Use of Moore's Law to Predict Implementation and Advancing of Science and Technology in Supporting Halal Requirements: a Scopus Study

S. Viridi*, Y. Bindar, S. Suhandono, E. Kardena, Rifqi, A. E. Fitriani & S. I. Ihsani
Lembaga Pusat Halal Salman Institut Teknologi Bandung
Jl. Ganesha No. 7, Bandung 40132, Indonesia
*dudung@gmail.com

Abstract

A literature study of number of publications listed in Scopus has been performed. Observation is limited only from 1990 to mid of 2015. The word halal is used in searching title, abstract, and keywords of the publications. Only four subject areas are considered: (i) agricultural and biological sciences, (ii) engineering, (iii) medicine, and (iv) computer sciences. In general sum of all fields tends to increase rapidly between 2010 and 2012 but then they decrease in the last three years of observation range. It also makes smooth pattern from 1999 until 2009. Individual field shows fluctuated pattern. Moore's law in form of $N(t) = N_0 \exp[k(t - t_0)]$ is implemented by setting some parameters such as offset of starting time t_0, exponent constant k, and proportional constant N_0. Correlation among observed fields is also discussed in brief.

Keywords:Moore's law, halal, Scopus, prediction model, science and technology.

Introduction

The use of Scopus database in obtaining dimension and progress of particular research topics has been common, e.g. in studying knowledge management research in India (Surulinathi *et al*., 2007) and research productivity of a leading private university in India (Swain *et al*., 2013), but less common than the use of other database, e.g. Web of Science, which is used in studying research performance on nanotechnology in India (Sivaraman *et al*., 2007), Indian research productivity of food science and technology (Poornnima *et al*., 2011), Indian perspective of medical plant research (Ragavan et al., 2012), and analysis of green computing research based on continent around the world (Surulinathi *et al*., 2013). We will use only the first database since our research group have only access to this one. And we also omit Google Scholar since it covers also non-peer review articles.

Moore's law in the 1965 original article described that number of transistors in a silicon chip will be doubled every 12 months, but then it became today's popular form, where processor performance will be doubled every 18 months (Liddle, 2006). Since that the law did not act only as predictor of the silicon era, but also as driver (Robison, 2012). Basically, it is a description and a consequence of synergism between increasing of computer power per price provided by industry and the new increasingly power applications customers wanted by customer, but unfortunately this macroscopic view of semiconductor components begins to fail as sizes approach atomic dimension (Keyes, 2006). Today processor technology allows the shrinking of component size below 100 nanometers, which actually requires reducing supply voltage (it also reduces power consumption), but smaller geometries exacerbate leakage and static power begins to dominate power consumption (Kim et al., 2003) and high density future miniaturization will face a fundamental an unavoidable noise process known as the thermal noise (Kish, 2002). Other aspect should also be considered, e.g. the importance of semiconductors in economy and society, it will lead the law to become an increasingly misleading predictor of future development, which requires revisions (Tuomi, 2002) or to survive it must be able to be adjusted through parameter (Jovanovic & Rousseau, 2002).

Method

Following criteria are used in searching Scopus data base: (i) year range from 1990 to mid of 2015, (ii) subject areas are agricultural and biological sciences, engineering, medicine, and computer sciences, (iii) search word is halal, (iv) field targets are title, abstract, and keywords of articles, and also those fields together, (v) type of articles is all, and (vi) other options are Scopus default. Obtained data will be fitted using Moore's law.

