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Open Source System as Innovation in Organizations: A Managerial Perspective on Its Adoption

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OPEN SOURCE SYSTEM AS INNOVATION IN ORGANIZATIONS

A Managerial Perspective on Its Adoption

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Abstract

This study identifies the factors that have a direct effect on a manager's decision towards Open Source System (OSS) enterprise system adoption in Malaysia. Using the Technology-Organization-Environment (TOE) framework, the research is initiated by inviting the managers in Malaysian organizations who implemented OSS. A survey was conducted via online OSS social communities and by sending emails to shortlisted public. A total of 124 managers from 124 organizations responded to the survey and the results showed that four out of six factors were found significant in this study. In the technological context, 'perceived relative advantage', 'perceived compatibility and trialability' and 'perceived complexity' factors were found significant in the OSS adoption. In the organizational context, 'management support, knowledge and expertise' was identified as the adoption factor. Two factors in the environmental context that was not supported were the 'technology skills and services' and 'platform long term viability' although previous studies suggested otherwise.

Keywords: open source system, Technology-Organization-Environment, innovation, adoption, Malaysia

Information technology is deemed a necessity for an organization to compete in today's competitive world. Thus, organizations seek to use the most cost effective tools in information systems. The use of information systems, which Whitten *et al*. (2001) defined as "an arrangement of people, data, processes, communications, and information technology that interact to support and improve day-to-day operations in a business, as well as support the problem-solving and decision-making needs of management and users," is considered as one of the options for cost a effective solution. The open source software would be such an option for managers to consider when deciding the tools to be invested in.

Studies have shown that the implementation of OSS can save cost and that the transition and migration from one platform to another requires significant investments as it involves training, data migration as well as hardware cost (Morgan and Finnegan, 2007; Ven and Verelst, 2006). The study by Hauge *et al*. (2010)study showed "the complete calculations of the true costs and savings of (1) introducing OSS products into organizations, and (2) keeping the OSS products operational over a longer period of time" were considered the challenges to the organizations.

A survey conducted by the Open Source Competency Center Malaysia in July, 2009 shows that more than 70% of Malaysian government offices were running on open source software (OSS Adoption Statistics Malaysian Public Sector Open Source Software Programme, 2010).This value increased in the year 2010 where 97% of the adoption rate was reported in the public sector (Open Source Competency Center (OSCC) Laporan Adoption Chart Tahun 2011, 2012). Looking at this statistic, it is can be fairly said that the implementation of the OSS in Malaysia is increasing. At present, there is still lack of studies about the OSS enterprise systems adoption, especially in Malaysia. Hence, this study will be valuable to organizations as it evaluates on the factors determining the adoption of OSS.

This study will explore the adoption of the OSS enterprise systems through sets of technological, organizational and environmental factors by managers in organizations. It would also be beneficial for the organizations to know the factors that contribute to the adoption of OSS besides the benefits of free software. This study is also expected to reinforce the factors of previous studies as well as to offer more perspectives of organizations on the adoption of OSS enterprise systems.

The goal of this research is to give the managers some insights as to the possible factors that contribute to the adoption of the OSS enterprise systems. Since the managers are the ones who are taking the risk of implementing these systems in a company, they are the people being surveyed. The specific research questions are (1) What is the level of adoption of OSS enterprise systems? (2) What are the significant factors that influence a manager's adoption of OSS enterprise systems in organizations?

LITERATURE REVIEW

Open Source Software (OSS)

Coppola and Neelley (2004) defines OSS as "software programs that are distributed with the source code which allows users the freedom to run the program for any purpose, to study and modify the program, and to freely redistribute copies of the original or modified program". The improvements of the OSS are being contributed mainly by users or usually in a community who have fixed the problems or added new features to it. Several success stories show that a huge number of people worldwide using Apache, Linux, Firefox and mySQL (Chamili *et al*., 2012).

The OSS may appear to be software that is cost free but it also gives an opportunity for business, where the users may use the system as needed or the users may offer it as a service to others. This means, the software can be commercialized (Coppola and Neelley, 2004) by offering services such as implementation, training, and support; packaging and integrating open source software to make its installation and use easier for a wider market; and creating complementary, add-on, or enhanced software for sale

The distribution of the modified software must also be the same as the original software. The license may restrict the modified software from being distributed only if the enhance-

ment is through 'patch files' to ensure the integrity of the author's source code. The distribution of the modified OSS should not discriminate against persons or groups of persons, use of program in a specified field or endeavour, and redistribution of the OSS with the same rights. The license too must not be specific to a product or restrict other software and it must be technology-neutral.

Over the years, the revenue from OSS has increased as reported in the *Worldwide Open Source Software 2009-2012 Forecast* (IDC, 2008). In the same report, it was revealed that worldwide revenue from OSS will grow at a 22.4% compound annual growth rate (CAGR) to reach $8.1 billion by 2013. This growth is expected due to the current economic crisis.

Diffusion of innovation (DOI)

Over the years, innovation of technologies has assisted organizations in achieving their goals. West and Farr (1990) have defined innovation as "the intentional introduction and application within a role, group or organisation of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to provide benefit for the individual, the group, the organisation or wider society". Open source software is considered as innovative activities because the distribution terms of the software have the following criteria: free redistribution, accessible source code, allows any modification and derived works (Open Source Initiatives (OSI), 2005). These activities enable the organizations to be innovative in terms of their processes and routines.

