UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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# A SOFTWARE REQUIREMENTS DEFECT MANAGEMENT APPROACH USING NEGOTIATION TECHNIQUE TO IMPROVE SOFTWARE REQUIREMENTS QUALITY

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**MASTER OF SCIENCE IN INFORMATION AND COMMUNICATION TECHNOLOGY**

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# Faculty of Information and Communication Technology

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## NURUL ATIKAH BINTI ROSMADI

**A thesis submitted**
**in fulfillment of the requirements for the degree of Master of Science in Information and Communication Technology**

**Faculty of Information and Communication Technology**

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# DECLARATION

I declare that this thesis entitled "A Software Requirements Defect Management Approach Using Negotiation Technique to Improve Software Requirements Quality" 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 : Nurul Atikah binti Rosmadi

Date : 8 May 2018

# 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 Master of Information and Communication Technology.

Signature                 :        ……………………………..

Supervisor Name    :        Dr. Sabrina binti Ahmad

Date                   :        20 July 2018

# DEDICATION

To my supportive supervisor, my husband, my parents and my best friends.

Thank you.

# ABSTRACT

Several defects are originated from requirements phase and poor requirements elicitation process leads to projects failure. Developing software projects with defects-free requirements are difficult, especially when project involve multiple stakeholders with different perspectives and perceptions. This is because conflicted stakeholders lead to mismatching goals and miscommunication. Traditionally, inspection method is proven effective to detect and to remove requirements defects. However, it is only feasible when the requirements document are ready. Earlier defects detection, fix and removed, can lessen the cost of testing and maintaining phase at later stages. Motivated by this, this research proposed a new defects management approach in software requirement to improve software requirements quality. This research introduces a prevention action to propose a defects management approach with embedding negotiation technique to prevent the defects from entering software requirements documents. Empirical software engineering method is adopted for this research and the evaluation is based on experimental study. A control group which deploy traditional inspection technique is used as our baseline to compare the effectiveness of defects management approach. Hence, to support that, we conduct experiments that runs both traditional and new approach using case study that involve multiple stakeholders. On top of that, five experts who are familiar with handling defects management and working in software engineering field more than five years, were selected to provide expert opinion. Overall results indicates that the new defects management approach and the inspection have similar capabilities to prevent and to detect defects respectively. Our new defect management approach able to prevent 28 percent more than inspection approach. This also means that both traditional inspection approach and the new approach complement each other by means that we can improve software requirements quality and reduce the maintenance cost in the future.

# ABSTRAK

*Beberapa kecacatan berasal dari fasa keperluan dan proses pencungkilan keperluan yang lemah membawa kepada kegagalan projek. Membangunkan projek perisian dengan keperluan bebas kecacatan adalah sukar, terutamanya apabila projek melibatkan pelbagai pemegang kepentingan dengan perspektif dan persepsi yang berbeza. Ini adalah kerana pihak berkepentingan yang bertentangan membawa kepada matlamat tidak sepadan dan miskomunikasi. Secara tradisi, kaedah pemeriksaan terbukti berkesan untuk mengesan dan menghapuskan kecacatan keperluan. Walau bagaimanapun, ia hanya boleh dilaksanakan apabila dokumen keperluan sudah siap. Kecacatan pengesanan, pembetulan dan penyingkiran awal, dapat mengurangkan kos pengujian dan memelihara fasa pada peringkat kemudian. Dengan motivasi ini, kajian ini mencadangkan pendekatan pengurusan kecacatan baru dalam keperluan perisian untuk meningkatkan kualiti keperluan perisian. Penyelidikan ini memperkenalkan tindakan pencegahan untuk mencadangkan pendekatan pengurusan kecacatan dengan teknik perundingan untuk membendung kecacatan daripada memasuki dokumen keperluan perisian. Kaedah kejuruteraan perisian empirikal digunakan untuk penyelidikan ini dan penilaiannya berdasarkan kajian eksperimen. Kumpulan kawalan yang menggunakan teknik pemeriksaan tradisional digunakan sebagai garis dasar untuk membandingkan keberkesanan pendekatan pengurusan kecacatan. Oleh itu, untuk menyokongnya, kami menjalankan eksperimen yang menggunakan pendekatan tradisional dan baru menggunakan kajian kes yang melibatkan pelbagai pemegang kepentingan. Di samping itu, lima pakar yang biasa mengendalikan pengurusan kecacatan dan bekerja di bidang kejuruteraan perisian lebih daripada lima tahun, telah dipilih untuk memberi pendapat pakar. Keputusan keseluruhan menunjukkan bahawa pendekatan pengurusan kecacatan baru dan pemeriksaan mempunyai keupayaan yang sama untuk mencegah dan mengesan kecacatan masing-masing. Pendekatan pengurusan kecacatan baru kami dapat menghalang 28 peratus lebih daripada pendekatan pemeriksaan. Ini juga bermakna bahawa kedua-dua pendekatan pemeriksaan tradisional dan pendekatan baru melengkapi antara satu sama lain dengan cara yang kita boleh meningkatkan kualiti keperluan perisian dan mengurangkan kos penyelenggaraan pada masa akan datang.*

