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CHANNELS OF PUBLISHED RESEARCH COMMUNICATION USED BY MALAYSIAN AUTHORS IN COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

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ABSTRACT

Analyse 389 records retrieved from Inspec (1990-1999), Compendex (1987-1999) and IEL (IEE/IEEE Electronic library)(1987-1999). The records comprised 159 journal articles, 229 conference papers and 1 monograph chapter. The subject coverage was computer science and information technology. The yearly output of Malaysian publications indicated a gentle upward trend. The highest contributions was 87 published in 1997. The channels used to publish differ slightly from the norm for scientists. Conference papers were preferred to journal articles. The spread of conference papers used to publish indicate three zonal distributions; the nucleus, moderate and low productivity in the ratio of 19 : 41 : 88, leading to a clustering index of 2.15. This shows that Malaysian conference contributions were concentrated in a few proceedings. No clear core journals can be identified for the journal articles and contributions were distributed in a wide variety of journal titles. Malaysian Journal of Computer Science published the highest number of journal articles. More than 83% of the articles were published in journals from the UK, USA, the Netherlands and Malaysia.

Keywords: Publication output; Publication productivity; Computer Science; Information Technology; Channels for research communication.

OBJECTIVES

Dissemination of research findings in the natural sciences depend primarily on periodicals literature, especially on a small number of core journals published in the field. Fussler (1949) indicated the high dependence on journals among chemists and physicists in the United States. Fussler added that scientists in his sample cited more than 90% to publications in serials. Garg and Kumar (1984) indicated that scientists preferred journals compared to other sources of information. Chen (1972) and Flowers (1965) similarly indicated these findings. Hallmark (1994) found that scientists in most disciplines except chemistry and physics depended heavily on informal sources. Hart (1996) noted that scientists relied more on journals and less on books. Another study indicated that engineers regarded oral communication as important as well as colleagues and internal sources of information while scholarly journals, books, and conference papers were regarded less important (Leckie, Karen and Sylvain, 1996). Print journals

also provided the most research support in the field of business management (Popovich, 1975). Even though this situation may be true in the sciences, this was not indicated for researches in the social sciences and humanities. Heinzkill (1980), Stern (1983) and Budd (1986) found that the percentage of the use of journal articles in English literature, literary scholarship and American literature were 20.0%, 15.1% and 26.7%, respectively. Zainab and Goi (1997) found that journal articles ranked second to books in the types of documents referenced by Malaysian humanities researchers. Publication counts in journals are often used as an indicator of research productivity in a field and may give useful information on the research performance as well as the nature of research carried out in university departments (Zachos, 1991; Arenas, 1992). Data from Malaysian government sources (*1994, 1996 Malaysian science and technology indicators*.., 1996, 1998; and *1994, 1996 National survey of research and development*.., 1996, 1998) indicated that five fields grew faster than average in the number of researchers. The fields were earth sciences, information technology, engineering sciences, biological and agricultural sciences. Malaysia's publication contribution on science and technology was ranked among the 50 top leading countries in publication output in the world (*Second European Report*.., 1997). From 1984-1989, Malaysia ranked 44th out of the 48 leading countries with 0.05% share of publication output in the world. From 1990-1995, Malaysia's percentage publication output increased to 0.07% and ranked number 46 out of 50 leading countries in the world. In terms of average annual growth, Malaysia's average publication output is 4%, 5% and 7% for 1980-1985, 1986-1989 and 1990-1995. Singapore was ahead of the other ASEAN nations, registering 16% in average annual growth rate of the world's share of publication output. Malaysia's performance in specific fields such as computer science and information technology, have not been explored. The aim of this paper is to firstly, ascertain the total number of papers in the field of computer science and information technology, published and available from selected databases between the years 1990 and 1998 and secondly, identify the main channels of research communication used to publish their research findings.

METHODS

The data for this study was collected from three CD-ROM databases; *COMPENDEX* (1987- 1999), *IEL (IEE/IEEE Electronic Library*) (1987-1999) and *INSPEC* (1990-1998). The records were entered into a Microsoft Access 97 database so that the total number of contributions in computer science and information technology submitted between the years 1988-1998 was bibliographically controlled. The database provided information on the types of publication authored. The Bibliometric Toolbox (version 1.4) developed by T.A. Brooks in 1987 was used to analyse data retrieved from the database. The tool provided a brief frequency summary of channel productivity by cohort groups and a minimum Bradford zonal analysis.

