

Quality Assessment Method for Software Development Process Document based on Software Document Characteristics Metric



Patra Thitisathienkul, Nakornthip Prompoon
Department of Computer Engineering
Chulalongkorn University
Bangkok, Thailand
patra.th@student.chula.ac.th, nakornthip.s@chula.ac.th

ABSTRACT: *Developing the software product that meets with customer's actual needs is a major objective of software development. Due to this reason, the appropriate Software Development Life Cycle (SDLC) is selected and performed. There are various kinds of documents specified in natural language delivered from each SDLC and are used to communicate among involved parties. However, characteristic of natural language itself may bring ambiguity and verifiability issue while the inappropriateness of document structure often causes the difficulty in document modification. All three issues may cause interpretation problem and customer's needs misunderstanding.*

To mitigate these problems, this paper proposes SDLC documents quality assessment method based on its characteristics which focus on two aspects; document contents and document structure. Measurement process model and measurement information model are applied as a guidance to propose the method. Software Requirements Specifications (SRS) document was used to illustrate our proposed method as a case study. Moreover, the functional requirements and the architectural design of a software tool which embedded the proposed method are presented. The result of applying the proposed method can indicate the quality level of SDLC documents which leads to quality improvement. The reviewed and improved SDLC documents can enhance the quality of communication among stakeholders and be stored as a lesson learned that can be applied for the future similar situation.

Keywords: Quality Assessment Method, Software Metric, SDLC Document, Characteristics, Document Structure, Document Quality Assessment Tool

Received: 12 June 2014, Revised 27 July 2014, Accepted 7 August 2014

© 2014 DLINE. All Rights Reserved

1. Introduction

The primary purposes of software development are to gain a quality software product that meets a customer actual need under the time and budget constraint. Apart from having sufficient and appropriate resources, selecting a suitable software development life cycle, method and technique matches with the project characteristic are of key successes of software development. Generally, the common processes of SDLC are gathering customer's needs, planning, analysis, design, development, test, implementation and maintenance. During SDLC process, there is various development information documented in natural language as depicted in figure 1. The main advantages of these documents are used to support the communication among

stakeholders according to the objective of each activity and verify the software products which are the outputs occur in each activity of SDLC.

There are many widely accepted industrial standards [1-3] and organization best practices provide a document structure and a list of document topics that should be appeared in SDLC documents. These can help developer as a guideline to specify necessary contents. These may directly affect the quality of the documents. Moreover, document modification can be performed easily in accordance with document requirements change.

However, using natural language may cause the problems of language interpretation because of characteristic of natural language which is ambiguity of words or sentences. For instance, software requirement is specified as “*The system shall print a login session report to the manager and the database administrator.*” This may be interpreted as “*The system shall print a login session report each to the manager and to the database administrator.*” or “*The system shall print a login session report for jointly used to the manager and the database administrator.*” [4].

Moreover, the inappropriateness of the document structure may cause the difficulty of content understanding and the deviation of software product from the actual customer needs. For example, the topics of key contents doesn't appear, or appear incorrect sequence or inconsistent with other topics in the same category.

As the two issues that we raised, the challenge research question is how to indicate the quality level of SDLC documents specified in natural language based on document characteristics in term of document contents and structure. Research's outcome is the quality level of document and the detected flaws if it is in a low level. The research outcome will help developer improve the document.

According to theories and related works [5-13], the method to indicate quality level and detect any appeared flaws is one of quality assessment of SDLC documents. Furthermore, this method leads to SDLC documents quality improvement.

The main purpose of this paper is to propose a method and metric for assessing quality of SDLC documents which contents were specified in natural language and the software architectural design to support the assessment process. The proposed method will be used to determine the quality of using natural language to specify contents and document structure. To propose the method and defined metric, measurement process model [14] and measurement information model [14] are applied.

In order to facilitate the application of the proposed method, we also present a software architecture that covers the assessment process and data needed to be capture for the assessment reporting purpose.

The major challenges and contributions of the proposed method are listed below.

1. Status of SDLC documents is revealed. That is, the quality level and the deficiency part in the documents is assessed and reported. If the result of assessment indicates that they are in an unexpected quality level, they must be improved before being used according to their objective. Quality of SDLC documents affect the success of project in several reasons; it can be used as communication supporting items among stakeholders, it can also be used to ensure that the project has proceeded within the scope and point out the progress of the project. So, the project will proceed with the minimal risk and software products will have a proper quality level.
2. The defined metrics, verification criteria, quality level and the potential improvement part of SDLC documents can be documented and be stored as an organization assets for future use. The conclusions on strengths, weakness and lesson learned from the assessment can also be used to improve the future assessment process.
3. Establishing the awareness of quality of SDLC documents to personnel is significantly improve employee morale. The quality attributes that influence on the quality of SDLC documents should be realized by developer team to have a quality document.

The rest of this paper is organized as follows. Literature review is discussed in section 2. Necessary background is provided in section 3. The proposed method is described in section 4. The application of the proposed method is illustrated in section 5. The architecture of a tool and an example of tool interface are shown in section 6. Conclusion and outlines of future work are provided in the final section.

2. Literature Review

The methods for assessing the quality of SRS in which document was often gathered and specified customer's needs by using natural language have been proposed by many researchers can be classified into two groups. In the first group [5-7], machine learning is applied to assess the quality of SRS such as classification, case-base reasoning and neural network. However, the limitations of the proposed method are 1) the efficiency to indicate the quality of SRS based on machine learning's algorithm and 2) the effectiveness based on training data set. In the second group [8-13], the defined metric is applied to assess quality of SRS. Characteristics of good SRS are extracted and measured directly. A problem remains because some certain metrics still require human decision. Moreover, researchers have focused primarily on the quality of using natural language to specify requirements with scant attention given to define metric of document structure.

The related research as mentioned above can be compared to our work as shown in Table 1.

