An Empirical Study Examining the Impacts of Open Source Software Quality Factors on Perceived Usefulness and Satisfaction

Sanghyun Kim and Hyunsun Park
School of Business Administration, Kyungpook National University,
80 Daehak-ro, Buk-gu, Daegu, South Korea

Abstract: Many companies are using Open Source Software (OSS) to make strategic use of their information technology assets. The purpose of this study is to investigate the factors affecting perceived usefulness and satisfaction from the use of open source software. For this purpose, this study proposes a research model that examines the impacts of open source software quality factors ease of maintenance, cost advantage, customization and job relevance on perceived usefulness and satisfaction with OSS. Data was collected from 328 randomly selected survey responses by employees in various organizations that are currently using OSS. The structural equational model was created using AMOS 22.0 in order to test the proposed hypothesis in the research model. Results show that all OSS quality factors are significantly related to perceived usefulness of OSS which then positively affects satisfaction. The findings suggest that employee's value OSS qualities in perceiving usefulness and satisfaction.

Key words: Open source software, software quality, perceived usefulness, satisfaction, organizations, OSS

INTRODUCTION

The software market is rapidly changing due to the fact that the industry is gaining importance and competitiveness in that it can secure global competitiveness as a representative knowledge-intensive high value-added industry in the knowledge information age. With this trend, software firms play a crucial role in the creation, practical use and spread of knowledge of all economic players/individuals, businesses and governments (Chiasson and Lovato, 2001). In addition, the software industry is one of the key players in creating new value through convergence with traditional industries such as automobiles, shipbuilding, energy and so, on. For this reason, companies are demanding development of rapid, low-cost and highly efficient software and the interest in Open Source Software (OSS) is rapidly increasing.

Unlike commercial software where distributors or developers may charge for services including programming, training and technical support, OSS releases a source code to the public without changing a fee. In this respect, Sarrab and Rehman (2014) claim that any open source software that publishes source code is free to use and modify and that redistribution of source code is free of charge. In addition, Marsan et al. (2012) suggested that OSS as software with its source code available to the public free of charge and can be used

copied and distributed with or without modifications. Thus, OSS differs from commercial software in terms of revenue generation because a commercial software firm will not release source code and prohibits others from modifying, duplicating and distributing its software without proper legal processes. In addition to being free, OSS provides users with various benefits such as software maintenance, cost reduction and customization. These advantages make efficient development possible for user information systems. Furthermore, OSS is significant in that it is produced through voluntary participation and contribution. For this reason, an increasing number of individuals as well as firms are utilizing OSS for various purposes in a stable and cost-effective manner. Nagy et al. (2010) claimed that the various benefits of OSS have led to the transformation of organization's software strategies from the use of commercial software to OSS.

Despite these changes, conceptualized research to understand user behavior related to OSS usage is still lacking. Most previous studies have focused only on the initial acceptance behavior by companies or general users (Gallego et al., 2008; Gwebu and Wang, 2011; Van Loon and Toshkov, 2015; Marsan et al., 2012; Mount and Fernandes, 2013; Sarrb and Rehman, 2014). These studies are mainly focused on how user's characteristics such as intrinsic and extrinsic motivation, innovation and professionalism affect user behavior.

Corresponding Author: Sanghyun Kim, School of Business Administration, Kyungpook National University, Daegu, South Korea

In addition to acceptance studies in OSS, research has also been conducted on OSS success factors based on an information systems success model (Midha and Palvia, 2012; Sarrab and Rehman, 2014). These studies focused on the benefits of OSS and user's intention-to-use in terms of system, service and information quality. However, the empirical study on the usability and satisfaction of OSS focusing on quality factors was very limited (Kim and Song, 2010). Thus, in order for an information system to be recognized as a continuously useful technology in the market, it is necessary to understand user's perception and satisfaction. For this reason, empirical research to understand the perceived usefulness of OSS and user satisfaction in organizations is very meaningful. This study seeks to find empirical answers to the following two research questions:

- RQ1: OSS quality factors positively affect perceived usefulness of OSS
- RQ2: The relationship between perceived usefulness and satisfaction still valid in OSS

To test this assumption, this study has developed a research model based on information system success (DeLone and McLean, 2003) and an expectation confirmation model (Bhattacherjee, 2001). The research model includes four OSS quality factors (ease of maintenance, cost advantage, customization and job relevance) based on the relevant research to explain their causal relationship with perceived usefulness and satisfaction. Verification of each path proposed in the research model can improve the understanding of the behavior of individual or organizational users of OSS.