ANALYSIS AND DISCUSSION

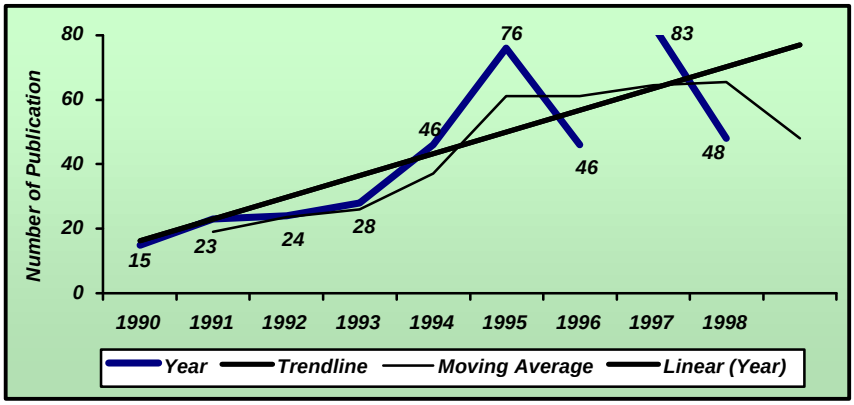
Malaysian Publications in Computer Science and Information Technology

The search contributed a total of 389 bibliographic records, which comprise 159 (40.9%) journal articles, 229 (58.9%) conference papers and 1 (0.2%) monograph chapter. The yearly average publication productivity was 43.2 (Table 1). The Table indicates an up-down trend in research publication productivity from 15 in 1990 to 28 in 1993. During the following five years (1994-1998) the trend was irregular, fluctuating up and down with a low of 46 in 1994 and a high of 83 in 1997. The trend line ($y=6.7333x + 9.5554$, $R^2=0.6043$) (Figure 1) indicates a gently upward trend in the ten-year publication productivity and predicts that this trend would continue.

Table 1: Malaysian Publications in Computer Science and Information Technology

Year	Number of Publications (n= 389)		Cumulative Number of Publications	
1990	15	3.9%	15	3.9%
1991	23	5.9%	38	9.8%
1992	24	6.2%	62	15.9%
1993	28	7.2%	90	23.1%
1994	46	11.8%	136	35.0%
1995	76	19.5%	212	54.5%
1996	46	11.8%	258	66.3%
1997	83	21.3%	341	87.7%
1998	48	12.3%	389	100.0%

Figure 1: Chronological Distribution of Total Publications Retrieved



Channels Used to Communicate Research Results

The bibliographic data revealed that conference papers were the primary channel of research communication used by Malaysian authors between the years 1990 and

1998. The secondary channel used was journals. These results differ from previous reports in the literature that indicated scientists' heavier use of journal literature.

