

Cloud Deployment Model Selection Assessment for SMEs: Renting or Buying a Cloud

Jacky Keung

Department of Computing

The Hong Kong Polytechnic University, Hong Kong

Jacky.Keung@comp.polyu.edu.hk

Fanny Kwok

Department of Computing

The Hong Kong Polytechnic University, Hong Kong

lmfanny7786@hotmail.com

ABSTRACT

Cloud computing technology is increasingly important in the industry with the promise of increased performance, dynamic resource allocation capabilities and provides a convincing opportunity for organizations to outsource their IT infrastructure under the pay-per-use model offered by many public cloud providers. But there are concerns when selecting between the private cloud and the public cloud that must be taken into account. Many SME enterprises with scarce in-house IT support and limited knowledge about different cloud technologies encounter difficulties in making the most appropriate choice on ‘buying’ a private cloud or ‘renting’ a public cloud service. Through a number of interviews with potential cloud adopters from the industry, this paper identifies the most relevant factors concerning cloud adoption and develops a cloud deployment model assessment method called Cloud Deployment Selection Model (CDSM). The model has been validated in real case studies, and recommendations derived have been compared with real adoption cases. Result shows it is able to accurately recommend a suitable cloud deployment model based on the factors identified from many SME organizations, an important tool for SMEs to decide between the private or the public cloud solution.

Index Terms – Cloud Selection, SME, Cloud Adoption, Deployment Model Selection

1. INTRODUCTION

Cloud computing is one of the most promising and dynamic IT infrastructure technologies available to enterprises today, from large multi-national enterprises to SMEs (small to medium sized) enterprises, all of which are able to enjoy the benefits delivered by the cloud computing paradigm. These benefits are mainly in the cost savings and better resource utilization by consolidating or outsourcing IT infrastructures using platform virtualization technologies available. [1]

Towards the utility paradigm of cloud computing, the most commonly used deployment models are the private cloud and the public cloud. Private cloud utilizes existing or new in-house IT infrastructure to setup a local and virtualized cloud environment to support the needs of the business operations, which provides flexibility in the resource allocation and enhanced data security where data are stored locally. The private cloud model is most commonly employed by companies require full control over their data assets such as in the banking industry, and has the resources available to procure and to

maintain their own cloud infrastructure internally. On contrary, towards the utility computing there is public cloud model provided by cloud hosting providers such as Amazon EC2, Microsoft Azure and Google. These cloud providers offer near infinite resource on demand using flexible pricing models, such as the pay-per-use model which is economically beneficial to many companies wishing to outsource their IT infrastructure and services to the public cloud. Towards this type of public cloud computing deployment, IT labors and equipment expenses can be largely reduced, as well as the reduced costs of electricity and space. All of these benefits are desirable but there are characteristics of concern related to the security and data management of their IT infrastructure in the public cloud, especially many of the public cloud data centers are not geographically located in the same region as they are operating.

Many organizations are aware that the cloud computing technology is able to provide a wide range of benefits to their business operation. However many SME organizations that lack relevant knowledge of the cloud technology may be uncertain whether to “buy” a private cloud or to “rent” a public cloud service. There are numerous reasons causing SMEs difficulties in selecting private cloud or public cloud. Based on observations of SMEs, we have found that a number of factors are related to the commercial promotion of the cloud technologies, the versatility of the cloud, lack of resources within SMEs and the individual requirements of SMEs, which will eventually lead to different interpretations and scenarios of cloud adoption. The Fishbone diagram in Figure 1 summarizes these four major difficulties based on our preliminary interviews with a number of companies in Asia.

To address these challenges this paper identifies the key factors influence the adoption of different cloud technology in the industry, and we introduce a Cloud Deployment Selection Model (CDSM) that will help SME’s to decide whether to adopt a private cloud or a public cloud. CDSM includes a set of metrics and an evaluation process to facilitate SMEs to gain more understanding about Cloud adoption to optimize the operational effectiveness, communication efficiency and cost reduction by utilizing different cloud technologies.

This study has conducted a rigorous research process including a literature review and interviews of eight industry and government-based cloud users for their organization. The selection of interviewees covers all the main stakeholders in the cloud adoption process (i.e. cloud users, cloud solution providers and cloud distributors). The method involved abstracting a rule base from the interview and literature, validating the rule base to exclude inconsistent rules. The

CDSM approach is able to take inputs in terms of responses to a questionnaire and provide appropriate advice to potential cloud adopters. The objectives are deepening SMEs' understanding of cloud, mapping the SMEs' characteristics with cloud's attributes and advising SMEs on renting a Public Cloud or owning a Private Cloud. The CDSM model uses radar charts to better illustrate individual differences in the requirement and recommends a set of suitable cloud deployment solutions based on the profile generated.

