Cloud computing model in higher education

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Abstract — Currently, higher education is institutions that should be managed as a global business institution. Higher education should improve continually its business processes according to the demands of increasing its stakeholders. of the problems faced in the development of educational, activities if related to the use of information technology for each service in higher education for stakeholders is the issue of available funds. Cloud computing also has advantages related to infrastructure and maintenance and increases operating efficiency. Most institutions are currently moving towards cloud computing technology to reduce operational costs. For achieving these objectives, the institutions need to be supported by reliable technology. This study aim to propose cloud model for education and IT Governance conceptual framework for Cloud Computing model adoption, Tarumanagara University as a study case.

Keywords: cloud computing, higher education, IT Governance

1. Introduction

One of the problems faced in the development of educational, activities, if related to the use of information technology for each service in higher education for stakeholders is the issue of available funds. The existence of cloud computing technology is expected as a technology that can be a solution with a significant level of efficiency and effectiveness for higher education. [1] Cloud computing technology increases user access to various resources in educational institutions without being limited by time and geographical location.[2]. Cloud computing also has advantages related to infrastructure and maintenance and increases operating efficiency. Most institutions are currently moving towards cloud computing technology to reduce operational costs.[3]. Cloud computing is also a technology adopted by many organisations with more dynamic development capabilities and virtualisation technology. This has a significant impact on universities in the future. Cloud computing technology is also an option for universities that have limited budget.[4]. Some universities in the US have implemented Cloud Computing technology to use this to save on software licensing costs and reduce technical resources. By implementing North State State University cloup computing it can reduce the number of technical staff from 15 people to 3 people.[5]. This study explores the concept of Cloud Computing in the Higher Education, Tarumanagara University as a study case. The research contributions from this paper in the academic and practice world are as follows:
- Propose cloud model for higher education
- Propose IT Governance framework for Cloud Computing Model Adoption

2. Cloud Computing

2.1. Definition of Cloud Computing

According to NIST cloud computing is “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction”. The International Organization for Standardization (ISO) defined cloud computing as “a paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand” [6].
2.2. Characteristics of Cloud Computing
The five characteristics of cloud computing are self-service based on demand, wide network access, resource collection, fast elasticity, and measured services. Three service models are Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), and Cloud Infrastructure as a Service (IaaS). The four deployment models are Private Cloud, Public Cloud, Community Cloud and Hybrid Cloud. A cloud-based education system is needed to create knowledge and use it in higher education as a factor needed for cultural, social, economic and technological transformation that enables the transfer of knowledge and create new innovations for education, research and development.[7]

![Cloud Computing Architecture](image)

**Figure 1. Cloud Computing Architecture [1]**

2.3. The Benefit of Cloud Computing in Higher Education
According to [8] expressed that the following are significant benefits of cloud computing in educational institution and can be divided as follows:

| No. | Aspect     | Benefit                                                                 |
|-----|------------|-------------------------------------------------------------------------|
| 1.  | Technical  | Easily access, Data management, Multi-tenancy, Student experience       |
| 2.  | Economical | Cost Reducing, most of the software applications are free, available, ready-to-use or pay-per-use. |
| 3.  | Non-Functional | Flexibility, Reliability, Availability                            |
| 4.  | Security   | Improved incredibility, Centralized data storage, Virtualization       |

3. Methods

The method used in this research is the study of literature, surveys and interviews. Literature studies are conducted through various journals that discuss cloud computing in tertiary institutions, and surveys are conducted through printed and electronic documents at the Computer Center of Universitas Tarumanagara while the interview was conducted with the Head of the Universitas Tarumanagara Computer Center.

4. Results
Currently, Tarumanagara University Information System is managed by the Computer Center. The application system is built using multiplatform with Windows and Linux based operating systems. The application is developed based on web using the programming language. Net and PHP. Network infrastructure, servers are managed independently by the Computer Center. The types of applications developed at Tarumanagara University include e-learning applications, e-library applications, research and community service applications, academic applications and other supporting applications. All applications are developed by Computer Center. The information system infrastructure of Tarumanagara University can be seen in Figure 1. While the network infrastructure and server infrastructure. Some problems with the current conditions are obstacles in development due to budget constraints and inadequate staff numbers. aims, a cloud computing model for Tarumanagara University is proposed and an IT governance framework to help determine the adoption of cloud computing technology.
The proposed cloud computing model can be seen in Figure 3. The proposed cloud computing model uses a hybrid architecture, which aims to keep Tarumanagara University in control of data for internal and confidential purposes. While applications and data that are in the public interest can be migrated to locations in cloud computing to increase flexibility, efficiency and service effectiveness. The proposed architecture consists of:

1. Infrastructure layer.
   At the infrastructure layer which can be divided into two things, namely physical infrastructure and functional infrastructure.