Diffusion of Innovation (DOI) has become the basis for current adoption theory studies (Rogers, 1962). Rogers' works elaborate on the concept of innovation and the factors that affect the innovation's adoption rate. His model outlines five stages of the adoption process; (1) knowledge of the innovation, (2) persuasion by influencing factors or entities, (3) a decision to adopt, (4) implementation of the innovation; and (5) confirmation of the decision to adopt. Rogers' (2003) Diffusion of Innovation theory lists five characteristics of innovations. Relative advantage is the degree to which an innovation is perceived as better than the idea, which it supersedes. Compatibility is the degree to which an innovation fits with the existing values, past experience, and needs of the potential adopter. Complexity is the degree to which an innovation is perceived as difficult to understand and use. Trialability is whether an innovation may be experimented with on a limited basis. Observability is the degree to which the results of an innovation are visible to others. Rogers' framework has some limitation when applied to organizational innovations. It focuses on the diffusion of mass-produced items which is through individuals in the population (Chau and Tam, 1997). Therefore, a more relevant model is needed to take into account the factors that can affect the propensity of adoption within the specific context of the technological, organizational and the environmental circumstances.

Technology-organization-environment (TOE) framework

In their study of technological innovation adoption, Tornatzky and Fleischer (1990)developed the technology-orga-

nization-environment (TOE) framework. This framework allowed the structure of various adoption factors from different contexts into a coherent framework (Ven and Verelst, 2012). The three contexts described here which would influence the adoption decision are the technological context, the organizational context and the environmental context. A number of literatures have analyzed and used the TOE framework as a foundation for the adoption of OSS in an organization(Chau and Tam, 1997; Dedrick and West, 2003, 2004; Ellis and Belle, 2009; Morgan and Finnegan, 2007, 2010; Ven and Verelst, 2006, 2012).

The technology context

OSS is likelier in larger organizations and those with many less productive employees, and is associated with IT and knowledge-intensive work and operating efficiencies (Spinellis and Giannikas, 2012). Factors like existing available technologies, new technologies to be adopted as well as business processes surrounding it are factors being described in most of the literatures(Chau and Tam, 1997; Zhu *et al*., 2002). Consistent with the studies by Rogers (2003), there are a few factors that would influence the adoption decision. They are relative advantage, compatibility, complexity and trialability and observability. This is then supported in the studies by (Dedrick and West, 2003, 2004; Morgan and Finnegan, 2007). They have identified in their studies four technological characteristics which were evident in their studies as influencing the adoption decision, namely relative advantage, compatibility, complexity and trialability. Observability however, was not seen as relevant (Morgan and Finnegan, 2010).

The organizational context

The organizational component describes the resources available in the organization to support the technologies. Rogers (2003)has identified that the organizational characteristic such as formalization, centralization, system openness, interconnectedness, organizational slack and size are related to the adoption of innovation. Open source adoption is perceived as an occasion for rapidly developing effective new business applications, even in the context of shrinking IT resources and a poor relationship between IT and the rest of the organization. IT management and staff see the potential to improve their strained relationship with users, and improve their image of themselves as product developers and explorers (Allen andGeller, 2012).

The organizational factors are often cited by previous studies as factors behind the managerial decision to adopt the OSS (Goode, 2005; Morgan and Finnegan, 2010; Varian and Shapiro, 2003). Factors such as management support and the internal knowledge and expertise are also identified as the important factor in considering the adoption of the OSS (Glynn *et al*., 2005; Goode, 2005; Morgan and Finnegan, 2010). It was found that resources, competences, and knowledge can themselves be a source of innovation. This means that in some cases the competences serve the need of simply importing external sources within the firm (Di Stefano, Gambardella and Verona, 2012).The lack of internal knowledge and expertise would impede a decision to work with the open

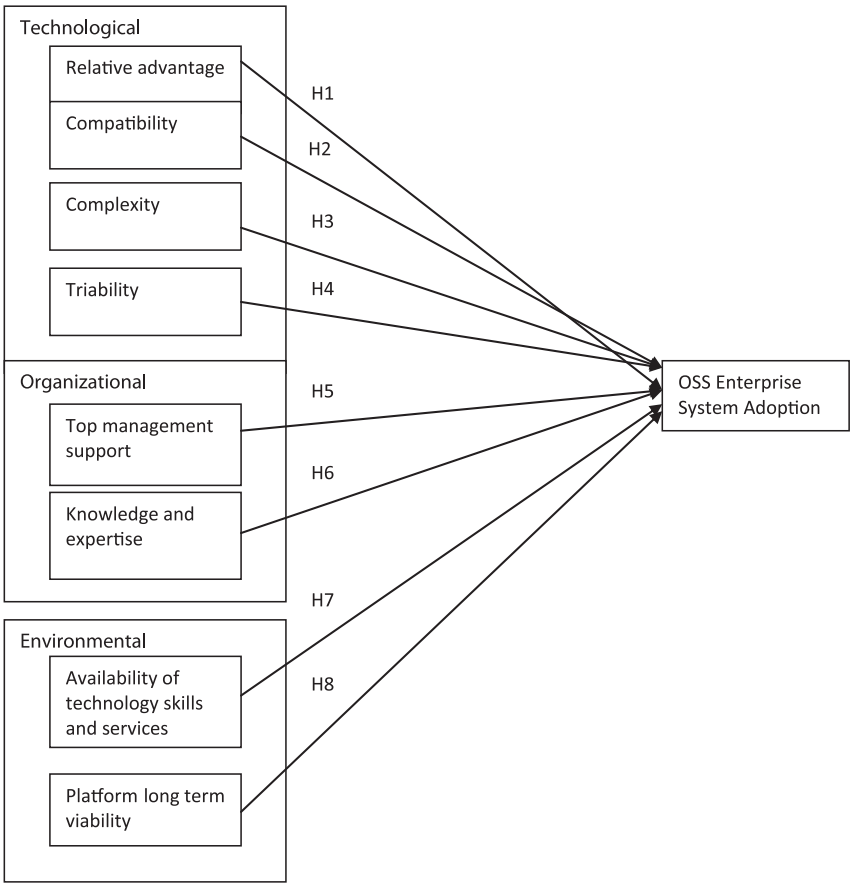

Figure 1. Research Framework

source software. Another factor to consider is the IT innovativeness, i.e., where the adoption of the new technology is based on the timing of when it is adopted into the organization (Ellis and Belle, 2009). In this study, we will focus on the management support and the internal knowledge and expertise factors.

