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Bibliometric analysis of journal articles published by Southeast Asian chemical engineering researchers

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ABSTRACT

In this study, journal articles publication trends among Southeast Asian chemical engineering (CE) researchers from 1996 to 2008 are analyzed through bibliometric means. The focus of the study is on the journal publication trend of CE researchers rather than the publication trend of papers that fall within the area of CE. Bibliometric data are obtained from Scopus, Journal Citation Reports® as well as the SCImago Journal & Country Rank online academic databases. The study shows that Singapore tops the amount of journal articles published by CE researchers from 1996 to 2008, followed by Malaysia, Thailand, Indonesia and Philippines. Overall observation indicates that journal articles publication trends among Southeast Asian CE researchers are highly dissimilar and noteworthy. Results accrued from this study are useful indicators for journal publishers to determine the publishing behaviour of CE researchers as well as for each country's science policy makers to formulate appropriate research policies and directions.

Keywords: Bibliometrics; Chemical engineering; Journal studies; Southeast Asia; Country's science policy

INTRODUCTION

Many Southeast Asian countries have enjoyed tremendous economic growth throughout the last two decades, culminating in improved socioeconomic classifications, namely, *developed country* (Singapore) and *newly industrialized country* (Malaysia, Thailand and Philippines) (Guillén 2003). In essence, nearly all Southeast Asian countries rely heavily on the manufacturing and agricultural sectors. Singapore, on the other hand, has begun initiatives to infuse knowledge-based concepts into its overall economy system. The dependence of the manufacturing, agricultural as well as knowledge-based economy within this region necessitates a high population of skilled workers and researchers of which chemical engineers constitute a significant portion.

The author observes that many South Asian countries, recognizing the importance of the chemical engineering (CE) discipline to generate the aforesaid skilled workforce, have intensified CE research activities at local institutions of higher learning and formed niche CE research institutes since the '90s. Consequently, it is natural for one to hypothesize that intensified CE research activities eventually results in improved publication of Science Citation Index (SCI) journal articles in terms of quantity and/or quality. It is deemed that a comprehensive quantitative analysis of journal articles published by CE researchers can provide useful information on several aspects such as research focus of a particular country, reputation and associated impact of researchers, as well as preference of CE journals. Previous related studies include Inonu (2003) where the influence of specific cultural factors from different countries on scientific production is assessed, as well as Peters and van Raan (1994) where a bibliometric profile of top chemical engineering scientists is studied. Anyi, Zainab and Anuar (2009) review 82 bibliometric studies on single journals published between 1998 and 2008 in which 34% of journals studied were published in the Asian countries. So far, there is no identified bibliometric study on journal articles published by Southeast Asian CE researchers.

The objective of the present study is to analyse the journal articles publication trend among Southeast Asian CE researchers from 1996 to 2008 through bibliometric means. It should be noted that the focus of the study pertains to the journal publication trend of CE researchers rather than the publication trend of papers that fall within the area of CE. Therefore, this distinction should be carefully considered when one intends to scrutinize the data presented in this paper.

METHODOLOGY

Bibliometric data on journal articles published by Southeast Asian CE researchers were primarily obtained from the Scopus database. Scopus is an international multidisciplinary database indexing more than 14000 international peer-reviewed journals in science and technology. Scopus is used in this study because it is currently utilized to help establish the annual THES-QS World University Rankings (Scopus 2007) which is extensively referred to by Asian universities to assess their international reputation.

From the main webpage of Scopus (http://www.scopus.com/home.url), the phrase "chemical engineering (country)" was keyed in the search engine under "affiliation". Under the *document type* column, documents under the categories of *conference paper*, *article in press*, *letter, erratum, editorial*, *abstract report*, *note*, *short survey* and *undefined* were excluded. Only regular technical and review articles published from 1996 to 2008 were considered for this study. Pertinent information such as *journal*, *amount published, keywords* and *subject area* were extracted from the search result (retrieved May 30, 2009). In addition to Scopus, the Journal Citation Reports® obtained from ISI Web of Knowledge℠ (http://www.isiknowledge.com) as well as the SCImago Journal & Country Rank (http://www.scimagojr.com) developed by the SCIMago Research Group were also used for this study.

