

Determinants and Impact of Cloud Computing Implementation in the Public Sector

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Abstract—This study empirically analyses which determinants influence the public sector to implement cloud computing, as well as the effect to performance. Drawing upon the theory on the technology-organization-environment and IS success model, the study hypothesizes that technological, organizational, environmental and human factors can be viewed as the reasons for cloud computing assimilation within the agencies in the Malaysian public sector. Our proposed research model and hypotheses are tested using SEM-PLS and survey data from a sample of 169 agencies in the Malaysian public sector. Our empirical analyses lead to several key findings. All second order factors of Technological, Organizational, Environmental and Human factors affect cloud computing implementation in the Malaysian public sector. Implementation of computing by the agencies significantly affect to IT operational effectiveness. Together, these article offer empirical insights into how cloud computing implementation is influenced by the contextual factors in the Malaysian public sector.

Index Terms—implementation, cloud computing, operational effectiveness, public sector

I. INTRODUCTION

The adoption and implementation of cloud computing services and resources continues to be an interesting research topic. Advances in IT innovation implementation provide organizations with an excess of potential opportunities to increase efficiency, enhance services, lower costs, and improve business value [1], [2]. As IT innovation implementation become an increasingly integral aspect of organizations, decision makers must understand the forces and factors that shape the adoption and implementation decision. However, this decision is far from simple. In today's dynamic, global, and highly competitive business environment, executives and IT decision makers must make smart and value-justified decisions about their technology implementation, investment and strategy [1], [2]. Organizations must carefully assess their current state of IT environment, determine potential gaps, identify opportunities, evaluate a range of IT options, and select the right solutions that can meet their immediate needs and align with their long-term business goals.

Therefore, in relation to the emergence of cloud computing services and resources, organizations innovativeness in adopting these technologies varies distinctly. Although the technologies are proclaimed to provide numerous benefits to the organizations, the acceptance of cloud computing services and resources among organization has been far from expectations [3]. Many organizations are undertaking cloud computing services and resources initiatives quite cautiously by taking one step at a time or preferring to 'wait-and-see'. Hence, it is imperative that a study on cloud computing services and resources adoption in organization is carried out to determine the factors that influence organizations' propensity to adopt technologies especially in the public sector. Our assertion is supported by the Cisco Internet Business Solutions Group (IBSG), which has identified the topic of cloud computing services and resources adoption, and measuring economics survive today as a critical strategy for organization and become the main research priority for 2013 to 2020 [4].

The structure of the paper is as it follows. Section II discusses the key benefits that drive organizations to adopt cloud and existing theories used to measure acceptance of technologies, as well as provides a critical review of other proposed models based on these theories. Section III presents the proposed hypotheses for cloud computing adoption. Section IV provides an overview of the research methodology. The preliminary results are presented in Section V. The discussion for the finding presented in Section VI. Finally, conclusion and future work in Section VII.

II. LITERATURE REVIEW

The TOE framework is an organizational level model which explains three different contextual attributes of a firm that influence adoption decision. These three elements are technological, organizational and environmental contexts [5]. The technology context describes technologies or innovation characteristics that are used by the organization and the technologies available in the market relevant to the firm. Organizational context refers to the characteristics and resources of the firm, such as size of the organization and volume of slack resources. Finally, the environmental context describes the structure of the industry and the conditions surrounding the organization in which it conducts its business. The TOE model posits that

attribute from the three contexts influence innovation adoption in organizations.

Previous study in IT innovation using TOE framework satisfied that it develops a better and capable of explaining intra-firm innovation adoption [6]. However, the explanation power for organization innovation adoption must taking a consideration to other domains that can be considered as different layers of the environment that influence the design and use of information technology such as individual and task [7], [8] and human factors [9]. Therefore, [7] in his study has conceptualized that individual and task domain also a factors to join together with technological, organizational and environment context. Previously, [10] tested that CEO characteristics as human factor as determinants for adoption of IT.

Based on IS success model, it is evident that IT innovation can provide a variety of benefits for organizations [11]. Improved quality of tasks, time parsimony, improved job performance, service productivity, operation efficiency, improvement in decision-making and competitive advantage are examples of IT innovation benefits for organizations [12]. For the individual level of analysis, perceived usefulness or job impact is the most common measure while at the organizational level, productivity, profitability and intangible benefits measurements are mostly preferred [13]. In the context of public sector, benefits of IT innovation are generally characterized as the effects of the IT innovation on the organizational performance of these enterprise [14]. Consistently, and following [11] notion that "more field-study research should investigate and incorporate 'Net Benefits' measures,". Thus, "net benefits" in this study is defined as exact improvement in operational metrics such as cost, productivity and quality.

