A Review of Cloud Computing Implementation in ASEAN Countries

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Abstract. Cloud Computing is a technology that allows services of the communication, file transfer, infrastructure and platform usage to the user through the internet. In the era of globalisation, each of the countries raced to growth cloud technology as the main part of their industrial development. Similarly, with ASEAN countries, they start using cloud technology as a core part of the industrial revolution 4.0 (IR 4.0) to increase their economy and raise productivity. ASEAN already started using cloud computing, but some country has slow progress due to several challenges such as the broadband quality, lack of cloud knowledge and security issues. They require some strategies to address this problem in order to prove the ASEAN can be competitive in the use of technology as it can open up better industrial opportunities. This article reviews the published literature on the implementation of cloud computing in ASEAN. The author systematically analysed a total of 37 selected articles. There were 22 of the articles selected through restrictive search criteria while the other 15 were selected based on unrestrictive search criteria. The review shows the cloud implementation, expose the benefit and challenge to grow a cloud computing in general, and focusing the challenge of ASEAN in cloud computing development. This paper concludes with some recommended future works to construct the theory and perform empirical research.

1. Introduction
Cloud Computing is computing based on the Internet [1]. Past previous years, people need to purchase physical software and install in the computer for them to use it. Nowadays, with cloud computing its allow people to use the same software via the internet. While user uploads their picture on Facebook, checking account balance on a smartphone, send an email to another and watching favourite live sport streaming on the laptop, cloud computing allows unrestricted technology that simplifies user tasks in everyday life. There is a Cloud Computing definition mention by others shown in Table 1.
2. Review of Cloud Computing

In networking, typically, the cloud symbols utilised to represent a wide network connection with computing tools. As John McCarthy said in 1961, “Computation may someday be organised as a public utility”, and now a public utility that mentions by him already exists, and it is called the Internet [10]. Cloud computing in the modern perception appeared around 1996 with the earliest acknowledged by Compaq [11]. The particular popularisation with the term could be traced to 2006 when Amazon released its cloud product which is Amazon’s Elastic Compute Cloud (EC2) as a commercial web service that allowed small companies and individuals to rent computers on which to run their computer applications [12].

The history of the computer business, as shown in Figure 1, there is some useful software that has been created. Starting in the 60s, the call central systems is first systematic as electronic data

Cloud Computing has issued as powerful platforms for companies or individual for hosting and delivering services over the Internet [5]. The term “cloud” describes a large scale of objects, and for this platform, it explains about publicly stored user data at an unknown location and can be accessed at any time and anywhere [6]. One of the benefits of cloud computing is to allow user to use applications online without need for software installation, maintenance and physical data storage [7]. The reason for the user requires the cloud is because all the data can be processed virtually through the Internet, instead of using physical hardware and software. Due to many benefits, Cloud Computing was adopted by industry such as Microsoft (Azure), Google (App Engine), and Amazon (AWS) as the main platform for cloud business. Nowadays cloud computing is growing rapidly, and it leads to several issues about freedom and creativity. Cloud user do not have freedom of their data since the user does not know and cannot access physical storage, and user needs approval from the administrator to install new applications and achieve specific tasks. Another issue is about security, which exposes the user data to attackers using a lot of attack techniques [8]. Otherwise, efficient energy usage in a natural technology environment, which will save the emission of carbon and reduce some electricity consumption is one of the cloud benefits [9].

This paper focuses on cloud computing, current implementation in ASEAN, the benefits, risk and challenge. The selected countries are Singapore, Malaysia, Philippines, Thailand, Indonesia and Vietnam. It organised as follows, the history of cloud will discuss in part two. Part three discusses the migration of cloud computing and how to implement cloud computing referred to a model of cloud. The material and method explained in part four. Then, discuss the current adopted in ASEAN and the challenge faced by ASEAN in part five. Lastly is a conclusion of the paper and a future discussion of the cloud.

### Table 1: Cloud Computing definition

| Reference | Definition |
|-----------|------------|
| [2]       | Cloud Computing is the computing technologies that provide services such as infrastructure, platforms, and applications through the internet. It is parallel and distributed computing system. |
| [3]       | Cloud computing defined as the delivery of IT infrastructure and applications as a service on-demand to individuals and organizations via the internet. |
| [4]       | Cloud computing is a mechanism that allows an organisation or industry to focus on its core business or the activity by outsourcing its resources in IT. |
processing. Mainframe computers are first used by businesses for computation, like census data processing, statistics and financial transaction processing. Then in 80s client-server technology was used to make all data processed will store by centralised on a server, but still in standalone mode.