RESULTS AND DISCUSSION

Published journal articles

Figure 1 compares the amount of articles published by respective Southeast Asian countries from 1996 to 2008. Only data from Singapore, Malaysia, Thailand, Indonesia and Philippines are presented as the amount of journal articles published by CE researchers in other Southeast Asian countries such as Vietnam, Cambodia and Myanmar are either too low (to be an accurate representation of CE research in that country) or non-existent. Singapore tops the amount of journal articles (2,699) followed by Malaysia (848), Thailand (686), Indonesia (128) and Philippines (60). This is hardly surprising since for the ordered list of science articles published in the world every year, economically most developed countries normally occupy the top rows (Inonu 2003). In terms of published SCI articles per million persons from 1996 to 2003, the calculated published journal articles by CE researchers from this study is compared with data obtained from Inonu (2003). In terms of normalized data (per million persons), similar trends are observed as well in which Singapore, Malaysia and Thailand occupy the top three spots. The considerably high amount of SCI journal articles published by Singaporean researchers compared to researchers from other Southeast Asian countries implies the prevailing publishing culture that exists in Singapore. One may argue that such culture exists due to the rigorous academic tenure system at Singaporean universities.

Figure 2 shows the progression of amount of journal articles published by CE researchers from 1996 to 2008. It appears that all countries exhibit gradual increases of journal publications while Singapore exhibits astonishing publication increases by approximately a factor of 4.6 from 2004 to 2006. At this point, one is likely to hypothesize that this is due to the increase of employment of graduate students or faculty members as well as increased international research collaborations among Singaporean CE researchers. However, a quick search using Scopus database indicates this is not so, since the total Singaporean CE researchers (or collaborators) who publish journal articles in years 2004 and 2006 are exactly the same (160 researchers). As such, a more likely reason to explain such drastic increases is the increased incentives offered by the respective Singaporean CE institutions in preceding years, albeit this postulate cannot be substantiated at present due to lack of archived information on this matter.

Bibliometric Analysis on Each Country

Table 1 shows the bibliometric data on journal articles published by Southeast Asian CE researchers from 1996 to 2008. Interestingly, overall observation indicates that journal articles publication trends among active Southeast Asian CE researchers are highly varied and they are discussed separately in the following sections. It should be noted that 5-year impact factor (released by Journal Citation Reports®) is used instead of the latest impact factor because the former provides a more encompassing and accurate value that reflects the mean impact factor throughout several years.

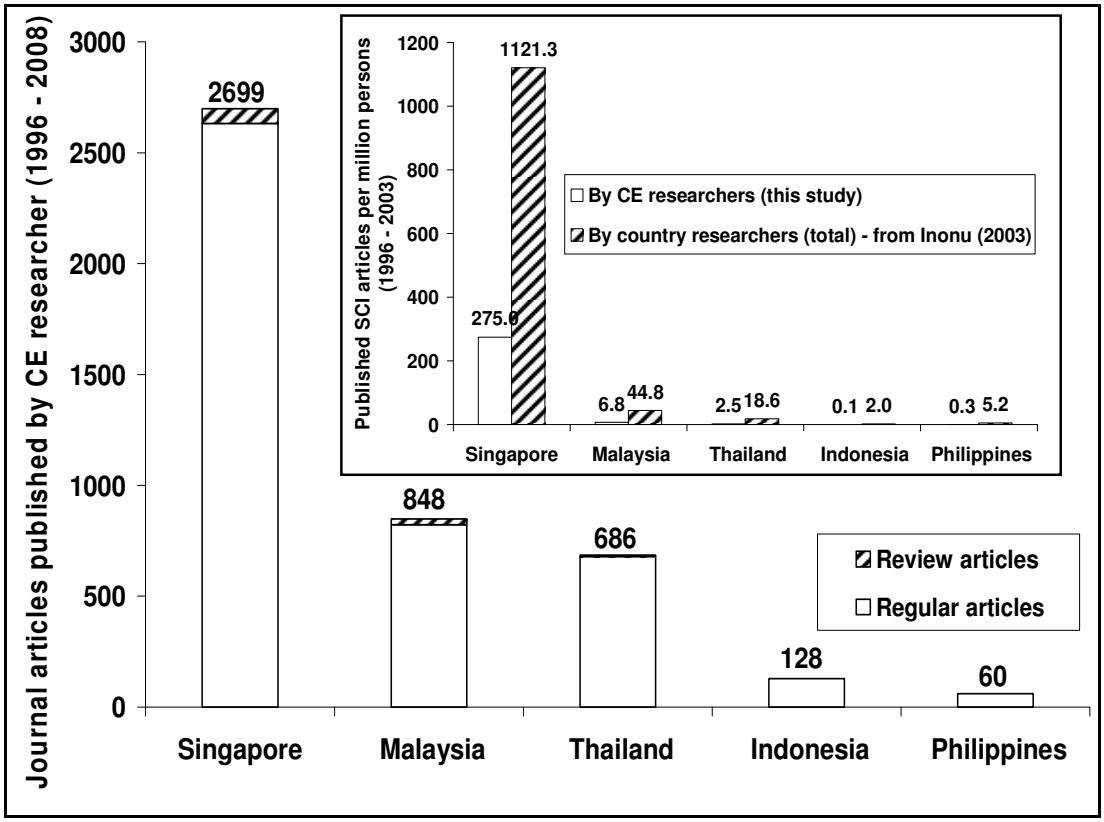

Figure 1: Comparison of amount of articles published by respective Southeast Asian countries.
(Main figure: journal articles from 1996 – 2008; Inset: SCI articles per million persons)