Related studies and research model: The purpose of adopting and utilizing an information system in an organization is to improve the effectiveness of the whole organization by supporting the decision-making of the members and work efficiency. In other words, the adoption and utilization of the information system affects organizational performance well as that of the information system. According to the information system success Model of DeLone and McLean (2003) as the various quality factors of the information system fit the purpose of utilization, satisfaction increases. An increase in satisfaction positively affects individual and organizational performance. Therefore, user satisfaction is used as a representative variable to measure the performance of the information system. It is also important to examine the relationship between satisfaction and quality factors.

Previous studies related to OSS have reported that individual factors (identification, innovativeness, experience), technological factors (complexity, compatibility, cost, usefulness), organizational and environmental factors (competence, competitive pressure) have a significantly positive impact on an individual's behavior regarding technology use (Chauhan *et al.*, 2018; Marsan *et al.*, 2012; Mount and Fernandes, 2013; Sarrb and Rehman, 2014). Other studies (Chauhan *et al.*, 2018) focus on the determinants influencing organizational adoption of OSS applications. Most of these studies selected adoption of OSS as a dependent variable. It only takes into account the adoption intention and intent to introduce OSS but it has limitations that cannot empirically explain the performance measurement and diffusion process of OSS. Therefore, it is necessary to demonstrate empirical evidence of OSS performance measurement such as satisfaction in organizations to overcome the limitations of previous studies (Midha and Palvia, 2012).

The research model introduces quality factors for user analysis in perceived usefulness of OSS and OSS satisfaction. Sarrab and Rehman (2014) proposed new quality characteristics for using OSS based on DeLone and McLean (2003)'s information systems success model. They argued that a variety of factors related to OSS quality have a significant impact on user satisfaction and net benefits. In addition, Seddon *et al.* (1999) claimed that in order to reflect the understanding of the relationships that have the different interests, it is important to use a different scale when adopting the IS success model for different situations. Therefore, the proposed research model incorporates OSS quality factors in explaining user's behavior regarding perceived usefulness and post adoption action (satisfaction). Based on the literature, four OSS quality factors, ease of maintenance, cost advantage, customization and job relevance were proposed. Figure 1 shows the proposed research model with hypothesis empirically tested.

Ease of maintenance: Ease of maintenance is defined as the degree to which a person believes that maintaining and using OSS would be free of effort (Kim, 2008). Davis (1989) found that perceived ease of use is a major driver of behavioral intention and the actual behavior of an individual. In addition, perceived ease of use has a direct impact on perceived usefulness (Venkatesh and Davis, 2000). In other words, if the maintenance and use of information technology is easy and convenient, it will be recognized as a useful system. Perceived ease of use is also suggested as the essential factor in user satisfaction measuring IS research (Bailey and Pearson, 1983; Sarrab and Rehman, 2014). If less effort is required to use and maintain the OSS, it will be used more and eventually improve job performance. Bailey and Pearson (1983)
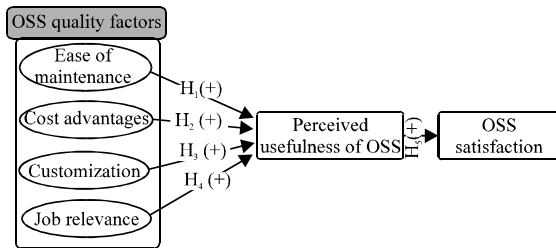
Fig. 1: Research model with hypothesis

proposed the ease of use and maintenance of information systems as a major quality factor in software. In addition, they demonstrated that these factors have a significant impact on perceived usefulness. Based on these claims, the following hypothesis is proposed:

