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Computer science research in Malaysia: a bibliometric analysis

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Abstract

Purpose - To analyse the publications of, and the citations to, the current staff of 19 departments of computer science in Malaysian universities, and to compare this bibliometric data with expert peer reviews of Malaysian research performance.

Method - Author and citation searches of the Scopus and Web of Science databases.

Findings – Both publication and citation rates are low, although this is at least in part due to some Malaysian universities having only a teaching function. More of the departments' publications were identified in Scopus than in Web of Science, but both databases were needed for comprehensive coverage. Statistically significant relationships were observed between the departments' publication and citation counts and the rankings of the departments' parent universities in two evaluations of the research performance of Malaysian universities

Originality - This is the first comparison of bibliometric and peer-review data for Malaysia, and, more generally, for a country with a newly developed higher education system.

Keywords - Bibliometrics; Citations; Computer science; Malaysia; Publications; Research evaluation

Paper type - Research paper

1. Introduction

Governments worldwide are looking for ways in which they can evaluate the quality of the research that is carried out in their countries' universities. Informal evaluations have been carried out for many years, but the increasing costs of higher education provision have resulted in the development of more formal evaluation mechanisms. These mechanisms are designed to ensure that government funding will be channelled to those institutions and research groups that have demonstrated their ability to carry out high-quality research in a cost-effective manner. Formal procedures are perhaps best established in the United Kingdom, where sector-wide evaluations have been carried out since the mid-Eighties (normally under the name of a Research Assessment Exercise, or RAE (at

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http://www.rae.ac.uk/)). In an RAE, panels of subject experts review research outputs and textual narratives produced by university departments, and then assign a grade (or set of grades in the most recent evaluation) reflecting the quality of the research that has been carried out by each submitted department. Similar nation-wide, multi-disciplinary procedures are being adopted in an increasing number of countries, e.g., Excellence in Research for Australia (at http://www.arc.gov.au/era/), Valutazione Triennale della Ricerca in Italy (at http://vtr2006.cineca.it/index_EN.html), and the Performance-Based Research Fund in New Zealand (at http://www.tec.govt.nz/Funding/Fund-finder/Performance-Based-Research-Fund-PBRF-/); while the Norwegian Research Council (at http://www.forskningsradet.no/en/Home_page/1177315753906) has carried out several such assessments that focus on specific disciplines or groups of disciplines.

Research quality has traditionally been assessed by means of expert review (in a manner analogous to the procedures used for refereeing journal articles and grant applications), not least because this approach is well established and generally enjoys the support of the academic community. It is, however, very costly in terms of the time of the subject experts, and this has spurred interest in the use of bibliometric indicators as a surrogate for peer review. These indicators can consider both the quantity of research (as reflected in the numbers of research publications produced by a university, department or whatever) and the quality of research (as reflected in the numbers of citations to those publications) and are typically far cheaper to use since they exploit existing bibliometric databases and do not require costly human judgments. Moreover, there is an increasing body of evidence to support the view that bibliometric approaches can yield results closely mirroring the judgments of subject experts. Specifically, significant correlations have been observed between expert judgments and bibliometric data in comparisons carried out in Italy (Abramo *et al*., 2009; Reale *et al*., 2007), the Netherlands (Rinia *et al*., 1998; van Raan, 2006) and the UK (Norris and Oppenheim, 2003; Oppenheim, 1997; Seng and Willett, 1995). That said, bibliometrics has its own limitations, and these would have to be borne in mind if a decision was taken at some point in the future to base research evaluation solely on bibliometric data, without recourse to expert judgments.

The previous comparisons of bibliometric and peer-review data cited above have all involved countries with long-established higher education systems; here, we extend such comparisons to a country where the research tradition in higher education is, perhaps, less well established thus far and is still under active development. Specifically, we report a bibliometric evaluation of the research published by university departments of computer science in Malaysia, and discuss the results obtained in the light of reviews of Malaysian universities that have been conducted by the Malaysian Ministry of Higher Education and the Malaysian Qualification Agency.

2. Background

Malaysia is a thriving hub for research and development in computer science and ICT more generally (Gu, 2002). Universiti Malaya was the first university to offer an academic computer science programme, this being the Diploma in Computer Science that was introduced in 1974, with higher degree programmes being first offered at the same institution in 1985. Since then computer science departments have been established in all but three of the country's 36 universities, with government funding of academic research starting in 1996.

