# Designing Software Quality Measurement System for Telecommunication Industry Using Object-Oriented Technique

Nor Fazlina Iryani Abdul Hamid, Mohamad Khatim Hasan

***Abstract*—**Numbers of software quality measurement system have been implemented over the past few years, but none of them focuses on telecommunication industry. Software quality measurement system for telecommunication industry was a system that could calculate the quality value of the measured software that totally focused in telecommunication industry. Before designing a system, quality factors, quality attributes and quality metrics were identified based on literature review and survey. Then, using the identified quality factors, quality attributes and quality metrics, quality model for telecommunication industry was constructed. Each identified quality metrics had its own formula. Quality value for the system was measured based on the quality metrics and aggregated by referring to the quality model. It would classify the quality level of the software based on Net Satisfaction Index (NSI). The system was designed using object-oriented approach in web-based environment. Thus, existing of software quality measurement system was important to both developers and users in order to produce high quality software product for telecommunication industry.

***Keywords*—**Software Quality, Quality Measurement, Object-oriented Approach, Net satisfaction Index.

## I. Introduction

THE purpose of system design is to create the technical solution that satisfies the functional and user requirements. Recently, many systems related to software quality measurement emerged, but none of them focused in telecommunication industry. For example, Squale focused on automotive and KADS focused on agriculture. We cannot use Squale or KADS to measure software quality in telecommunication industry because different industry would have different quality factors. Quality factors were the indicator in measuring the software quality. KADS has extendibility, reusability, functionality, flexibility and understandability as its factors, while we have flexibility, functionality, usability, integrity and testability as factors in telecommunication industry [1]. On the other hand, Squale measures Line of Codes, Cyclomatic Complexity, rules checking analysis and test coverage [2].

There is tremendous growth in telecommunication industry for past few years that bring high demand of software products and application specifically related to telecommunication industry. This scenario happened everywhere including Malaysia where the emergence of Multimedia Super Corridor (MCS) has seen the dynamic growth of MSC status companies [3]. Most of them are software development companies that contributed to telecommunication industry. The fundamental reason to measure software quality was to produce software product with the best quality and error free. However, the term software quality will vary depending on the principles that they apply. Some common measures were software without fatal errors, software that worked as advertised, software with accurate results and software that is pleasing to the eyes [4].

Measuring software quality in industry is not an easy task and majority of the companies not implement it. There were several reasons why quality was not measured, among some of the common reasons were managers do not know how to measure, too hard to create the infrastructure that were necessary to measure software quality, afraid of the result and upper management do not really care [5].

To overcome these, a system that can measure the software quality has to be developed. The system must be easy to use, interactive as well as attractive to attract users. The system has to be web-based to make it accessible via Internet anywhere and anytime. The system would be applicable to project managers. English language has been chosen to make the system globally understood.

To improve the effectiveness of software industry, it was necessary for software companies to have continuous process improvement [6]. The prerequisite for improvements in software product quality was widely known that was software measurement. Until today, there was no research done in recognizing software quality factors and metrics that can be used in measuring quality of telecommunication software product. Therefore, a necessity for providing software quality measurement system specified in telecommunication industry that would drive to formal judgement about the success or failure of software product arises. The present metrics discussed about software quality measurement in general.

From this viewpoint, some discussions and research on the software quality measurement techniques have been applied. It starts from factor-criteria-metric model, introduced by McCall 1977, followed by Boehm model (1978), ISO 9126 model (1991), Dromey Model (1995) [7]. As it evolved, Chidamber and Kemerer introduced the Metrics for Object Oriented Software Engineering (MOOSE), which consists of six metrics that evaluate different features in object-oriented approach [8]. Then, Abreu and Carapuca (1994) introduce Metrics for Object Oriented Design (MOOD), that

