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# Faculty of Information and Communication Technology

## PORElicit: A PAIR ORIENTED APPROACH FOR IMPROVING MULTI-LINGUAL REQUIREMENTS ELICITATION FOR REQUIREMENTS ENGINEERS

**Ow Li Lee**

**Master of Science in Information and Communication Technology**

**2016**

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# PORElicit: A PAIR ORIENTED APPROACH FOR IMPROVING MULTI-LINGUAL REQUIREMENTS ELICITATION FOR REQUIREMENTS ENGINEERS

**OW LI LEE**

**A thesis submitted**
**In fulfilment of the requirements for the degree of Master of Science**
**In Information and Communication Technology**

**Faculty of Information and Communication Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2016**

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## DECLARATION

I declare that this thesis entitle "PORElicit: A Pair Oriented Approach for Improving Multi-lingual Requirements Elicitation for Requirements Engineers" 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 : Ow Li Lee

Date :

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## APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Information and Communication Technology.

Signature :

Name : Dr Massila Kamalrudin

Date :

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**DEDICATION**

This thesis is dedicated to my parents and siblings:
"For their countless love, support and encouragement"

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## ABSTRACT

The rise of software project offshoring has resulted in the increased of usage of multi-lingual in software development activities including requirements elicitation. In Malaysia, code switching between Malay and English language has become a common practice in multi-lingual requirements elicitation which leads to miscommunication and misinterpretation between both requirements engineers and stakeholders, due to the language barriers. Motivated from this problem, this research proposes a Pair Oriented Requirements Elicitation approach (POREIicit), to improve the performance and the accuracy of multi-lingual requirements. We adopt the concept of pair which involves two requirements engineers, namely the elicitor and the reviewer in eliciting the multi-lingual requirements. Three studies were carried out in this research: 1) controlled experiments 2) surveys and 3) observations. The focus of these studies was to evaluate POREIicit approach in comparison to solo approach in term of its performance (time spent) and the accuracy of the multi-lingual requirements (requirements correctness). The other focus is on its usability which is based on user perception on its usability and satisfaction. Based on these studies, we found that POREIicit approach is able to provide better multi-lingual requirements with lesser effort in comparison to solo approach. Further, POREIicit approach is also able to improve the communication between the requirements engineers and the stakeholders. The collaboration between the requirements engineers in POREIicit approach also helps in validating the multi-lingual requirements at the early stage of requirements engineering activities.




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# ABSTRAK

Pembangunan sistem perisian dari sumber luar telah mewujudkan peningkatan penggunaan pelbagai bahasa termasuk dalam aktiviti pencungkilan keperluan pelbagai bahasa. Dalam hal ini, pertukaran kod antara Bahasa Melayu dan Bahasa Inggeris untuk pencungkilan keperluan pelbagai bahasa menjadi satu amalan biasa di Malaysia. Namun, halangan bahasa didapati menyebabkan salah faham dan salah tafsiran di antara dua keperluan jurutera dan pihak berkepentingan. Justeru itu, kajian ini mencadangkan pendekatan berorientasikan pasangan (POREliciT) untuk meningkatkan prestasi dan kualiti pencungkilan keperluan pelbagai bahasa. Kami mengamalkan konsep pasangan yang melibatkan dua keperluan jurutera, iaitu pencungkil dan penilai dalam pencungkilan keperluan multi-bahasa. Tiga kajian telah dijalankan termasuk i) kawalan eksperimen, ii) tinjauan, dan iii) pemerhatian. Fokus kajian ini adalah untuk menilai pendekatan POREliciT berkenaan dengan prestasi (usaha) dan kualiti (ketepatan keperluan). Fokus lain kajian ini adalah pada kebolehgunaan yang berdasarkan persepsi pengguna pada kegunaan dan atas pendekatan POREliciT. Keputusan kajian menunjukkan bahawa pendekatan POREliciT menghasilkan keperluan pelbagai bahasa yang lebih baik dengan usaha yang lebih kurang berbanding dengan pendekatan solo dalam pencungkilan keperluan pelbagai bahasa. Di samping itu, pendekatan POREliciT juga dapat menambahbaik komunikasi antara jurutera keperluan dan pihak yang berkepentingan. Kerjasama antara jurutera keperluan dalam pendekatan POREliciT juga membantu dalam pengesahan keperluan pelbagai bahasa di peringkat awal aktiviti kejuruteraan keperluan.