Section 2 discusses the related work and the background of the study. Section 3 introduces the proposed CDSM cloud technology selection model, including the metrics identified in the study, and follow by the interpretation of the model using radar charts in Section 4. An empirical evaluation using a real case study is discussed in Section 5. Section 6 summarizes and concludes the paper.

2. BACKGROUND

Having overwhelming promotion of cloud (Figure 1), Information of cloud floods the industry when every IT vendor emphasizes their products or services with cloud element in their advertisement and company website and distributors organize various cloud related workshops discussing benefits of cloud. [2] As a result, SMEs may have difficulties in digesting and screening the relevant information, which is applicable and useful for their SME needs. [3, 4] As there is lacking of both internal and external resources[5], SMEs may not have time to study and evaluate every cloud solutions available in the market. SMEs may not possess in-house experienced and professional IT experts advising the choices of cloud adoption as there are thousands of choices abound in the market. [6] And in terms of external resources, there is no open source cloud adoption advisory model for SMEs' reference in selecting Private Cloud or Public Cloud. SMEs have to seek for external consulting services of Cloud suppliers because vendors have their own set of evaluation framework to planning clients' cloud migration journey. [3, 5]

For cloud technology adoption assessment, Wu [7] [8] uses the classical TAM technology acceptance model for the SaaS adoption [9] in the cloud, but the model is only useful to evaluate user perceived usefulness after a certain period of actual usage, which is a common drawback within the TAM model. To further assess the benefits, Subha et al. [10] correlates the suitability of the adoption of cloud computing by its corresponding return on investment to assess the benefits of such a deployment. Most of which SME studies reported are concerning the post deployment evaluation, and many of which are focusing on the related challenges in security and privacy aspects of cloud computing adoption.[11].

In order to address the key factors leading difficulties in cloud adoption, we have prepared a set of questionnaires and conducted interviews with relevant stakeholders from 7 organizations to gathering experts' opinion about the adoption of cloud, the information collected were vital for us to develop a qualitative set of evaluation metrics for private cloud or public cloud adoption, which later formulates the CDSM model proposed in the paper.

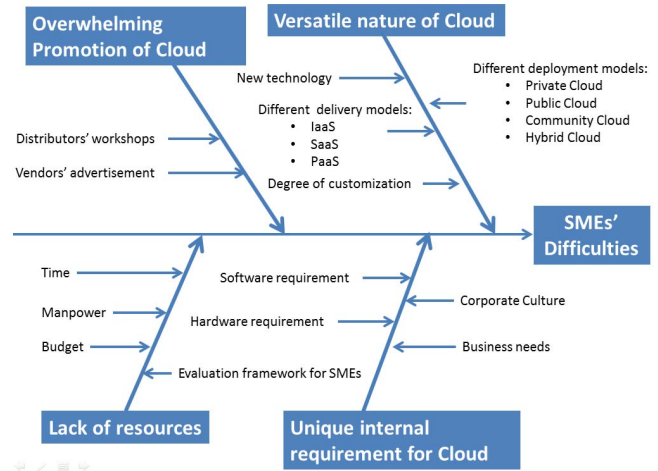


Figure 1. Factors leading difficulties in cloud adoption by SMEs.

3. CDSM - Cloud Deployment Selection Model

After aggregating and analyzing the criteria recommended by the industry experts and the factors discussed in research papers, eight key aspects affecting the adoption of Private Cloud and Public Cloud were identified (see Table 1). They are general aspects for Cloud adoption, *AS-IS IT condition*, *TO-BE IT condition*, *sensitivity of data*, *availability of resources*, *demand of IT resources*, *nature of organization* and *risk possibility*. More specific criteria were identified under each major aspect (Table 1).

One rationale in determining these eight aspects was to encourage SMEs gaining knowledge of their internal condition in advance. Among the eight aspects included in the evaluation metric, general aspects for cloud adoption is designed to advise SMEs on cloud adoption in general before recommending either private cloud or public cloud. Assuming that the SME is advised to seek for a cloud solution, the remaining seven aspects are designed to examine the characteristics and the expectation of the SMEs' on cloud in more specific dimensions.

3.1 General aspects for cloud adoption (S1)

Four specific criteria are covered in this section and they are *data traffic*, *data traffic's influence on the SME's business*, *current IT capacity* and *predictability of IT demand*.

