VALIDATION OF QUALITY REQUIREMENTS THROUGH REQUIREMENTS-BASED TESTING WITH SEMI-FORMALISED MODEL

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DOCTOR OF PHILOSOPHY

2018

Faculty of Information and Communication Technology

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A thesis submitted
in fulfillment of the requirements for the degree ofDoctor of Philosophy

Faculty of Information and Communication Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

DECLARATION

I declare that this thesis entitled "Validation of Quality Requirements through Requirements-Based Testing with Semi-formalised Model" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : Nor Aiza Binti Moketar

Date : ……

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of Doctor of Philosophy.

Signature	:	……...
Supervisor Name	:	Assoc. Prof. Dr. Massila Binti Kamalrudin
Date	:	……..…….....

DEDICATION

I dedicate this thesis to

My husbandMuhamad Hafiz, my children Nur Hani Sufia and Umar Hariz, my beloved parent, my parent-in-law, my brothers, and sisters.

ABSTRACT

The usage of software system and applications has increased massively to fulfill various kind of purpose for organization, business and individual. In this case, high quality software system and application are required to ensure it provides the intended functionalities. To achieve quality software system and application, a good quality of requirements needs to be defined and validated. However, it is difficult to accomplish due to the flexibility of natural language requirements that can be confusing and easily misinterpreted. This can lead to requirements-related problems such as incorrectness, incompleteness and inconsistency.These errors in requirements will produce defective software that can lead to undesirable and non-acceptance by stakeholders. Therefore, it is crucial for the software requirements to fulfill basic quality attributes such as correctness, completeness, and consistency (3Cs). Motivated from these problems, the main objective of this studyis to develop an automated approach to validate the quality of requirements through Requirements-Based Testing methodology with semi-formalized model. This studyproposes a new automated approach to assist the requirements engineer and client-stakeholders to validate the quality of requirements. For this, we generate abstract tests by integratingRequirements-based Testing (RBT) methodology and rapid prototyping with semi-formalized models:Essential Use Cases (EUCs) and Essential User Interface (EUI).Next, we have developed pattern libraries to support the automatic extraction of abstract tests from the EUC model. They are test requirements pattern library and testcase pattern library. Here, an automated tool support called TestMEReq is also developed to realize the approach. The test-authoring template to assist requirements engineer to write accurate tests is also developed. Then, a real-time collaborative approachis also integrated with the tool to encourage users' involvement in the validation process as well as to support better communication and collaboration among stakeholders. Finally, a comprehensive evaluation of the approach, comprising experiments of correctness test and usability test were conducted. In summary, the findings of the evaluations show that our approach can contribute to the body of knowledge of requirements engineering especially in enhancing the quality of requirements at the earliest stage. It is found that the approach is able to enhance the correctness level of the elicited requirements compared to the manual approach and produce correct generation of test. The results of the usability tests show that the approach is useful and helpful in validating the quality of requirements at the early stage of software development and able to ease the requirements validation process.