Many studies have been reported that review computer science in specific countries (e.g., Guan and Mar, 2004; Kumar and Garg, 2005; Moed and Visser, 2007; Wainer *et al*., 2009). There have been four such studies that focus on Malaysian computer science research. In the earliest of these, Davis and Eisemon (1989) were unable to identify any Malaysian computer science articles that had been included in WoS in either 1980 or 1985. The most detailed study is that by Gu (2002), who analysed 461 Malaysian publications in computer science during the period 1990-1999 that had appeared in the COMPENDEX, INSPEC or IEE/IEEE Electronic Library bibliographic databases. The largest number of articles appeared in the country's national academic journal in the subject, the *Malaysian Journal of Computer Science*; the largest number of authors came from the Universiti Teknologi Malaysia; and simulation systems was the most popular research area. Shari and Ahmad (2005) identified 127 articles that had appeared in WoS in the period 1981-2002, and showed that the greatest level of collaboration by Malaysian computer scientists was with academics in the United Kingdom and Japan. Finally, Bakri and Willett (2009) reported a bibliometric analysis of the *Malaysian Journal of Computer Science* for the period 1996-2006; this is the only one of the four articles to consider citations to Malaysian publications, as well as the publications themselves.

There have, to date, been three attempts to evaluate the quality of research carried out in Malaysian universities. In 2004, the Malaysian Ministry of Higher Education (MOHE, at http://www.mohe.gov.my) invited universities to apply for the status of a "research university", which would bring increased government funding for research, development and commercialisation activities. The most important criteria in the evaluation of a university were the quality and quantity of the researchers, of their research and of their postgraduates; these criteria comprised 80% of the evaluation, with the remainder covering research innovation, professional services and gifts, networking and linkages, and support facilities. Six universities applied, and the status of research university was subsequently awarded to four of these in 2007: Universiti Malaya (UM), Universiti

Teknologi Malaysia (UKM), Universiti Putra Malaysia (UPM), and Universiti Sains Malaysia (USM)[2]. This status was renewed for a further three years for all four universities in July 2010.

The Malaysian Qualification Agency (MQA, at http://www.mqa.gov.my) is responsible for overseeing quality assurance in Malaysian universities. In 2007, MQA carried out a perception survey of 242 educational institutions, public and corporate bodies, with these organisations ranking 17 of the 20 public universities on a range of criteria (the other three public universities were not considered as they had been established only recently when the evaluation was carried out). This survey (called ARES for Academic Reputation Survey) was followed by the Rating System for Higher Education in Malaysia (or SETARA in its Malay acronym), the aim of which was to identify strengths and weaknesses in Malaysian universities and to enhance their international status. The SETARA report published in 2008 ranked the same 17 universities on a scale that ran from outstanding (6*) down to weak (1*). The main criteria used in SETARA were: the reputation of the academic staff, student selection, research, academic programmes, resources and management, with research accounting for just 15% of the overall grade. None of the universities received either the highest (6*) or lowest (1*) rankings and only one university, UM, received the 5* (excellent) ranking. It must be emphasised that both the MQA and SETARA evaluations ranked universities as a whole, and took no specific account of each university's constituent departments. The two evaluations do, however, provide at least some basis for comparison with the bibliometric data collected here.

3. Methods

Until very recently, most bibliometric studies have used WoS to obtain citation data. This database contains articles and citations appearing in over 10,000 of the world's leading academic journals, these being published in 45 different languages and covering the whole range of academic research (sciences, social sciences, arts and humanities) since 1900. In 2009, WoS extended its coverage to include 110,000 proceedings from significant conferences, symposia, seminars, colloquia etc that have taken place since 1990.

The recent development of the Elsevier Scopus and Google Scholar databases has provided alternative, and possibly complementary, sources of data to WoS (e.g., Bar-Ilan, 2008; Bauer and Bakkalbasi, 2005; Falagas *et al*., 2008; Jacso, 2008abc; Li *et al*., 2010; Meho and Yang, 2007; Sanderson, 2008). Scopus covers 16,500 journals, as well as book series and conferences. The extent of the coverage is variable: Elsevier journals go back to 1823, but some have only been added in the present century; and citation data are available only for publications since 1996 (Jacso, 2008b). The coverage of Google Scholar is far greater than that of the two other databases, including not just

[2] *The abbreviations used here and elsewhere in this paper are those employed by the universities themselves.*

articles and conference proceedings, but also working papers, student theses, reports etc, and also many more non-English publications. Google Scholar does, however, suffer from the purely automated nature of the database creation routines, which result in many errors that require careful, time-consuming processing if accurate results are to be obtained; it also lacks the sophisticated searching tools that are provided by WoS and Scopus to facilitate comprehensive bibliometric analyses (Jacso, 2008c; Meho and Yang, 2007). The work reported below hence used WoS and Scopus.