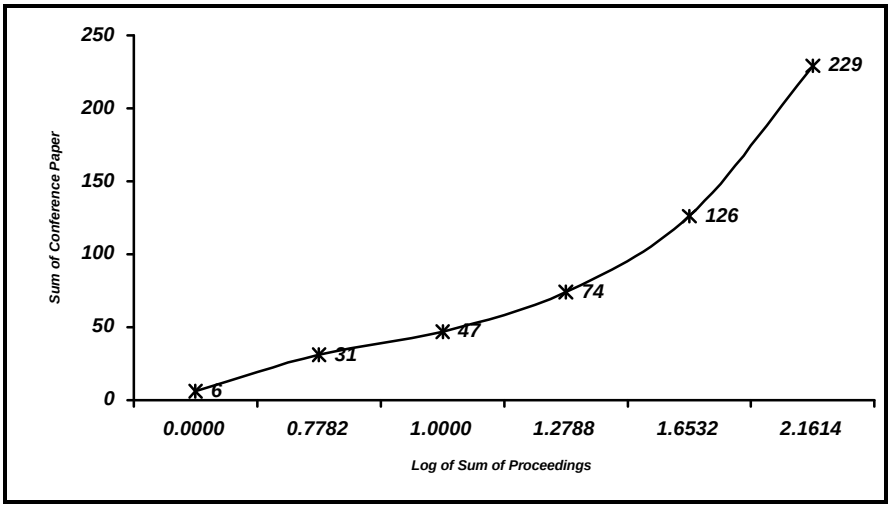
Conference papers

A total of 229 papers were published in 148 conferences (Table 2). Over 55% of total conference papers were published in less than one third of the proceedings. A bibliograph (Fig 2) showing cumulative number of proceedings illustrated that a few core proceedings contributed the majority of Malaysian conference papers. Three zones are indicated which equally share an approximate value of one third of the 229 papers. The nucleus zone contains 19 core proceedings contributing 74 papers, the moderate productive zone consists 41 proceedings publishing 67 papers and the low productive zone comprises 88 conference titles, which accounted for 88 papers. Each of the three zones contains conference papers in the ratio of 19 : 41 : 88. This results lead to a clustering index with the value of 2.15, indicating that the distribution of Malaysian conference papers are concentrated in a few proceeding titles.

Table 2: Distribution of Conference Paper by Proceedings

Number of Proceedings (n=145)		Number of Paper (n=226)		Cumulative Number of Proceedings		Cumulative Number of Paper		Log (Cum. Number of Proceedings)
1	0.7%	6	2.6%	1	0.7%	6	2.6%	0.0000
5	3.4%	5	2.2%	6	4.1%	31	13.5%	0.7782
4	2.7%	4	1.7%	10	6.8%	47	20.5%	1.0000
9	6.1%	3	1.3%	19	12.8%	74	32.3%	1.2788
26	17.6%	2	0.9%	45	30.4%	126	55.0%	1.6532
100	**69.6%**	**1**	**0.4%**	**148**	**100.0%**	**229**	**100.0%**	**2.1703**

Figure 2: Bibliograph of Cumulative Number of Proceedings



A total of six papers were published in one single conference proceeding, that is *Proceedings of IEEE International Conference on Semiconductor Electronics, ICSE 97* published in USA. A total of eighteen individual authors from five institutions (three were institutions of higher learning and two private sectors) contributed the six papers. Table 3 presents the titles of proceedings that publish three or more conference papers submitted by Malaysian authors.

Table 3: Conference Paper Publication by Proceedings

Group	Proceedings	No. of Paper	Sum of Paper
1	**Cohort: 1** IEEE International Conference on Semiconductor Electronics, ICSE 97 (1997)	6	6
2	**Cohort: 5** Singapore ICCS Conference (1994) Proceedings of SPIE - The International Society for Optical Engineering (1996) IEEE Singapore International Conference on Networks/ International Conference on Information Engineering – IEEE SICONVICIE (1995) IEEE International Conference on Multi-Media Engineering Education (1994) ICARCV '92. Second International Conference on Automation, Robotics and Computer Vision (1992)	5	31
3	**Cohort: 4** IEEE International Conference on Neural Networks (1995) International Conference on Computer Integrated Manufacturing. ICCIM '91. Manufacturing Enterprises of the 21st Century (1991) 3rd International Conference, Computer Integrated Manufacturing (1995) ACCV '95. Second Asian Conference on Computer Vision (1995)	4	47
4	**Cohort: 9** IEE Conference Publication (1995) ICARCV '94. Third International Conference on Automation, Robotics and Computer Vision (1994) Trends in Information Systems Engineering and Wireless Multimedia Communications – Proceedings of the International Conference on Information, Communications and Signal Processing, ICICS (1997) SICE Annual Conference (1998) International Conference on Power Electronics and Drive Systems (1997) IEEE International Conference on Systems, Man and Cybernetics (1995) National Conference Publication - Institution of Engineers, Australia (1994) IEEE International Conference on Neural Networks (1995) IEEE International Conference on Intelligent Engineering Systems, INES (1997)	3	74
5	**Cohort: 26**	2	126
6	**Cohort: 100**	1	229