![Figure 1: History of Cloud Computing](image)

The 90s is an era of the Internet which all the data will store in server storage that can be accessed via the Internet. The term "cloud computing" was first used by Information System Professor, Ramnath Chellappa [13] on their talk in 1997. Now is the Internet of Thing (IoT) revolution, which is not only computer used to process and send a data, but there are more devices such as smartphone, smart car, smart home, and smart factory that can remotely control their device using the Internet at any time and anywhere. Unfortunately, this technology needs a big space of storage to store data, and better solution is the Cloud Computing [14].

Today, cloud computing is seen as the main technology to driving the success against Industry Revolution 4.0. Similarly, with ASEAN, that has a plan to deploy a cloud computing in order to assist the region in moving forward within a short period of time. Based on ASEAN ICT Master Plan 2020 [15] they aim to transform the ASEAN economy to the ASEAN digital economy that is secure, sustainable and transformative in order to compete with the world economy [16]. The three big giant of cloud provider (Amazon AWS, Google App Engine and Microsoft Azure) also opens their branch in Singapore [17] to strengthen the ASEAN market and provide the best services in the region, this explains the good growth of cloud computing in the ASEAN global environment.

3. Material and Method

The published literature reviewed in this paper were collected through two different ways, namely restrictive and unrestrictive search criteria. Articles were collected from three sources, namely ISI Web of Science, SCOPUS and Google Scholar. The keywords “cloud computing AND issues” and “cloud computing AND review” were used when the search was conducted using the ISI Web of Science and SCOPUS. On the other hand, the search using Google Scholar used the keyword “cloud computing”. Both SCOPUS and ISI Web of Science searches were restricted for resources published from 2000 to 2018, while Google Scholar was for all years. The articles yielded from the searches were then refined to ensure that only the related ones were selected for review. In general, the search yielded articles which may be divided into three broad categories, namely cloud implementation, benefit and risk. As a result, 22 articles were selected from restrictive search criteria, and 15 more articles were selected from unrestrictive search criteria.

Cloud computing has several characteristics which provide low-cost service, high reliability, sustainability, multi-tenancy, independence of device and location, and data security, which make cloud is the best choice for a budget company to start a business with minimum cost [18]. In 2019, RightScale was surveyed over 786 IT professional about acceptance and implementation of cloud computing on their organisation in the year of 2019 [19]. Figure 2 shows the migration of cloud usage from public and private cloud to hybrid cloud.
Mostly, hybrid cloud adopting by an organisation or a company, due to a lower-cost cloud implementation compare to the private cloud, and it provides better security compared to the public cloud [20], [21]. The reason for this migration because the user needs both which is security as well as cost-effectiveness and the hybrid cloud is the answer [22]. In 2015, there is 81% cloud user using a public and private cloud and the drastic changing on 2016 show that 57% of cloud user (additional of 38%) in 2015 started using the hybrid cloud, it is because of slow performance in the public cloud and difficult to access a data due to a high-security implementation in a private cloud. Otherwise, the hybrid is greater flexible and most effective model compares to other clouds [21].

In ASEAN, around 360,288,700 million internet user and estimated around 40% of them use cloud computing, but to become a digital world economy, ASEAN facing some challenges. There will be a discussion about cloud computing, focusing on implementation and challenges in ASEAN countries, then some suggestion to overcome the issues.

4. Related Works
There are some studies about cloud implementation. Based on NIST, cloud computing has a three different stage, which contains five essential characteristics, three delivery models and three deployment models, as shown in Figure 3 [21]. Cloud Deployment Model is a service provided by the cloud, and it grouped into three different types, each type will address a different set of business requirement. Cloud Delivery Model is a reference model on which of the Cloud Computing based, also about user selection that described based on the appropriate service, and its dependence on a factor such as management of distributed data, availability of the suitable program, or developing an application.
4.1. Cloud Deployment Model
Cloud Computing Deployment Model as Figure 4 determines a way of the user to access to the cloud, and it will depend on business and the type of services that user need, it might be sorted into three types based on the deployment:

**Public Cloud:** The Cloud provider will manage and control a resource located in the provider facilities, and it is available to the general public via the Internet. It could be no cost and offered on a pay-per-usage product [21]. Usually, the public cloud user has limited control to the application, storage and security implementation. If the user needs more access, storage and better security, the user needs to pay or subscribe some amount from a cloud provider.

