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Mapping of Mobile Technology Publications: A Scientometric Approach

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ABSTRACT

This paper focus on the growth and development of mobile technology in terms of publication output as reflected in engineering index database. During 2003-2012, a total of 144567 publications were published in the field. The average number of publications published per year was 14456.7 and the highest number of publications 20318 were published in 2011. Authors from China have contributed maximum number of publications compared to the other countries and India stood 7th in terms of productivity in this period. The most prolific author is Wang, Wei who contributed 223 publications followed by Barolli, Leonard with 160 publications. Institute of Electrical and Electronic Engineering (IEEE), New York (USA) is the highly contributed institution with 1248 publications followed by South-East University (China) with 508 publications, Nokia Research Centre, Cambridge (UK) with 502 publications and School of Electrical and Electronic Engineering, Nanyang Technological University (Singapore) with 290 publications. The relative growth rates (RGR) has decreased from 2004 (0.98) to 2012 (0.13) in the span of 10 years. The doubling time (DT) has gradually increased from 0.71 in 2004 to 5.15 in 2012.

Keywords: Mobile technology, scientometrics, scientometric analysis, author productivity, relative growth rate, doubling time

1. INTRODUCTION

With the development of information communication technologies (ICTs), mobile phones are gaining popularity quickly in recent years and become indispensable in people's daily life. Mobile applications for information seeker too have grown up extremely with the growth of technology. Mobile technology has made improvement in communication, entertainment, exercising, and travel. Mobile users are almost instantly connected to each other through a series of cellular connections that reach even to the most remote areas of the world. People are adapting mobile technology more easily than any other technologies. Mobile phones are increasingly one of the most popular information sharing devices[1]. As a result of developments and advancements in information and communication, the mobile technology becomes essential for connecting with internet. People are currently more positive about accessing and seeking information from their mobile phones.

Mobile technology is one of the fastest growing areas in computer science and will very likely dominate software development in the future. The widespread use and development of mobile applications as a social development have played an enormous role in increasing the use of applications for business and other transactions like banking and insurance and therefore the trend of using mobile for these crucial purposes is already showing up and becoming popular. The application of mobile phone services have recently managed to penetrate the educational endeavor in an effort to improve campus-wide information delivery services. Mobile technology has played a great role in the education sector by enabling people to access the internet, even in remote locations using mobile broadband. This enables students and researchers in these far flung areas to carry out research using this feature of mobile technology. Therefore, the present study has been undertaken to know the growth and development of publications in the field of mobile technology as indexed in Engineering Index database.

Scientometric is an academic discipline and much research is being carried out for a quantitative study of the various aspects of literature of a given subject. It is a branch of information science which analyses quantitatively the published information based on bibliographic data elements. The scientometric analysis has received adequate attention in the recent years and it has been widely applied to evaluate the research performance of the scientists and the growth of various disciplines of science. Further, Scientometric could be used in the identification of emerging research areas.

Van Raan[2] described that the scientometric research is devoted to quantitative analysis of

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science and technology. It aims at the advancement of knowledge and development of science and technology and also in relation to social and political questions. Sengupta[3] explained the term scientometric as the organisation, classification, and quantitative evaluation of publication patterns of all macro and micro communications along with their authorship by mathematical and statistical calculations. Basically, the scientometric analysis focuses on the measurement of magnitude of the growth of literature along with various dimensions.

2. LITERATURE REVIEW

Gupta[4], *et al*. studied the World Cataract Research publications covered in the *Scopus Database* during the period of 2002 to 2011. Their study confirmed an exponential growth of publications from 2025 papers in 2002 to 3080 papers in 2011, witnessing an annual average growth rate of 4.89 %.The study analysed the authorship pattern, citation impact of most productive countries, different types of cataract research, subject-wise break up, relatedness of various diseases to cataract research, research output by different population age groups. Khan[5], *et al*. conducted a bibliometric study on library and information science literature in Bangladesh from 1966 to 1977. The study found that a total of 308 articles were authored by 116 professionals in 32 years that is on average 9.62 articles per years and 2.6 articles per author in 32 years.

Ramakrishnan & Ramesh Babu[6] analysed the literature output in the field of hepatitis from three bibliographic databases, namely MEDLINE, CINAHL, and IPA, and found that collaboration in authorship pattern is prevalent, averaging 0.85. Using the PubMed database, Falagas[7], *et al*. collected information for the period of 1995-2003 in the field of parasitology. Research productivity was evaluated based on a methodology and used in other bibliometric studies. The research productivity was evaluated in relation to gross domestic product of each region and in relation to gross national income per capita and population of each region. Arya[8], *et al*. studied the collaboration in research and authorship trend in the area of veterinary sciences all over the world with special reference to India. The study was based on the data collected from 'CABI abstracts' for the period of 2006-2010. The findings of the study revealed that the average degree of collaboration was found 0.84 and subject analysis showed a good research in the area of animal nutrition and veterinary physiology.