The stability of *data traffic* in the company is associated with the *data traffic's influence* over SMEs' business revenue or service performance. The higher impact that the data traffic has on the business, the more likely it is that the Cloud is appropriate for the SME. In addition, the *existing IT capacity* of the company is also considered because if the current IT support does not satisfy the SME's demands, the scalability provided by Cloud computing is definitely a good choice to solve the SME's problems. Moreover, if the *predictability of IT capacity demands* of the company is low (i.e. the IT capacity demands are unpredictable), it is very likely that Cloud's elasticity and pay-per-use charging scheme will reduce costs and at the same time provide the ability to seize any business opportunity arising in unexpected circumstances.

Major Aspects	Score Notation	Criteria	Factor Notation	Weighting
1. General aspects for cloud adoption	S1	- Data traffic - Data traffic influence to business - Current IT capacity - Predictability of IT demand	G1 G2 G3 G4	0.3 0.4 0.2 0.1
2. AS-IS IT condition	S2	- IT maturity - IT complexity - IT compatibility - Dependency on legacy system	A1 A2 A3 A4	0.1 0.3 0.3 0.3
3. TO-BE IT condition	S3	- Expected level of IT changes - Expected workload assigned to in-house IT department - Desired IT control - Intended coverage of Cloud	T1 T2 T3 T4	0.25 0.25 0.25 0.25
4. Sensitivity of data	S4	- Data significance - Data confidentiality	S1 S2	0.5 0.5
5. Availability of resources	S5	- In-house IT support - Manpower - IT skills - Time - Space	R1 R2 R3 R4 R5	0.2 0.2 0.2 0.2 0.2
6. Demand of IT resources	S6	- Customization of IT solutions - Users' mobility - Future IT usage expansion - Strategic alignment	D1 D2 D3 D4	0.4 0.15 0.15 0.3
7. Nature of organization	S7	- Scale of business - Development stage - IT conservativeness - IT decisiveness	N1 N2 N3 N4	0.15 0.2 0.4 0.25
8. Risk Possibility	S8	- Risk of natural disaster - IT failure rate	RP1 RP2	0.5 0.5

Table 1 Summary of major aspects and their respective criteria identified.

3.2 AS-IS IT condition (S2)

Four specific criteria are covered in the AS-IS IT condition describing the current situation, which increases understanding of the existing IT infrastructure of SMEs: their level of *IT maturity*, *complexity*, *compatibility* and *legacy dependency on their current IT infrastructure* are measured. All these factors have a significant impact when determining whether a Private Cloud or a Public Cloud solution is more suitable for an SME.

The *IT maturity* of SMEs will be assessed with respect to the level of business process automation and virtualization. This factor is considered because only SMEs with higher level of IT maturity can utilize a Private Cloud and optimize the benefit of Cloud computing. This is because the level of IT maturity reflects the standardization level of the business process or management style of SMEs. Public Cloud is likely a better choice for SMEs possessing relatively low IT maturity as their IT infrastructure is likely to be still growing and subject to change. The Public Cloud requires a smaller scale migration effort than a Private Cloud and is applicable to these types of SMEs.

In terms of *IT complexity*, *compatibility* and *dependency on legacy systems* there is a similar influence on an SME's Cloud decision. These three concerns are derived from the

existing IT management issues such as the operation system, software and hardware, involvement of self-developed systems and legacy systems. If an SME's recent IT infrastructure shows a high degree of complexity, compatibility and *dependency on specific legacy systems* then a Private Cloud is likely to be recommended because issues such as vendor lock-in and system integration become more controllable. In addition, system crashes may occur as a result of low interoperability between a Public Cloud platform and the SME's internal IT infrastructure. In this case a Private Cloud allows an SME to have a comprehensive Cloud solution without suffering from problems caused by the Public Cloud infrastructure. In contrast, SMEs with relatively low scores for these three factors indicating their current IT infrastructure is relatively simple, are likely to gain benefits from a Public cloud solution.

3.3 TO-BE IT condition (S3)

Four specific criteria are used to assess an SME's attitude towards future IT changes and planned IT strategies. The factors are: *expected level of IT changes*, *workload assigned to in-house IT department*, *desired level of IT control* and *intended coverage of cloud solutions*.

The level of IT changes within the cloud can be further classified into incremental changes and radical changes. A Private Cloud allows SMEs to develop a brand new business model using Cloud technology by completely re-architecting the current IT infrastructure to accomplish radical IT changes. A Private Cloud is likely to be the best for SMEs that plan for radical *IT changes* whereas Public Cloud enables SMEs to restrict themselves to small-scale Cloud migration progressively.