- H_1: ease of maintenance is positively associated with the perceived usefulness of OSS

Cost advantage: This study defines cost advantage as the degree of belief employees have about monetary and non-monetary benefits including time and effort from using OSS. OSS allows freedom to have access to the system software regardless of associated price or cost. This has brought about increased interest from industry as to how to use OSS. The use of information technology, which incurs high costs for companies with limited financial resources is not an easy problem to deal with (Rogers, 1995). The costs associated with information technology have always been a primary consideration in technology adoption (Chauhan *et al.*, 2018; Kim, 2008). These costs include various factors such as time and effort as well as monetary factors and cannot be ignored in the process of software diffusion (Ven and Verelst, 2011). The biggest difference between OSS and commercial software is licensing costs (Lundell *et al.*, 2010). In other words, OSS has a significant cost advantage because there is no license fee at all. Lower licensing costs are also an important reason for using OSS and companies with OSS can achieve cost savings. In addition, OSS can be seen as a useful system in that it can reduce an organization's licensing costs. Therefore, this study suggests the following hypothesis:

- H_2: cost advantage is positively associated with the perceived usefulness of OSS

Customization: Customization is defined as the extent to which OSS is well designed to accommodate user's needs and attract their interest (Sarrab and Rehman, 2014). Zeithaml *et al.* (2002) argued that customization or

personalization should be considered important when developing e-Service quality. They explained that customized and personalized aspects of an information system can enhance its efficiency and effectiveness.

Allard argued that usefulness is related to the application of appropriate technology to the individual in terms of content and usage. The software industry has been surprised by user's positive assessment of their expected OSS requirements (Sarrab and Rehman, 2014). That is if OSS can provide qualities customized to user needs, it will also have a positive impact on perceived usefulness. Therefore, the following hypothesis is proposed:

- H_3: customization is positively associated with the perceived usefulness of OSS

Job relevance: In this study, job relevance is defined as the extent of the need for OSS and its relevance to work (Kim, 2008; Venkatesh and Davis, 2000). According to the extended technology acceptance model usefulness of an information system is determined by an individual's perception regarding the degree to which the target system is applicable (Dishaw and Strong, 1999). Venkatesh and Davis (2000) argued that job relevance has a positive effect on perceived usefulness. That is if OSS can enhance job performance, the individual will recognize that the system is helpful. It is important to note that individuals have different knowledge systems and apply this knowledge in their jobs by using information systems (Chauhan *et al.*, 2018). Therefore, the ability of an information system to support an individual's job needs to be considered important. In this study, if the OSS is highly relevant to a user's job, they will also appreciate the benefits of OSS. Therefore, the following hypothesis is proposed:

- H_4: job relevance is positively associated with the perceived usefulness of OSS

Perceived usefulness and satisfaction: In this study, perceived usefulness of OSS is defined as the extent to which an individual believes that using OSS will improve his or her performance (Bhattacherjee, 2001; Davis, 1989; Mount and Fernandes, 2013). Satisfaction is defined as the extent to which users believe the OSS available to them meets their information requirements (DeLone and McLean, 2003; Sarrab and Rehman, 2014). David (1989) has argued that perceived usefulness is a critical factor in explaining user behavior. In other words, the user belief formed by perceived usefulness has a crucial influence on the adoption and use intention of the information system.