(a) Singapore

The bibliometric data on Singapore clearly indicate the prevalence of articles published by Singaporean CE researchers in society-based journals published in the United States (USA) (12 out of *top 20 journals*). Such prevalence is mostly due to the fact that tenure and promotion policy at its universities are stringent and in line with the benchmarks of leading universities in the US (Wong, Ho and Singh 2007). Among the 12 USA-based journals, *Industrial & Engineering Chemistry*, *Chemical Engineering Science* and *AIChE Journal* (Peters and van Raan 1994) are generally considered as the most prestigious broad-based CE journals within the international CE community. The similar prestige level of such journals is directly correlated to their rather high and somewhat consistent *h*-indices (60 – 69). Besides that, it can be observed that highly-ranked basic chemistry (*Langmuir* and *Journal of Physical Chemistry B*) and material science (*Chemistry of Materials*, *Biomaterials* and *Journal of Materials Chemistry*) journals seem to be the preferred research outlets of Singaporean CE researchers. At this juncture, it is implied that academic rewarding and promotion systems at Singaporean universities are based largely on publication in these top-ranked journals.

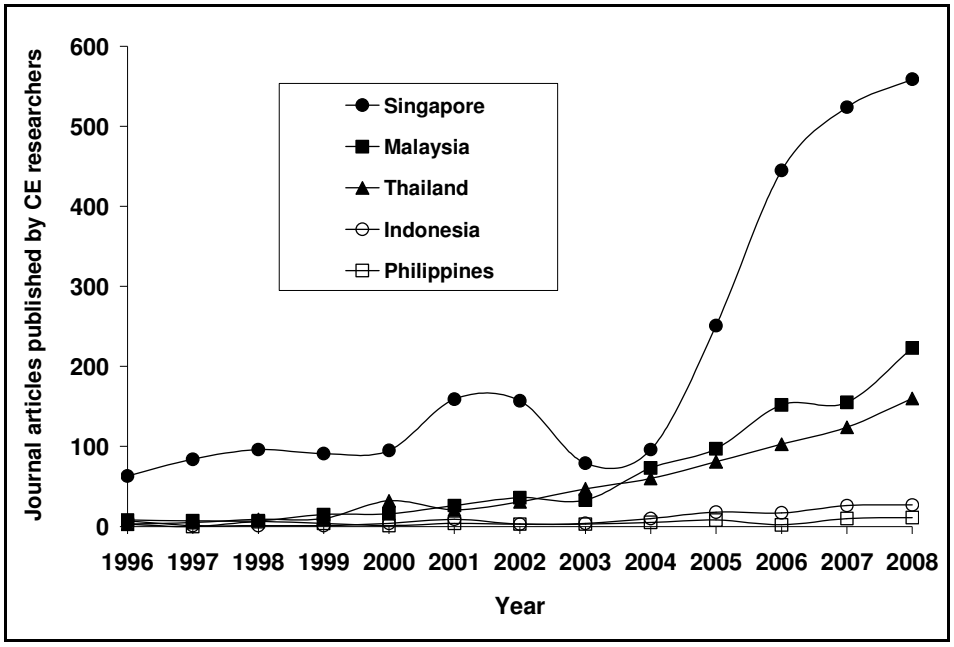

Figure 2: Progression of amount of journal articles published by CE researchers from 1996 to 2008.

By carefully analyzing the data on *top 20 keywords* and *subject area*, the research focus of CE researchers can be determined qualitatively. In the case of Singapore, CE research seems to be geared towards synthesis and development of novel materials of which their properties are elucidated by fundamental chemistry knowledge. The appearance of *X-ray photoelectron spectroscopy, scanning electron microscopy, fourier transform infrared spectroscopy, adsorption, polymer, nanostructured materials* and *humans* among the *top 20 keywords* further suggests extensive research on development and characterization of nanostructure or nanoporous materials as applied to chemical separation processes or medical uses such as nano-based biosensors and diagnostic devices (Huang 2004). Such research initiatives are indicative of effort to further develop the knowledge-based economy of Singapore.