The *expected workload of the in-house IT department* is related to the level of *desired IT control* by an SME because the more responsibilities that the in-house department bears, the higher internal IT control is required. SMEs with a heavy workload assignment to their in-house IT department require stronger control by IT management, and hence a Private Cloud is an appropriate choice for this type of SME. A Private Cloud solution allows almost complete control over the Cloud infrastructure. In contrast, renting a Public Cloud solution is an option for SMEs, which require less control of IT and have a limited internal IT department because IT management can be outsourced to the Public Cloud vendors.

The *intended coverage of the Cloud* is associated with strategic alignment with the corporate strategies of the SME. If an SME intends to implement a cloud solution that covers the corporate business process, a Private Cloud is an alternative that likely to be suitable, because massive IT resources are required for large scale of implementation. In contrast, for SMEs that simply want to achieve a small-scale benefit such as project-based strategy, a Public Cloud solution is preferable because the Public Cloud involves less costs and manpower effort for deployment and management and enabling SMEs to adjust their Cloud solution from time to time quickly.

3.4 Sensitivity of Data (S4)

Two specific factors need to be assessed in order to understand the nature of data that SMEs would like to be managed by cloud and importance placed on data significance and data confidentiality.

The *significance of data* examines whether the data involved belongs to the core business processes of SMEs or not. If the data has a high degree of association with the core business of the enterprise, then corruption of data resulting from Cloud service failure would have a large negative impact on SME's business performance. In this case a Private Cloud is recommended because data loss or service failure of Cloud will lead to chaotic situation and if the Private Cloud is under SMEs' control it will help to reducing the possibility of such a risk. If data has lower degree of association with the core business, a Public Cloud can be adopted by SMEs because the failure of a Cloud service will have a minimal impact to overall business operation of the SME.

Data confidentiality is related to the legal concerns of personal privacy and internal management issues. A Private Cloud is suggested for SMEs with data that possesses high degree of confidentiality if the data involve personal information of employees, clients or company confidential material. A particular problem occurs if there is a possibility of breaching government policy or the internal policy of the

SME. A Public Cloud is a better choice for SMEs if the data involved in the solution does not include any personal information concerning employees, clients or business secret of SMEs.

3.5 Availability of resources (S5)

Five specific factors are included in evaluating the capability of SMEs for renting or buying a Cloud solution in terms of an SME's internal resources availability: the level of *in-house IT support*, *manpower*, *IT skills of manpower*, *time*, and *physical floor space*.

Level of in-house IT support, *number of IT experts and staff IT skills* comprises the overall evaluation of an SME's ability to adopt a Private Cloud or Public Cloud. If SMEs have high level of internal IT support and there are sufficient number of IT experts having advance knowledge of monitoring the Cloud's deployment then a Private Cloud is a preferred alternative. In addition to these three considerations, owning a Private Cloud requires longer life cycle and the actual space for the hardware equipment storage of Cloud solution is a significant cost overhead in many cities where the cost of floor spaces are extremely expensive (e.g. Tokyo, Hong Kong, Singapore, etc.)

In contrast, a Public Cloud becomes a better choice for SMEs that do not have sufficient IT capability and physical resources to buy a Private Cloud. Public Cloud suppliers can solve an SME's problems by providing professional consultancy services to the SMEs, and floor space can be saved if a public cloud solution is adopted.

3.6 Demand of IT resources (S6)

Four specific criteria are included in this factor in order to determine the appropriateness of Private Cloud or Public Cloud adoption based on the SME's future demand of IT resources. The factors are *the degree of customization of IT solutions*, *users' mobility*, and *future IT usage expansion and company strategic alignment*.

The *degree of IT solutions customization* indicates whether renting or buying a Cloud solution is a wiser decision for SMEs. Some SMEs may differentiate their business from their competitors with special business process or management procedures. In such cases, the relatively more standardized services offered by Public Cloud providers cannot satisfy the needs of these SMEs. Implementing a Private Cloud solution provides SMEs greater control in establishing tailor-made solutions that are appropriate for the special features of the business and management process. For SMEs that envisage a lower degree of Cloud customization, renting a Public Cloud solution may be adequate to manage the needs of SMEs with minimal costs.

User's mobility relates to the location of employees accessing company data as well as the growth of IT in the company. This has a significant impact on whether SMEs should adopt a Private Cloud or a Public Cloud solution. For example, for SMEs with a high degree of users' mobility and that are expecting to experience an *expansion of IT requirements*, a Public Cloud can be deployed to satisfy the dynamic data access point of employees and cater for rapid expansion of IT capacity driven by the business needs.

