

Effectiveness of Open Source Cloud Computing in Developing Countries: Empirical Study

¹Hala A. Albaroodi, ²Mohammed Abomaali, ¹Aseel Ismael and ³Selvakumar Manickam

¹Ministry of Education, Baghdad, Iraq

²Department of Computer Technologies Engineering, Alsafwa University College, Karbala, Iraq

³National Advanced IPv6 Centre (NAV6) Universiti Sains Malaysia, 11800 USM, Penang, Malaysia
hala.albaroodi5@gmail.com

Abstract: Open source cloud computing has gained an increased attention in current researches and practises. However, a common understanding and agreement on open source cloud computing is still missing. In addition, the propagation of literature makes it heavy to look over and determine state of the art and further to identify research challenges and weaknesses. In summary, a comprehensive overview of state of the art in researches and practises in the area of open source cloud computing in Malaysia is substantial. This study investigates research on open source cloud computing and aims at establishing a common understanding of terminology in this context. Further, it investigates which shared value and trust are currently applied in open source cloud computing. A systematic literature review is conducted in order to classify and define open source cloud computing, shared value and trust. In literature, shared value and trust often centers on specific open source cloud computing aspects. In addition, we identified trust and shared value as moderates in the area of open source cloud computing concepts. Based on the results, open research challenges and gaps are identified and discussed with respect to possible solutions. This survey provides a comprehensive review of current open source cloud computing practice and shows that shared value and trust in open source cloud computing is a challenging interdisciplinary research field that assembles research methods and principles from shared value and trust and open source cloud computing. We show that state of the art provides a rich set of methods but still several open research challenges remain.

Key words: Open Source Cloud Computing (OSCC), Cronbach's alpha, Information Communication Technology (ICT), Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS)

INTRODUCTION

Cloud computing is an innovative and constantly growing technology that allows users (from organizations and small businesses) to access their data via the use of internet without having an arsenal of sophisticated computers or professional operators. This technology provides an elastic capacity to serve a wide and continuous expanding range of information processing needs which include government, military, business and education. Cloud computing, however is commonly known for its diverse glitches which include vulnerable security and lack of customization options. These shortcomings are tackled via the use of open source software systems (Gamalielsson *et al.*, 2015; Leitner and Rinderle-Ma, 2014; Rebollo *et al.*, 2015). These systems are characterized by having an obtainable source code, thus, allowing for immediate and simultaneous

incorporation of improvements and adaptations of the system by third-party developers, facilitating the branching of the system into customized variants and allowing clouds to be deployed for any type of application domain. These open source systems created a new breed of cloud computing which is referred to as Open Source Cloud Computing (OSCC). In Malaysia, the usage of OSCC is limited in the open literature because only. A few studies have been dedicated to this subject. Although, few investigators made attempts to tackle this subject specifically and the usage of information technologies in general, extensive research work is still needed for a better understanding of this new type of distribution channel. Among these investigators (Ndubisi and Jantan, 2003) focused on the impact of perceived usefulness and perceived ease of use on information systems used in small and medium firms in Malaysia. Ma'ruf *et al.* (2005) focused on the intention to

