# MEMS Output in Scopus Database: A Bibliometric Analysis

**A. L. Bathrinarayanan**
Librarian
Sri Krishna College of Technology
Kovaipudur, Coimbatore

**M. Tamizhchelvan**
Deputy Librarian
Gandhigram Rural Institute-Deemed University
Gandhigram -624302, Dindigul Dt.

Abstract

*The present study examines the bibliometric analysis of the MEMS output in Scopus database during the year 1988 -2012. A total of 86978 records are retrieved and data analyzed. Scientometrics tools such as, Relative Growth Rate and Doubling Time, block-year wise distribution of article, growth and country wise article were analyzed. Type of document has been analyzed. A total of 94.4% of MEMS publications are appearing as journal articles and conference paper*

Keywords

SCOPUS, MEMS, RGR & DT, Growth of Article

Electronic access

The journal is available at www.jalis.in

**Journal of Advances in Library and Information Science**
ISSN: 2277-2219 Vol. 2. No.2. 2013. pp. 100-104

## INTRODUCTION

MEMS, acronym for Micro-Electro Mechanical Systems, is an emerging field, has been identified as one of the most promising technologies for the 21st Century and has the potential to revolutionize both industrial and consumer products by combining silicon-based microelectronics with micromachining technology. Its techniques and micro system-based devices have the potential to major impact in the global economy. If semiconductor micro fabrication was seen to be the first micro manufacturing revolution, MEMS is the second revolution. This paper presents a general introduction to the field of MEMS, with literature growth with emphasis on scopus data base.

## BIBLIOMETRIC STUDY

Bibliometric analysis is employed by researchers to study the growth of literature in given field. Pritchard (1969) defined the term Bibliometric as the application of statistical and mathematical methods to books and other communication. The bibliometrics has emerged as a thrust area of research, incorporating different branches of human knowledge. There are famous Laws of Bibliometric i.e. Lotka's law (1926) of scientific productivity, Bradford's law (1934) of scattering and Zips law (1949) on frequency of words. But the Bibliometric studies started in late sixties.

## WHAT IS MEMS?

MEMS, are a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using integrated circuit (IC) batchprocessing techniques and can range in size from a few micrometers to millimetres. These devices (or systems) have the ability to sense, control and actuate on the micro scale, and generate effects on the macro scale.

The interdisciplinary nature of MEMS utilizes design, engineering and manufacturing expertise from a wide and diverse range of technical areas including integrated circuit fabrication technology, mechanical engineering, materials science, electrical engineering, chemistry and chemical engineering, as well as fluid engineering, optics, instrumentation and packaging. The complexity of MEMS is also shown in the extensive range of markets and applications that incorporate MEMS devices. MEMS can be

found in systems ranging across automotive, medical, electronic, communication and defence applications. Current MEMS devices include accelerometers for airbag sensors, inkjet printer heads, computer disk drive read/write heads, projection display chips, blood pressure sensors, optical switches, microvalves, biosensors and many other products that are all manufactured and shipped in high commercial volumes.

## OBJECTIVES OF THE STUDY

Main objectives of the study are

1. To examine the worldwide research production in MEMS.
2. To identify the document type of the publications in MEMS.
3. To compare and measure the growth rate of literature published.

## HYPOTHESES

The following hypotheses will be formulated for this study based on objectives.

- There exists substantial literature on MEMS.
- Growth of publications in mems research is comparatively higher in developed countries.
- There exists domination of collaborative research in MEMS.
- Journals are major source of publications for MEMS.
- There exists steady growth in publication production in MEMS.

## COLLECTION OF DATA

For this study, the literature on textile research data has been downloaded from 'Scopus', multidisciplinary online database, which is an international indexing and abstracting database, using the search term "MEMS". For this study, publications commencing from 1988-2012 (25 years) has been downloaded from the database. A total of 86978 data has been identified.

The collected data has been classified by using Excel and the same was loaded in to SPSS (statistical package for social sciences) for the purpose of analysis. Statistical tools such as frequency distribution and percentage analysis and Scientometric techniques such as Authorship pattern, Relative Growth Rate (RGR), Doubling time (dt) citation analysis etc will be used for the study.

