Report

Cloud infrastructure-as-a-service consumption at the organisation level: Exploratory study in Thailand

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Abstract: This study investigates the status of services, issues and needs related to infrastructure-as-a-service (IaaS) for organisational consumers in Thailand. The important advantage of this study is that it provides useful information to providers for developing guidelines to promote the readiness of IaaS provision in Thailand to meet consumers' needs. Furthermore, related organisations can use the study results to foster cloud IaaS in the country based on the problems and needs of providers.

We conducted a survey using the statistical methodology of mixed sampling with stratified random sampling and purposive sampling based on government and private sectors including various types of businesses, as well as a set of questionnaires as a tool to collect data for analysis. In addition, we studied existing research and scholarly work to create a clear survey procedure. Based on the survey results, we find that the majority of organisational consumers already use domestic IaaS to reduce costs and also use overseas IaaS to increase data availability. The most popular form of IaaS consumption is virtual data storage. Some major consumer concerns are the lack of confidence in service security, quality and standards, and their main demands are security regulations on the provider's side and improved service level agreement standards.

INTRODUCTION

The government of Thailand has established a digital economic policy to drive the national economy using information and communication technology to connect every sector at every business level to enhance intra- and inter-organisational management efficiency and to create large-scale economic activities for business and industrial development. The Ministry of Information and Communication Technology responded to this policy by stipulating a strategic framework for the digital economy and society [1] that focuses mainly on establishing digital infrastructure including information technology infrastructure. The framework consists of five strategies. In particular, these strategies include a digital infrastructure (hard infrastructure) development strategy, the establishment of a data centre for cloud computing services [2] and globally recognised technology that can meet both technical and economic demands [3, 4], especially infrastructure-as-a-service (IaaS), which provides highly flexible computing resources such as data storage and virtual servers suitable for all types of business. Domestic providers include public cloud providers (e.g. CAT Telecom Public Company Limited) [5], community cloud providers (e.g. Electronic Government Agency, which is a public organisation) [6] and private cloud providers (i.e. organisations that are clients of the public cloud providers and are able to set up their own clouds).

A survey of related work finds reports on cloud computing readiness for organisations in Thailand [7] and a guideline for domestic cloud service development [8]. Our previous work [9] examined a survey of IaaS providers in Thailand. These related studies, however, focus only on providing an overview of cloud service providers in Thailand, not IaaS, but they are outdated. Although our recent work [10] investigated the status, problems and demands of IaaS individual users in Thailand, an up-to-date study on organisational consumers' needs will allow existing service providers to improve their services and potential service providers to provide services that can best address consumers' needs at the organisational scale. Thus, the objective of this study is to explore the status of services, issues and needs related to IaaS for organisational consumers in Thailand.

RELATED CONCEPTS

The important concepts for understanding the results of this study are cloud computing and virtualisation, as described below.

Cloud computing is defined [11] as a model that allows convenient access to shared, configurable computing resources such as networks, servers, storage, applications and services via an on-demand network. These resources can be swiftly supplied and retrieved with minimal management exertion and interaction with service providers. One of the causes of the paradigm shift towards cloud computing that is continuously occurring in many organisations worldwide is its ability to reduce economic risk [12] by specifying expenditures based on the volume or actual usage period (pay-as-you-go) of computing resources. Whenever the user demand for a service change, organisations can promptly add or remove leased computing resources accordingly. The key concepts of this study are as follows. 1) IaaS is the provision of computing resources including processing units, data storage and networks that users can employ to install operating systems or any applications as required [11]. 2) Public cloud is a model of application in which IaaS is provided for public use, and it may be owned, managed and operated by a business organisation, educational institution, public sector organisation or any combination thereof provided that it is installed on the public cloud provider's site [11]. 3) Private cloud is a model of application in which

IaaS is provided for the exclusive use of any organisation with multiple consumers, and it may be owned, managed and operated by the organisation, a third party or a combination thereof provided that it is installed either on the public cloud provider's site or on the user's site [11]. 4) Community cloud is a model of application in which IaaS is provided for the exclusive use of a community of consumers from organisations with common goals (e.g. obligations and security requirements), and it may be owned, managed and operated by one or more organisations in the community, a third party or a combination thereof provided that it is installed either on the public cloud provider's site or on the user's site [11]. 5) Hybrid cloud is a model of application in which IaaS consists of multiple cloud infrastructures bound together by technology for easy data and application portability [11].