Previous work has shown that perceived usefulness directly influences user satisfaction (Seddon and Kiew 1996; Wang and Song, 2017). Seddon (1997) argued that satisfaction is a user's subjective evaluation of an information system based on its quality. In addition if users perceive the information system as useful they can make a positive evaluation of the system. That is perceived usefulness is a variable that reflects post expectation and is emphasized as a cognitive belief variable that consistently affects user behavior on information systems (Bhattacherjee, 2001; Kim, 2008). Therefore, this study suggests that the perceived usefulness of OSS has a positive effect on OSS satisfaction and proposes the following hypothesis:

- H_5: perceived usefulness of OSS positively associated with OSS satisfaction

MATERIALS AND METHODS

Data were collected from employees in organizations that are currently using OSS as part of their information technology. A total of 1, 000 employees from 10 organizations were surveyed. A total of 369 valid responses were collected and the response rate was 36.9%. The largest number of responses came from employees in the IT industry with 134 responses (40.85%), followed by the retail (69, 21.04%) and manufacturing (68, 20.73%) industries. This implies that OSS is used in many industries. Among participating employees, 68.9% were male and 31.10% female. In terms of the positions of the participating employees, 28.5% were CIOs responsible for information systems, followed by CEO and Senior Manager with 24.39 and 24.09%, respectively. This implies that most responses were from management positions, which increases data validity. A total of 91.16% of the respondents indicated that they use web applications, followed by 83.54% that they use databases and 62.50% using operating systems. The majority of participants (89.33%) have been using OSS for various business purposes for more than 3 years. Table 1 shows the profile of the respondents.

Most of the items in the questionnaire were measured using a 7-point Likert scale from (1) strongly disagree to (7) strongly agree. In order to verify the proposed research model, the survey items were first evaluated through interviews with domestic companies and employees who are interested in OSS and then finalized questionnaires based on the theoretical review. In addition, a pre-test was conducted to elaborate and select the questionnaires in order to verify the validity of the items. The results of the verification

Table 1: Breakdown of the study participants (n = 328)

Demographic categories	Range	Percentage
Industry		
Manufacturing	68	20.73
IT	134	40.85
Retail	69	21.04
Service	50	15.24
Others	7	2.13
Gender		
Male	226	68.90
Female	102	31.10
Position		
CEO	80	24.39
CIO	92	28.05
Senior manager	79	24.09
Director	54	16.46
Others	23	7.01
Type of OSS		
(multiple responses)		
OS	205	62.50
Database	274	83.54
Web application	299	91.16
Other	54	16.46
Length of time using OSS (years)		
<2	35	10.67
<3	101	30.79
<4	116	35.37
>5	76	23.17

showed that there were no items that interfered with the validity. Operational definitions and related studies for each variable are.

RESULTS AND DISCUSSION

Prior to the research hypothesis testing, the reliability and validity of the measurement model were verified. First, the overall fitness of measurement model was confirmed with several indices resulted from the Confirmatory Factor Analysis (CFA) using AMOS 22.0. The result shows that two items (em4 and cus3) had a cross-loading issue, therefore, these items were removed. The modified measurement model was then reexamined. The result shows a good fit with all indices greater than the threshold. Table 2 and 3 summarizes the result of the overall fit test.

Next, reliability and validity were assessed using two validity tests (convergent and discriminant). The reliability was examined using Cronbach's alpha which should be >0.7 (Teo *et al.*, 1999). As shown in Table 4, the alpha value for all latent constructs was greater than the recommended value, ranging from 0.763-0.921. Thus, the reliability of measurement model confirmed strong internal consistency.

Convergent validity indicating how closely the items are related to the latent construct the study is trying to assess was examined by performing Confirmatory Factor Analysis (CFA) with the value of factor loading as well as other indices such as Composite Reliability (CR) and

Table 2: Constructs and related studies

Constructs	Operational definition	Related studies
Ease of maintenance	The degree to which a person believes that maintaining and using an OSS would be free of effort	Davis (1989)
Cost advantage	The degree of belief by employees about monetary and non-monetary benefits including time and effort from using OSS	Son *et al.* (2005)
Customization	The extent to which OSS is well designed to accommodate user needs and attract their interest	Sarrab and Rehman (2014)
		Venkatesh and Davis (2000)
Job relevance	The extent of the need for OSS and its relevance to resaerch	Dishaw and Strong (1999)
Perceived usefulness of OSS	The extent to which an individual believes that using OSS will improve his or her performance	Mount and Fernandes (2013)
OSS satisfaction	The extent to which users believe the OSS available to them meets their information requirements	Sarrab and Rehman (2014)

