Open Learning Optimization Based on Cloud Technology: Case Study Implementation in Personalization E-learning

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Abstract— **Indonesia is a developing country that began to utilize information technology in education. A form of its implementation is the use of e-learning. However, in practice there are still some obstacles, such as learning resources are not evenly distributed, limited access to services provided, qualified educators resources are concentrated in specific areas. This led to the emergence of disparities educational process, and technology gap due to differences in ICT infrastructure owned by any educational institution.**

Therefore this study propose an architecture of cloud-based open learning to solve these problems. The term open learning is used in order to encouraging the development of the concept of Indonesia Open Educational Resources (IOER) and as well as the adoption of concept of cloud computing. This research through several phases of research including analysis, design, implementation, testing and evaluation. The design of the proposed architecture consists of six layers: (1) Infrastructure, (2) Platform, (3) Application, (4) Service, (5) Access, (6) User. As a results of the implementation from this architecture is a prototype of Indonesia - Virtual Open Learning System (iVOLS).

In experiment, personalization e-learning runs as a service that need large storage and other shared facilities to conduct the program so the system can delivered different learning materials to different learners. The personalization e-learning in cloud environment successed when the learners got the best performance on learning and it shown by their evaluation score. Based on the test results and evaluation showed that the availability on Cloud-Based Open Learning further meet user needs. This is indicated by the presence of a simple infrastructure services, application services with just one stage and the availability of a wider range of data and the resource sharing. In accessibility, Cloud-Based Open Learning provides easy access to the user. By economically, the result of evaluation showed that Cloud-Based Open Learning has an investment of 35.61% efficiency, increase return on investment (ROI) of 60.95% and an increase in benefits (NPV) of 81.97% from the user's perspective. While from the provider's perspective, Cloud-Based Open Learning has an investment of 200% efficiency, increase return on investment (RoI) of 220.4% and an increase in benefits (NPV) of 109.55%.

Keywords— **E-Learning, Indonesia Open Educational Resources, Open learning, Cloud Computing**

I. INTRODUCTION

E-Learning provides many benefits such as flexibility, diversity, measurement, and others [1], even though its implementation still exist many difficulties. The main problem experienced when to start applying e-learning is the high initial cost or in other words is the economic factor [2]. It is becoming a major focus for the institutions that will implementing e-learning. The initial cost consists of three main problems: (1) Infrastructure; (2) Human Resources; (3) Maintenance. Another problem might accured when implementing e-learning is access to the learning material. This problem experienced in Indonesia as a country with thousands of islands.

Along with the development of the IT world, cloud computing is gradually become the new paradigm of innovation in the IT world, cloud computing is a computing services that can be used through the Internet in accordance with the needs of users with little interaction between service providers and users. Cloud computing technology as well described as a computing resource that provides a highly scalable as external services through the Internet. Therefore, cloud computing can be considered as an alternative to minimize the cost of infrastructure and human resources for development and maintenance process of e-learning systems [3].

In this paper the author will discussed previous cloud learning architecture and the basic concept of open educational resources. The proposed open learning architechture also will be described in Chapter 4. Further more in this paper also will discussed the approach of the implementation, experiment in personalization learning, and the evaluation. For final chapter authors will described the conclusions and discussed the future works of this study.

II. CLOUD COMPUTING

Cloud Computing is a new paradigm to organize and manage ICT resources. There are various definitions of cloud computing, one of which is the definition according to The National Institute of Standards and Technology (NIST) which defines cloud computing as "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" [22]. Generally speaking, the cloud computing service model consists of three layers [5], among others: (1) Software as a Service (SaaS); (2) Platform as a service (PaaS); (3) Infrastructure as a service (IaaS) [6].

In practice, cloud computing has four implementation models where each model has certain characteristics [7], among others: (1) Private, the model is aimed at an organization where cloud operations are managed by a third party or the organization itself; (2) Public, service on this model is intended for the general public or the industry in which the various services provided by the cloud computing service provider organi-zation (3) Community, this model is managed by several organizations that form a community of practice in which the operations are managed by the community with the division of tasks particular; (4) Hybrid, this model is a combination of various models existing cloud distribution. Typically, this is done with a combination of spe-cific purposes where there is an attachment for example: technological standards and data ownership.

III. Open Educational Resources

Open Educational Resources (OER) initiative is an initiative that enable to share all educational resources to public domain with open access, open license, open format, and open system. This OER implementation can be seen in many country in the world like MIT Open Courseware, China Open Resource for Education, or Paris OCW Project.

