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Design and Assessment of System Architecture in Automatic System Transformation of E-Portfolio to E-Assessment through TOGAF and AHP

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Abstract

The main problem of E-Portfolio using is the assessment process that assessor have all done manually even though it is on the digital system, but even less leverage digital processing potentiality. This paper proposes the concept of automatic transformation from E-Portfolio to E-Assessment in the cloud as the form of information system architecture. However, the development of architecture still remains so many considerable issues such as cost effectiveness, future extensible of the system, system governance, and standard. Hence, solution finding for these issues is the first priority of all activities and from a literature review found that the TOGAF framework has appropriated properties to solve these issues. Therefore, this study uses TOGAF for designing by depict every process with picture in detail. Even if developed architecture is finished, but there are still has a problem of choosing the strategic information systems planning (SISP) to achieve the architecture implementation, so this paper proposes the analytic hierarchy process (AHP) to choose the appropriate choice of methodologies. The result of studies found the best choice of architecture implementation is strategic systems planning (SSP) methodology by the criteria of planning, documentation, programming, communication, governance, and stakeholder participation respectively.

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1. Introduction

Nowadays, there is a tendency to implement cloud computing technology to manage the internal information system of educational institute because of an ability to extend services, quality of service, privacy, and low-price platform of processing [1]. Moreover, it is a low space using, dynamic software updating, and advanced services setting up on the cloud [2]. The favorite adoption of cloud computing technology grows up continuously and enthusiastically as seen from growing rate of service providers and leading to market competition of cloud service providers business that give advantage to consumer to choose appropriate and cheaper service. However, even though there have the technical advantages of cloud computing technology, but practical application is not easy because of it must pass the customization process of cloud services. The implementation of cloud computing technology is challenges for education institute because there have several considerable factors, e.g. bandwidth, security, management, user, and service charge [3]. Even though there have several available facilities on the cloud, but the most services are general purpose services and have a problem of platform difference among service providers. Some missing services from service provider typically are the particular task that are different among organizations so it is a responsibility of organization to develop their own information system with developing tool of service provider.

In education, E-Portfolio is a popular information system as a tool to develop learning and teaching. Since 1980s, E-Portfolio has brought to education by Peter Elbow and Pat Belanoff [4]. At the beginning, E-Portfolio has used in the form of paper and transform to electronic after coming of web technology. When coming of cloud computing technology, E-Portfolio has been customized to be one of the cloud services finally. Today, there are several E-Portfolio in various kinds of application and purpose.

The creating of E-Portfolio is an easy work for student because of facilities, tools and user-friendly interface, but contrary to teacher because of complicated processes and manual operation of teacher. Moreover. E-Portfolio has the uncertainty structure of content in HTML form that make information locate in different position so teacher must concentrate to a laborious working page by page to extract information and become a time-consuming work inevitably.

Even though there have widely used of E-Portfolio on cloud computing technology as a free website, e.g. Google Site and Microsoft Sway, but this using pattern is still inefficient because it is not different from simple storage, e.g. Google drive. Dropbox, and OneDrive. The difficulty of E-Portfolio assessment by teacher is not less than a classical paper-based portfolio and sometime may

take more time because of more processes handling before the assessment. The only way to solve this problem is to develop a new service in the form of Platform as a Service (PaaS) that enable to leverage potential of cloud computing and reduce teacher workload.

2. Study Objectives

2.1 Designing of information system architecture for automatic transformation from cloud-based E-Portfolio to E-Assessment

2.2 Assessment of the implementation capability of information system architecture with analytic hierarchy process (AHP) for finding the most appropriate strategic information systems planning (SISP)

3. Scope of Study

3.1 Population and Samples

3.1.1 Population are the expert of information technology

3.1.2 Samples are eight experts of information technology by purposive selection, over three years' experience and a doctorate degree in information technology or related field

3.2 Research Variables

3.2.1 Independent variables

- E-Portfolio
- E-Assessment
- Cloud computing technology
- TOGAF enterprise architecture framework

3.2.2 Dependent variables

- Information system architecture of automatic transformation from cloud-based E-Portfolio to E-Assessment
- The implementation capability of information system architecture from method of analytic hierarchy process (AHP) for finding the most appropriate strategic information systems planning (SISP) methodologies

4. Conceptual Framework

Information system architecture of automatic transformation from cloud-based E-Portfolio to E-Assessment have a conceptual framework as follows:

4.1 E-Porfolio

E-Portfolio is a digital tool for storing and presenting learning processes and learning outcomes of student in a system-atic approach. E-Portfolio can solve a using problem of paper-based portfolio, e.g. editing and storing [5]. E-Portfolio has a lot of media form, e.g. audio, image, video, and text, so connected work are easy to access and edit to show learning outcomes of E-Portfolio creator. The objectives of E-Portfolio need to be customized for conforming to curriculum [6] and implementation of E-Portfolio need to integrate to all learning processes [7]. The rapid progresses of information and communication technology make E-Portfolio develop for various roles beyond a traditional form of classroom E-Portfolio [8].

There are four elements of E-Portfolio: (1) purposes of E-Portfolio creating, (2) contents as a reflective evidence of learning purposes, (3) timeline for purposes evaluating, and (4) E-Portfolio evaluation for the consistency between E-Portfolio and purposes from learning evidence by a rubric [9]. Developing process of E-Portfolio consist of five step: (1) objectives and contents determination for student and teacher are on the same page, (2) student create E-Portfolio to achieve objectives, (3) student self-reflection according to criteria on the first step (4) design of work connection in E-Portfolio, and (5) E-Portfolio presentation [10].

There are various platforms of E-Portfolio development range from free of charge platform to a commercial E-Portfolio platform so appropriated platform selection is not easy. E-Portfolio platform can be categorized to four types: (1) local portfolio is internal organization portfolio creation, (2) open source portfolio is free of charge and given source code for self-development, (3) commercial portfolio has purchasing cost, but well development and technical support, and (4) general software portfolio such as Microsoft Word. PowerPoint. Publisher that easy to create, but difficult to design even though it has an easy structure [11].

E-Portfolio have more advantages than a paper-based portfolio especially the ability for stimulating and participating to student. E-Portfolio is used for displaying student achievements, abilities, and interesting. Additionally, the other main target of E-Portfolio is to ensure user enabling to display before and after self-development, learning, work out-put, and progress.

4.2 E-Assessment

The word “assessment” always uses to conclude all teacher activities to assist student to learn and measure study progress and learning outputs [12]. The assessment processes of learning output have been represented by learning objectives [13] and learning assessment domain have four types: formative assessment, summative assessment, diagnostic assessment, and self-assessment [14]. Nowadays. Technological advances drive assessment development by helping of information and communication technology called electronic assessment or E-Assessment that use information technology to integrate to educational measurement and all assessment process are electronic form include assessment activities and assessment recording [15]. The assessment by computer enables to reduce time, resources, and increase reliability [16]. The scoring by computer is useful to large scale classroom and enables to increase values and enable practitioner to increase productivity [17].

Assessment is major element in teaching environment and should be promoted to learning at the same time of measurement and certify to learning output [18]. The cognitive and high-level effective skill cannot be assessed by classical assessment form, but these skills can be assessed by authentic assessment [19]. Formative assessment provides the controlling, focusing, and guiding

student in learning process and support student without teacher work loading. Student can get benefit from rapid, private and convenient feedback. The Summative assessment occurs when teaching process has finished and achievement result of student has been sending to reference person.

The Summative assessment shared benefit of formative assessment meanwhile improve ability to achieve more objectives. E-Assessment is a natural partner of E-Learning and providing to assess student knowledge [20]. Therefore, E-Assessment also have problems and challenges as same as E-Learning. The various platforms and approaches using in different LMS make it difficult to exchange information between different LMS and E-Assessment. Moreover, E-Assessment should be accepted by educator, mechanism must be de-fined to examine all learning objective for covering to subject and educational principles. E-Learning system should support to complex levels of assessment in a different phases of teaching processes.

4.3 Cloud Computing Technology

Cloud computing technology is a model for network accessibility on demand for sharing a customized resource of computing that can be provided or removed with a little management or interaction to service provider [21]. Nowadays, there are three different models of cloud computing. Software as a Service (SaaS) is an online application. Platform as a Service (PaaS) is a service to develop user customized application, and Infrastructure as a Service (IaaS) is a computing power or storage providing.