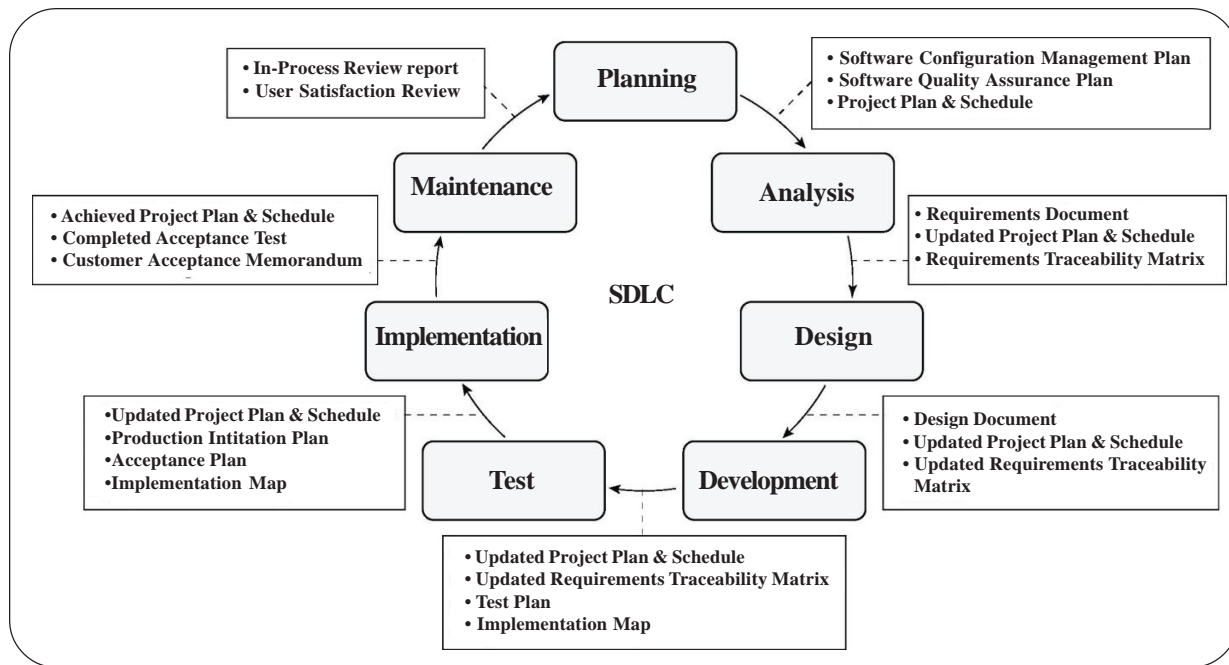


Figure 1. Deliverable Documents Occurred During SDLC Process

3. Background

3.1 Measurement Process Model

In software development process, there will usually be an information needs used to assess the process status such as the quality of design, the rate of programming defect and the development productivity. The efficient way to produce the information needs to measure the healthiness of process and product is a defining metric which is direct related to information needs' characteristic. The appropriate concept, method and process are selected by developer for a particular purpose of information measurement. These may be specified in industry standards, organization best practices and organization knowledge asset repository.

In this paper, ISO/IEC 15939 [14], that mentions about measurement process for software development; identifies the activities and tasks that are necessary to measures information needs, is applied to propose the method for SDLC documents quality assessment. Measurement process model is depicted as shown in figure 2.

Figure 2 shows that measurement process model consists of four activities as follows.

- 1. Establish and Sustain Measurement Commitment:** The scope of measurement is identified and the responsibility of organizational unit is assigned in this activity.
- 2. Plan the Measurement Process:** Information needs identification, appropriate measurement method selection, data collection

definition, analysis, procedures report, and criteria definition for information products evaluation are performed in this activity.

3. Perform the Measurement Process: Measurement process, which may use “*Measurement Experience Base*”, in accordance with the planning phase is performed in this activity.

4. Evaluate Measurement: Information products evaluation and potential improvements identification are performed in this activity. The results of this activity shall be stored in the “*Measurement Experience Base*” and can be used to plan for future measurement process.

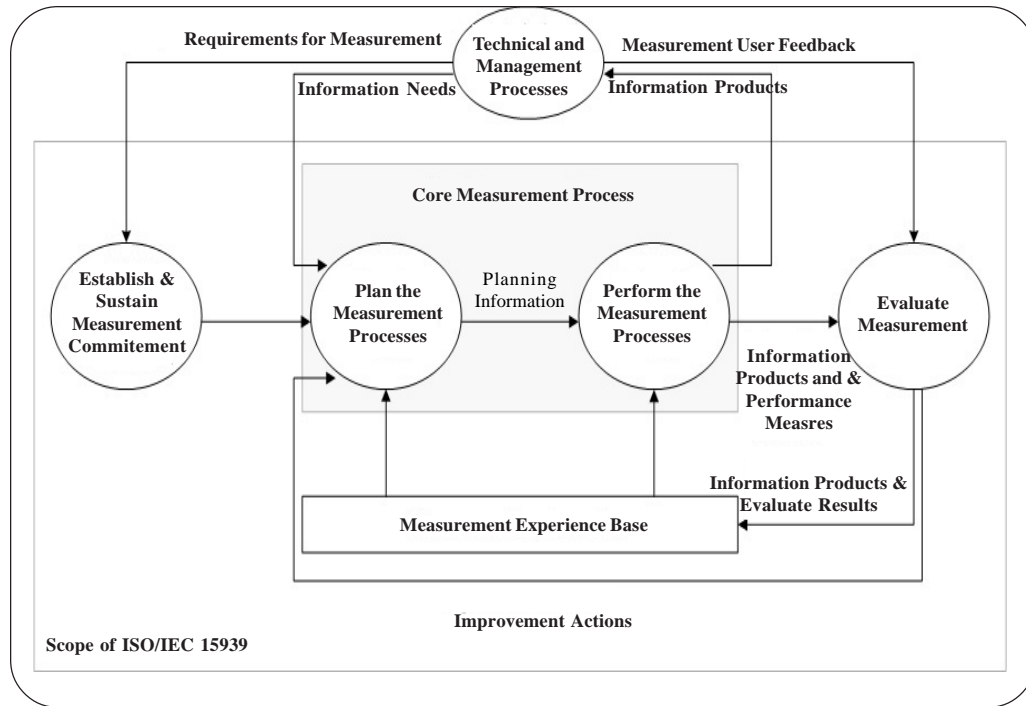


Figure 2. Measurement Process Model [14]

3.2 Measurement Information Model

Measurement information model is also presented in ISO/IEC 15939 [14]. This model describes how to quantify the relevant attributes and convert it to indicators that provide a basis for the decision making of software developer. Apply this model, the defined metric for measuring information needs which is document characteristic in our research is developed.

Defining metric as three levels of components; base measure, derived measure, and indicator must basically be constructed. The detail of each metric level is shown in table 2.

3.3 Metric Validation Method

IEEE 1061 standard [15] supplies information for software quality metric methodology and provides its framework as depicted in figure 3. Moreover, software quality metrics validation is also suggested in this standard.

Figure 3 shows the framework of software quality metrics which is presented as a hierarchy level. It is composed of three levels as follows.

1. The First Level: The quality attributes that are used to describe the quality of system are assigned in this level. These defined attributes refer to the quality requirements which are agreed upon project team.

2. The Second Level: The quality sub-factors which are independent attributes of software and more meaningful than quality factor are assigned to quality factor in this level if necessary. Communication between manager and technical person are facilitated by using these sub-factors according to their quality objectives.

3. The Third Level: The direct metrics which are involved with each quality factor or quality sub-factor are assigned and served as quantitative representation. These metrics are used to measure software process and product during SDLC.