Environment context

The environmental component is the platform the organization to conducts its business. The environmental components of the organization include the industry in which the business is conducted, its competitors, and the regulations affecting the organization and its relationship with the government(Chau and Tam, 1997). It represents the constraints and opportunity for the technologies adopted. Rogers (1993) also identified adopter characteristics as the environmental attributes. Factors such as the availability of external supports and skills, avoidance of vendor lock-in are often cited (Dedrick and West, 2004; Goode, 2005; Morgan and Finnegan, 2007). The lack of those factors and ownership are among the drawbacks – which encourage the companies to search for available skills and support. This differs with the proprietary software where there is a legal comfort from a signed guaranteed maintenance contract signed. After much deliberation on the related literatures and previous studies done by other researchers, a proposed framework for the study is illustrated in Figure 1.

RESEARCH METHOD

Development of hypotheses

Based on the literature review and prior studies, hypotheses were developed for the study.Rogers (2003)defines relative advantage as the degree to which innovation is perceived as better than the idea it supersedes. A number of rigorous studies (Dedrick and West, 2003, 2004; Morgan and Finnegan, 2007, 2010) also indicate that relative advantage is one of the factors that influence the decision in the adoption decision. Dedrick and West (2003)in their study of Linux adoption states that the relative advantage of OSS as compared to proprietary systems is perceived in terms of cost and reliability. Cost consists of the hardware and software cost which were deemed as important relative to the advantage of OSS. Switching cost for the labor and human to adopt the new technology which includes the cost of training and evaluation depend largely on the availability of IT skills in the organization (Dedrick and West, 2003). Therefore, Hypothesis 1 reflects the relationship described here:

H1: *Perceived higher relative advantage of OSS is positively affecting the adoption of OSS.*

The adoption of open source systems is greatly influenced by the compatibility of the new technology with current technology, skills and tasks (Dedrick and West, 2003; Gurusamy and Campbell, 2012). Adoption is greatly influenced by the compatibility of the new technology with the current infrastructures, skills and tasks (Dedrick and West, 2004; Glynn *et al*., 2005). The compatibility of the new technology with the current systems is a major factor as mentioned in Dedrick and West's study. The respondents prefer the platform with the largest variety of applications. Skill sets of the IT staff in the organization also plays as a determinant role in the adoption as it would ensure a smooth and manageable adaptation of the new technology(Dedrick and West, 2004). Therefore, in this study the aspects of technology and skills are explored to see whether they could influence the adoption. Thus, we reflect on the second hypothesis:

H2: *Perceived higher compatibility of OSS is positively related to the adoption of OSS.*

Complexity is the level to which an innovation is perceived as difficult to understand and use (Rogers, 2003). Lack of the IT skills as well as knowledge on OSS would be a resulted in complexity issue causing it to be a technical drawback(Ellis and Belle, 2009; Morgan and Finnegan, 2007). The organization will find it difficult to find the right expertise and to develop the right skills (Morgan and Finnegan, 2007). It would be a high investment for the organization to train the existing resources and thus this becomes a barrier in adopting the software. Hypothesis 3 is then developed as below:

H3: *Perceived complexity of OSS is negatively affecting the adoption of OSS.*

Trialability can be defined as the ability to try out the software at a very low cost as it could be downloaded for free from various sources or run on the existing hardware(DedrickandWest, 2004). As supported by Rogers (2003), the organization would be more likely to adopt the OSS in which the inno-

vation can be tried and assimilated in small chunks over time. It is then proposed that hypothesis 4 is to be constructed as below:

H4: *Perceived trialability of OSS is positively related to the adoption of OSS.*

According to Glynn *et al*. (2005), in OSS development, it is critical for the support from the top management as this contravenes the traditional model where support is legally guaranteed by a vendor. Morgan and Finnegan (2007) in their study also revealed the necessity of having top management support for OSS adoption. Both the benefits and drawbacks of an OSS influenced the decision to adopt OSS in organizations. Hence, Hypothesis 5 is derived as:

H5: *Greater top management support of OSS is positively affecting the adoption of OSS.*

Quality of the organization's human capital is being discussed by numerous study in different perspectives such as skilled personnel (Glynn *et al*., 2005), boundary spanners (Morgan and Finnegan, 2007; Ven and Verelst, 2006) and source code availability (Ven*et al*., 2008). Unlike proprietary software which has the vendor to turn to for support, OSS has none and relies on the organization's own skills and online OSS community(Dedrick and West, 2004).Gurusamy and Campbell (2012)stated that the lack of knowledge and experience with OSS in the organization made it harder for the organization to adopt OSS. This shows the relevance of having knowledge and expertise of OSS in the organization in order for the organization to adopt OSS. The Hypothesis 6 is derived as below:

H6: *Higher knowledge and expertise of OSS is positively related to the adoption of OSS.*