## DATA ANALYSIS

The year wise distribution of a total 86978 records were shown in table 1

**Table 1: Year wise distribution**

| Sl.No. | Year | Articles | % | Cumul-ative | Cum. % |
|---|---|---|---|---|---|
| 1 | 1988 | 1872 | 2.15 | 1872 | 2.15 |
| 2 | 1989 | 1995 | 2.29 | 3867 | 4.44 |
| 3 | 1990 | 2182 | 2.51 | 6049 | 6.95 |
| 4 | 1991 | 1796 | 2.06 | 7845 | 9.02 |
| 5 | 1992 | 1519 | 1.75 | 9364 | 10.76 |
| 6 | 1993 | 1525 | 1.75 | 10889 | 12.52 |
| 7 | 1994 | 1457 | 1.68 | 12346 | 14.19 |
| 8 | 1995 | 1548 | 1.78 | 13894 | 15.97 |
| 9 | 1996 | 2104 | 2.42 | 15998 | 18.39 |
| 10 | 1997 | 2040 | 2.35 | 18038 | 20.74 |
| 11 | 1998 | 2115 | 2.43 | 20153 | 23.17 |
| 12 | 1999 | 2185 | 2.51 | 22338 | 25.68 |
| 13 | 2000 | 2623 | 3.02 | 24961 | 28.70 |
| 14 | 2001 | 2625 | 3.02 | 27586 | 31.71 |
| 15 | 2002 | 3208 | 3.69 | 30794 | 35.40 |
| 16 | 2003 | 2097 | 2.41 | 32891 | 37.81 |
| 17 | 2004 | 3975 | 4.57 | 36866 | 42.38 |
| 18 | 2005 | 3961 | 4.55 | 40827 | 46.94 |
| 19 | 2006 | 4400 | 5.06 | 45227 | 52.00 |
| 20 | 2007 | 4833 | 5.56 | 50060 | 57.55 |
| 21 | 2008 | 6918 | 7.95 | 56978 | 65.51 |
| 22 | 2009 | 7696 | 8.85 | 64674 | 74.35 |
| 23 | 2010 | 8208 | 9.44 | 72882 | 83.79 |
| 24 | 2011 | 7878 | 9.06 | 80760 | 92.85 |
| 25 | 2012 | 6218 | 7.15 | 86978 | 100.00 |
| | **Total** | **86978** | **100.00** | | |

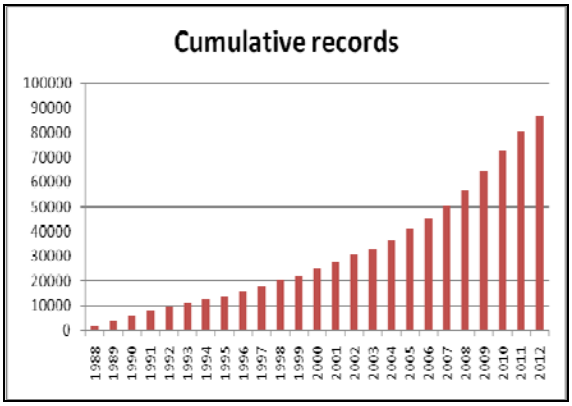

***Fig. 1 Year wise Distribution of Articles***

**Table 2: Publication Distribution over Block Period**

| S. No | Block Year | Output | % | Ratio of between block period |
|---|---|---|---|---|
| 1 | 1988-1992 | 9364 | 10.76 | 1.00 |
| 2 | 1993-1997 | 8674 | 9.97 | 0.93 |
| 3 | 1998-2002 | 12756 | 14.67 | 1.47 |
| 4 | 2003-2007 | 19266 | 22.15 | 1.51 |
| 5 | 2008-2012 | 36918 | 42.45 | 1.92 |
| | **Total** | **86978** | **100.00** | |

The global output during the block period "1988-1992" is only 10.76% (9364) and 9.97% (8674) in the block year 1993-97. During the block period 1998-2002, it can be seen 14.67% (12756) and 22.67% (19266) during the block "2003-2007. 42.45% (36918) of publications can be seen during the block period. In all 64.60% publication appeared during the block period 2003-2012.