The remaining 129 proceedings published one or two papers respectively. The following 26 proceedings published two papers each authored by Malaysian authors:

CALISCE '91. Proceedings of the International Conference on Computer Aided Learning and Instruction in Science and Engineering (1991)

Canadian Conference on Electrical and Computer Engineering (1993)

Computing in Civil Engineering (New York) (1995)
IECON Proceedings (Industrial Electronics Conference) (1991)
IEE Conference Publication (1994)
IEE Conference Publication (1997)
IEE Conference Publication (1998)
Proceeding of the IASTED International Conference on Power Systems and Engineering (1994)
Proceedings of ED-MEDIA 96 - World Conference on Educational Multimedia and Hypermedia (1996)
Proceedings of EMPD '98. International Conference on Energy Management and Power Delivery (1998)
Proceedings of ICCC'95. Information Highways for a Smaller World and Better Living. (12th International Conference on Computer Communication) (1995)
Proceedings of IEEE Region 10 Annual International Conference – TENCON (1996)
Proceedings of IEEE World Congress on Computational Intelligence IEEE International Conference on Neural Networks (1998)
Proceedings of the 10th IEEE Region Conference on Computer, Communication, Control and Power Engineering (1993)
Proceedings of the Fifteenth IASTED International Conference. Applied Informatics (1997)
Proceedings of the Fourth IASTED International Conference Computer Applications in Industry (1995)
Proceedings of the IASTED International Conference, Applied Modelling, Simulation and Optimization (1995)
Proceedings of the IEEE Conference on Control Applications (1994)
Proceedings of the International Symposium on the Physical & Failure Analysis of Integrated Circui IPFA (1995)
Proceedings of the SPIE - The International Society for Optical Engineering (1993)
Proceedings of the Twelfth IASTED International Conference Applied Informatics (1994)
SICE '90. Proceedings of the 29th SICE Annual Conference—Volume II (1990)
SPE - Asia Pacific Oil & Gas Conference (1997)
SPE Asia Pacific Conference (1991)
Technology and Teacher Education Annual, 1996. Proceedings of SITE 96 - Seventh International Conference of the Society for Information Technology and Teacher Education (SITE) (1996)
Thirteenth IEEE/CHMT International Electronics Manufacturing Technology Symposium (1992).

Seventeen countries or regions published these proceedings. Table 4 shows the distribution of conference papers by the country of publication. A total of 149 papers were published in the United States, followed by 23 in the United Kingdom and Singapore respectively. The proportion of conference publications from the three countries reached 85.2 per cent. The “Others” comprises conference proceedings published in countries such as The Netherlands, Japan, Australia, China, Canada, Switzerland, Austria, Belgium, Hong Kong, India and Turkey. The results indicate that Malaysian conference papers in the fields of computer science and information technology during 1990 to 1998, were mainly published in conference proceedings abroad.

Table 4: Distribution of Conference Paper by Country of Publisher

Country	Number of Country (n=15)		Number of Paper (n=229)		Cumulative Number of Country		Cumulative Number of Paper	
USA	1	5.9%	149	65.1%	1	5.9%	149	65.1%
Singapore UK	2	11.8%	23	10.0%	3	17.6%	195	85.2%
Netherlands	1	5.9%	9	3.9%	4	23.5%	204	90.7%
Japan	1	5.9%	6	2.6%	5	29.4%	210	89.1%
Australia China	2	11.8%	3	1.3%	7	41.2%	216	94.3%
Canada/Egypt Switzerland	3	17.6%	2	0.9%	10	58.8%	222	96.9%
Others	7	41.2%	1	0.4%	17	100%	229	100%

The most productive author of conference papers was Mohd Ali Borhanuddin who published 9 papers. Mazlan Abbas and Shamsudin M. H. Amin ranked second with 8 contributions each. Seven conference papers came from Ahmed Sohail, Ishak Ismail and K.I. Lo and S.M. Rezaul, respectively. The authors who each wrote 6 conference papers were Abdullah Asuhaimi Mohd Zin and Ibrahim Khalil, while P. Raveendran published 5 conference papers.

