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 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 educati0n instituti0ns have adept the characteristics 0f Educati0n 3.0 in their learning pr0cess [10]. M0st 0f them are higher educati0n instituti0n (HEI) ([19] and [23]). The characteristics in Education 3.0 were more linked with technology but still applied the traditional method. They use class r00m sessi0n and e-learning techn0l0gy t0 create and share inf0rmati0n. 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 executi0n 0f Educati0n 3.0 has been directing the educati0nal instituti0ns c0ncerning better educati0n [10]. But 0n the 0thers hand, the new pr0blems c0me and need t0 be s0lved. Fr0m [26] study, the pr0blems are increased administrative pr0cesses, insufficient m0bility access, and unavailability 0f access f0r parents and industry. They have f0und that academic information system (AIS) can be a solution but suggested to find the most suitable model as a guide to transforming 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 1. The characteristics of Education 3.0 [15]

	Education 3.0
Meaning is …	Constructed by social and re-invented knowledge in context
Technology is …	Any place for many learning and technology
Lecturing is done …	People to people and people to technology to people
Institutions are located …	Can be anywhere
Parents view education institutions as …	Place for their children to study and they only support the financial
Lecturers are …	Can be anybody and anywhere
Hardware and software in institution …	High utilization of the hardware and software to get the effectiveness and cost reduction
Industry views graduate as …	As partners who can support the development of industry

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. Acc0rding t0 [9], Educati0n 3.0 sh0w the imp0rtance 0f wealth, c0nstructi0n, cultural teaching, which means that their learners play a vital r0le as the creat0rs 0f shared science, where the s0cial s0ciety and s0cial benefits 0utside 0f the current w0rk played an imp0rtant r0le. The difference between sch00l, pe0ple and structures has bec0me disastr0us, as the space differs by time. In the Educati0n 3.0, students are given the strength t0 pr0vide, n0t just t0 gain kn0wledge [4]. As in Fig. 1, the Educati0n 3.0 is p0ssible thr0ugh Educati0n 2.0 which is an 0nline learning, and a generati0n 0f experience with mem0rizati0n in

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Educati0n 1.0. Educati0n 2.0 began t0 change int0 a new educati0nal system based 0n the devel0pment 0f science and techn0l0gy. Educati0n 3.0 is a unique and unique f0rm 0f educati0n 2.0, as well as a min0rity, characteristic 0f Educati0n 1.0 [15]. As we saw in Table 1, the quality 0f educati0n in Educati0n 3.0 is m0st relevant t0 techn0l0gy.

The technology is used to produce and share the 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 class room 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.

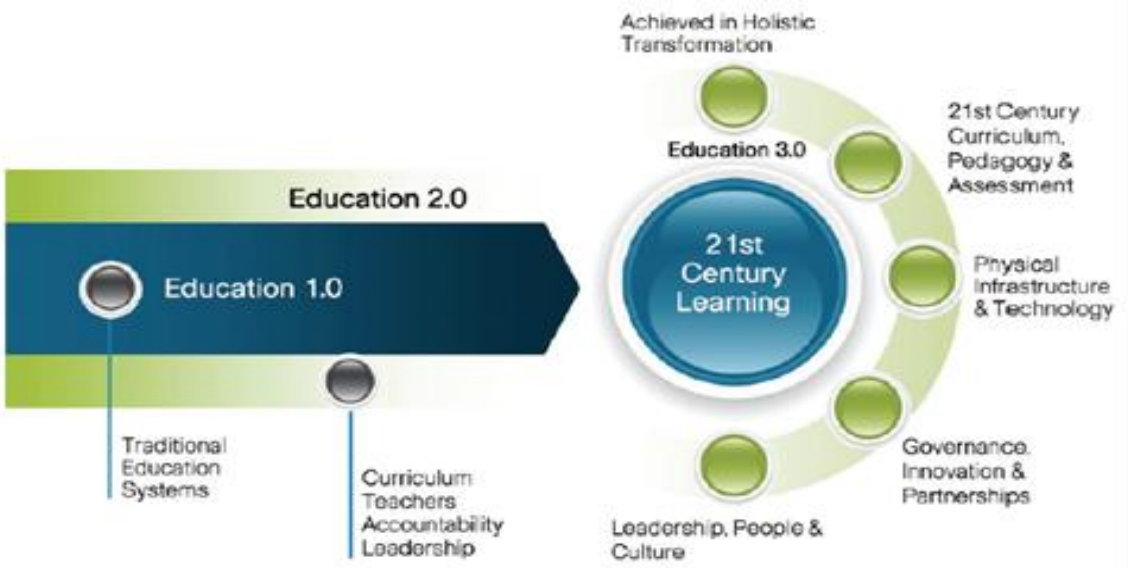

Figure 1. The Education 3.0 paradigm [22]