The key enabling technology for cloud computing is virtualisation, which means the simulation of the software function and/or hardware on which other softwares operate. This simulated environment is known as a virtual machine. There are many types of virtualisation, but the key virtualisation in cloud computing is full virtualisation, which can support multiple operating systems and applications run on the virtual hardware. Each instance of an operating system, called a 'guest OS', and its applications runs on a separate virtual machine managed by the hypervisor or virtual machine monitor. The key utilisation of full virtualisation is server virtualisation [13]. The virtual hardware generally includes virtual computing resources (e.g. virtualised storage and networks). The hypervisor may create virtual switches, hubs and other network devices. The hypervisor may also simulate disk storage for guest OSs called 'virtual hard drives' or use other storage interfaces (e.g. network-attached storage and storage area networks) [13].

STUDY METHOD

The studied population was a group of organisations that use IaaS in Thailand. The sample selected from this population included domestic IaaS providers, Stock Exchange of Thailand listed companies and other domestic organisations that use information technology, as detailed below.

A mixed sampling approach [14, 15] which combines both the probability and non-probability sampling methods was used as the statistical methodology. We used the probability sampling method to specify the strata of the stratified random samples—organisations that use IaaS in Thailand. However, the populations in the strata were disorganised and scattered. The composition (organisations and people) of each stratum was unclear. Hence we could not estimate the probability that each unit of population would be selected as part of the sample. Each unit had a different probability of selection, so we could not use probability theory to estimate the population and sample sizes. The stratified random sample had to be selected using the non-probability sampling method because the actual population size was unknown and we could not determine each unit's probability of being selected. In addition to using the non-probability sampling method, we, at our discretion, selected two sample groups for the survey using a more specific method, purposive sampling, as follows:

1. Domestic Internet service providers: Members of this group have the potential to establish their own IaaS for public and private cloud services or have already been offering public IaaS. In addition, they may have potentially been using their own IaaS. The size of this sample group is 15 providers.

2. Stock Exchange of Thailand listed companies: These companies may use on-premise and off-premise IaaS. This sample group includes the public sector and other private sector organisations that use information technology and may subsequently use off-premise IaaS. The size

of this second sample group is 167 companies including four Stock Exchange of Thailand listed companies from the first group.

The procedure for our study was as follows.
1) Review related studies to formulate questions for the questionnaire.
2) Design and create the questionnaire using an online tool [16].
3) Collect and select the list (name and address) of organisations to respond to the questionnaire.
4) Collect data from the questionnaire within the response period of four months.
5) Analyse the survey results.

We formulated new questions for the questionnaire based on a sample questionnaire, related survey results [17-21] and related standard documents [11] to ensure clarity regarding the academic issues, especially the cloud computing service models.

EXPLORATORY RESULTS

From the questionnaire responses of the two sample groups (domestic Internet service providers and Stock Exchange of Thailand listed companies and other domestic organisations that use information technology), it appears that 52 of the 178 total organisations (total size of both sample groups) completed the questionnaire (29%). The basic statistical characteristics of the representatives of the organisations that completed the questionnaire are as follows:

- 92.6% male and 7.4% female
- 16% under 30 years old, 48% between 30 and 40 years old, 32% between 40 and 50 years old and 4% over 50 years old
- 44.2% at the executive level and 55.8% at the operational level
- 7.7% industrial products, 7.7% services, 5.8% consumer products, 30.8% technology, 40.4% government agencies, 1.9% real estate and construction, 1.9% agriculture and food industry and 3.8% financial businesses (business categories based on the Stock Exchange of Thailand [22] with government agencies included to understand the domestic sector-based report)
- 78.7% large organisations (over 200 employees), 9.6% medium-sized organisations (51-200 employees) and 11.5% small organisations (up to 50 employees). The organisation sizes are based on definitions from the Department of Industrial Works [23].

