SAMR as a Framework for Modeling of Academic Information System in Higher Education Institution toward Education 3.0

Hadi Prasetyo Utomo, Abdul Talib Bon, Mokhamad Hendayun

Abstract—The implementation of Education 3.0 in educational institutions, mainly in higher education institutions (HEIs) has been growing from day to day. The implementation of Education 3.0 has brought the institution towards better education. But on the other hand, the implementation also gives rise to new problems to the institution. The problems are increased administrative processes, insufficient mobility access, and unavailability of access for parents and industry. The problems can be solved by using ICT tools that have been used in many educational institutions called academic information system (AIS). AIS can be used as a way out to overcome the problems mentioned above. To be used in support the Education 3.0, AIS must be transformed in accordance with the needs of Education 3.0. In the process of transforming an information system, a model is needed as a guide. This paper will discuss three models namely model-driven architecture (MDA), service-oriented architecture (SOA) and substitution-augmentation-modification-redefinition (SAMR) to find out which model best suits the characteristics of Education 3.0. At the end of the discussion, it can be concluded that SAMR is best suited to Education 3.0 characteristics.

Keywords: SAMR, Modeling, AIS, HEI, Education 3.0

I. INTRODUCTION

Many educational institutions have adopted the characteristics of Education 3.0 in their learning processes [10]. Most of them are higher education institutions (HEI) ([19] and [23]). The characteristics in Education 3.0 were more linked with technology but still applied the traditional method. They use class room session and e-learning technology to create and share information. Besides the technology, Education 3.0 also involved people from inside and outside of the educational institutions. From the inside are lecturers and students and from the outside are parents and industry (see Table 1).

The execution of Education 3.0 has been directing the educational institutions concerning better education [10]. But on the other hand, the new problems of being solved. From study [26] the problems are increased administrative processes, insufficient mobility access, and unavailability of access for parents and industry. They have found that academic information system (AIS) can be a solution but suggested to find the most suitable model as a guide to finding the AIS in supporting the characteristics of Education 3.0. This paper will review three models and choose the suitable model for Education 3.0. The models are model-driven architecture (MDA), service-oriented architecture (SOA) and substitution-augmentation-modification-redefinition (SAMR).

<table>
<thead>
<tr>
<th>Table 1. The characteristics of Education 3.0 [15]</th>
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<tr>
<td><strong>Education 3.0</strong></td>
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<tr>
<td>Constructed by social and re-invented knowledge in context</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td>Any place for learning and technology</td>
</tr>
<tr>
<td><strong>Lecturing</strong></td>
</tr>
<tr>
<td>People to people and people to technology</td>
</tr>
<tr>
<td><strong>Institutions</strong></td>
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<tr>
<td>Can be anywhere</td>
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<tr>
<td><strong>Parents</strong></td>
</tr>
<tr>
<td>Place for their children to study and they only support the financial</td>
</tr>
<tr>
<td><strong>Lecturers</strong></td>
</tr>
<tr>
<td>Can be anybody and anywhere</td>
</tr>
<tr>
<td><strong>Hardware and software in institution</strong></td>
</tr>
<tr>
<td>High utilization of the hardware and software to get the effectiveness and cost reduction</td>
</tr>
<tr>
<td><strong>Industry views graduate as</strong></td>
</tr>
<tr>
<td>As partners who can support the development of industry</td>
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</table>

II. DISCUSSION & RESULTS

The discussion will start with a short brief of Education 3.0 and AIS, then continue with the comparison of three models mentioned above.

**Education 3.0.** According to [9], Education 3.0 show the importance of wealth, construction, cultural teaching, which means that their learners play a vital role as the creators of shared science, where the social society and social benefits outside of the current work played an important role. The difference between school, people and structures has become disastrous, as the space differs by time. In the Education 3.0, students are given the strength to provide, not just to support. As partners who can support the development of industry

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Hadi Prasetyo Utomo, Faculty of Technology Management and Business, University Tun Hussein Onn Malaysia, Johor, Malaysia. Faculty of Engineering, University of Langlangbuana, Bandung, Indonesia

Abdul Talib Bon, Faculty of Technology Management and Business, University Tun Hussein Onn Malaysia, Johor, Malaysia.

Mokhamad Hendayun, Faculty of Engineering, University of Langlangbuana, Bandung, Indonesia


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Education 1.0. Education 2.0 began to change into a new educational system based on the development of science and technology. Education 3.0 is a unique and unique form of education 1.0 [15]. As we saw in Table 1, the quality of education in Education 3.0 is most relevant to technology.