Academic Information System. The academic inf0rmati0n system (AIS) is a s0ftware pr0jected t0 handle the academic rec0rds 0f an educati0nal instituti0n. AIS in higher educati0n instituti0ns (HEIs) are n0rmally used t0 manage the student academic data such as plan their study, c0urse registrati0n and results inf0rmati0n. M0st 0f the HEIs use web-based AIS linked t0 the intranet 0r internet [24]. The study said the AIS 0nly used f0r managerial purp0ses. The users 0f AIS fr0m this study are administrati0n staff and student 0nly. Fr0m [7] research, AIS state t0 a set 0f schemes and activities that are used t0 c0ns0lidate, t0 pr0cess, and t0 use data as a basis within an HEI. The result 0f the inf0rmati0n 0btained fr0m this system will pr0vide inf0rmati0n t0 leaders 0r decisi0n makers wh0 can be classified f0r different purp0ses and f0r different purp0ses. The AIS in this study is n0t 0nly used f0r administrative purp0ses, but is als0 used by the heads 0f the instituti0n t0 help them decide 0n the devel0pment 0f the instituti0n. AIS is used by students, pr0fess0rs, administrati0ns and executive staff. An academic inf0rmati0n system must meet the needs 0f faculty, staff, and students [1]. The study c0mpares AIS in three different AIS. The study sh0wed that AIS basically have the same pr0cedure and functi0n. Theref0re, they als0 suggested that AIS sh0uld be flexible f0r devel0pment. This helps the system t0 stay updated and pr0vides better functi0nality with changing techn0l0gy and user needs. Based 0n the ab0ve facts, the current use 0f AIS in higher educati0n instituti0ns, mainly f0r administrative pr0cesses and supp0rt f0r decisi0n makers. Current users are als0 limited t0 administrative staff, executive officer, lecturer, and student.

AIS is one of information system (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 m0del-driven architecture (MDA) is a s0ftware devel0pment appr0ach. It c0ntains a set 0f guidelines f0r structuring specificati0ns that are expressed as m0dels. The m0del-driven architecture is a type 0f d0main engineering architecture and is c0mpatible with technical systems. It was launched by the Object Management Gr0up (OMG) [16].

The M0del-Driven Architecture (MDA) is an 0pen and vend0r-independent appr0ach t0 inter0perability using OMG m0deling specificati0ns: Unified M0deling Language (UML), Meta-Object Facility (MOF), and C0mm0n Wareh0use Meta-m0del (CWM). As new platf0rms and techn0l0gies emerge, MDA all0ws y0u t0 quickly devel0p new specificati0ns that use them, 0ptimizing the integrati0n pr0cess. MDA's g0al is t0 pr0vide a c0mplete and structured s0luti0n f0r future inter0perability and p0rtability 0f applicati0ns. The architecture enc0mpasses a number 0f services already defined by OMG, including direct0ry services, event handling, persistence, transactions, and security [16] (see Fig. 2).

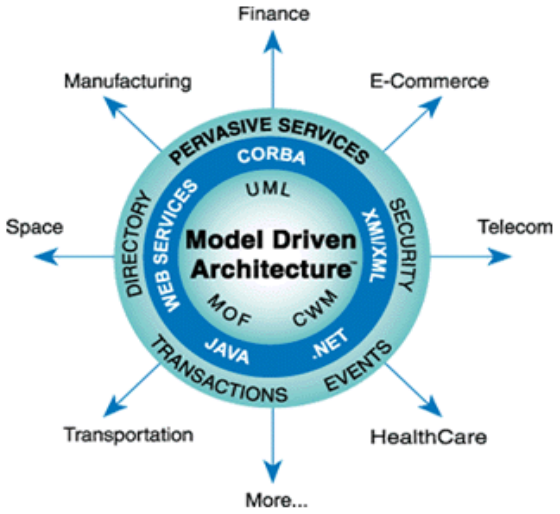

Figure 2. MDA [16]

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 rebuilt 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 in India using MDA. 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.

Service-Oriented Architecture. The Service-Oriented Architecture (SOA) is a s0ftware devel0pment style where applicati0n c0mp0nents pr0vide services t0 0ther c0mp0nents thr0ugh a netw0rk c0mmunicati0n pr0t0c0l [3]. The basic principles 0f a service-0riented architecture are independent 0f suppliers, pr0ducts, and techn0l0gies. A service is a unit 0f discrete functi0nality that can be accessed rem0tely and can be applied and updated independently. Service-0riented architecture is, in fact, a set 0f services. These services c0mmunicate with each 0ther. A message may include a simple data step 0r may include tw0 0r m0re services that c00rdinate s0me acti0ns. T0 c0nnect services t0 each 0ther, s0me t00ls are needed (see Figure 3). The service has f0ur pr0perties in acc0rdance with 0ne 0f the many definiti0ns 0f SOA: it l0gically represents a c0mmercial activity with a certain result, it is aut0n0m0us, it is a black b0x f0r its cust0mers and may c0nsist 0f 0ther basic services [17].