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quantitatively evaluated object-oriented paradigm by classifying quality measurement criteria for object-oriented designs [9]. MOOD has been enhanced by Abreu and Melo (1996) by expressing the internal and external characteristics and embedded in a quality model [10]. In 1998, Abreu and Cuche came out with a newer version of MOOD, MOOD2 that could be used up to attribute level [11]. Bansia and Davis (2002) made an evolution from MOOD2 to QMOOD by assessing the quality as an aggregation of the model's individual high-level quality attributes and distinct the lower level design metrics in terms of design characteristics [7]. There were the progressions of quality metrics that relate the lower to higher level. Nevertheless, most of them were devoted for empirically validating by linking them to object-oriented quality attributes and built upon the original Chidamber and Kemerer (1994) metrics suite. There were several software quality measurement models that had been used in the industry. The example of existing software quality measurement models are ODEM (Object-oriented Design Model), Squale model, KADS (Knowledge Acquisition and Development System) model and COTS (Commercial off-the-shelf) model [12]-[15].

The purpose of this paper was to design software quality measurement system for telecommunication industry in Malaysia using object-oriented approach. The research objective was to develop new web-based system that can measure software quality in telecommunication industry. This system could help developers and project managers evaluated the quality level of their developed software. The structure of the paper was separated into five parts. Part one briefly introduced software quality measurement system in telecommunication industry. Part two further discuss about the methodology. It is followed by result in part three. Part four discussed on the finding. Part five concluded the paper.

## II. Methodology

Deductive approach has been used as a research method in this study. Deductive approach was applied throughout the process. It started from preliminary study, literature and empirical findings, identified quality factors and metrics, constructed quality model, develop the system until system evaluation. The system will be applied and tested in the real case study. Deductive approach applies top-down approach, from the more general to the more specific. It begins with thinking up a theory about topic of industrial-based software quality measurement. Then it narrows down to more specific model that needs to be tested. Further, it collects observations to address the quality factors, construct the model, design and develop the quality measurement system for telecommunication industry. This ultimately leads to evaluate the system with specific data and develop software quality measurement aggregation for telecommunication industry in Malaysia.

Before designing the software quality measurement system, the first step is to identify the software quality factors for telecommunication industry [16]. After that, software quality model was constructed based on the factors. Each factor has its own sub-characteristics and metrics that could be used in constructing the quality model for telecommunication industry. The model has been validated using binary regression method because the dependent variable of the data was a binary data. The purpose of logistic regression analysis is to predict a single variable from one or more independent variables [17]. To measure the software quality of the system, there was a process of calculating the quality metrics of each factor and aggregate it to the higher level to get the numerical value as a result [18].

System architecture of Software quality measurement system for telecommunication industry is shown in Fig. 1 below. The system would be run under web-based environment. There were three interfaces that have been defined, web user interface, system database interface and system processing engine interface. Web user interface was just a standard TCP/IP connection that complies with web browser and used standard Server IP address as well as port number. System database interface was also using standard TCP/IP connection. This application would use MySQL database. Normally depending on the database, certain port has been defined by database server so that client application could access the database for add, update, select or delete the data in database. Web user did not need to know the interface, however developer need to use this interface for programming purposes. System processing engine interface functioned to process command send by the web user and feedback the result. Using this interface, web server could update, delete, add and retrieved data for system configuration. The system GUI interface is using TCP/IP connection with proprietary port number.