	The First Group [5-7]	The Second Group [8-13]	Our Work
Objective	To assess quality of SRS	To assess quality of SRS	To assess quality of SDLC documents
Methodology	Applying machine learning	Defining the direct SRS metrics	Defining the direct SDLC documents metrics
Advantages	Automated indicate quality of SRS.	Assess good characteristics of SRS directly.	<ul style="list-style-type: none"> - Assess good characteristics of SDLC documents directly. - Metrics of document structure are defined. - Quality threshold must be defined by human.
Limitations	<ul style="list-style-type: none"> - Efficiency based on machine learning's algorithm. - Effectiveness based on training data set. 	<ul style="list-style-type: none"> - Some certain metrics still require human decision. - Metrics of document structure are earned little attention. 	<ul style="list-style-type: none"> - Focus on predefined document structure and content specified in natural language

Table 1. The Comparison between Related Researches and Our Work

Level of Metric	Component	Meaning of Component
Base Measure	Attribute	Property relevant to information needs
	Measurement Method	Sequence of operations used in quantifying an attribute to a scale
	Base Measure	Variable assigned a value by applying the method to one attribute
Derived Measure	Measurement Function	Algorithm for combining two or more base measures
	Derived Measure	Variable assigned a value by applying the measurement function to two or more values of base measures
Indicator	Analysis Model	Algorithm for combining measures and decision criteria
	Indicator	Variable assigned a value by applying the analysis model to base and/or derived measures
	Decision Criteria	Numerical thresholds or targets used to determine the need for action or further investigation, or to describe the level of confidence in a given result

Table 2. Detail of Key Components in the Measurement Information Model [14]

Defined metric validation is one of the methods to ensure that it can predict or reflect the quantitative value of the object that it measures. Moreover, the reliability of the defined metric will also be increased. According to IEEE 1061 standard [15], the correlation validity criterion can be applied to validate the defined metric. This criterion is derived from the key idea of the variation in the object values can be explained by the variation in the metric values. So, the square of the linear correlation coefficient between the result obtained by using the defined metric and the real value of object to be measured is the method used to consider their association.

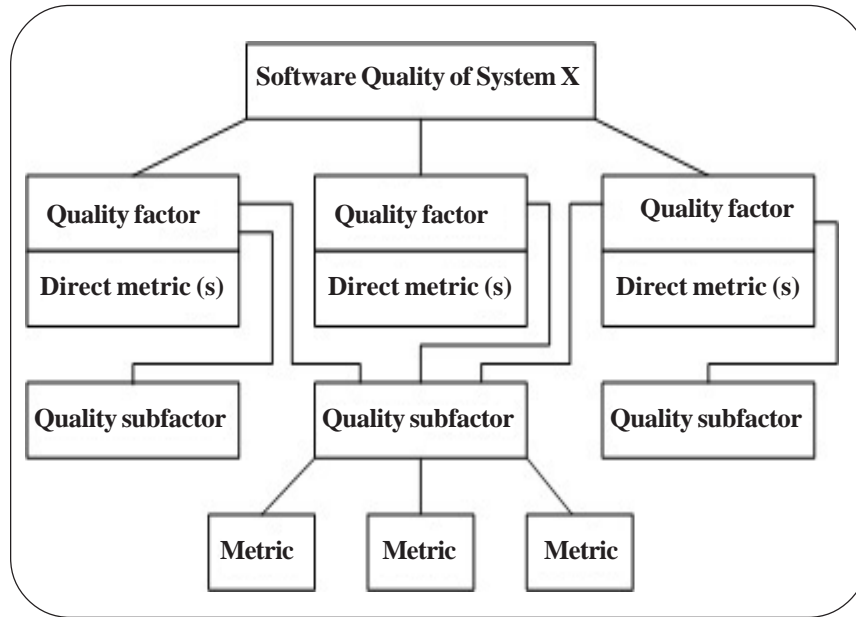


Figure 3. Software Quality Metrics Framework [15]

4. The Proposed Method

This section presents the method for SDLC documents quality assessment which uses the measurement process model as a guideline for proposing. An overview of the proposed method is depicted as shown in figure 4.

Figure 4 shows that the proposed method is separated into three main parts as described in details as follows.

4.1 Information Needs Identification

4.1.1 Identify the Scope of Requirements for Measurement

The basic things that are required to comprehend and recognize are requirements for measurement because they are used to help project manager manage each activity of software development process and future project that has similar characteristic.

The goal and scope of measurement requirements are identified in this activity. In this paper, the requirement is to assess SDLC documents quality because the information about software product development are gathered in these documents and they are used to communicate among stakeholders during SDLC. Software product may not conform to customer's actual needs or suitably work in the operational environment if these documents have any defects or lack of necessary information.

4.1.2 Study and Identify the Good Characteristics of Information Needs

Good characteristics of SDLC documents are studied, analyzed and identified in this activity. For instance, good characteristics of using natural language to specify contents and suggested document structure that are directly support the aspect of document understandability such as unambiguous sentence are taken into consideration. Activity's outcomes are used as quality assessment criteria.

4.1.3 Identify Information Needs

Good characteristics of SDLC documents that were studied in previous activity are selected and identified in this activity. That is, selection of good document characteristics which correspond to the goal of measurement or certain good characteristics under the study domain is performed. The attributes that can influence the quality of selected characteristics are then identified.

4.2 Metric Definition and Verification

4.2.1 Define Metric for Measuring Information Needs

Attributes and metric related to good characteristics of SDLC documents are defined in this activity by applying measurement information model as a guideline. Attributes are quantified to quantitative values and converted to indicators that support