Organisation Status

1. Organisations' IaaS deployment status:

16% 'No' with no plan to deploy, 16% 'Not yet' with a plan to deploy and 68% 'Yes'. Note: These percentages are based on the number of organisations that completed the questionnaire (i.e. 53 organisations).

2. Organisations' overseas IaaS (public cloud / community cloud) deployment status:

51.5% not in use, 6.1% pending deployment, 9.1% using Amazon AWS, 18.2% using Microsoft Azure, 9.1% using Google Compute, 0% using Rackspace and 6% using others (e.g. Hostgator VPS and SingTel). Note: These percentages are based on the number of services organisations used, with a total of 33 services. Some organisations used more than one service. Of the organisations that completed the questionnaire, 31 gave reasonable answers to this question.

3. Organisations' domestic IaaS (public cloud / community cloud) deployment status:

47.2% not in use, 11.1% pending deployment, 13.9% using G-cloud, 2.8% using INET, 13.9% using CS Loxinfo, 5.6% using CAT, 2.8% using True IDC and 2.8% using others (e.g.

KSC). Note: These percentages are based on the number of services used by organisations, with a total of 36 services. Some organisations used more than one service. Of the organisations that completed the questionnaire, 32 gave reasonable answers to this question.

4. Organisations' domestic IaaS (private cloud) deployment status (i.e. IaaS of respondents' headquarters in Thailand):

46.7% not using, 10% pending deployment and 43.3% using. Note: The percentages for this question and questions 5 to 7 are based on the number of organisations that answered this question (i.e. 32 organisations).

5. Organisations' overseas IaaS (private cloud) deployment status (i.e. IaaS of respondents' overseas headquarters):

76.7% not using, 6.7% pending deployment and 16.7% using

6. Organisations' domestic IaaS (community cloud) deployment status (e.g. G-cloud):

80% not using, 3.3% pending deployment and 16.7% using

7. Organisations' domestic IaaS (hybrid cloud) deployment status (i.e. availability of IaaS on multiple clouds connected to one another):

67.7% not using, 12.9% pending deployment and 19.4% using

Reasons for Using Cloud Services

The organisations' reasons for using cloud services are as follows: 16.7% to reduce costs of hardware and software and operating costs (e.g. IT personnel wages and IT system maintenance fees on a pay-as-you-go basis); 4.2% to increase their profitability; 11.1% to achieve high stability for business continuity; 10.4% to promptly support business changes and expansions to prevent lost opportunities; 8.3% to create a good image; 8.3% to promote coordination among personnel; 7.6% to develop product and service innovation; 11.8% to enhance internal efficiency for smoother business operations, allowing the fast delivery of products and services to the market; 9% to use new IT services; 3.5% to have a team of experts taking care of the IT system; 8.3% to replace an old IT system and 0.7% others (e.g. compulsory, as in the case of G-cloud). Note: The percentages for this question are based on the total number of reasons selected, with a total of 144 reasons selected. Most organisations selected more than one reason. This question was answered by 28 organisations.

Duration of Use

Organisations' domestic IaaS deployment durations: 34.5% never, 17.2% less than one year, 34.5% one to three years, 3.4% over three years but not more than five years and 10.3% over five years. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 29 organisations).

Number of Domestic IaaS Projects

Number of domestic IaaS projects in the organisations: 14.8% none, 29.6% initiating the first project, 25.9% initiated one project and 29.6% initiated many projects. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 27 organisations).

Local IaaS Budget Status

Status of organisations' budgets for domestic IaaS: 36.4% spend less than 200,000 baht per annum, 18.2% spend 200,000-500,000 baht per annum, 9.1% spend 500,000-1,000,000 baht per annum, 22.7% spend 1,000,000-5,000,000 baht per annum and 13.6% spend over 5,000,000 baht per annum. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 22 organisations).

Types of Subscribed IaaS

Types of IaaS from domestic service providers (including respondents' own, if any) used by respondent organisations: 36.7% virtual computer, 42.9% virtual storage, 18.4% virtual network and 2% others (e.g. GPU on cloud). Note: The percentages for this question are based on the total number of IaaS types used in different organisations, with a total of 49 types. Some organisations use more than one type. This question was answered by 27 organisations.