In the context of external environment, most literatures stressed the importance of the availability of external support and services and also the lack of it would be the reason for certain management rejections as well as business drawbacks (Goode, 2005; Morgan and Finnegan, 2007). OSS users have to rely on the collaborative support from the online community, whose services are not guaranteed to be available (Dedrick and West, 2003). This affects large corporations who have the necessary resources to pay for formal support agreements and has less of an effect on small businesses that often rely on in-house skills and community support. Vendor lock-in was also often being cited as one of the difficulties to extend the use of the software (Dedrick and West, 2003; Miralles *et al*.,2005; Ven and Verelst, 2012). The following hypothesis can therefore be established:

H7: *Higher availability of technological skills and services is positively related to the adoption of OSS.*

It is an important factor to ensure that the OSS product is viable for a long term. Many organizations prefer platforms which are perceived to be the winning standard (Dedrick and West, 2003). Broadly accepted technology standards will have a greater investment as well as vendor support. This is also supported by most of the OSS adoption studies (Chau and Tam, 1997; Dedrick and West, 2003) where high

perceived performance for multivendor standards would be a characteristic of the open systems innovation. Based on this, hypothesis 8 is proposed as below:

H8: *Greater platform long-term viability is positively affecting the adoption of OSS.*

Development of questionnaires

A questionnaire was developed and designed to measure the perceptions on each of the hypotheses that have been developed. Questionnaire survey has been commonly used in previous organizational technological innovation adoption (Chau and Tam, 1997). The development of the questionnaire is based on the measurements adopted from previous studies that used Tornatzky and Fleischer (1990) TOE model. The measurements of the variables is an essential part of research and a significant aspect of quantitative research design (Cavana *et al*.,2001). The following sections will discuss in detail on measurement of variables.

Measurement of Scales

The dependent variable and independent variables that were used to test the validity of the hypotheses are summarized and categorized in Table 1. Instruments of these variables are taken from prior researches. However, the items for each of the constructs in the variables were being rephrased to reflect the OSS implementation.

Sampling Design

The target population was the Malaysian organizations that were using OSS as their key application. A sample size of 300 was expected. The targeted respondents were the IT and non IT managers who were involved in decision making of adopting the OSS systems. Designation of the IT managers and non IT managers for the target population may include IT Manager, Team leader, Project manager and middle management.

Data Collection Procedure

This study used quantitative survey to collect the primary data using a structured, closed item questionnaire. The questionnaire was divided into four sections; Section A - to collect the respondents' demographics data including gender, age, education level and current role in the organization. Section B -to collect respondents' organization's profile such as the organization name, the type of industry, size of the company and also what are the OSS system used in the company. Section C – to collect data on the whether or not the organization adopt OSS and measured the impact of the OSS on business performance and business process. Section D – to collect the OSS determinants factors based on the hypotheses developed for this study.

The measurements of Section C and Section D were using the seven-point Likert scale, where a 'seven point' score meant that the item was the most agreeable and a 'one point' score meant that it was the most disagreeable item. In the data collection phase, the survey was made available to both public and private organizations. The mode of data collection is via an online survey. The questionnaires were updated to the online survey and its URL was sent to each of the respondent via online OSS communities and to the shortlisted public organizations derived from the 2012 OSS Initiative

Table 1. Dependent and Independent Variables Measurements

Factor	Item	Source
Dependent Variables		
OSS Adoption	OSS implementation in the organization	Srinivasan, Lilien, and Rangaswamy (2002)
	Impact on business performance	Srinivasan et al. (2002)
	Capability to support business process	Scupola (2003)
	Change of business process	Scupola (2003)
Independent Variables		
Perceived Relative Advantage	Hardware Cost	Dedrick & West (2004), Ellis & Van Belle (2009), Ven & Verelst (2012)
	Software Cost	Dedrick & West (2004), Ellis & Van Belle (2009),Ven & Verelst (2012)
	Switching Cost	Dedrick & West (2003),Ven & Verelst (2012)
	Software license	Gurusamy & Campbell (2012)
Perceived Compatibility	OSS system's features as per proprietary	Gurusamy & Campbell (2012)
	Co-existence with current key applications.	Glynn et al (2005)
	Good fit with current IT architecture	Dedrick & West (2004),Glynn et al (2005) , Gurusamy & Campbell (2012)
	Organizational fit as per business needs	Dedrick & West (2004),Gurusamy & Campbell (2012)
	Matches well with the organization's need	Gurusamy & Campbell (2012)
Perceived Complexity	Difficult to use	Scupola (2003), Ellis & Belle (2009)
	Learning to operate is hard	Scupola (2003)
	Interaction is confusing	Scupola (2003)
	Takes a long time to use successfully	Scupola (2003)
Perceived Trialability	Ability to test the software	Gurusamy & Campbell (2012)
	Less difficult to try out	Morgan & Finnegan (2010)
	It is useful to try out the software	Morgan & Finnegan (2010)
Management Support	Enthusiastic on adoption	Goode (2005)
	Top management's willingness to invest	Goode (2005)
	Support OSS initiatives	Gurusamy & Campbell (2012)
	Resource allocation	Goode (2005)
	OSS relevance to business	Goode (2005)
Knowledge & Expertise	Right expertise for OSS implementation	Gurusamy & Campbell (2012)
	Sufficient training / awareness	Ellis & Van Belle (2009)
	Understanding on OSS systems / product knowledge	Ellis & Van Belle (2009)
	Right expertise for OSS support	Dedrick & West (2004), Gurusamy & Campbell (2012)
Technology Skills & Services	There are enough skilled OSS Support (Online Community) available to support our organization's OSS enterprise systems	Ellis & Van Belle (2009), Macredie & Mijinyawa (2011)
	External support services (vendors)	Dedrick & West (2003), Ellis & Van Belle (2009), Ven & Verelst (2012)
	Technical information availability	Glynn et al (2005)
	Availability of IT-skilled worker	Dedrick & West (2003),
	Avoid vendor lock-in	West & Dedrick (2003,2004), Ven & Verelest (2012)
Platform	Software features	Gurusamy & Campbell (2012)
Long Term Viability	OSS Security	Gurusamy & Campbell (2012)
	Winning standards platform	Ellis & Van Belle (2009)

