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Technological Factors of Cloud Computing Adoption Model for Malaysian Small and Medium Enterprises (SMEs)

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***Abstract*—** Cloud computing (CC) provides an economy of scale, efficient resources usage, and the availability of the resources to a large user base. Despite the provision of electronic infrastructure by Malaysian government and spending billions of dollars annually for cloud computing adoption, its level among SMEs is still low. Therefore, the key objective of the current research is to propose a cloud computing adoption model to determine technology attributes that affect the adoption in Malaysian SMEs, as technology component suffers the most significant threat against cloud adoption. The research model is based on Technology Organization Environment Framework (TOE) and its extended conceptual model by Opala. The technology factors include service level, security, cost effectiveness, IT compliance, reliability, flexibility and confidentiality. The primary data collection was conducted using the survey method. A total of 225 questionnaires were collected from IT Executives of the SMEs in Malaysia. Quantitative data was analyzed statistically using SPSS and AMOS software version 21. The results of the data analysis show that the exogenous variables, reliability, confidentiality, flexibility, service level explained 69% of the variance in security effectiveness and explained 41% of the variance in cost effectiveness as well as explained 33% of the variance in IT compliance.

***Keywords*—**Cloud Computing Adoption, Technology Factors, SMEs

I. INTRODUCTION

Cloud Computing (CC) can lead to an assembly of computing and information management features, bringing the economy of scale, efficient use of the resources, and the presence of the resources to a bigger number of users [1]. All of these functions are very attractive to large number of companies which have the limited resources and the need to utilize their resources wisely. The cloud computing is still a new technology that is able to facilitate the users in different ways however, despite of the research expectations, the adoption rate of cloud computing technologies is not increasing.

Despite the provision of electronic infrastructure by Malaysian government and spending billions of dollars annually for adoption of cloud computing, cloud computing adoption by SMEs is still low and minimal in Malaysia [2]. It has been found that the SMEs pay very little attention in investing in IT infrastructure and face cost-related issues in employing the workers who have computer expertise, therefore, they need to rely on outside resources [3]. Even though the potential for cloud computing is clear and much of the existing research has been carried out on cloud computing adoption, the empirical studies on the factors which can affect the cloud computing adoption in the Malaysian SMEs are, however, lacking.

Hence, the increasing access to cloud computing services considerably requires an appropriate model, which can help to address the risks that appear with computing services across Malaysia. As the technology component receives more threat during the cloud computing adoption, it is imperative to analyze the elements within it more intensively. Moreover, due to the growing demand of service and budget pressure, the government may rather turn to technology innovation, as a way to bring better information and services, along with lower IT costs. Despite the presence of a large number of cloud computing adoption models, one of the major obstacles to successful deployment of technology-based adoption is the lack of model tailored to the needs of the users and to date there is no standard model in cloud computing adoption [4].

The main goal of this research is to propose a model for cloud computing adoption, which involves the critical technological attributes to achieve successful adoption.

This study has added some relevant constructs to be used in the technology factors as supported by similar studies on specific IS/IT adoption as are most in the context of this research. These factors are the role of cloud computing adoption, reliability, confidentiality, and flexibility. This study attempts to advance the knowledge on the factors such as service level, security, reliability, flexibility, confidentiality, cost effectiveness and IT compliance that influence cloud computing adoption in organizations, especially in the context of Malaysian SMEs.

The research model attempts to help IT decision makers and the Malaysian government to find out how to raise the adoption rate of cloud computing among SMEs in Malaysia. Many factors must be taken into account to ensure that the model meets the requirements needed to achieve a high level of adoption. This will raise the level of satisfaction, and therefore encourage users to adopt cloud computing.

This research study contributes to the literature and knowledge base in this field and, as well, it makes suggestions for future research. More immediately, it contributes to a more comprehensive understanding of the cloud computing adoption.

One of the contributions of the current work is that it determines the technological factors that are necessary to help users focus on the components that will lead to higher levels of cloud computing adoption. These factors are the selected elements from the TOE (technology context) and the model proposed by Opala. This study has added some relevant constructs to be used in the technological factors as supported by similar studies on specific IS/IT adoption. The key contribution of the current research is to create awareness for the organizations on the important technology factors influencing cloud computing adoption. These factors include Cloud Computing Adoption, Reliability, Confidentiality, Flexibility, and Service Level, as well as Security Effectiveness, IT Compliance, and Cost-Effectiveness. Some of these factors were found to have relationships with each other. There are direct and indirect relationships between the constructs of the model and the cloud computing adoption. Based on the research findings, the direct relationships, namely reliability and service level have a significant effect to cloud computing adoption, while the indirect relationships, namely confidentiality with cloud adoption through IT compliance showed the significant effect.

