

# Requirements Engineering Problems and Practices in Software Companies: An Industrial Survey

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**Abstract.** This paper presents about a study conducted to investigate the current state of Requirements Engineering (RE) problems and practices amongst the software development companies in Malaysia. The main objective of the study is to determine areas in RE process that should be addressed in future research in order to improve the process. Information required for the study was obtained through a survey, questionnaires distributed to project managers and software developers who are working at various software development companies in the country. Results show that software companies in this study are still facing great challenges in getting their requirements right due to organizational and technical factors. Also, we found out that high-maturity ratings do not generally correlate better performance and do not indicate effective, high-maturity practices especially to the RE practices. The findings imply that we must consider both human and technical problems, with extra care should be given to the technical issues and all the RE practices in our future research which is to re-build a specialized RE process improvement model.

**Keywords:** Requirements Engineering (RE), RE problems, RE state-of-the-practice.

## 1 Introduction

System and software development projects have been plagued with problems since the 1960s [1]. Since then, Requirements Engineering (RE) has become one of the central research topics in the field of software engineering. Although progress in RE has been painfully slow with software development projects continue to experienced problems associated with RE [2], research effort in the area continues to be done. These research are mainly motivated by the list of advantages expected to be brought about by the successful implementation of an improved RE process. Review made on recent related literatures discovered at least two research that study the state of RE problems experienced by organizations in different parts of the world. The first research by Sarah Beecham et al. [3],[4] studied the RE problems in twelve software

companies in UK. Their main findings suggest that most of the requirements problems experienced in the companies in their study were organizational. Also, results of the study suggested that the higher the maturity level of the company the less frequent are the requirements problems. The second research performed similar study covering eleven Australian software companies [5]. In this study, however, it concluded that while companies with immature RE process experience technical problems; companies with mature RE process cited more organizational problems. We also uncover several field surveys of RE practices. RE practices, especially those good ones, can “either reduces the cost of the development project or increases the quality of the resulting project when used in specific situation” [6]. Research that study the state of RE practice include those in [7],[8],[9],[10]. However, relationships between company’s maturity and RE practices are not shown in the research.

Since most of these existing surveys results, which focus at identifying either the RE problems or practices to improve RE process, may not be appropriate to generalize from such a relatively small samples used, it is obviously useful to conduct similar studies, in other part of the world. The new study, however, must be designed carefully to guaranty its highest representativeness. Furthermore, the situation in Malaysia is not quite known as there are not any research done thus far to study both the current state of the RE problems and RE practices in this country. Motivated mainly by the work done by [3],[5], we performed a similar study in Malaysia. The main objective of the study is to determine areas in RE process that should be addressed in order to improve the process.

In the next three sections, the materials and data collection method, the results on valid responses, and the analyses performed to interpret the results of the study are explained.

## **2 Data Gathering**

We used mailed, self-administered questionnaires as our main approach to investigate those RE problems and practices. Questionnaires entitled “A Survey to Investigate the Current Requirements Engineering (RE) Practices and Problems amongst the Software Companies in Malaysia” were distributed to practitioners working at various software development companies in Malaysia. Practitioners in our study refer to project managers and software developers as suggested in [3]. Self-administered questionnaires are chosen mainly because of their suitability to cater our target population, i.e. practitioners who are working at various software development companies located throughout the country, in line with the recommendation made in [11].

### **2.1 Questionnaire Design**

The questionnaire was organized into four main sections: section A, section B, section C and section D. Section A has two parts: part 1 and part 2. Part 1 contains questions that ask for the company profiles of our respondents whilst part 2 contains question that find out the background information of the respondents. Section B contains a list of project problems, organizational and technical RE related problems. Section C

aims to find out the respondents' RE practices in a software development project that they have taken part recently. This section lists 82 RE practices which are grouped into 9 key practices: requirements document, requirement elicitation, requirements analysis and negotiation, describing requirements, requirements modeling, requirements verification and validation, requirements management, and other practices. The practices mainly were gathered from literature such as [1], [2], [3], [5], [12], [13].

## 2.2 Population Determination

In this study, a software development company is defined, following definition by Sison et al.[14], as "a for-profit organization whose main business is the development of software for customers external to the organization. Excluded in this definition is IT departments that cater primarily to the needs of the organization of which they are part". Our main source of information to estimate the number of software development companies in Malaysia is the Multimedia Super Corridor (MSC) portal [15] where a list of Information and Communication (ICT) related companies awarded the MSC Malaysia status is publicly available. This portal is considered the most reliable source of information in estimating the number of software development companies in Malaysia and referred by a number of research such as [16],[17],[18],[19]. Based on the company information in the portal, the population of our study is 1193 and we randomly selected 500 of the software development companies.