(b) Malaysia

Malaysian CE researchers, on the other hand, have relatively more *Elsevier* journal publications (11) among the *top 20 journals* compared to other publishers with such journals occupying the top five places. It is widely believed that this is due to the popularity of *ScienceDirect.com* (owned by *Elsevier*) as a much used online academic database. Further analysis indicates that many of *top 20 journals* are focused more on the field of applied sciences (*Desalination*, *Journal of Hazardous Materials, Journal of Chemical Technology and Biotechnology, Journal of Applied Sciences, Bioresource Technology*) rather than fundamental and chemical engineering sciences (which is more prevalent in the case of Singapore). Closer inspection on the titles and abstracts of these articles seems to suggest that most articles are indeed skewed towards the area of applied sciences. Interestingly, *AIChE Journal* does not appear in the *top 20 journals* list.

Table 1: Bibliometric data on journal articles published by Southeast Asian CE researchers from 1996 to 2008.

Country	No	Top 20 journals[a]	Publisher[b]	Journal Country[a]	5-year Impact Factor[b]	*h*-index[c]	Amount published[a]	%	Top 20 keywords[a]	Total associated journals[a]	Subject Area[a]	Total associated journals[a]
Singapore	1	Langmuir	American Chemical Society	USA	4.189	127	125	4.63	X ray photoelectron spectroscopy	295	Materials Science	1142
	2	Industrial & Engineering Chemistry Research	American Chemical Society	USA	1.860	69	108	4.00	Synthesis (chemical)	232	Chemistry	1061
	3	Journal of Membrane Science	Elsevier Science BV	Netherlands	2.897	75	106	3.93	Scanning electron microscopy	215	Chemical Engineering	1036
	4	Chemical Engineering Science	Pergamon-Elsevier Science Ltd.	USA	1.995	61	85	3.15	Adsorption	213	Physics and Astronomy	429
	5	Journal of Physical Chemistry B	American Chemical Society	USA	4.475	149	69	2.56	Nanostructured materials	205	Biochemistry, Genetics and Molecular Biology	385
	6	Journal of Physical Chemistry C	American Chemical Society	USA	-na-	-na-	54	2.00	Controlled study	188	Engineering	357
	7	Journal of Colloid and Interface Science	Academic Press Inc. Elsevier Science	USA	2.494	71	53	1.96	Polymers	184	Environmental Science	268
	8	Journal of Applied Polymer Science	John Wiley & Sons Inc.	USA	1.334	66	45	1.67	Polymer	168	Energy	116
	9	Chemistry of Materials	American Chemical Society	USA	5.536	134	42	1.56	Chemistry	166	Pharmacology, Toxicology and Pharmaceutics	92
	10	Biomaterials	Elsevier Science Ltd.	England	6.378	103	42	1.56	Mathematical models	165	Medicine	72
	11	Macromolecules	American Chemical Society	USA	4.533	141	36	1.33	Polymerization	157	Immunology and Microbiology	57
	12	Polymer	Elsevier Science Ltd.	England	3.333	87	34	1.26	Surface property	154	Earth and Planetary Sciences	39
	13	Applied Physics Letters	American Institute of Physics	USA	4.068	196	32	1.19	Humans	142	Computer Science	27
	14	AIChE Journal	John Wiley & Sons Inc.	USA	2.052	60	31	1.15	Fourier transform infrared spectroscopy	138	Agricultural and Biological Sciences	25
	15	Journal of Power Sources	Elsevier Science BV	Netherlands	3.516	79	30	1.11	Computer simulation	136	Mathematics	15
	16	Separation and Purification Technology	Elsevier Science BV	Netherlands	2.401	36	29	1.07	Morphology	132	Health Professions	6
	17	Journal of Materials Chemistry	Royal Society of Chemistry	England	4.226	86	28	1.04	Synthesis	131	Social Sciences	6
	18	Journal of the Electrochemical Society	Electrochemical Society Inc.	USA	2.758	108	26	0.96	Transmission electron microscopy	129	Dentistry	3
	19	Nanotechnology	IOP Publishing Ltd.	England	3.511	55	24	0.89	Unclassified drug	129	Multidisciplinary	3
	20	Microporous and Mesoporous Materials	Elsevier Science BV	Netherlands	2.699	57	23	0.85	Oxidation	126	Neuroscience	3
				Mean = 3.382 SD = 1.313		Mean = 92.632 SD = 40.623						

Table 1: Bibliometric data on journal articles published by Southeast Asian CE researchers from 1996 to 2008 (con't).