There are explicit increasing rate of cloud services adopting per year as seen on the top enterprise of any industrial around the world begin using cloud services [22]. This event makes behavior and function of cloud computing change all the time that influence to architecture and classification of cloud computing services. However, even though cloud services have been developed and implemented in a wide range, but it is still no standard [23] that make cooperation difficult when working in multiple service providers and data migration to new service providers.

The cloud computing technology is contributing to educational institute because of educational cloud services support to reduce cost of automatic processing. Moreover, cloud services have ability of any time availability and individual service supporting from accessible devices. There are several studies about cloud technology application to education, e.g. a challenge-based learning model developing by cloud technology and social media to enhance skills of information management [24], a collaborative learning developing with case-based learning by cloud technology and social media to enhance skills of problem-solving, and cloud computing virtual team for enhancing teamwork skill [25].

4.4 TOGAF Enterprise Architecture Framework

The enterprise architecture framework is defined as the creating of information system that including principle and practice. TOGAF stand for the open group architecture framework and being one of global standard architecture framework provides approach to design, plan, implement, and govern enterprise architecture. TOGAF typically modeled to four levels, business, application, data, and technology. TOGAF framework ensures the consistence of under-standing, avoiding lock-in to owner solution, saving time and money, and verifiable ROI.

TOGAF developed the first version in 1995 (TOGAF 1.0) based on technical architecture framework for information management (TAFIM) in 1980s by US department of defense (DoD) and consecutively develop to the latest version TOGAF 9.1 and available to free of charge download for non-commercial use in organization [26].

The architecture development method (ADM) of TOGAF is description of methods for developing and managing the enterprise architecture life cycle and forming the core of TOGAF. ADM consist of architecture views (business, data, application, and technology), suggestion of tools for developing, recommendations, case studies, and method of requirement managing. ADM integrates TOGAF description to a document to achieve the business and IT need of enterprise.

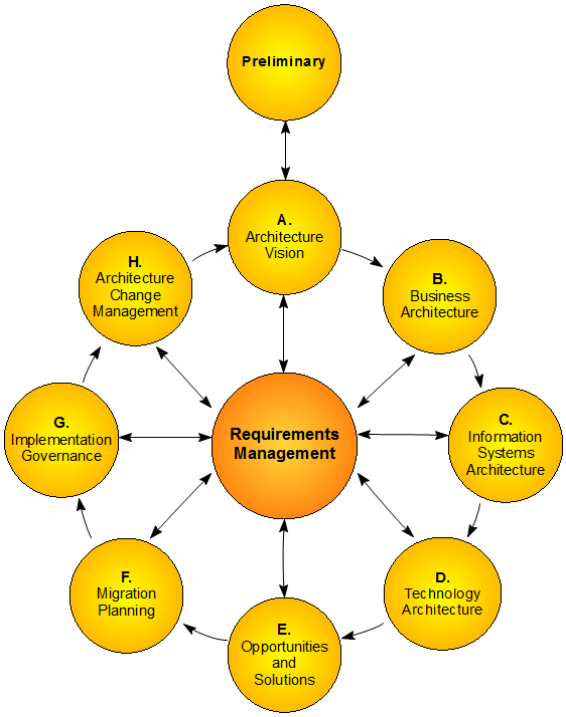


Figure 1 Architecture Development Cycle [27]

4.5 Analytic Hierarchy Process

The analytic hierarchy process (AHP) is a multi-criteria decision-making approach for analyzing the complex decision. AHP was proposed by Thomas L. Saaty in the 1970s [28] and has been extensively studied and applied in several fields of research. AHP separate problem element both abstract and concrete and reorganize to hierarchy form then numerical representation from comparison judgment of criteria and alternatives for synthesizing a maximum priority vector.

The advantage of AHP is an ability to use both quantitative and qualitative factor to be decision criteria. Moreover, AHP can assist to increase process of group thinking because priority pairwise comparison make a confidence of consistency priority. The first step of AHP is discriminate a complex problem into three levels of hierarchical structure (goal, criteria, and alternatives).

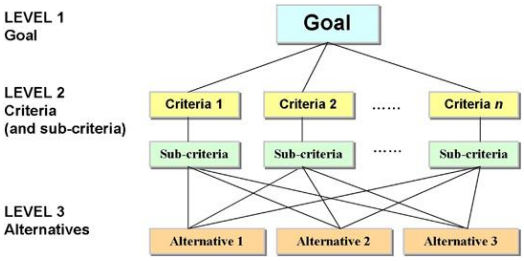


Figure 2 Hierarchical structure of AHP [29]

A judgment is the numerical representation of relationship between two alternatives in the same criteria. The scale of judgment is the intensity of importance from one to nine as follows:

Table 1 The Saaty's fundamental scale [30]

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to objective
3	Moderate importance	Experience and judgment slightly favor one activity over another
5	Strong importance	Experience and judgment strongly favor one activity over another
7	Very strong or demonstrated importance	An activities is favored very strong over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	For compromise between the above values	Sometimes one needs to interpolate a compromise judgment numerically because there is no good word to describe it

The judgment matrices of criteria and alternatives result in priority vector that enable to verify the consistency ratio (CR) from the equation as follows:

$$CR = CI / RI$$

Where CI is stand for consistency index and come from the equation as follows:

$$CI = (\lambda_{max} - n) / (n - 1)$$

Where λ_{max} is largest eigenvalue and n being the size of matrix. RI stand for random consistency index

The calculation result of consistency ratio might be compared to the same index of a randomly generated reciprocal matrix from the scale 1 to 9 as follows:

Table 2 Random Consistency Index [31]

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The acceptance level of CR range varies to the size of matrix (n), less than or equal to 10% if n more than five, less than or equal to 9% if n equal to four, and less than or equal to 5% if n equal to three.

4.6 Strategic Information System Planning

The strategic information systems planning (SISP) is the process to decide application portfolio to help organization executing business plans and understanding business goals [32]. SISP can help user to enhance communication, to support executive management, to forecast and allocate resources, to improve MIS department opportunities, and to calculate payback of new application [33]. Sometime, organization also adopts selection of application from the list of most appropriate to current and future need of organization [34] and SISP can also result in searching for application to create advantage over competitors [35].

SISP methodology is consisting of techniques, procedures, and rules. There are several criteria of methodology selection, resource availability, supplier, familiarity, etc. [36]. The wrong methodologies selection brings about to SISP failures and come to review a literature of SISP for improving its methodology [37]. Nowadays, there are several proposed SISP, but the common purposes are to allocate resources, to coordinate between company and information system goals, to support data for decision making, and to create a competitive advantage [38]. This paper will focus on four SISP methodologies because they are in the same group of alignment methodologies [39], Business Systems Planning [40], Strategic Systems Planning [41], Information Engineering [42], and Method/1 [43].

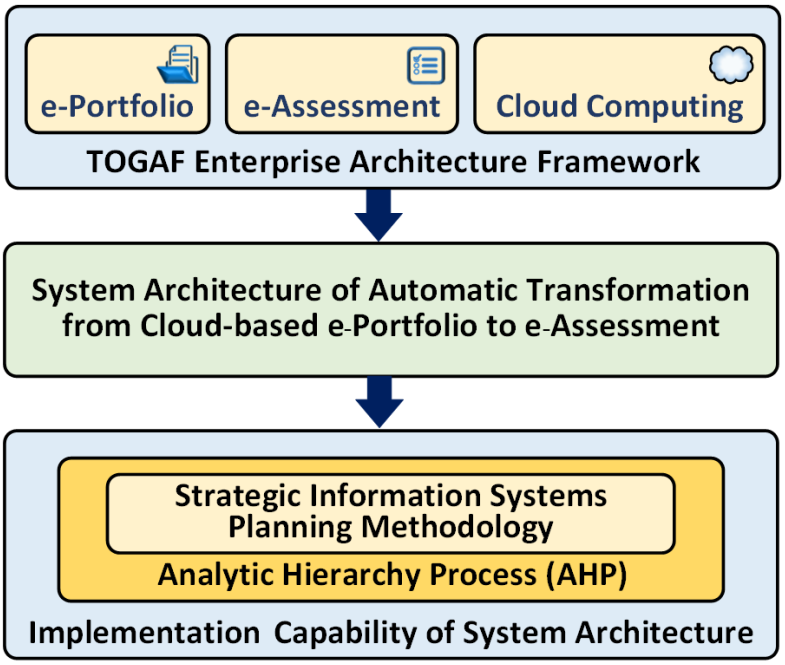


Figure 3 Conceptual framework of Information System Architecture designing of automatic transformation from cloud-based E-Portfolio to E-Assessment using integration of TOGAF and analytic hierarchy process

5. Research Methodology

The research methodology of this study is separated to two phases as follows:

Phase I: Designing information system architecture according to TOGAF enterprise architecture framework but finished to phase C. for conforming to information system architecture of this paper study.