## NATURE OF PUBLICATION AND DISTRIBUTION OF ARTICLES

The collected records were categorized based on source type and the same is presented in Table 3

**Table 3: Nature of Publication and Distribution of Articles**

| Sl. No. | Source Type | No. of Articles | % |
|---|---|---|---|
| 1 | Article | 56402 | 64.85 |
| 2. | Conference Paper | 25705 | 29.55 |
| 3. | Conference Review | 765 | 0.88 |
| 4. | Review | 2824 | 3.25 |
| 5. | Book | 197 | 0.23 |
| 6. | Abstract Report | 190 | 0.22 |
| 7. | others | 895 | 1.03 |
| | **Total** | **86978** | **100.00** |

Nearly 64.85% of the publication was journal articles. It is followed by conference paper 29.55%. A total of 94.4% of MEMS publications are appearing as journal articles and conference paper.

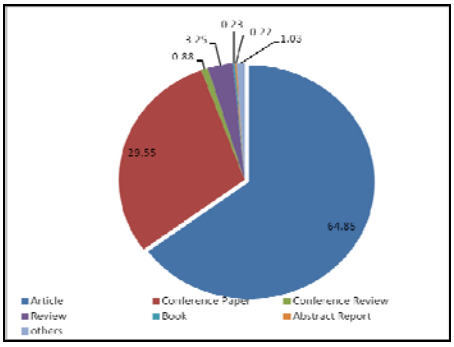


***Fig. 2: Nature of Publication and Distribution of Articles***

## COUNTRY WISE DISTRIBUTION AND GROWTH OF ARTICLES

The MEMS publications were further grouped into country wise and the distribution of records has been shown in Table 4.

**Table 4:Country wise Distribution and Growth of Articles**

| Sl.no | Country | No. of articles | % |
|---|---|---|---|
| 1 | United States | 20924 | 24.06 |
| 2 | China | 9414 | 10.82 |
| 3 | Germany | 5806 | 6.68 |
| 4 | United Kingdom | 4343 | 4.99 |
| 5 | Japan | 3386 | 3.89 |
| 6 | Canada | 2611 | 3.00 |
| 7 | France | 2078 | 2.39 |
| 8 | Italy | 1870 | 2.15 |
| 9 | India | 1684 | 1.94 |
| 10 | South Korea | 1508 | 1.73 |
| 11 | Netherlands | 1414 | 1.63 |
| 12 | Taiwan | 1407 | 1.62 |
| 13 | Russian Federation | 1367 | 1.57 |
| 14 | Australia | 1339 | 1.54 |
| 15 | Brazil | 1289 | 1.48 |
| 16 | Spain | 1195 | 1.37 |
| 17 | Sweden | 949 | 1.09 |
| 18 | Switzerland | 776 | 0.89 |
| 19 | Iran | 729 | 0.84 |
| 20 | others | 22200 | 25.52 |
| | **Total** | **86978** | **100.00** |

The table reveals that 24.06% of the total articles were contributed by the authors from USA, followed by China (10.82%), Germany (6.68%), United Kingdom(4.99%), and Japan (3.89%). Further it can be seen that only 16 countries were contributed more than 1000 publications. Among the 16 countries India position itself on 9th place with 1684 publications. . The contribution of India comes to nearly 1.94% of World Output.

**GROWTH OF PUBLICATIONS**

The growth of publications were analysed by using two parameters Relative Growth rate and Doubling time (Mahapatra 1985). RGR is a measure to study the increase in number of articles of time.

It is calculated as

$RGR = (\ln W_2 - \ln W_1) / (t_2 - t_1)$

Where $W_2$ and $W_1$ are the cumulative number of publications in years $t_2$ and $t_1$.

The relative growth rate and the doubling time (Dt) was calculated and the result are represented in table 5.

