workfloor" of research practice: departments,
research groups and programmes within universities and large institutes.

On the meso and micro-level, all necessary information, particularly data
on personnel and on the composition of groups and programmes, is only available
within the university or institute concerned. Such institutional infrastructure data
are never available in general publication databases and must always be collected
separately in relation to the institutions concerned (Okubo, 1997).
About the University

Bharathidasan University established in February 1982 was named after the great revolutionary Tamil Poet, Bharathidasan (1891-1968). The motto of the University "We will create a brave new world" has been framed from Bharathidasan's poetic words “óżĂ anj h@c yf « br ġnt h«”. The University endeavours to be true to such a vision by creating in the region a brave new world of academic innovation for social change. The university got its recognition under 2f and 12B in the year 1984. The university has been re-accredited with ‘A’ grade by National Assessment and Accreditation Council (NAAC) in the year 2012. The year 2006-2007 was the Silver Jubilee year for this great and vibrant university (www.bdu.ac.in/).

The university's main campus was initially located in a sprawling area of over 1000 acres in Palkalaiperur. However, as years passed on, the South Campus at Palkalaiperur with the available infrastructure was donated to the newly started Anna University of Technology. Very recently, another portion of the land has been allotted to the Indian Institute of Management (IIM), Tiruchirappalli. Also, the university has a downtown campus at Khajamalai, which housed originally the Autonomous Post-Graduate Centre of the University of Madras at Tiruchirappalli. In addition to the administrative complex, which includes the Vice-Chancellor's Secretariat, Registrar's Office, Finance and Examination offices, most of the academic departments and research laboratories are located in the main
Palkalaiperur Campus. Among the academic units in the Palkalaiperur Campus are Schools of Mathematics, Physics, Chemistry, Life Sciences, Basic Medical Sciences, Geosciences, Social Sciences, Marine Sciences and the Schools of Languages. In addition, the Campus also has the Central Library, Informatics Centre, Hostels, Staff Quarters, Health Centre, Canteen and others. The downtown campus has the Departments of Economics, Social Work, Computer Science, the Centre for Remote Sensing, the Academic Staff College and others. Besides these, the Bharathidasan Institute of Management popularly known as BIM (adjudged as one of the top business schools in the country) is located within the BHEL premises, a public sector undertaking at Tiruverumbur.

The university has totally four Faculties, 16 Schools, 34 Departments and 11 Specialized Research Centres. There are 195 faculty members catering to 2372 students and scholars in the university. The university Departments/Schools are offering 177 programmes including 40 PG programmes in M.A., M.Sc. and M.Tech. The above programmes are conducted under the Choice Based Credit System (CBCS) in Semesters 31 M.Phil., 33 Ph.D., 19 P.G. Diploma, 11 Diploma and 10 Certificate programmes are offered. The University's supporting staff strength is 521. In addition to the regular teaching programmes in the Departments and Schools, the university under its Distance Education mode is conducting 15 UG and 26 PG programmes. All the UG programmes are conducted under non-semester system and all the PG programmes are conducted under semester system.
along with the regular programmes. The MCA and MBA programmes conducted under this mode are very popular.

The research work going on in some of the departments and research centres (Physics, Chemistry, Life Sciences, Centre for Nonlinear Dynamics) are internationally recognized because of their high quality. Some of the research centres of the university are strongly supported by scientific agencies in India. The Centre for Nonlinear Dynamics is supported by Department of Science and Technology (DST) and Department of Atomic Energy (DAE) and the National Facility for Marine Cyanobacteria is supported by Department of Biotechnology (DBT). The number of ongoing research projects at the moment in various Departments and Research Centres are 119 with a total outlay of Rs.3,200.29 lakhs. The faculty members have made substantial contribution in their fields of research in terms of quality publication in reputed international journals with high impact factor. Six of the University Departments are generously supported by DST under its Fund for Improvement of Science and Technology Infrastructure in Higher Education Institutions (FIST) programme and seven departments are supported by the UGC the under its Special Assistance Programme (SAP). Bharathidasan University is also selected by DST for a generous support of Rs.9.0 crores under its Promotion of University Research and Scientific Excellence (PURSE) programme in recognition of the high quality publications by some of the science departments.
The university is an affiliating one with the jurisdiction over the eight districts of Tiruchirappalli, Pudukkottai, Karur, Perambalur, Ariyalur, Thanjavur, Tiruvarur and Nagapattinam. The university area lies in the strategic central part of Tamil Nadu, covering the cauvery delta, traditionally known as intellectual capital of the state. There are 123 colleges affiliated to the university including 120 Arts and Science Colleges and three Colleges of Fine Arts. Among them eight government and 11 government aided colleges have autonomous status. There are nine constituent colleges in Perambalur, Orathanadu, Lalugdi, Aranthangi, Inamkulathur-Srirangam Taluk, Vedaranayam, Thiruthuraipoondi, Nannilam and Nagapattinam. There are totally 55 UG programmes and 62 PG programmes conducted in the affiliated colleges and the total strength of the students studying in the affiliated colleges is 1,14,276. The extension services rendered by the Institute of Entrepreneurship and Career Development (IECD) and the Department of Women Studies to community, especially to the under-privileged are commendable.