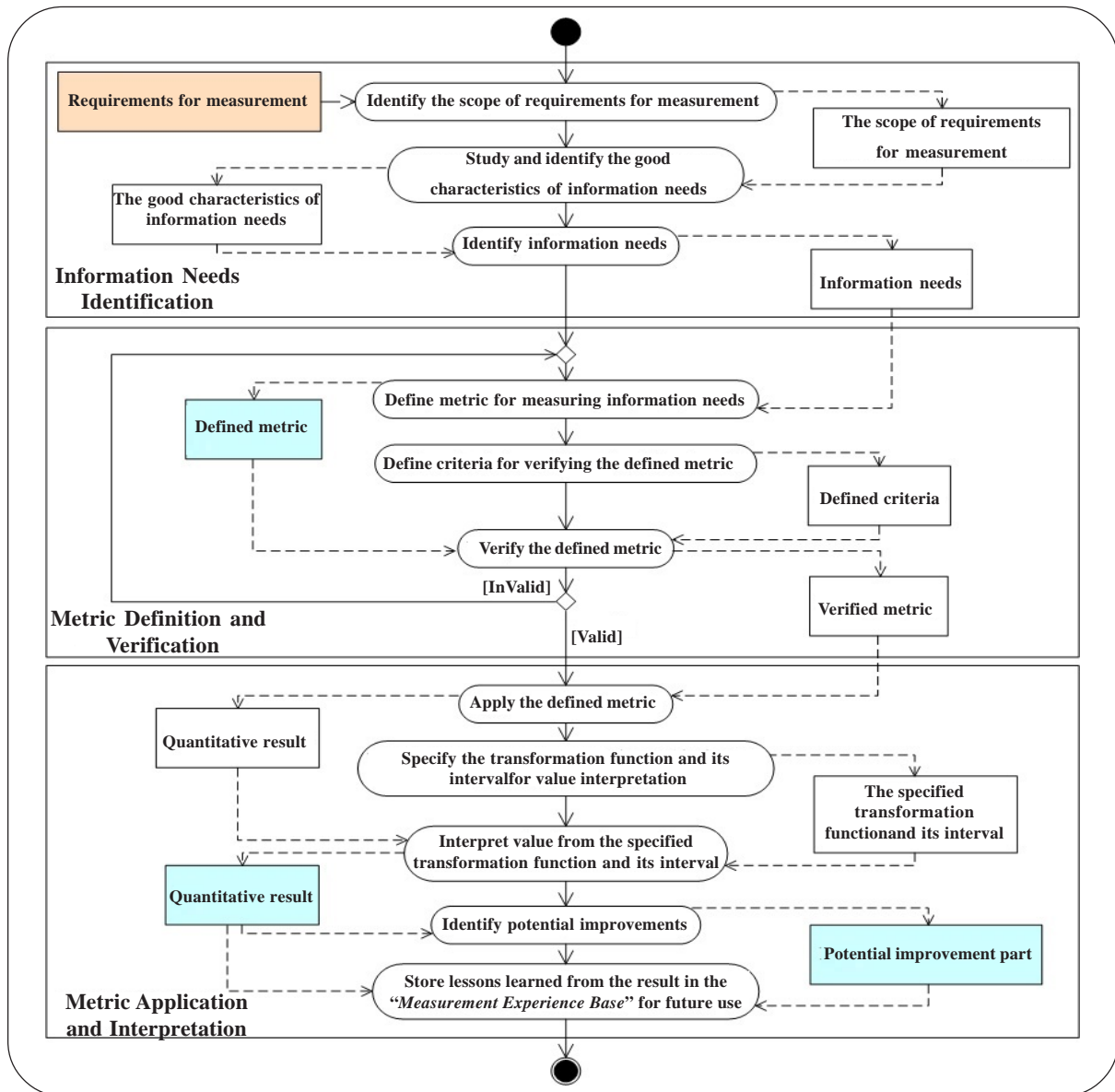


Figure 4. The Proposed Method Overview

decision making. In order to measure the quality of SDLC documents thoroughly, metric definition is divided into three levels that are closely related to one another. That is, the upper level is derived from the lower level. Those three metric level definitions are explained as follows.

1. Base Measure: To assess quality of attribute, which is good characteristic's property, this metric level is used. Defining two components; base measure and measurement method are necessary to be performed because these components help in identifying unit of measurement and quantifying attribute of document. Then, attributes will be transformed into quantitative value that basically can be further used in the upper metric level.

2. Derived Measure: Several base measures obtained by defining lower metric level; base measure are defined to assess the quality of SDLC document's good characteristic since it is comprised of various attributes. Defining two components; derived measure and measurement function which is an algorithm defined from combining two or more base measures are necessary to be performed.

3. Indicator: Several base measures or derived measures are defined to assess the quality of SDLC document in this level. Defining three components; indicator, decision criteria of the result and analysis model which is algorithm for combining one or

more base and/or derived measures with associated decision criteria are necessary to be performed. The acquired result that responses to measurement requirement will be used to support the decision of project manager.

4.2.2 Define Criteria for Verifying the Defined Metric

The appropriate criteria for verifying the defined metric are specified in this activity to ensure whether the defined metric has suitable quality. That is, it was defined completely and correctly. Furthermore, the result of applying the defined metric should be reasonable. Criteria definition begins with considering the objective of defined metric verification and follows by considering types of scale such as nominal scale, ordinal scale, interval scale or ratio scale. These types of scale must conform to the defined criterion. In order to verify the defined metric, criteria may be defined as 1) completeness and correctness; the defined metric was defined completely and correctly according to industrial standards or organization best practices and 2) correlation between the defined metric result and the real metric value of object; the higher the correlation coefficient, the stronger the relationship.

4.2.3 Verify the Defined Metric

Completeness and correctness of all components of each metric level according to measurement information model which is mentioned in section 3.2 are used as verification criteria in this activity. If the result of verification indicates that metrics were defined incompletely or incorrectly, they must be reviewed and corrected.

In addition, pilot test can be conducted with the small number of target SDLC documents to assure that the defined metrics are specified appropriately before they are applied in a real environment. The square of the linear correlation coefficient which is mentioned in section 3.3 can be used to measure the correlation and indicate the appropriateness of the defined metrics.

4.3 Metric Application and Interpretation

4.3.1 Apply the Defined Metric

Metrics that passed all verification criteria from previous activity are used in this activity to assess quality of SDLC documents according to measurement information model. The obtained result is as a quantitative value.

4.3.2 Specify the Transformation Function and Its Interval for Value Interpretation

Transformation function and its correspond interval value are specified in this activity in order to convert the acquired quantitative result from previous activity to qualitative result which is able to indicate quality level of SDLC documents. Transformation function consists of four kinds; increasing, decreasing, convex and concave [12].

Two ways to specify transformation function and its interval value are mentioned below.

1. Specify by historical results analysis that are derived from SDLC document quality assessment. These results can be used to specify possible quantitative results for each of the quality level.
2. Specify by expert's judgment or any person who has experience in SDLC document quality assessment.

4.3.3 Interpret Value from the Specified Transformation Function and Its Interval

The quantitative result acquired from the first activity in this part is interpreted as a qualitative result by using the specified transformation function and interval value. To indicate quality level of SDLC documents, qualitative result can be classified as good, moderate or improvement according to decision criteria based on past organization experience.

4.3.4 Identify Potential Improvements

The interpreted result obtained from previous activity especially one in the improvement level must be taken into consideration for improvement.

4.3.5 Store Lessons Learned From the Result in the “*Measurement Experience Base*” for Future Use

The purpose of this activity is to analyze the results of proposed method which is composed of defined metric, qualitative value and improvement part whether they reflect the actual quality of SDLC documents. These results are validated by comparing it with expert's expected results. If the results are invalid or inconsistent, they must be identified, analyzed, and improved by applying feedback from stakeholders including system analyst, project manager or external consultant. Then, the reviewed results of the proposed method will be used for measurement process improvement.

