Logic Requirement Model of Web Based e-learning in Learning Management System for Features Selection

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Abstract—Requirement engineering phase is logically known to check the compliance of application such in web-based e-learning development. This research indicates that basic aspects of web-based e-learning can be used to identify or eliciting the early requirement and classify it into the functional and non-functional approach. The research found that even in learning management system (LMS) Based, some of the web-based e-learning are using for different goals. It is challenging to develop a system of web-based e-learning to get the requirement focus at the early phase and select the feature that can fill the requirement. This study goal is developing a requirement model to describe the web requirement focus and decompose every web requirement aspects through logical modeling. Analysis due to the interaction and coverage of web-based e-learning is combined with web modeling aspects including content, interaction, functional, navigation and configuration to show the relation among detail requirements. Requirements are found in a systematic way by modeling its logic to determine the basic needs in the using of learning management system. The result from this requirement model proves that web-based e-learning requirements are sustainably identified to complement each requirements and can be implemented to classify the specific requirement to select the appropriate web-based e-learning features from early phase development.

Keywords— Requirement Model, Logic, Web Based e-learning, Learning Management System, Features Selection

I. INTRODUCTION

The intensive use of web application has improved the interest in methodological approach to elaborate the development process appropriately [1]. Web development is analyzed by type of built-up web applications, web classification model, and web requirement analysis [2] through several kind of e-learning [3].

There are some different characteristics to develop web application toward another type of applications. Many kinds of stakeholders participate in development process including: users, analysts, security experts, customers, graphic designers, marketing, multimedia, and others. Another concern from main features of web system are navigation structure, user interface, and personalization capabilities [1].

Analysis from detail requirement becomes very important in web development to meet stakeholders expectations and save cost from a re-built process [4].

Requirement engineering activity then used to improve the consistency of user requirements in development of web-based e-learning application. Compliance requirements are required to meet concerns from all focus in web-based e-learning to optimally support the administration process of learning based on LMS environment [5].

The knowledge extracted from this information can be feedback to the e-learning environment in order to fit it to the students’ needs and requirements, while easing the course advisers’ workload. The teachers in the distance education need to gather all the learning materials and use the collaborative resources and it means the data dimensionality will be increased. By using the web-based e-learning, it would be helpful to reduce the data dimensionality by identifying and selecting features that are relevant to predict students’ performance [6].

Requirement engineering phases generally based on: elicitation, modeling, analysis, validation & verification (V&V) and management [7]. Some challenges come from feature selection based on basic requirement and requirement classification itself. This research proposed a requirement model to discover the goal of web-based e-learning at elicitation phase, modeling appropriate specifications, and decomposition of requirements logical to support the feature selection in LMS Based. Modeling in a graphical notation is useful in problem finding and check the problem domain understanding [8].

II. RELATED WORK

Terminologies of web-based e-learning in the study consist of the description from web-based e-learning in [9], [10], [11]. Such in web-based application, the success of web-based e-learning depend on user satisfaction and other factors that will improve the user intention sustainability. Standard system that used as guidance to elicit the requirement is Learning Management System (LMS) that has role in maintain the learner, track learning progress, and performance of learning event [12]. All aspects in web e-learning refer to “Global Architecture for Education and Training System” [13].
The web-based e-learning components is identified by research focus on learning technologies and it is classified into several main themes including pedagogically, technology and organizational aspects based on e-learning research framework [14]. Component initialization from web-based e-learning already discussed in the previous research and being used as requirement support in this research. Logic requirement identified by requirement engineering phases, in particular: elicitation and modeling [7] that combined with web requirement focus in two approaches: web requirement classification [1] and web requirement model [15]. All related researches still not do some reviews to the aspect of web-based e-learning requirement and how to describe it in modeling notation to help the requirement finding system and support the research underlies those aspects through comprehensive analysis.

Some correlated researches being the basic of further this research in requirement model for features selection of web e-learning has been proposed in [16]. The research that conducts the requirement finding in developing web-based e-learning has been described and implemented in another research in [17], [18], [19], [20].

III. OBJECTIVES

Requirement identification through requirement engineering phases is arranged logically and modeled according to web-based e-learning aspects. Goal for every user are identified to get the specific supporting features and can cover each requirement focus. Web-based e-learning by using the logical model to describe the requirement can be arranged by this action:

A. Requirement Elicitation

Requirement elicitation is using the 'Model Driven Technique’ [21] to present the specific model of collected information (web-based e-learning components) in early requirement finding process. The use of Goal-based approach to describe the dependencies and rational connection among components is needed to state the purpose for each goal. Early requirements identification are modeled to clarify the understanding of requirement domain. Modeling of early requirement utilizes the i* notation through two methods:

1) Strategic Dependencies (SD): This approach describes the dependencies among early requirements. SD considers goal compliance from pedagogical aspect, implementation of technology, and actor relation in requirement dependency. The web based e-learning aspects can be represented (→) toward SD elements with dependencies as follows:
- Pedagogy Aspect → Requirement finding goal (□□□□□) and the provision of resources (□□□□□).
- Underpinning Technology → Implementation of technology (soft goal (□□□□□) and task (□□□□ □□□□□)).
- Organizational Issue → Actor in system (□□□□□).