In March 2009, the MOHE website was used to identify the names and URLs of all the 20 public and 16 private universities in Malaysia. However, some of these universities have been established only very recently, do not have a computer science department, or have not had any articles published in either WoS or Scopus. Removal of universities falling into any of these three categories left a total of 16 public and three private universities for further study: these 19 universities are listed in Table 1. Each university also has listed the official abbreviation that it uses for its name and the educational unit (i.e., a department, school or faculty) in which computer science is based within that university: in the remainder of this paper we shall refer to these as departments, irrespective of their precise status. The third and fourth columns in each row of the table contain the outcomes of the MOHE and MQA evaluations that have been discussed previously; the three private universities marked N/A in the SETARA column were not included in the MQA evaluation since this was restricted to public universities.

A choice had to be made as to how the departmental publications were to be identified. One approach would be to carry out subject searches: however, this is extremely difficult given the huge range of possible topics on which a computer science department might publish, and an alternative, author-based approach was hence adopted. The home-pages of the 19 chosen computer science departments were inspected to identify the names of their permanent faculty. The resulting individuals were searched in WoS and Scopus to identify their publications and then the citations to those publications. Care was taken to encompass the variations in name-forms that are to be expected for faculty who may be (principally) Malay, Chinese or Indian. For example, Lee Sai Peck (a Chinese name) from UM is listed in WoS as having published 10 articles as Lee SP and one article as Peck LS; whilst Mashkuri Yaacob (a Malay name) from UM is listed in WoS as having published 11 articles as Yaacob, M. and one article as Mashkuri, Y. Name changes can also occur, e.g., when a person gets married or changes their religion; these variants were also searched if this information was available. The searches were hence as comprehensive as possible; however, name processing is highly complex (Aksnes, 2008) and some publications have probably been missed. Note also that we have considered only the current faculty members, and there are undoubtedly earlier publications not covered here as their authors have now left the institutions under study.

In April 2009, the *Science Citation Index, Social Science Citation Index, Arts and Humanities Citation Index* and *Conference Proceedings Citation Index* databases in WoS were used to download the publications for the faculty who work in the 19 selected departments, with the corresponding downloads for Scopus being carried out in November 2009. Publications were sought for the period 1987-2007: 1987 was chosen as the start-point as several Malaysian universities were established in that year; and 2007 as the end-point so as to allow sufficient time for at least some citations to have appeared (2007 also saw the completion of the second phase of the Multimedia Super-Corridor, an ambitious government programme to develop ICT research and development in Malaysia). An article written by multiple authors from the same department was considered as a single publication; if the authors came from multiple universities then each individual university was credited with that publication (this latter situation was much less frequent with only ca. 10% of the collaborative publications involving more than one university). The publications identified in these searches were then used as the bases for citation searches. The individual numbers of publications by each university, and of citations to those publications, are shown in Table 2. The sets of downloaded publications and citations were then analysed as discussed below.

4. Results

4.1 Publications

We consider first the results of the WoS publication searches. When this study was carried out, there was a total of 1631 academics working in the 19 computer science departments in Table 1. Table 2 shows that they were responsible for a total of 508 publications in WoS, which implies an extremely low level of author productivity. It should be noted that some Malaysian universities are specifically charged with teaching rather than with research, and are thus not expected to produce many research publications, and that databases often provide less coverage of research in developing, than in developed, countries (Arunachalam, 2003; Baird and Oppenheim, 1994). Even so, the numbers reported in Table 2 are very low, albeit better than 1980 and 1985 when no Malaysian computer science publications at all could be found in WoS (Davis and Eisemon, 1989).

It might have been expected that the most productive departments would be those in the four research universities. This is indeed generally the case, with these institutions (USM, UKM, UPM and UM) being in positions 2 and 4-6 when the universities are ranked in order of decreasing numbers of publications. The top university is MMU. This was the first private university established in Malaysia; it specialises in ICT, and its research strength has been noted previously by Shari and Ahmad (2005). The next non-research university is UTM, which focuses on engineering and which might thus be expected to have strong computer science programmes. Five of the university

departments had no WoS publications: UPSI, UniMAP, UMP, UMT and UTP. These are all new universities with a focus on teaching rather than on research, and with even the oldest (UPSI and UTP) having been established as recently as 1997.