Ravichandran[9] analysed on research publications in the field of Biodiversity during the period 1975-2010. It analysed 1,57,557 articles of *Scopus database* and examined year-wise distribution of articles, country-wise distribution, languages distribution and bibliographic form of articles, authorship pattern, country-wise authorship pattern, high productive Indian institutes, etc. inferences and findings were shown with relevant data analysis. Dutta & Rath[10] analysed the global output of 'Cosmology' research. The study covered the publications on the subject available in the Web of Science covering the period of 1999 to 2012. The various scientometric indicators have been used in the analysis, with regard to the literature growth trends, authorship pattern, document types involved and active Indian institutions and co-coordinating research in this subject area. Bradford law of scattering was employed to identify the core journals and Lotka's law was employed to study the authors' productivity pattern are also been analysed. Sevukan & Sharma[11] study presents a detailed analysis of research performance of biotechnology faculties in central universities of India from 1997 to 2006. The study indicate that the growth of literature in biotechnology has steadily increased from 15 articles in 1997 to 43 articles and two authored publications predominate amongst the pattern of authorship.

Garg[12] analysed 1223 papers published by India (347 papers) and China (876 papers) at conferences and as journal articles during 1993 and 1997 in the field of laser science and technology, and indicated that China's output was twice to that of India. Chinese scientists preferred to publish in domestic journals, while Indian scientists published in foreign journals. Indian papers also have more citations per paper than China. Dutt & Nikam[13] analysed research publications in the field of solar cell research in India indexed in Web of Science for a period of 20 years from 1991 to 2010. The study found that academic institutions have contributed half of the total output. Solar cell research by Indian Scientists is well connected to international research trends in the field.

3. OBJECTIVES

The objectives framed for the study are to:

- Depict the growth of literature in the field of mobile technology.
- Find the scattering of literature based on publication types.
- Identify the prolific authors in the mobile technology field.
- Find out the highly productivity affiliated institutions.
- Present language-wise proportion of the literature.
- Analyse country-wise contributions of the publications.
- Quantify the publications as per the Engineering Index subject fields.

4. METHODOLOGY

The data for the present study was retrieved from Engineering Index online database which is published by Elsevier. This is one of the largest-established and best known bibliographic databases for engineering information and it covers almost 10 million records referencing 5,000 engineering journals and conference materials and technical reports dating from 1970. With the aim of covering all the available citations on the subject, the database was searched. The advanced search options were used. A total of 1,44,567 publications spanning over the years 2003 to 2012 were downloaded. Each publication contains English language citation with detailed bibliographic information, e.g., year, author, name of publications, author's affiliation, country, and language, etc. The retrieved records were converted into FoxPro and the same has been loaded into Statistical package for Social Sciences (SPSS) for the purpose of analysis.

5. DATA ANALYSIS AND INTERPRETATIONS

5.1 Publications Output and Types

The major source of publications covered by engineering index databases on mobile technology is conference articles with 94,205 (65.16 %) followed by journal articles with 48,363 publications (33.45 %). Conference proceedings ranks the 3rd position with 1,634 (1.13 %) and articles in press are in the fourth place with 365 (0.25 %) respectively (Table 1).

Table 1. Publications output and type

S. No.	Forms of publications	No. of publications (%)
1.	Conference articles	94,205 (65.16)
2.	Journal articles	48,363 (33.45)
3.	Conference proceedings	1,634 (1.13)
4.	Articles in press	365 (0.25)

5.2 Growth of Publications

During the period of 2003 to 2012, a total of 1,44,567 publications were published on mobile technology. The highest number of publications is 20,318 articles in 2011. The lowest publication is 5,789 in 2003. The average number of publications published per year was 14456.7. But it is seen from the Table 2 that there is a downward trend in 2012.

5.3 Relative Growth Rate and Doubling Time

The Relative Growth Rate (RGR) is the increase in number of articles or pages per unit of time. The mean relative growth rate (R) over the specific period of interval can be calculated from the following equation:

$$1\text{-}2^R = \text{Log}_e W_2 - \text{Log}_e W_1 / T_2\text{-}T_1$$

where,

$1 - 2^R$ – Mean relative growth rate over the specific period of interval

$\text{Log}_e W_1$ – log of initial number of articles

$\text{Log}_e W_2$ – log of final number of articles after a specific period of interval

$T_2\text{-}T_1$ – Unit difference between the initial time and the final time

aa^{-1} – average no. of articles

The year is taken here as the unit of time. The RGR for articles is hereby calculated.