Frequency of Use

Frequency of domestic IaaS use – average total number of virtual computers per day: 22.2% up to 2 virtual computers, 22.2% 3-5 virtual computers, 22.2% 6-10 virtual computers, 22.2% 11-100 virtual computers and 11.1% over 101 virtual computers. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 9 organisations).

Frequency of domestic IaaS use – average total number of virtual CPU cores per day: 12.5% up to 10, 25% 11-20, 37.5% 21-50 and 25% over 51. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 8 organisations).

Frequency of domestic IaaS use – average total RAM capacity per day: 12.5% up to 32 GB, 62.5% 33-64 GB and 25% over 64 GB. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 8 organisations).

Frequency of domestic IaaS use – average total storage capacity per day: 22.2% up to 10 GB, 11.1% 11-100 GB, 22.2% 101 GB to 1 TB and 44.4% over 1 TB. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 9 organisations).

Frequency of domestic IaaS use – average number of IP addresses on the virtual network per day: 28.6% up to 4, 42.9% 5-10, 14.3% 11-15 and 14.3% over 15. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 7 organisations).

Frequency of domestic IaaS use – average total volume of data uploaded to the cloud per day (bytes): 14.5% up to 500 MB, 42.9% 501 MB to 1 GB, 28.6% 1.1-100 GB and 14.3% over 100 GB. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 7 organisations).

Frequency of domestic IaaS use – average total volume of data downloaded from the cloud per day (bytes): 14.3% up to 500 MB, 42.9% 501 MB to 1 GB, 28.6% 1.1-100 GB and 14.3% over 100 GB. Note: The percentages for this question are based on the number of organisations that answered this question (i.e. 7 organisations).

Purposes of IaaS Use

Of the respondents, 20.5% use IaaS for data backup, 26.5% use it as a web server, 13.3% use it as an e-mail server, 19.3 use it as an Intranet server, 12% use it for organisational network management and 8.4% use it as virtual desktop infrastructure. Note: The percentages for this question are based on the total number of functions used in different organisations, with a total of 83 functions. Some organisations use more than one function. This question was answered by 25 organisations.

IaaS Accessing Platforms

Platforms used by organisations to access IaaS: 32.5% MS Windows, 7.8% Mac OS X, 23.4% Linux, 11.7% iOS, 13% Android, 7.8% Chrome OS / Chromium OS and 3.9% others (e.g. AIX, Windows Phone and Solaris). Note: The percentages for this question are based on the total number of platforms used by different organisations, with a total of 77 platforms. Some organisations use more than one platform. This question was answered by 27 organisations.

Required Additional Domestic IaaS Deployment Models

Models of domestic IaaS deployment required in addition to the existing model: 40% on-premise private cloud for self-service; 15.6% off-premise private cloud, such as leased public cloud, for self-service; 17.8% community cloud shared with other organisations for self-service; 13.3% public cloud for rent and 13.3% hybrid cloud (a combination of two or more types). Note: The percentages for this question are based on the total number of installation types required by organisations, with a total of 45 types. Some organisations require more than one type. This question was answered by 24 organisations.

Required Additional Domestic IaaS Types

Types of domestic IaaS required in addition to the existing type: 27.3% virtual computers, 50% virtual data storage and 22.7% virtual network. Note: The percentages for this question are based on the total number of types used by different organisations, with a total of 44 types. Some organisations use more than one type. Of the organisations that completed the questionnaire, 23 gave reasonable answers to this question.

Domestic IaaS Selection Factors

Factors used to select domestic IaaS: 21.8% technical factors (service efficacy and capacity), 25.7% price, 21.8% service level agreement, 18.8% service provider's visibility, 10.9% referral from professionals and 1% others (e.g. security). Note: The percentages for this question are based on the total number of factors used by different organisations, with a total of 101 factors. Some organisations use more than one factor. Of the organisations that completed the questionnaire, 27 gave reasonable answers to this question.

Problems and Limitations

Problems and limitations in domestic IaaS deployment (Note: The percentages for this question are based on the number of organisations answering this question, with a total of 41 organisations):

- No budget:

4.9% disagree, 7.3% slightly agree, 41.5% somewhat agree, 24.4% mostly agree and 22% completely agree.