Moore's law in general has a form of

$$N(t) = N_0 e^{k(t-t_0)} \qquad (1)$$

where N_0 is number or amount at time t_0, $N(t)$ is number or amount at time t, and k is rate constant.
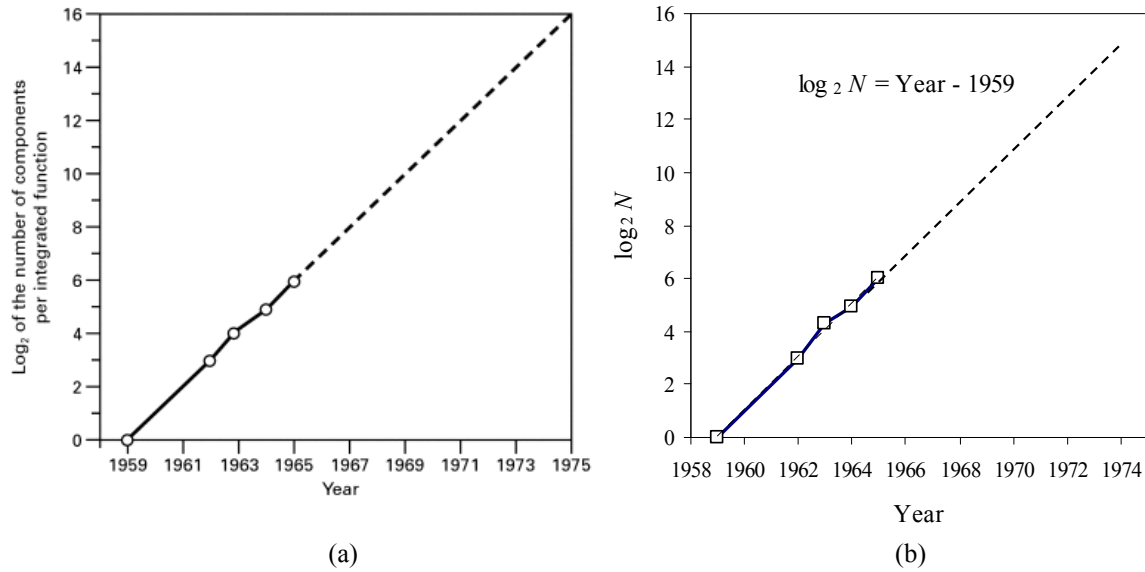
Figure 1. (a) Number of components per integrated function (Moore, 2006) and (b) its prediction.

Equation (1) can be also represented in form of

$$\log_a N = \left(k \log_a e\right)t - \left[\left(k \log_a e\right)t_0 - \log_a N_0\right], \tag{2}$$

where from Figure 1 it can be found that $a = 2$, $k\log_a e = 1$, and $[(k\log_a e)t_0 - \log_a N_0] = 1959$ for that case. In this work, for simplicity we choose that $a = e$ or $\log_a \rightarrow \ln$.

Results and discussion

Several abbreviations are used to identify subject areas and part of articles as shown in Table 1.

Table 1. Abbreviations used in this work for searching articles listed in Scopus database with search key halal.

Abbreviation	Search Options	Meaning
SCI	Subject Areas	Agricultural and Biological Sciences
ENG		Engineering
MED		Medicine
COM		Computer Sciences
HAL		SCI+ENG+MED+COM
TITLE	Search Fields	Title
ABS		Abstract
KEY		Keywords
TITLE+ABS+KEY		Title+Abstract+Keywords