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# LIST OF ABBREVIATIONS

SRS – Software Requirement Specification

SRD – Software Requirement Document

IBM – The International Business Machines Corporation

HP – Hewlett-Packard Company

ODC – Orthogonal Defect Classification

SDLC – Software Development Life Cycle

SLR – Systematic Literature Review

# LIST OF PUBLICATIONS

1. Rosmadi, N.A., Ahmad, S., Asmai S.A. and N. Abdullah, 2017. Requirement Elicitation with Defect Prevention Approach. Journal of Next Generation Information Technology, vol8, no1.

2. Rosmadi, N.A., Ahmad, S. and Abdullah, N., 2015. The Relevance of Software Requirement Defect Management to Improve Requirements and Product Quality: A Systematic Literature Review. In Pattern Analysis, Intelligent Security and the Internet of Things. Springer, Cham. pp. 95-106.

3. Ahmad, S., Asmai, S.A. and Rosmadi, N.A., 2015. A Significant Study of Determining Software Requirements Defects: A Survey. In *14th International Conference on Applied Computer and Applied Computational Science (ACACOS'15)*. pp. 117-122.

# CHAPTER 1

# INTRODUCTION

This research introduces a prevention action to handle defects during the introduction of requirements statements among multiple stakeholders. The defects in the requirements stage if taken care early will improve the software quality and reduce unnecessary cost to remove the defects later in the system development life cycle. This research examines software requirements defect management effectiveness to improve the requirements quality by avoiding the introduction of defects. The evaluation of the effectiveness was done in two layers which are empirical investigation and experts' opinion. In addition, it elaborates the experimental process, explores defect management concepts in the early stages of requirement phase, introduces defects management approach and presents the benefits gained from the approach.

This chapter provides an overview of the problem of the requirement engineering practice and the need for defect management approach to handle requirements defects. The explanation of the defect management approach and its contribution will be elaborate more in this thesis. It concludes with an overview of the structure of the thesis.

## 1.1 Research Background

Software defects are usually referred to defects in the code of software product and they are mainly detected during the testing phase. This is the main reason why software maintenance usually incurred more cost than the development cost itself.

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In the requirements phase, the defects are usually detected during the requirements validation process and inspection technique is commonly used to detect and to remove the defects from the Software Requirements Specification (SRS) document. This traditional approach is a corrective action. On the other hand, this research is looking into a prevention action to manage the defects during the requirements elicitation process. In order to handle multiple stakeholders during the elicitation process, formal negotiation mechanism is embedded into the proposed defects management approach.

There are so many defect detection and defect prevention approaches have been propose by researchers. For example by multinational companies such as The International Business Machines Corporation (IBM) and Hewlett-Packard Company (HP). IBM approach is called Orthogonal Defect Classification (ODC). A defect is classified by the IBM was across the dimensions defect type, source, impact, trigger, phase found and severity (Chillarege, 1996). While for HP which is the approach quite similar to ODC is called Defect Origins, Types, and Modes (Grady, 1992). The description of the approach by HP was defined by their name itself. However, the previous ODC approach were not applicable for requirement phase (Margarido et. al., 2011). Different with the Defect Origins, Types and Modes that were suitable in requirements and specifications phase (Huber, 2000). Jon T. Huber (2000), stated that ODC were used throughout the product lifecycle while HP model used after development and testing is complete as part of the project retrospective.

Furthermore, Watt S. Humprey et al.(1989) suggested the industry to go for defect management at every stage of development to gain total confident with customers. Hence, defect management approaches can be categories into two categories which are defect detection and defect prevention. The defect detection identify defect and where it is comes from, while the defect prevention method will be used to minimize the

defects and preventing them from occurring in future (Watts, 1989). Studies by Suma V and Gopalakrishnan Nair T.R. (2009) shows that 50% to 60% of total defect originate at requirement phase, 15% to 30% at design phase and 10% to 20% of total defect originate at implementation phase (Suma and Gopalakrishnan, 2009). This shows that most of the defects are likely found during the requirement phase. Dealing with the stakeholders who are the domain experts, tacit knowledge are common threats which might cause miscommunication and eventually caused the development of the wrong system.