III. THE PROPOSED HYPOTHESES

Based on the literature review, an integrated model has been developed to examine what are the most important factors that affect public sector's decision to adopt the cloud. This model incorporates aspects of the TOE framework [5] and IS success model [11].

A. Technological Factors

The technological innovation represents the technology characteristics. This study defines the technological innovation factor as the cloud computing characteristics that might determine the likelihood of its assimilation by the Malaysian public sector and might stimulate the Malaysian public sector to adopt it. Moreover, the literature also suggested the further investigation of the influences of the innovation characteristics on the organizational level adoption of innovations (e.g. [15]). Therefore, the four characteristics of the innovation by [16] namely; relative advantage, complexity, compatibility, and trialability, in addition to the perceived risks characteristic which is suggested by [17] are the technological innovation characteristics of the cloud computing that determine its adoption by the Malaysian public sector. Therefore, the following hypotheses is proposed.

H1: The technological innovation factor positively affects the actual implementation of the cloud computing.

B. Organizational Factors

The organizational factor represents the organizational characteristics, which is defined by this study as the characteristics of the agencies in Malaysian public sector that will determine its abilities and capabilities to adopt the cloud computing innovation. The TOE framework emphasizes on the importance of the organizational factor to the adoption of innovation. However, the organizational factor needs to be modified based on the current issues and problems identified at the organizational-level adoption of innovations in the Malaysian public sector such as top management support, organizational readiness and size. Many studies have emphasized on the importance of the organizational factor to the adoption of IT innovation [18], [19]. Therefore, the following hypothesis is proposed.

H2: The organizational factor positively affects the actual implementation of the cloud computing.

C. Environmental Factors

The environmental factor represents the environmental characteristics, in which it is defined as the characteristics of the environment in which the agencies run its business that may contribute in creating the need for and ability to adopt and implement the cloud computing innovation. The TOE framework emphasizes on the importance of the environmental factor to the adoption of innovation. However, the environmental factor needs to be modified based on the current issues and problems identified at the organizational-level adoption of innovations in the Malaysian public sector agencies. Many studies have emphasized on the importance of the environmental factor to the adoption of IT innovation (e.g. [18], [19]). Therefore, the following hypothesis is proposed.

H3: The environmental factor positively affects the actual implementation of the cloud computing.

D. Human Factors

The IT personnel factor represents the IT personnel characteristics, in which it is defined as the characteristics of the IT personnel in the Malaysian public sector in which the agencies run its business that may contribute in creating the need for and ability to adopt and implement the cloud computing innovation. The model of IS innovation by [10], [20] emphasizes on the importance of the CEO characteristics factor to the adoption of innovation. However, in this study the personnel factor is modified to IT personnel based on the current issues and problems identified at the organizational-level adoption of innovations in the Malaysian public sector agencies. According to [21]–[23], this group of individual plays crucial roles in the Malaysian public sector for IT innovation implementation. Therefore, the following hypothesis is proposed.

H4: The human factor positively affects the actual implementation of the cloud computing.

E. Relationship between Implementation to Operational Effectiveness

The benefits of cloud computing services and resources assimilation in the public sector are also reflected in the use of the extended IT exchange networks to create government value. Because of the virtualization environment [24], that characterize the system of cloud computing services and resources could increase government's ability to sense and respond to the service delivery needs by consolidate and disseminating their infrastructure and IT throughout the organization. With that environment, the organization could accurately assess or stimulate stakeholders demand and search for service delivery provided by the government. Making the right decision would in turn have a strategic impact that could change the relationship of the government with their stakeholders. As such, the extent of cloud computing assimilation could lead to improved quality in service delivery and productivity [24], [25].

In addition, the cloud computing services and resources aids the IT procurement cost by saving the purchasing of redundancies hardware and software across agencies in public sector as well as improves IT staff utilization. Cloud computing services and resources provides cheaper, faster, reduced inventory, enhance efficiency of logistics, as well as increased access to IT services [24], [25]. For instance, one platform of IT server or data center can be consolidated by many organizations. As such, the operational of IT services by one agency can be shared by other agency may reduce the IT operational cost for entire organization. From the purchasing government's point of view, cloud computing services and resources facilitates procurement innovations to result in reduced purchased price, reduced cycle time, and improved IT sourcing [24]. Thus, the cost savings and efficiencies associated with cloud computing services and resources assimilation would result in reduced IT operating cost, which in tum result in better financial performance. Therefore, the following hypotheses is proposed.

H5: The actual implementation of cloud computing technology positively affects operational effectiveness.