Dependencies element (→) connect the specific component toward actor identification through requirement analysis. The dependencies can be seen on the strategic dependencies (SD) model as follows:

2) Strategic Rationale (SR): Dependencies that connect the scope of actor behavior to another actor are described in detail through Strategic Rationale (SR). Analysis of objectives and compliance requirement are identified in each scope of the actor through modeling element of an early requirement in rational way by involving web-based e-learning specific components. Rational elements in requirement elicitation can affect the involvement of components in actor scope. Determination of an early requirement with ‘Model Driven Technique’ can position the specific component of web-based e-learning to support the system functionality and define the non-functional aspects. Analysis from mostly used learning standard, LMS, give the insight to depict the strategic rationale model. LMS structure can be used to describe strategic rationale elements such in Figure 2.

Figure 1. Proposed strategic dependencies model in web based e-learning

Figure 2. Detail component in LMS structure system [12]

Some of the LMS characteristics such in [12] and [22] affect the behaviour in actor scope including:
- Manage e-learning,
- System personalization and authentication,
- Provide tools and supporting technologies,
- Provide navigation control and interface to present learning modules and training for learners,
- Mechanism to regulate user access control and user classifications,
- Ability to monitor activities progress and completion status.
Early requirements are logically framed according to each component relation in the scope of rational actors as follow in Figure 3.

Detail requirements are framed by involving requirements type (functional and non-functional) as web requirement focus to analyze the conflict potential and inconsistency of early requirements during requirement finding such in Table 1 below.

**TABLE I**  
WEB-BASED E-LEARNING EARLY REQUIREMENTS ANALYSIS

<table>
<thead>
<tr>
<th>Conflict Potential of Requirements</th>
<th>Condition</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prediction of the biggest conflict potential is in resources management including learner data management, learning activity, and learning object.</td>
<td>To decrease the negative impact in web-based e-learning system, hardware support and appropriate database capacity are needed to keep the system reliable. Conflict potential can be minimized by stated the requirement specification that support the efficiency aspect.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirement Inconsistency</th>
<th>Condition</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learning content management can be done in two different roles based on management type. 2. Description of personalization aspect in learning visualization must represent aspect of system user.</td>
<td>Requirement, including several specific components, must be stated consistently in order to avoid repetition in requirement definition.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Strategic rationale model in web-based e-learning

Analysis of strategic rationale success to placed the System Quality Characteristic based on ISO/IEC 9126-Software Quality Characteristics with supporting sub-criteria based on study [23] and define the non-functional requirement from certain actor scope. Quality requirements can be modeled separately to support learning object management and web-based e-learning access.

B. Requirement Categorization

Categorization frame the requirement from web-based e-learning consistently and decompose the specific requirement according to web modeling analysis. Categorization is started by classify web requirement [1] with several sub classifications that mapped to the early requirement and web-based e-learning specific components into:

1) Functional Requirements: Web-based e-learning requirements can be mapped toward system functionality and specific components. Functional requirements then being classified again into Data, Interface, Navigation, Personalization, and Transactional Requirements.

2) Non-Functional Requirements: Requirements are considered by design and implementation boundaries into quality aspect in web application development. Non-functional requirements are mapped in detail to assess the quality requirement that appropriate with rational identification.

Requirement classification can be modeled separately or integrated to describe the requirement model in web application. Detail requirement represents each logical necessity in functional and non-functional by requirement finding process that sustainably maintained in each phase of research according to subset schema that ensure the requirement can be traced toward the specific component and focus of web requirement. Web-based e-learning is
used based on component interaction that commonly described in two approaches [24]:

a. Interaction to Content

This interaction describes the use of learning content included data management and learning object by end user in LMS environment.

b. Interaction Among End-user of System

This interaction prepares the technological aspect in data management and learning visualization to support the pedagogical aspect.

Based on requirement categorization in functional and non-functional, the element of requirement finding from web-based e-learning could be analyzed. Through the categorization, requirement define first into web requirement classification to build logic of requirement model. Relation from all classified requirements is depicted in Figure 4.

