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The *Malaysian Journal of Computer Science*: a bibliometric study

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ABSTRACT

This paper analyses publication and citation patterns in the Malaysian Journal of Computer Science (MJCS) from 1996-2006. The articles in MJCS are mostly written by Malaysian academics, with only limited inputs from international sources. Comparisons are made with the companion Malaysian Journal of Library and Information Science in terms of the type, number of references, length and numbers of authors for individual papers. Searches of Google Scholar showed that 53 MJCS articles attracted a total of 86 citations, of which 43 were self-citations.

Keywords: Bibliometrics; Citation analysis; *Malaysian Journal of Computer Science*; *Malaysian Journal of Library and Information Science;* Publications analysis

INTRODUCTION

The subject of *bibliometrics* was first defined by Pritchard (1996) as "the application of mathematical and statistical methods to books and other media". It involves the analysis of a set of publications characterized by bibliographic variables such as the author(s), the place of publication, the associated subject keywords, and the citations. The methods of bibliometrics (and the closely related specialisms of informetrics, scientometrics and webometrics (Hood and Wilson 2001)) are used to investigate an increasing range of topics, including: the frequency distributions that characterize the use of words and phrases in text databases; the extent to which websites are linked together; longitudinal studies of the development of academic disciplines; and the extent to which individuals, research groups or institutions are published or cited in the literature (Bar-Ilan 2008; Borgman and Furner 2002; Cronin 1984; Garfield 1979; Thelwall, Vaughan and Björneborn 2005; Wilson 1999). This last application is of particular current importance as publication and citation measures are increasingly being used as performance indicators relating to the quality of the research of an individual or of an institution.

There have been several previous bibliometric studies of computer science. One of the very first such studies sought to identify the principal subject areas in the discipline (Salton and Bergmark 1979) while, more recently, Goodrum et al. (2001) and

Katerattanakul, Han and Hong (2003) have reviewed the discipline's literature. There have also been several bibliometric analyses of specific subject areas, such as XML (Zhao and Logan 2002), computer supported collaborative work (Holsapple and Luo 2003) and software engineering (Cai and Card 2008). However, studies on the the status of computer science research in Malaysia have been restricted to the work of Gu, who looked at the publication channels used by Malaysian computer scientists (Gu and Zainab 2000), and at their research productivity (Gu, 2002; Gu and Zainab 2001). Here, we report a bibliometric analysis that extends Gu's work in two ways. First, rather than discussing computer science research in general, it focuses on the characteristics of papers published in the premier Malaysian journal for the discipline, the *Malaysian Journal of Computer Science* (hereafter MJCS). This journal is published by the Faculty of Computer Science and Information Technology, University of Malaya (FCSIT, UM). Second, it considers not only the papers that have been published in that journal but also citations to those published papers. The study of MJCS covers the period 1996-2006 and to put our results in context, they have been compared with the results obtained in two recent studies of the *Malaysian Journal of Library and Information Science* (hereafter MJLIS) (Bakri and Willett 2008; Tiew, Abdullah and Kaur 2002), which is also published by the FCSIT, UM, with both of them being indexed by Thomson Scientific for the *Web of Science* database since 2007.

METHODS

The bibliometric data for the study was obtained using procedures analogous to those used in our previous analysis of MJLIS (Bakri and Willett 2008). The journal homepage was used in January 2008 to download all of the issues of MJCS published from 1996 (volume 9, the first year for which the full-text journal is available in machine-readable form via the website) through till 2006 (at http://ejum.fsktm.um.edu.my/VolumeListing.aspx?JournalID=4). Bibliographic data for all volumes of the journal are available from the Malaysian Abstracting and Indexing System (MyAIS) database (at http://myais.fsktm.um.edu.my/view/type/article/Malaysian_Journal_of_Computer_Science.html). In all, there were 197 articles, and a range of data was then extracted from each of the downloaded articles: year, volume, issues, number of authors, author names and addresses, number of pages, and number of references. A note was also made as to whether the author had included any self-citations or journal self-citations. Finally, each article was inspected to ascertain its type and subject category.