Of the publications that were identified, 367 were papers in conference proceedings and 134 were journal articles, with 3 meetings abstracts, 2 letters and 2 review articles. This marked preference for conference publication is well known in computer science (Sanderson, 2008; Snoeyink, 2005). Table 3 lists the ten publications that provided the greatest number of WoS articles, together with the impact factor (or CORE grade as discussed below) of those publications where available: the 2007 impact factor is used for the *International Journal of Computer Mathematics* and the 2005 factors for the two *Lectures in…* publications, which have now been removed from the *Journal Citation Reports* database. All three impact factors here are very low when compared with those for the great bulk of the 393 journals comprising the *Journal Citation Reports* computer science categories (for which the median impact factor is 1.091). The Computing Research and Education Association of Australasia (CORE, at http://www.core.edu.au) has devised a five-part categorisation of computer science conferences: A+ represents the top international conferences; A represents international conferences; B represents less important research conferences; L represents local conferences that might not have substantial research content; and C is all other conferences. Two of the seven conferences listed in Table 3 have a CORE grading. Analysis of the 367 Malaysian conference papers showed that none of these had been presented at A+ conferences and only 17 at A or B conferences. We thus conclude that the majority of the most popular publication routes are likely to have only limited impact.

There were 567 distinct authors for the set of 508 publications. Of these 507 were from Malaysia, 17 from Japan and 16 from the UK, with no other country providing more than 4 authors. The collaborations with Japanese colleagues may be a result of the Malaysian government's Look East Policy, which sought to increase collaborations with Korean and Japanese educational institutions, while the collaborations with UK colleagues derive from the fact that many Malaysian academics have carried out their graduate and/or postgraduate studies in the UK. Overall, then, there would appear to be only a very limited level of international collaboration. This is regrettable since it has been suggested that publications involving international collaborations attract more citations than do purely national publications (van Leeuwen, 2009).

The results obtained from the Scopus publication searches are broadly comparable to the WoS results. Table 2 shows that MMU again has the most productive computer science department, and that the four research universities all have relatively large numbers of publications. Just two institutions – UPSI and UniMAP - did not yield any publications in Scopus, and both of these were amongst those not represented in WoS**.** If we consider the ten most productive publications, *Lecture Notes in*

Computer Science was ranked first and the *International Journal of Computer Mathematics* was ranked fourth; there were no other journals, and none of the eight conferences (two of which are in Table 3) had CORE gradings. Of the 888 distinct authors identified, 748 were from Malaysia, 46 from the UK, and 10 from both India and Japan, with no other country providing more than 8 authors.

4.2 Citations

Turning now to the citation searches, we first consider the Scopus results. The 748 Scopus publications attracted a total of 871 citations, with these citations being shared by 251 of the publications, i.e., almost exactly two-thirds of the publications did not attract any citations at all. The ten most-cited articles are listed in Table 4, and show a wide range of research areas, e.g., artificial intelligence, information retrieval, medical informatics and pattern recognition. Citation counts accumulate over time, and it is hence interesting to note that several of the articles in the table have been published quite recently. Hardly surprisingly, the highly-cited publications occur in well-known, high-profile sources such as the *Journal of the American Society for Information Science* (as it was then) and *IEEE Transactions…* journals. The 871 citations came from 343 different institutions in 54 different countries. With 28 citations, MMU was the only institution to yield more than ten citations; the most productive nation was China (80 citations), then Malaysia (65) itself, followed by the UK (50), the USA (40), Taiwan (30), India (24) and Canada (22), and with no other country yielding more than 20 citations.

The WoS citation results are very similar. The 508 publications attracted a total of 481 citations so that at 0.95, the mean number of citations per publication is slightly less than the Scopus figure of 1.16. Seven of the ten most cited WoS articles are also included in Table 4; and China, Malaysia, the UK and the USA were again (in that same descending order) the countries that cited Malaysian publications most frequently.