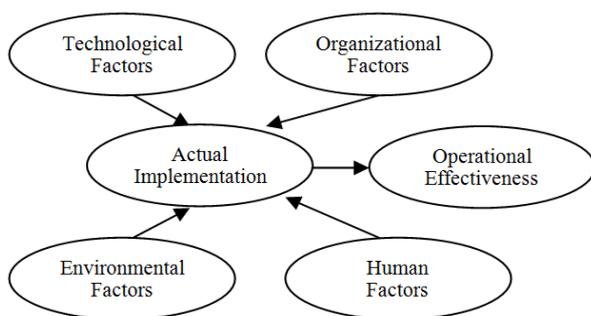


Figure 1. Research model

The summary of all the hypothesis relationship is illustrated in Fig. 1.

IV. RESEARCH METHODOLOGY

A. Sample

The study population comprises Chief Information Officers (CIO), Heads of IT Departments, IT Managers, and IT personnel who are currently working in the Malaysian public sectors. The selected sampling frame for this study consists of 730 in various ministries, departments, and agencies across the country. Off total 500 questionnaires distributed, 226 questionnaires were collected and 169 were valid for data analysis. The percentage of the respondents according to their types of agency is 80% from federal agencies, 63% from federal statutory agencies, 18.7% from state agencies, 43% from state statutory agencies and 40% from local authorities.

B. Measures

Items' measures were obtained from previous researches whose validity and reliability have been demonstrated. TOE construct comprised 54 items, which included relative advantage (5 items), compatibility (4 items), complexity (5 items), trialability (6 items), perceived risks (5 items), top management support (4 items), organizational readiness (6 items), external IS support (5 items) and government regulatory (5 items), IT personnel innovativeness (4 items) and IT personal knowledge (5 items). All items were adapted from previous researcher [26]–[29] and rephrased to match with this study context. Five-point Likert scales ranging from “1=strongly disagree” to “5 = strongly agree” were used. The implementation of cloud of cloud computing service and resource was measured through summated of 13 items. Three measures items for IT operational effectiveness were used to assess the value of cloud computing service and resource in increasing productivity, reducing operation cost and improving customer service quality adapted from [30]. All measurement items listed in Appendix A.

V. DATA ANALYSIS AND RESULTS

All TOE construct are modelled as first order reflective because they are seen as functions of their associated second order latent construct [31]. The methodology to measure the research model for this research is structural equation modelling (SEM) of the data analysis. This approach has many advantages over other methods, such as multiple regression. Using a SEM approach, a partial least squares (PLS) method were selected. Partial least squares (PLS) is a popular Structural Equation Modelling (SEM) technique to conduct data analysis. SmartPLS M3 2.0 [32] was chosen because it is more suitable to handle relatively small sample sizes [33], in comparison to covariance based SEM techniques like AMOS and LISREL.

Confirmatory factor analysis was conducted to measure the reliability and uni-dimensionality of the items. As suggested by [34] we used the factor loadings, composite reliability (CR) and average variance extracted (AVE) to assess convergence validity. The loadings for all items exceeded the recommended value of 0.5 [34] except for one (1) item from organizational readiness and

two (2) items from perceived risk which below than recommended value and dropped out for further analysis. Other item-construct factor loadings were high and significant, ranging from 0.579 to 0.917, which provides evidence of adequate convergent validity. CR values, which depict the degree to which the construct indicators indicate the latent construct ranged from 0.778 to 0.965 which exceeded the recommended value of 0.7 [34]. The AVE, which reflects the overall amount of variance in the indicators accounted for by the latent construct, were in the range of 0.522 and 0.776 which exceeded the recommended value of 0.5 [34]. This suggested that there was adequate convergent validity in all measures. Discriminant validity is supported when the square root of the average variance extracted for each construct is highest for its assigned construct [35]. The evidence of discriminant validity between the dimensions was provided by the comparison of the square root of the AVE with the correlations among constructs. Results revealed that correlations for each construct is less than the square root of average variance extracted by the indicators measuring that construct indicating adequate discriminant validity. In total, the measurement model demonstrated adequate convergent validity and discriminant validity.

Finally, the causal relationships among constructs are tested through the structural model. The R², the path coefficient and t-value analysis can indicate how the data support a hypothesized model [36]. To run this analysis, statistical significance was assessed by t-tests based on a bootstrap procedure with 5,000 bootstrapping. This study begins our interpretation with the hypothesized factors.

As shown in Table I, all five hypotheses were supported. Technology context, Organizational context, Environmental context, Human context are significant to the implementation of cloud computing service and resources by the Malaysian public sector. The R² of implementation was 0.465, which indicates that the factors variables explain 46.5% of the variance of cloud computing service and resources implementation by the Malaysian public sector.