Country	No	Top 20 journals[a]	Publisher[b]	Journal Country[a]	5-year Impact Factor[b]	*h*-index[c]	Amount published[a]	%	Top 20 keywords[a]	Total associated journals[a]	Subject Area[a]	Total associated journals[a]
Malaysia	1	Desalination	Elsevier Science BV	Netherlands	1.185	34	34	4.01	Adsorption	120	Chemical Engineering	456
	2	Chemical Engineering Journal	Elsevier Science SA	Switzerland	2.110	36	34	4.01	Mathematical models	99	Materials Science	185
	3	Journal of Hazardous Materials	Elsevier Science BV	Netherlands	2.641	45	31	3.66	Kinetics	62	Environmental Science	183
	4	Journal of Membrane Science	Elsevier Science BV	Netherlands	2.897	75	24	2.83	Reaction kinetics	61	Chemistry	176
	5	Separation and Purification Technology	Elsevier Science BV	Netherlands	2.401	36	23	2.71	Optimization	59	Engineering	139
	6	Industrial & Engineering Chemistry Research	American Chemical Society	USA	1.860	69	20	2.36	Temperature	55	Biochemistry, Genetics and Molecular Biology	136
	7	Journal of Chemical Technology and Biotechnology	John Wiley & Sons Ltd.	England	1.423	39	18	2.12	Carbon dioxide	53	Energy	76
	8	Process Biochemistry	Elsevier Science Ltd.	England	2.628	38	18	2.12	Catalysts	53	Immunology and Microbiology	65
	9	Biochemical Engineering Journal	Elsevier Science SA	Switzerland	2.137	28	18	2.12	pH	53	Agricultural and Biological Sciences	61
	10	Journal of Applied Sciences	Asian Network for Scientific Information	Pakistan	-na-	-na-	17	2.00	Activated carbon	52	Multidisciplinary	32
	11	Bioresource Technology	Elsevier Science Ltd.	England	3.455	52	17	2.00	Solutions	52	Physics and Astronomy	30
	12	Chemical Engineering Science	Pergamon-Elsevier Science Ltd.	USA	1.995	61	15	1.77	Palm oil	51	Medicine	22
	13	Biotechnology and Bioprocess Engineering	Korean Society of Biotechnology & Bioengineering	South Korea	-na-	-na-	15	1.77	Biomass	50	Computer Science	10
	14	Journal of Applied Polymer Science	John Wiley & Sons Inc.	USA	1.334	66	14	1.65	Computer simulation	49	Earth and Planetary Sciences	9
	15	Journal of Chemical and Engineering Data	American Chemical Society	USA	1.775	39	12	1.42	Concentration (process)	48	Social Sciences	8
	16	Journal of Food Engineering	Elsevier Science Ltd.	England	2.322	38	12	1.42	Membrane	48	Business, Management and Accounting	6
	17	Journal of Natural Gas Chemistry	Kexue Chubaneshe/ Science Press	China	-na-	-na-	11	1.30	Scanning electron microscopy	46	Mathematics	6
	18	Computers & Chemical Engineering	Pergamon-Elsevier Science Ltd.	USA	1.815	42	11	1.30	Catalysis	45	Pharmacology, Toxicology and Pharmaceutics	3
	19	Chemical Engineering Research & Design	Institution of Chemical Engineers	England	0.949	30	10	1.18	pH effects	43	Psychology	1
	20	Drying Technology	Taylor & Francis Inc.	USA	1.431	26	10	1.18	Methane	42	-na-	-na-
					Mean = 2.021 SD = 0.661	Mean = 44.353 SD = 14.899						

Table 1: Bibliometric data on journal articles published by Southeast Asian CE researchers from 1996 to 2008 (con't).

