E-Learning Analysis And Design Based On Technology Acceptance Model

Hilmi Aulawi, Abdusy Syakur Amin

Abstract: E-Learning is one of the information systems technology that should be owned by educational institutions in Industrial era 4.0 or the era of Internet of Things. Aim of this study is to analyze and design e-Learning completely and systematically based on Technology Acceptance Model (TAM). In this case, TAM is associated with software reuse approach begin from adapting the existing e-Learning models and being given different touches as needed on the new system. We used Unified Modeling Language (UML) as software analysis and design model. The experiment of this study was conducted in Sekolah Tinggi Teknologi Garut. The results show that TAM can accelerate and simplify e-Learning analysis and designs processes, as all the needs are adapted from existing systems and improvised according to the needs of new e-Learning systems.

Index Terms: E-Learning, Software Engineering, Software Reuse, Technology Acceptance Model, Unified Modeling Language

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1 INTRODUCTION

IN the "Internet of Things" era, almost all of human activity utilize internet technology, including in education. The role of e-Learning is very important to help all teaching and learning activities more efficient [1]–[4] Technological devices are designed to enhance a quality of human's life [5], one of those which is enable efficiency and effectiveness in business process is information systems. Information systems (IS) is a combination of information technology utilizations and human activity upon a set of agreed procedure [6], generally is used to support management and operation [7]. IS is an organized data process [8], IS has a high level of flexibilities to develop and scalable [9]. Refers to several research, an information system has a high capability in decision making, the system has an accurate data accessibility and efficient run-time [10], high accuracy [11], and to support a proper decision [12], low cost [13], extended accessibility [14], intensify user knowledge [15], increase productivity [16], provide a better data and information [17],and in the certain cases are potentially used as data storage [18].

Analysis and design activities for e-Learning as IS take more time to produce quality e-Learning. All of stakeholder needs and system requirements must be met, so that e-Learning works according to the business process of teaching and learning activities. In the study of software engineering, there is reuse approach where system is developed by composing existing system, either the whole of existing system is reused (without changing), component reuse, or object and function reuse [19], [20]. Other sources group software reuse in two categories, among others higher level abstraction reuse and implementation level reuse [21]. With software reuse we can decrease the development time significantly, decrease the time required to identify infeasible tasks, and improve sense and ability of developer to manage the risk tasks [22].

In the software reuse process (describe in Figure 1), there

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are "adapt existing system" process. In this study we propose TAM to adapt the existing e-Learning to develop new e-Learning. We used TAM because it had been proven capable and highly cited model to create new technology efficiently and effectively based on existing technology [23], [24]. TAM model continues to evolve with the development of technology and case study that implements it such as information technology. In TAM, it is important to consider what should be maintained, what to dispose of, and what needs to be added as needed by the beneficiaries of the technology [25]. Basically the usefulness of technology, in this case e-Learning or whatever the technology, relates and depends on the needs of its users [26], [27].

Therefore, the aim of this study is to combine TAM and software reuse approach to analyze and design e-Learning. To develop new e-Learning based on TAM, we need to adapt the widely used and well-used e-Learning models today, such as Google Classroom, Moodle, and some college e-Learning. We used UML for modelling the result of e-Learning analysis and design process. In this case, we do not adapt the whole of the existing e-Learning into new e-Learning. We adapt the higher level abstraction of existing e-Learning and still based on user requirements.

2 RESEARCH METHOD

The concept of TAM has system feature and capabilities as stimulus, user's motivation to use system as organism, and actual system use as response (described in Figure 2) [24], [28]. Whereas, software reuse approach process, among others elicit stakeholder requirements, choose closest-fit system instance that can renegotiate or adapt, and deliver new system instance (described in Figure 1) [20]. Actually, TAM and software reuse approach have a similarity, that is both adapting existing technology to produce new technology. So, in this study, TAM and software reuse are combined as research methodology.
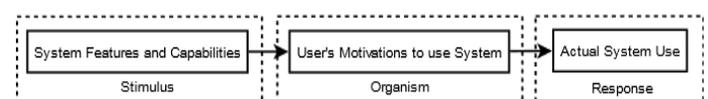