Search results are shown in Figures 2-5. In general subject area SCI dominate the results since the word halal is mainly related to food products and food technologies, which are listed in this subject area. Surprisingly MED does not sit at the second place as expected, but ENG. At the third and fourth places alternately sit MED and COM. It can roughly be interpreted that researchers are considering that foods and related topics more important than medicine even both product will enter human body. Or the established pharmacy industries do not yet care about halal requirement in their product.
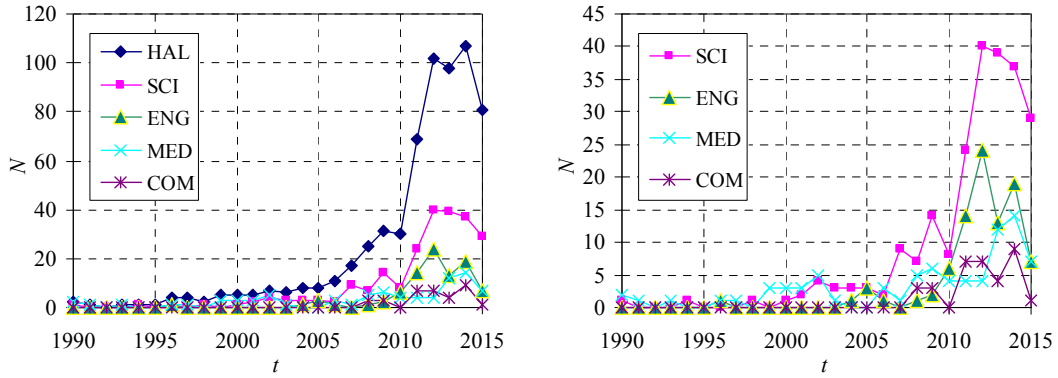
Figure 2. Search results on TITLE+ABS+KEY for mentioned subject areas: with (left) and without total results (right).
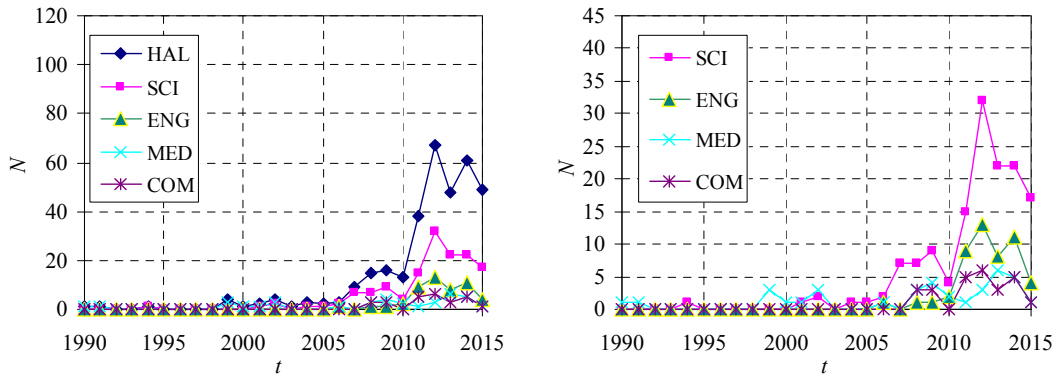

Figure 3. Search results on TITLE for mentioned subject areas: with (left) and without total results (right).
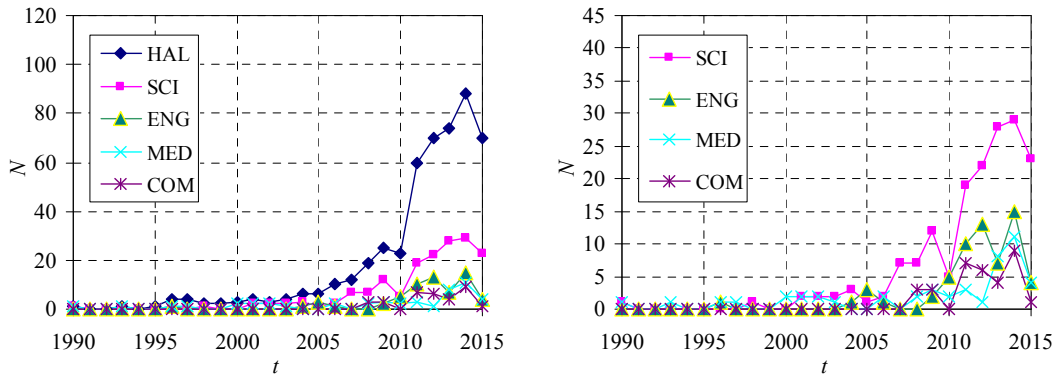