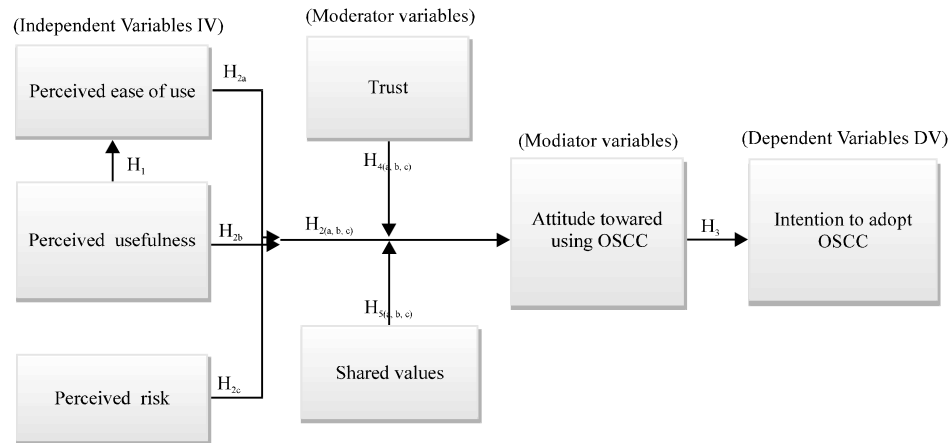


Fig. 1: A model for OSCC adapted and relationship representation from (Davis, 1989), perceived risk (Teo and Liu, 2007), trust (Chiou, 2004), shared value (Mukherjee and Nath, 2003)

purchase via the internet and compared two theoretical models: TAM and a Theory of Planned Behavior (TPB) Model. Ramayah and Jantan (2004) investigated the technology changes over a period of time and the influence of perceived usefulness and perceived ease of use on usage behaviour over three time periods.

Therefore, the need for an additional contribution, especially in the field of OSCC is still present in Malaysia. A review of the available published studies in open literature sources has revealed the existence of research in which investigators studied the influence of consumer demographics and consumer purchase preferences on attitudes toward using online shopping and online shopping decisions (Wu, 2003; Davis, 1989). Investigated the effect of perceived usefulness and perceived ease of use on attitudes toward using technology and on intentional behaviour (“TAM theory”). In addition, Shih (2004) has studied the influence of the access cost of using internet technology on attitudes and behaviours toward online shopping (Luarn and Lin, 2005). Have studied the influence of the perceived financial cost on the intentional behaviour of using mobile banking. Accordingly, several researchers have studied TAM theory. However, no study has been conducted on an extension of this theory in the OSCC context by examining the impact of trust and shared values on the attitude and intention to use OSCC for products and services in Malaysia organisations.

To summarise this problem, we ask the question what are the impacts of perceived usefulness, perceived ease of use and perceived risk on the attitude and intention to use OSCC without a moderator variable and with the moderator (Trust and shared value) for products and

services in Malaysia? By conducting a study and proposing a model, we look at the solutions that are helpful to the OSCC customer and the companies that offer services in Malaysia with a secure and trusted environment (For review regarding elements of the exploratory study.

Framework and hypothesis: The hypothesis of this study are developed based on a conceptual framework and are intended to investigate the research objective. An appropriate model is the “TAM Model” to examine the end user’s acceptance of OSCC. A TAM Model has been found that has a significant positive influence between the perceived ease of use and the perceived usefulness. Furthermore, the perceived ease of use and perceived usefulness have a significant positive relationship with respect to the attitude toward OSCC; the following Hypothesis (H₁-H₆) were adopted from the original TAM and other research papers (Davis, 1989; Teo and Liu, 2007; Venkatesh *et al.*, 2003; Mukherjee and Nath, 2003; Chiou, 2004) and are shown in Fig. 1:

- H₁: perceived usefulness has a significant positive influence on perceived ease of use
- H₂: attitude toward using OSCC mediates the relationship between the Independent Variables (IV) and the Dependent Variable (DV) (intention to use OSCC)
- Perceived ease of use will have a positive effect on attitude toward using OSCC
- Perceived usefulness will have a positive effect on attitude toward using OSCC