Citations to a published paper provide a measure of the importance of that paper to subsequent researchers, and citation analysis is often used to guide hiring, promotion and research funding priorities (Cronin 1984; Garfield 1979; Nicolaisen 2007). There is an increasing range of data sources that can be used for citation analysis (Neuhaus and Daniel 2008): we have chosen to collect the citation data using the Google Scholar since this system often identifies more citations than do alternative commercial services such as Web of Science and Scopus, especially for papers with a strong computer science content (Sanderson 2008). That said, Google Scholar search outputs do require some degree of post-processing to remove duplicate and obviously erroneous records, although the numbers of such records identified here were much less than in our

previous MJLIS study (Bakri and Willett 2008). In all, a search for "Malaysian Journal of Computer Science" identified 86 citations after post-processing.

The resulting publication and citation data were then loaded into a spreadsheet. The Statistical Product and Service Solutions (SPSS) was used for statistical analysis of the data, using the ^{2} test at the 0.05 level of statistical significance.

PUBLICATION ANALYSES

We have allocated each of the 197 MJCS articles to one of three categories: (a) purely theoretical papers that describe, for example, new algorithms or system designs; (b) applications papers, which involve at least some degree of implementation; and (c) review articles. These allocations (and similarly for the 161 MJLIS papers for the same 1996-2006 period) are shown in Table 1, for which a ^{2} analysis shows a significant difference between the two journals (15.36 for the ^{2} statistic as against a critical value of 5.99 for two degrees of freedom), with noticeably fewer review articles in MJCS than in MJLIS. While there are differences in the types of article, there is no significant difference in the numbers of references associated with the articles in the two journals, the data in Table 2 yielding a ^{2} value of 6.86 (as against a critical value of 7.82 for three degrees of freedom). Perhaps surprisingly, the reviews have a smaller mean number of references (30.2) than do the application articles (39.3), with the theory papers having, as might be expected, far fewer references (16.7). The subjects covered in the MJCS papers include many of the most important areas of computer science, with the five most popular categories being: Artificial intelligence (43 papers), Communications and networking (41), Software engineering (34), Information systems and technologies (21), and Computer graphics and multimedia (14). These five subject categories encompassed 77.6% of the published papers: all of the other 14 categories of computer science research listed on the MJCS homepage attracted no more than 10 papers during the period 1996-2006.

Table 1: Types of Article

Article type	MJCS	MJLIS
Application	157	119
Theory	29	23
Review	11	19

^{2} = 15.36

Table 2: References per Article

References per article	MJCS	MJLIS
< 10	55	57
11-20	89	56
21-30	37	26
> 30	16	22

^{2} = 6.86

Significant differences between the two journals are again evident if we consider the degree of collaboration involved, as reflected in the number of authors associated with each article and as shown in Table 3. The computed value for ^{2} is 37.67 (compared with a critical value of 7.82 for three degrees of freedom), with MJCS papers having significantly more authors than MJLIS papers: the mean number of authors per paper were 2.4 and 1.2, respectively. This marked difference is evident from previous studies: thus a study of Malaysian publications in computer science and information technology between 1990 and 1999 suggested that only ca. 20% of the articles were the work of a single author (Gu 2002), whereas a study of Malaysian publications in library and information science suggested that ca. 80% of the articles were the work of a single author (Yazit and Zainab 2007).

Table 3: Authors per Article

Authors per article	MJCS	MJLIS
1	35	67
2	78	63
3	53	27
≥ 4	31	4

^{2} = 37.67

A journal can only be regarded as being of international importance if it is able to publish articles that have been submitted from a wide range of countries. The 197 MJCS articles had a total of 480 associated authors, these coming from 20 different countries as shown in Table 4. There is clearly a large preponderance of Malaysian authors, and this is still more strongly marked when the distribution of geographic affiliations is compared not only with MJLIS (186 authors from 15 countries during 1996-2006) but also with two other Asian journals in computer science and information technology: the *International Journal of Information Technology* (IJIT) from Singapore (available at http://www.icis.ntu.edu.sg/scs-ijit/) with 40 authors from 19 countries during 1996-2006; and the *Journal of Research and Practice in Information Technology* (JRPIT) from Australia (available at http://www.acs.org.au/jrpit/) with 203 authors from 31 countries during 1996-2006. The author affiliations (using broad geographical categories) in the four journals are shown in Table 5. The computed value for ^{2} is 131.94 (compared to a critical value of 12.59 for six degrees of freedom), with MJCS being the clear outlier in terms of the fraction of international authors.