- Too expensive:

2.5% disagree, 7.3% slightly agree, 31.7% somewhat agree, 31.7% mostly agree and 26.8% completely agree.

- Difficult cloud migration:

2.5% disagree, 5% slightly agree, 45% somewhat agree, 30% mostly agree and 17.5% completely agree.

- Lack of expertise in IaaS deployment:

2.4% disagree, 7.3% slightly agree, 19.5% somewhat agree, 48.8% mostly agree and 22% completely agree.

- Lack of confidence in service provider's standard and quality:

7.3% slightly agree, 26.8% somewhat agree, 34.1% mostly agree and 31.7% completely agree.

- Already have a traditional data centre; no need to use cloud:

4.85% disagree, 4.85% slightly agree, 39% somewhat agree, 22% mostly agree and 29.3% completely agree.

- Lack of confidence in privacy and security:

5% slightly agree, 20% somewhat agree, 35% mostly agree and 40% completely agree. Note: The percentages for this question are based on the number of organisations answering this question, with a total of 40 organisations.

- No service provider that can fully satisfy the organisation's needs:

5% slightly agree, 34.1% somewhat agree, 31.7% mostly agree and 29.3% completely agree.

- Lack of confidence in cost reduction effectiveness:

4.9% disagree, 4.9% slightly agree, 41.5% somewhat agree, 26.8% mostly agree and 22% completely agree.

- Not supported by organisational and national regulations:

4.9% disagree, 9.8% slightly agree, 34.1% somewhat agree, 22% mostly agree and 29.3% completely agree.

Other problems and limitations in domestic IaaS deployment are price and reliability; the lack of information on domestic services; the feeling that it is unnecessary; a preference to keep information confidential or the restriction of its use by the organisation because of confidential information; internal bandwidth and data centre distribution problems (only available in a few places); personnel issues including the service provider's capacity and a lack of knowledge and understanding among non-IT users; a focus on only cheap/free and reliable choices; the lack of a common standard causing a lack of confidence in deployment; unreliability (availability); the lack of choice and quality because most IaaS is operated by the public sector, whereas that operated by the private sector is mostly cheap or uses a community cloud; and the lack of a specialist.

Consumers' Suggestions

The top three suggestions from organisational respondents were that a regulation should require all service providers to have a mechanism to review and assess security regularly according to the global standard; that providers should adopt open standards to support interoperability and data portability and to prevent vendor lock-in; and that the availability of quality broadband service should be extensively and equally promoted according to the ICT 2020 framework. Note: The percentages for this question are based on the number of organisations answering this question, with a total of 27 organisations.

Pricing Strategies

The survey results show that organisational consumers desire the following pricing strategies: 73.1% free of charge for an unlimited period, except for certain functions (freemium); 11.5% free of charge for a limited period and 15.2% others (e.g. reasonable prices compared to those of overseas providers, reasonable prices for organisations in Thailand with easy adjustments of plans and free of charge for basic applications with additional charges for extra space, like the Microsoft e-mail system). Note: The percentages for this question are based on the number of organisations answering this question, with a total of 26 organisations.

CONCLUSIONS

The survey on the deployment status of organisational users from the sample group shows that most firms employ domestic and overseas public IaaS, with a similar number of firms using each type, and the firms employ private IaaS from domestic providers more than they employ that from overseas providers. The main reasons for using IaaS are to reduce cost and to enhance internal efficiency. Most organisations already use IaaS for many of their projects, mostly in the form of virtual storage with more than 1 TB capacity and with a budget of less than 200,000 baht per annum. The respondents mostly and completely agree that organisational users' top three problems are a lack of confidence in privacy and security, a lack of expertise in IaaS deployment and a lack of confidence in the service provider's standard and quality. The survey of organisational users' demands shows that most of them require an on-premise private cloud in the form of virtual storage. The most important factor in IaaS selection appears to be price. The other top three demands are regulations requiring that all service providers have a mechanism to review and assess security regularly according to the global standard, the improvement of service level agreement standards and the extensive and equal promotion of the availability of quality broadband services. Freemium is the most desired pricing strategy. In our future work we wish to eliminate the limitations of our current work by conducting an extensive survey on sufficient up-to-date data based on the themes of this analysis.

ACKNOWLEDGEMENTS

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