CHAPTER IV

DESCRIPTION OF SOURCE DATABASE AND STATISTICAL
TECHNIQUES / SCIENTOMETRIC INDICATORS
EMPLOYED

4.1 INTRODUCTION

The main aim of this study is to examine the quantitative growth of literature in the field of ‘Wireless Communication' with the help of a source database namely SCOPUS. This study is exploratory and analytical in nature by using different kinds of statistical tools and techniques. In this chapter, in the description of the source database, scientometric indicators and statistical tools have been outlined.

4.2 SOURCE DATABASE

SCOPUS is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 21,000 titles from over 5,000 publishers of which 20,000 are peer reviewed journals in the scientific, technical, medical, and social sciences including arts and humanities. It is owned by Elsevier and is available online by subscription.

SCOPUS is the world’s largest multidisciplinary database in terms of more recent scholarly literature. SCOPUS has wider coverage of journals and conference / seminar proceedings from developed and developing countries, compared to other
international multidisciplinary database Web of Science (WOS). Hence, SCOPUS has been selected as a source of bibliographic information for this study.

**SCOPUS** covers the following subjects

SCOPUS database published large number of literature and citation database of peer-reviewed research literature in the fields of Science, Technology, Medicine, Social Sciences and Arts and Humanities, delivers a comprehensive overview of global scientific output.

Updated daily, SCOPUS includes:

- 21,912 titles from more than 5,000 international publishers
- 20,874 peer-reviewed journals (including 2,800 open access journals)
- 367 trade publications
- 421 book series
- 0,000 books and growing
- 5.5 million conference papers

Articles-in-Press” from more than 3,750 journals and publishers such as Cambridge University Press, Elsevier, Springer, Wiley-Blackwell, Nature Publishing Group and the IEEE (Institute of Electrical and Electronics Engineers)
The 53 million records on SCOPUS include:

- 32 million records, including references, going back to 1995 (84% include abstracts)
- 21 million pre-1996 records going back as far as 1823


Sample Data

**Electronics Letters**

Volume 45, Issue 16, 2009, Pages 811-813

**Compact triple band antenna for WLAN/WiMAX applications**

**Thomas, K.G. , Sreenivasan, M.**

SAMEER-Centre for Electromagnetics, CIT Campus, 2nd Cross Road, Taramani

Chennai, India

View references (5)

**Abstract**

A low profile printed antenna with triple band operation is presented for simultaneous use in wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) applications. The antenna consists of a rectangular radiating element fed asymmetrically by a 50Ω microstrip
line and a shaped trapezoidal ground plane. Rectangular horizontal strips are attached to the radiation element to form different current paths which make the antenna resonate in WLAN and WiMAX frequency bands. The antenna operates in dipole configuration outlining overall dimensions of $38 \times 30 \times 0.8 \text{mm}^3$. © 2009 The Institution of Engineering and Technology.

Indexed keywords

Current paths; Dipole configurations; Ground planes; Low profile; Printed antenna; Radiating elements; Simultaneous use; Triple band antennas; Triple-band operation; WiMAX frequency bands; Worldwide interoperability for microwave access

**Engineering controlled terms:** Antenna grounds; Broadband networks; Channel estimation; Frequency bands; Interoperability; Local area networks; Microwave antennas; Wimax; Wireless local area networks (WLAN)

**Engineering main heading:** Antennas

**ISSN:** 0013-5194  **CODEN:** ELLEA

**Source Type:** Journal  **Original language:** English

**DOI:** 10.1049/el.2009.1658  **Document Type:** Article

### 4.3 DATA COLLECTION

The data has been extracted from SCOPUS international multidisciplinary database for this study and the following search strategy has been used to extract the data: `TITLE-ABS-KEY ("wireless communication") AND PUBYEAR > 1997 AND PUBYEAR < 2013`). The search was carried out on 30th December 2013.
and refined to restrict the literature to articles, conference papers and reviews published in journals. In this study was confined from 1998 to 2012. A SCOPUS record format is shown in the Appendix I

4.4 STATISTICAL TOOLS AND TECHNIQUES EMPLOYED

In this study, the following bibliometric/scientometric indicators and statistical techniques were employed while analyzing the data on Wireless Communication research output collected from the SCOPUS database.

- Relative Growth Rate (RGR)
- Citation per Paper (CPP)
- $h$-Index
- Collaborative coefficient (CC)
- Activity index (AI)
- Co-authorship Index (CAI)
- Doubling Time (Dt)
- Author Productivity
- Degree of Collaboration (DC)
- Bradford Law of Scattering and Lotka’s Law
Relative Growth Rate (RGR)

One of the most obvious features of science in recent years has been its rate of growth. Scientific growth has involved not only increase in manpower and finance\(^1\). The flood of papers represents one aspect of the general growth of scientific communication. Wooster (1970)\(^2\) has estimated the number of journals that existed in the world at any one time, where as some estimates of the number of papers published annually at various times was done by Vickery (1968)\(^3\). Martyn (1973)\(^4\) Gottschalk and Desmond (1963)\(^5\) have also estimated the number of scientific and technical journals existed in the World. Growth studies in other scientific areas included the work of Baker (1976)\(^6\) in chemistry, Conard (1957)\(^7\) in biology, May (1966)\(^8\) and Lamb (1971)\(^9\) in mathematics, Sengupta (1973) in microbiology\(^10\), physiology\(^11\) and biochemistry\(^12\).