Table 3: Summary of the overall fit indices for measurement model

Models	NFI	GFI	AGFI	CFI	χ^2/df	RMSEA
Measurement model	0.878	0.919	0.843	0.922	1.776	0.081
Revised model	0.937	0.945	0.899	0.948	1.693	0.049
Recommended value	≥0.900	≥0.900	≥0.800	≥0.900	≤3.000	≤0.100

In the revised model, EM4 and CUS3 were removed

Table 4: Results of reliability testing

Latent construct	Number of items	Removed item	Cronbach's alpha
Ease of maintenance	4	1	0.837
Cost advantage	4	0	0.899
Customization	4	1	0.763
Job relevance	3	0	0.815
Perceived usefulness of OSS	4	0	0.899
OSS satisfaction	2	0	0.921

Table 5: Results of convergent validity

Latent construct	Items	Mean	SD	Factor loading	CR	AVE
Ease of Maintenance	EM1	5.003	0.103	0.785	0.830	0.620
	EM2	4.436	0.350	0.840		
	EM3	5.081	0.626	0.733		
	EM4	Removed				
Cost Advantage	CA1	5.066	0.215	0.795	0.889	0.667
	CA2	4.607	0.534	0.870		
	CA3	5.248	0.086	0.766		
	CA4	5.043	0.416	0.832		
Customization	CUS1	3.129	0.572	0.826	0.841	0.699
	CUS2	4.640	0.195	0.757		
	CUS3	Removed				
	CUS4	5.173	0.092	0.813		
Job Relevance	JR1	4.262	0.374	0.798	0.888	0.727
	JR2	5.106	0.736	0.866		
	JR3	4.899	0.503	0.891		
Perceived Usefulness of OSS	PU1	4.254	0.685	0.786	0.922	0.748
	PU2	5.121	0.710	0.888		
	PU3	4.788	0.208	0.894		
	PU4	5.694	0.253	0.887		
OSS Satisfaction	SAT1	5.680	0.501	0.912	0.890	0.801
	SAT2	5.737	0.198	0.878		

Average Variance Extracted (AVE). In order to achieve convergent validity, the factor loadings of each measurement item and CR should be at least 0.7 and AVE should be larger than 0.5 (Chin, 1998). Table 5 shows the results of convergent validity. All items had factor loading >0.7 and CR and AVE for all latent construct ranged from 0.830-0.922 and from 0.62-0.801, respectively, demonstrating convergent validity.

Finally, the study conducted a discriminant validity test to verify that items designed to measure a particular latent construct do not correlate with other constructs.

The square root of AVE and correlation were used for discriminant validity. The AVE square root value of each latent construct must be greater than the correlation value of species and transverses to ensure discriminant validity. As shown in Table 6, all values in bold representing the square root of AVE for each latent construct were greater than correlation values, therefore, the discriminant validity was ensured.

The structural model was analyzed after the verification of the measurement model. The structural model was formed using AMOS 22.0 and the hypothesis

Table 6: Discriminant validity test

Latent construct	1	2	3	4	5	6
Ease of maintenance	**0.787**					
Cost advantage	0.211	**0.816**				
Customization	0.237	0.217	**0.799**			
Job relevance	0.336	0.406	0.346	**0.853**		
Perceived usefulness of OSS	0.292	0.417	0.331	0.342	**0.865**	
OSS satisfaction	0.425	0.411	0.366	0.366	0.483	**0.896**

The values in bold are the square root values of AVE

Table 7: Summary of hypothesis testing

Hypothesis	Path/SD	β	t-values	Results
H$_1$	Ease of maintenance→Perceived usefulness of OSS	0.218	5.309	S**
H$_2$	Cost advantage	0.406	8.874	S**
H$_3$	Customization	0.285	3.663	S**
H$_4$	Job relevance	0.197	2.115	S*
H$_5$	Perceived usefulness of OSS→OSS satisfaction	0.479	9.627	S**

*p<0.05, **p<0.01, S Supported

can be verified through this. Structural model analysis reveals three important results. First, it can provide information about how the data characteristics collected in this study fit with the structural model. Second, the degree of influence of each path of the research model can be measured by the standardized path coefficient (β). Finally, it is possible to determine the explanatory power of the endogenous variables by the exogenous variables of the structural model through the squared multiple correlation (R^2).