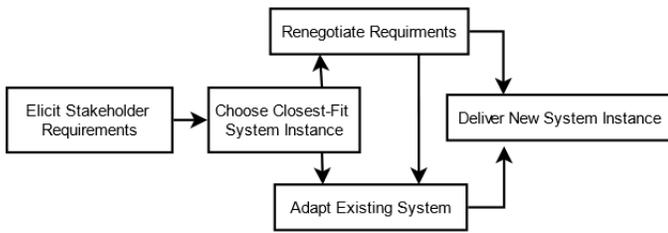Fig. 1. Conceptual model for technology acceptance [24], [28]

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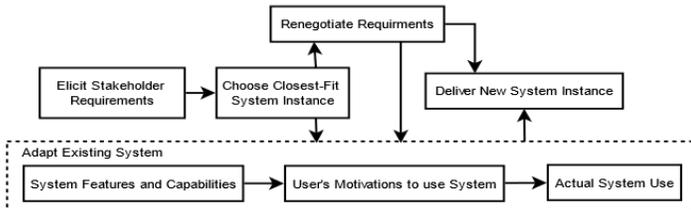Fig. 2. Process of software reuse approach [20]

Fig. 3. Combination of TAM and software reuse approach

Figure 3 describes the combination between TAM and software reuse approach for this study. e-Learning in this study is developed based on research methodology in Figure 3. Starting from elicit stakeholder requirements where requirement elicitation should be as complete as possible to reduce the risk of the system does not run as expected [29]. Then, after collecting all of stakeholder requirements, we do requirement analysis and choose which requirements are important and in accordance with the system. In software engineering development it is possible to change the requirement, the change can be influenced by many factors, whether it is a direct request from stakeholders, changing business processes, and rules and laws that directly affect the changing requirements. Because of that, renegotiate process of requirement could be happen. If renegotiation of the requirement is agreed, then the next process is to adapt the existing system, but if there is no renegotiation then the adaptation process to existing system can be done directly. However, after renegotiation process, it is also possible to develop new system without adapt existing system. The main point of TAM is in adapt existing system. As explain before, this study uses higher level abstraction of software reuse, so that in adapt existing system process, we analyze an architecture of existing system, analyze all of system features, and analyze functionalities or capabilities of existing system. The adaptation of existing system do not until implementation level, such as component, class, object, or function (method) reuse. The difference between basic software reuse with combination of software reuse and TAM is user's motivation to use system evaluation process. So, we re-analyze all of software features and capabilities based on user's motivation. And the last, conducting the actual system use process until deliver new system.

3   RESULT AND DISCUSSION

Based on proposed research methodology of combine TAM and software reuse approach that explained in section 2 above, this study grouping the process of analysis and design of e-Learning into 3 parts, among others: pre-adapt existing e-Learning, adapt existing e-Learning, and post-adapt e-

Learning. In pre-adapt existing e-Learning, there are conducted elicit the stakeholder requirement process, choose closest-fit system instance process, and renegotiate requirements process. In adapt existing e-Learning, all of TAM process is conducted. Then, in post-adapt e-Learning produce deliverable of analysis and design process of new e-Learning that are modelled using UML. This study uses Google Classroom, Moodle, and several college e-Learning as existing system and e-Learning of Sekolah Tinggi Teknologi Garut as new system.

3.1 Pre-adapt Existing e-Learning

Requirement elicitation process is conducted with several stakeholders of e-Learning such as lecturers, students, and administrative staff. The result of requirement elicitation is explain in Table 1 that is grouped based on stakeholders or users requirements. In Table 1 also describes about which one the requirement is choosen and which requirement is eliminated because not in accordance with the requirement of the system. Because not all of user requirements is choosen as system or software requirements [19], [20], [29], [30]. Renegotiation process is conducted based on user requirement, if user requirement is beyond system boundary or not accordance with system requirement then it possible to renegotiate for the best decision.