To put the Malaysian publication and citation figures in perspective, we carried out a WoS search for the 32 current members of the University of Sheffield's Department of Computer Science, which was ranked 33rd in the last RAE in the UK in 2008 (Times Higher Education, 2008). The search identified a total of 265 publications and 1341 citations. Thus, this one department with just less than 2.0% of the number of Malaysian academics (32 as against 1631) produced over half the number of publications (265 as against 508) and received almost three times as many citations (1341 as against 481) as the combined staff of the 19 departments considered here. It should be noted that there is some degree of bias in the results, as demonstrated by the publication and citation counts till 2007 in Table 5, which make clear that the Malaysian departments have only recently started to become research-active and to attract citations. The Sheffield department, conversely, has been established for many years and some of the staff have hence had a considerable period of time to publish and to

attract citations. Even so, there is a striking disparity between the levels of productivity and recognition in the two cases.

4.3 Comparison of WoS and Scopus data

Several comparisons have been reported between WoS and Scopus (Archambault *et al*., 2009; Gavel and Iselib, 2008; Lopez-Illescas *et al*., 2009; Meho and Sugimoto, 2009; Norris and Oppenheim, 2007; Vieira and Gomes, 2009) but we are aware of only one focusing on computer science. Meho and Rogers (2008) studied collaborations between human computer interaction researchers, and found that Scopus provided significantly better coverage of project publications than did WoS, principally owing to the former's inclusion of conference proceedings; however, the study predated the inclusion of such material in the WoS database, and also involved a total of only 22 researchers.

Here, we identified a total of 988 distinct publications in the two databases. Of these, 480 were unique to Scopus, 240 were unique to WoS and 268 were common to both. If just one database is to be used for the evaluation of publications by Malaysian computer scientists, then Scopus would appear to be the database of choice; however, this would result in the identification of only 73.9% of the complete corpus of publications (the corresponding figure is 51.4% if WoS is chosen as the sole database). Similar results are obtained if the overlap in citations is considered: the use of just Scopus results in the identification of 70.6% of the citations, with 57.8% being identified using WoS. The publication counts from the two sources for the individual departments are highly correlated, with the Pearson correlation coefficient between the WoS and Scopus counts being 0.981 ($p <= 0.01$); the corresponding figure for the correlation between the citation counts is also high at 0.956 ($p <= 0.01$).

4.4 Relationships between bibliometric data and peer review

As noted in the Introduction, there has been much interest in identifying whether bibliometric measures can be related to the results of expert peer review for purposes of research evaluation. In this section, we shall consider the extent of such relationships for the citation and publication data discussed above. It must be emphasised again that the peer reviews (i.e., the evaluations carried out by MOHE and MQA) have been performed at the institutional level, whereas the bibliometric data is at the departmental level. Any relationships that are identified hence involve the assumption that the research performance of the computer science department in each institution is typical of the performance of the institution as a whole.

We consider first the MOHE research university evaluation. Inspection of the bibliometric data in Table 2 immediately suggests that the research universities have higher publication and citation counts than the universities that do not have this status. Thus, using the WoS data, the mean number of papers for the research universities is 53.8 and that for the remainder is 29.3; the corresponding

figures for the citation counts are 43.8 and 30.6, respectively. The most common way to establish a relationship between the MOHE research status (a categorical variable, with values research or non-research) and publication counts would be to use a chi-squared test. However, only 19 universities have been considered in this study, and this number is insufficient for application of the test. There is, however, an alternative test of statistical significance that can be used with this data: the two-sample Kolmogorov-Smirnov test, which determines whether there is a significant difference in the distributions of values for some variable in two samples (Siegel and Castellan, 1988). The two samples here are the sets of 4 research and 15 non-research universities, and the variables are the publication counts and the citation counts derived from WoS and Scopus. The results of the analysis are listed in Table 6. In each case, we show the value of the Kolmogorov-Smirnov statistic and the statistical significance under the null hypothesis of no difference between the distributions of the chosen variable for the research and non-research universities: single-starred values are significant at the 0.05 level of statistical significance and double-starred values at the 0.01 level (the same notation is used in Table 7). It will be seen that the null hypothesis can be rejected ($p <= 0.05$) for three of the four cases, with the Scopus citation data being the sole exception.

The data from the MQA evaluation is ordinal in character, since each of the 16 public universities considered has been given one of the six available grades for research quality. It is hence possible to use the Spearman rank correlation to determine whether there is a statistically significant correlation between the bibliometric data (e.g., the WoS publication counts) and the SETARA grades. The results of the analysis are listed in Table 7. In each case we show the observed correlation coefficients: statistically significant correlations are obtained for three of the four elements of the table, the sole exception again being the Scopus citation data. There is hence generally a significant correlation between the bibliometric data and the SETARA grades for this set of 16 universities.