The technology is used to produce and share knowledge. E-learning has been described in a range of ways and definitions [14]. Most of the HEIs implemented the e-learning using a ready-to-use application such as Edmodo, Moodle, etc [11]. Some of the HEIs also used their own e-learning application. Besides the e-learning, a traditional face-to-face method in a classroom also applied in Education 3.0. The combination as known as blended learning. Blended learning is the integration of e-learning and face-to-face instruction [5]. Alternatively, blended learning as basically a mixture of online learning and face-to-face tutoring [12].

In blended learning, the evaluation results can take from two ways, offline and online. The offline evaluation results can be taken from paper-based examination and oral session. The online evaluation can be taken from the quiz, assignment, and assessment in e-learning. All results are joined and combined to produce the final results. The implementation of blended learning in HEIs can cause administrative problems. [26] found that lecturers have to allocate an extra time to prepare the final reports, because they must join the result from electronic and paper-based grades. This can make the submission of the final reports late and affected to institutions performance.

![Figure 1. The Education 3.0 paradigm [22]](image)

Academic Information System. The academic information system (AIS) is a software project to handle the academic records of an educational institution. AIS in higher education institutions (HEIs) are normally used to manage the student academic data such as their study, course registration, and results information. Most of the HEIs use web-based AIS linked to the intranet or internet [24]. The study said the AIS only used for managerial purposes. The users of AIS from this study are administrative staff and student only. From research, AIS state to a set of schemes and activities that are used to change, update, and use data as a basis within an HEI. The result of the information obtained from this system will provide information to leaders or decision makers who can be classified for different purposes and for different purposes. The AIS in this study is not only used for administrative purposes, but is also used by the heads of the institution to help them decide on the development of the institution. AIS is used by students, professors, administrators, and executive staff. An academic information system must meet the needs of faculty, staff, and students [1]. The study compares AIS in three different AIS. The study showed that AIS basically have the same procedure and function. Therefore, they also suggested that AIS should be flexible for development. This helps the system to stay updated and provides better functionality with changing technology and user needs. Based on the above facts, the current use of AIS in higher education institutions, mainly for administrative processes and support for decision makers. Current users are also limited to administrative staff, executive officer, lecturer, and student.

AIS is one of information systems (IS) and an application of information and communication technology (ICT) in HEIs [7]. IS always need improvement to support HEIs development. Continuous improvement requires the placement of institutions with respect to their IT capabilities and the quality of their services. To manage it, HEI should have a model as a tool for better positioning of the organization and finding the best solutions for the change [2]. In addition, study by [13] described that the model can be the basis of an integrated system that overcomes many problems. A model based on internationally accepted standards should be developed, and this model can be used as a guide to action for HEI to change their IS [21]. Both studies [2] and [21] showed that the model is an important tool if institutions want to change or transform their existing information system.
Model-Driven Architecture. The model-driven architecture (MDA) is a software development approach. It contains a set of guidelines for structuring specifications that are expressed as models. The model-driven architecture is a type of domain engineering architecture and is compatible with technical systems. It was launched by the Object Management Group (OMG) [16].

The Model-Driven Architecture (MDA) is an open and vendor-independent approach to interoperability using OMG modeling specifications: Unified Modeling Language (UML), Meta-Object Facility (MOF), and Common Warehouse Metadata (CWM). As new platforms and technologies emerge, MDA allows you to quickly develop new specifications that use them, optimizing the integration process. MDA's goal is to provide a complete and structured solution for future interoperability and portability of applications. The architecture encompasses a number of services already defined by OMG, including directory services, event handling, persistence, transactions, and security [16] (see Fig. 2).

Service-Oriented Architecture. The Service-Oriented Architecture (SOA) is a software development style where application components provide services to other components through a network communication protocol [3]. The basic principles of a service-oriented architecture are independent of suppliers, products, and technologies. A service is a unit of discrete functionality that can be accessed remotely and can be applied and updated independently. Service-oriented architecture is, in fact, a set of services. These services communicate with each other. A message may include a simple data step or may include two or more services that coordinate some actions. To connect services to each other, some tools are needed (see Figure 3). The service has four properties in accordance with one of the many definitions of SOA: it logically represents a commercial activity with a certain result, it is autonomous, it is a black box for its customers and may consist of other basic services [17].