As a result of the overall fitness test of the structural model, all indicators, $\chi^2/df = 1.790$, NFI = 0.944, GFI = 0.961, AGFI = 0.925, CFI = 0.953 and RMSEA = 0.036 were above the recommended value required in the literature in order to ensure the fitness, therefore, the collected data fitted well into the structural model. Second, the results show that four OSS quality variables had a positive influence on perceived usefulness of OSS which was also significantly associated with OSS satisfaction. The standardized path coefficient between ease of maintenance and perceived usefulness of OSS was 0.218 (t = 5.309) which was significant at p<0.01; thus, H$_1$ was supported. This result implies that employees and firms want to use software that can be easily maintained as they have their own duties and responsibilities. Therefore, it is understandable that software management is not their priority, so, management of software used for their jobs needs to be easy. Previous studies (Sarrab and Rehman, 2014) claimed that when employees feel using technology is easy, they tend to perceive it as more useful.

In addition, cost advantage and customization had the standardized path coefficient 0.406 (t = 8, 874) and 0.285 (t = 3.663), respectively. Thus, H$_2$ and H$_3$ were supported at p<0.01. Cost advantage has been shown to have the greatest impact on users' perception on usefulness of OSS. This is because most users appreciate the usefulness of OSS as a free software. In this respect,

Lundell *et al.* (2010) claimed that due to the limited resources of many organizations, the cost advantage of OSS alone makes managers aware of its high usefulness. Furthermore, since, the source code of the OSS is free, organizations can customize the software by modifying the source code to suit their situation. Commercial software is hard to customize but OSS can be customized to the organization's business processes or environment, which increases its perceived usefulness. Job relevance was significantly related to perceived usefulness of OSS with the path coefficient 0.197 (t = 2.115). Thus, the H$_4$ was supported at p<0.05. This result indicates that some users are highly aware of the usefulness of OSS because of its relevance to their work. Mount and Fernandes (2013) claimed that the more job-related software there is the greater the perceived usefulness. Finally, the relationship between perceived usefulness and OSS satisfaction was significant with the path coefficient 0.479 (t = 9.627). Thus, H$_5$ was supported at p<0.01. This result is consistent with previous studies (DeLone and McLean, 2003; Sarrab and Rehman, 2014) in the context of various information systems. That is when users feel usefulness more, their level of satisfaction increases.

Regarding the squared multiple correlation (R^2), four external constructs (ease of maintenance, cost advantage, customization and job relevance) explained 62.7% of the variance in perceived usefulness of OSS which then explained 22.9% of the variance in OSS satisfaction. This means that 62.7% of the information that the endogenous variable, perceived usefulness of OSS has is determined by the direction in which the four exogenous variables move. Similarly, 22.9% of the information that OSS satisfaction has moves the same direction of perceived usefulness of OSS. Figure 2 describes the structural model analysis and Table 7 summarizes the results of hypothesis testing. In addition, based on the result of the analysis, the following linear regression models are suggested:
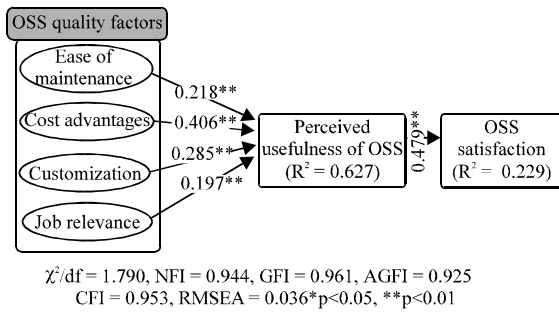
$\chi^2/df = 1.790$, NFI = 0.944, GFI = 0.961, AGFI = 0.925
CFI = 0.953, RMSEA = 0.036*p<0.05, **p<0.01