5. Conclusions

This paper has described the first attempt to evaluate the research performance of Malaysian departments of computer science using bibliometric methods. Searches of the WoS and Scopus databases identified 508 and 748 publications respectively that had been published by the 1631 current academic faculty of the 19 departments that were chosen for analysis. These publication rates are very low, even allowing for the fact that some of the universities considered here have a purely teaching function. Only a few of the publications appeared in high-impact journals or conference proceedings: this is reflected in the low impact of much of the work, with the publications attracting totals of 481 (WoS) and 871 (Scopus) citations. A few of the publications have succeeded in attracting non-trivial numbers of citations, these generally being in high-impact international journals. The overall level of performance is consistent with a recent review of international research in

computer science (Ma *et al*., 2008), which did not identify Malaysia as a leading research country**.** The publication and citation counts support the view that Scopus provides better coverage than does WoS for this sort of analysis; however, the two data sources are complementary in scope, with less than half of the distinct publications appearing in both sources.

Two evaluations have been carried out of the research performance of Malaysian universities, and we have investigated the extent to which the results of these evaluations (which have been carried out at the university level) mirror the publication and citation counts obtained here (which have been obtained at the departmental level). The two sets of data are found to be in general agreement with each other, in that the bibliometric data support the results of the two public, peer-review evaluations. We hence conclude that the computer science departments are generally performing at levels that are compatible with the status of their parent institutions.

In conclusion, we note again the two major limitations of the work. First, the study has considered only the current staff of the universities, and the publication counts (and the resulting citation counts) hence represent just a snapshot in time of faculty productivity. It is also, of course, the case that there will be additional, but less significant, publications not considered here because the sources in which they were published are not included in WoS and Scopus. Second, there are as yet no department-level evaluations of research excellence, and we have hence used the two sets of university gradings. It is the stated policy of the Malaysian government to enhance the international standing of its universities, and the instigation of department-level evaluations would undoubtedly support this aim. In the interim, studies such as that reported here may serve to identify those departments that are most worthy of government research funding.

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University	Code	Research university	SETARA grade	Educational unit
Universiti Multimedia	MMU	No	N/A	Faculty of Information Science and Technology
Universiti Sains Malaysia	USM	Yes	4	School of Computer Sciences
Universiti Teknologi Malaysia	UTM	No	3	Faculty of Computer Science and Information System
Universiti Kebangsaan Malaysia	UKM	Yes	4	Faculty of Information Science and Technology
Universiti Putra Malaysia	UPM	Yes	4	Faculty of Computer Science and Information Technology
Universiti Malaya	UM	Yes	5	Faculty of Computer Science and Information Technology
Universiti Teknologi Mara	UiTM	No	4	Faculty of Information Technology and Quantitative Sciences
Universiti Utara Malaysia	UUM	No	2	Department of Information Technology and Computer Science
Universiti Malaysia Sawarak	UNIMAS	No	2	Faculty of Computer Science & Information Technology
Universiti Islam Antarabangsa	UIA	No	4	Faculty of Information and Communication Technology
Universiti Teknologi Tun Hussein Onn Malaysia	UTHM	No	2	Faculty of Information Technology and Multimedia
Universiti Malaysia Sabah	UMS	No	3	School of Engineering and Information Technology
Universiti Tenaga Nasional	UNITEN	No	N/A	College of Information Technology
Universiti Teknikal Melaka	UTeM	No	2	Faculty of Information & Communication Technology
Universiti Pendidikan Sultan Idris	UPSI	No	2	Faculty of Information & Communication Technology
Universiti Malaysia Perlis	UniMAP	No	2	School of Computer and Communication Engineering
Universiti Malaysia Pahang	UMP	No	2	Faculty of Computer System and Software Engineering
Universiti Malaysia Terengganu	UMT	No	2	Department of Computer Science
Universiti Teknologi PETRONAS	UTP	No	N/A	Department of Computer and Information Science