**Private Cloud:** Generally, an organisation use the private cloud to have its own data centre (DC), and only registered members can access. The user has permission to customise the cloud because the organisation has full access to manage and control its own cloud [21]. Private cloud is suitable for a high-security implementation since it has a restricted number of users behind a firewall [23].

**Hybrid Cloud:** This flexible cloud is a combination between Public and Private cloud provides more deployment option for better performance [24], [25]. It will use a function of a private cloud when to deploy sensitive data, and it will use a public cloud when to deploy a non-sensitive data. For example, an organisation will use public cloud applications such as Google Email (Gmail) for backup data but continues to maintain a private cloud when performing sensitive user data.

4.2. Cloud Delivery Model
Cloud computing describes the applications, hardware and system software provided as services via the internet [26]. It uses to improve business flexibility and provide a lower cost of engineering
infrastructure resources with a pay-per-use. The term used to describe a service is “as-a-service” or “aaS”, and XaaS is a term used to refer to any cloud-based services. “X” means anything services provide through the cloud [27]. The most common services that provide by cloud computing known as Software as a Service (SaaS) offer a cloud application to the user, then Infrastructure as Service (IaaS) offers infrastructure and hardware on the web, and Platform as a Service (PaaS) offers a development of application via the web [26]. This delivery model provides a different level of users that can integrate directly to a service. There are three main services provided by cloud delivery model:

**Infrastructure as a Service (IaaS):** The cloud services provide physical infrastructures such as a server, storage, and other networking devices to cloud user [28]. This service will directly perform by network architecture or network engineer that responsible for configuring and setting up a physical data centre for use by cloud user. The organisation will take a service based on the need, and user also can subscribe if the current services not enough for them. Amazon S3 that provides big data storage for an organisation is an example of IaaS.

**Platform as a Service (PaaS):** This service will provide a facility for application developer or programmer to develop an application through the web. Usually, PaaS is comprised an Operating System, Programming Language, Database and web server [29]. Then the developer can execute their program with no cost and easy to develop because no need to think either the software compatible or not with a hardware, for example, Amazon Aurora that provide MySQL and PostgreSQL as a database platform and Google that provides cloud operating system services namely Chromium OS.

**Software as a Service (SaaS):** SaaS is a software distribution model that provides access to a user through web-based services [26]. This platform allows end-user to use an application without the need to buy a license or pay for additional hardware. Suitable for a small organisation that runs a low-cost business, because this service will wipe out all possibilities for organisations to manage the installation, software updating, license setup and maintenance. For example, Google provides several SaaS services such as a Google Doc, Spreadsheets, Slide and Form that can be accessed and shared with another, anywhere and anytime through the internet.

5. Discussion

There have several issues about cloud computing, which is a benefit and a risk-based on a survey conducted by RightScale [30] in January 2017, a total of 1002 respondents from technical professional background already answered, they discover several benefits and the challenge of using Cloud Computing.

5.1. Benefit of Cloud Computing

Cloud computing is a technology to deploy and delivery services; many of benefit related to the cloud will be determined as a new. According to Figure 5, shows there is a top benefit of cloud implementation in 2017 [30] which is, faster access to the infrastructure, greater scalability, higher availability, faster time to market and business continuity.
Figure 5: Shown cloud top benefit of Cloud Computing in 2017

Faster access to Infrastructure: Nowadays, a user needs faster access to infrastructure resources across multiple devices, network and storages. When the needs grow, and some resource is added to the environment, the packet will take a long time for delivery, and it makes slower business growth. The higher percentages of the survey show the importance of faster access to infrastructure to ensure the reliable delivery of cloud computing services is manageable, scalable and easy for a user to develop and market their application.

Greater Scalability: Scalability is an important factor in a technology environment, it shows an increase of 3% in 2017 from 58% in the previous year, this explains the ability to increase the scale without implying increased costs [31], and also decrease time to market, which is the meantime, use to develop or deliver a cloud service. Now, the internet becomes popular, this increase due to the additional cloud user where, the request from the user will make the server receive more traffic and if there is no solution to handle, the site will not available (breakdown) to access by the user.

Higher Availability: According to [32] measurement of higher availability in the cloud services is based on accessible 99.999% of the time, its mean 5.26 minutes of downtime per year [33], based on the formula shown in Figure 6. The application, tools or data provided by cloud services can be accessed anytime and anywhere. It is also mentions about reliability, where the cloud provider will always provide technical support 24/7 at 365 days without fail. An increase from 2016 (52%) to 2017 (56%) show the importance of high availability in a cloud provider, because nowadays in the paperless workplace, most of the data will be processed by computer, it needs downtime protection in order to make user data can be accessible as possible.