Many educational resource sharing system implementation have been developed all over the world with many different techniques. Web service architecture more often used in the recent past year. This implementation uses web service as an integration, retrieval and data exchange application [6]. The newer trend that is often used today is the semantic web technology where the resources was formed in the semantic description [7]. Other researchers also are using P2P technology combined with semantic web technologies and formed a super-peer P2P semantic grid where the semantic metadata retrieved from many educational sources [8].

IV. Cloud-Based Open Learning Architecture

There are several architectural cloud-based e-learning have been proposed by previous researcher. In this paper will discuss three architectural cloud-based e-learning, such as architecture proposed by Phankokkruad [4], Wang, Pai, & Yen [5], and Masud & Huang [1].

In this study we propose the architecture that we have designed by modifying previous architectures that we used as references. Our proposed architecture [7] consists of six layers (as shown in Figure 1), namely : (1) infrastructure layer; (2) platform layer; (3) application layer; (4) service layer (5) access layer; and (6) user layer.

We have modified the user layer. Our user layer consists of all stakeholders that might involve to the system. We also add two more layers which is Access layer for addressing the access issue for Indonesian local context and service layer that describes the services that provided by the system, which is: e-learning as a service, data as a service, and infrastructure as a service.

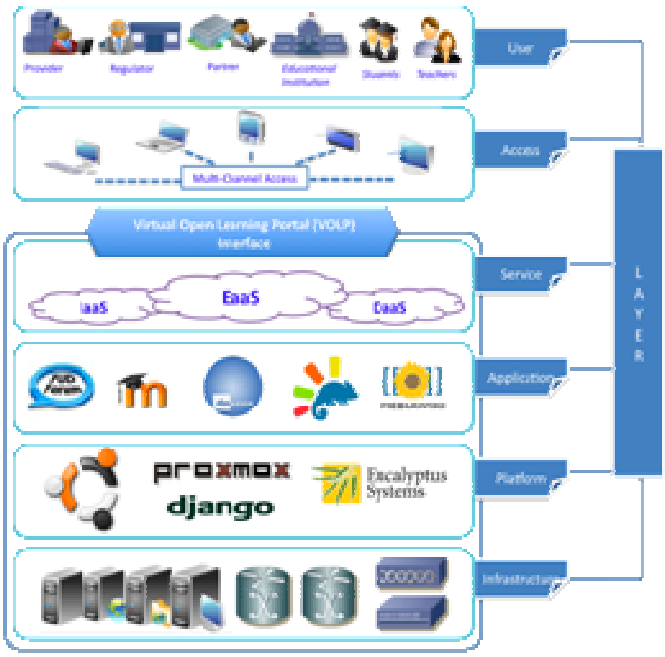

Figure 1. Cloud Based Open Learning Architecture

V. Implementation

Cloud environment developed using proxmox platform. Table 1 Describes the Hardware and software spesification for the environment.

TABLE 1. Hardware Spesifications

Hardware	Proxmox Minimum	Current Hardware	Remark
CPU	64bit	64bit	Fulfilled
Memori	Minimum 1 GB RAM	2 GB	Fulfilled
Hard drive	Hard drive	Hard drive	Fulfilled
Network	1 NIC	1 NIC	Fulfilled

Main activity in this process is developing a working prototype portal. Authors used Java Script and PHP programming language to developed the portal. This portal will be the gate for the users to use their e-learning system.

This portal main service called as a E-Learning as a Service. The objective is to provide a e-learning system for the users. This service will provide three possible cases, which is : (1) Enable users to request a e-learning system for users who do not have an e-learning system and create a new one for educational purpose only; (2) Enable users to enroll to existing e-learning system for users who do not have an e-learning system or institution; (3) Enable users to migrate their e-learning system to join the e-learning based on cloud

environment for users who already have an e-learning system and willing to entrust the maintenance duty to cloud provider.