Figure 4. Search results on ABS for mentioned subject areas: with (left) and without total results (right).
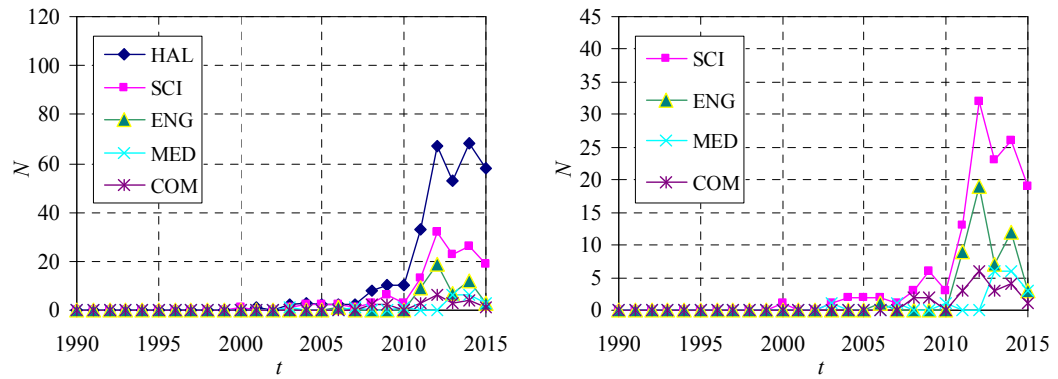

Figure 5. Search results on KEY for mentioned subject areas: with (left) and without total results (right).
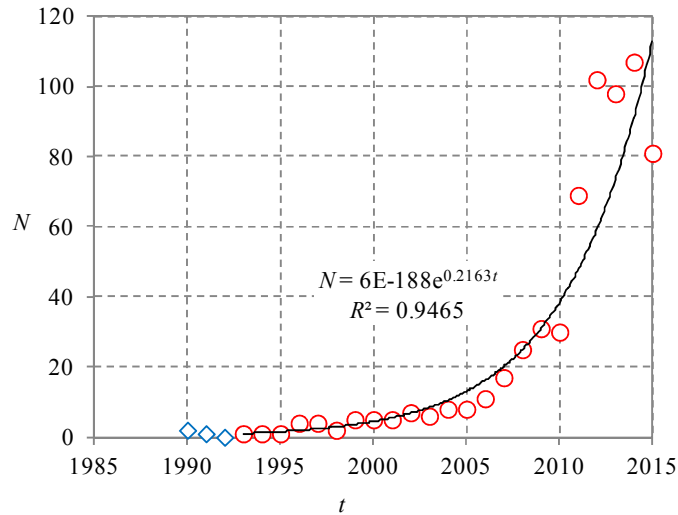
Figure 6. Search results on TITLE+ABS+KEY for all mentioned subject areas and its fitting function from Moore's law with $N_0 = 6 \times 10^{-188}$, $k = 0.2163$, and $t_0 = 1993$.