The affiliating jurisdiction is over seven districts with 104 Arts & Science and Fine Arts Colleges and 13 Approved Institutions. Eighteen of the affiliated colleges are autonomous. Among the affiliated colleges, more than 50% are offering PG programmes and 25% are offering M.Phil./Ph.D. programmes. A good number of them are nationally recognized for quality education. The
programmes offered through affiliated colleges are so diversified that they number more than 250. The student strength in the affiliated colleges is over 1.50 lakhs.

**Faculties, Schools and Departments**

**I. Faculty of Arts**

School of Social Sciences
- Department of History
- Department of Social Work
- Department of Sociology
- Department of Women's Studies

School of Economics and Commerce & Financial Studies
- Department of Commerce and Financial Studies
- Department of Economics

School of Education
- Department of Education
- Department of Educational Technology
- Department of Life Long Learning
- Department of Physical Education and Yoga Centre

**II. Faculty of Indian and other Languages**

School of English and other Foreign Languages
- Department of English and other Foreign Languages

School of Indian Languages
Department of Tamil Studies

School of Performing Arts

Department of Performing Arts

III. Faculty of Science, Engineering and Technology

School of Basic Medical Sciences

Department of Biomedical Science

School of Chemistry

Department of Chemistry

School of Computer Science and Engineering

Department of Computer Science and Engineering

School of Engineering and Technology

School of Environmental Studies

Department of Environmental Biotechnology

Department of Environmental Management

School of Geo Sciences

Department of Geography

Department of Geology

Department of Remote Sensing

School of Life Sciences

Department of Animal Science

Department of Biochemistry
IV. Faculty of Management (Autonomous Society)

Bharathidasan Institute of Management. (www.bdu.ac.in/).

Objectives of the Study

The objectives of this investigation are

- To quantify the Ph.D output from 16 schools of the Bharthidasan University as awarded between 1996 and 2010.

- To obtain school wise, year wise, and gender wise Ph.D completions in the form of an exhaustive bibliography with details.

- To collect data regarding the research publications of the faculty.
• To analyse such collected data on the Ph.D completions and other forms of research publications of the guides and scholars in the light of Bibliometric principles.
• To find out the relationship between the Ph.D completions and output of the journal articles.
• To apply the Bradford’s law of bibliometrics to the collected data and arrive at results.

Hypotheses

• There is significant growth in academic research output from faculties of various schools of Bharathidasan University.
• There is significant difference between number of years and their number of Ph.D awards.
• There is significant difference between number years and their number of grants.
• There is significant difference between number of years and their number of guides.
• There is significant relationship between the publications of articles and the number of Ph.D completions.
• The numbers of awards to male candidates are more than those of the female candidates.
There is significant difference between the research outputs of Life Sciences compared to the other three clusters.

**Chapterisation**

*Chapterisation of this research report is structured as follows:*

- The first chapter deals with the most important transformation occurred in the mechanism of technological creation in recent past; the emergence of science-based technology and its relation with the performance of the innovation system that structure modern knowledge-based economics is emphasized.
- The second chapter provides a review of related literature found relevant to this investigation.
- The third chapter comprises the problem statement, period of coverage, sources of data and data collection, set of hypotheses, limitations of the study and the style of rendering the bibliography.
- The fourth chapter provides tabulated display of data along with analysis and interpretations. It includes the test of hypotheses applying the laws of bibliometrics and selective statistical principles found suitable wherever necessary.
- The fifth chapter provides a set of findings and conclusion. It provides suggestions for future study related to the present study.

This report is appended with a bibliography related to the citations in the text of the chapters.