![Figure 4. Model of web-based e-learning requirement classification](image)

**C. Requirement Modeling**

The scope of requirements categorization by logical modeling is supported by specific component to comply the requirements. Requirements are modeled in SysML and notation of each requirement categorization are being analyzed to be decomposed. Decomposition then identify relation of each requirement and described web-based e-learning global requirement. Analysis of requirement finding element in web-based e-learning are described by using logical modeling and can be used to evaluate the identification and tracing of requirements.
IV. METHODOLOGY

The proposed requirement model of web-based e-learning are defined into several decompositions to guide the system developer to find LMS features that fill the specific requirement. It generalized the basic requirements and can be adopted in any kind of web-based e-learning such as Moodle, Edmodo, and another platform. Supporting component represent aspects include Pedagogical (P), Technology (T), and Organizational (O) describe appropriately with web modeling aspects in SysML Notation.

A. Content Requirement Model Decomposition

The content requirement specifically focus on learning object in abstraction level. Contents are also including data management from learning activities and active user. Data management as a primary need in the model content is supported by specific component that provides information based on web-based e-learning content.

B. Interaction Requirement Model Decomposition

Interaction model according to requirement classification provide proper interface of learning visualization for user access. Technological aspect is filled through the providing of learning supporting tools.

C. Navigation Requirement Model Decomposition

Navigation requirement set the navigation service based on user personalization aspect. Navigation also specifically provides a search function, which can be set into navigation management to comply the query-based search.
D. Functional Requirement Model Decomposition

The functional component generally describes features that support the functionality of web-based e-learning system. The functionality is associated with the personalization requirement including access system, communications between users, and assessment process.

![Figure 9. Web-based e-learning functional requirement model](image)

E. Configuration Requirement Model Decomposition

Configuration requirement are detailed in two classifications including transactional requirement in functional and quality requirements in non-functional.

1) Transactional Requirement Model Decomposition (Functional): Transactional requirement specifically devoted to resources management in database access. The use of course database and querying utilization are compiled the requirement of storage and data retrieval.

![Figure 10. Web-based e-learning transactional requirement model](image)

2) Non-Functional Requirement Decomposition: Non-functional requirement describes quality requirements aspect that supported by sub-criteria of quality such as:

- Reliability Aspect
  This aspect is based on data management capabilities to ensure the integrity of learning content. Data and managed learning content should be corrected when an interruption occurs, so that it must met the sub-criteria: recoverability.

- Usability Aspect
  Usability aspect ensures the provision of technology can support the sub-criteria: operability and understandability. One of the technologies that support this aspect is query-based search feature.

- Efficiency Aspect
  This aspect considers resources setting efficiency in order to optimize the use of web-based e-learning. Sub-criteria that filled by this aspect is resources utilization.

- Maintainability Aspect
  Aspect that supports maintainability is system management. This aspect is based on the ease of system maintenance that filled by sub-criteria: changeability and stability.

- Portability Aspect
  Portability aspect is associated with sub-criteria: adaptability and conformance where initiation to system configuration should be carried out to support the use of web-based e-learning.

V. DISCUSSION

Requirement model could be one of the alternatives for the system developer to find the right requirements and
optimize the system through the functional and non-functional approach. Requirement model of web-based e-learning could be implemented to learning management system especially supported by features option such as Moodle, Edmodo, Learning Forum or customized web-based e-learning. The theoretical and terms in e-learning still ideal for some nomenclature and it becomes the basic for some web based e-learning implementation. Based on literature review and model studies, the requirement model for web-based e-learning can be developed by using the modeling notation of i*star modeling and SysML. The detailed requirement and recommended features based on the functional and non-functional aspects are described using the modeling notation to help the system developer to create the usable Learning Management System and can fulfill the user requirement by considering the Pedagogically (P), Technology (T), and Organizational (O) aspects.

VI. CONCLUSION

All identified aspects from the web-based e-learning component are being used to frame the requirement systematically through the proposed requirement model of web-based e-learning. This research denotes that classification of web-based e-learning requirements in functional and non-functional can be related to web requirement focus to establish the requirement logical model. Eliciting the early requirements based on the system requirement can help the system developer to use the right features of LMS based that support the learning process. The proposed model can be decomposed for further elaborating that appropriate with requirement categorization in LMS area. Decomposition of the requirement logical through SysML notation successfully mapped the relationship between the web-based e-learning requirement in functional (Content, Interaction, Functional, Navigation, Configuration) and non-functional that support quality attributes include: Functionality, Reliability, Usability, Efficiency, Maintainability and Portability. This proposed requirement model can help feature selection that fill the requirement in LMS development and can related it to requirement engineering to evaluate and trace all requirement that identified towards web-based e-learning research area. It will be useful as an insight to identify the basic requirements and features selection in developing of web-based e-learning.

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REFERENCE