The Relative Growth Rate (RGR) is the increase in number of articles/pages per unit of time. This definition is derived from the definition of relative growth rates in the study of growth analysis of individual plants and effectively applied in the field of botany\(^13\), which in turn, had its origin from the study of the rate of interest in the financial investment\(^14\). The mean Relative Growth Rate (R) over the specific period of interval can be calculated from the following equation:

\[
1-2^R = \frac{\log_e 2W - \log_e 1W}{2^T - 1^T}
\]
whereas

\[ 1 - 2 \bar{R} = \text{mean relative growth rate over the specific period of interval} \]

\[ \log_e 1W = \log \text{of initial number of articles/pages} \]

\[ \log_e 2W = \log \text{of final number of articles/pages after a specific period of interval} \]

\[ 2T - 1T = \text{the unit difference between the initial time and the final time} \]

The year can be taken here as the unit of time. The RGR for both articles and pages can be calculated separately.

Therefore

\[ 1 - 2 \bar{R} (aa - 1 \text{ year} - 1) \] can represent the mean relative growth rate per unit of articles per unit of year over a specific period of interval and

\[ 1 - 2 \bar{R} (pp - 1 \text{ year} - 1) \] can represent the mean relative growth rate per unit of pages per unit of year over a specific period of interval.

**Citations per publication (CPP)**

CPP has been extensively used in scientometric assessment to normalize the inconsistencies in volumes of literature published by different institutions / sectors / countries, etc (Dutt & Nikam 2013)\textsuperscript{15}. CPP can be used to assess the
impact of publications for publication years, countries, institutes and authors. The formula of CPP is:

\[ \text{CPP} = \frac{\text{Total Citations}}{\text{Total Papers}} \]

**h-index**

Hirsch (2005)\(^{16}\) proposed the h-index as an alternative to standard bibliometric indicators for single scientists, it is defined as follows:

A scientist has index \( h \) if \( h \) of his or her \( N_p \) papers have at least \( h \) citations each and other papers \( (N_p - h) \) have \( \leq \) citations each.

Ye (2009)\(^{17}\) found that the Glanzel-Schubert\(^{18}\) model was better than the Hirsch and Egghe-Rousseau\(^{19}\) model to estimate the h-index of countries and other units. Elango, Rajendran and Bornmann (2003)\(^{20}\) discussed the differences among the various models of the h-index (table 1). Since its introduction in 2005, the h-index has been applied not only to single scientists, but also to research groups (van Raan, 2006)\(^{21}\) and countries (Schubert, 2007)\(^{22}\).

**Table 4.1 Differences among the various models of h-index**

<table>
<thead>
<tr>
<th>Model</th>
<th>Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirsch</td>
<td>( h = \sqrt{\frac{C}{a}} )</td>
<td>C = total citations; a = constant</td>
</tr>
<tr>
<td>Egghe-Rousseau</td>
<td>( h = P^{\frac{1}{a_0}} )</td>
<td>( P = \text{total publications; } a &gt; 1 \text{ is Lotka’s exponential} )</td>
</tr>
<tr>
<td>Glanzel-Schubert</td>
<td>( h = c P^{\frac{1}{3}} (\text{CPP})^{\frac{2}{3}} )</td>
<td>( c ) is a constant; ( P = \text{total publications; CPP = citations per publications} )</td>
</tr>
</tbody>
</table>
Collaborative Coefficient (CC)

The patterns of co-authorship among different countries have been examined by making use of Collaborative Coefficient (CC) suggested by Ajiferuke\(^2\). The formula used for calculating CC is given below:

\[
CC = 1 - \left[ \sum_{j=1}^{k} \frac{1}{j} \frac{F_j}{N} \right]
\]

where as

\[F_j = \text{the number of authored papers}\]
\[N = \text{total number of research published; and}\]
\[k = \text{the greatest number of authors per paper}\]

Activity Index (AI)

Activity Index characterise the relative research effort of a country to a given field and it is defined as

\[
AI = \frac{\text{(given field’s share in the country’s publication output)}}{\text{(given field’s share in the world’s publication output)}} \times 100
\]

In this study activity index for India has been calculated for different years to see how India’s research activity changed during different years using the above
formula. First suggested by Frame\textsuperscript{24} and used among others by Sehubert and Braun\textsuperscript{25}, Price\textsuperscript{26}, Karki and Garg\textsuperscript{27} activity index characterise the relative research effort of a country to a given field.