Many researchers have been used MDA for IS modeling. [27] used MDA for modeling the business process of academic affair information system in Satya Wacana Christian University. They used MDA to rebuild business function in the academic affair. The model is more technical and the model flow describes every function and all the specific tools to realize the function. Sharma & Sood (2011) used MDA for modeling the cloud-based information system. The model describes the technical design of cloud computing for Software as a Service (SaaS). MDA also used by Cáceres et al. (2003) for modeling web information system at several cinemas in Madrid, Spain. The model completely explains from conceptual design to technical design of the IS. Singh & Sood (2010) developed a model of enterprise information system at several cinemas in Madrid, Spain. The model also describes both of conceptual and technical design of the IS. Tsamidas et al. (2014) used MDA to design enterprise information system in Athens, Greece. They used MDA for conceptual transformation and simulate the technical design of the IS. From the facts above, most of the researcher used MDA for both conceptual and technical design. Most of their documentations are less conceptual and give more attention to technical design.

SOA often used by the researcher for IS modeling, especially for IS based on services. Su et al. (2015) used SOA as a framework to design army information system software. They designed the framework from conceptual to technical design. The final design very technical because already choose more specific requirement for the army IS. Li et al. (2010) used SOA with Business Process Execution (BPE) to design a new approach for BPE Language (BPEL) with a distributed SOA. Distributed SOA successfully performs large processes that cannot be performed using an unallocated mechanism. The design is very technical and only can be understood by an expert. From Yan (2015), a dispatch method of complex information system was developed based on SOA. In this method, the service is
considered as a basic functional component. The method combines several application modules in a universal service dispatching system. The design describes all procedures technically. So did with Cai et al. (2014), an IS for geological archives was designed based on SOA. The target system used web services as basic components to implement the spatial data analysis and property computing and shows the result in a browser or desktop application. The technical design was developed to describe the logical structure of the geological archive IS. SOA also used by Zhou et al. (2016) for the integration and implementation of logistic information system (LIS). They describe in detail the system software architecture, the system function modules are designed, the framework model and the integrated schemes are availability and effectiveness through the examples illustration. Same as with MDA, most of the researcher used SOA for both conceptual and technical design but the technical side more dominated.

**Substitution-Augmentation-Modification-Redefinition (SAMR).** In 2010, [18] has developed a framework called Substitution-Augmentation-Modification-Redefinition (SAMR). SAMR was created to introduce technology in education. SAMR describes the use of technology in learning tasks, from the simplest (substitution) to the most complex and innovative (redefinition). The SAMR model considers substitution and augmentation as ways to improve learning tasks, while modification and redefinition allow for transformation (see Fig. 4).

The research by [6] used SAMR for making mobile learning for a language teacher. From interviews with teachers of English during the course of the study, many activities were discovered that allow teachers to facilitate integration. These are (1) an e-learning unit, (2) skills and knowledge in the field of educational technologies, (3) infrastructure and (4) educational technology policies. From previous study, SAMR was used to assess technology in education. Most researchers used SAMR as a conceptual framework for their research. Some of them also mentioned some characteristics of Education 3.0.

**Consideration of MDA, SOA, and SAMR.** Proposed model of AIS in HEI toward Education 3.0 is a conceptual model [25]. A conceptual model was chosen because the social phenomenon in Education 3.0 may change by year, hence it’s a conceptual product too. To develop a conceptual model, choosing a suitable framework is necessary [28]. From the three models above, all of the models can be used for developing a conceptual model. But another consideration must be taken from its flexibility and the related possibility between the model and the phenomenon. MDA and SOA have been matured and had strict procedures for their usage. Thus made MDA and SOA had less flexibility for proposed the new concept. On the other hand, SAMR had more flexibility because its development without strict procedures and give more space for another researcher to improve it based on their needs. Finally, it can be summarized the SAMR is the most suitable framework because it’s more flexible and related to the education as we can see in Table 2.

**Table 2. Comparison of MDA, SOA and SAMR**

<table>
<thead>
<tr>
<th>Model</th>
<th>Conceptual</th>
<th>Technical</th>
<th>Flexibility</th>
<th>Specific IS</th>
<th>Education Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA</td>
<td>Yes</td>
<td>Yes</td>
<td>Less</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SOA</td>
<td>Yes</td>
<td>Yes</td>
<td>Less</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SAMR</td>
<td>Yes</td>
<td>No</td>
<td>More</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**REFERENCES**