Total search results on TITLE+ABS+KEY gives rather good fit with $N_0 = 6 \times 10^{-188}$, $k = 0.2163$, and $t_0 = 1993$ as shown in Figure 6. Three earlier data before 1993 are not included since there is zero in 1992.
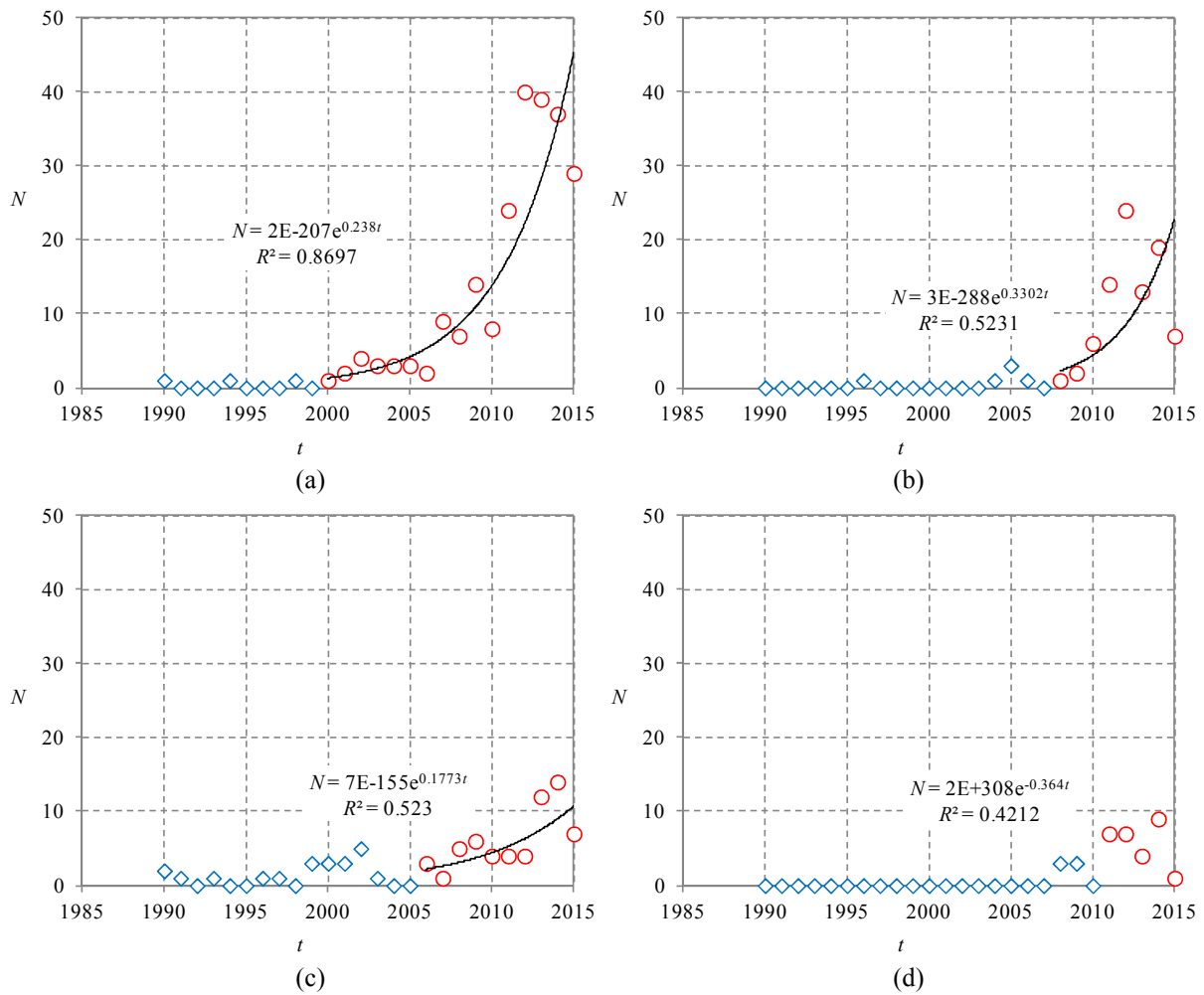

Figure 7. Search results on TITLE+ABS+KEY for subject area: (a) SCI, (b) ENG, (c) MED, and (d) COM.

We believe that search results on TITLE+ABS+KEY are more representative than only on TITLE, ABS, or KEY individually. And the fit function for total subject areas give good results with $R^2 = 0.9465$.

Table 2. Fitting parameters of search results on TITLE+ABS+KEY for subject area: HAL, SCI, ENG, MED, and COM.

