Challenges of Infrastructure in Cloud Computing for Education Field: A Systemmatic Literature Review

Nurma Ayu Wigati, Ari Wibisono and Acmad Nizar Hidayanto

Faculty of Computer Science, Universitas Indonesia, Depok, Indonesia

Abstract: The usage of cloud computing is needed for educational sector, especially in universities to ease all of administration and learning access to everyone. So that, the development infrastructure cloud computing need to concern the aim of the university. Infrastructure as a Service (IaaS) in cloud computing has problems, like resource, security, and finance. This study follows Kitchenham protocol to explore the challenges in the cloud computing as a infrastructure service for education field literature systematically, then reviewed their techniques which can use to all of university in Indonesia. This study recommends that the management of IaaS should be considered well to get result development of cloud computing optimally.

1 INTRODUCTION

Cloud computing is defined as a services that together provide ways to deliver cloud services. In higher education, cloud computing services are commonly used to provide the means for students to collaborate and interact in a distributed learning space (Al-Samarraie & Saeed, 2018). Cloud computing technology is one of the services provided by the use of IT in it to facilitate human work in various fields to be more efficient and effective, such as in education (Njenga, Garg, Bhardwaj, Prakash, & Bawa, 2019). Universities and colleges usually do not have sufficient fund to install and continuously maintain state-of-the-art ICT technologies for learning environment that can support students, staff, researchers and developer (Elamir, Jailani, & Bakar, 2013). Thus, cloud computing and its applications are vital to the future of distance education worldwide. The rate at which ICT technologies change, will continue to place pressure on institutions’ budget. Increasing bandwidth availability has enable cloud computing to be a potential solution in reducing ICT cost and freeing them from the expense and hassle of hardware and software maintenance. Several universities in UK have adopted Google Apps due to cost and unreliable in-house email systems. Even universities and schools in poor countries in Africa are using cloud computing supported by Google and Microsoft.

Based on the conditions and problems that have been described, the output of study is expected to identify and map the right solutions to be carried out when implementing cloud computing infrastructure in educational sector. To answer the expected research objectives, our work is organized as follows: Section 1 shows why we choose to raise the issue of the challenges faced in cloud computing infrastructure as a service, Section 2’s regarding the theoretical basis of cloud computing infrastructure as a service (IaaS) and its challenges. Section 3 is about research methodology which tells the workmanship of the research on how the research was conducted. Section 4’s regarding the results and analysis that shows the results of research that has been done and how the analysis of the outputs on these results. In Section 5, the authors provide conclusions from this literature study.

2 RELATED WORKS

Cloud computing (CC) also presents new security challenges (A. M. Ibrahim & Hemayed, 2019). In education field, we have some problems about cloud computing. Education institutions will continue to enhance infrastructure and curriculum to attract...
students (Sun, 2020). Scholars and researchers have done lots of studies concern the cloud computing adoption model and proposed a suitable way for different categories of cloud computing such as layout, implementing, challenges and so many. Students, staff and lecturers in the studied area suffer enough due to the problem of data storage for their academic purposes (Juma & Tjahyanto, 2019). Unfortunately, these methods require the suspension of the cloud computing applications due to the mandatory shutdown of the associated virtual machines (Lin, Wang, Liang, & Qi, 2011).

3 METHODOLOGY

The need for cloud computing infrastructure as a service is needed to support the profits to be obtained by university (Lis & Paula, 2015). This study needs to map the problems arising from cloud computing infrastructure as a service (IaaS) implementation over the past 5 years using Kitchenham’s SLR and are expected to be grouped in a more structured way in Figure 1 (Suryono, Purwandari, & Budi, 2019).

![Figure 1: Methodology by Kitchenham.](image)

### 3.1 Identification Requirement and Organization of Review Protocol

It is categorized as the planning stage to search for keywords of the problems, the research questions to be submitted in this study is “What are the challenges that have been proposed in the paper article that is reviewed in the implementation infrastructure using cloud computing in the education field?”

Meanwhile, the Review Protocol is used to map keywords such as what will be used and not used in the SLR that is done and this looks like in table 1.

<table>
<thead>
<tr>
<th>Review Protocol</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>cloud computing, education filed</td>
</tr>
<tr>
<td>Intervention</td>
<td>challenges, implication, infrastructure</td>
</tr>
<tr>
<td>Comparison</td>
<td>n/a</td>
</tr>
<tr>
<td>Outcome</td>
<td>challenges of infrastructure in cloud computing</td>
</tr>
</tbody>
</table>

### 3.2 Selection Database

The selection process can be shown in table 2. The inclusion criteria are should be relevant with the search keywords, written in English, published in 2015 – 2020, include all of education domain, contain the impact or challenge of cloud computing, and accessible. The exclusion criteria are articles that have no relevance with the search keyword, not include education domain, not contain the cloud computing topics, not accessible, duplicate articles, and review articles.