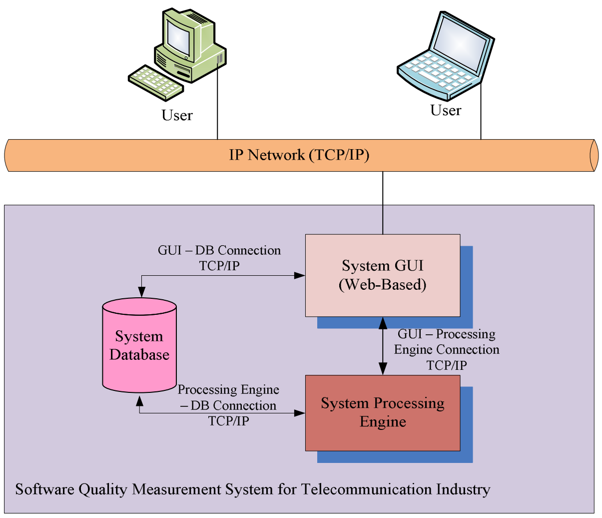


Fig. 1 System Architecture

In designing software quality measurement system for telecommunication industry using object-oriented technique, use case diagram, layered architecture, class diagram and sequence diagram have to be constructed. Use case diagram would illustrate the system functionality from users' perspective. Layered architecture would demonstrate the system module in each layer. Class diagram would clarify the relationship between classes in the system. Sequence diagram would explain the sequence process flow of the system [19]. Next section will discuss on diagrams construction.

## III. Designing the System

There were several diagrams have to be constructed during design phase like use case diagram, layered architecture, class diagram and sequence diagram.UML methodology has been used for the system design and modeling. Use case diagram represent the functionality of the system from users' perspective and identified the scope of the system [20]. The functional description for this system described what the system must do. This includes the processes, interface with users and data hold by the system. It is an interaction between the system and its environment. It showed the function that would be provided by the system and which user the system communicates with. For software quality measurement system using object-oriented technique, three actors of the use case has been identified based on its requirements. The identified actors for the system were system admin, general user and registered user. The use case diagram for the system was shown in Fig. 2.

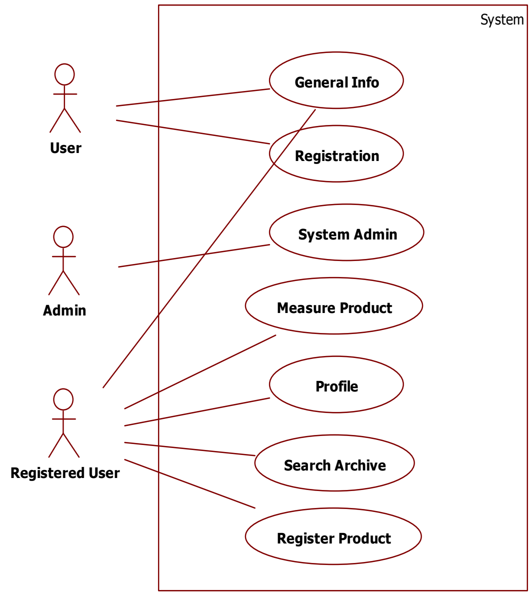


Fig. 2 Use Case Diagram

Use case diagram above showed that software quality measurement system for telecommunication industry had seven different modules with different functionalities. Both user and registered user would be the project managers, user was unregistered with limited access, whereas registered users were the people who registered with the system and they have full access to the system. System admin is the person who maintains the system. User could access general info and registration module. Registered user could access general info, profile, register product, search archive and measure product modules.

The system design has been supported by layered architecture to illustrate the real system. Layered architecture usually used in designing web application by using different layers for allocating responsibility of an application. Layered architecture was a division on network model into multiple discrete layers or levels through which message pass as they were prepared for transmission. Layered architecture for software quality measurement system for telecommunication industry consists of three layers which are presentation layer, application layer and database layer as in Fig. 3.

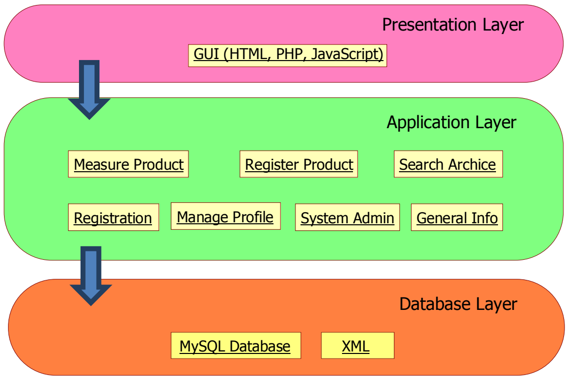


Fig. 3 Layered Architecture

Presentation layer provided the application's user interface and involves the use of HTML, PHP and JavaScript for browser-based interaction. Application layer implements the core functionality of the application. This layer typically consists of a number of modules implemented using programming languages. These modules were the engine of the system. The data layer provides access to external systems that was databases. The database used for this system was MySQL database and connected using PDO_MySQL extension.