Table 1: Malaysian computer science departments

University	WoS		Scopus	
	Publications	**Citations**	**Publications**	**Citations**
MMU	142	204	180	296
USM	79	24	119	78
UTM	57	60	94	137
UKM	52	76	71	79
UP	44	67	57	88
UM	40	8	59	21
UiTM	25	19	23	7
UUM	22	12	33	56
UNIMAS	18	5	24	30
UIA	8	2	15	16
UTHM	7	0	4	1
UMS	5	1	33	21
UNITEN	5	3	11	6
UTeM	4	0	1	0
UPSI	0	0	0	0
UniMAP	0	0	0	0
UMP	0	0	4	0
UMT	0	0	17	35
UTP	0	0	3	0
Totals	**508**	**481**	**748**	**871**

Table 2: Publications by, and citations to, Malaysian computer science departments using WoS and Scopus

Publication	Frequency	Impact or CORE
Lecture Notes in Computer Science	84	0.402
International Journal of Computer Mathematics	17	0.423
Lecture Notes in Artificial Intelligence	14	0.302
IEEE International Conference on Networks jointly held with IEEE Malaysia International Conference on Communications	13	N/A
Asia-Pacific Conference on Communications conjunction with the Malaysia International Conference on Communications	12	N/A
IEEE International Conference on Advanced Learning Technologies	8	A
Student Conference on Research and Development – Globalizing Research and Development in Electrical and Electronics Engineering	7	N/A
TENCON IEEE Conference – Intelligent Systems and Technologies for the New Millennium	7	N/A
International Conference on Computational Science and Applications	6	N/A
IEEE/WIC/ACM International Conference on Web Intelligence	6	B

Table 3. The ten publications providing the most WoS articles

Cited publication	Citations
Connie T, Jin A.T.B., Ong M.G.K., Ling D.N.C. (2005). An automated palmprint recognition system. *Image and Vision Computing*, 23, 501-515	48
Connie T., Teoh A., Goh M., Ngo D. (2005). PalmHashing: A novel approach for cancellable biometrics. *Information Processing Letters*, 93, 1-5.	28
Salam MS, Hamdan AR, Nor KM (1991). Integrating an expert system into a thermal unit-commitment algorithm. *IEE Proceedings C: Generation Transmission and Distribution*, 138, 553-559.	24
Yahia M.E., Mahmod R., Sulaiman N., Ahmad F. (2000). Rough neural expert systems. *Expert Systems with Applications*, 18, 87-99.	21
Yap W.-S., Heng S.-H., Goi B.-M. (2006). An efficient certificateless signature scheme. *Lecture Notes in Computer Science*, 4097, 322-331	19
Salleh M., Ibrahim S., Isnin I.F. (2003). Enhanced chaotic image encryption algorithm based on Baker's map. *Proceedings of the IEEE International Symposium on Circuits and Systems*, 2, 508-511.	16
Deris S.B., Omatu S., Ohta H., Samat P.A.B.D. (1997). University timetabling by constraint-based reasoning: A case study. *Journal of the Operational Research Society*, 48, 1178-1190.	16
RoyChowdhury P., Singh Y.P., Chansarkar R.A. (2000). Hybridization of gradient descent algorithms with dynamic tunnelling methods for global optimization. *IEEE Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans*, 30, 384-390.	15
Ahmad F., Yusoff M., Sembok T.M.T. (1996). Experiments with a stemming algorithm for Malay words. *Journal of the American Society for Information Science*, 47, 909-918.	15
Srinivasan V., Eswaran C., Sriraam N. (2007). Approximate entropy-based epileptic EEG detection using artificial neural networks. *IEEE Transactions on Information Technology in Biomedicine*, 11, 288-295.3	14

Table 4. The ten publications most heavily cited in Scopus (one other publication was also cited 14 times)

Period	WoS		Scopus	
	Publications	**Citations**	**Publications**	**Citations**
<= 1995	3	1	15	0
1996-2000	66	8	50	18
2001-2005	277	82	292	145
2006-07	162	155	391	229
Totals	**508**	**246**	**748**	**392**

Table 5: Publications by, and citations until 2007 to, Malaysian computer science departments using WoS and Scopus

Data	WoS	Scopus
Publication	1.540 (*)	1.540 (*)
Citation counts	1.303 (*)	1.096

Table 6. Kolmogorov-Smirnov test values for the relationship between a university's MOHE research grade and the bibliometric data for that university's computer science department.

Data	WoS	Scopus
Publication	0.662 (**)	0.670 (**)
Citation counts	0.643 (**)	0.464

Table 7. Spearman rank correlation coefficients for the relationship between a university's SETARA grade and the bibliometric data for that university's computer science department.

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