- Preliminary phase
- Phase A. Architecture vision
- Phase B. Business architecture
- Phase C. Information system architecture
- Data architecture
- Application architecture

Phase II: Assessment of Information System Architecture

Step 1. Designing a judgment matrices according to AHP method

Step 2. Creating an assessment questionnaire conforming to AHP designed model

Step 3. Send information system architecture and assessment questionnaire to eight experts for assessing to priority vector of alternative SISP

Step 4. Gathering of assessment result and data calculating.

Step 5. Conclusion of assessment result

6. Research Tools

6.1 The information system architecture of automatic transformation from cloud-based E-Portfolio to E-Assessment according to TOGAF

6.2 The assessment questionnaire of information system architecture of automatic transformation from cloud-based E-Portfolio to E-Assessment to priority vector of alternative SISP

7. Results

7.1 PHASE I: Designing information system architecture according to TOGAF enterprise architecture framework, but finished to phase C**.** for conforming to information system architecture of this paper study**.**

(1) Preliminary phase

The objectives of preliminary phase are to review the organizational context, to identify the stakeholder, to ensure participants are committed to success, to enable the architecture sponsor to create requirement, to identify and scope organization elements, to confirm a governance, to select supporting tools, and to define the architecture principles.

The problem of E-Portfolio assessment is too many time-consuming tasks manually done by teacher even though using cloud computing for storing E-Portfolio. This problem often seen when using free website for keeping E-Portfolio, e.g. Google Site and Microsoft Sway. This pattern of cloud using not only unable to reduce time, but also increase mistake from manually perform transforming E-Portfolio to E-Assessment gradually.

If it compares to paper-based portfolio, processing time of this E-Portfolio is not faster than paper-based portfolio. Generally, cloud computing has several services for supporting complex task when using platform as a service (PaaS). These inefficiencies using of cloud computing because of using only software as a service (SaaS) that reason why this pattern of E-Portfolio is not different from cloud storage, e.g. Google Drive, OneDrive, and Dropbox.

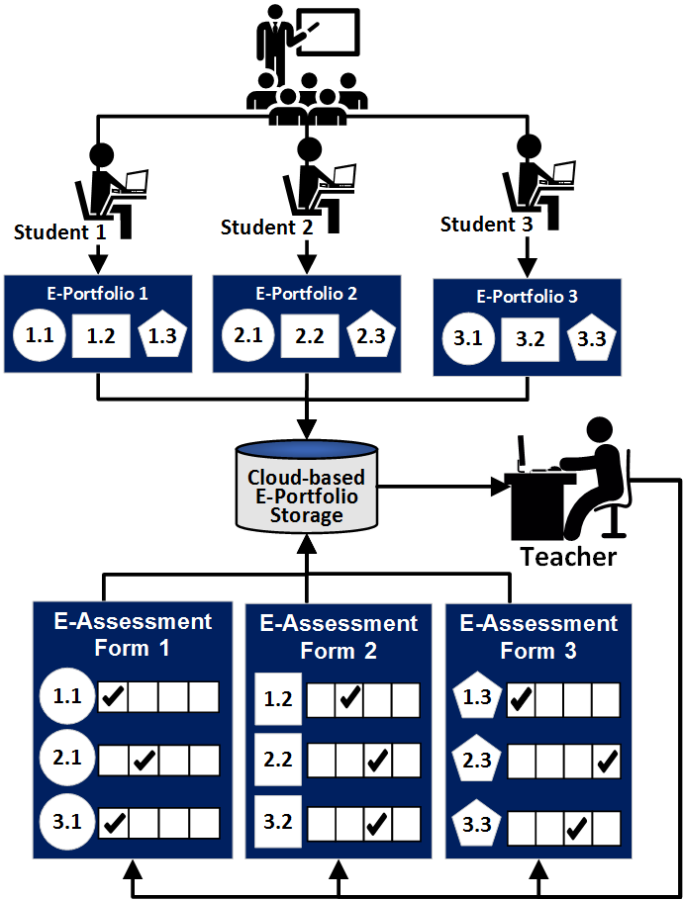


Figure 4 Using free website for keeping E-Portfolio and manually perform transforming E-Portfolio to E-Assessment by teacher

In fig. 4, demonstrate problem of using free website for keeping E-Portfolio. After teacher assignment, all students do their work and upload to free website as E-Portfolio. Assume that geometric form means expected content to assess of teacher (circle, rectangle, and pentagon). The time-consuming task of teacher is extracting contents, grouping content and create E-Assessment form. Form 1 is circle content, form 2 is rectangle content, and form 3 is pentagon content. Even though the free website such as Google site is in the cloud, but teacher still use cloud as just data storage and manually manage every E-Portfolio content.

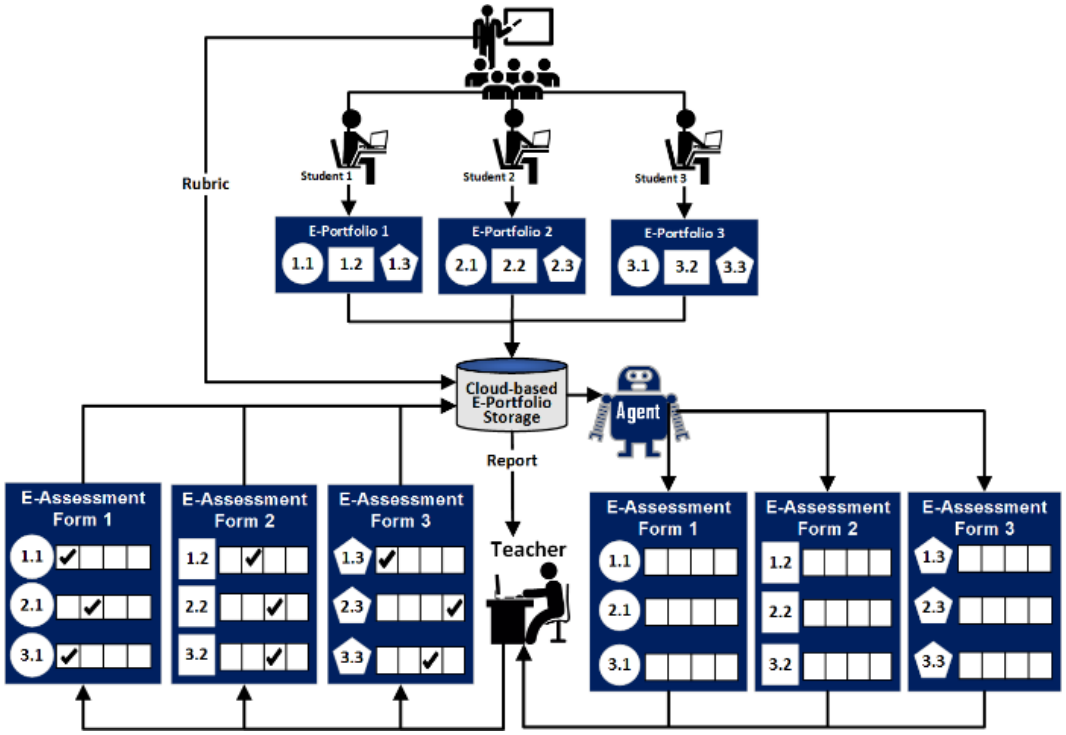


Figure 5 Using free website for keeping E-Portfolio and manually perform transforming E-Portfolio to E-Assessment by teacher

In fig. 5, demonstrate problem solution of figure 3. Using PaaS to develop an automatic service agent to reduce time-consuming task of teacher. After teacher assignment, all students do their work and upload to free website as E-Portfolio, but service agent automatic doing every task of teacher, extracting contents, grouping content and create E-Assessment form. Teacher only wait for E-Assessment form to assess student work.