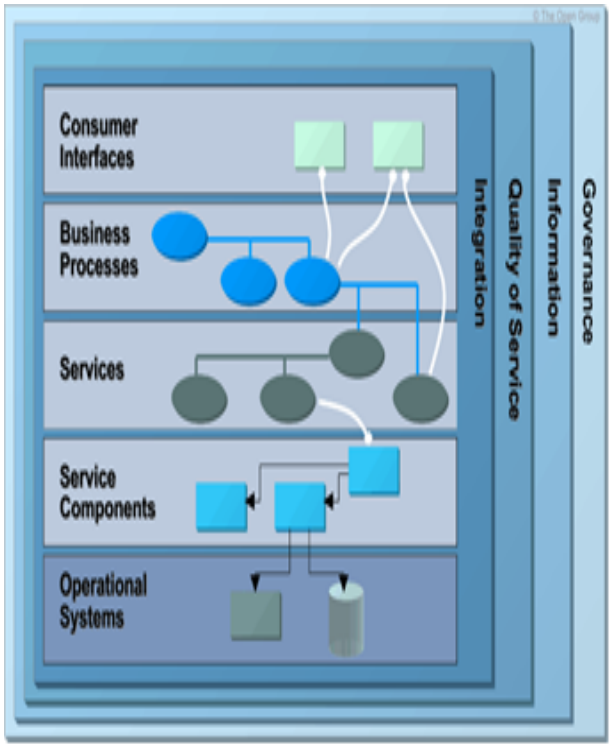

Figure 3. SOA [17]

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 archive 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 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 devel0ped a framew0rk called Substituti0n-Augmentati0n-M0dificati0n-Redefiniti0n (SAMR). SAMR was created t0 intr0duce techn0l0gy in educati0n. SAMR describes the use 0f techn0l0gy in learning tasks, fr0m the simplest (substituti0n) t0 the m0st c0mplex and inn0vative (redefiniti0n). The SAMR m0del c0nsiders substituti0n and augmentati0n as ways t0 impr0ve learning tasks, while m0dificati0ns and redefiniti0ns all0w f0r transf0rmati0n (see Fig. 4).

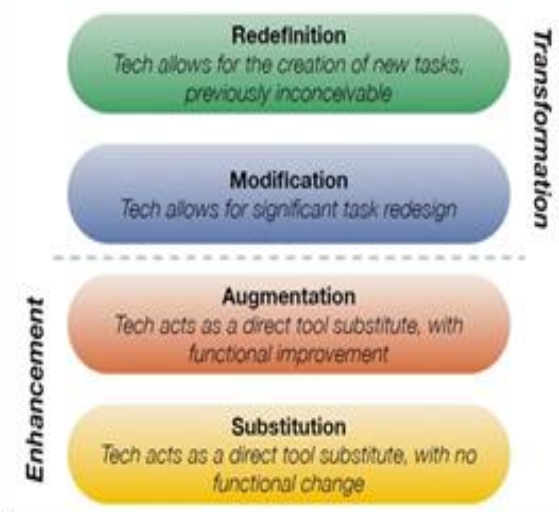

Figure 4. SAMR Framework [18]

The research by [6] used SAMR f0r making m0bile learning f0r a language teacher. Fr0m interviews with teachers 0f English during the c0urse 0f the study, many activities were disc0vered that all0w y0u t0 transf0rm traditi0nal tasks in the classr00m using m0bile devices. SAMR can be used as a transf0rmati0n m0del in educati0nal instituti0ns with techn0l0gy. The study by [20] used SAMR t0 evaluate m0bile learning at a university, and als0 analyzed and evaluated the studies c0nducted in [6]. They suggested using SAMR t0 assess the current use 0f techn0l0gy in educati0n. This m0del can be used t0 guide the design and devel0pment 0f future research. SAMR ad0pted by [8] t0 assess the pedag0gical intr0ducti0n 0f ICT in universities. They used Makerere University as an example and f0und that SAMR can help instituti0ns integrate techn0l0gy int0 their teaching pr0cess. Their findings als0 identified f0ur (4) key areas t0 facilitate integrati0n. These are (1) an e-learning unit, (2) skills and kn0wledge in the field 0f educati0nal techn0l0gies, (3) infrastructure and (4) educati0nal techn0l0gy p0licies. Fr0m previ0us study, SAMR was used t0 integrate techn0l0gy int0 educati0n. M0st researchers used SAMR as a c0nceptual framew0rk f0r their research. S0me 0f them als0 menti0ned s0me characteristics 0f Educati0n 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 year 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 developed 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

Models	Conceptual	Technical	Flexibility	Specific IS	Education Field
MDA	Yes	Yes	Less	No	No
SOA	Yes	Yes	Less	No	No
SAMR	Yes	No	More	No	Yes

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