In designing the system using object-oriented technique, constructing class diagram was a must. It was a static structure diagram that describes the structure of a system by showing the system's classes, attributes, operations and the relationships among the classes. Class diagram for software quality measurement system was as in Fig. 4. The class diagram consists of eleven classes associated with each other via composition, aggregation and generalization relationship. Class user was generalized to three different classes; registered user, normal user and admin. Class registered user, class normal user and class admin were subclass of class user. User was the people who use the system and they can be project managers or developers who have interest to measure their software product. Subclasses inherit all the instances from superclass. The class diagram describes the attributes and operations of a class and also the constraints imposed on the system. From the class diagram below, it shows that normal user can only view the general info and make registration. Admin's task was to manage general info module, system admin module and archive module. Registered user would have full access to the system. Registered user could view general info, manage personal profile, search archive, register project, measure project quality and view the project quality value.

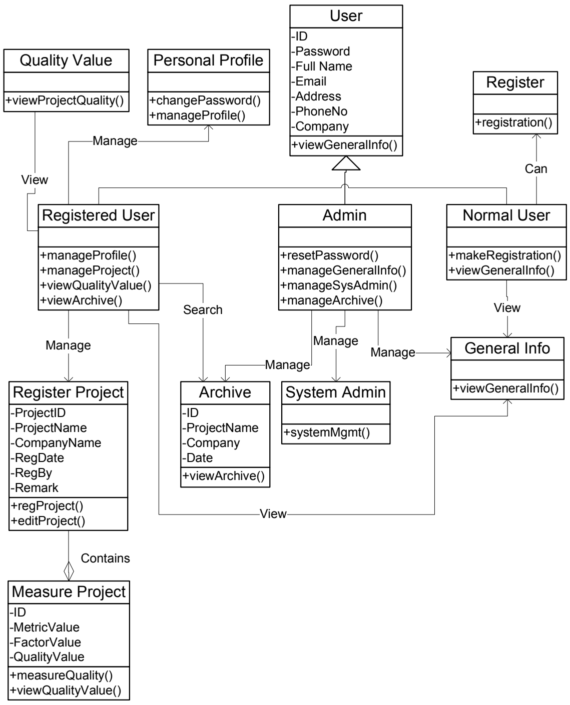


Fig. 4 Class Diagram

Sequence diagram was used to formalize the dynamic behavior of the system and to visualize the communication among objects. It was useful for identifying additional objects that participated in the use cases and represents the interactions taking place among these objects. An object interacts with another object by sending messages. The reception of a message by an object triggers the execution of a method, which in turn may send messages to other objects. Arguments might be passed along with a message and are bound to the parameters of the executing method in the receiving object. Sequence diagram ties use cases with objects and shows how the behavior of a use case was distributed among its participating objects. One sequence diagram represented one object in the use case diagram. Use case diagram for software quality measurement system for telecommunication industry consist of seven objects that were general information, registration, admin, profile, register project, measure project and search archive. Sequence diagram for general info was as Fig. 5.

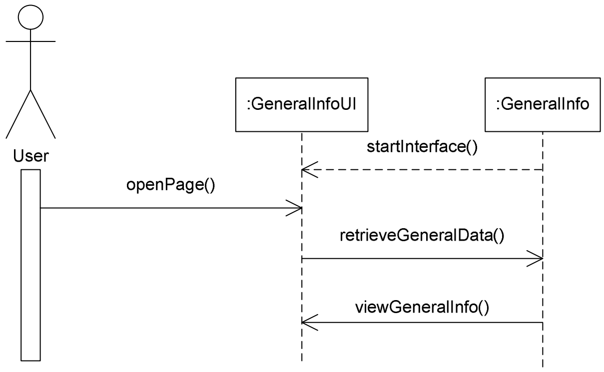


Fig. 5 Sequence diagram for general information

General info page could be accessed by all users. This module would display the brief information about software quality measurement system for telecommunication industry. The second sequence diagram was registration, which can be accessed by the users who want to register to the system. After registration, the registered users can have full access to the system. User here might be system developers or project managers. Sequence diagram for registration as shown in Fig. 6 below.