Therefore,

$1 - 2^R$ (aa^{-1} $year^{-1}$) can represent the mean RGR per unit of articles per unit of year over a specific period of interval.

$2004 \Rightarrow = \text{Log}_e 15376 - \text{Log}_e 5789/2004 - 2003$

$= 9.64 - 8.66/1 = 0.98$

$2005 \Rightarrow = \text{Log}_e 26734 - \text{Log}_e 15376/2005 - 2004$

$= 10.19 - 9.64/ 1 = 0.55$

It has been observed from Table 2 and Fig. 1, that the RGR has decreased from 2003 (0.98) to 2012

Table 2. Relative growth rate (RGR) and doubling time (DT) of publications

Year	No. of publications	Cumulative total	$\text{Log}_e W_1$	$\text{Log}_e W_2$	RGR	DT
2003	5789	5789		8.66		
2004	9587	15376	8.66	9.64	0.98	0.71
2005	11358	26734	9.64	10.19	0.55	1.25
2006	12652	39386	10.19	10.58	0.39	1.79
2007	13920	53306	10.58	10.88	0.30	2.29
2008	17515	70821	10.88	11.17	0.28	2.44
2009	16966	87787	11.17	11.38	0.21	3.23
2010	18253	106040	11.38	11.57	0.19	3.67
2011	20318	126358	11.57	11.75	0.18	3.95
2012	18209	144567	11.75	11.88	0.13	5.15

(0.13) in the span of 10 years. The DT has increased when calculated year-wise. The Doubling Time increases from 0.71 in 2003 to 5.15 in 2012.

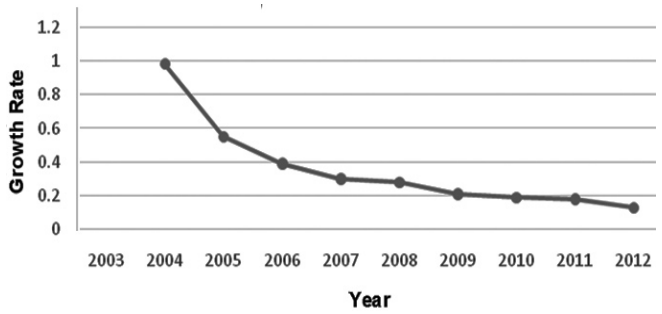

Figure 1. Relative growth rate for research output.

5.4 Doubling Time (DT)

There exists a direct equivalence between the relative growth rate and the doubling time. If the number of articles or 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 logarithm of the 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 formula.

Doubling Time (DT) = 0.693/R

Therefore,

Doubling time for articles

Dt (a) = $0.693/1\text{-}2^{R}$ (aa^{-1} $year^{-1}$)

2004 $\Rightarrow$ 0.693/0.98 = 0.71

2005 $\Rightarrow$ 0.693/0.55 = 1.26

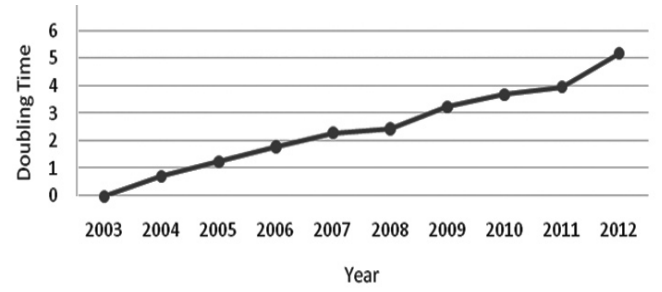

Figure 2. Doubling time for research output.

5.5 Geographical Distribution of Publications

There are 75 countries involved in carrying out research in the field of mobile technology. It is seen from the Table 3, 10 countries From China to Canada 75 % of total output of the research over the study period and among these countries China ranked first followed by USA. The remaining countries from Italy to Brazil, i.e., 16 countries contributed 22.85 % of output and 2.1 % of the research output is contributed by 49 countries which are not mentioned in the table.