- Perceived risk will have a positive effect on attitude toward using OSCC
- H₃: attitude toward using OSCC has a significant positive influence on the Dependent Variable (DV) (intention to use OSCC)
- H₄: trust moderates the relationship between the Independent Variables (IV) and the Dependent Variable (DV) (intention to use OSCC)
- The positive effect of perceived ease of use on attitude toward using OSCC will decrease with the increased trust
- The positive effect of perceived usefulness on attitude toward using OSCC will decrease with the increased trust
- The positive effect of perceived risk on attitude toward using OSCC will decrease with the increased trust
- H₅: shared value moderates the relationship between the Independent Variables (IV) and the Dependent Variable (DV) (intention to use OSCC)
- The positive effect of perceived ease of use on attitude toward using OSCC will decrease with increased shared values
- The positive effect of perceived usefulness on attitude toward using OSCC will decrease with increased shared values
- The positive effect of perceived risk on attitude toward using OSCC will decrease with increased shared values

MATERIALS AND METHODS

The nature of this study is to validate the conceptual model and the proposed hypothesis. Thus, a quantitative research design is chosen for principal component analyses and hypothesis testing. The type of investigation is a correlation study that attempts to explain the variation in the dependent variable which is (intention to use OSCC) supported by three independent variables: the perceived ease of use, perceived usefulness and perceived risk. The attitude toward using OSCC will be the mediating variable between the independent variables and the dependent variable. The trust and shared value will be the moderating variable between the independent variables and the dependent variable. The ideal number of respondents to an academic study is twenty times the number of variables. Because the number of variables for this study is seven, it is therefore, expected that the number of responses should be at least 140 (Hair *et al.*, 2006). Thus, by using the simple random

sampling method, a list of names of OSCC users is not necessary. Referring to Krejcie and Morgan (1970) provided a significant guideline for the sample size decisions. Therefore, the target number of questionnaires that must be collected is 385.

The measurements of the variables in this study represent the scale items for each construct that is to be measured. The theoretical model for this research is represented by seven variables three independent, one mediating, two moderating and one dependent variable. These variables are the perceived ease of use (independent variable) perceived usefulness (independent variable), perceived risk (independent variable), attitude toward using OSCC (mediating variable), trust, shared value (moderating variable) and intention to use OSCC (dependent variable). This study will provide a discussion that is related to the scales and its items which is to be employed in the measurement of all of those constructs (for more on the scales of measure and their pilot testing (Albaroodi *et al.*, 2013).

RESULTS AND DISCUSSION

The Statistical Package for the Social Science program (SPSS 20.0) will be used after collecting the returned questionnaires the data will be edited to exclude the empty responses. Subsequently, the data are to be entered, categorised, coded and analysed. This study presents the survey findings and the results of the statistical analysis. It includes an overall factor analysis which is followed by the results of the reliability test on the data. The results of the hypothesis testing are then summarised.

A total of 500 sets of questionnaires were distributed to the users of OSCC in Malaysia. The drop and pick technique method was used to distribute and collect the questionnaires. Therefore, by using a simple random sampling method, a list of names of OSCC users was not needed once the population was chosen randomly. Five hundred questionnaires were distributed and target number of questionnaires (sample size) that was needed was 385; however, 204 were returned, 296 questionnaires were not returned and 31 were rejected due to incompleteness and were unusable. Hence, 173 complete sets were used for the data analysis in this study which gives a total response rate of 40.8%. Based on Hair *et al.* (2006), a sample size of 100 is needed to sufficiently conduct the analysis.

A reliability test that is a variable or set of variables is a consistent measure when the result is repeated under

the same conditions (Hair *et al.*, 2006; Keenan, 1993). Cronbach's alpha will be used for internal consistency by checking the components of the questionnaire against each other (Cronbach, 1951). In other words, the reliability of the measures is an indication of the consistency and stability with the same instrument measures and concepts to assess the goodness of a measure (Sekaran, 2003). Items that have a high reliability measurement will be those that have a Cronbach's alpha close to 1.