(2) Phase A. Architecture vision

The objectives of phase A. are to ensure the endorsement from corporate management, to organize architecture development cycle with framework, to validate business domain, to define stakeholders, to define business requirements, to articulate architecture vision, to create a universally plan, and to secure formal approval to proceed.

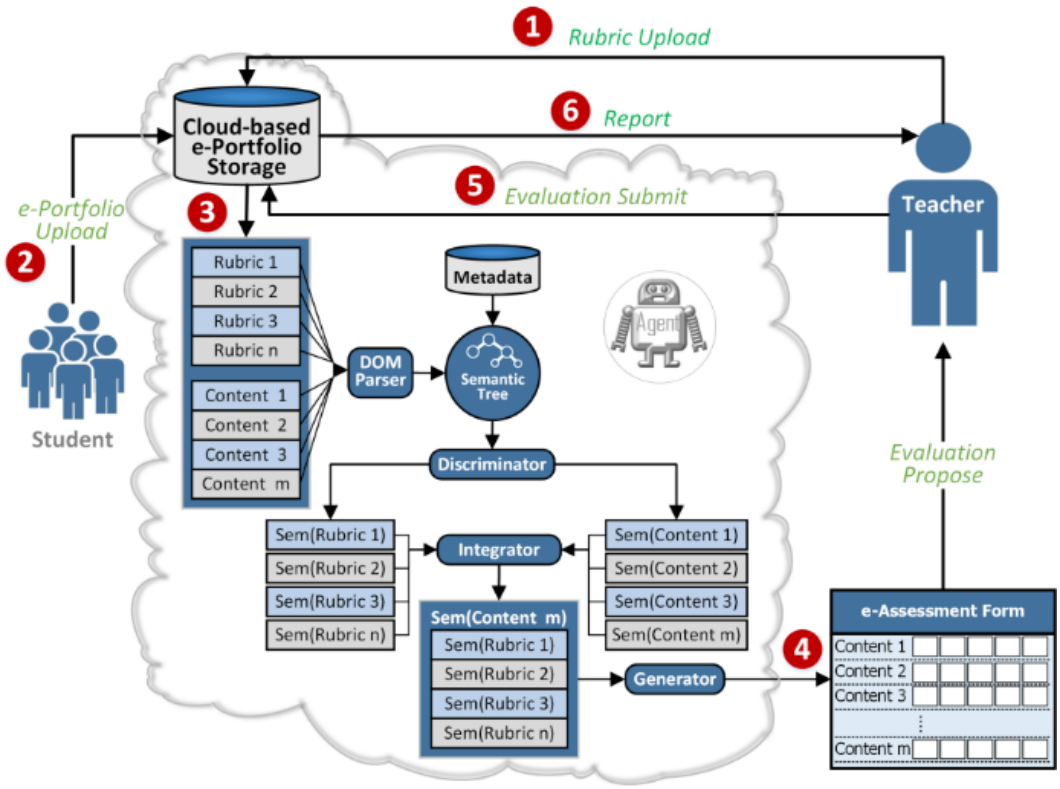


Figure 6 Solution concept of Information System Architecture

In fig. 6, demonstrate solution concept of information system architecture. The key concept is service agent from PaaS development to transform E-Portfolio to E-Assessment automatically. The correctness of E-Assessment created from services agent is depend on the coordination of each sub processes within services agent. The sequence of sub process within service agent start from content extraction of student's E-Portfolio, rubric extraction, semantic mapping between E-Portfolio content and rubric, E-Assessment generation, and E-Assessment scoring report respectively.

The Document Object Model (DOM) parser has a role of extraction both E-Portfolio content and rubric because it enables to extract to HTML object structure. However, extracted object still no meaning enough so the semantic tree technique has a role of adding meaning to the object. After both E-Portfolio content and rubric have enough meaning it can generate E-Assessment correctly according to the teacher's requirement. When teacher assess the E-Assessment form and submit to the system, service agent will calculate student score and generate report to a teacher automatically.

(3) Phase B. Business architecture

The objectives of phase B. are to express the baseline of business architecture, to develop a target of business architecture, to analyze business architectures gap between the baseline and target, to

develop the relevant architecture viewpoint, to select tool to be used in viewpoints.

(3.1) Business footprint diagram

Business footprint diagram is a high-level diagram of the considered solution at the outline of engagement.

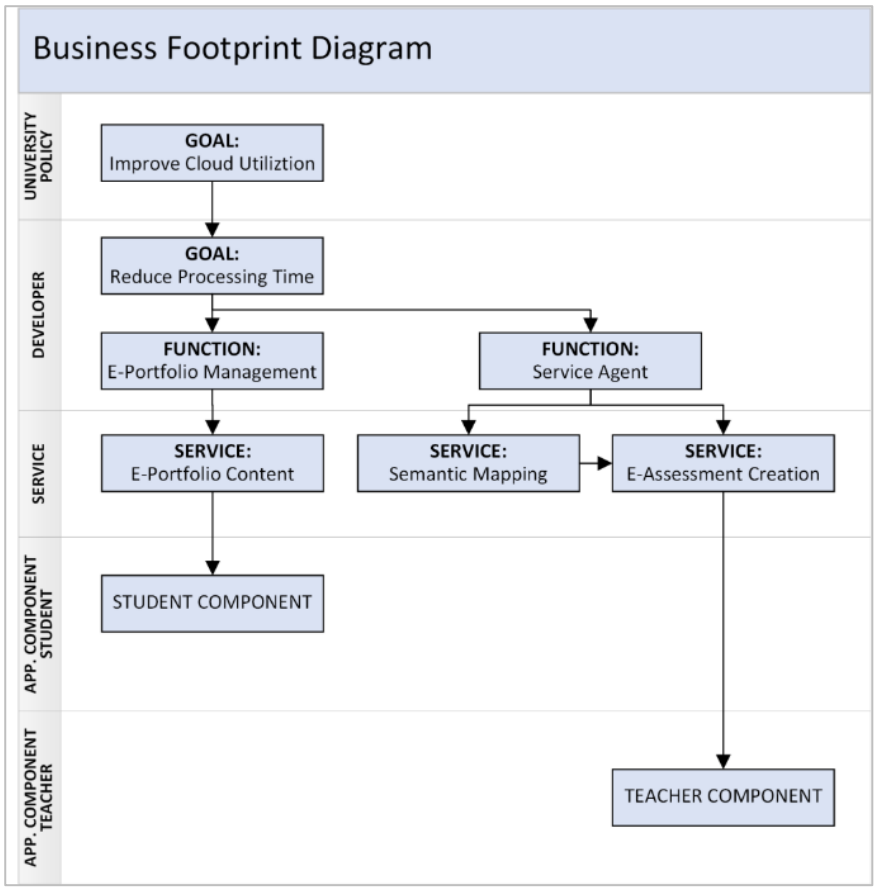


Figure 7 Business footprint diagram

In fig. 7, there are five groups of engagement start from the university policy for the goal of improve cloud utilization. The developer interprets the goal of improve cloud utilization to a practical goal, reduce processing time that can extend to function of E-Portfolio management and service agent. In service group, E-Portfolio management service are developed from E-Portfolio management function and service agent function are developed to semantic mapping and E-Assessment service. In application component group of students, E-Portfolio content service from previous group are extended to be student component as well as application component group of teachers is extending to be teacher component from E-Assessment creation service.

(3.2) Business Service/Information Diagram

The business service information diagram demonstrates the information needed to support business services and data consuming or producing by business service. Moreover, it demonstrates representative information within the architecture and organizes a pedestal for elaboration and refinement (data architecture).