**Table 5: RGR and Doubling Time**

| Sl.No. | Year | Articles | % | w1 | w2 | RGR | Dt |
|---|---|---|---|---|---|---|---|
| 1 | 1988 | 1872 | 2.15 | 0.00 | 7.53 | 7.53 | 0.09 |
| 2 | 1989 | 1995 | 2.29 | 7.53 | 7.60 | 0.06 | 10.73 |
| 3 | 1990 | 2182 | 2.51 | 7.60 | 7.69 | 0.09 | 7.62 |
| 4 | 1991 | 1796 | 2.06 | 7.69 | 7.49 | -0.19 | -3.51 |
| 5 | 1992 | 1519 | 1.75 | 7.49 | 7.33 | -0.17 | -4.08 |
| 6 | 1993 | 1525 | 1.75 | 7.33 | 7.33 | 0.00 | 173.25 |
| 7 | 1994 | 1457 | 1.68 | 7.33 | 7.28 | -0.05 | -14.97 |
| 8 | 1995 | 1548 | 1.78 | 7.28 | 7.34 | 0.06 | 11.27 |
| 9 | 1996 | 2104 | 2.42 | 7.34 | 7.65 | 0.31 | 2.23 |
| 10 | 1997 | 2040 | 2.35 | 7.65 | 7.62 | -0.03 | -22.11 |
| 11 | 1998 | 2115 | 2.43 | 7.62 | 7.66 | 0.04 | 18.92 |
| 12 | 1999 | 2185 | 2.51 | 7.66 | 7.69 | 0.03 | 20.98 |
| 13 | 2000 | 2623 | 3.02 | 7.69 | 7.87 | 0.18 | 3.74 |
| 14 | 2001 | 2625 | 3.02 | 7.87 | 7.87 | 0.00 | 896.10 |
| 15 | 2002 | 3208 | 3.69 | 7.87 | 8.07 | 0.20 | 3.41 |
| 16 | 2003 | 2097 | 2.41 | 8.07 | 7.65 | -0.43 | -1.61 |
| 17 | 2004 | 3975 | 4.57 | 7.65 | 8.29 | 0.64 | 1.07 |
| 18 | 2005 | 3961 | 4.55 | 8.29 | 8.28 | 0.00 | -193.58 |
| 19 | 2006 | 4400 | 5.06 | 8.28 | 8.39 | 0.11 | 6.50 |
| 20 | 2007 | 4833 | 5.56 | 8.39 | 8.48 | 0.09 | 7.28 |
| 21 | 2008 | 6918 | 7.95 | 8.48 | 8.84 | 0.36 | 1.90 |
| 22 | 2009 | 7696 | 8.85 | 8.84 | 8.95 | 0.11 | 6.41 |
| 23 | 2010 | 8208 | 9.44 | 8.95 | 9.01 | 0.06 | 10.60 |
| 24 | 2011 | 7878 | 9.06 | 9.01 | 8.97 | -0.04 | -16.64 |
| 25 | 2012 | 6218 | 7.15 | 8.97 | 8.74 | -0.24 | -2.89 |
| | **Total** | **86978** | **100** | | | | |

The Dt is directly related to RGR. It is the time required for articles to become bouble of the existing amount. The Table 5 represents the chronological distribution, RGR, Dt, Publications in the field of MEMS during the period 1988-2012. Dt is the period of time required for a quantity to double in size or value. Dt or period which can be calculated directly from the growth rate. The growth rate is found to be at a maximum during 2004 (0.64) and minimum during 1991 (-0.19). It is observed from the table in the year 1989 (10.73) and 1999 it was doubled as

(20.98) with in the decade double the publications and it goes doubling time is not steady.

## FINDINGS

The output of mems data from Scopus database, the global output during the block period "1988-1992" is only 10.76% (9364) and 9.97% (8674) in the block year 1993-97. During the block period 1998-2002, it can be seen 14.67% (12756) and 22.67% (19266) during the block "2003-2007. 42.45% (36918) of publications can be seen during the block period. In all 64.60% publication appeared during the block period 2003-2012.

The type publications are identified from the data, there are nearly 64.85% of the publication was journal articles. It is followed by conference paper 29.55%. A total of 94.4% of MEMS publications are appearing as journal articles and conference paper.

The contribution of papers and research articles by the various countries, the table4 reveals that 24.06% of the total articles were contributed by the authors from USA, followed by China (10.82%), Germany (6.68%), United Kingdom (4.99%), and Japan (3.89%). Among the 16 countries India position itself on 9$^{th}$ place with 1684 publications. The contribution of India comes to nearly 1.94% of World Output.

The growth of publications on mems, 'Doubling' the article production within a decade it is doubled the publications.

## CONCLUSION

In general, bibliometric analysis use data on numbers and authors of scientific publications and on articles and the citations therein to measure the output of countries, type of articles published in the database and the growth of its publications, in the field, etc. It is necessary to have more data to identify the nature of the growth in the field, the development of the field.

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