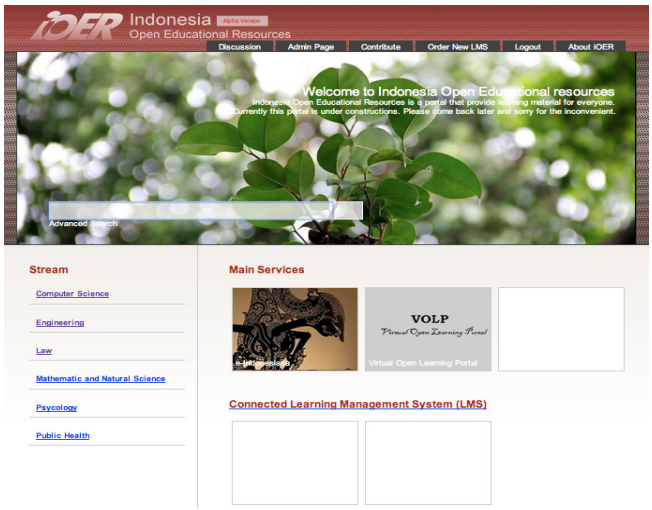

Figure 2. Open Learning Portal Prototype

Two another services that provided by this portal are data and infrastructure services. By joining open learning portal users automatically rewards by free data storage and cloud based infrastructure. Data services consists of multimedia data that uploaded by another users and every users could store and share their data with another users.

Infrastructure service will be provided to the users by using virtual machine. Virtualization helps solve the problem of the physical barriers that are generally inherent in the lack of resources and infrastructure to automate the management of these resources as if they were a single entity through hypervisor technologies such as virtual machine (VM).

One of the service that runs in Open Learning Portal is Student-Centered E-learning Environment-Pesonalization Dyanmic E-learning (SCELE-PDE). This service is an e-learning that built from modified moodle LMS so the system can provide personalization based on triple-factor model. The learners that registered use the e-learning to improve their performance in learning. They learn the materials that be given by teachers in the way they like. The e-learning recorded learner's activity such as access to learning material and involved in forums. The learner's activity determined learning behavior patterns of the learner. Learning behavior patterns filled the triple-factor parameter that consist of learning style category, level of motivation, and knowledge ability.

Learning style of the learner determined level of learning material that suitable with the learner preferences. Based on [8], learning style of learner calculated based on mean in frequent table of the group as a threshold. Learning style divide into 3 categories, they are seldom access category for number of access learning materials below the threshold, discipline catgeory for number of access equal with the range of threshold, and diligent access category for number of access greater or equal than the threshold.

Level of motivation determined which forum activity that should be improved by the learner. Level of motivation calculated from mean of activities in frequent table of group as threshold and divide into 3 categories, they are low, medium, and high motivation. Low motivation category gives to learner with number of access to forum discussions is below than the threshold. Medium motivation category gives to learner with number of access to forum discussion equal with the range of threshlod. High motivation category gives to learner with number of access to forum discussion is greater than the threshold.

Knowledge ability determined the performance of the learner after they use the e-learning. Knowledge ability calculated based on evaluation score of users. Knowlegde ability divide into 4 categories, they are fail for interval score 0-60, fair category for interval score 61-80, good catgeory for interval score 81-90, and very good category for interval score 91-100. The outcomes of the personalization are suitable learning contents for every learner that registered in the system. The architechture of the personalization e-learning depicted in figure 3.

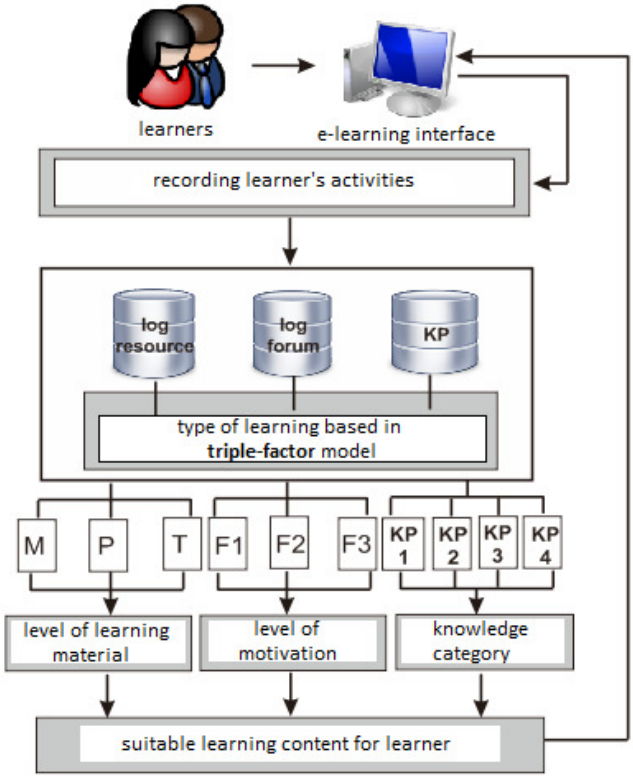

Figure 3. Architechture of Personalization Learning Content in E-learning

In order to improve their performance, level of learning material has been proposed. Level of learning materials that delivered to learner consist of three level, they are LV1 is short material (M), LV2 are short and explanation material (M+P) and, LV3 is short, explanation, and additional material (M+P+T). Short materials delivered in slide form. Explanation materials delivered in audio, video, and

multimedia form such as slide-audio mixing and video-slide mixing. Additional materials delivered in link, example, and other references form. Many form of learning materials need large repository and cloud environment used as a solution to store and delivered it. In the experiment, there are 118 learners that registered in Science Writing subject during a semester. In the subject there are 40 learning materials with different format and size that have been delivered. The composition of learning materials describe in table 2.