To strengthen the process of adaptation of learning in e-learning, multimedia is recommended as content in e-learning. Multimedia is a digital product that presents and combines text, sound, images, animation, audio and video, implemented with tools and connection so that users can navigate, interact, work, and communicate [31]. In the world of education, multimedia is used as a teaching medium, either in classroom or self-learning [32]. In learning process, multimedia has proven to be able to create a fun learning atmosphere [33], enhance learning motivation [34], increase the effectiveness of learning [35], improve the level of understanding [36], create student-centered learning [37], and make efficient investment of learning means[38].

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Table 1. The result of requirement elicitation, requirement selection, and requirement renegotiation

Users	Code ID and User Requirement	Selection Decision	Renegotiation Result
Lecturers	UR-1. Lecturers need personal access to e-Learning so that the teaching and learning activities for the subjects are not mixed with other lecturers and keep the lecturers' rights in giving assesment to the lecture activities.	Accepted	-
	UR-2. The lecturer can add a class to the course he / she is held and add the students who attend the class.	Accepted with negotiation	It is better for the lecturer not to create their own class, but college provides or opens the class according to the letter of teaching duty, including the list of students who attend the class. This ensures that all lecturers have online classes in e-Learning and ensure that all students taking the course are enrolled.
	UR-3. Lecturers can upload lecture materials with flexible file format according to lecture needs, be it in the form of .pdf, .doc / .docx, video format, image format, and more. Then the size of the file used is large enough so as not to limit the material in the uploaded.	Accepted	-
	UR-4. Lecturer can freely make assignment for the course he holds with various forms of assignment as needed, either in essays, multiple choice, papers, and other forms. And also lecturers can give assignment deadline, then the system can close assignment automatically if the deadline time has passed.	Accepted	-
	UR-5. Lecturers can easily examine student answers and assign values to the students' assignments. If possible e-Learning provides automatic assessment or autograder, regardless of the assignments, both multiple and essay.	Accepted with negotiation	Assessment can automatically be added as a function of e-Learning, meaning the lecturer should include the key answer of the assigned task. For tasks in the multiple-choice form it is easier to perform automated assessments, but for essays or papers it is necessary to add a function of assessing text similarity, even when it is possible to add plagiarism checks.
	UR-6. Lecturers can see all of lecture activities in e-Learning, whether that is already running, is running, or that will run. All activities ranging from assignments and assessments can be seen statistically (complete with the presentation of diagrams) as well as in detail and personal based on each student. And also lecturers can print the assignments and assesments report of their class.	Accepted	-
Students	UR-7. Students can access e-Learning personally, so that the student's personal data either self profile, task, values, or history of student's lecture activity is safe.	Accepted	-
	UR-8. Students can change their profile or identity if they are not appropriate.	Accepted with negotiation	Changes in the profile or identity of the students must be informed by the campus to maintain the validity of student data, so there needs to be a verifier that ensures changes in student identity in accordance with the original.
	UR-9. Students can update status messages in their e-Learning.	Declined	-
	UR-10. Students can join any class they are interested in and can download the required course material.	Accepted with negotiation	Students can not freely join a class that he does not take in accordance with the contract of the course that has been registered. Because the classes and students who join are automatically created by e-Learning. However, students can

Users	Code ID and User Requirement	Selection Decision	Renegotiation Result
			freely access material from any course according to students' interests and needs.
	UR-11. Students need open communication facilities both between students and lecturers as well as between students and students, so there needs to be discussion media. In addition, students also need personal communication media with lecturers.	Accepted with negotiation	Discussion forums are provided open on each course, so the discussion is focused on for each course. If there is a distorted discussion, the lecturer or the campus can throw it away. This is to maintain the quality of the discussion in accordance with the activities of the lecture.
	UR-12. Students can see the assigment given by the lecturer. It is better if e-Learning gives notification of a assignments and gives a warning if the deadline of collecting assigments will be end. Students can also do their tasks on e-Learning directly in accordance with the type of assignment.	Accepted	-
	UR-13. Students can see the value of the assignments that he did, either directly after the assignment done or the history of assigments that have been done. And the report of assesment ban be printed.	Accepted	-
Admnistrative Staff	UR-14. Administrative staff can control the authentification of lectures and students.	Accepted	-
	UR-15. Administrative staff can see the logbook or e-Learning activity history, and also they can print report of assignments and assesments without changing anything.	Accepted	-