ABSTRAK

Penggunaan perisian sistem dan aplikasi telah meningkat secara besar-besaran untuk memenuhi pelbagai keperluan organisasi, perniagaan dan individu. Maka, perisian sistem dan aplikasi yang berkualiti tinggi amat diperlukan untuk memastikan ia menyediakan fungsi yang dikehendaki. Bagi mencapai perisian sistem dan aplikasi yang berkualiti, keperluan perisian yang berkualiti tinggi perlu dikenalpasti dan divalidasikan. Walau bagaimanapun, ia sukar untuk dicapai disebabkan oleh fleksibiliti keperluan bahasa semulajadi yang mengelirukan dan mudah disalah tafsir. Ini akan menyebabkan masalah berkaitan-keperluan seperti kesilapan, ketidaksempurnaan, dan tidak konsisten. Kesilapan di dalam keperluan ini akan menghasilkan perisian yang rosak dimana ianya tidak diingini and diterima oleh pemegang kepentingan. Oleh itu, ia amat penting untuk keperluan perisian memenuhi atribut berkualiti seperti ketepatan, lengkap dan konsisten (3Cs). Motivasi kepada masalah ini,objektif penyelidikan ini adalah untuk membina satu pendekatan automatic untuk menvalidasikan kualiti keperluan melalui Ujian berasaskan Keperluan (RBT) bersama model separa formal.Penyelidikan ini mencadangkan satu pendekatan automatik baharu untuk membantu Jurutera Keperluan dan pelanggan-pemegang kepentingan untuk menvalidasikan kualiti keperluan perisian. Untuk ini, kami menjana ujian abstrak dengan mengintegrasikan metodologi Ujian berasaskan Keperluan (RBT) dan prototaip pantas bersama model separa formal:Kes Berguna Penting (EUC) dan Antara-muka Penting (EUI). Kami kemudiannya telah membangunkan pangkalan data untuk menyokong pengekstakan ujian abstrak daripada EUC model secara automatik. Pangkalan data tersebut terdiri daripada ujian keperluan dan kes ujian. Disini, satu alatan sokongan automatik dipanggil TestMEReq juga dibangunkan untuk merealisasikan pendekatan tersebut. Templat pengarang-ujian untuk membantu Jurutera Keperluan menulis ujian yang tepat juga dibangunkan. Kemudian, satu pendekatan kolaborasi masa-sebenar juga diintegrasikan bersama alatan tersebut untuk menggalakkan penglibatan pengguna dalam proses validasi serta menyokong komunikasi dan kolaborasi yang lebih baik diantara pemegang kepentingan. Akhir sekali, penilaian menyeluruh pendekatan terdiri daripada eksperimen ujian ketepatan dan kebolehgunaan telah dijalankan.Kesimpulannya, dapatan daripada penilaian menunjukkan pendekatan kami mampu menyumbang kepada badan pengetahuan kejuruteraan keperluan terutamanya dalam meningkatkan kualiti keperluan perisian di peringkat awal. Ianya dikenalpasti bahawa pendekatan ini boleh meningkatkan ketepatan keperluan yang dicungkil berbanding manual dan menghasilkan ketepatan ujian penjanaan. Kemudiannya, keputusan ujian kebolehgunaan menunjukkan pendekatan ini berguna dan membantu dalam menvalidasikan kualiti keperluan perisian pada peringkat awal pembangunan aplikasi dan memudahkan proses validasi keperluan perisian.

ACKNOWLEDGEMENTS

All praise and thanks belong to Allah the Most Gracious, the Most Mercifulfor choosing me to experience this wonderfuljourney. I was blessed withgood health, strength, and ability to complete this study.

I would like to thank all who contributed in the completion of this thesis. My sincere thanks go to my supervisors, Associate Professor Dr. Massila Kamalrudin and Professor Dr. Mokhtar Mohd Yusoffor the patience guidance, encouragement and advices toward the completion of this thesis. I am extremely lucky to have committed supervisors who willing to spare their precious time to help me with my study; for many fruitful discussions and constructive suggestion for improvement.

In addition, I would like to thank everyone from my research group for their continuous assistance and support. A veryspecial thanks to Associate Professor Dr. Safiah Sidekfor valuable proofreading and numerous advice on the organisation of this thesis.

My deepest thanks go to my family who always be with me through thick and thin, especially to my husband and my children for their incomparable patience, support and understanding.

Thanks for all your encouragement.

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LIST OF ABBREVIATIONS

TestMEReq	-	Test Malay English Requirements
3C	-	Correctness, Completeness and Consistency
RBT	-	Requirements-Based Testing
EUC	-	Essential Use Case
EUI	-	Essential User Interface
UTeM	-	Universiti Teknikal Malaysia Melaka
TR	-	Test Requirements
TC	-	Test Case
IT	-	Information Technology
CD	-	Cognitive Dimensions
GUI	-	Graphical User Interface

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents an overview of this thesis. First, it describes the backgroundof the research and introduces the motivation of the research. The next section presents the research questions as well as the objectives of the research, followed by the description of the contribution of the study in relation to the field of Requirements Engineering. Finally, the chapter concludes with the outline of the thesis structure.