<table>
<thead>
<tr>
<th>Database</th>
<th>Initiation Stage</th>
<th>1st Stage</th>
<th>2nd Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM Digital Library</td>
<td>915</td>
<td>120</td>
<td>14</td>
</tr>
<tr>
<td>Emerald Insight</td>
<td>43</td>
<td>23</td>
<td>4</td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>36</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Science Direct</td>
<td>83</td>
<td>55</td>
<td>10</td>
</tr>
<tr>
<td>Scopus</td>
<td>773</td>
<td>145</td>
<td>23</td>
</tr>
</tbody>
</table>

### 3.3 Measurement of Paper Quality

This paper quality test measurement is used to select the final paper used as an analysis, this can be seen in table 3.
Table 3: Article Quality Assessment Checklist.

<table>
<thead>
<tr>
<th>Checklist</th>
<th>Checklist Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Does the article describe the objectives of the research clearly?</td>
</tr>
<tr>
<td>C2</td>
<td>Does the article provide literature review, background, and context of the research?</td>
</tr>
<tr>
<td>C3</td>
<td>Does the article show related works from previous studies in order to highlight the main contributions of the research?</td>
</tr>
<tr>
<td>C4</td>
<td>Does the article explain the architecture of the idea or method used?</td>
</tr>
<tr>
<td>C5</td>
<td>Does the article deliver results?</td>
</tr>
<tr>
<td>C6</td>
<td>Does the article produce relevant conclusion with the objective of the research?</td>
</tr>
<tr>
<td>C7</td>
<td>Does the article recommend future work or improvement?</td>
</tr>
<tr>
<td>C8</td>
<td>Indexes (Q1/Q2/Q3/Q4/conf)</td>
</tr>
</tbody>
</table>

3.4 Extraction Data & Synthesis Data

Result of extraction data with summary and analysis with implication or impact, challenges, and solution.

4 RESULTS & DISCUSSION

We reviewed the paper and determined the database that we used, then qualified it. Table 4 showed the resource and database we reviewed in the 2nd stage, but we could not use them. The quality of articles result with did not have 4.5 scores can be seen in table 5. For that purpose, an 8-item checklist on a five-point scale: “not at all” (0), “very little” (0.25), “a little” (0.5), “yes, but not adequate enough” (0.75), and “adequately” (1). Therefore, the possible range of scores is 0–8. We choose to include articles that scored more than 4.5 for further analysis in Figure 2.

We got total all of the documents with Kitchenham methodology were 1850 for initiation stage, 350 for 1st stage, and 53 for 2nd stage. This final stage, we used as an analysis. There are 3 literatures which do not fulfill the requirements. The techniques used in IaaS are convolutional neural networks, genetic algorithms, SDN approaches, LSTM-RNN networks, deep neural networks, cloud e-learning for technology (CLEM), GPU accelerated algorithm, CMBA, and SVM approach.

Figure 2: Requirement by Keyword.

After that, we collected the article which we done with synthesis that development of infrastructure in cloud computing as a service still has problems, such as security can not accomodate maximal yet (no backup), amount of the data used is greater, of course server development increase by complex, and the cost is expensive when using complex data because it requires a lot of space.

Cloud computing has delivered services efficiently (Ashourd & Jafari Navimipour, 2015), (Rao, Ma, & He, 2018), (Singh & Chen, 2019), (Jayanetti & Buyya, 2019). Data centers application
play important role to support network diverse to array of requirements from latency-sensitive application such as web servers with a distributed data processing and virtual machine live-migration (Sharma, Javadi, Si, & Sun, 2017), (Chauffournier, Ali-Eldin, Sharma, Shenoy, & Towsley, 2019). One of algorithm such as PLBA and SVM algorithm can be implemented (Hamza, Abderaouf, Abdelhak, & Okba, 2017), (Gao & Yu, 2017). Another algorithm like GPU for allocating virtual infrastructure in cloud data centers can be handle large data center (Nesi, Pillon, de Assunção, & Koslovski, 2018). The technology of cloud computing virtualization provides efficient resources for end users (Mewally, Jarray, & Karmouch, 2015). The characteristics of cloud computing include manageability, scalability and availability (Jun, Jie, & DingHong, 2019), (Allison, Turner, & Allen, 2015). Cloud computing mainly provides three service delivery models and one of the type’s IaaS (Shaik & Baskiyar, 2018).

There are several problems to be considered while managing resources, such as, type of resource required (physical/logical), allocation, brokering, provisioning, mapping, adaptation and estimation (Diouani & Medromi, 2019), (Alqahtany, Clarke, Furnell, & Reich, 2016), (J. He & Zhang, 2017), (Manvi & Krishna Shyam, 2014). Virtual machine introspection (VMI) is a technique whereby an observer can interact with a virtual machine client from the outside through the hypervisor (Dykstra & Sherman, 2012).

Capabilities complexity can be handled by the traffic scheduling detection to fix the problem (Yazidi, Abdi, & Feng, 2018). Many resources need to build the architecture the cloud computing data servers (Aitaie et al., 2019). So, we can minimized the financial by concerned with acquiring broadband connectivity to the cloud (Atiwei, Abhussein, & Saleh, 2018). The efficiency allocation cloud computing also offers the usage of CPU core, memory, and disk storage based on cloud providers (Alshamrani, 2018). On the e-learning development, the role of cloud computing about availability, reliability, cost, flexibility, ease of use, and waiting time must be considered (Yuvaraj, 2016). Because it has the high influence and significant to teachers and students who use it (Rabajion, Wakil, Badfar, Nazif, & Ehsani, 2019).