5. Applying the Proposed Model

The proposed method can be applied with any SDLC documents which the contents are specified using natural language and has its recommended document structure. This section, SRS is selected to illustrate how to apply proposed method because it has been recognized among software developers that it has high impact on the success of software product development in order to meet customer's needs.

5.1 Information Needs Identification

5.1.1 Identify the Scope of Requirements for Measurement

SRS is a work product of gathering and specifying software requirements phase of SDLC. So, it can normally be used as a baseline to verify subsequent work products that occur in another phases of SDLC. Furthermore, it can also be used as a communication document between two parties, customer and development team, because customer expectations and development commitments are contained in this document.

Customer's needs specification in SRS can be specified in various ways such as using natural language, using semi-formal language or using formal language. This paper only focus on using natural language to specify software requirements because interpretation problem usually be arisen because of the natural language's characteristics itself; ambiguous characteristic. This may lead to develop software in a wrong direction and finally does not fulfill customer requirement.

In addition, the other significant factor for delivering a good SRS document is its structure. The defined SRS structure and a list of topics that should appear are recommended in IEEE 830 standard [2]. To assess SRS document structure as an example, we select one of suggested structure patterns.

Proposing a method for SRS document quality assessment is the goal of our research which divided into two sub-goals: 1) quality assessment of SRS specifying in natural language and 2) quality assessment of SRS document structure. Assessed result of both aspects will finally result in the overall SRS document quality. This result can help developer to improve quality of SRS since it can indicate the quality level and defect part.

5.1.2 Study and Identify the Good Characteristics of Information Needs

Many facets of good SRS characteristics are specified in software industrial standards and organization best practices. IEEE 830 standard [2] which is a recommended practice for writing software requirements is applied in this paper. There is a part in this standard that mentions eight characteristics of good SRS; correct, unambiguous, complete, consistent, ranked for importance and/or stability, verifiable, modifiable and traceable.

Moreover, this standard [2] also recommends topics of key content that should present in SRS. These topics should be arranged as 1) Introduction; Purpose, Scope, Definitions, acronyms, and abbreviations, References, Overview, 2) Overall description; Product perspective, Product functions, User characteristics, Constraints, Assumptions and dependencies, 3) Specific requirements, 4) Appendixes and 5) Index.

5.1.3 Identify Information Needs

After analyzing all suggested characteristics in [2], we select unambiguous, verifiable and modifiable characteristics of SRS as the information needs because they are tightly related to the defined sub-goals in section 5.1.1. Software requirements interpretation are directly associated with unambiguous and verifiable characteristics and document structure are directly associated with modifiable characteristic. This is a reason why we select those characteristics. Moreover, other characteristics are quite difficult to be verified and require human judgment. Selected characteristics' details are described as follows.

1. Unambiguous: From [2], an SRS is unambiguous if, and only if, every requirement stated therein has only one interpretation.

An example of attribute which is involved with this characteristic property is a conjunction that connects between nominatives. Considering only one of subject is acting or both subjects jointly are acting may cause software requirements interpretation problem. For example, software requirement is specified as "*The manager or the database administrator shall monitor every access to the database.*" which has conjunction "*or*" connects between "*the manager*" and "*the database administrator*". This may be interpreted as "*Either the manager or the database administrator shall monitor every access to the database.*", "*The manager and the database administrator shall monitor together every access to the database.*" or "*Each of the manager or the database administrator shall monitor every access to the database separately.*" [4].

2. Verifiable: From [2], an SRS is verifiable if, and only if, there exists some finite cost-effective process with which a person or machine can check that the software product meets the requirement. In general any ambiguous requirement is not verifiable.

An example of attribute which is involved with this characteristic property is using the adverb that cannot define the exact meaning. Problem of software requirements verification may be arisen. That is, the specified software requirements meet customer's actual needs or not. For example, software requirement is specified as "*The system must work well*" which has adverb "*well*". This sentence influence on the software requirement verification because it is impossible to measure the terms "*well*" [2].

3. Modifiable: From [2], an SRS is modifiable if, and only if, it has table of contents, index and explicit cross-referencing. Moreover, each requirement should be expressed separately and appear in one place in the SRS.

An example of attribute which is involved with a property of this characteristic is the presence of the topic "*table of contents*" in SRS. The association between key topics that appear in SRS and page number in which key topics appear are specified in this topic. So, modifying SRS can be conducted easily if there are any changes affect structure or style of SRS.

In addition, software requirements tend to be evolved over SDLC. This is a reason why the specific requirements part in SRS should be organized in order to provide optimal understanding. Most of customers often specify their needs as a group of functions, named as feature. Organizing SRS document structure in accordance with specifying customer's needs should be performed. The selected structure pattern of this paper is SRS organized by feature which is provided in IEEE 830 standard [2] as 1) External interface requirements; User interfaces, Hardware interfaces, Software interfaces, Communications interfaces, 2) System features; Introduction/Purpose of feature, Stimulus/Response sequence, Associated functional requirements, Functional requirements, 3) Performance requirements, 4) Design constraints, 5) Software system attributes and 6) Other requirements.

5.2 Metric Definition and Verification

5.2.1 Define Metric for Measuring Information Needs

In order to convert attributes which are properties relevant to information needs to quantitative values, metrics must be defined. Result of applying the defined metrics can satisfy sub-goals; assessing quality of using natural language to specify software requirements and assessing quality of document structure. Moreover, in order to satisfy main goal; assessing quality of SRS, metric for assessing the overall quality of SRS that combines the result of those two quality assessments must be defined. Detail of defining metric are described as follows.

1. Define metric for measuring quality of SRS specified in natural language

- **Base measure:** To assess quality of document attributes, this metric level is used by observing the occurrence of predefined term in a sentence. An example of defining base measure metric is shown in table 3. Attribute which is involved with a property of unambiguous characteristic is conjunction as we discussed in section 5.1.3. Base measure is the number of conjunction occurrence that obtained by performing measurement method; counting the "*CC*" and "*IN*" tags which appear in a sentence. Stanford log-linear part-of-speech tagger [16, 17] facilitates to acquire these tags by analyzing structure of sentence and tag Part-Of-Speech (POS) for each word of sentence.

- **Derived measure:** To assess the quality of software requirement specified in SRS, this metric level results from the combining base measures. Three measurement functions [12] that may be used are defined as follows.

- o Weighted Average. Weight is assigned to each base measure metric according to its important to software requirement.

- o Prevailing. Certain base measure metrics that affect quality of software requirement than others are set as prevailing.

- o Minimum Value. Minimum threshold value of each base measure metric is set based on expert judgment. If any metric has a value below the defined value, it is considered to review.

- **Indicator:** To assess the quality of group or overall software requirements, the indicator value earns from applying weighted average function. The reason why we apply this computation function is that the quality of each software requirement may affect overall quality of SRS document differently.