Fig. 2: The structural model

$$Y_{(Perceived\,usefulness\,of\,OSS)} = 0.218X_{(Ease\,of\,maintenance)} +$$
$$0.406X_{(Cost\,advantages)} + 0.285X_{(customization)} + 0.197 \quad (1)$$
$$X_{(Job\,relevance)} + 4.005_{(constant)}$$

$$Y_{(OSS\,satisfaction)} = 0.479X_{(Perceived\,usefulness\,of\,OSS)} + 3.379_{(Constant)} \quad (2)$$

The results of this study provide diverse academic and practical implications. First, it is significant that quality factors that affect the usefulness and satisfaction of OSS technology are not only derived from the organizational perspective but are also empirically tested. This attempt may be a good starting point for a future study that explains the behavior of individuals and organizations. In particular, this study is more meaningful in that it reflects not only the theoretical background in deriving the research model for OSS satisfaction but also the results of actual interviews with corporate practitioners. Second, there is a great deal of implication in the theorizing of OSS quality factors that can explain the usefulness and satisfaction of OSS at the present time. This means that it has been theoretically proven that the factors and the causal relationships that have not been empirically studied in the previous studies. Finally, it can be said that the new items for measuring OSS quality constructs and constructs related to usefulness and satisfaction of OSS can be verified from previous research.

Practically, the findings of this study provide OSS-related companies with information about what they should focus on to help users recognize the usefulness and satisfaction of OSS. In particular, maintenance and customization are recognized as a very important factor for OSS users in perceiving its usefulness. Therefore, OSS companies should provide users with a variety of support to enhance the maintainable ease-of-use. In addition, OSS practitioners can explore the professions or business areas that need to use OSS and can make them more practical for OSS through intensive marketing

activities. The results of this study provide motivation for the usefulness of OSS to companies that want to adapt to rapidly changing business environments and rapidly developing information technology environments and to improve competitive advantage, cost reduction and work efficiency.

CONCLUSION

This study examined quality factors affecting perceived usefulness and satisfaction of OSS by employees who are currently using OSS as a main information technology strategy. This study introduced four quality factors ease of maintenance, cost advantage, customization and job relevance influencing the perceived usefulness of OSS which then leads to OSS satisfaction. A total of 328 questionnaire responses were collected from employees of firms in various industries and analyzed to test the proposed hypotheses. The results of the analysis showed that the model satisfies the overall fit, reliability and validity of the whole research model and shows support for the 5 hypotheses proposed in this study. First, ease of maintenance, cost advantage, customization and job relevance positively influenced the perceived usefulness of OSS. These results are consistent with the results of previous studies (Kim, 2008; Sarrab and Rehman, 2014; Zeithaml *et al.*, 2002) in explaining user's behaviors regarding a certain technology. In other words, employees have a higher level of positive perception and satisfaction with OSS when it can be easily maintained and customized, provides cost benefits and is relevant to their jobs. Furthermore, employees in various industries believe that a positive perception of usefulness increases their expectation regarding OSS satisfaction. This result is also consistent with previous studies (Bhattacherjee, 2001; Wang and Song, 2017).

However, despite the various implications of the results, this study has some limitations that should be investigated in future studies. For example, this study focuses only on OSS quality factors which can be either a strength or weakness. There may be a variety of external factors that may cause to recognize the usefulness of OSS. Therefore, future studies will need to investigate other external factors that affect the usefulness and satisfaction of OSS. In addition, since, this study was conducted at a specific point in time, it may be difficult to measure the usefulness and satisfaction of OSS.

RECOMMENDATION

Future research will need to study the behavior of OSS users over time in order to provide stronger justification.

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