Subject Area	N_0	k	t_0	R^2
HAL	6.00E-188	0.2163	1993	0.9465
SCI	2.00E-207	0.238	2000	0.8697
ENG	3.00E-288	0.3302	2008	0.5231
MED	7.00E-155	0.1773	2006	0.523
COM	2E+308	-0.364	2011	0.4212

Value of t_0 does not mean that a subject area begin at t_0 since this value is chosen after the last zero value in N from search results. Equation (1) can not be used if there is zero value in N. Subject area COM can not be trusted since $k < 0$, which means that it decreases as t increases. It will be against Moore's law. It is also interesting to find out what the first title of publication for each subject area as shown in Table 3.

Table 3. Title of publication in early and last years for each subject area.

Subject Area	Year	Title
SCI	1990	An enquiry into the attitudes of Muslim Asian mothers regarding infant feeding practices and dental health
	2015	A comparison of blood loss during the Halal slaughter of lambs following Traditional Religious Slaughter without stunning, Electric Head-Only Stunning and Post-Cut Electric Head-Only Stunning
ENG	2004	New products: Anderol 6000 series food grade lubricants
	2015	Pork adulteration in commercial meatballs determined by chemometric analysis of NIR Spectra
MED	1990	Jhatka and halal meat
	2015	Multiplex PCR assay for the detection of five meat species forbidden in Islamic foods
COM	2008	The users perceptions and opportunities in Malaysia in introducing RFID system for Halal food tracking
	2015	Determining halal product using automated recognition of product logo

First publication in a subject area can not guarantee that in succeeding year the subject area will also have articles, which explains the difference between t_0 in Table 2 and first year in Table 3. In general SCI and MED have better similar pattern and also for ENG and COM as it can be seen in Figure 7. Moore's law than can be used to predict the implementation and advancing of science and technology in supporting halal requirements, if number of publications is the only considered factor. Then, we can say that in 2025 there will be about 1000 publications searchable with search word halal. In the near future we can also predict that more sophisticated science and technology will be used in halal related research since until this 2015 near infra read (NIR) spectra, radio-frequency identification (RFID), and polymerase chain reaction (PCR) are already common.

Conclusion
Moore's law has been used to fit data of publication listed in Scopus between 1990 to mid of 2015 for several subject areas. Total subject areas gives better results (higher R^2, about 0.9465) than individual subject area.

References
Jovanovic, B. and Rousseau, P.L. (2002): Review of Economic Dynamics 5(2): 346-375.

Keyes, R.W. (2006): IEEE Solid-State Circuits Society Newsletter 11(5): 25-27.

Kim, N.S., Blaauw, D., Mudge, T., Flautner, K., Hu, J.S., Irwin, M.J., Kandemir, M. and Narayanan, V. (2003): Computer 36(12): 68-75.

Kish, L.B. (2002): Physics Letters A 305(3-4): 144-149.

Liddle, D.E. (2006): IEEE Solid-State Circuits Society Newsletter 11(5): 28-30.

Moore, G. (2006). "Chapter 7: Moore's law at 40" in Brock, D., Understanding Moore's Law: Four Decades of Innovation, Chemical Heritage Foundation, pp. 67–84.

Poornima, A., Surulinathi M., Amsaveni, N. and Vijayaragavan, M. (2011): Food Biology 1(1):36-41.

Ragavan, S.S., Surulinathi, M. and Neelakandan, B. (2012): International Journal of Plant, Animal and Environmental Sciences 2(3):195-203.

Robison, R.A. (2012): World Neurosurgery 78(5): 339-403.

Sivaraman, P., Sivaraj, S. and Surulinathi, M. (2007): Indian Journal of Information Science and Services 1(1): 68-74.

Surulinathi, M., Amsaveni, N., Maheswaran, K. and Srinivasarghavan, S. (2007): Sri Lankan Journal of Librarianship and Information Management 2(2): 13-24.

Surulinathi M., Balasubramani, R. and Kalisdha (2013): Journal of Advances in Library and Information Science 2(1):39-44.

Swain, D.K., Rautaray, B. and Swain, C. (2013): Library Philosophy and Practice (e-journal) Paper 933.

Tuomi, I. (2002): First Monday 7(11): Article 1.