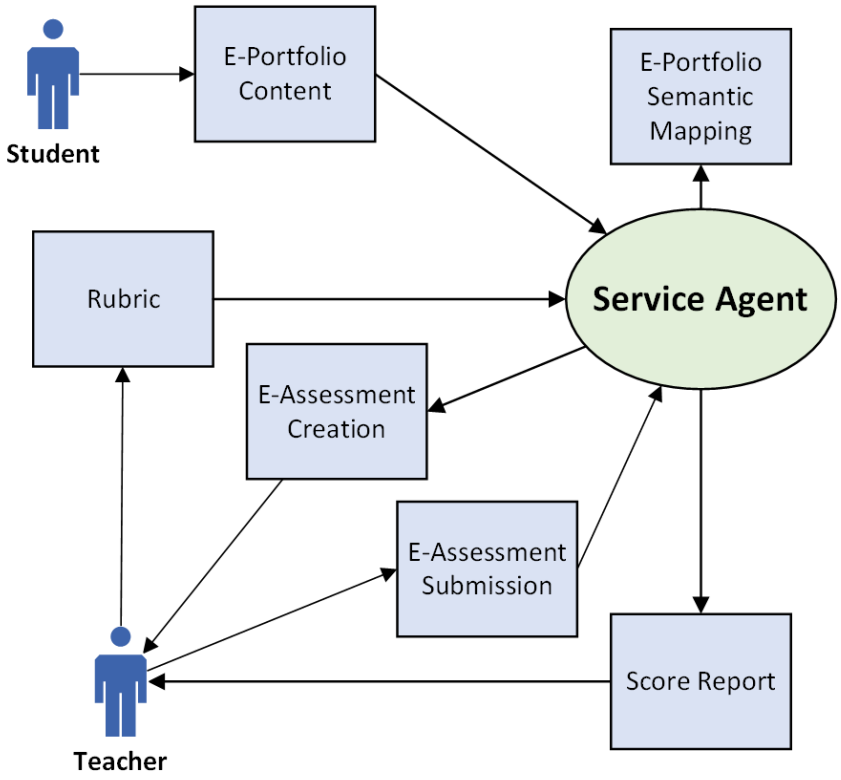


Figure 8 Business Service/Information Diagram

In fig. 8, the service agent need to input information from student and teacher to map a semantic of E-Portfolio and rubric, student produce E-Portfolio content and teacher produce a rubric. After semantic mapping of both E-Portfolio and rubric, service agent will create E-Assessment form for assessing by teacher. When assessment is completed and teacher submitted E-Assessment form to service agent, it will create a score report back to a teacher finally.

(3.3) Goal/object/service diagram

The goal/object/service diagram determine service approach for success of a business vision or strategy and allowing the enterprise to understand affording service to similar aspects of business performance. Additionally, it will provide qualitative input for a particular service.

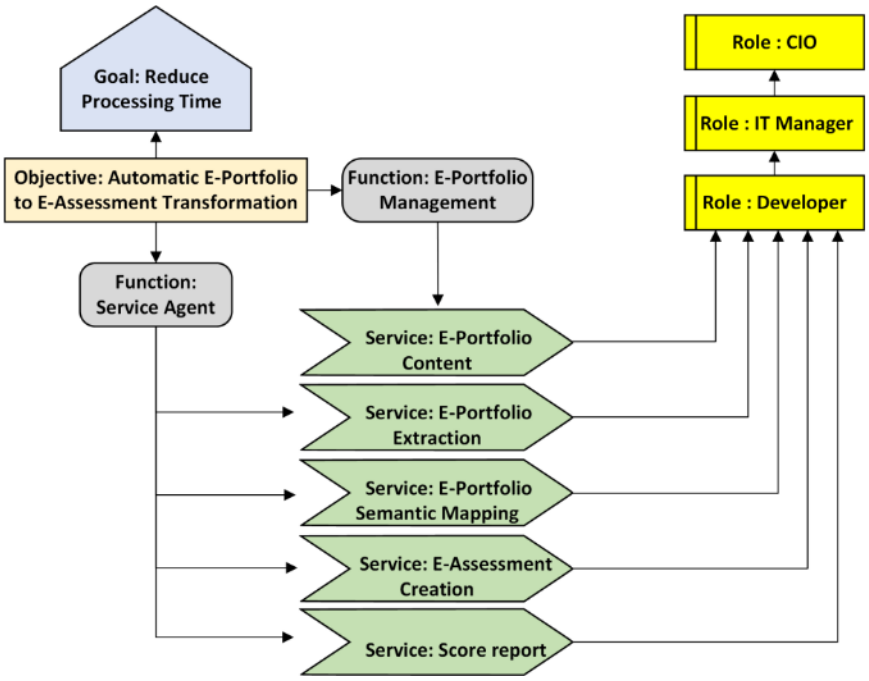


Figure 9 Goal object/service diagram

In fig. 9, demonstrate the relationship of goal, object, and service. The objective of automatic E-Portfolio to E-Assessment transformation is according to the goal of reduce processing time. The function of service agent and E-Portfolio management are extended from the previous objective that forward to affording service of each function. In the case of service agent function, developed services are E-Portfolio content, E-Portfolio extraction, E-Portfolio semantic mapping, E-Assessment creation, and score report. In the case of E-Portfolio function, developed services is E-Portfolio content. The developer response to all services that hierarchical authorize from CIO and IT manager respectively.

(3.4) Business use case diagram

The business use case diagram demonstrates consumers and provider relationship of business services that consumed by actors or other business services and expressing business capability, validating the interaction between actors and their role to processes, developing from the business level to data and technology detail, and also reused in system designing.

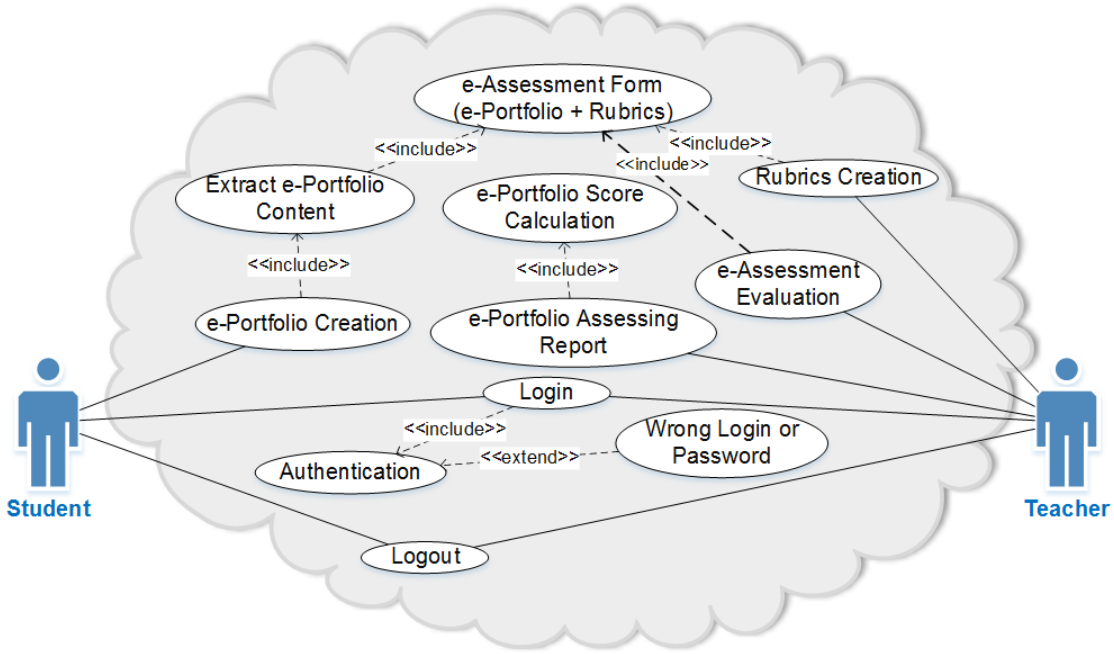


Figure 10 Business use case diagram

In fig. 10, both students and teachers have the same activity before enter to system, authentication from login account and password. In the student's viewpoint, they see only login and uploading assigned work to E-Portfolio. In the teacher's viewpoint, they see only login and rubric uploading, wait for assessing, and wait for scoring report after submission of E-Assessment form. However, behind the scenes are complex task from E-Portfolio content and rubric extraction, E-Assessment creation, E-Assessment score calculation, and score report creation.