reports by MAMPU (2005). Selection of the designations are IT officers and above. Request to participate the online survey was being posted in the OSDC.my Facebook page as well as other online OSS community forum. The administrator of the page also promoted the posting to attract the participation of the survey. The questionnaire contained a cover letter and the

questionnaire form. The cover letter explained the purpose and objective of the survey. The respondents were assured of the confidentiality of their responses. It was requested that the survey was being completed within a week from the date the respondent received the questionnaire.

Descriptive Data Analysis

Descriptive statistics were used to analyze the demographic profile of the respondents and the mean for each of the factors. To measure the dispersion of the interval scale, variance and standard deviation was being used (Sekaran and Bougie, 2010).

Reliability Analysis

Zikmund *et al*. (2012) defined reliability as "the degree to which measures are free from random error and therefore yield consistent results". Cronbach's alpha is an adequate test of internal consistency reliability in most cases (Sekaran and Bougie, 2010). The Cronbach's alpha indicates how highly the items in the questionnaire are interrelated in order to determine the instrument's reliability.

Correlation Analysis

The correlation is it is used to examine the association between each factors and the extent of it in relation to the OSS adoption. A Pearson correlation matrix will indicate the direction, strength and significance of the relationships among the variables that were measured at an interval (Sekaran and Bougie, 2010). Correlation analysis indicates if a linear relationship exists between two variables. By having a coefficient of 1.0, it is indicated that it has a perfect positive correlation and a negative correlation has coefficient of -1.0 (Coakes*et al*., 2010).

Multiple Regression Analysis

Regression analysis is used in a situation where one independent variable is hypothesized to affect one dependent variable (Sekaran and Bougie, 2010). Simple regression uses a single predictor of the dependent variable and multiple regression uses two or more predictors of the dependent variable (Field, 2009). There are three major regression models: standard or simultaneous, hierarchical and stepwise regression. In standard or simultaneous method, the independent variables are entered in the equation all at once to examine the relationship between the whole set of predictors and the dependent variable. In the hierarchical multiple regression, the determinants of the order of independent variable entry is based on theoretical knowledge (Coakes *et al*., 2010).

RESULT AND DISCUSSION

Descriptive Statistic

The highest figure for the industry type of the organization is the government sector (59%) followed by16% from the computer / IT sector, 8% from the education industry, 4% are from the telecommunication industry and the remaining7.3% from other industries. The rest of it is well distributed in the manufacturing and services industries. For the company size other than government sector, 17% have less than 150 employees, about 16% of the companies have more than 1000 employees, 3.2% have 150 – 250 employees, 0.8% have 250 – 500 employees and the rest have about 500 – 1000 employees.The results are shown in Table 2.

Table 2. Demographic Profile of the Companies

Characteristics	Frequency	Percentage(%)
Type of Industry		
Computers / IT	20	16.1
Education	10	8.1
Government	73	58.9
Manufacturing	1	0.8
Services	1	0.8
Telecommunication	5	4.0
Others	9	7.3
Company Size		
<150 Employees	21	16.9
150 - 250 Employees	4	3.2
250 - 5000 Employees	1	0.8
500 - 1000 Employees	5	4.0
>1000 Employees	20	16.1
Government	73	58.9

Table 3. OSS System Implementation

	Frequency	Percent*
Operating System	99	79.8%
Database	98	79.0%
Manufacturing	4	3.2%
Accounting / Financial	14	11.3%
Marketing / Sales	10	8.1%
Human Resource	18	14.5%
Enterprise Portals	48	38.7%
Others	31	25.0%

*percentage calculated based on n=124

The survey also requested the respondent to indicate the OSS system implemented. The results are shown in Table 3. About 80% of the respondents implemented OSS for their operating system and database.Another highly-implemented system is in enterprise portals where the percentage of implementation is about 38.7%. Implementation of OSS in accounting/financial and human resource recorded about 11.3% and 14.5% respectively whilst manufacturing recorded the lowest with 3% implementation.

Table 4 summarizes the descriptive statistic of independent and dependent variables. In the technology context, perceived trialability recorded the highest means of 5.26 out of 7. This shows that on average, the respondents tend to agree that the ability to test out the open source system for free and the usefulness of the OSS were among the reason for the adoption of the OSS. The results also indicate that by implementing OSS, it provides relative advantage to the organization. This is shown by having a mean of 4.65 out of 7. Therefore, based on overall results of descriptive statistics, the respondents indicate that the OSS implementation is not complex, easy to be used and learn as well as a shorter time for the OSS to be implemented successfully is shown in the perceived trialability.