Table 3. Geographical distribution of publications

S. No.	Country	No. of articles (%)
1.	China	33,010 (22.83)
2.	USA	19,166 (13.26)
3.	Japan	11,730 (8.11)
4.	Korea	98,55 (6.82)
5.	Germany	79,23 (5.48)
6.	Taiwan	63,40 (4.38)
7.	India	61,50 (4.25)
8.	UK	60,15 (4.16)
9.	France	42,86 (2.96)
10.	Canada	37,56 (2.60)
11.	Italy	31,47 (2.18)
12.	Australia	31,12 (2.15)
13.	Finland	29,90 (2.07)
14.	Spain	2820 (1.95)
15.	Sweden	2658 (1.84)
16.	Netherlands	2388 (1.65)
17.	Singapore	2293 (1.59)
18.	Hong Kong	1881 (1.30)
19.	Greece	1784 (1.23)
20.	Austria	1635 (1.13)
21.	Iran	1603 (1.11)
22.	Poland	1569 (1.08)
23.	Switzerland	1530 (1.06)
24.	Malaysia	1416 (0.98)
25.	Belgium	1199 (0.83)
26.	Brazil	1018 (0.70)

5.6 Distribution of Author Affiliation

Table 4 shows that the most prolific institutions. Findings revealed that Institute of Electrical and Electronics Engineering (IEEE), USA with 1248 articles is the most productive institutions in the field of mobile technology literature followed by Southeast University, China with 528 articles.

5.7 Most Prolific Authors

Table 5 indicates that the rank list the authors who have contributed more than 80 articles or more are taken into account to avoid a long list. The list contains the name of 15 authors with more than 100 articles each. It reveals that Wang, Wei is the most productive author contributing 223 articles followed by Barolli, Leonard with 160 articles and Wong, Kin Lu with 154 articles respectively. A total of 1337 authors had contributed entire research output of the period under study.

5.8 Language-wise Distributions

For all of the 144527 documents, publication language was examined. It is found that the overwhelming

Table 4. Distribution of author affiliation

S. No.	Author affiliation	No. of publications
1.	Institute of Electrical and Electronics Engineering (IEEE), New York, USA	1248
2.	National Mobile Communications Research Laboratory, Southeast University, China	508
3.	Nokia Research Center, Cambridge, UK	502
4.	School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore	290
5.	School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanda, GA	282
6.	State Key Laboratory of Networking and Switching Technology, Beijing University, Beijing, China	238
7.	Tokyo Institute of Technology, Japan	226
8.	School of Computer Engineering, Nanyang Technological University, Singapore	224
9.	Interuniversity Micro Electronics Centre, Leuven, Belgium	214
10.	National Institute of Information and Communications Technology, Japan	212

Table 5. Most prolific authors

S. No.	Author	No. of publications (%)
1.	Wang, Wei	223 (0.154)
2.	Baroli, Leonard	160 (0.110)
3.	Wong, Kin Lu	154 (0.106)
4.	Zhang, Ping	147 (0.102)
5.	Harada, Hiroshi	142 (0.098)
6.	Zhang, Yan	139 (0.096)
7.	Li,Wei	130 (0.090)
8.	Wang, Jing	123 (0.085)
9.	Fettweis, Gerhard	122 (0.084)
10.	Liu, Wei	120 (0.083)
11.	Wang, Jun	119 (0.082)
12.	Wang, Lei	11 5 (0. 079)
13.	Li, Jun	105 (0. 072)
14.	Hosono, Hideo	102 (0. 070)
15.	Zhang, Xin	101 (0.070)

Table 6. Subject-wise distribution of articles

S. No.	Subject	No. of articles (%)
1.	Wireless Telecommunication Systems	20585 (14.24)
2.	Mobile Telecommunication Systems	18423 (12.74)
3.	Wireless Networks	15320 (10.6)
4.	Mobile Computing	12782 (8.84)
5.	Computer Simulation	11688 (8.08)
6.	Algorithms	10707 (7.41)
7.	Mobile Devices	8890 (6.15)
8.	Mobile Robots	7283 (5.04)
9.	Telecommunication Networks	6480 (4.48)
10.	Internet	6473 (4.48)

majority is in English (138965), includes Chinese (4533), Japanese (391), Russian (204) and German (198). The remaining publications are very less in other languages such as, Korean, French, and so on.

5.9 High Productivity Subject Areas

Table 6 depicts that the highest number of articles contributed on wireless communication system during this study period and followed by mobile communication systems constituted second rank and followed by wireless networks. The fourth highest articles belonged to the subject mobile computing. The subjects are identified and classified with the option available in the database as Subject.

6. CONCLUSIONS

After analysis of Engineering Index database (2003-2012) in the field of mobile technology it is conclude that 1,44,527 publications were published in the field of mobile technology. The single most prevalent type of publications is the conference article, in which 65.16 % of the total literature is published. This shows that mobile technology researcher's preferred medium of communication is conference articles. Majority of publications were found in English language. A large number of researchers and scientists are pursuing their research in the field of mobile technology, giving hope that more literature would be published on the subject from all the countries in the world.

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