(3.5) Process flow diagram

The process flow diagram demonstrates the relation of process metamodel entity and flow of control between activities. Additionally, it shows a sequence of activity, detail of control to process, trigger or result of event from completion of a process, and process execution products.

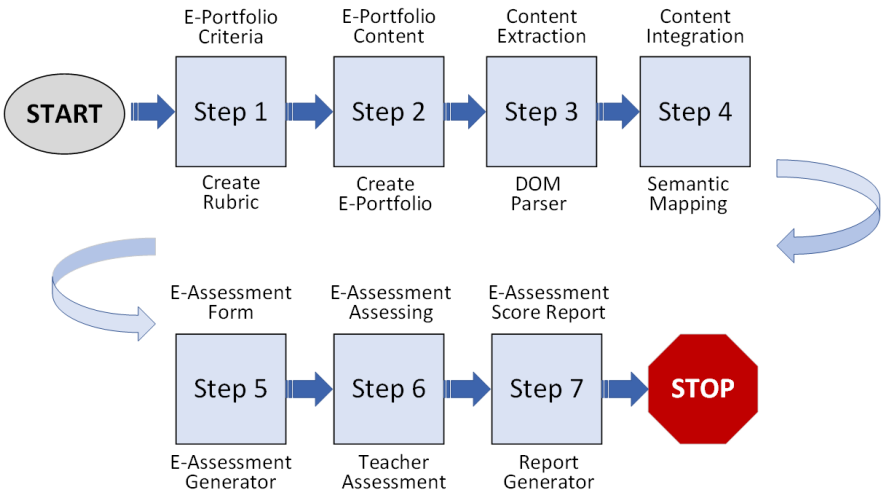


Figure 11 Process flow diagram

In fig. 11, there are seven steps of process from start to stop**.** Starting from create rubric for E-Portfolio criteria, create E-Portfolio content, DOM parser operation for extracting content, semantic mapping for integrating content, E-Assessment form generation, teacher assessing, and score report of E-Assessment generation.

3.6 Event diagram

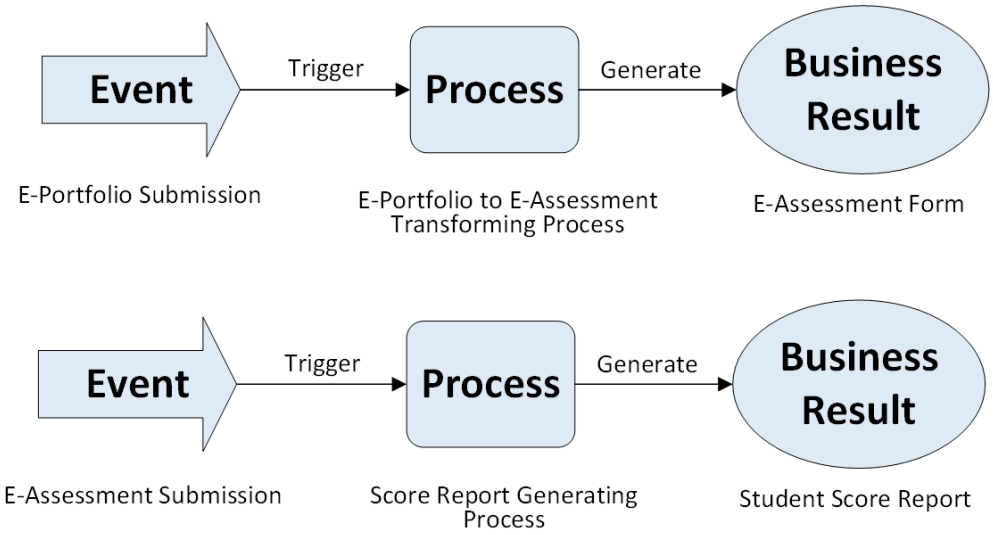


Figure 12 Event diagram

In fig. 12, there are two main events in the system**.** The first event is E-Portfolio submission by student will trigger a process of E-Portfolio to E-Assessment transformation that will create E-Assessment form as a final business result**.** The second event is E-Assessment submission by teacher will trigger a process of score report

generation that will create student score report as a business result.

(4) Phase C. Information system architecture

The objectives of phase C. are to develop architecture covering data and application domain, to identify and define the application and data supporting business architecture

(4.1) Data architecture

4.1.1 Conceptual data diagram

The conceptual data diagram demonstrates the relationships among critical data entities/classes within the enterprise.

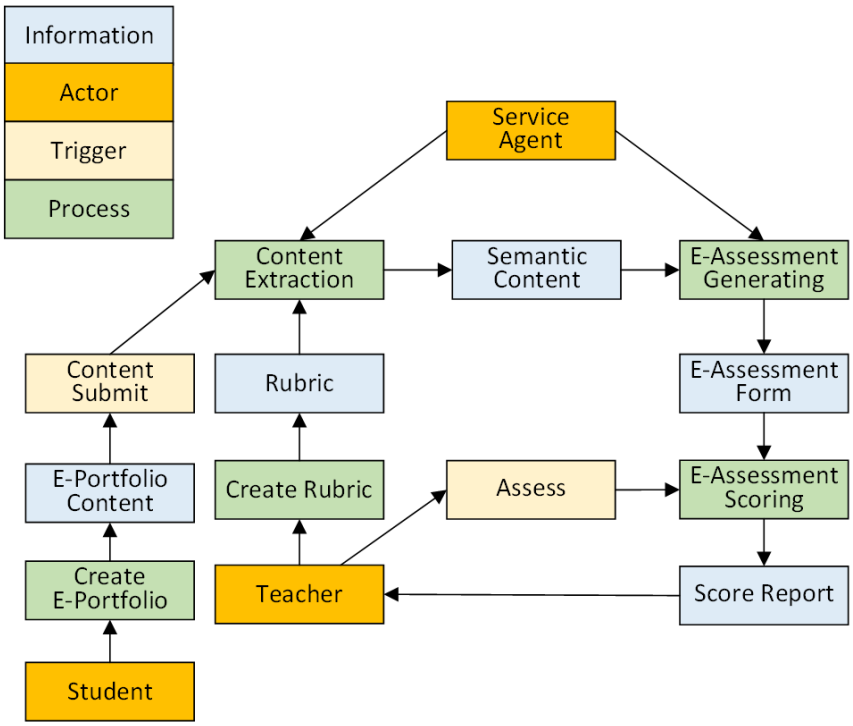
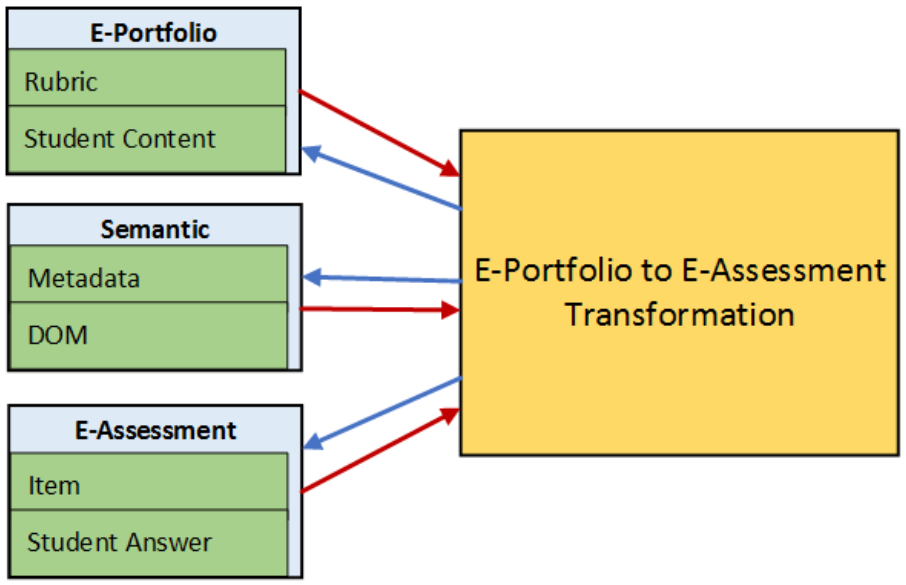


Figure 13 Conceptual data diagram

In fig. 13, there are three main entities (actors), student, teacher, and service agent. These entities interact to processes of their task, teacher create rubric, student create E-Portfolio, and service agent generate E-Assessment form and extract content. In each process, there are engagements information, rubric, E-Portfolio, semantic content, E-Assessment form, and score report. Moreover, some information will trigger to another process, E-Portfolio content trigger content submit to content extraction and some entity trigger assess E-Assessment scoring.