Another contribution of this research is the proposed Cloud Computing Adoption Model (CCAM). This study is one of the first to derive the required technology factors based on Technology Organization Environment Framework (TOE) and its extended conceptual model by Opala, and combine them into one research model in order to provide further clarification of what determines users' cloud computing adoption. In the current study, several models have been reviewed to identify the most frequently incorporated factors to include in the proposed. Using these theories, this study provides a mechanism to understand cloud computing adoption, using four main technology factors (reliability, confidentiality, flexibility, and service level).

Using these theories, the current study provides the guidelines for developers to be able to adopt main factors from a user point of view in order to incorporate them as the standard factors of technology that support adoption of cloud computing services. In addition, developers, as well as the government, can adapt this model to enhance the cloud computing adoption among the SMEs in Malaysia.

Section I contains the introduction of the proposed model for cloud computing adoption, which involves the critical technological attributes to achieve successful adoption. Section II reviews the literature based on the previous studies. The chapter aims at providing the necessary information on cloud computing adoption. Section III discusses the research methodology employed to address the research problem, Section IV provides the details of important findings and results, section V concludes research work with future directions.

II. RELATED WORK

Building on existing literature gaps was helpful in providing meaningful information about the progress and limitations of the development of cloud computing system. The literature provides a support that will be used to explain the research findings and provide a conclusive report on the appropriate adoption measures to support the newly developed adoption model of cloud computing.

The literature review has revealed a large number of technology models, each of which consists of a number of attributes. Selecting the appropriate models to use is the real challenge. The current work mainly focuses on the high-level attributes of the technology models, which are reported in previous studies. Moreover, it discusses the contents of the technological attributes, which are extracted from the models, to highlight the key attributes and similarities between them. These common attributes will be adopted in the proposed research model as the best attributes for cloud computing adoption.

The TOE framework consists of the technology-organization-environment trifecta, which drives the decision-making process of innovation or new technology adoption. Environment refers to all the external factors that affect the organization and technology, for instance, the nature of the industry. Organization signifies the characteristics of the entity in question while technology is the technological infrastructure and processes that it has. Each component contains a multitude of sub-components that in turn would determine the behavior or ecology of the framework as a whole [5].

The model proposed by Opala is focusing on technological components derived from TOE framework. The main purpose of this model was to provide IT management with valuable data on the factors that influence their decision to adopt cloud computing [6]. The research had an aim to provide data on security, cost-effectiveness and IT compliance attributed that influence the cloud computing adoption as demonstrated in Figure 1. The security risks that are associated with the existing cloud adoption model incorporate issues of identifying the data ownership, confidentiality, integrity, privacy, and virtualization. The compliance exists in each facet of IT, requiring rigorous enforcement policy in order to make the companies maintain proper processes to protect clients and personally

identifiable data from unlawful access. The key aim of the model is to facilitate the IT management professionals to identify if the security, cost-effectiveness, and IT compliance can be generally considered as significant aspects of cloud computing adoption by IT decision makers. Moreover, the model offered the cloud service provider organizations with information that can help in the determination of what is significant to their customer base.

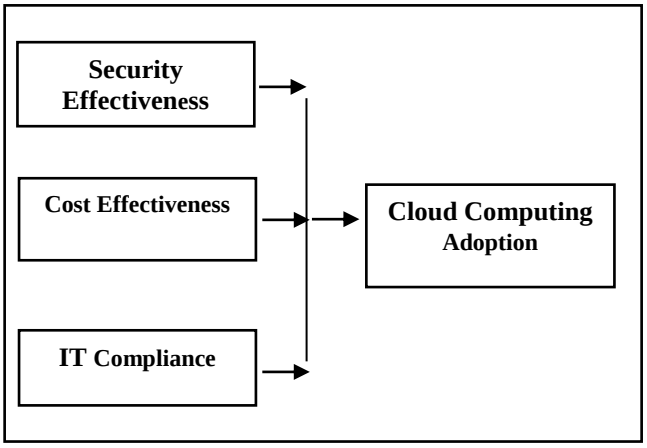

Figure 1. Cloud Computing Adoption Model Proposed by Opala

The selected attributes were derived for the current study from TOE and model of Opala, namely: Service Level, Confidentiality, Flexibility, Reliability, Security Effectiveness, IT Compliance, and Cost Effectiveness.