And with respect to *strategic alignment* with cloud adoption and SMEs' internal strategies, a Private Cloud is a preferable option for SMEs if the deployment of cloud computing is one of the corporate IT strategies which are the policies applicable to the enterprise as a whole. In contrast, a Public Cloud is more suitable for SMEs when the deployment of cloud computing is used for optimizing the performance and minimizing the cost of particular project.

3.7 Nature of organization (S7)

Four specific aspects need to be examined in order to diagnose the impact of the SME's management attitude and organizational culture towards IT evolution. These factors are: *the scale of business, development stage, IT conservativeness, and IT decisiveness.*

The *business scale of SMEs* and the *development stage of SMEs* have a critical impact on the Cloud adoption decision. Relatively large or expanding SMEs may require more IT support and therefore need a Private Cloud infrastructure. In contrast the benefits available from a Public Cloud are sufficient to support SMEs, which are operating in the startup stage with more restricted business model.

An SME's level of acceptance and willingness to adopt Cloud computing are also considered in the evaluation framework. A Private Cloud requires SMEs to re-architect their existing IT infrastructure, corporate IT strategies and the operation model of the company. Thus, only SMEs with low *IT conservativeness*, a liberal attitude, and strong determination to move their current IT condition to next era of IT changes, will be ready for Private Cloud migration. In contrast, SMEs with higher conservativeness and weaker enthusiasm for upgrading their current IT infrastructure but that, nonetheless, would like to improve the efficiency and effectiveness of their existing business process, should consider adopting a Public Cloud solution.

3.8 Risk Possibility (S8)

Two specific factors of geographical location of SMEs' office and the *IT related failures* are to be assessed. Obviously, a Private Cloud is suitable for SMEs that face strong risks of possessing sensitive data because the hardware of Private Cloud requires safer storage environment. In contrary, public cloud could be a viable option if data security is not a major concern, and is recommended for SMEs located in areas with high risk of suffering from *natural disasters*, where their data can be relatively safely stored in a remote environment.

The reason for examining the existing IT failure rate of SMEs is that the rate may reflect the suitability of outsourcing the IT management. If the SME currently has a low rate of IT failure, then Private Cloud can be recommended. This is because the degree of IT failure suggests that the current capability of the SME's IT management is likely to be able to handle the IT workload brought by Private Cloud. In the case of SMEs with higher rates of IT failure, a Public Cloud is a better choice because the majority IT management tasks are provided by the services offered by vendors. By outsourcing IT management to a Cloud provider, an SME can devote more of their resources to development of their core business

instead of spending time, manpower and financial resources in solving problems caused by IT failure.

4. CDSM RADAR CHART

Radar charts for CDSM (Cloud Deployment Selection Model) is used to illustrate three reference models derived from the eight Cloud selection criteria specified. The rationale of using radar chart is that the similarities and dissimilarities of each selection criteria can be represented in a clear graphical format for interpretation.

The score for each criterion is calculated based on the weights (Table 1) derived from the main study and then transformed into a radar diagram to represent the overall requirement of the SME. The initial reference model (general aspects S1) is used to assess whether any Cloud solution is appropriate for an SME. The remaining reference models recommend SMEs to adopt either a Private Cloud or Public Cloud solution are derived from the remaining 7 aspects of *AS-IS IT condition, TO-BE IT condition, sensitivity of data, availability of resources, demand of IT resources, nature of organization and risk possibility* described in the previous section.

4.1 Cloud adoption reference model in general- view

Before going into further decision of adopting Private Cloud or Public Cloud, the Cloud Technology Selection Framework will firstly identifying the appropriateness of Cloud adoption for the SME under investigation.

Figure 2 and Table 3 demonstrate 3 decision outcomes indicating whether Cloud Computing technology should be recommended based on the scores. For any SME that requires *high data traffic, high IT predictability, high data traffic influence and high IT capacity*, we strongly advise that they start planning the Cloud adoption strategies. There is strong evidence in this circumstance that Cloud Computing enables better IT resources management, enhances company's responsiveness to dynamic business opportunities and in achieving economic of scale. The scalability and flexibility of Cloud offers IT capacity to SMEs whenever needed and Cloud services can be terminated as requested, avoiding the need for surplus capacity or slow response to increased demand.