1.2 Research Background

In-line with the massive growth of technology, the usage of software systems and applications has increased accordingly. The demand for the software has risen in the early 1960s and expanded greatly with the emerging of personal computers (PC) in the middle of 1970s. It has continued to grow in the recent years with the rapid evolution of mobile devices such as laptops, tablets, and smartphone. Software systems have been used for various kinds of purpose and have delivered many positive impacts to the way howan (a) organization, business and individual works and coordinates. They are designed and developed to automatically handle complex functionality in various domains of application to ease the manual tasks and processes as well as to increase the productivity. Accordingly, the demand for high quality of software system has also increased to ensure it provides the intended functionality as required by the users. High quality software system is extremely

important for the safety-critical domains such as healthcare, infrastructure, and transportation to avoid any risks such as failure or malfunction in the software that may result in serious injury or death, as well as lost or severe damage to equipment/property. However, developing an effective and high-quality software system is not an easy task. It involves a few critical phases and activities that require full commitment and collaboration from all client-stakeholders to ensure its success.

There were many Software Development Life Cycle (SDLC) models proposed such as waterfall, spiral, V-model, and agile model. Regardless of these various models and methodologies, a software development process generally involves five main phases, which include the requirements analysis, design, development, testing, and maintenance. Figure 1.1 shows the traditional SDLC model: the Waterfall model(Sommerville, 2001). Among these phases, the requirements analysis is claimed to be the most essential phase in a software development process since it gives critical impact to the quality of end product (Hsia et al., 1993)(Lamsweerde, 2000)(Vieira et al., 2012).

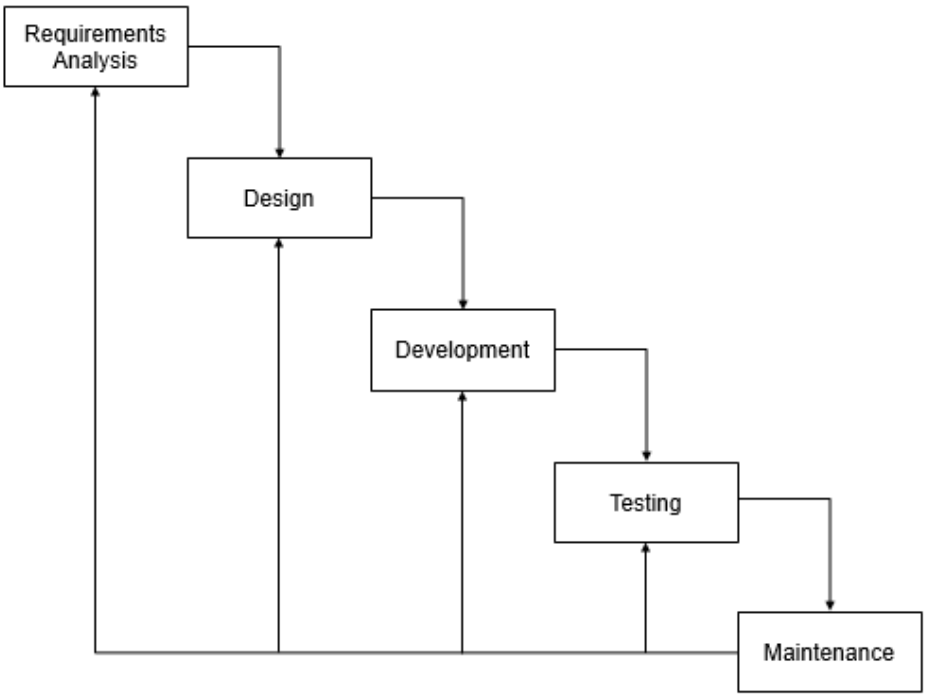

Figure 1.1: Waterfall Model