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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| RE | - | Requirements Engineering |



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## LIST OF RELATED PUBLICATIONS

| No. | Publications | Related Chapter |
|---|---|---|
| | **Journal (3)** | |
| 1. | Science International Lahore Journal:<br>Lee, O.L., Kamalrudin, M., Sidek, S., Sakinah, S., Ahmad, S., et al., 2014. ELICITING MULTI-LINGUAL REQUIREMENTS : TRENDS & CHALLENGES. , 2014(October), pp.15–16. | 2 |
| 2. | International Journal of Applied Engineering Research:<br>Lee, O.L., Kamalrudin, M., Sidek, S., 2015. PAIR IN SOFTWARE REQUIREMENTS ENGINEERING: A REVIEW. , 2015(July). | 2 |
| 3. | IEEE Transaction of Software Engineering:<br>Lee, O.L., Kamalrudin, M., Sidek, S., 2015. PORElicit: A PAIR ORIENTED APPROACH FOR IMPROVING MULTI-LINGUAL REQUIREMENTS ELICITATION. , 2015(October) Submitted. | 2, 3, 4 & 5 |



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# CHAPTER 1

# INTRODUCTION

This research aims to propose an approach that facilitates the elicitation of multi-lingual requirements between requirement engineers. The research was motivated by the increasing usages of multi languages in requirements elicitation which have affected the quality of requirements elicitation between requirement engineers due to language barriers.

In this chapter, we begin with the background regarding the phenomenon of globalization that always involves with multi-lingual requirements in regard to software project development. Furthermore, we define our research scope, research questions and research objectives based on our research motivations. The research contributions are mentioned prior to this research. This last section is this chapter shows the outline of our thesis.

## 1.1 Background

Requirements elicitation is an essential activity in requirements engineering and is found to be a human-centered activity whereby intensive communication, collaboration, cooperative and negotiation between relevant stakeholders are required. Additionally, the quality of requirements elicitation reflects on how requirements engineers perceived and understand on the requirement discussion with stakeholders. However, it has been considered as the most challenging and error-prone task since problems such as miscommunication, difficulty in articulating their needs, lack of sharing mutual understanding and poor requirements quality (Zowghi & Coulin 2005)(Firesmith 2007)

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may occur any time during Software Development Life Cycle. In this context, it is crucial to ensure correct requirements elicitation as errors in the requirements elicitation may result in the development of poor quality software. Most importantly, requirements elicitation has been recognized as the major contributor to system failure.

Within the present era of globalization, requirements elicitation becomes more challenging as it involves the use of multiple languages. For example, it has been reported that stakeholders and requirements engineers often suffer from communication issues (Bhat et al. 2006)(Coughlan & Macredie 2014)(Lopez et al. 2009)(Lee et al. 2014)(Pa & Zin 2011) since both parties speak different native language besides English language during requirements elicitation activity. The communication issue derived from the activity of multi-lingual requirements elicitation between stakeholders often results in poor quality of multi-lingual requirements (Lee et al. 2014), including ambiguity, inconsistency, incompleteness and incorrectness, as language is considered as the point of tension. Moreover, multi-lingual requirements elicitation always requires the requirements documents to be tailored in more than one language. Requirements elicitation also becomes more critical when translation needs to be done from time to time by the requirements engineer individually (Abufardeh & Magel n.d.).

In the context of Malaysian software industry, both English and Malay languages are widely adopted in eliciting requirements and preparing requirements documents. It has been a common practice wherein English language is used in the private sector, while Malay language is used for official purposes by the government sector. In this respect, code switching between English and Malay language has become a common practice in the software development as there is a mixture or multi of languages used (Kamalrudin, Sidek & Yusop 2014). The practice of code switching often results in miscommunication due to



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language barrier which consequently leads to requirements inconsistency, incomplete and ambiguities (Damian & Lanubile 2003).

In addition, we also found that the approaches adopted by requirements engineers for multi-lingual requirements elicitation activity are similar as the traditional style of requirements elicitation techniques such as document analysis, brainstorming, interview, observation, survey and expert reference. Up to now, approaches designed for multi-lingual requirements elicitation in practice have been non-existing. Besides, multi-lingual requirements elicitation activity is usually an individual work instead of collaborative work in order to reduce overhead cost. It is a common practice for the project manager to assign a requirements engineer to elicit requirements directly from the stakeholders. An individual work often lack in discussion and it is not possible to conduct review among requirements engineers to confirm the quality of the requirements. Apart from the identified approaches, we also found several challenges faced by the requirements engineers in multi-lingual requirements elicitation, such as language barrier, requirements inconsistency and incompleteness as well as the lack of time and resources. Further, among all of these challenges, language barrier was found to be the most challenging factor (Lee et al. 2014).

In order to overcome the issues found from our preliminary study, we believe that collaboration between requirements engineers and validation are crucial to confirm the quality of the multi-lingual requirements. Hence, we design and propose a pair oriented approach to improve the multi-lingual requirements elicitation, named POREIicit, emphasized on collaboration between requirements engineers. We explore the way in which POREIicit approach improves the process of multi-lingual requirements elicitation, particularly in the context of performance (in term of time spent), quality of the requirements (in terms of requirements correctness) and usability (in terms participants



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satisfaction) through controlled experiments, surveys and observations adopting of PORElicit approach in multi-lingual requirements elicitation.