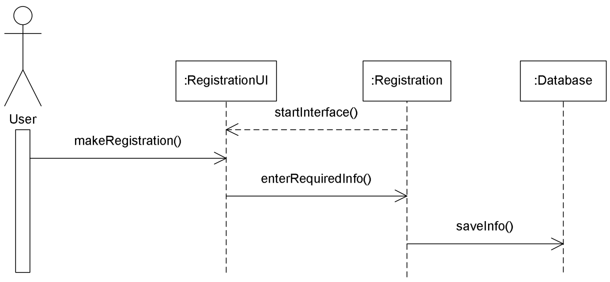


Fig. 6 Sequence diagram for registration

The third sequence diagram was system admin. System admin module could only be accessed by admin. Function of system admin module was to administer the whole system. The sequence diagram for system admin was shown in Fig. 7. The forth sequence diagram was user profile. User profile module could be accessed by the registered user to manage their profile. The flow of user profile module was shown in sequence diagram in Fig. 8. The fifth sequence diagram was register project. Before measuring the quality of the project, the particular project must be registered to the system. To register, user had to enter all required information. The entered information can be edited by the user from time to time. The sequence diagram for register project was illustrated in Fig. 9. The sixth sequence diagram was measure project. The sequence diagram illustrated the flow to measure the software quality. This module only can be accessed by registered user. First, users have to specify the project they want to measure. After that, enter all the required data for measurement process. Then system calculated the entered data by applying all the related equations and displays the system quality value as a result. The sequence diagram for measure project was shown in Fig. 10.

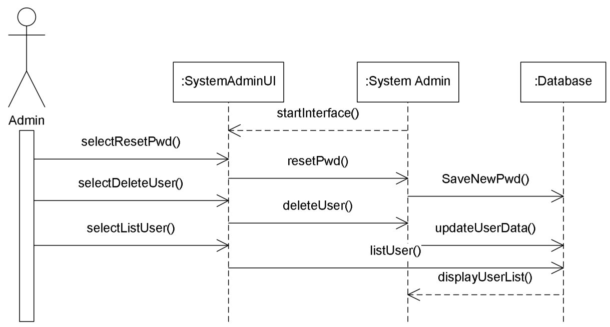


Fig. 7 Sequence diagram for system admin

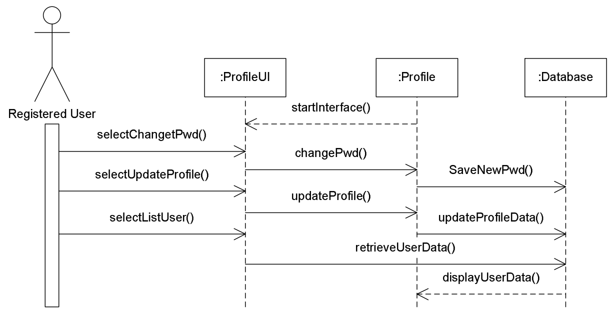


Fig. 8 Sequence diagram for user profile

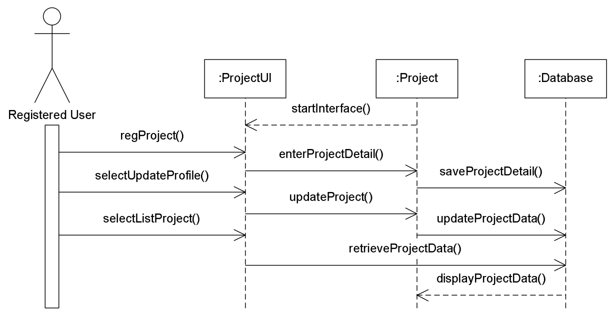


Fig. 9 Sequence diagram for register project

The seventh and final sequence diagram was search archive. Only registered users could access this module. Function search archive module was to give the facility to users to retrieve past project data. The sequence diagram for search archive was shown in Fig. 11.