II.I Service Level

A service level of agreement is referred to a document which helps to identify the service level that the customers are expecting along with technical factors like recovery time objectives and daily backups. The agreement includes the metrics based on which the service can be measured on and the penalties that can happen in case it is not achieved [7]. Cloud vendors offer services such as software, platform, infrastructure, and storage utilizing cloud scalability uniqueness. Cloud interoperability is a concern for cloud providers, and users may prefer to employ multiple vendors or switch between them. Users may be locked in with a cloud vendor and may not be able to transfer their services to others because of incompatibility issues.

II.II Confidentiality

Confidentiality is referred to process of keeping customers' data secret in the cloud system. The confidentiality in cloud system is a large obstacle for the clients to step into it, according to users "My sensitive corporate data will never be in the cloud".

Confidentiality is a term that is still remains rather blurry in the literature and it does not look very clear in the research community, which is the main difference between privacy and confidentiality.

II.III Flexibility

Flexibility provides a competitive advantage as the business needs dictate the consumption of the technology. Flexibility within the cloud computing solution is achieved through an architecture in which organizations are able to scale up or down the computing resource needs [8].

Scalability is realized through the availability of computing resources delivered through cloud computing on-demand. Integrating the concept of technology independence through flexibility architecture with scale is a key attribute for evaluation of adoption to the technology.

II.IV Reliability

Reliability is an ability of a system to keep operating over time without failure. Reliability is one of the most important issues in the cloud computing environment. According to Yang et al., the reliability and performance of services are two important aspects of cloud computing [9]. The service requirements need to be dispatched to remote service processors and gathered for completing these jobs even if some components are faulty: such as power exhaustion and timeout.

II.V Security Effectiveness

In regards to system security, it includes having stable security measures and as well convincing the clients to adopt and have proper security safeguards, mostly with rigorous outcomes due to the carelessness. Software and hardware problems related to standards may also be a deterrent. Another security issues is that if not adequately secured it could be illegally accessed anywhere in the world.

Studies have shown that companies with above average governance have generated 20% higher profits than other companies with poor governance even when the same strategies are employed at each firm [10].

II. VI IT Compliance

IT compliance refers to the corporate norms, procedures and which have an aim to meet the needs that are required by the government with further penalties in case of violation. The cloud-enabled networks IT compliance includes distinct internal IT procedures, like log analysis, authorization, authentication, archiving, system logging, data life cycle, its retention, archival and physical security of cloud servers, and back-up [11].

II. VII Cost Effectiveness

A key factor that helps drives the company towards cloud computing services adoption is the potential to lessen the infrastructure and labor costs. In case the company is public or private the cost is an important factor in cloud computing adoption. The cloud computing technology adoption leads to a more cost-efficient computing by decreasing most of the upfront costs involving setting up an IT infrastructure [12]. The cost effectiveness of the cloud computing, however, mainly lies in the pool of shared resources which leads to a lowered cost of delivery as one server is able to host hundreds of users.

Figure 2 shows the constructs of the proposed model as well the relationship between each pair of constructs.

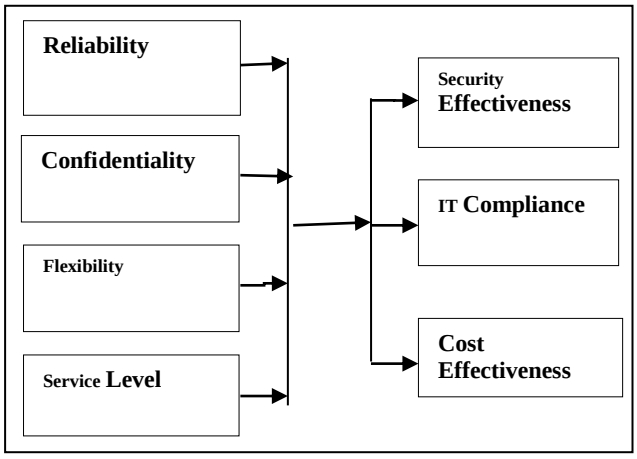

Figure 2. Cloud Computing Adoption Model (CCAM)

III. METHODOLOGY

The research design selected for this study was the step-by-step procedures that are used in developing the research and is based on the whole research structure and context. This research employs quantitative research approach. The focus was to use statistical numbers to represent values to theoretical constructs and concepts. These numbers portray strong scientific evidence of how an event works or takes place. Data were obtained from experts' review by conducting a survey. All the questions in this study were closed questions.

Moreover, the review of the related literature has been made to provide the conclusion in regard to the different issues in order to develop a proper conceptual model with the related attributes for successful cloud computing adoption.

To obtain the necessary data, a survey questionnaire is used to gather data from an appropriate sample size of respondents. Research questions which involve a quantitative approach are particularly applicable to find the answer.