The following two sections describe multi-lingual requirements and the activities involved in multi-lingual requirements.

## 1.2 Research Scope

In this research, we investigated the challenges faced by requirements engineers in handling multi-lingual requirements, the state of the art of tools or approaches to handle multi-lingual requirements and state of practice of collaboration or similar concept in requirements engineering activities. Based on the problems statements stated, we propose an approach for requirements engineers to overcome the challenges faced in multi-lingual requirements elicitation. The focus of our proposed approach is at the early stage of multi-lingual requirements engineering activities. Specifically, we focus on the multi-lingual requirements elicitation, particularly the communication between requirements engineers in multi-lingual requirements elicitation.

## 1.3 Research Motivation

This research aims to address the difficulties faced between requirement engineers derived from multi-language requirements that have the potential to affect the quality of software development. Within the context of borderless world, communication often involves different languages among requirements engineers despite of the variety of different culture background. Communication is found to be even harder and inefficient due to the multi languages used in their discussion for requirements. Information is often



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partially delivered or misinterpret based on their limited proficiency in foreign language. The communication barrier is hence imposing a formidable challenge to achieve the same level of understanding among the requirements engineers. Poor communication is highlighted as one of the obstacles that hinder the user's needs in multi-lingual requirements elicitation. The subsequent effects of poor multi-lingual requirements elicitation regularly include costly rebuild, budget and schedule overruns and project failure. Based on the communication issues in multi-lingual requirements elicitation and the lack of approaches designed for multi-lingual requirements elicitation, this results in a significant gap for proposing an approach for multi-lingual requirements elicitation.

Further, collaboration is not emphasized in requirements elicitation as it incurs more cost to the project development. As a norm, industry commonly assigns the requirements elicitation task to just one requirements engineer to reduce the overhead cost. The requirements engineer has the full responsibility on the requirements for project development. The requirements engineer is the only person to be found familiar to the requirements captured from the stakeholders. Less discussion is found among requirements engineers as there is no one else familiar with the requirements delivered from the stakeholders. This situation exacerbates when the sole requirements engineer conduct the multi-lingual requirements elicitation in a wrong way. It is found that a better communication is positively correlated with collaboration due to the existence of discussion among the stakeholders. Discussion is proven to stimulate and encourage the group to have a richer overview towards the requirements (Farinha & Mira da Silva 2012). In addition, verification on requirements quality (Firesmith 2007) is found to be inadequate. In addition, most of the requirements were not formally or sufficiently verified early in the development process. This is because review and verification on requirements



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during multi-lingual requirements elicitation should be emphasized for early requirements defects discovery.

In summary, based on all of these issues and problems, we are motivated to develop and propose a new pair-oriented approach for multi-lingual requirements elicitation for requirements engineers, named as POREIicit. This research is aimed to improve multi-lingual requirements elicitation between requirements engineers in terms of performance of requirements elicitation, the accuracy of the requirements and the usability of the proposed approach. This research is also motivated by the two main findings: one is derived from the preliminary readings as presented in section 1.1.3 and the other is from our preliminary study presented in the next chapter.

## 1.4 Research Questions

We believe that the adoption of POREIicit approach in multi-lingual requirements elicitation between requirements engineers in comparison to solo approach can improve the performance in terms of time spent, requirements accuracy in terms of correctness. Further it also could enhance the usability in term of its satisfaction in eliciting multi-lingual requirements. Hence, the two main research questions of this research are formulated.

The first main research question is: "Does POREIicit approach perform better than solo approach in multi-lingual requirements elicitation?" Further, the first research question mentioned is addressed by the following sub-research questions:

1. Can the POREIicit approach help to improve the quality of the requirements in comparison to solo approach?



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This question focuses on the assertion that the adoption of POREIicit approach in the multi-lingual elicitation can produce better requirements accuracy than the solo approach. In this respect, two hypotheses were formulated and two controlled experiments were conducted to test the hypotheses. The accuracy of the requirements is the criteria to determine whether the quality of the requirements is improved by adopting our proposed POREIicit approach.

2. Can the POREIicit approach help in improving the performance of multi-lingual requirements elicitation in comparison to solo approach?

This question focuses on the assertion that the adoption of POREIicit approach in the multi-lingual elicitation can improve the performance of participants by reducing the time spent in comparison to the solo approach. In this respect, another two hypotheses were formulated and two controlled experiments were conducted to test the hypotheses. The time spent during multi-lingual requirements elicitation is the criteria to determine whether the performance of the multi-lingual requirements elicitation is improved by adopting our proposed POREIicit approach.

In addition, the second research question addresses "Does POREIicit approach usable and able to improve the communication in multi-lingual requirements elicitation?" The second research question mentioned is addressed by the following sub-research questions:

3. Is POREIicit approach usable for multi-lingual requirements elicitation?



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