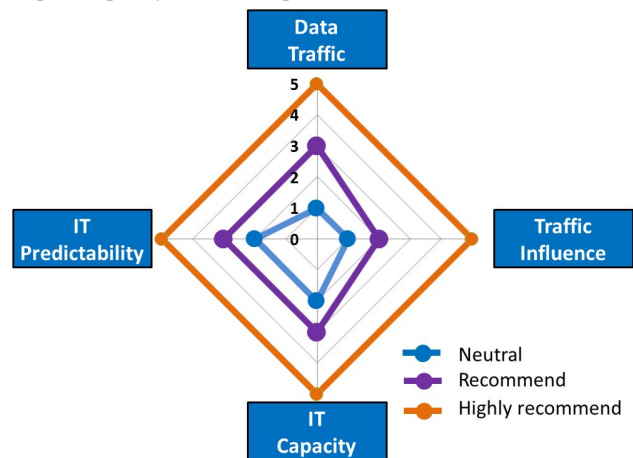


Figure 2. CDSM Reference models for 3 different cloud technology recommendation

Factors	Score		
	Neutral	Recommend	Highly recommend
Data traffic	1	3	5
Data traffic influence	1	2	5
Current IT capacity	2	3	5
Predictability of IT demand	2	3	5

Table 2. CDSM scores for different cloud solution recommendations

4.2 Reference models for Cloud Adoption in specific view: To rent or to buy

After assessing the general concerns of whether an SME should consider Cloud adoption at all, we conduct a more specific and advanced evaluation of the appropriateness of adopting a Private Cloud or a Public Cloud solution with respected to the other seven aspects: *AS-IS IT condition*, *TO-BE IT condition*, *sensitivity of data*, *availability of resources*, *demand of IT resources*, *nature of organization* and *risk*.

4.3 When Private Cloud is Highly Recommended

‘Buying’ a Private Cloud is recommended to any SMEs that exhibit similar pattern to the reference model shown in Figure 3 and Table 3 derived from the study. With respect to the internal environment of SMEs in this scenario, the company scored marks in range of four to five in the *AS-IS IT* and *availability of resources* aspects. The rationale behind these scores is that the maturity of both IT development and business operation have already reached a stage of standardized or optimizing level which allows the company to enjoy fully the benefits available from adopting a Private Cloud.

More importantly, the high score reflected in the *AS-IS IT* condition implies the interoperability of SMEs’ existing IT infrastructure with a Public Cloud solution is problematic due to the complexity and the internal compatibility of the current IT solution is high. In addition, the availability of high quality internal resources such as manpower, IT skills, floor space and time are available to control the entire Private Cloud deployment and any follow-up actions.

Other than internal resource affordability, the company nature and culture also determines the success of Private Cloud adoption in relation to two aspects and they are data sensitivity and the nature of organization. The aspect of data sensitivity evaluates the impact of data corruption or Cloud service failure on the business operation of the SME. The scores of five in Table 3 imply that the information to be managed in a Cloud solution may involve personal information or confidentiality issues with severe privacy concerns.

To conclude, a Private Cloud is highly recommended to SMEs that fall into this reference model category developed in the study. Because the company requires the power of Private Cloud to achieve better resources management over IT infrastructure as well as requiring absolute control of its own IT infrastructure. The score distribution shown in Figure 3

demonstrates the characteristics of this type of SME are an appropriate match with Private Cloud’s attributes. The SMEs’ maturity in business process and IT management allows it to optimize the benefit of Private Cloud. The complexity of the existing infrastructure might require more effort for an SME to migrate its IT infrastructure to a Public Cloud solution than to re-architect the whole IT infrastructure with a Private Cloud. At the same time, SMEs of this type assume to have sufficient resources especially among IT staff to follow-up and monitor the development of Private Cloud. They are able to develop a sustainable IT infrastructure to support the extensive IT capacity implied by the desired revolutionary IT strategies and expected increase in business demands.

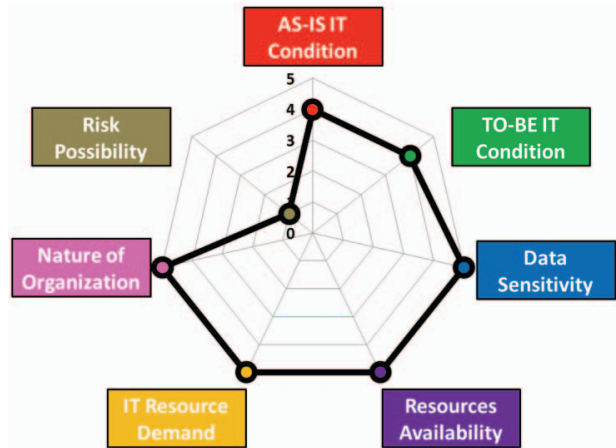


Figure 3. CDSM reference model for Private Cloud – Highly Recommended

Factors	Score
AS-IS IT condition	4
TO-BE IT condition	4
Data sensitivity	5
Availability of resources	5
Demand of IT resources	5
Nature of organization	5
Risk possibility	1

Table 3. CDSM scores to highly recommended Private Cloud

4.4 When Public Cloud is Highly Recommended

The CDSM model highly recommends SMEs to ‘rent’ a Public Cloud solution if SMEs score is similar to that of the reference model shown in Table 4 and Figure 4.