Table 2. e-Learning requirements based on TAM

Existing e-Learning Feature	Code of User Requirements	Adapt?	New e-Learning Requirements
Login	UR-1, UR-7, UR-14	Yes	(SR-1) e-Learning main page is a login page to authenticate each user.
Create class	UR-2	No	(SR-2) e-Learning can create class and add all of student who attend the class automatically based on lecture contract that are enrolled.
Upload course material (for lecturers)	UR-3	Yes	(SR-3) e-Learning provides feature for uploading course materials for lecturer. File type of material is multiform such as .pdf, .doc/.docx, .ppt/.pptx, video format file, image format file, and so on based on the needs of course. Visibility of course material can also be set whether those materials may be free access or only students who take the course who can access.
Create assignment (for lecturers)	UR-4	Yes	(SR-4) e-Learning provides feature for lecturers to create assignment or examination in ther class. The assignment is in multiform based on the course needs, such as multiple choice type, essay, paper, and so on. Deadline schedule can be added into assignment.
Assesment (for lecturers)	UR-5	Yes	(SR-5) e-Learning can asses the assignments automatically and manually based on lecturers' choice.
History	UR-6, UR-13, UR-15	Yes	(SR-6) e-Learning provides lectures activities history for lecturers, students and administrations. Each user can not see another user's history.
Report	UR-6, UR-13, UR-15	Yes	(SR-7) e-Learning provides summary report about lectures activity for lecturers, students, and administrations. Report is presented statistically using diagram and detail of report. For lecturers can see all of their students report, while students only can see their own report. Administration can see all of activity report of lecturers and students.
Print report	UR-6, UR-13, UR-15	Yes	(SR-8) e-Learning provides feature for printing reports.

Existing e-Learning Feature	Code of User Requirements	Adapt?	New e-Learning Requirements
Update profile (for student)	UR-8	Yes	(SR-9) e-Learning can be update students' profil if administration or campus has been verified new profile that submitted by students.
Update status (for students)	UR-9	No	-
Join class (for student)	UR-10	No	Same as SR-2
Discussion	UR-11	Yes	(SR-10) e-Learning provides group discussion media that categorized based on the course. This group is open for lecturers and students.
Personal Message	UR-11	Yes	(SR-11) e-Learning provides personal message feature that make communication between lecturers, students, and administration easy.
Notification and alert (for students)	UR-12	Yes	(SR-12) e-Learning can give assignment notification for students and give an alert if the deadline of collecting assigments will be end.
Manage account	UR-14	Yes	(SR-13) e-Learning provides administration page that can manage all of data and activities of users, including about authentification of user.

3.2. Adapt Existing e-Learning

The result of user requirements elicitation process, choosing closest-fit system instance, and renegotiate process, in adapt existing e-Learning, all of features of existing e-Learning will be analyzed and adapted to the user's motivations and needs. Next, it will be generated system or software requirements adaptation from the existing system. Table 2 explains about features of existing e-Learning (based on Google Classroom, Moodle, and several collage e-Learning) and what the relation of these features to the motivation or user requirements that have been presented in Table 1. The existing e-Learning features are adapted if in accordance with the results of user requirements in Table 1, then changed it into software requirements. Software requirement of e-Learning is actual system used and result of TAM process that adapt higher level abstraction of existing e-Learning.