To ensure the measurement of the reliability, the multiple statement of the intention to use OSCC in Malaysia, the attitude toward using OSCC in Malaysia, the perceived usefulness, the perceived ease of use, the perceived risk, the shared value and the trust have been assessed with Cronbach's alpha reliability test. Cronbach's alpha value is 0.993 this value indicates a high measurement reliability for all of the variables which is in line with the statement of (Hair *et al.*, 1998) that the desirable coefficient alpha is >0.70 . In other words, the constructs of this study are reliable because the measures that were used are above the lower limit of Cronbach's alpha, >0.70 . Hala and her colleague provides a summary of Cronbach's alpha for the constructs (Albaroodi and Manickam, 2016).

Factor analysis was conducted to analyse the goodness of the data. The data reduction analysis will help specify the small number of factors that explain most of the differences that are observed in a large number of variables. Factor analysis was used to test the independent variables (perceived usefulness (4 items), perceived ease of use (4 items), perceived risk (5 items)), the mediating variable (attitude toward OSCC services in Malaysian organisations (4 items)), the moderating variable (trust (5 items), shared value (3 items)), the dependent variable (intention to use OSCC (3 items)) and the user knowledge toward OSCC use completeness and its importance (13 items).

According to Albaroodi and Manickam (2016), factor loading is achieved when the value is equal to 0.50 or >0.50 whereas cross loading is attained if the value is 0.35 or lower. The result of the factors analysis of this study is presented in the (Albaroodi and Manickam, 2016). KMO and Bartlett's test which has a loading of 0.90 and above was used to indicate whether the data is valid for performing factor analysis. According to Hair *et al.* (1998), KMO sampling adequacy is interpreted as follows: Marvelous is 90 or above 80, meritorious is 70 or above, middling is 60 or above, mediocre is 50 or above and finally, miserable is 50 and below. The results indicate that the Kaiser-Meyer-Olkin measure of sampling is 0.975 which is considered meritorious and the Bartlett's test of sphericity is significant at $p < 0.01$ as illustrated in

(Albaroodi and Manickam, 2016). Principle axis factor analysis with varimax rotation was conducted to assess the underlying structure for the forty items that deal with the effectiveness of implementing open source cloud computing in organizations in Malaysia. After performing the rotation, three factors were generated based on the fact that the items were designed to index three constructs: perception, attitude and intention. The first factor accounted for 75.417% of the variance, the second factor accounted for 3.066% and the third factor accounted for 2.458%. Clarifies the items and the factor loading for the rotated factors. It is crucial to note that if the loading is <0.40 it will be omitted for the sake of improving clarity. Consequently, only occupation and number of employee constituents were dropped as they have no loading values.

The first factor indexes attitude (attitude towards OSCC, shared value, trust and some user knowledge towards OSCC). The second factor indexes perception (perceived usefulness, perceived ease of use and perceived risks). The third factor indexes intention (Intention to use OSCC) with strong and moderate loading as explained by Albaroodi and Manickam (2016). Correlation analysis was used to determine the correlation between the variables as shown by Albaroodi and Manickam (2016). The first column shows the correlations of the perceived attitude with the intention in which both were significantly correlated with the intention. As we observed before, predictors/independent variables are low to moderately correlate with one another.

The mediating analyses were verified to assure that they are free from any violations toward the assumptions of the least squares procedures that are used in multiple regression analyses. The rationale behind conducting diagnostic procedures is to ensure whether the errors in the prediction are the result of the absence of a relationship among the predictors of the two independent variables (perceived and attitude) and one dependent variable (intention). Therefore, the output provides the usual descriptive statistics for all three variables as shown in Table 1. Note that the N is 201 because 3 participants are missing a score on one or more variables. Multiple regressions use only the participants who have complete data for all of the variables. Moreover, the Model 1 summary table indicated that the multiple correlation coefficient (R), using all the predictors simultaneously is 0.68 ($R^2 = 0.464$) and the adjusted R^2 is 0.43. These statistics mean that 43% of the variance in intention can be predicted from perception and attitude. The Model 2 summary table showed that the multiple correlation coefficient (R), using all the predictors simultaneously is