Figure 6: Availability formula

Faster time-to-market: The average length of time has been taken in the product development process from product idea to the complete finished product, and it is also a critical element of time-based competition. The organisation can speed up and get the job done by the service or product to market more rapidly. Based on Figure 5, it decreases 1%, due to a restrictive control process that applies a certain level of security in the cloud, and it will make the high latency in data processing and affect the time taken to market.

Business Continuity: Cloud computing is network dependent, it needs an internet connection to operate, and without the internet, the cloud cannot deliver a service to users [34]. The most important
part of making the business grow is, when the occurrence of the disaster, user still can access the data on a cloud. The cloud still can operate a service, but a reduction of 1% shown that the trusted is the main issue, where the file management of the organization need to manage by cloud providers, where there is not the owner, and it maybe can be accessed by unauthorized way. Some company not ready because of the vulnerabilities of interception during transmission of data.

5.2. Risk of Cloud Computing

The current acceptance of cloud computing is associated with many challenges. Users are still in doubt about the use of cloud computing, especially in some aspects that recognised by cloud maturity which declare as a major challenge [30], such as lack of resources, security, managing cloud spend, compliance and governance/control shown in Figure 7.

Figure 7: Shown cloud top challenge of Cloud Computing in 2017

Lack of Resource: The lack of resource here is about knowledge and expertise, according to a McAfee on September 2016 [19] and supported by Forbes on 2017, the lack of security skills causing almost half of IT organisation and engineering firms slowdown of their cloud adoption plan. Cloud starting the huge adoption around 2016 and it brings more workloads to the cloud, at that time, not many IT organisations are capable of solving cloud issues, and it needs to refer to cloud expert. Some provider focusing on internal training and skill improvement to overcome this issue and the result in 2017 has shown the significant decrease in that challenge.

Security: The security is the big challenge in Cloud Computing. IT organisation will increase 46% budget in 2015 to spend on security implementation. A report from RightScale [30] said the security issues increase by 4% from 25% in 2016. Due to the cloud still new, there are vulnerability and issues to address [35]. The cloud provider needs to have the ability to control and overcome a security problem to prevent the cloud from beginning attacked. The addition of a high level of security implementation and strategy on previous years has made a changing on cloud security, and it starts to be trusted by users and the strategy cause the decrease of security issues in 2017.

Managing Cloud Spend: Although cloud computing implementation is more cost-efficient compared to the traditional way, it also contains a wasted spend on cloud cost. The cloud user is wasting 30-45% of their spend in cloud computing [30]. An organisation that uses a hybrid or private cloud spends money to set up a data center that focuses on server, infrastructure, power requirements and networking [36]. Optimisation a cost of cloud was applied in 2017 to reduce wasted spending in cloud implementation.

Compliance: Cloud compliance becomes an issue for cloud users; it’s also a reason for several companies still using traditional server-based rather than using cloud computing. The user still argues
about security, data storage location, the integrity of data, availability of access and so on. The Service Level Agreement (SLA) which is a contract on the particular services between the cloud provider and cloud user [37], used to fix the compliance argument and make cloud start to gain user trust.

Governance: Cloud computing provides governance services for applying policy and rules to control and manage a system [38]. The main function is to secure a service, assets, remote facility and data that provide by cloud. Cloud Governance has some good factor where the optimisation can leverage to cloud to prevent cloud wasted, and the profitability showed the good governance applies in cloud computing will make the highest profit compare to the poor governance.

5.3. ASEAN Challenge

Compare to other countries, ASEAN started quite late for adopter cloud computing development because of several challenges such as cost, social-economy, network connectivity, and broadband quality. Now the awareness of adoption of cloud computing in ASEAN shows a good improvement. Based on a report from the Asia Cloud Computing Association (ACCA) about Cloud Readiness Index on 2018 presents that Asia is leading the world in Cloud Computing readiness and ASEAN countries such as Singapore, Malaysia, Philippines, Thailand, Indonesia and Vietnam overcome the challenge as a catalyst to their industrial revolution 4.0 development. Figure 8 shows the cloud computer readiness index of ASEAN country in 2018 [13]. In ASEAN, Singapore leading with a 76.6% score follows by Malaysia with 61%, and the Philippines with 53.6%, then Thailand 50.6%, Indonesia 49.4% and Vietnam 41%. The result in Figure 8 influenced by various factors and one of it is an ability of network connectivity to support the development of cloud computing. The good internet speed will make the development of cloud computing become faster.