Study of the collaborations in MJCS showed that the most extensive were those between authors at the University Putra of Malaysia and at the University of Malaya, with five jointly-authored papers. The University Putra of Malaysia also had two jointly-authored papers with the Multimedia University and with the National University of Malaysia. The strongest international links were those between Malaysia and the United Kingdom, which is hardly surprising given the historical links between the two countries and the fact that many Malaysian students carry out their undergraduate and/or graduate studies in the United Kingdom; similarly strong links were noted by the Malaysian Science and Technology Information Centre (2004). It is noticeable that there were only three collaborating authors from India in MJCS, despite this being by far the largest non-Malaysian source (52 authors out of the total of 186) for MJLIS, and despite the strong

academic links between Malaysia and India that have been noted by Anuradha and Urs (2007) and by Gupta, Lal and Zainab (2002).

Table 4: Geographical Affiliations of MJCS Authors

Author affiliation	Authors
Malaysia	339
United Kingdom	21
Bangladesh	17
Brunei	16
Africa	15
Taiwan	13
Japan	13
Australia	9
Korea	9
Pakistan	5
China	3
France	3
India	3
Jordan	3
United States of America	3
Iran	2
New Zealand	2
Saudi Arabia	2
Kuwait	1
Sri Lanka	1

Table 5: Geographical Affiliations of Authors in Four Journals

Author affiliation	MJCS	MJLIS	IJIT	JRPIT
Country of origin	339	81	12	107
Other Asian countries	91	91	19	35
Other countries	50	14	9	61

^{2} = 131.94

Hardly surprisingly given the nature of computer science, the overwhelming majority of the authors in MJCS come from academic institutions: 470 of the 480 authors. In MJLIS, however, about one-third of the authors come from non-academic institutions (Bakri and Willett 2008), this reflecting the professional nature of many of the contributions to this journal (and to many other journals in library and information science). The single most productive institution with 100 papers in MJCS was the Faculty of Computer Science and Information Technology, University of Malaya, which houses the editorial office of MJCS (and the same comments apply to the MJLIS). Gu and Zainab (2001) state that the University Technology of Malaysia was the most productive across all journals in the field of computer science and information technology, whereas it has contributed 21 papers (only the fourth highest total) to MJCS.

Tables 6-8 present additional features of MJCS and MJLIS: specifically, author or journal self-citation, article length and acknowledgements, respectively.

Table 6 looks at the incidence of self-citation in MJCS and MJLIS: author self-citation occurs when the authors of a paper cite their previous work, and journal self-citation occurs when the authors of a paper cite previous work in the same journal. The ^{2} test shows no significant difference in terms of author self-citations between the two journals (a value of 2.28 as compared to a critical value of 3.84 for one degree of freedom) but there is a significant difference in terms of journal self-citation (a value of 11.31), with MJCS authors citing MJCS noticeably less than is the case with MJLIS. This might be taken to represent a more outward view by the MJCS authors. Alternatively, or additionally, the strong professional component in MJLIS would be expected to lead to a stronger focus on local matters than in the more academically-focused MJCS, giving a greater prominence to previous MJLIS articles that were specific to the Malaysian context.