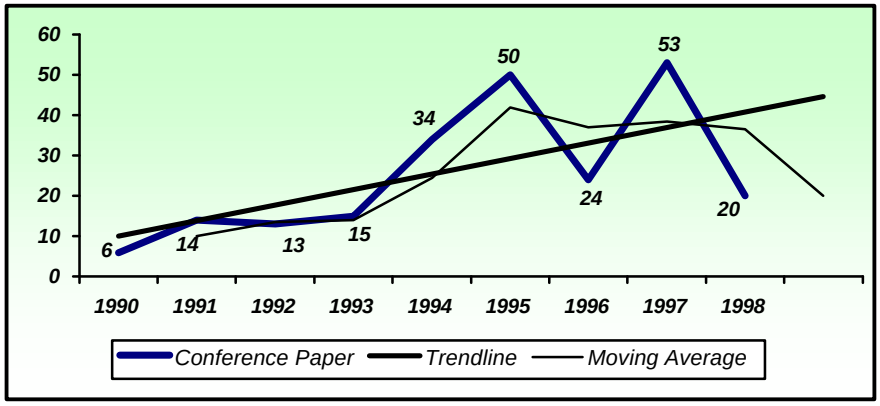
Based on the first author's affiliation status, the results indicated that 35 first authors' affiliations contributed the 229 conference papers during 1990 to 1998. Universiti Teknologi Malaysia (UTM), Universiti Sains Malaysia (USM) and Universiti Malaya (UM) were the top institutional providers of conference paper, with 63, 44 and 28 titles each, respectively, comprising a total of 135 (57.5%) papers. Universiti Putra Malaysia (UPM), Universiti Kebangsaan Malaysia (UKM), Institut Teknologi MARA (ITM), Universiti Malaysia Sarawak (UNIMAS) and Universiti Islam Antarabangsa Malaysia (UIAM) contributed 17, 16, 11, 5 and 3 conference papers each respectively. The total number of conference papers from the eight institutions of higher learning was 187. Four private organisations, Intel Technology Sdn Bhd (9), Esso Production Malaysia Inc (6), Advanced Micro Devices Export Sdn Bhd (2) and Kuala Lumpur City Centre (2), contributed a total 19 conference papers. No government research institutions offered two or more conference papers.

Table 5 presents the distribution of conference papers according to the number of papers produced. The most productive years for conference paper publication were 1995 and 1997. The beginning of the period, 1990, had the least number of conference papers. The number of papers per year for 1991, 1992 and 1993 showed little difference. Figure 3 reveals the nine-year trend of conference paper productivity, the moving average line (period: 2) displays a slow increase between 1991 and 1993, followed by a big increase in 1995, and a gentle decline in 1998. The trend line ($y = 3.8333x + 6.2778$ and $R^2 = 0.3936$) indicates a gentle upward trend.

Table 5: Distribution of Conference Paper by Number of Papers

Year	Number of Paper (n=226)		Cumulative Number of Years		Cumulative Number of Paper	
1997	53	23.1%	1	11.1%	53	23.1%
1995	50	21.8%	2	22.2%	103	45.0%
1994	34	14.8%	3	33.3%	137	59.8%
1996	24	10.5%	4	44.4%	161	70.3%
1998	20	8.7%	5	55.6%	181	79.0%
1993	15	6.6%	6	66.7%	196	85.6%
1991	14	6.1%	7	77.8%	210	91.7%
1992	13	5.7%	8	88.9%	223	97.4%
1990	6	2.6%	9	100.0%	229	100.0%

Figure 3: Ten-Year Trend of Conference Paper Productivity



Journal articles

Scholarly journals constitute the secondary channel used by Malaysian computer science and information technology researchers to publish their papers. The 159 articles published in this medium were distributed in 108 journals. About half (48.4%) of total journal articles were published in one quarter of the journal titles (Table 6). A total of 82 journals published one article each. This trend indicates that there was a wide distribution of Malaysian journal articles in the fields of computer science and information technology during 1990 to 1998. It was difficult to identify a representative core of journals responsible for the majority of articles written by Malaysian authors. One journal, however, was found to publish 17 Malaysian articles. This is the *Malaysian Journal of Computer Science*, which is indexed by *Inspec*. This indicates that this Malaysian journal is an important channel in making Malaysian authors more "visible". Table 7 presents the titles of journals in decreasing order of frequency in total publication of articles by Malaysian authors. The remaining 85 journals published one article each.