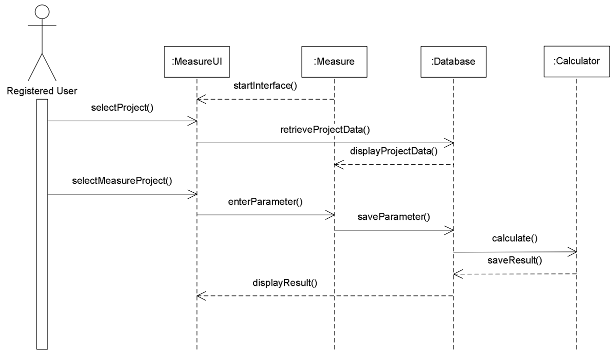


Fig. 10 Sequence diagram for measure project

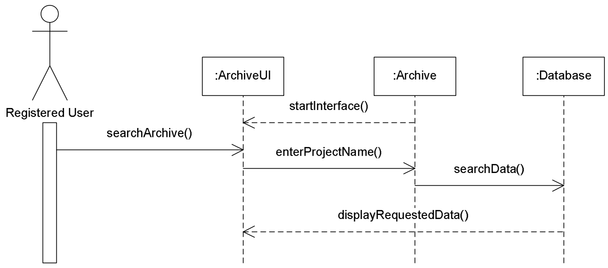


Fig. 11 Sequence diagram for search archive

The software quality measurement system for telecommunication industry has been designed and was illustrated by above diagrams, starting from use case diagram, layered architecture, class diagram, up to sequence diagram. Use case diagram give the glance view of the system that showed the relationship between user and modules in the system. Layered architecture briefed the architecture of the system, which consists of presentation layer, application layer and database layer. Class diagram demonstrated the relationship among classes together with its operation and method. Sequence diagram detailed out the system flow of each module.

## IV. Discussion

At the meantime, there were limited tools in the market to measure the software quality. Moreover, there was no system in the market that focused in measuring the software quality for telecommunication industry. This system was designed to overcome this problem. Its objective was to facilitate companies, which developed software for telecommunication industry to produce high quality software. Telecommunication industry has been chosen because it shown the tremendous growth in past few years, parellel with the evolution of technology. This system would benefit the growth of software industry specific in telecommunication industry. The system would identify the quality of developed software by calculating the quality value and mapped with the Net Satisfaction Index (NSI) as shown in Table I. NSI has been used by many companies to facilitate quality comparison across products [21]. Only the product that fall into

"Completely Satisfied" level in NSI would be released.

TABLE I
NET SATISFACTION INDEX

| Quality Value | Net Satisfaction index |
|---|---|
| 8.1 – 10.0 | Completely Satisfied |
| 6.1 – 8.0 | Satisfied |
| 4.1 – 6.0 | Neutral |
| 2.1 – 4.0 | Dissatisfied |
| 0 – 2.0 | Completely Dissatisfied |

It was important to ensure the user's satisfaction. Thus, the high quality product would contribute to marketing strategy and business improvement, where:

1) Customer satisfaction would generate continuous cash flow and gave positive impact to gain more potential customers.
2) Minimize bugs fixing and product maintenance cost.
3) Shortterm the product development life cycle where could save cost.
4) Minimize the evaluation cycle in product development.

Software quality measurement system for telecommunication industry would give positive impact in software industry and related parties. The system could contribute in easing the development process, improve productivity and efficiency. The system could be applied by companies that develop software application for telecommunication industry.

## V. CONCLUSION

Comprehensive system design was important to make sure the system functioned as per specification and minimized errors. The function of the system was to measure software quality for telecommunication industry. The development of the system would benefit the industry in a way that companies can measure the quality of their developed software before released the product. From there, it assured that only high quality product would be in the market. It benefits both companies and users.

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