![ASEAN Cloud Computing Readiness Index](image)

**Figure 8:** ASEAN Cloud Computing Readiness Index

Table 2 shows the average connection speed of the internet in ASEAN. Refer to Table 2, Singapore has a 181.47Mbps in 2018 and 199.62Mbps in 2019, which increase 18.15Mbps in a year followed by Thailand with 76.62Mbps in 2019, the lowest in Indonesia with 16.65 Mbps in 2019. Malaysia shows the highest increase in internet connection with a different of 39.72Mbps from previous average speed.
Table 2: Average connection speed of internet in ASEAN 2018 and 2019 [39-40]

| Country   | Global Rank | ASEAN Rank | Ave. Speed (Mbps) |
|-----------|-------------|------------|-------------------|
|           | 2018 | 2019 | 2018 | 2019 |
| Singapore | 1    | 1    | 1    | 1    | 181.47 | 199.62 |
| Thailand  | 34   | 27   | 2    | 2    | 47.35  | 76.62  |
| Malaysia  | 58   | 36   | 3    | 3    | 27.43  | 67.15  |
| Vietnam   | 60   | 72   | 4    | 4    | 25.28  | 27.60  |
| Philippines | 88  | 101  | 5    | 5    | 17.32  | 19.31  |
| Indonesia | 94   | 111  | 6    | 6    | 15.18  | 16.65  |

Figure 9 shows the affordability of cloud user to subscribe to Internet service on fixed broadband. Based on Figure 8, 9 and Table 2, show that the highest internet speed connection will make the country smoothly develop and deploy a cloud computing, but the lower connection speed with the high cost will make vice versa. ASEAN announces in AIM2020 (2016 – 2020), planning to develop the cloud computing environment in the private and public sectors [15]. Some of ASEAN country has slow development progress compare to others, because they have a different problem and challenge.

Table 3 shows the challenge of each country which are Malaysia, Indonesia, Singapore, Philippines, Thailand and Vietnam.

Table 3: Challenge of ASEAN country to develop a cloud computing

| Country    | Challenge |
|------------|-----------|
| Malaysia   | • Lack of physical infrastructure.  
| [13], [41] | • Lack of competent cloud engineers, knowledgeable cloud lawmakers, and service consumers.  
|            | • Security and privacy issues.     |
| Country       | Challenges                                                                 |
|--------------|-----------------------------------------------------------------------------|
| Indonesia    | Low quality of internet.  
              | Security issues.  
              | Low-speed internet connection in rural areas.  
              | Slow user adoption.  
              | Users anxiety to use cloud computing.  
              | Lack of knowledge of the cloud business model.  
              | Low partnership opportunity. |
| Singapore    | Lack of international connectivity.  
              | Lack of freedom of information. |
| Philippines  | Low quality of broadband and mobile access to the internet.  
              | Lacks a standard for ICT handling and exchange.  
              | Most expensive broadband connectivity. |
| Thailand     | Lack of international connectivity.  
              | Lack of comprehensive software for cloud development.  
              | Only a few domestic cloud providers. |
| Vietnam      | Lack of freedom of information.  
              | High risk of Data Center.  
              | Lack of explicit a cloud strategy. |

6. Conclusion
Nowadays, cloud technology was used as the main medium to store a data as individual (small storage) or organisation (large scale of data), a cloud used as an online application that allows a user to do their job anywhere and anytime. Cloud computing is about a time, cost, and performance for applying effective technology. It is a good comparison between traditional server-based and cloud computing in term of effectiveness. Cloud computing saves time to set up a data centre, cost of power and electricity and save 50% emission of carbon on earth. Every day the usage of cloud increased, and it will continue to increase in the next few years, but, recently security, reliability and scalability have arisen as issues, and it causes some organisation still not using a cloud service. It is a difficult part to manage because of virtualisation and the resources it is. ASEAN countries also have a challenge to ensuring that cloud computing will be operating well in their country. They need a strategy to fix the issues, to fulfil the requirement of Industries Revolution 4.0. The suggestion is to empower the ICT infrastructure, including a broadband quality, provide enhancement of security and assurance to the user, and transform the ASEAN economy to a digital economy in order to overcome the highlight challenges.
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