Table 1: Descriptive statistics

Variables	Mean	SD	N
Intention	4.0467	2.35790	204
Attitude	3.0701	1.31711	204
Perceive	2.7933	1.14934	204

Table 2: Model summary

Models	R	R ²	Adjusted R ²
1	0.681	0.464	0.431
2	0.688	0.473	0.444

Table 3: ANOVA

Models	df	F-values	Sig.*
1			
Regression	3	14.240	0.000
Residual	201		
Total	204		
2			
Regression	4	13.834	0.000
Residual	202		
Total	204		

*ANOVA test; p (sig.) <0.05

0.688 (R² = 0.473) and the adjusted R² is 0.47. This indicates that 47% of the variance in attitude can be predicted from perception. Table 2 represents the model summary. Table 3 presents the ANOVA test results which show that the first model of attitude and perception significantly predicts intention, F (3, 201) = 14.240, p<0.001. In addition, the second model of attitude significantly predicts perception, F (3, 201) = 13.834, p<0.001. Coefficients test which specifies the consistent beta coefficients that are inferred similarly to correlation coefficients or factor weights is crucial in this research. The t-value and the sig. opposite each independent variable are fundamental to indicate whether the variable is considerably contributing to the equation for predicting math achievement from the whole set of predictors. Based on the results of the coefficients test, attitude and perception in this study are the only variables that are significantly contributing to the prediction. Therefore, if there is any deletion of the predictors because of their insignificance, it can affect the levels of significance for other predictors. Table 4 illustrates the coefficients value.

As a result, multiple regressions were conducted to determine the best linear combination of attitude and perception for predicting the test scores of intention in Model 1 and attitude for predicting perception test scores in Model 2. Attitude and perception have almost similar beta weights in predicting intention in Model 1. The adjusted R² value for Model 1 was 0.43. This indicates that 43% of the variance in intention was explained by the model. This statistic is perceived to have a significant effect (Ajzen, 1991). The adjusted R² value for Model 2 was 0.47. This designates that 47% of the variance in intention was explained by the model. According (Naha and Othman, 2014), this is a great effect.

Table 4: Coefficients value

Models	Unstandardized coefficients		Standardized coefficients		
	B	SD	β	t-values	Sig.*
Attitude-intention	2.146	0.890	0.195	2.159	0.000
Perceive-intention	0.693	0.182	0.189	2.004	0.012
Perceive-attitude	3.501	1.140	0.250	2.616	0.006

*p (sig.) <0.05

The result of mediated regression analysis was useful in presenting the following graph which shows the regression coefficients with coefficients to indicate the effect of the IV (Perception and Attitude) on the DV (Intention) in both analyses. First, the DV (Intention) is regressed on the IV (Perception) in path c (0.189). The standardized regression coefficient (β) was examined to determine the size and direction of the relationship. The results indicate the existence of a direct effect relationship that is significant p<0.001. Second, the MV (Attitude) is regressed on the IV (Perception) in path a (0.250). The beta was examined for its size, direction and significance. The results show the existence of an indirect effect relationship that is significant p = 0.006. Third, the MV (Attitude) is regressed on the DV (Intention) in path b (0.195). The beta was examined for its size, direction and significance. The results indicate an indirect effect relationship that is significant p = 0.012. Based on these results, all the relationships are significant. Hence, the hypothesized MV (Attitude) can be perceived as fully mediating. Furthermore, the size of the indirect effect is calculated as a product of the direct effect of the IV (Perception) on the MV (Attitude) and the MV (Attitude) on the DV (Intention) as illustrated in Fig. 1.