The current research utilizes non-probability sampling technique and for data collection it uses the purposive sampling approach. The primary data collection was conducted using the survey method. A total of 225 completed and usable questionnaires were collected from IT Executives of the SMEs in Malaysia. In order to collect the required data the survey has been undertaken with the use of a structured questionnaire. The main objective of this survey was to investigate the research questions. Furthermore, it intended to test the hypotheses. After the data collection based on the quantitative method, the researcher provided the analysis of the data using SPSS and AMOS software version 21.

VI. RESULTS

There are two types of structural model tested as the part of result. They are measurement model and structural model.

A. Measurement Model

According to Yuserrie et al., the four major fitness indices like GFI, TLI, RMSEA or CFI are used for evaluating the model fit [13]. Similarly, Smith stated that there must be at least three fitness indices significant in order to confirm the model fit. This study adopts the major fitness indices that are commonly used in research. The absolute values like GFI and RMSEA, incremental values include CFI, TLI and parsimonious values like chi-square/df were used to confirm the model fit.

An examination of the goodness-of-fit indices showed that the model fitted the data effectively ($\chi 2$ = 611.442, df= 335). The TLI=0. 931, CFI=.938, RMSEA =.060 and $\chi 2$/df = 1.798. From the square multiple correlation result, it is noted that the model fit criteria are solved and there is a significant influence of reliability of system quality and service level of need for cloud computing with successful adoption of cloud computing. With the significant standardized regression weights of all the constructs and items, the overall square multiple correlation was found to be 0.43 (43%), which is considered a very active and important finding of the study. Figure 3 shows structural model.

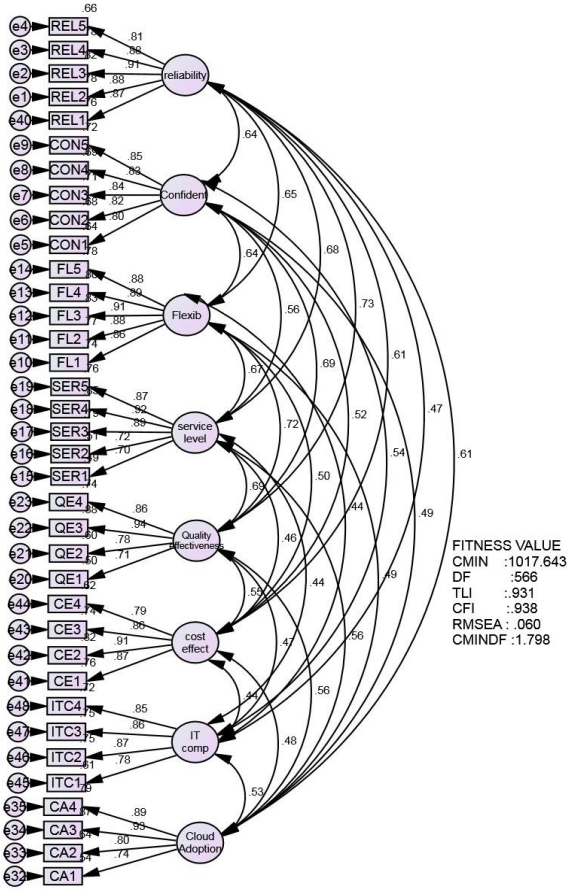

Figure 3. Measurement Model

B. Structural Model

The structural analysis was conducted to determine the cloud computing adoption measurement as a latent construct and to confirm the relationships of the mediating factors, security effectiveness, cost effectiveness and IT compliance, used in the present study with four independent constructs (reliability, confidentiality, flexibility and service level). The structural model as shown in Figure 3 was run on the 36 items of the factors.

The results of the structural model show the model fit indices such as normed $\chi 2$ value (ratio value) was 1.798 less than 5, indicating sufficient fit. In addition, CFI= 0.938, TLI = 0.931. It was noted that if the CFI and TLI values are above 0.90, the model employed in this research is good fit to data.

Moreover, the parsimonious index (RMSEA) was the better measurement. The results also indicate that RMSEA = 0.060 which was the recommended less than of 0.08.