Country	No	Top 20 journals[a]	Publisher[b]	Journal Country[a]	5-year Impact Factor[b]	*h*-index[c]	Amount published[a]	%	Top 20 keywords[a]	Total associated journals[a]	Subject Area[a]	Total associated journals[a]
Thailand	1	Korean Journal of Chemical Engineering	Korean Institute of Chemical Engineers	South Korea	0.655	16	38	5.54	Catalysts	76	Chemical Engineering	372
	2	Chemical Engineering Journal	Elsevier Science SA	Switzerland	2.110	36	31	4.52	Adsorption	62	Materials Science	201
	3	Journal of Membrane Science	Elsevier Science BV	Netherlands	2.897	75	24	3.50	Mathematical models	59	Chemistry	176
	4	Journal of Applied Polymer Science	John Wiley & Sons Inc.	USA	1.334	66	23	3.35	Catalysis	55	Environmental Science	115
	5	Songklanakarin Journal of Science and Technology	Samnakngan Athikanbodi	Thailand	-na-	-na-	21	3.06	Catalyst activity	47	Agricultural and Biological Sciences	64
	6	Journal of Chemical Engineering of Japan	Society of Chemical Engineers Japan	Japan	0.614	23	21	3.06	Computer simulation	42	Engineering	57
	7	Catalysis Communications	Elsevier Science BV	USA	2.579	26	21	3.06	Hydrogenation	42	Energy	41
	8	Bioresource Technology	Elsevier Science Ltd.	England	3.455	52	20	2.92	Synthesis (chemical)	42	Biochemistry, Genetics and Molecular Biology	38
	9	Journal of Industrial and Engineering Chemistry	Korean Society of Industrial Engineering Chemistry	South Korea	1.062	8	16	2.33	Carbon	40	Immunology and Microbiology	36
	10	Chemical Engineering Science	Pergamon-Elsevier Science Ltd.	USA	1.995	61	15	2.19	Silica	39	Physics and Astronomy	30
	11	Journal of Food Engineering	Elsevier Science Ltd.	England	2.322	38	15	2.19	Temperature	38	Multidisciplinary	26
	12	Catalysis Letters	Springer	USA	2.023	55	14	2.04	Ethanol	37	Earth and Planetary Sciences	15
	13	Industrial & Engineering Chemistry Research	American Chemical Society	USA	1.860	69	13	1.90	Scanning electron microscopy	37	Computer Science	5
	14	Materials Chemistry and Physics	Elsevier Science SA	Switzerland	1.936	35	13	1.90	Mass transfer	36	Social Sciences	4
	15	Applied Catalysis A General	Elsevier Science BV	Netherlands	3.340	77	12	1.75	Thermal effects	35	Mathematics	3
	16	Separation and Purification Technology	Elsevier Science BV	Netherlands	2.401	36	12	1.75	Water	35	Pharmacology, Toxicology and Pharmaceutics	2
	17	Reaction Kinetics and Catalysis Letters	Springer	Hungary	0.607	18	12	1.75	Concentration (process)	34	Business, Management and Accounting	1
	18	Journal of the Chinese Institute of Chemical Engineers	Chinese Institute of Chemical Engineers	Taiwan	0.378	9	10	1.46	Ethylene	31	Medicine	1
	19	Journal of Power Sources	Elsevier Science BV	Netherlands	3.516	79	10	1.46	Nanostructured materials	31	-na-	-na-
	20	Crystal Growth & Design	American Chemical Society	USA	4.073	35	7	1.02	Chemical reactors	29	-na-	-na-
					Mean = 2.061 SD= 1.093	Mean = 45.750 SD = 24.674						

Table 1: Bibliometric data on journal articles published by Southeast Asian CE researchers from 1996 to 2008 (con't).

Country	No	Top 20 journals[a]	Publisher[b]	Journal Country[a]	5-year Impact Factor[b]	*h*-index[c]	Amount published[a]	%	Top 20 keywords[a]	Total associated journals[a]	Subject Area[a]	Total associated journals[a]
Indonesia	1	Journal of Chemical and Engineering Data	American Chemical Society	USA	1.775	39	10	7.81	Carbon dioxide	22	Chemical Engineering	87
	2	Journal of Natural Gas Chemistry	Kexue Chubaneshe/ cience Press	China	-na-	-na-	7	5.47	Mathematical models	17	Chemistry	39
	3	Separation and Purification Technology	Elsevier Science BV	Netherlands	2.401	36	7	5.47	Adsorption	14	Energy	21
	4	Industrial & Engineering Chemistry Research	American Chemical Society	USA	1.860	69	6	4.69	Catalysts	13	Materials Science	21
	5	Journal of Chemical Engineering of Japan	Society of Chemical Engineers Japan	Japan	0.614	23	5	3.91	Thermal effects	13	Engineering	19
	6	Bioresource Technology	Elsevier Science Ltd.	England	3.455	52	4	3.13	Temperature	12	Environmental Science	18
	7	Renewable Energy	Pergamon-Elsevier Science Ltd.	England	1.288	22	4	3.13	Computer simulation	11	Biochemistry, Genetics and Molecular Biology	14
	8	Chemical Engineering Journal	Elsevier Science SA	Switzerland	2.110	36	4	3.13	Methane	11	Immunology and Microbiology	12
	9	Desalination	Elsevier Science BV	Netherlands	1.185	34	3	2.34	Chemical reactors	10	Agricultural and Biological Sciences	8
	10	Fuel	Elsevier Science Ltd.	England	2.041	40	3	2.34	Binary mixtures	9	Physics and Astronomy	4
	11	Separation Science and Technology	Taylor & Francis Inc.	USA	1.060	31	3	2.34	Solubility	9	Medicine	3
	12	Chemical Engineering Research & Design	Institution of Chemical Engineers	England	0.949	30	3	2.34	Carbon	8	Multidisciplinary	2
	13	Journal of Membrane Science	Elsevier Science BV	Netherlands	2.897	75	2	1.56	Reaction kinetics	8	Social Sciences	1
	14	Drying Technology	Taylor & Francis Inc.	USA	1.431	26	2	1.56	Ethanol	7	-na-	-na-
	15	Journal of Energy Engineering	American Society of Civil Engineers	USA	-na-	-na-	2	1.56	Kinetics	7	-na-	-na-
	16	Chemical Engineering Science	Pergamon-Elsevier Science Ltd.	USA	1.995	61	2	1.56	Solutions	7	-na-	-na-
	17	Chemical Engineering Communications	Taylor & Francis Inc.	USA	0.438	17	2	1.56	Water	7	-na-	-na-
	18	International Journal of Heat and Mass Transfer	Pergamon-Elsevier Science Ltd.	England	1.811	55	2	1.56	Zeolites	7	-na-	-na-
	19	Biotechnology and Bioprocess Engineering	Korean Society of Biotechnology & Bioengineering	South Korea	-na-	-na-	2	1.56	Concentration (process)	6	-na-	-na-
	20	Biochemical Engineering Journal	Elsevier Science SA	Switzerland	2.137	28	2	1.56	Extraction	6	-na-	-na-
					Mean = 1.732 SD = 0.784	Mean = 39.647 SD= 19.967						