Table 6: Distribution of Journal Titles Publishing Malaysian Articles

Number of Journal (n=108)		Number of Articles (n=159)		Cumulative Number of Journal		Cumulative Number of Articles	
1	0.9%	17	10.7%	1	0.9%	17	10.7%
2	1.9%	5	3.1%	3	2.8%	27	17.0%
1	0.9%	4	2.5%	4	3.7%	28	16.6%
2	1.9%	3	1.9%	6	5.6%	32	32.7%
20	18.5%	2	1.3%	26	24.1%	44	18.9%
82	75.9%	1	0.6%	108	100.0%	84	49.7%

Table 7: Journal Titles Involved in Publishing Malaysian Articles

Group	Journals	Number of Paper	Sum of Paper
1	Cohort: 1 Malaysian Journal of Computer Science	17	17
2	Cohort: 2 International Journal of Computer Applications in Technology Journal of Materials Processing Technology	5	27
3	Cohort: 1 IEE Proceedings, Part C: Generation, Transmission and Distribution	4	31
4	Cohort: 2 Electronics Letters Journal of Systems & Control Engineering	3	37
5	Cohort: 20 Automatica Computer Assisted Language Learning Computer & Education Desalination Electric Machines and Power Systems Geophysical Prospecting IEEE Transactions on Power Systems Insight: Non-Destructive Testing and Condition Monitoring International Journal of Computer Mathematics International Journal of Electrical Engineering Education International Journal of Information Management International Journal of Intelligent Systems Internal Journal of Power and Energy Systems International Journal of Remote Sensing Journal of Electromagnetic Waves and Applications Laboratory Microcomputer Microelectronics Journal Oil and Gas Journal Renewable Energy Water Science and Technology	2	77
7	Cohort: 82	1	159

The 108 journals were published in 15 countries. Table 8 presents the distribution of the 159 journal articles geographically. There were 63 journal articles published in UK, 32 in USA, 20 in The Netherlands, 17 in Malaysia, 13 in Switzerland, 4 in Canada, 3 in Singapore, and 2 each in Australia and Canada. The "others" were published in Bangladesh, France, Germany, India, Japan, Slovenia and Taiwan. The results indicated that during 1990 and 1998, most Malaysian journal articles in the fields of computer science and information technology were published in the United States and European countries.

Table 8: Geographical Distribution of Journal Titles

Country	Number of Country (n=15)		Number of Paper (n=169)		Cumulative Number of Country		Cumulative Number of Paper	
UK	1	6.7%	63	39.6%	1	6.7%	63	39.6%
USA	1	6.7%	32	20.1%	2	13.3%	95	59.7%
Netherlands	1	6.7%	20	12.6%	3	20.0%	115	72.3%
Malaysia	1	6.7%	17	10.7%	4	26.7%	132	83.0%
Switzerland	1	6.7%	13	8.2%	5	33.3%	145	91.2%
Singapore	1	6.7%	3	1.9%	6	40.0%	148	93.1%
Australia Canada	2	13.3%	2	1.3%	8	53.3%	152	95.6%
Others	7	46.7%	1	0.6%	15	100.0%	159	100.0%

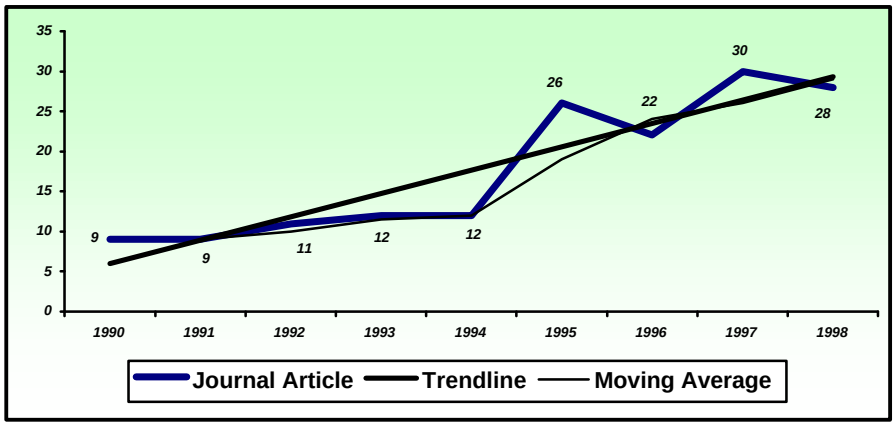
Mashkuri Yaacob produced the most number of publication with 7 journal articles, followed by H. T. Chuah and Mohamed Nor Khalid with 5 articles each.