Low cost computing can be integrated with web services to optimum the cost (Yuvaraj, 2015). Private cloud design still need (Makori, 2016), (E. A. Ahmed & Ahmed, 2019). Configuration and availability can be build by combination deep neural network (Chiba, Abghour, Moussaid, omri), & Rida, 2019). There are potential benefits of adopting cloud computing technology in higher education institutions (Tashkandi & Al-Jabri, 2015), (F. F. Ahmed, 2015), such as Google Docs (Amron, Ibrahim, & Chuprat, 2017), (Farzai, Shirvani, & Rabbani, 2020) and consultation services in addition to the cloud solutions offered to higher education institutions (Shorfuzzaman, Alelaiwi, Masud, Hassan, & Hossain, 2015). Collaboration solutions, infrastructure computing or virtual desktops solutions (Couto et al., 2018) offers a shift from computing as a product that is owned to as a service that is delivered from large-scale data centers or clouds (Kumar, Goomer, & Singh, 2018).

Cloud computing technology has revolutionized to make the cost become effective and resource efficient (Kertesz, Dombi, & Benyi, 2016), (Njenga et al., 2019). The deployment of a data-intensive application to a cloud poses a number of serious challenges, mainly concerning the provider and resources selection process, based on the Quality of Service expected, as well as the management of the Virtual Machines in the provider premises (Psychas et al., 2020) and Control system can use by mechatronics (Chao et al., 2015), (Cerroni et al., 2015). Component failures within the cloud infrastructure are common, but large cloud data centers should be designed to guarantee a certain level of availability to the business system (Cheng, Cao, Yu, & Ma, 2017).

Cloud systems have a high failure rate because they have many servers, which are geographically dispersed and have a large workload (Patel, Patel, & Patel, 2016). In order to ensure that cloud users can use the service, the cloud infrastructure should be designed so that their system downtime is minimal or irrelevant. The latest advances in machine learning and cloud storage provide an excellent opportunity to take advantage of the large amounts of data generated from cloud infrastructure, which provides room for predicting when components may fail or fail (Peng & Ho, 2018). Currently, mathematical and statistical modelling are the prominent approaches used for failure predictions, these are based on equipment degradation, physical models and machine learning techniques respectively (Mollahajari & Shahhoseini, 2016), (Mohammed et al., 2018), (Xu, Chen, & Alcaraz Calero, 2017), (Chawki, Ahmed, & Zakariae, 2018).

To ensure the security of business-sensitive data and information, organizations must understand the type of cloud used (Vogel, Griebler, Maron, Schepke, & Fernandes, 2016). In terms of data storage and access security (Jain, Tyagi, & Kalra, 2016), (Rahouti
& Xiong, 2019) or cloudStack (Abdulhamid, Abd Latiff, Abdul-Salaam, & Madni, 2016). Regarding optimization and cost minimization, we can also build smartphones to release SDKs for Apple iOS or Android (Ilyas, Khan, Saleem, & Alowibdi, 2019).

On a comprehensive basis, current technological advancements play a key role in the development of formal education by providing a variety of learning delivery and communication modes that can meet the needs of continuing education at low cost. Ultimately, the issue of interest to decision makers is how to use modern technology to attract distance learners to participate in collaborative learning courses. In addition, given the continuing need for universities to build capacity to take advantage of technological and teaching advances in the formal education sector.

Information security in the cloud is based on the fact that no one can access client information from the cloud, so they will not be able to understand the essence of the information. These lines ensure information security, which is the most important prerequisite for cloud clients, and can actually avoid hardware costs, and there is little understanding of configuration software. When using cloud computing in the education sector, transparency and audit control are still not working optimally, so we need a system that can use innovative technologies to read business performance requirements.

5 CONCLUSION

The aim of this work was to present a comprehensive overview of cloud computing implementation research in the education field. A systematic review has been conducted which included planning, implementation, and reporting phases. Various technique of cloud computing infrastructure as a service implementation in education field have been identified from 53 selected literatures. In this study also identified the challenges, such as security, data server complexity, and financial problems in educational sector.

To take on these challenges, there are several solutions are proposed, such as the selection of the best technology approach for effective and efficient use, regular and routine checks and backups, and infrastructure management to manage as effectively and efficiently as possible as needed. So that, the costs incurred will be optimal.

However, the author only about technical aspects such as security, complexity, or financial. Meanwhile, non-technical aspects also need to be considered (eg human factors). Development can continue when people can have a lot of professional experience for cloud computing adoption maximal. So, the next study deeply discusses user interest and user research on cloud computing issues.

REFERENCES


Challenges of Infrastructure in Cloud Computing for Education Field: A Systematic Literature Review

International Conference on Reliability, Infocom Technologies and Optimization, ICRITO 2016: Trends and Future Directions (pp. 501–504). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICRITO.2016.7785007