Table 1: Bibliometric data on journal articles published by Southeast Asian CE researchers from 1996 to 2008 (con't).

Country	No	Top 20 journals[a]	Publisher[b]	Journal Country[a]	5-year Impact Factor[b]	*h*-index[c]	Amount published[a]	%	Top 20 keywords[a]	Total associated journals[a]	Subject Area[a]	Total associated journals[a]
Philippines	1	Philippine Agricultural Scientist	University of the Philippines at Los Banos	Philippines	0.149	3	9	15.00	Process integration	8	Chemical Engineering	18
	2	Journal of Cleaner Production	Elsevier Science Ltd.	USA	1.435	24	4	6.67	Mathematical models	6	Environmental Science	18
	3	Journal of Chemical Engineering of Japan	Society of Chemical Engineers Japan	Japan	0.614	23	3	5.00	Optimization	5	Chemistry	15
	4	Clean Technologies and Environmental Policy	Springer Verlag	Germany	-na-	-na-	3	5.00	Pinch analysis	5	Energy	12
	5	Energy	Pergamon-Elsevier Science Ltd.	England	1.398	27	3	5.00	Unclassified drug	5	Agricultural and Biological Sciences	11
	6	Water Science and Technology	International Water Association Publishing	England	1.238	53	2	3.33	Carbon	4	Biochemistry, Genetics and Molecular Biology	8
	7	Chemical Engineering Research & Design	Institution of Chemical Engineers	England	0.949	30	2	3.33	Carbon dioxide	4	Engineering	6
	8	Computers & Chemical Engineering	Pergamon-Elsevier Science Ltd.	USA	1.815	42	2	3.33	Life cycle assessment	4	Materials Science	5
	9	Environmental Modelling and Software	Elsevier Science Ltd.	England	2.217	25	2	3.33	Philippines	4	Earth and Planetary Sciences	4
	10	Journal of Hazardous Materials	Elsevier Science BV	Netherlands	2.641	45	1	1.67	Waste water management	4	Immunology and Microbiology	2
	11	Journal of Material Cycles and Waste Management	Springer Verlag	Japan	-na-	-na-	1	1.67	Wastewater	4	Physics and Astronomy	2
	12	Korean Journal of Chemical Engineering	Korean Institute of Chemical Engineers	South Korea	0.655	16	1	1.67	Wastewater treatment	4	Social Sciences	1
	13	Process Safety and Environmental Protection	Institution of Chemical Engineers	England	0.561	15	1	1.67	Adsorption	3	-na-	-na-
	14	Pure and Applied Geophysics	Birkhauser Verlag	Switzerland	1.142	29	1	1.67	Alcohol	3	-na-	-na-
	15	Reaction Kinetics and Catalysis Letters	Springer	Hungary	0.607	18	1	1.67	Aqueous solution	3	-na-	-na-
	16	Research Journal of Chemistry and Environment	International Congress of Chemistry and Environment	India	-na-	-na-	1	1.67	Biodiesel	3	-na-	-na-
	17	Research on Chemical Intermediates	VSP BV	Netherlands	0.683	21	1	1.67	Bioreactors	3	-na-	-na-
	18	Rheologica Acta	Springer	Germany	1.640	33	1	1.67	Carbon emission	3	-na-	-na-
	19	Separation Science and Technology	Taylor & Francis Inc.	USA	1.060	31	1	1.67	Chemical reactors	3	-na-	-na-
	20	Separation and Purification Technology	Elsevier Science BV	Netherlands	2.401	36	1	1.67	Concentration (parameters)	3	-na-	-na-
					Mean = 1.247 SD = 0.709	Mean = 27.706 SD = 12.118						

"-na-" denotes "not available"
"SD" denotes standard deviation

[b]obtained from *Journal Citation Reports*
[a]obtained from *Scopus* database

[c]obtained from *SCImago Journal & Country Rank* (1996 – 2007)

It does not seem that *journal country* has an influence on the publication behaviour of Malaysian CE researchers and that there is a relatively good mixture of journals from different countries.