(4.1.2) Data dissemination diagram

The data dissemination diagram demonstrates the relationship among data entities, business service, and application components and method to transform logical entities to physical entities by application components. Moreover, it may depict data replication and system ownership of the master reference for data.



Business Service	Data Entries	Application
E-Portfolio to E-Assessment Transformation	Rubric	E-Portfolio
	Student Content	E-Portfolio
	Metadata	Semantic
	DOM	Semantic
	Item	E-Assessment
	Student Answer	E-Assessment

Figure 14 Data dissemination diagram

In fig. 14, there are three main applications in the data dissemination diagram, E-Portfolio, semantic, and E-Assessment. These applications are relating to business service and data entries as a below table. In E-Portfolio application, data entries are rubric and student content. In semantic application data entries are metadata and DOM. In E-Assessment application data entries are item and student answer.

(4.2) Application architecture

(4.2.1) Application realization diagram

The application realization diagram demonstrates event sequence when business processes are executed involving the multiple application and enhance the application communication diagram by extending with sequencing constraints.

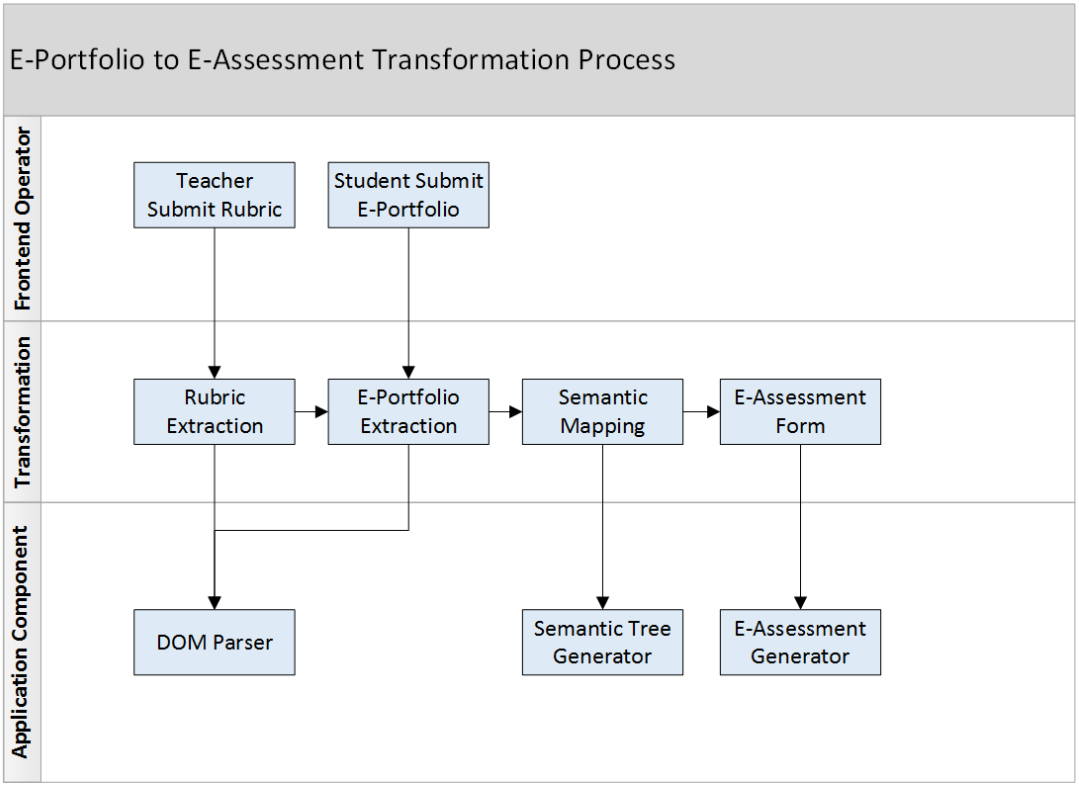


Figure 15 Application realization diagram

In fig. 15, the application realization diagram expresses the process of transformation from E-Portfolio to E-Assessment. There are three main processes, frontend operator, transformation, and application component. In frontend operator, teacher submit rubric and student submit E-Portfolio. In transformation, there are four steps of process, rubric extraction, E-Portfolio extraction, semantic mapping, and E-Assessment form. In application component, DOM parser process rubric and E-portfolio content from previous process, semantic tree generator process from semantic mapping, and E-Assessment generator from E-Assessment form.

(4.2.2) Software engineering diagram

The software engineering diagram demonstrates the distribution of application to package, modules, services, and operation from perspective of development that make detail effect for analyzing when on the stage of migration planning and analyzing opportunities and solutions. Additionally, it is optimal for team development and team management when managing complex development environments.

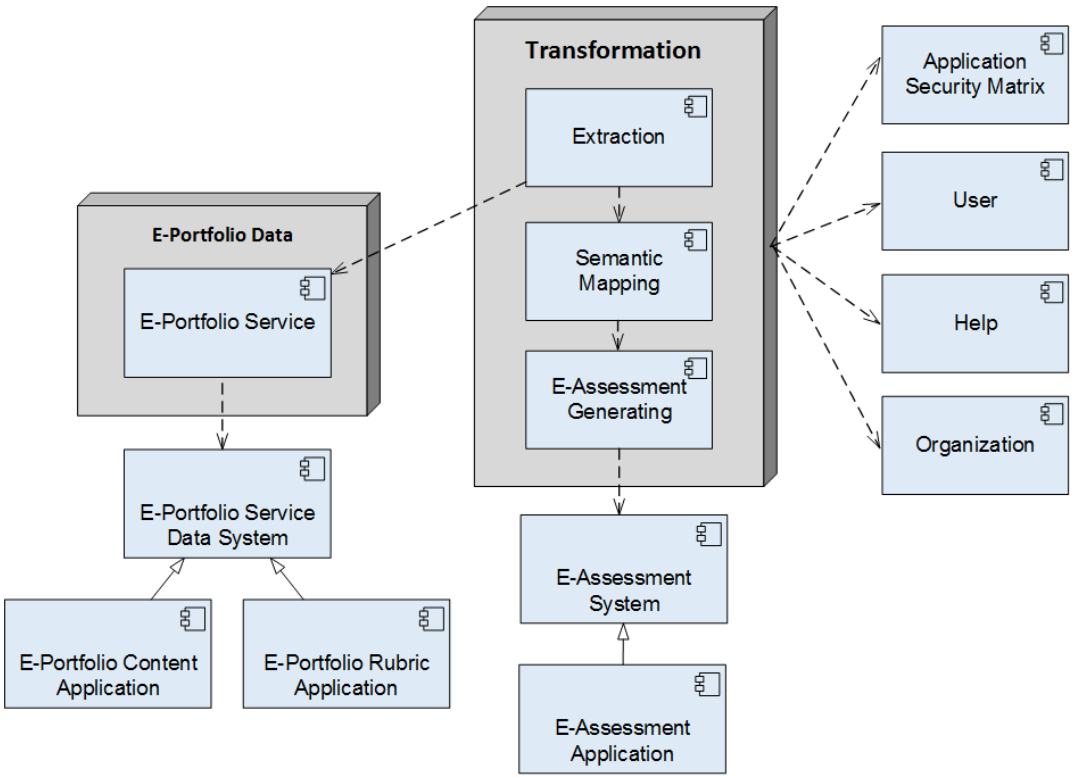


Figure 16 Software engineering diagram

In fig. 16, the software engineering diagram express the distribution of application to software modules and services**.** The E-Portfolio content application and E-Portfolio rubric application use the same service of data system from E-Portfolio service in the module of E-portfolio data**.** Meanwhile, E-Assessment application use the service of E-Assessment systems that come from transformation module**.** In transformation module, there are composed of three services, extraction, semantic mapping, and E-Assessment generating. The extraction service has support data to E-Portfolio service**.** Additionally, transformation module also supports to the service of application security matrix, user, help, and organization**.**