## 1.2 Requirement Engineering Process

Requirements are needed in order to describe what is to be done before the system is implemented (Davis, 1994). To gather the requirements, identify the correct requirements, modelling, communicating and documenting the requirements of the system are called requirement engineering (Paetsch et. al., 2003). Requirement engineering process is represented by four phases which is requirements elicitation, requirement analysis, requirement specification and requirement validation. This research aims to prevent and manage the defects early of the requirement engineering process. Therefore, we are looking into requirement elicitation process because this is the core process where the requirements started to be collected. Paetsch (2003) stated that there are various techniques used during the requirement elicitation process to get the requirements, such as interview, brainstorming, observation, focus group, prototyping and use case. Most of the techniques involved stakeholders who happen to be the domain experts and therefore, conflicts are inevitable. In order to reduce and to solve the problem that could happen due to conflicts between the stakeholders, we are embedding negotiation technique within the defect management approach during the requirements elicitation process.

### 1.2.1   Negotiation during the requirement elicitation process

Requirements elicitation process involving multiple stakeholders from different background knowledge can cause conflict. Conflicts may lead to issues which may content defects. The requirements defects can affect the subsequent phases in the development life cycle and eventually affecting the end products. Therefore, in order to handle conflicts which may cause defects from appearing at early stage of development process, we are embedding a negotiation technique. This is supported by Ross (1977) who recognised the needs of negotiation during the requirements definition that must embody multiple viewpoints from multiple stakeholders. Robinson (1990) mentioned that incorporating negotiation ideas into the design methods will lessen the problems such, conflict poor resolutions, the goals that possibly getting removed and good design that not rationalized.

## 1.3  Research Motivations

Defects are the major problems for everything. It is impossible to get zero defects while developing a system. However, it does not mean that the defects cannot be control or remove. This research motivates to solve the early stage problem with defect management approach in software requirement development process. In order to obtain the quality of products, the defect should be highlighted as early as possible and obtaining the solutions for every defects is compulsory. However, not every problem can be classified as defects as there are differences between defects, conflicts and issues in early stage of developments especially while gathering the requirements from stakeholders. Besides, the complication level will differ depending on the size of the project and the

number of stakeholders involve with the project. This research is driven to provide a mechanism to manage the defects early in order to improve the overall quality.

### 1.4  Research Objectives

The main purpose of this research is to introduce a new approach on how to manage software requirements defects to improve the quality of the software requirement process and products. The research is also aims to provide the following particular objectives.

1.  **To propose a new defects management approach in software requirement to improve software requirements quality.**

    This new defects management approach which embed a negotiation technique will be able to manage the defects early in order to improve the software quality and products.

2.   **To embed negotiation technique into the proposed approach to prevent the introduction of defects into software requirements documents.**

    Dealing with multiple stakeholders who have different perspectives and perceptions, conflicts are inevitable. Conflicts are usually due to miscommunications that lead to misunderstanding. However, miscommunication among multiple stakeholders can be prevented or at least the effect of it can be reduced. Conflicts among multiple stakeholders can be resolved through negotiation which usually involving two-ways communication that needed both parties to involve actively during the process. Some problems can be easily solved during the process and some of them needed further action from both parties to reach consensus.

3.  **To evaluate the effectiveness of defects management approach.**

The new approach should be able to minimise the risk of products failure and save the unnecessary cost to fix unforeseen defects later in the system development life cycle. The evaluation will also look into the specific quality attributes improvement.

The effectiveness of the new approach will be tested and the result will be analyses as if the approach reaches the target to improve the software quality or not. The experiment is conducted to ensure the effectiveness of approach.

## 1.5  Research Contributions

Since the management of requirements defects at this early stage is new and the result is valuable to the software development organization for a long run, the new improved approach is useful to be adopted for various sizes of software projects. It will produce sustainable quality software and therefore has lower maintenance cost in the future. Here are our research contributions:

1. A new approach for early software requirement defect management.
2. New requirements defects classification taxonomy for future references.
3. An empirical evidence to show the usefulness of the negotiation technique to assist in reducing the introduction of defects into the requirements statements.
4. An empirical evidence to show the effectiveness of the new approach to improve requirements quality.

## 1.6  Summary

Since several software defects are originated from requirement phase, we were motivated to improve the traditional requirements defects management technique with our approach. Our approach will provide the defects taxonomy for future references that may

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help in preventing the same defects from entering the software requirements specifications. Building a complex project involving multiple stakeholders with different perspectives and perceptions regarding their roles, may lead to mismatching goals and miscommunication among them. Through negotiation embedded within the approach, we provide empirical evidence to support our research objective which is to prevent the defects from entering the requirements phase.