In the organizational context, the mean response to this was positioned 'slightly agree' on interval of the agreement scale (mean~ 4.6). This is reflected in

Table 4. Descriptive Statistics for OSS Adoption Independent Variables

Independent Variables Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Open Source System Adoption	**124**	**1.5**	**7**	**5.04**	**1.32**
Technology Context					
Relative Advantage	124	1	7	4.67	1.17
Perceived Compatibility	124	2	7	4.99	1.09
Perceived Complexity	124	1	6	3.53	1.20
Perceived Trialability	124	2	7	5.26	1.08
Organizational Context					
Management Support	124	1.80	7.00	4.66	1.33
Knowledge & Expertise	124	1.00	7.00	4.43	1.33
Environmental Context					
Technology Skills & Services	124	2.00	7.00	4.45	1.15
Platform Long Term Viability	124	2.00	7.00	5.09	1.05

Dependent Variables Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
OSS Adoption	**124**	**1.5**	**7**	**5.04**	**1.32**
Implemented OSS in systems and apps	124	1	7	5.27	1.50
Implemented with big impact to business process	124	1	7	5.05	1.46
Implemented with capabilities to support business process	124	1	7	5.12	1.41
Implementation substantially changed business process	124	1	7	4.72	1.42

Table 5. Reliability Statistics for Research Variables

Reliability Statistics

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
OSS Adoption	**0.933**	**0.933**	**4**
Technology Context			
Relative Advantage	0.817	0.815	4
Perceived Compatibility	0.917	0.918	5
Perceived Complexity	0.880	0.882	4
Perceived Trialability	0.815	0.813	3
Organizational Context			
Management Support	0.938	0.938	5
Knowledge & Expertise	0.916	0.916	4
Environmental Context			
Technology Skills & Services	0.860	0.860	5
Platform Long Term Viability	0.782	0.785	3

the management support item, where the mean is reported at 4.66 and the internal knowledge and expertise at 4.43. This showed that the respondents slightly agree that both factors play a role in adopting the OSS to the organization.

In the environmental context, platform long term viability factor had the second highest mean of 5.09. The results showed that on average, the factors of adopting the OSS are based on the features of the software, whether or not the solution is viable in the long term. The respondents 'moderately' agree that there are enough IT skilled workers, availability of online community support as well as external support services by the vendors. Overall, the re-

Table 6. Correlation Table

Technological Correlations

		Relative Advantage	Perceived Compatibility	Perceived Complexity	Perceived Trialability
OSS Adoption	*r*	0.489**	0.739**	-0.383**	0.557**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
Relative Advantage	*r*	1.000	0.466**	0.012	0.296**
	Sig. (2-tailed)		0.000	0.891	0.001
Perceived Compatibility	*r*		1.000	-0.314**	0.717
	Sig. (2-tailed)	0.000		0.000	0.000
Perceived Complexity	*r*			1.000	-0.162
	Sig. (2-tailed)	0.000	0.000		0.000
Perceived Trialability	*r*				1.000
	Sig. (2-tailed)	0.000	0.000	0.000	

**. Correlation is significant at the 0.01 level (2-tailed).

Organisational Correlations

		Open Source Adoption	Management Support	Knowledge & Expertise
Open Source Adoption	*r*	1	0.633**	0.668**
	Sig. (2-tailed)		0.000	0.000
Management Support	*r*		1	0.791**
	Sig. (2-tailed)			0.000
Knowledge & Expertise	*r*			1
	Sig. (2-tailed)			

**. Correlation is significant at the 0.01 level (2-tailed).

Environmental Correlations

		Open Source Adoption	Technology Skills & Services	Platform Long Term Viability
Open Source Adoption	*r*	1	0.524**	0.576**
	Sig. (2-tailed)		0.000	0.000
Technology Skills & Services	*r*	0.524**	1	0.595**
	Sig. (2-tailed)	0.000		0.000
Platform Long Term Viability	*r*	0.576**	0.595**	1
	Sig. (2-tailed)	0.000	0.000	

**. Correlation is significant at the 0.01 level (2-tailed).

spondents agree that by implementing OSS, the organization can avoid vendor lock-in. This is reported by having the mean of 4.45 out of 7 for technology skills and services. For the OSS adoption dependent variable, a mean of 5.04 was reported with standard deviation of 1.32. Further analysis was done based on each of the item in the OSS adoption.

Reliability and Validity

Table 5 summarizes the results from the reliability testing done on each of the constructs. The Cronbach's alpha results shows consistently high in all variables. The alpha for the OSS adoption variable is 0.933. In technology context, perceived relative advantage's alpha is 0.817, perceived compatibility's alpha is 0.917, perceived complexity is 0.88 and perceived trialability is 0.815. The overall Cronbach's alpha result was high for the organizational context resulted high where the management support construct recorded with the highest alpha of 0.938 and knowledge and expertise with a record of 0.916. Thus, both items are highly reliable and valid for this analysis. In environmental context, the technology skills and services' alpha is 0.860 and

Table 7. Total variance explained for the Technological context

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.857	39.047	39.047	5.857	39.047	39.047
2	2.919	19.462	58.509	2.919	19.462	58.509
3	1.910	12.736	71.245	1.910	12.736	71.245
4	0.805	5.364	76.609			
5	0.629	4.194	80.803			
6	0.515	3.436	84.239			
7	0.437	2.913	87.152			
8	0.376	2.509	89.661			
9	0.331	2.207	91.868			
10	0.291	1.937	93.805			
11	0.242	1.613	95.417			
12	0.217	1.447	96.865			
13	0.171	1.137	98.002			
14	0.168	1.122	99.124			
15	0.131	0.876	100.000			

Extraction Method: Principal Component Analysis

Table 8. Total Variance Explained for the Organizational Context

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.468	71.872	71.872	6.468	71.872	71.872
2	0.797	8.858	80.729			
3	0.430	4.778	85.507			
4	0.348	3.870	89.377			
5	0.281	3.117	92.494			
6	0.241	2.673	95.167			
7	0.190	2.108	97.275			
8	0.139	1.548	98.823			
9	0.106	1.177	100.000			

Extraction Method: Principal Component Analysis.

platform long term viability is 0.782. Further analysis was done to item technology skills and services' and found out that if item avoid vendor lock in is deleted, it can increased the alpha to 0.870. Thus, this item is taken out for the rest of analysis. Nunnally (1978) recommended a minimum level of 0.7 for the Cronbach's alpha.