In this study, it has been proven that perceived (group of variables) has a significant positive impact on the attitude (group of variables) which is in line with previous studies (Naha and Othman, 2014; Cohen, 1988). Thus, this finding supports the TAM Model which predicts the relationship between perceived and attitude. Therefore, it could be a deduced perception that using OSCC enhances the outcome of their services experience and would have a significant positive impact on their attitude for cloud services (Mulia *et al.*, 2013; Hwang and Sun, 2013). In other words, this finding shows a significant positive relationship between cloud user's perceptions of the benefits of using OSCC and their feelings toward using OSCC in Malaysia. As a result, a cloud provider should be able to show the utility of using OSCC services because it has been revealed that perceived has a significant positive influence on attitude toward using OSCC. Indeed, this research obviously shows that consumers can be explained through their

attitude which encompasses their perceptions. Thus, positive feelings or higher attitude toward using OSCC could be made up by the perception of the perceived of using OSCC.

According to the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), TAM (Davis, 1989) and the planned behaviour (TAB) (Ajzen, 1991), the attitude has a significant positive influence on behavioural intention. Accordingly, it has been hypothesised that the attitude toward using OSCC has a direct positive impact on the intention to use OSCC. In this study, it has been proven that the attitude toward using OSCC has a significant positive impact on the intention to use OSCC. The explanation for this finding is obvious once the positive feelings of attitude to use OSCC are high, cloud users would have a higher Intention to use OSCC. Thus, consumers can be explained through their Attitude which is made up of perceptions. Indeed, attitude does appear to be a basis for studies that concern consumer's behaviours. This finding reconfirms the role of attitude in predicting the intention and hence, supports the argument that this construct should continue to be used in the subsequent imperative for using cloud providers to develop a use of OSCC that can foster positive feelings toward performing OSCC services because this study highlights the vital role of attitude in the intention to use OSCC services. The mediation effect of attitude toward using OSCC is between the independent dependent variable "Intention" (intention to use OSCC services in Malaysian organisations).

However, it appears from the findings of this study that the mediation effect of attitude toward using OSCC has a significant influence on Intention and perceived. In this study, it has been found that the attitude is fully a mediation effect of the relationship between the independent variables "perceived" and the dependent variable "Intention". In other words, a mediator variable is a variable that carries the impact of the independent variables to the dependent variable. This finding is in agreement with TRA (Fishbein and Ajzen, 1975), TAM (Davis, 1989) and TPB (Ajzen, 1991) which indicate the vital role of attitude as a mediator variable. This result reconfirms the role of the attitude as a mediator variable and hence, supports the argument that this construct should continue to be used as a mediator variable in future TAM research.

CONCLUSION

This study investigated the impacts of OSCC components reuse adoption on the developing countries.

TAM has been employed as theoretical background. The purpose of this research is to extend TAM theory to the OSCC context. This extension is conducted through the use of perceived (perceived usefulness, perceived ease of use and perceived risk) as independent variables that influence the attitude (attitude toward OSCC services in Malaysian organisations, shared values and trust) as mediation variables and intention (intention to use OSCC services in Malaysian organisations) as the dependent variable. Thus, this research has extended TAM theory by incorporating additional significant factor-specific knowledge to the field of OSCC and also fills a gap in existing academic knowledge.

It has been found that perceived has a significant positive impact on the attitude toward using OSCC and Intention. Additionally, it has been shown that there is a direct positive impact on intention and an indirect positive impact on intention via attitude. In this study, it has been found that attitude is a full mediation effect of the relationship between perceived and intention. Based on these results, it is recommended that the OSCC in Malaysia formulate their service strategies to prompt OSCC in the future using the following steps. First, the cloud vender should be able to exhibit the perceived of OSCC. Second, it is also important for the cloud vender to develop an OSCC that could be able to foster positive feelings (attitude) for the cloud user. Overall, the results of this study have contributed to the existing literature by highlighting that different perception and motivation variables (shared value and trust) can influence the attitude and intention to use OSCC services. In another word, we found motivation variables (ethics, security, privacy and trust) can be the higher concern from the user and can effect on their the attitude and Intention to use OSCC any services from, here, the results of this study will help us to provide good insights for a secure proposed model. Consequently, the findings of our exploratory study open a new horizon for proposing the new security model.

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