2. Define metric for measuring quality of SRS document structure

- **Base measure:** This metric level is used to check whether essential predefined topics which should be mentioned in SRS are presented or not. An example of defining base measure metric is shown in table 4. Attribute which is involved with a property of modifiable characteristic is "*table of contents*" topic as we discussed in section 5.1.3. The measurement method is to check the appearance of this topic.

However, topics may be specified by using other words with the same meaning. For this reason, a group of synonyms of these topics should be defined. WordNet which is a large lexical database of English [19-21] can be used to serve this purpose.

- **Indicator:** To assess quality of document structure, this metric level is used. The presence of each topic may influence on the quality of document structure differently, so weighted average function is selected for computation. The weighted score of each topic is given upon the stakeholder agreement.

3. Define metric for measuring overall quality

- **Indicator:** To assess the overall quality of SRS, this metric level is used. Weighted average function is used as an analysis model by combining the quality of using natural language to specify SRS and the quality of document structure because these two qualities may affect the overall quality of SRS document differently.

Characteristic	Unambiguous
Attribute	Conjunction
Base Measure	The number of conjunction occurrence
Measurement Method	Counting the “CC” and “IN” tags which appear in software requirement
Tag’s meaning [18]	CC : Coordinating conjunction IN : Preposition/subordinating participle conjunction

Table 3. An Example of Defining Base Measure Metric for Measuring Quality of SRS Specified in Natural Language

Characteristic	Modifiable
Attribute	“ <i>table of contents</i> ” topic appearance in SRS
Base Measure	Appearance of “ <i>table of contents</i> ” topic in SRS
Measurement Method	Checking the appearance of topic “ <i>table of contents</i> ” in SRS

Table 4. An Example of Defining Base Measure Metric for Measuring Quality of SRS Document Structure

Software Requirement [4]	The system shall print a login session report to the manager and the database administrator.
Stanford log-linear part-of-speech tagger result’s [17]	The/DT system/NN shall/MD print/VB a/DT login/NN session/NN report/NN to/TO the/DT manager/NN and/CC the/DT database/NN administrator/NN ./.
Result	1 word/requirement

Table 5. An Example of Applying Defined Metric for Measuring Quality of Using Natural Language to Specify SRS

Quality Level	Interval
Good	[0, 1)
Moderate	[0, 1)
Improvement	[1, α)

Table 6. Specified Interval Value for Each Quality Level (At least one conjunction found, this requirement needs to be improved)

5.2.2 Define Criteria For Verifying The Defined Metric

Defining verification criteria can be conducted by considering the objective of defined metric verification. They are 1) the metric was defined completely and correctly according to measurement information model as mentioned in section 3.2 or not. So, completeness and correctness are defined as criteria and 2) the result of applying the defined metric and the real value of the object it measures are in the same direction or not. So, validity is defined as criteria. In addition, the scale type of values that is used to verify should be considered. After checking scale type of all values of both aspects, they have ratio scale. The square of linear correlation coefficient which is mentioned in section 3.3 is used as correlation validity criterion because it is the validity

criterion for the values that have ratio scale.

5.2.3 Verify the Defined Metric

Completeness and correctness criteria are used to verify metrics in all level of both aspects. A defined checklist may help to verify. For example, in terms of completeness, in a base measure level, there are attribute, base measure and measurement method needed to be defined. In terms of correctness, in a base measurement level, a unit of measurement and a scale type were defined as a number of statements and ratio respectively. Thus, a conformance checking on the unit of measurement and scale type must be performed.

Correlation validity criteria are also used to validate the defined metrics by applying them with small number of target SDLC documents. For instance, base measure metrics validation, the square of linear correlation coefficient between the number of conjunction occurrence obtained by using the defined metric and the actual number of conjunction occur in SDLC document is applied. If the result yields positive, this mean that there is a correlation between the defined metric and the real object measurement.

5.3 Metric Application and Interpretation

5.3.1 Apply the Defined Metric

Verified metrics are used to assess quality of SRS. Table 5 shows an example of applying defined metric as shown in table 3 for measuring the quality of using natural language to specify SRS. Considered characteristic is unambiguous. In accordance with its measurement method, the result is 1 word per a software requirement; “*and/CC*” which is quantitative value.

5.3.2 Specify the Transformation Function and Its Interval for Value Interpretation

Transformation function and its correspond interval value are specified by using historical result data or expert’s judgment in order to convert the quantitative result from previous activity to qualitative result to indicate quality level. From the example as shown in table 5, unambiguous characteristic was assessed. Decreasing function and its interval value of each quality level are specified as shown in table 6 since the number of conjunction appearance increase while the quality of unambiguous decrease.

5.3.3 Interpret Value from the Specified Transformation Function and Its Interval

Transformation function and its interval which are specified in previous activity are used to interpret quantitative result from section 5.3.1. The interpreted result which is as a qualitative value is able to indicate the quality level of SRS. As a result of an example that is shown in table 5, the result of interpretation is improvement. This indicates that review for improving quality of the example part of this requirement must be conducted.

5.3.4 Identify Potential Improvements

Potential improvement part is indicated by analyzing the result interpretation which has a value lower than the expected one. For instance, the interpreted result of example shown in table 5 is improvement due to its defect; the numbers of conjunction occurrence exceed the threshold. It should be improved by get rid of conjunctions under supervision of expert judgment in order to enhance the quality of SRS.

5.3.5 Store Lessons Learned From the Result in the “*Measurement Experience Base*” for Future Use

Lesson learned from applying the proposed model should be kept in a repository for future use in a similar situation. For example, the defined metric for a particular type or format of SRS may be applied for others. In addition, the active assessment result can be used for benchmarking with the next one.

6. Designing Architecture of Tool

To apply our proposed method to assess the quality of SDLC document in a practical way, a supporting tool should be developed. After analyzing the processes and data should be supplied in this proposed method, the tool functions and architecture are proposed. A list of tool functions is defined as follows.

1. System must receive SDLC document which is entered by user via user interface.
2. System must show the SDLC document quality assessment result to user via user interface.
3. System must assess the quality of using natural language to specify the content in SDLC document.

4. System must assess the quality of SDLC document structure.
5. System must assess the overall quality of SDLC document.

The logical multi-layer architecture design is selected for this tool. The overview of tool architecture as depicted in figure 5. Figure 5 shows that architectural design of a tool consists of three layers as follows.

6.1 Presentation Layer

This layer is responsible for receiving user's request; request to assess quality of SDLC document or request to view the result of assessment via user interface and sending it to business logic layer in order to process in response to the request. The computation result is shown to user via user interface. The presentation layer is composed of two modules as described in the followings.

1. Receive File Module: SDLC document file which expected to be measured is received by this module via user interface. The module will send this file to document extractor for extracting the necessary elements according to measurement information model.