Analysis on the *top 20 keywords* and *subject area* reveals that the predominant research activity among Malaysian CE researchers is the application of adsorption science for environmental protection, particularly within the field of wastewater treatment. This is in good agreement with the list of journals occupying the top five places in which their publication policies favour articles that report on this subject matter. It is interesting to note that *palm oil* is among the *top 20 keywords. Palm oil* is edible oil extracted from the seeds and fruit of the oil palm plant (*Elaeis guineensis*). Such finding reveals the concerted effort by the Malaysian government to promote niche research activities on indigenous agricultural resources among Malaysian researchers since Malaysia is one of the largest *palm oil* exporters in the world. The importance of the *palm oil* commodity to Malaysia is reflected by the 160 nutritional research projects carried out by the Malaysian Palm Oil Board (MPOB) (Lam et al. 2009), the main authority of *palm oil* research in Malaysia.

(c) Thailand

In terms of journal articles prevalence, Thai CE researchers also have comparatively more *Elsevier* journal publications (10) among the *top 20 journals* compared to other publishers. Again, this is most probably attributed to the popularity of *ScienceDirect.com* as an online academic database. Similarly, there is a relatively good mixture of journals from different countries. Interestingly though, Thai CE researchers also prefer to publish their work in a local journal, *Songklanakarin Journal of Science and Technology,* which accounts for 3.06 % of the total journal articles published.

Analysis on the *top 20 keywords* and *subject area* indicates a noteworthy aspect where *catalysis* as applied to *hydrogenation* (chemical reaction due to addition of hydrogen in a substance) research is highly prominent among Thai CE researchers. This is also reflected in the prevalence of articles in four specialized catalysis journals in the *top 20 journals* list, namely, *Catalysis Communications, Catalysis Letters, Applied Catalysis A: General* and *Reaction Kinetics and Catalysis Letters.* This may suggest that Thai CE researchers focus more on the chemical reaction and production aspects of chemical engineering research rather than separation process, waste treatment or plant management aspects.

(d) Indonesia and Philippines

Of all the bibliometric data analyzed, Indonesia and Philippines provide considerably smaller sample sizes as opposed to relatively bigger sample sizes provided by the other three. This, in turn, reduces the accuracy of determining their journal articles publication trends. Nonetheless, analysis of such data is still important to determine significant research initiatives conducted by these CE researchers. Close inspection on the Indonesian data shows that their chemical engineers conduct more research work within the oil and gas engineering field, specifically, on the separation of carbon dioxide gas from gas processing streams judging by the listing of *Journal of Natural Gas*

Chemistry, Separation and Purification Technology, Separation Science and Technology in *top 20 journals* as well as listing of *carbon dioxide, methane, solubility* in *top 20 keywords.* With regards to the Philippines data, it is rather obvious that *Philippines Agricultural Research* (a prominent Philippines agriculture journal) is a preferred research outlet for Filipino CE researchers. Further analysis on other journals is redundant due to sparse amount of published articles.

CONCLUSIONS

Bibliometric analysis is shown to be an important means for determining journal articles publication trend among Southeast Asian CE researchers. Singapore tops the amount of journal articles published by CE researchers from 1996 to 2008, followed by Malaysia, Thailand, Indonesia and Philippines. Overall observation indicates that journal articles publication trends among Southeast Asian CE researchers are highly dissimilar. The following salient points are surmised:

a) Singaporean CE researchers frequently publish their work in journals based in the USA. These include top-ranked broad-based CE, basic chemistry and material science journals. They conduct extensive research on development and characterization of nanostructure or nanoporous materials as applied to chemical separation processes or medical uses.

b) Malaysian and Thai CE researchers have relatively more *Elsevier* journal publications among the *top 20 journals* compared to other publishers. This is probably due to the popularity of *ScienceDirect.com* (owned by *Elsevier*) as a much used online academic database.

c) Malaysian, Thai and Indonesian CE researchers focus more on environmental chemical engineering, catalysis and oil and gas engineering research respectively.

It is the opinion of the author that findings of such study are useful indicators for journal publishers to determine the publishing behaviour of CE researchers as well as for each country's science policy makers to formulate appropriate research policies and directions.

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