From the perspective of the internal condition of SMEs indicated by this reference model: they achieve low scores for the *AS-IS IT* condition and *availability of resources* as shown in Table 4. Such a scoring pattern enables SMEs of this scenario to enjoy an improvement in business efficiency and IT effectiveness with a Public Cloud solution. This is because the maturity level of both IT development and business operation is relatively weak and the simplicity of the current IT structure allows a high degree of interoperability between the SMEs platform and platforms available from Public Cloud services.

In addition, the organizational nature and culture also plays an influential role in determining the appropriateness of Public Cloud adoption. In this case, data sensitivity and nature of organization of SMEs will be assessed by the system. With a score of one as displayed in Table 4, the sensitivity of data

should have limited impact on the business. Therefore the information involved in the Cloud solution is unlikely have a high degree of privacy or company confidential concerns.

In terms of the future growth of the SME IT infrastructure, the TO-BE IT condition and demand on IT resources of SMEs need to be examined. The score for these two factors reflects the expectation derived from the strategic plan and the future IT demand of the enterprise. Obviously, the desire of SMEs to transform their IT infrastructure with Cloud technology is weak and hence only the small changes necessary to adopt a Public Cloud solution are required.

In relation to IT resources demand, the Public Cloud's power is capable of satisfying the anticipated growth of IT capacity because SMEs in this scenario have relatively simple business processes and do not require high degree of customization of their technological solutions. Although SMEs in this scenario do not seek massive support of Cloud Computing, certain functions and the performance of the Public Cloud are needed for potential development of IT capacity which is needed in the current dynamic and competitive business environment.

Risk is one of the most important factors in the buy or rent decision. Table 4 shows that SMEs that fall into this scenario have the highest score in the risk assessment. This implies the need to outsource SME's IT infrastructure because the company is vulnerable to the possibility of natural disaster or IT failure likely caused either by a potentially dangerous geographical location of the office or an inexperienced IT operator.

Above all, a Public Cloud solution is highly recommended to SMEs that share similar characteristics to that of in Figure 5 because the features of Cloud Computing are necessary to improve the business and IT condition of the company but the SMEs have limited resources and relatively less IT demand. Hence, a Public Cloud is a better choice for the enterprise. A Public Cloud migration requires only changes to that specific public cloud platform while adoption of Public Cloud reduces the risk of natural disaster and/or IT failure. Consequently, the adoption of Public Cloud can enhance the business performance of SMEs with better resources management supported by highly scalable and speedy deployment of the Public Cloud and at the same time saving SMEs' budget.

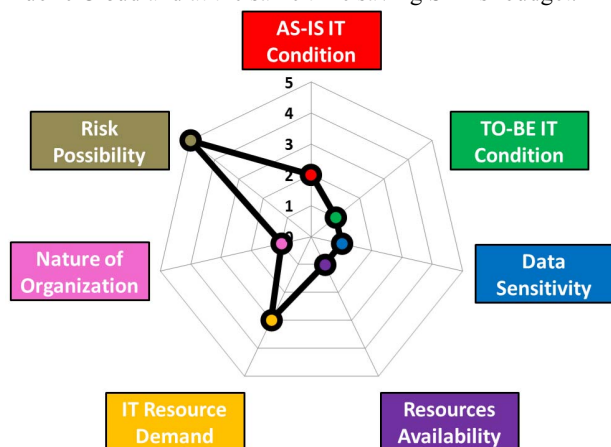


Figure 4. CDSM reference model for Public Cloud – Highly Recommend

Factors	Score
AS-IS IT condition	2
TO-BE IT condition	1
Data sensitivity	1
Availability of resources	1
Demand of IT resources	3
Nature of organization	1
Risk possibility	5

Table 4. CDSM scores to highly recommend Public Cloud

4.5 Summary

Figure 3 and Figure 4 show the major differences between two CDSM reference models for Private Cloud and Public Cloud recommendations according to our study, and there are two observations that can be made. First of all, both SMEs that fall into these two reference model share the common characters in terms of seeking Cloud technology to upgrade their existing business and IT infrastructure models but there are major differences between SMEs recommended to adopt Private Cloud and Public Cloud in terms of the seven aspects of the reference model.