2. Show Result Module: The result of SDLC quality assessment will be shown to user in accordance with user's request via user interface. The result may be the immediately computation or any results of previous computation which have been stored in database.

6.2 Business Logic Layer

This layer is responsible for coordinating between presentation layer and data access layer. Once the system receives user's request from presentation layer then calls the data access layer to obtain the required data that will be used to compute in order to accomplish the request. The obtained result will be sent to presentation layer and stored in database. Business logic layer is composed of two parts as explained in the followings.

6.2.1 Document Extractor

The major function of this part is the extraction of the necessary data that are used for computation. This part has two modules; content extractor module and topic extractor module.

1. Content Extractor Module: Contents that are desired to assess quality are extracted from SDLC document. For example, requirements are extracted from SRS in order to assess the quality of using natural language to specify requirements. Extracted contents will be sent to manage content module and saved in a database.

2. Topic Extractor Module: Detecting key topics which should appear in SDLC document are conducted by this module. However, topics may be represented by using other words with the same meaning. So, this module will send a request to manage synonym module in order to obtain synonyms of topics that are collected in a database and use them for topic detection.

6.2.2 Document Assessor

Extracted data from document extractor part are sent to this part. The major function of this part is the quality computation of SDLC document. The results of computation are stored in the database by calling data access layer. This part has three modules; natural language assessor module, structure assessor module and overall assessor module.

1. Natural Language Assessor Module: Quality of using natural language to specify contents is computed by this module. Extracted contents that are sent from content extractor module are used in quality computation. In addition, the request to manage ambiguous module in order to obtain ambiguous words and use them to compute the quality is also performed by this module.

2. Structure Assessor Module: Quality of SDLC document structure is computed by this module. Extracted topics that are sent from topic extractor module are used in quality computation.

3. Overall Assessor Module: Overall quality of SDLC document is computed by this module. That is, the result from natural language assessor module and the result from structure assessor module are combined. In addition, show result controller module is responsible for communicating between show result module and manage result module.

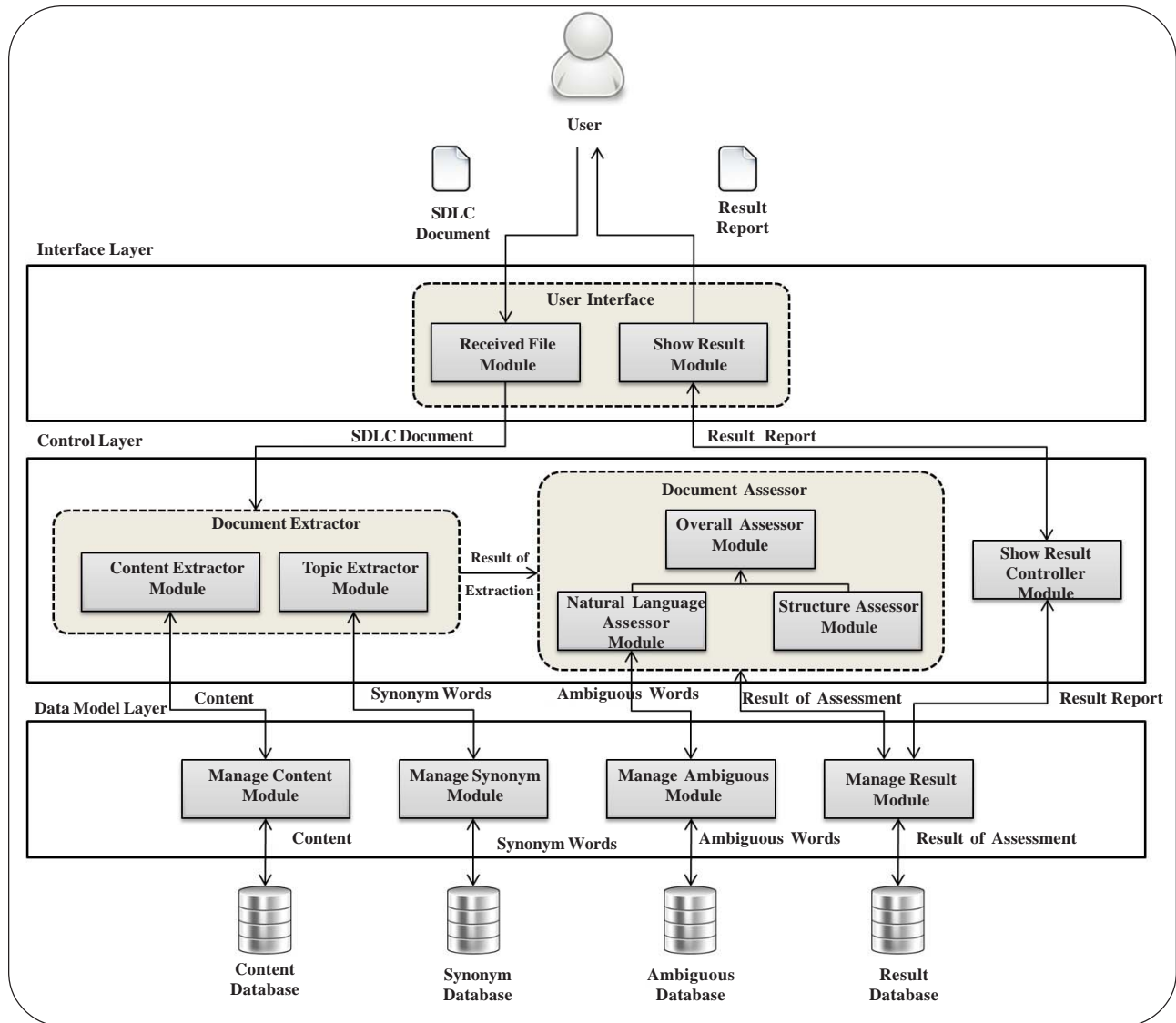


Figure 5. The Overview of Tool Architecture

6.3 Data Access Layer

This layer is responsible for retrieving data that stored in database and sending them to the business logic layer for computation. This layer has four modules; 1) Manage Content Module 2) Manage Synonym Module 3) Manage Ambiguous Module and 4) Manage Result Module that communicate with 1) Content Database 2) Synonym Database 3) Ambiguous Database and 4) Result Database respectively.

An example of user interface's SDLC document quality assessment system for import SDLC document is shown in figure 6. In addition, user can specify the target location of the result report file and desired quality assessment aspect.