Testing of Hypotheses

Pearson correlation is used to explore the relationship between two variables. This will give an indication of the relationship direction whether it is positive or negative and also the strength of the relationship (Pallant, 2011). The results are shown in Table 6.

Multiple Regression

The standard multiple regression was applied to test the research hypotheses. This is due to the dependent variable which is a continuous variable and because as the scores are normally distributed (Pallant, 2011). The regression analysis is used to "predict an outcome variable from one predictor (simple regression) or several predictor variables (multiple regression)"

Table 9. Total Variance Explained for the Environmental Context

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.781	54.009	54.009	3.781	54.009	54.009
2	1.264	18.059	72.068	1.264	18.059	72.068
3	0.607	8.678	80.746			
4	0.502	7.167	87.913			
5	0.321	4.582	92.495			
6	0.311	4.441	96.936			
7	0.214	3.064	100.000			

Extraction Method: Principal Component Analysis.

Table 10. Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.803[a]	0.645	0.627	0.79751

a. Predictors: (Constant), Platform Long Term Viability, Perceived Complexity, Relative Advantage, Technology Skills & Services, Management Support, Knowledge & Expertise, Perceived Compatibility & Trialability
b. Dependent Variable: Open Source Adoption

Table 11. ANOVA Table

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	135.131	6	22.522	35.41	.000[b]
	Residual	74.415	117	0.636		
	Total	209.546	123			

a. Dependent Variable: Open Source Adoption
b. Predictors: (Constant), Platform Long Term Viability, Perceived Complexity, Relative Advantage, Technology Skills & Services, Management Support, Knowledge & Expertise, Perceived Compatibility & Trialability

Table 12. Coefficient Table

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	0.646	0.521		1.239	0.218					
	Relative Advantage	0.217	0.059	0.216	3.65	0.000	0.387	0.320	0.201	0.868	1.152
	Perceived Compatibility & Trialability	0.485	0.120	0.375	4.025	0.000	0.720	0.349	0.222	0.349	2.862
	Perceived Complexity	-0.208	0.066	-0.191	-3.168	0.002	-0.383	-0.281	-0.175	0.832	1.202
	Management Support, Knowledge & Expertise	0.269	0.092	0.259	2.929	0.004	0.685	0.261	0.161	0.387	2.586
	Technology Skills & Services	-0.029	0.077	-0.027	-0.371	0.712	0.459	-0.034	-0.02	0.580	1.725
	Platform Long Term Viability	0.114	0.098	0.091	1.153	0.251	0.576	0.106	0.063	0.484	2.065

(Field, 2009). The first analysis is done on the correlation of the new factors with the dependent variable. In Table 10, the R square explained that the model explains 64.5% of the variance in OSS adoption.

To look at the significance of the relationship between the factors, the ANOVA analysis was conducted. The results were as per Table 11. It is reported that the significance value is 0.00, where there is about zero chance in 1000 type 1 error. This also shows that the data reliability with the OSS adoption decision is strongly related. From the correlation in Table 12, two factors have high correlations with the dependent variable. The Pearson Correlation r value for perceived compat-

ibility and trialability is 0.720 with and significance at p=0.00. The other factor is management support, knowledge and expertise resulted r=0.685 and its significance is at p=0.00.

Hypothesis Testing

The first hypothesis (H1) tested on the relationship between perceived relative advantage and OSS adoption. As reported in the coefficient analysis in Table 12, the standardized coefficient between perceived relative advantage and OSS adoption is 0.216 and the significance at 0.000, which is significant at $p< 0.05$. In other words, there is high level perceived relative advantage of OSS adoption in the organization. Thus, the result provides support for H1.

The second and fourth hypothesis (H2, H4) tests the relationship of perceived compatibility and trialability with OSS adoption. The standard coefficient beta is 0.375 with significant level at p=0.000. This shows that the item is significant at $p< 0.05$. With this, the perceived compatibility and trialability does significantly contribute to the OSS adoption in an organization.

The third hypothesis (H3) tests the relationship of perceived complexity with the OSS adoption. The regression table state the coefficient beta at -0.191 and it is significantly contributed to the OSS adoption by having a significant level which is less than 0.05 (p=0.002). Thus, it is perceived that complexity has a unique contribution to the OSS adoption.

In the organizational context, two hypotheses were tested and during the regression analysis, both items were grouped together. The fifth hypothesis (H5) states the relationship between management support and the OSS adoption while (H6) relates the knowledge and expertise with the OSS adoption. The beta value is at 0.259 and the significance level is at 0.004. Hence this results shows that management support, knowledge and expertise significantly contributed to the OSS adoption for the significant $p<0.05$ and does support H5 and H6.

In the environmental context, the seventh hypothesis (H7) relates the technological skills and services to the OSS adoption. As shown in the table above, the standardized coefficient is-0.27 and the p-value is 0.712, which is more than p at 0.05. Hence, the result does not support for H7 and H7 is insignificantly relates to the OSS adoption.

The last hypothesis (H8) tested on the platform long term viability relationship with the OSS adoption. The results in the table above shows that the coefficient beta is 0.091 and the p-value is 0.251. This means that the platform long term viability does not make a significant unique contribution to the OSS adoption. Hence, the result does not support H8.

Overall, two hypotheses are not supported by the results of the analysis and both of which are under the environmental context. On the other hand, both technology and the organizational context do have a significant contribution to the decision on the OSS implementation in the organizations. A summary of the hypotheses testing is shown in Table 13.