Mathematically:\[AI = \{ \frac{I_i}{I_o} / \frac{W_i}{W_o} \} \times 100\]

whereas

\[I_i = \text{Indian output in the year } i\]
\[I_o = \text{Total Indian output}\]
\[W_i = \text{World output in the year } i\]
\[W_o = \text{Total output}\]

The method used for calculating AI has been explained below for research output by different nations in different blocks.

\[AI = \{ \frac{N_{ij}}{N_{io}} / \frac{N_{oj}}{N_{oo}} \} \times 100\]

whereas
\[N_{ij} = \text{Number papers in theme } i \text{ and block } A\]
\[N_{io} = \text{Number papers in theme I for all blocks}\]
\[N_{oj} = \text{Number of papers in all fields block } A\]
\[N_{oo} = \text{Number of papers for all fields and all blocks}\]
Co-authorship Index (CAI)

To study how the pattern of co-authorship, the use of Co-authorship Index suggested by Garg and Padhi\textsuperscript{28} has been made and is explained below. For calculating Co-authorship Index (CAI) the entire data set was divided into five blocks.

\[
\text{CAI} = \left\{ \frac{N_{ij}}{N_{io}} \right\} \times 100
\]

whereas

\[
\begin{align*}
N_{ij} & : \text{Number of papers having j authors in block i;} \\
N_{io} & : \text{Total output of block i;} \\
N_{oj} & : \text{Number of papers having j authors for all blocks;} \\
N_{oo} & : \text{Total number of papers for all authors and all blocks;} \\
j & = 1, 2, 3, 4 \geq 5
\end{align*}
\]

Doubling Time (Dt)

There exists a direct equivalence between the relative growth rate and the doubling time. If the number of articles/pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be the logarithms of number 2. If natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the following formula:
Doubling time (Dt) = \frac{0.693}{\bar{R}}

Therefore

Doubling time for articles Dt (a) = \frac{0.693}{1-2\bar{R}} (aa-1 \text{ year}^{-1})

and

Doubling time for pages Dt (p) = \frac{0.693}{1-2\bar{R}} (pp-1 \text{ year}^{-1})

Author Productivity

It is now widely recognized that scholarly productivity, as measured by number of publications produced, is an elitist phenomenon. Most authors contributing to a particular body of literature contribute very little and the number of authors who are highly productive is very small indeed. Lotka’s chi-square model\(^2\) has been considered to examine the author productivity in this study. Potter (1981)\(^{30}\) identified the Lotka’s fraction \(1/n^a 4.65\) on the basis of Euler Maclaurin formula of summation. The sum was used as a devisor for \(1/n 4.65\) to determine the proportion of the total number of authors expected to produce \(n\) papers (in the case of present study \(n =1,2,3,4,\ldots\)). This model is applied in the present study. The following formula was used to find the proportions:
In the present study $S$ is the sum of Lotka’s modified ratios for the value $\alpha = 4.65$. The formula is a

$$an = \frac{1}{n} \frac{T}{S} \quad n = 1, 2, 3, \ldots$$

where $T$ is total number of authors in the sample and ‘$an$’ is the total number of expected authors producing ‘$n$’ papers.

The Lotka’s law also tested with the application of scientific productivity using chi-square model in relation to a number of authors who contributed ‘$n$’ number of publications.

It can be expressed by the equation

$$an = \frac{a_1}{n^2}$$

where as $n = 1, 2, 3$

In other words, for every 100 authors making one contribution each, there would be 25 authors contributing two articles each (100/2^2 = 25) about 11 contributing three articles each 100/3^2 = 11.1, and so on.

Where ‘$an$’ is the number of authors contributing ‘$n$’ papers each and $a_1$ is the number of authors contributing each one paper.
The Chi-square can be computed as \((O-E)^2/E\)

\[ O = \text{observed number of authors with n publications} \]

\[ E = \text{expected number of authors} \]

**Degree of Collaboration**

Subramanyam’s\(^{31}\) formula has been adopted to examine the extent of research collaboration in the study.

\[ C = \frac{N_m}{N_m + N_s} \]

whereas

\[ C = \text{degree of collaboration in a subject} \]

\[ N_m = \text{number of multiple authored papers} \]

\[ N_s = \text{number of single authored papers} \]

**Bradford Law of Scattering**

Bradford (1934)\(^{32}\) first formulated his law, but it did not receive wide attention until the publication of his book ‘Documentation’ in 1948. Bradford examined all of the journal titles contributing to a bibliography on Applied Geophysics. He divided the list into three ‘zones’ each containing roughly equal number of references. He observed that the number of journals contributing references to each zone increased by a multiple of about five. The first zone contained nine journals, which contributed 429 references. The second zone
contained 59 journals producing 499 references and in the third zone 258 journals contributed 404 references. Bradford found a similar pattern of reference scatter in the field of Lubrication. On the basis of these observations Bradford deduced his law, as

“If scientific periodicals are arranged in the order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus where the number of periodicals in the nucleus and the succeeding zones will be as 1:n:n^2”

For describing the scattering phenomena, he gave the following formula:

\[ F(x) = a + b \log x \]

Where \( F(x) \) is the cumulative number of references as contained in the first \( x \) most productive journal and ‘a’ and ‘b’ are constants.

Bradford’s law has been found to be applicable to bibliographies as well as to larger aggregates of literature.

4.5 CONCLUSION

In the next chapter, the data collected from SCOPUS database on Wireless Communication research output has been analyzed and interpreted by applying the above stated Scientometric Indicators.
REFERENCES