Table 9 presents the distribution of journal articles by number of papers produced. The number of journal article publication in the four continuous years, i.e., from 1995 to 1998, were over the level of ten-year annual rate of 16.9.

Table 9: Chronological Distribution of Journal Article

Year	Number of Years (n=10)		Number of Paper (n=169)		Cumulative Number of Years		Cumulative Number of Paper	
1997	1	11.1%	30	17.8%	1	11.1%	30	17.8%
1998	1	11.1%	28	13.6%	2	22.2%	58	36.5%
1995	1	11.1%	26	15.4%	3	33.3%	84	52.8%
1996	1	11.1%	22	13.0%	4	44.4%	106	66.7%
1993/ 1994	2	22.2%	12	7.1%	6	66.7%	130	81.8%
1992	1	11.1%	11	6.5%	7	77.8%	141	88.7%
1990/ 1991	2	22.2%	9	5.3%	9	100.0%	159	100.0%

Figure 4: Trend of Journal Article Productivity for Ten Years



The most productive year in terms of journal article publication, was 1997 with 30 papers published. More than ten journal articles each were published in 1992, 1993, and 1994. The years 1990 and 1991 show the least number of production in journal article. Figure 4 reveals the ten-year trend of journal article productivity. The moving average line (period: 2) displays a stagnation between 1991 and 1994, followed by a big ascent from 1995 until 1998. The trend line ($y = 2.9167x + 3.0833$, $R^2 = 0.8423$) generally indicates a remarkably upward tendency.

Research communication in the natural science depends primarily on periodicals literature and is confined to a small number of core journals. The refereed journal article is the most acceptable type of publication within the scientific community (Allen, 1991). Arora and Sharan (1994) found that scientists writing in the field of immunology published in a few journals (four journals contributed 47.96% of total publication). However, this was not found to be true for fields such as Computer Science and Information Technology. The publication distribution analysis of the present study revealed that conference paper was the primary channel of research communication used by Malaysian authors during 1990 to 1998 followed by contributions to journals. Perhaps, this is a reflection of a field that recognizes the completeness of conference papers and prefers them as a more effective communication medium. There is, therefore, a shift of opinion about conference proceedings as a channel for research communication. Drott (1995) found that only 15% of conference papers presented at the Annual Meeting of the American Society of Information Science actually get published as journal articles. This suggests that the evolution of publication in this field is different and that information science regards proceeding papers as a final form of publication on par with journal articles. Drott (1995) suggested that further study needs to be undertaken on conferences and conference presentations as a channel for self-improvement and as a final product of research.

Another interesting finding from this study is the lack of core journals in which Malaysian computer scientists and information technologists can publish their works. About 23% of the journal articles were published by 6 journals and two-third of total articles were published in102 different journals. The articles were therefore published in a wide variety of titles and no core journals could be identified. There is, however, an increasing trend towards journal article publication.

CONCLUSION

The results of this study have indicated, firstly, that Malaysian publications in the fields of computer science and information technology is on an upward trend; and secondly, researchers in these fields are more inclined to publish in the form of a conference paper, which they regard as their primary channel for communicating their research findings.

The current study has only focused on Malaysian publications listed in three databases and is, therefore, limited in scope. Further studies, covering local contributions from local databases and indexes, could greatly complement this study. Such studies could also take into account citation count to publications identified from the three databases to identify the paper that has achieved the most impact, or determine the percentage of publications in high impact journals (as listed in the *Journal Citation Index*).

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