Table 13. Summary of Hypothesis Testing Results

No	Hypothesis	Conclusion
	Technological Context	
H1	Perceived higher relative advantage of OSS is positively affecting the adoption of OSS.	Supported
H2	Perceived higher compatibility of OSS is positively related to the adoption of OSS.	Supported
H3	Perceived complexity of OSS is negatively affecting the adoption of OSS.	Supported
H4	Perceived triability of OSS is positively related to the adoption of OSS.	Supported
	Organizational Context	
H5	Greater top management support of OSS is positively affecting the adoption of OSS.	Supported
H6	Higher knowledge & expertise of OSS is positively related to the adoption of OSS.	Supported
	Environmental Context	
H7	Higher availability of technological skills and services is positively related to the adoption of OSS.	Rejected
H8	Greater platform long term viability is positively affecting the adoption of OSS.	Rejected

Discussion

This research also attempts to identify the variables and significant factors that relate to the OSS adoption as well as the level of the adoption. Thus the first question addressed in this research is "*What is the level of adoption of OSS enterprise systems in Malaysia?"* Based on the results, the level of adoption is high especially in the government sector in Malaysia. The results also show a very high implementation in operating systems (79.8%) as well as the databases(79.0%). These findings are different from that in developed countries. In the US, the famous OSS applications are web servers followed by web browsers (Spinellis and Giannikas, 2012).The research was then further conducted to analyze the significant factors that influence the manager's decision by constructing the second question "*What are the significant factors that influence a managers' adoption of OSS enterprise system"*.Thus, this research provides answers to the antecedents of OSS adoption in organizations as implications for research.

Nonetheless, there are also implications for practice for all the antecedents of OSS adoption. For example, in technological context, four factors were being used: relative advantage, compatibility, complexity and trialability. All the factors were found significant to the adoption of OSS. Managers should consider the relative advantage when evaluating the OSS application to the organization. These include the cost of implementation for hardware, software and switching cost related to adopting the OSS. Thus, comparison of financial implication between the traditional approach of acquiring software and OSS must be evaluated before organizations decide to move to OSS.

In the study, compatibility and trialability were also found as important factors in OSS adoption. The respondents preferred more compatible OSS platform to the existing applications to ease the transition process. With the compatibility of OSS, managers in organizations would be able to justify the investment made thus gain recognition that it is beneficial in the long run. Managers in organizations would also like to be able to test the software before implementing it. This enables end-users to have hands-on experience of the features and functions of systems developed using OSS. In addi-

tion, if OSS is less complex, it is more likely to be accepted by the managers who make IT decision in organizations. They would like to see systems developed using OSS less complex to encourage end users to switch to OSS.

Two factors of the organizational context were identified, namely management support as well as knowledge and expertise. The results show that these factorsare significant in relation to the OSS adoption. It is therefore important for any OSS implementation to have support from the top management as well as having internal knowledge and expertise. This is to ensure the success of the implementation. Managers in organizations, which intend to adopt OSS, must be able to convince the top management to move away from those systems developed through the traditional software.

The last context discussed in this study is the environment. Two factors were being identified; technological skills and services and platform long term viability. These factors were being highlighted, as important factors in adopting OSS in numerous studies but it have been proven unsupported in this study. It could be due to the fact that Malaysian organizations consider other factors, which are more important such as the monetary aspect or the relevance and requirements of the OSS to the organizations.

Without the technological skill and services, the organizations would opt to have its own internal staff to support the system, which is also related to the availability of knowledge and expertise in the organization. This could be one of the reasons why technological skills and services were not found to affecting the OSS adoption. With the internal skill and services developed within the organization, innovation among the organization level would be increased.

Similarly, for platform long-term viability, the results showed that this factor was not found to affect the OSS adoption. As mentioned earlier in this study the users or the community who have fixed or added new features to the software is contributing the improvement of OSS. Thus, it is not required for the OSS to be winning standards or enriched features in order for the users to implement the OSS.

Limitation to the study

This study has several limitations that affect the generalization of the findings. The first limitation is due to the unfairly distribution between the public and private sector. The second limitation to this research is the collection method of this survey. The main method of distribution is via email and the distribution list is only on the public sector based on the OSS adoption report by OSCC. Due to time constraints, the target respondents were being contacted via email. The third limitation is due to the location of the organization where most of the organizations were located in the Klang Valley and Putrajaya. Only a few of the organizations are from other states in Malaysia which do not represent the overall findings. Lastly, this study was taken at the point of time of the OSS implementation. The results might differ by doing surveys on continuous usage or cross sectional surveys of the OSS implementation.

Suggestions for future research

It would be interesting to do an exploratory research of this study to investigate further the actual perceptions of managers on the OSS adoption. This is to address any other factors that were not counted such as the security features of the systems and source code availability. Further study can also be done to differentiate the effects in the public and private sector separately as this study is generalized for both sectors. The significant factors might be different between the two sectors. This study also can be extended to different levels of respondents. Data can be collected from the top management level in an organization to the end users. This is to explore different views of the OSS adoption in an organization. Data can be collected from other states in Malaysia to generalize the findings. The external support in the market could also use this research to create a better support and services to be offered to the organization. Other practitioners in other regions to test out the effects especially in developing countries can also duplicate this research.

Conclusion

This study provides empirical evidence of the technological, organizational and environmental factors that affect the OSS adoption among companies in Malaysia. The findings give managers some insights before adopting OSS enterprise systems. This study shows that from the TOE framework, only two contexts are applicable in Malaysian perspective. The contexts are technological and organizational. This shows that a different finding may result when conducted in a different region than the originated study. The findings from this study add evidence to existing studies on the OSS adoption specifically to those using the TOE framework.

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