Secondly, a high score of six aspects of *AS-IS IT* condition, *TO-BE IT* condition, data sensitivity, resources availability, demand of IT resources and nature of organization implies that a Private Cloud is likely suitable for the enterprises, and a lower mark implies that Public Cloud is preferable for SMEs. In contrast, the lower score gained in aspect of risk, the better match between the SME and the Private Cloud while a higher score represents a better match with the Public Cloud and the SME.

5. EMPIRICAL EVALUATION

Two real business cases have been carried out to evaluate the CDSM reference model developed, due to space limitation we only show the result of the first case study from a real estate company in Hong Kong, the 2nd study exhibited similar conclusion.

This company is a privately held real estate agency in Hong Kong, with businesses spread across the region including Hong Kong, Macau and China. As the IT capacity is growing rapidly together with the business expansion, as well as their online business and services, there is an urgent need to consolidate the IT resources to provide better customer services and experiences.

The objective is to compare the reference model using CDSM we have developed in the study and with their privately held cloud infrastructure, more importantly to observe the differences between the scores we have derived from other companies in the study. The first part of the evaluation examines the S1 metric, which measures the general aspects for cloud adoption, the scores are 5, 4, 2 and 4 for *Data Traffic*, *Data traffic influence to business*, *Current IT capacity* and *Predictability of IT demand* respectively, resulting an overall calculated score of 3.9 in which case a cloud-based solution is suitable for the circumstance based on the CDSM interpretation.

The remaining 7 aspects have been measured and are shown in Table 5. Figure 5 shows the radar chart overlapping our CDSM reference model with the Midland Realty's model. Table 5 shows that the 7 aspects are closely marching to the

profile of the Midland Realty Company that we are evaluating. Given that the differences between factors are insignificantly different, this implies that the CDSM can be effectively used as a reference model to aid selecting a suitable cloud solution for many other SME companies. The main limitation is the sample size and the geographical locations of these companies, and we are anticipating exploring and studying more samples to be collected from other regions to improve the performance of the CDSM model for cloud deployment model selection.

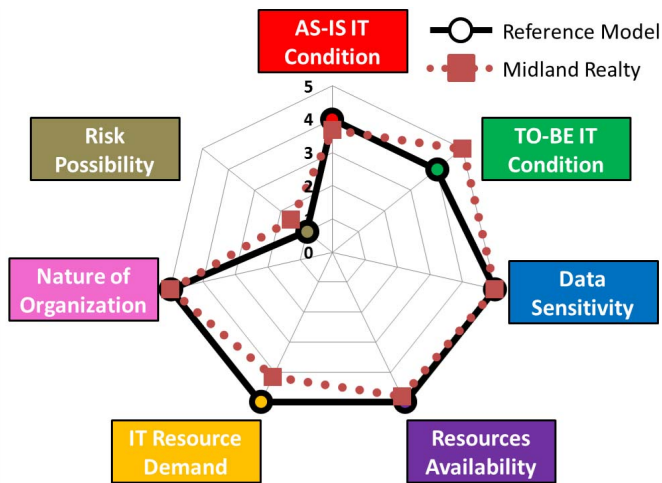


Figure 5. Our CDSM Private Cloud Reference Model vs. Midland Realty's model

Factors	Score		Difference
	Realty Company	Reference Model	
AS-IS IT condition	3.7	4	-0.3
TO-BE IT condition	5	4	+1
Data sensitivity	5	5	0
Availability of resources	4.8	5	-0.2
Demand of IT resources	4.15	5	-0.85
Nature of organization	5	5	0
Risk possibility	1.6	1	+0.6

Table 5. Score variance of Midland Realty and CDSM model

6. CONCLUSION

This paper provides an evolutionary approach to construct an effective cloud deployment selection model (CDSM) for SME organizations. In order to facilitate important IT decisions on different cloud technology adoption, the CDSM model captures important requirements and aspects related to the core IT resource requirements, and future IT resource provisioning needs, and to facilitate SME's decision making process when deciding whether to buy or rent a Cloud solution. The information collected from the industry experts was carefully analysed and converted into reference models for recommending Private Cloud or Public Cloud to SMEs by mapping the characteristic of SMEs to various features of cloud computing.

The CDSM model identified twenty-nine important cloud selection criteria categorised into eight separate measurable aspects. Evaluation result shows that the reference model developed is closely align with the real situation, correctly reflects its choice of technology adopted by the company. The implication is that the CDSM model can be effectively used to provide important recommendations as to whether to consider the private cloud or the public cloud.

To conclude, the success of SMEs' Cloud adoption does not solely rely on the selection criteria discussed in this study, but depends on the development of technology, strategic actions of stakeholders and other peripheral elements. We believe our metric and evaluation process represent a starting point for SMEs seeking to assess the value of cloud computing as their IT infrastructure.

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