TABLE II
LEARNING CONTENT THAT DELIVER IN EACH WEEK IN INDENTIFICATION STEP

Week	Topic	audio slide	forum	animation	video	trigger	reference	outline	assignment	feedback
1	What is scientific writing	x	x	x	-	-	-	x	-	-	-
2	Fundamental concept of reserach	x	-	x	x	-	-	-	x	-	x
3	Scientifi Inquiry and Logical Thinking	x	x	x	-	x	x	-	-	x	-
4	Writing and developing paragraph	x	x	x	-	x	x	x	-	x	-
5	Problem Identification & Hypothesis	x	x	x	-	x	-	x	-	-	-
6	How to Review Literature	x	x	x	x	x	-	x	-	-	-
7	Quantitative Analysis	x	x	x	-	x	-	x	-	-	x
8	Quanlitative Analysis	x	-	-	-	-	-	x	-	-	-
9	Writing Research Proposal	x	x	x	-	-	-	-	-	x	-
10	Plagiarsm & Bibliography	x	-	-	-	-	-	x	-	-	-

When learner login into personalization e-learning, the system will record the activities. In experiment, learning process with e-learning devided into 2 step. Step 1 is identification step and Step 2 is personalization step. The step 1 held from week 1 till 7. The learner used e-learning without personalization and learning content delivered in many form but in limited amount. Based on step 1, learning activities that have been recorded describe in tabel 3.

TABLE III
LEARNING ACTIVITES IN IDENTIFICATION STEP

Week	Amount of access to learning materials	Amount of access to forum discussions	Evaluation Score			
			Fail	Fair	Good	Very Good
1	451	1162				
2	236	118				
3	372	197				
4	219	477	6	55	53	4
5	247	-				
6	268	409				
7	-	441				
Sum	**1793**	**2804**	**118**			

There are so many activities in a week. Both of activities need a large storage. Based on experiment, number of activities will increase equally with number of users and learning materials. Cloud environment as a service gives the facilities to enjoy the learner when they use personalization e-learning.

In order to improve performance of learners when use personalization e-learning in cloud environment, relation between level of learning materials and knowledge ability of learners has been observed. The relation in step 1 will be compared with the relation in step 2. Tabel IV shows the distribution of learners about relation between level of learning materials and knowledge ability in identification step.

TABLE IV
DISTRIBUTION OF LEVEL OF LEARNING MATERIALS AND KNOWLEDGE ABILITY IN IDENTIFICATION STEP

	LV1 (M)	**LV2 (M+P)**	**LV3 (M+P+T)**	**Sum**
Fail (0-60)	4	1	1	6
Fair (61-80)	43	4	9	56
Good (81-90)	46	0	6	52
Very Good (91-100)	2	1	1	4
Sum	**95**	**6**	**17**	**118**

Based on the table IV, the distribution of learners focus on LV 1. There are 6 learners which belong to fail category, 4 of them are in LV1 who only access short learning material but fail to gain more information because lack of knowledge ability. In fair category there are 43 learners that only access short material and gain enough information. The others in this category distributed to different level of learning materials but in small number. In good catgeory, 46 learners have preference to access short learning materials (LV1) too. They have higher knowledge ability than the category before, so their evaluation score belong to interval 81-90. In very good category there are only 4 learners, 2 learners belong to LV1 and the others belong to LV2 dan LV3.

The experiment continues to step 2 or personalization step. Based on preferences and calculation of means from frequent table of access learning materials, the personalization of learning materials delivered to learners. The step 2 held from week 8th untill week 12th. The learner used personalization e-learning and got more different form and size of learning materials. 40 learning materials delivered in the system got the feedback such as number of access and other learning activities. Number of learning activities in learning step 2 describe in tabel V

TABLE V
LEARNING ACTIVITES IN PERSONALIZATION STEP

Week	Amount of access to learning materials	Amount of access to forum discussions	Evaluation Score			
			Fail	Fair	Good	Very Good
8	221	564				
9	554	344	4	45	61	8
10	252	609				
11	728	1113				

12	380	1301	
Sum	**2135**	**3931**	**118**

Table V shown that learning activities in personalization step increased more than learning activities in identification step. Number of access to learning materials increased from 1793 to 2135 activities and number of access to forum discussions increased from 2804 to 3931 activities. It shown that personalization e-learning is able to improve learner's participation when they learnt because system deliver type of learning materials that suitable with the learner's need. So the learners will be focused on their exploration to get the information when they learn.