7. Conclusion and Future Work

This paper presents the method for assessing the quality of SDLC document which its contents were specified in natural language based on document characteristics. In addition, the functional requirements and architectural design of a tool to support our proposed method is described. We apply the measurement process model and measurement information model to accomplish the aim of the proposed method. This method is separated into three main parts; information needs identification, metric definition and verification, and metric application and interpretation. The result of applying this method can be used to

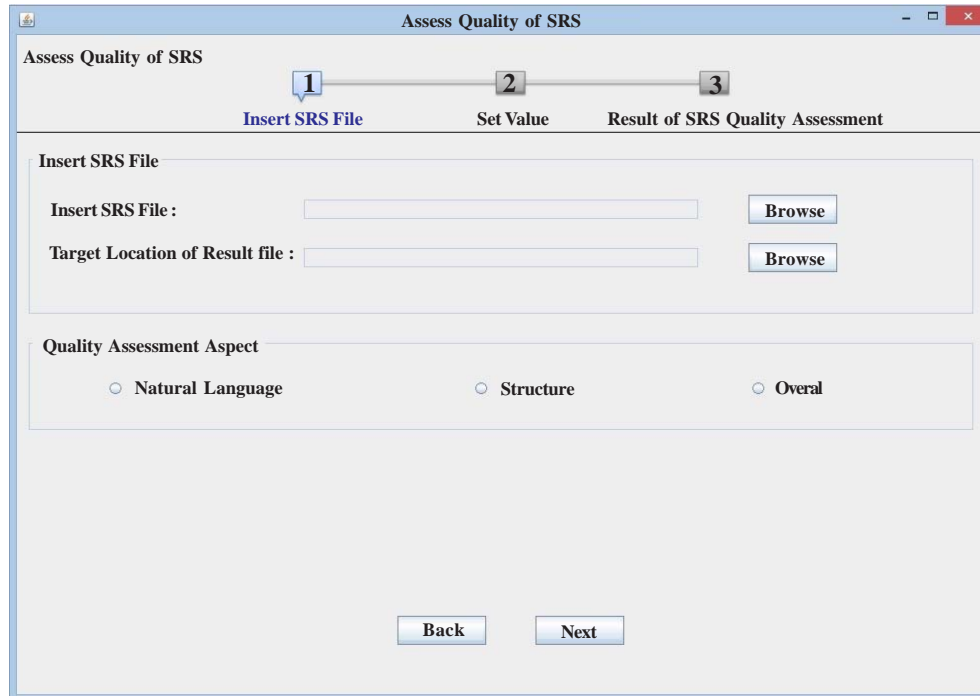


Figure 6. An Example of User Interface's SDLC Document Quality Assessment System for Import SDLC Document

indicate the quality level of SDLC documents which leads to document quality improvement. Lesson learned from the review and improvement process can be applied for future similar scenario.

The architecture of a tool is designed based on a logical multi-layer design composed of three layers; presentation layer, control layer and data model layer.

For future work, we will apply the proposed method to assess the quality of SRS. An automated tool for SRS quality measurement will be developed. Furthermore, validation of the proposed method's outcome will be conducted by comparing it with expert's expected result.

References

- [1] IEEE Standard for Software Project Management Plans. (1998). IEEE Std 1058-1998, 1-28.
- [2] IEEE Recommended Practice for Software Requirements Specifications. (1998). IEEE Std 830-1998, 1-40.
- [3] IEEE Standard for Software Test Documentation. (1998). IEEE Std 829-1998, 1-59.
- [4] Tjong, S. F. (2008). Avoiding ambiguity in requirements specifications. (University of Waterloo)
- [5] Hussain, I., Ormandjieva, O., Kosseim, L. (2007). Automatic Quality Assessment of SRS Text by Means of a Decision-Tree-Based Text Classifier. Paper presented at the Quality Software, 2007. QSIC '07. Seventh International Conference on.
- [6] Jani, H. M. (2010). Applying Case-Based Reasoning to software requirements specifications quality analysis system. Paper presented at the Software Engineering and Data Mining (SEDM), 2010 2nd International Conference on.
- [7] Mat Jani, H., Tariquul Islam, A. B. M. (2012). A framework of software requirements quality analysis system using case-based reasoning and Neural Network. Paper presented at the Information Science and Service Science and Data Mining (ISSDM), 6th International Conference on New Trends in.
- [8] Davis A. Davis, S. Overmyer, K. Jordan, J. Caruso, F. Dandashi, A. Dinh, et al. (1993). Identifying and measuring quality in a software requirements specification. Paper presented at the Software Metrics Symposium. *In*: Proceedings., First International.

- [9] Kenett, R. S. (1996). Software specifications metrics: a quantitative approach to assess the quality of documents. Paper presented at the Electrical and Electronics Engineers in Israel, Nineteenth Convention of.
- [10] Lami, G., Gnesi, S., Fabbrini, F., Fusani, M., Trentanni, G. (2004). An automatic tool for the analysis of natural language requirements. Informe técnico, CNR Information Science and Technology Institute, Pisa, Italia, Setiembre.
- [11] Jani, H. M. (2007). Online Quality Analysis of the Requirements Specifications Phase of the Software Development Cycle. Paper presented at the South East Asian Association for Institutional Research (SEAAIR), Bangkok, Thailand.
- [12] Génova, G., Fuentes, J., Llorens, J., Hurtado, O., Moreno, V. (2013). A framework to measure and improve the quality of textual requirements. *Requirements Engineering*, 18 (1), 25-41.
- [13] Carlson, N., Laplante, P. (2014). The NASA automated requirements measurement tool: a reconstruction. *Innovations in Systems and Software Engineering*, 10 (2), 77-91.
- [14] ISO/IEC Systems and software engineering — Measurement process. (2007). ISO/IEC Std 15939-2007, 1-46.
- [15] IEEE Standard for a Software Quality Metrics Methodology. (1998). IEEE Std 1061-1998, 1-26.
- [16] Stanford Log-linear Part-Of-Speech Tagger, <http://nlp.stanford.edu/software/tagger.shtml>
- [17] Stanford Parser, <http://nlp.stanford.edu:8080/parser/>
- [18] Marcus, M. P., Marcinkiewicz, M. A., Santorini, B. (1993). Building a large annotated corpus of English: the penn treebank. *Computational Linguistics*, 19 (2), 313-330.
- [19] Miller, G. A. (1995). WordNet: a lexical database for English. *Commun. ACM*, 38 (11), 39-41.
- [20] WordNet A lexical database for English, <http://wordnet.princeton.edu/>
- [21] WordNet Search – 3.1, <http://wordnetweb.princeton.edu/perl/webwn>

Biographies

Patra Thitisathienkul received B.Eng. degree in Computer Engineering at Chulalongkorn University in 2012. She is a master student in the Department of Computer Engineering, faculty of Computer Engineering at Chulalongkorn University. Her research interest is software requirements engineering.

Nakornthip Prompoon received M.S. degree in M.B.A. at Chulalongkorn University in 1991 and Computer Science at the George Washington University in 1993. She is working as an assistant professor in the Department of Computer Engineering, faculty of Computer Engineering at Chulalongkorn University. Her research interests are software requirements engineering, software process engineering and improving and information storage and retrieval.