2. Data Layer
   At this layer various types of data are available such as lecture materials, library collections, publication data.

3. Application Layer
   Its applications include e-learning applications, e-libraries, Human Resource Management, academic applications, and other supporting applications.

4. Presentation Layer
   This layer is for managing users both internal and external users to access various services and applications available in cloud computing.
4.2. Proposed IT Governance Conceptual Framework

Accord [9] decision the adoption of a technology influenced by factors:

1. Organisational Aspect
   In governance from the aspect of the organization that includes organisational structure, communication models, company size that will influence the decision to adopt technology

2. Technological Aspect
   Refers to internal and external technology that is appropriate for the company, strengths and weaknesses, complexity and compatibility

3. Environmental Aspect
   Refers to type of business, type of industry, access to resources and relationship with the government

Figure 4 is the proposed IT governance of cloud computing technology adoption which is an adaptation of the TOE framework.[9]

![Figure 4. IT Governance Conceptual Framework](image)

5. Conclusions

Based on consideration of these benefits to adopting cloud computing technology at Tarumanagara University. Given the demands of students in the 21st century to get better services, more interactive teaching and learning processes and multimedia-based teaching materials. Seen was utilizing cloud computing technology at Tarumanagara University as well as introducing cloud technology students so that it was also useful to prepare students for the world of work. The technology proposed as a solution for this is Hybrid Cloud Computing. Hybrid Cloud is a model of Cloud Computing deployment. It provides the ability to access, manage and use third party resources and incorporate them into internal infrastructure (private cloud) with this system to avoid dependence on particular vendors. Also, application security controls and essential company data remain in the internal system and cannot be accessed by third parties. However, for the implementation of cloud computing the model can be influenced by the factors of governance structure, technological context, organisational context, and environmental context.

6. References

[1] G. Soni Fajar Surya and K. Surendra, “E-readiness framework for cloud computing adoption in higher education,” Proc. - 2014 Int. Conf. Adv. Informatics Concept, Theory Appl. ICAICTA 2014, pp. 278–282, 2015.

[2] A. O. Akande and J. P. Van Belle, “Cloud computing in higher education: A snapshot of software as a service,” IEEE Int. Conf. Adapt. Sci. Technol. ICAST, vol. 2015-Janua, 2015.

[3] N. S. Aldahwan and M. S. Saleh, “Developing a Framework for Cost-Benefit Analysis of Cloud Computing Adoption by Higher Education Institutions in Saudi Arabia,” 2018 Int. Conf. Smart Comput. Electron. Enterp. ICSCEE 2018, pp. 1–9, 2018.

[4] X. Liu, “A Study on Smart Campus Model in the Era of Big Data,” vol. 87, no. Icemeet 2016, pp. 919–922, 2017.
[5] B. A. Nan Cenka and Z. A. Hasibuan, “Enhancing educational services using cloud technology,” *2013 Int. Conf. Inf. Commun. Technol. ICoICT 2013*, pp. 155–160, 2013.

[6] N. I. Alsaeed and M. S. Saleh, “Towards Cloud Computing Services for Higher Educational Institutions: Concepts & Literature Review,” *2015 Int. Conf. Cloud Comput. ICCC 2015*, 2015.

[7] A. H. Masud, J. Yong, and X. Huang, “Cloud Computing for Higher Education: A roadmap,” *Proc. 2012 IEEE 16th Int. Conf. Comput. Support. Coop. Work Des. CSCWD 2012*, pp. 552–557, 2012.

[8] M. M. Mosbah, H. S. Alnashar, and M. A. El-Nasr, “Cloud computing framework for solving egyptian higher education,” *Proc. - 2014 4th Int. Conf. Adv. Comput. Commun. ICACC 2014*, pp. 208–213, 2014.

[9] H. P. Borgman, B. Bahli, H. Heier, and F. Schewski, “Cloudrise: Exploring cloud computing adoption and governance with the TOE framework,” *Proc. Annu. Hawaii Int. Conf. Syst. Sci.*, pp. 4425–4435, 2013.