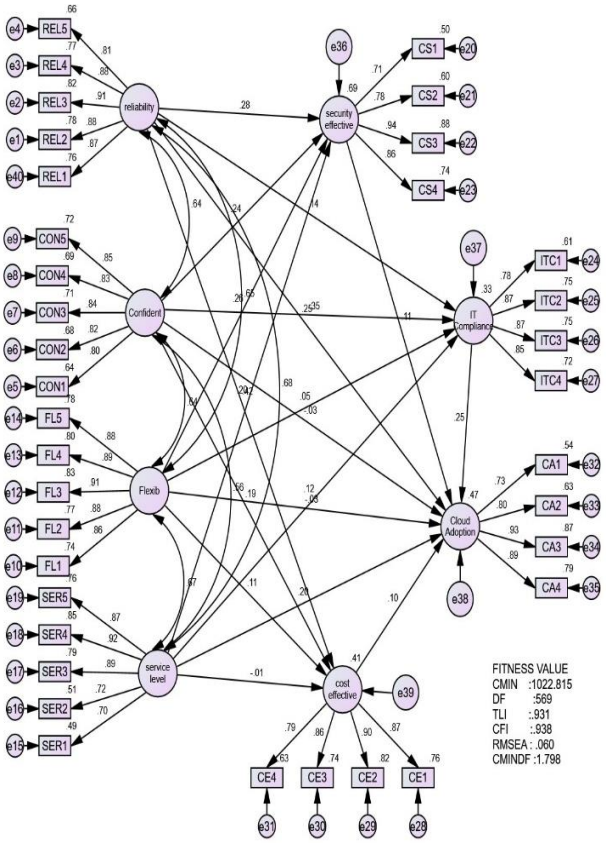

Figure 4. Structural Model

The results of the data analysis show that the exogenous variables, reliability, confidentiality, flexibility, service level explained 69% of the variance in security effectiveness and explained 41% of the variance in cost-effectiveness as well as explained 33% of the variance in IT compliance. Moreover, the results show that all exogenous variables, reliability, confidentiality, flexibility, service level, security effectiveness, cost-effectiveness and IT compliance explained 47% of the variance in cloud computing adoption.

There are direct and indirect relationships between the constructs of the model to the cloud computing adoption. Based on the research findings, the direct relationships, namely reliability, and service level have a significant effect to cloud computing adoption. The indirect relationships, namely confidentiality with cloud adoption through IT compliance showed the significant effect.

According to the findings, reliability and service level were found to have direct significant relationship with cloud computing adoption. Thus, these attributes are necessary as the components of success in cloud computing adoption.

Moreover, the findings have demonstrated that confidentiality has indirect significant effect on the cloud computing adoption through IT compliance. Thus, these attributes are necessary as the components of success in cloud computing adoption

VII. CONCLUSION AND FUTURE SCOPE

The current research focuses on the cloud computing adoption among the SMEs in Malaysia. The study has highlighted the Technology attributes. As a result, cloud computing adoption model has been developed in order to help the organizations increase the rate of adoption and the quality of cloud computing services. Furthermore, the present study has bridged the existing gap.

The benefits of this research are generated from its usefulness to different fields. The research extends the line of developing an e-learning success by development of a cloud computing adoption model, by identifying the significant technology attributes that facilitate in improving the quality in the system. This, in turn, can strongly contribute to users' satisfaction and thus encourage the organizations to adopt the cloud computing.

It is almost impossible for any single study to cover every aspect of the research field of interest. The current study has some limitations, which could be overcome in future work.

Firstly, there is a large number of significant technology factors that can be utilized for the adoption of cloud computing. However, the current research focuses only on seven of them, which are most frequently found in the previous studies on cloud computing adoption. The choice of these specific factors has been based on systematic review of the previous studies and derived and combined with the existing models. The future study can focus on the application of other factors of Technology component, such as complexity, relative advantage, compatibility, and accessibility. This is significant for obtaining broader findings that represent a variety of factors of Technology.

Secondly, this study is based on the quantitative approach, which incorporated a survey with questionnaires that have been distributed among the IT Executives of SMEs in Malaysia to determine the critical technology factors. However, the research could have more validity if this

study had adopted a mixed method of a quantitative approach and qualitative approach (experts' review) to add more in-depth information about aspects of cloud computing adoption. Thus, the results may not be applicable to other approaches, such as qualitative. However, future studies using other approaches may certainly test the research model proposed in this study and provide additional knowledge to the research body.

Thirdly, the cloud computing adoption model in the present study was developed based on the existing models reported in the literature. So, the proposed model is based on TOE model, specifically Technology components according to the previous researchers who suggested that the technology component suffers the most significant threat to cloud adoption. However, in order to expand the knowledge and increase the level of cloud computing adoption, it would be needful to study other contexts from TOE model in the future, namely organizational and environmental for the results to be as representative as expected.

Finally, there is a limitation of the respondents who took part in the data collection of the present study. The main population of the research was IT Executives of the SMEs in Malaysia. The sample did not incorporate line employees who utilize cloud computing services and the providers. Future research could consider the applicability of the sample to other stakeholders' points of view, such as line workers of the organizations, the developers, and providers.

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