Result also shows that the extent of implementation of cloud computing service and resources by the Malaysian public sector is positively related to the operational. The R² was 0.071, which indicates that the implementation of cloud computing service and resources by the Malaysian public sector only explain 7.1% of the variance of the operational efficiency.

TABLE I. SUMMARY OF THE STRUCTURAL MODEL

Hypotheses	Path Coefficient	t - value	p - value
H1	0.284	4.011	0.000
H2	0.218	3.577	0.000
H3	0.272	4.952	0.000
H4	0.414	7.079	0.000
H5	0.267	3.932	0.000

VI. DISCUSSION

Hypotheses H1 posit that technological context has a positive impact on agencies' implementation of cloud

computing services and resources. All [16] and perceived risks variables have been found to be significant technological factors in determining cloud computing services and resources implementation in the Malaysian public sector. This result is consistent with previous study that looking at the adoption of other types IT innovation in IS domain [6] that conclude organization tend to implement the new IT innovation when they clearly believe that it will derive the advantage on that technology.

Hypotheses H2 proposed that organizational context is associated with the implementation of cloud computing services and resources by the Malaysian public sector. The result shows that organizational context is significant to the implementation stage cloud computing services and resources. Two of the important determinants of organizational context is top management support and organizational readiness also found the same result. The results is consistent with previous study that found organizational factors has positive impact on organizations' implementation of IT innovation [6], [7], [19], [29].

Hypotheses H3 proposed that environment context factors are associated with the implementation of cloud computing services and resources by the Malaysian public sector. Two of the important determinants of environmental context in this study is government regulation and external IS support also found the same result which is significant to cloud computing services and resources implementation stage. This finding is in line with previous literature [18], [37], which consider that government regulation is a mandatory for agency to implement new IT innovation together with support from IS vendors and other organizations.

Hypotheses H4 posit that human context is associated with the implementation of cloud computing services and resources by the Malaysian public sector. This study was designed to determine the factors of human characteristics in the context of innovativeness, knowledge and skills amongst IT personnel in the Malaysian public sector toward cloud computing services and resources assimilation. Therefore, along with the research questions, the result shows that human factors element positively significant to cloud computing services and resources implementation in the Malaysian public sector. This result was in line with previous studies [10], [21] in which found that the assimilation of new IT innovation influenced by human factors. In this regard, both IT personnel innovativeness and IT personnel knowledge influence the assimilation cloud computing services and resources by the Malaysian public sector.

Finally, H5 suggest that the extent of implementation of cloud computing services and resources is related to operational effectiveness. Result indicates a positive relationship between these two constructs. This finding is in line with previous literature [3], [38], which indicates that the extent of implementation computing services and resources may offer new opportunities to gain operational effectiveness in the public sector. However, the variance for opportunities to gain operational effectiveness was

very weak in this study that is only 7.1% explained by the agencies that implement and utilized cloud-based service and resources. Therefore, we consider that additional research is required to explore the nature of this relationship using resource-based view dimension that is not covered in this study.

VII. CONCLUSIONS, LIMITATION AND FUTURE RESEARCH

The model described the factors variables in this study indicates that the factors variables explain 46.5% of the variance of the utilization, use and implement of cloud computing service and resources by the Malaysian public sector. Moreover, model indicates that the implementation of cloud computing service and resources by the Malaysian public sector only explain 7.1% of the variance of the operational efficiency.

The major finding was that the relationship between the implementation stage and operational effectiveness. These relationship was found significant but the variance is very low. This can be concluded that the implementation of cloud-based service and resource is not directly influence to operational effectiveness. In this sense, the agency that implement and utilized the cloud-based service and resource may increase their resource capability before get advantage to their operational effectiveness. Through this perspective, the result of this study suggests that resource capability mediate the relationship between implementation and operational effectiveness.

Although this study provides insightful results, there are some limitations that need to be considered when examining the results. First, the present study was conducted in context of the Malaysian public sector. In future research, a sampling frame that combines both public sector and private sector from other countries could be used in order to provide a more international perspective on the subject. Second, the nature of this study is cross-sectional mode. Therefore, future research proposed to include a longitudinal study to increase the ability of making causal inferences. Third, future research should confirm this finding and look into other possible mediator relationship between implementation and operational effectiveness in order to have a more comprehensive understanding of the subject.