Table 6: Articles involving Author or Journal Self-Citation

Self-citation	Author		Journal	
	MJCS	MJLIS	MJCS	MJLIS
Yes	94	64	17	34
No	103	97	180	127

The lengths of the articles are summarized in Table 7. Papers containing 1-10 pages are the most frequent in MJCS and the mean lengths are 9.06 pages for MJCS and 14.50 pages for MJLIS – with a significant ^{2} value of 74.75 (compared to the critical value of 5.99 for two degrees of freedom). The greater length of the latter's papers is in line with the author instructions for the two journals: those submitted to MJLIS should be 2,500-5,000 words long (which is probably about 10-20 printed pages) whereas those submitted to MJCS should not exceed 10 pages (which was found to be the case for 74% of the published papers in our sample).

Table 7: Lengths of Articles

Pages per article	MJCS	MJLIS
1-10	146	47
11-20	49	99
21-30	2	15

Finally, Table 8 notes the number of papers that included an acknowledgement. There is no significant difference between the two journals, neither of which contains many acknowledgements. This is not surprising in the case of MJLIS since library and information science journals are known to carry only a few acknowledgments; however, the greater availability of research funding in computer science might have been expected to increase the number of papers carrying an acknowledgment, i.e., to the

funding agency that supported the research: of those papers in MJCS that contained an acknowledgement, exactly one-half (21 papers) acknowledged the funding agency.

Table 8: Articles Containing One or More Acknowledgements

Acknowledgement	MJCS	MJLIS
Yes	42	38
No	155	123

CITATION ANALYSES

As noted previously, 86 citations to MJCS articles were identified after post-processing of the outputs of Google Scholar searches carried out in January 2008. Table 9 lists those 16 articles that received at least two citations; there were a further 37 articles that received a single citation, making a total of 53 articles from MJCS that have subsequently been cited in the literature (as perceived by Google Scholar). Note that these 86 citations are to articles published in MJCS at any time, and not just during the period 1996-2006 for which the publication data were available. That said, there are only five cited articles (one published in 1994 and four published in 1995) that had been published before 1996 and citations of such earlier work become increasingly unlikely the older the material, given the speed with which computer science has evolved. Of the 86 citations, 43 were self-citations, i.e., by the author to his/her previous work.

In view of the fact that there have been only 11 review articles published in MJCS in 1996-2006, it is interesting to note that two of them (those published by Lee in 1997 and by Zamli in 2001) are included in Table 9. Lee and Tee are the two authors that appear most frequently in this table, with both having authored three papers; in addition to the papers listed here, Tee has two further papers and Lee one further paper that have appeared in MJCS and that have attracted a single citation.

We were able to obtain 70 of the 86 citing papers, from which we identified the institutions that most frequently cited MJCS. The five most frequent citers were the University of Malaya (11 citations), University Putra of Malaysia (7 citations), University Technology of Malaysia (6 citations), and Pahang University of Science and Technology and the University of Amsterdam (both 4 citations). The University of Malaya is thus the most frequently citing institution: this is also true for MJLIS, and is perhaps hardly surprising since both journals are published by the same University's faculty. The list of most frequently citing institutions means that Malaysia provided the largest proportion (ca. 50%) of the total citations when they are divided on a geographical basis. When they are divided on the basis of information source, there are just two specific sources that cite MJCS to any great extent: MJCS itself (15 citations) and MJLIS (5 citations). These two journals apart, the principal sources of citations are: conference papers, with 23 citations from across a range of conferences (e.g., the Seventh International Symposium on Manufacturing with Applications, Hawai, 2000; the 15th International Workshop on Software Measurement, Montreal, 2005; Proceedings of the Summit on Arabic and Chinese Handwriting, University of Maryland, 2006); student theses, with 8 citations (e.g., Yun, T.H., *Communication Service for Distributed Multimedia Applications*, MSc

thesis, 1998; and Du Bois, B., *A Study of Quality Improvements by Refactoring*, PhD thesis, 2006); technical reports, with 6 citations (e.g., Wiering M, et al., *Intelligent Traffic Light Control*, 2003; and Zainab, A.N., *Scholarly Skywriting: E-Print Archives and E-journals, Panacea or Problem?*, 2006); and with no other source (general or specific) providing more than a single citation. The large number of conference citations is to be expected given the popularity of this mode of publication for research in computer science (Goodrum et al. 2001; Sanderson 2008). Even so, one might have hoped for a greater degree of recognition of MJCS in the shape of citations from mainstream computer science journals.