(7.2) PHASE II: Assessment of Information System Architecture

There are two major parts of judgment matrices in AHP method, criteria and alternatives. In the case of criteria, we choose critical success factors (CSFs) of enterprise architecture implementation [44], EA documentation, EA planning, EA programming, EA communication and support, EA governance, and EA stakeholder participation. In the case of alternatives, we choose four methodologies of SISP, Business Systems Planning, Strategic Systems Planning, Information Engineering, and Method/1

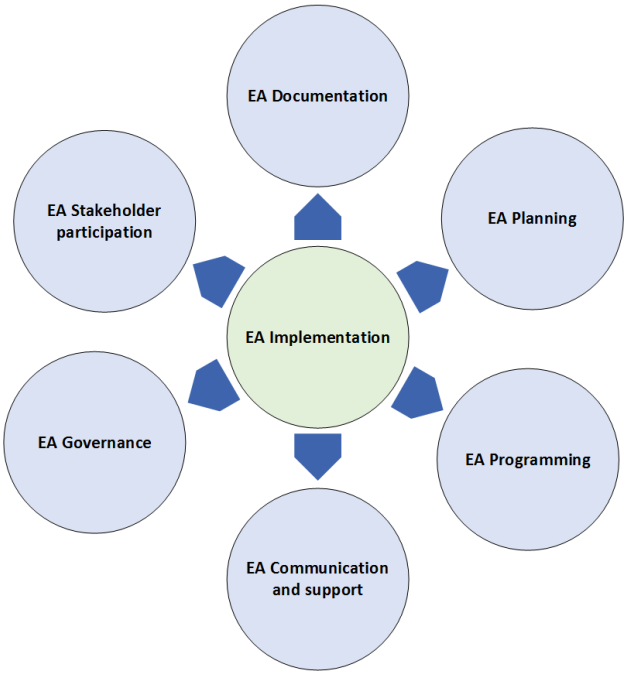


Figure 17 Critical success factors of enterprise architecture implementation

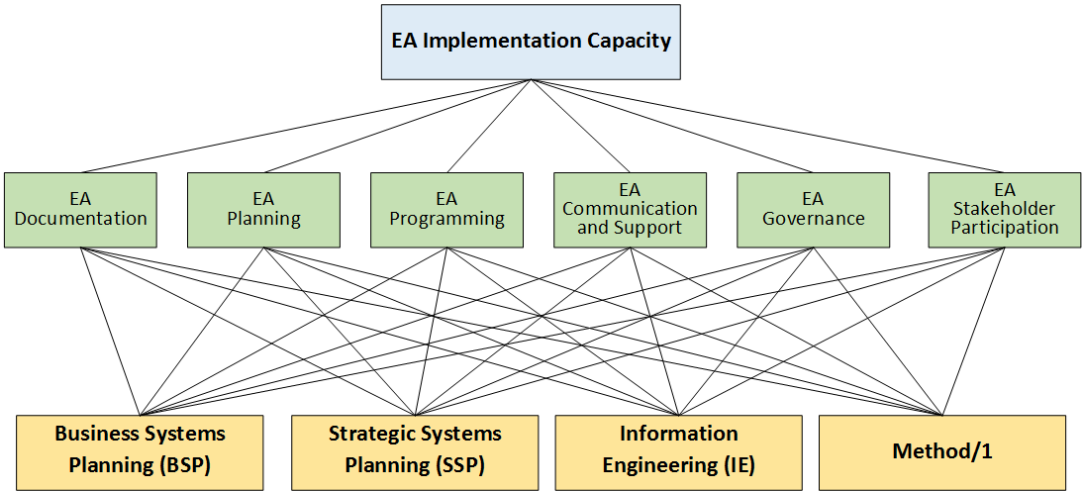


Figure 18 Judgment matrices model to reach the goal of enterprise architecture implementation capacity

After gathering data from questionnaire reply back from eight experts, the calculation of AHP start from finding the consistency ratio (CR). In this study, there are six criteria that the same as matrix size. In the case of matrix size more than five, CR might below or equal to 10% for acceptance level. The result of CR from this study calculation is 7.66% that below to 10%. Therefore, the consistency ratio from this study is within the acceptance level. The result of priority vector on criteria (CSFs of enterprise architecture implementation) calculations are as follows:

Table 3 The priority vector on criteria (CSFs of enterprise architecture implementation)

Criteria	Priority Vector
EA Documentation	0.22
EA Planning	0.34
EA Programing	0.19
EA Communication	0.14
EA Governance	0.07
EA Stakeholder Participation	0.05

From results table of criteria and priority vector, enterprise architecture planning is the most important (0.34) follow by enterprise architecture documentation (0.22), enterprise architecture programming (0.19), enterprise architecture communication (0.14), enterprise architecture governance (0.07), and enterprise architecture stakeholder participation (0.05) respectively. The result of priority vector on alternatives (SISP) calculation are as follows:

Table 4 The priority vector on alternative (SISP)

Alternative	Priority Vector
BSP	0.38
SSP	0.42
IE	0.20
Method/1	0.11

From the results table of alternative and priority vector, SSP (0.42) is the best alternative follow by BSP (0.38), IE (0.20), and Method/1 (0.11) respectively. Therefore, the consideration of implementation capability, the strategic system planning (SSP) methodology is the most appropriate to implement to the information system architecture for automatic system of cloud-based E-Portfolio to E-Assessment transformation.

8. Discussion

8.1 Designing of Information System Architecture

Information system architecture of service agent in automatic transformation from cloud-based E-Portfolio to E-Assessment has background service agent working automatically. It starts from a teacher rubric and student E-Portfolio gathering to extract by DOM parser and increase meaning by metadata to semantic tree by mapping between rubric and content correctly. However, the correctness of semantic tree is depend on the completeness of metadata that widely study in various field of research especially the natural language processing (NLP) and often involving to Wordnet and ontology.

There are some examples of semantic tree studies, e.g. a reduction of disambiguate meaning by semantic tree for each meaning in lexicon network that use calculation of similarity meaning cost among words meaning [45], the text clustering algorithm by semantic tree with Wordnet for reducing time complexity and increasing correctness in text clustering [46], a natural language analysis by semantic tree of ontology for representing conceptual structure meaning of natural language query that has more effective meaning structure than basic system on sequences of flexible word [47] .

8.2 Information System Architecture Assessment

The results from AHP method for assessing designed information system architecture of this study expresses the best methodology of SISP from four alternatives, the strategic systems planning (0.42), the business system planning (0.38), the information engineering (0.20), and method/1 (0.11) respectively. The ranking of six criteria priority vector from the first to the last, enterprise architecture planning (0.34), follow by enterprise documentation (0.22), enterprise architecture programming (0.19),enterprise architecture communication (0.14), enterprise architecture governance (0.07), and enterprise architecture stakeholder participation (0.05) respectively. However, if it uses the different criteria the result alternative may be different from this study. Additionally, if it applies more than only four alternatives of this study the result may be not the SSP methodology.

9. Conclusion and Recommendations

9.1 Implementation of Information system architecture

(1) The TOGAF designing of this study enable to transform to real system with any programming language so developers can choose any developing tool they have expertise.

(2) DOM parser with metadata enables to extract HTML document structure deeply enough for mapping between rubric and extracted content of E-Portfolio. DOM parser is basic techniques in several programming languages with different format, but the same objective to segment HTML document entirely. However, there are still have any techniques to replace DOM parser depend on readiness and expertness of developer because of each technique has different advantage and disadvantage.

(3) The AHP method is look like a multiple-choice test because the static number of alternative is the same as limited choice of the test. Therefore, alternative selection from several SISP methodologies is the important process to use an appropriate criterion to find the best alternative methodologies.

9.2 Future research

(1) The implementation of the designed information system architecture from this study to the real system

(2) Beside the AHP method to assess the enterprise architecture, there are another quantitative method for assessing as well. The probabilistic relational models (PRM) is one of the interesting methodologies to use for assessing the enterprise architecture of future research.

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