3.3. Post-adapt Existing e-Learning

Post-adapt existing e-Learning is the last stage that produce new e-Learning. The deliverable of new e-Learning using combination of TAM and software reuse approach is analysis and design model with UML. UML is used because until now object-oriented programming is still a tren [39], so the model of analysis and design of e-Learning in this study can be implemented easily. In addition, object-oriented analysis and design with UML is modular so it can be easily maintained [40]–[43]. The analysis and design of e-Learning is modelled using Use Case Diagram in Figure 4 and Class Diagram in Figure 5 (Class Diagram is still abstraction/prototype, it has not been implemented yet). Those model is created based on software requirements.
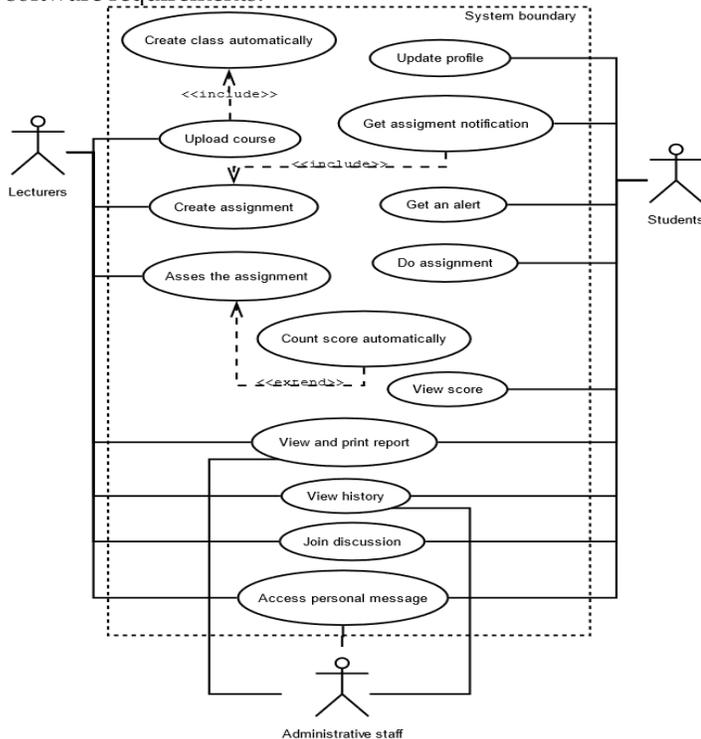

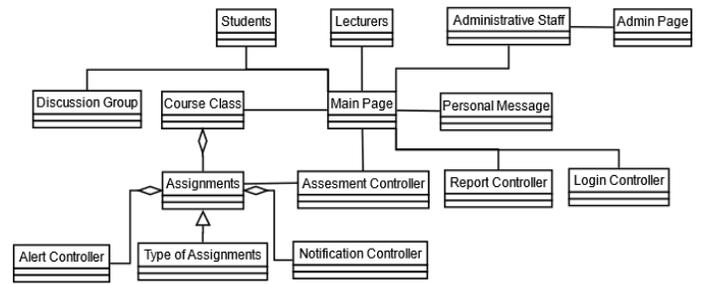Fig. 4. Use Case Diagram of e-Learning based on TAM

Fig. 5. Class Diagram of e-Learning based on TAM

4 CONCLUSION

TAM is an approach to adapt existing technology efficiently and easily to create new technology. And also with software reuse approach that reuse and adapt existing software to develop new software. This study combines TAM and software reuse approach to build e-Learning. Adaptation is done at higher level abstraction reuse. The realization of TAM and reuse approach software was successfully done by dividing the process into pre-adapt, adapt, and post adapt of existing e-Learning. Based on Focus Group Discussion with some experts in Sekolah Tinggi Teknologi Garut where e-Learning is built, TAM method combined with software reuse approach is quite easy to understand and applied. With the TAM, ensuring all the user's motivation as stated in user requirements can be fulfilled as needed. So with TAM can reduce the possibility of changes both in software requirements and on e-Learning as a whole. For future research can be done quality measurement to combination of TAM and software reuse approach. Similarly, quality measurements of the new e-Learning analysis and design using TAM can be measured.

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