APPENDIX A MEASUREMENT ITEMS

Variables	Items
Relative Advantage	i. Cloud computing services enables your agency to accomplish tasks more quickly.
	ii. Cloud computing services improves the quality of work your agency does.
	iii. Cloud computing services makes it easier to do your agency activity.
	iv. Cloud computing services improves your agency service delivery performance.
	v. Cloud computing services enhances your agency's effectiveness on the service delivery.
Compatibility	i. Cloud computing services is compatible with all aspects of IT services in your

Variables	Items
Complexity	agency.
	ii. Cloud computing services is completely compatible with current IT system situation in your agency.
	iii. Cloud computing services fits well with the way your agency delivers the services.
	iv. Cloud computing services fits into your agency's service delivery style.
	i. Using the cloud computing service takes too much time from your normal duties.
Trialability	ii. Using the cloud computing service involves too much time doing technical operations.
	iii. Integrating cloud computing services with your agency's current IT practice is a challenge
	iv. Cloud computing service is so complicated, it is difficult to understand and use.
	v. Cloud computing services takes too long to learn how to use.
	i. Your agency had a great deal of opportunity to try various cloud computing services.
Perceived Risks	ii. Your agency is able to experiment with the cloud computing services if necessary.
	iii. Your agency can have cloud computing services for long enough periods to try them out.
	iv. Your agency know where to go to satisfactorily try out various uses of the cloud computing services.
	v. Cloud computing services is available to your agency to adequately test and run various applications.
	vi. Before deciding whether to use any cloud computing services, your agency were be able to try them out.
	i. Using the cloud computing services, there is high probability of your agency losing control over the privacy of information
Top Management Support	ii. The security of the cloud computing services for your agency's data confidentiality will affect its implementation.
	iii. Using of cloud computing services would lead your agency to a loss of privacy.
	iv. <i>The privacy of the cloud computing services for your agency's data confidentiality will affect its implementation.*</i>
	v. <i>Your agency does not have confidence in the cloud computing services system.*</i>
	i. Top management team is highly interested in using cloud computing services.
Organizational Readiness	ii. Top management team is aware of the benefits cloud computing services for future success of agency.
	iii. Top management team has allocated adequate resources for the implementation of cloud computing services.
	iv. Top management team has a vision as a leader to promote cloud computing services to the agency.
	i. <i>Appropriate hardware and software is in place prior to cloud computing implementation.*</i>
	ii. Sufficient network infrastructure is implemented before the cloud computing implementation.
	iii. Internet connection in your agency is reliable.
Organizational Support	iv. Internet downloading/uploading speed in your agency is fast.
	v. Lack of technical supports in your agency resulted in problematic cloud computing implementation.
	vi. Manpower in your agency has the technical

Variables	Items
External IS Support	competence to implement cloud computing.
	i. There are vendors outside your agency which provide technical support for effective use of the cloud computing services
	ii. There are organization outside your agency provide incentives for the adoption of the cloud computing services.
	iii. There are organization outside your agency that provide training on the cloud computing services.
	iv. There are technology vendors outside your agency actively marketing the cloud computing services.
Government Support	v. There are technology vendors outside your agency promote the cloud computing services by offering free training-workshop sessions.
	i. Your agency is under pressure from some agencies to adopt cloud computing technology.
	ii. The government is active in providing incentives to adopt cloud computing.
	iii. The government is active in setting up the facilities to enable cloud computing.
	iv. Current laws and regulations are sufficient to protect the interests of cloud computing.
IT Personnel Innovativeness	v. Private government cloud computing environment is currently available for the Malaysian public sector.
	i. Your IT personnel have original ideas.
	ii. Your IT personnel are self-directed and proactive
	iii. Your IT personnel often risk doing things differently
	iv. Your IT personnel work well in cross-functional teams addressing business problems.
IT Personnel Knowledge	i. Your IT personnel are knowledgeable about the key success factors that must go right if our organization is to succeed.
	ii. Your IT personnel are able to interpret business problems and develop appropriate technical solutions
	iii. Your IT personnel closely follow the trends in current technology.
	iv. Your IT personnel are knowledgeable about cloud computing technology
	v. Your IT personnel are skilled in cloud computing technology.
Operational Effectiveness	i. The extent of cloud computing use in leading to reduced IT operation costs at your agency.
	ii. The extent of cloud computing use in leading to increased productivity at your agency.
	iii. The extent of cloud computing use in leading to improved quality in service delivery at your agency.
Cloud Computing Implementation	Email, Data Centre, Database, File Storage, File Sharing, Antivirus & Anti-spam services, Data recovery Centre, Cloud-based desktop, Web hosting, Office productivity, Online collaboration or conferencing, Virtual Machine, Testing and Development

*Item dropped

ACKNOWLEDGEMENT

We would like to thank the anonymous reviewers for their highly constructive comments and suggestions which allowed us to further the work.

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