Table 9: MJCS Articles that Have Been Cited at Least Twice in Google Scholar.

Cited article	**Citations***
Tan, K.K., Khalid, M. & Yusof, R. (1996). Intelligent traffic lights control by fuzzy logic.	7 (0)
Khan, M.K., Rashid, M.A. & Lo, W.N.B. (1996). A task-oriented software maintenance model.	5 (3)
Hong, J.W., Yun, T.H., Kong, J.Y. & Shin, Y.M. (1997). A flexible and reliable distributed multimedia system for multimedia information superhighways.	4 (4)
Saffor, A., Ramli, R. & Ng, K. (2001). A comparative study of image compression between JPEG and Wavelet.	(2)
Tee, E.R. & Selvanathan, N. (1996). Enhancing the personal identification number input as a means of identification signature.	4 (1)
Abdullah, S. (1997). The fundamentals of case-based reasoning: application to a building defect problem.	4 (0)
Lee, S.P., Rolland, C. & Brunet, J. (1997). Abstraction in an object-oriented analysis method.	2 (1)
Tee, E.R. & Selvanathan, N. (1996). Pin signature verification using wavelet transform.	3 (1)
Zakaria, M.N. & Selvanathan, N. (1999). Hybrid shear-warp rendering.	3 (0)
Zamli, K.Z. (2001). Process modeling languages: a literature review.	3 (2)
Ali, N.H.M. & Abdullah, A.R. (1997). A new fast Navier–Stokes solver and its parallel implementation.	2 (2)
Ghani, A.A & Hunter, R. (1996), An attribute grammar approach to specifying Halstead's metrics.	2 (0)
Islam, M.R., Selamat, H. & Sap, M.N.M. (1997). A dynamic access control with binary key-pair.	2 (1)
Lee, S.P. (1997). Issues in requirements engineering of object-oriented information system: a review.	2 (0)
Lee, S.P., Thin, S.K. & Liu, H.S. (2000). Object-oriented application framework on manufacturing domain.	2 (2)
Tee, E.R., Selvakennedy, S. & Ramani, A.K. (1998). A token-passing variable buffer model for a double-layered hierarchical WDM all-optical network.	2 (2)

(*) Self-citations are given in brackets

CONCLUSIONS

Previous bibliometric studies of Malaysian work in computer science and information technology (Gu 2002; Gu and Zaina 2000; Gu and Zainab, 2001) have been at the national level, highlighting Malaysian research in general without any specific attention being paid to individual journals or to the citations attracted by Malaysian journal articles. Here, we have complemented the previous work with a detailed analysis of publications in, and citations to, the MJCS, with some comparisons being made to the related MJLIS. The papers in MJCS focus principally on applications, with very few review articles; given the frequency with which review articles are cited, the editors of the journal might usefully encourage the submission of such articles in the future to enhance the impact of the journal. MJCS papers are well referenced, typically multi-authored, and mainly come from authors within Malaysia; in this respect the journal would appear to be less international in scope than the other Asian journals in the information sciences with which it has been compared here. The citations identified cover 53 MJCS articles, with the most-cited article (one first published in 1996) attracting a total of 7 citations. The citations are mainly from non-journal sources with MJCS itself and MJLIS being the only two journals that cite the journal at all frequently.

The MJCS website (at http://ejum.fsktm.um.edu.my) lists the journal's objectives as being: "To promote exchange of information and knowledge in research work, new inventions/developments of Computer Science and on the use of Information Technology towards the structuring of an information-rich society and to assist the academic staff from local and foreign universities, business and industrial sectors, government departments and academic institutions on publishing research results and studies in Computer Science and Information Technology through a scholarly publication." The analysis reported here has demonstrated that the journal has met at least some of these objectives. In particular, it is clear that it forms a key communication route by which local (i.e., Malaysian) universities can publish their academic research; however there is considerable scope for enhancing the international aspect of the journal, in terms of both articles and citations.

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