In personalization step, distribution of learners in relation between level of learning materials and knowledge ability was observed and describe in table VI below.

TABLE VI
DISTRIBUTION OF LEVEL OF LEARNING MATERIALS AND KNOWLEDGE ABILITY IN PERSONALIZATION STEP

	LV1 (M)	LV2 (M+P)	LV3 (M+P+T)	Sum
Fail (0-60)	1	0	3	**4**
Fair (61-80)	26	5	14	**45**
Good (81-90)	27	5	29	**61**
Very Good (91-100)	5	1	2	**8**
Sum	**59**	**11**	**48**	**118**

Tabel VI shown that learners in fail category decreased into 4 learners. 45 learners in fair category distributed to LV1, LV2, and LV3 in 26, 5, and 14 respectively. In good category, there are 61 learners. This number increase from 52 in identification step. The last category is very good that increased from 4 to 8.

In general, personalization e-learning success to improve performance of the learners. Many learners moved from low category to higher category in knowledge ability and get the higher score. It can be happened because in environment level, personalization e-learning runs in cloud computing environment which can provide wide access to broad storage of learning materials, facilities, and others services that support personalization.

VI. EVALUATION

The evaluation process for technical system will be used functional testing method. The system will be tested by input scenario and the output will be recorded and matched by the expected output. This scenario aimed to tested that the system will be running properly.

After making sure that the system has running properly by evaluated the functional system, the next evaluation process is concerning to economical aspect. Authors approach for this evaluation is by comparing two cases: non-cloud e-learning and cloud e-learning. This two cases will be evaluated by two approach: (1) Cost (Capex & Opex) analysis; (2) Net Present Value (NPV).

Cost anaylsis is measured by calculating sum of Capex and Opex between non-cloud and cloud open learning then the result will conclude the cost efficiency. The following is the formula for calculating cost analysis (for NC stands for Non Cloud-Based system and C stands for Cloud-Based system.

$$Cost\ Analysis\ (\%) = \frac{\sum NC_{expense} - \sum C_{expense}}{\sum NC_{expense}} \quad (1)$$

The simulation process with this approach conclude that by using cloud-based system could decrease the investation cost up to 35.61%.

Net Present Value (NPV) is measured by calculating the the difference between the present value of cash inflows and the present value of cash outflows. In this case NPV non cloud based formula could be describes as follows [6]:

$$NPVnc = -CaPex + \sum_{t=0}^{N} \left(\frac{C_t - OpEx}{(1+r)^t}\right) \quad (2)$$

and NPV for cloud based formula described as follows:

$$NPVc = \sum_{t=0}^{N} \left(\frac{C_t - OpEx}{(1+r)^t}\right) \quad (3)$$

The simulation process needs several assumptions such as salary of programmer, analyst, and server procurement cost. Furthermore, the result by calculating the NPV approach shows that the value of NPV is positive (greater than 0) by using NPV percentage formula :

$$NPV\ Percentage = \frac{NPVc - NPVnc}{NPVnc} x\ 100\% \quad (4)$$

with the results shows positive value (43,9%) of NPV that means by using cloud based system could give more benefits than using non cloud based system.

VII. CONCLUSIONS AND FUTURE WORKS

This paper discussed the problems while developing and implementing the e-learning system stressing the initial cost issue. Authors proposed a solution for these problems by adopting cloud technology and the concept of open educational resources to implement the e-learning and expected become a cloud based open learning system.

Authors steps for solved the initial cost problem are designing a architecture of cloud based open learning and implementing this architechture to a working prototype system. Final step is evaluate the prototype system by stressing the initial cost using the Net Pressent Value method.

The results of the evaluation shows that by implementing the cloud based open learning portal could decrease the investation cost up to 59% in compares to non cloud e-learning systems and with NPV approach shows that the results is 43,9% of NPV percentage that means by using cloud

based system could give more benefits than using non cloud based system.

In our future work, we will design and develop a semantyc based search engine for enhanced the system and integration it with personalization e-learning.

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