## 2.3 Data Collection

Prior to posting the questionnaires, pilot studies were conducted to assess respondents' level of understanding, level of difficulty in responding and level of relevance to subject area. We also used the pilot studies to assess the level of time commitment required to complete the questionnaire which was estimated to be 30 minutes. The pilot studies involved five software development companies which were chosen from a convenience sampling. Changes were made to the questionnaires as results of the feedback received.

This survey data was collected through February and March 2008. A total of 113 responses were received, making up 23% response rate. However, only 64 responses are complete and considered valid for analysis. Most are excluded mainly due to incomplete answers. Despite the low valid response rate (13%), we decided to proceed with analyzing the responses. According to Lethbridge et al. [11], a low response rate of about 5% would already be sufficient for an exploratory study of this kind. Furthermore, the 13% response rate is consistent with the exploratory study done in [14] on software practices in five ASEAN countries (Malaysia, Philippines, Singapore, Thailand and Vietnam) reported in 2006.

## 3 Results

In the following sections, we present the analyses performed on the information gathered from 64 valid responses.

### 3.1 Demographic of Respondents

The survey participants include 73.4% companies which are “100% locally owned” type of company. Interestingly, about half of these companies (54.7%) employed less than 19 IT staffs only. About 18.8% (12) companies are appraised with various levels of the Software Engineering Institute’s Capability Maturity Model Integration (CMMI) and 6 (6.25%) companies in the survey are currently in the process of getting the CMMI-DEV appraisals. About one third of the respondents are project managers (35.9%) and another one third (37.6%) are business analyst, software engineer, and consultant. The remaining 26.5% respondents who chose “Others” range from senior software process engineer to high-level managers. The respondents’ experiences in handling RE are mainly between 1 to 5 years (45.3%) and some have had been handling RE between 5 to 10 years (40.6%).

### 3.2 Size of RE Problems

Following classification by [3], [4], we classify problems experienced related to RE into two: organizational-based and RE process-based. Research conducted by [1], [3] show that 63% of RE problems can be attributed to organizational factors that are external to the RE process where almost all organizational-based RE problems are human-based. Our results show that 60% of RE problems experienced by the companies in our study can be attributed to factors inherent within the RE process rather than to factors external to the RE process. This suggests an opposite pattern in term of RE problems experienced by companies in Malaysia and companies in the study by [3], [4]. Our results also show that organizational issues contributing to the RE problems are quite diverse, similar in data collected by [1], [3]. However, our data suggested a few problems have different pattern of supportive response. Also, the results suggests that about half of the problems can be contributed by lack of customer and user communication problem, lack of developer communication problem, and poor time and resources allocations issues. We also discovered that almost 60% RE process-based problems are related to changing requirements, incomplete requirements, ambiguous requirements and poor user understanding.

### 3.3 RE Problems Pattern and Company Maturity

A finer grained analysis was done to view the relationship between these problems and the maturity level of the companies. Unlike the study in [3] that performed self-assessment activity to the companies’ maturity prior execution of the focus groups, we based our study only on the formal CMMI appraisal. For analysis purpose, we did a two-by-two cross tabulation between the CMMI appraised companies and the RE problems. Then, we performed the Fisher’s exact test [20] to see the significant difference between these two types of companies. As shown in Table 1, the resulting p-values, greater than 0.05 for all the RE problems excluding Item 2.12, indicate there is no statistical difference (at the  $\alpha = 0.05$  level) in the critical and supportive responses between these companies. For Item 2.12, the p value 0.048 indicates there is statistical difference in the critical and supportive responses between the two types of companies. We suspect that this is related to the companies having been formally appraised at various CMMI maturity levels. It is likely that the appraisal process has made everyone very aware of the companies’ state of RE processes.

**Table 1.** The p-values of RE problems

RE problem	Fisher's exact test Exact Sig (2-sided)
<i>Organizational-based:</i>	
2.4 Lack of customer and user communication	1.000
2.5 Lack of developer communication	0.117
2.6 Lack of training	1.000
2.7 Inappropriate skills	0.531
2.8 Lack of defined responsibility	0.537
2.9 Unstable workforce (low staff retention)	0.754
2.10 Poor time and resource allocations	0.750
<i>RE process-based:</i>	
2.11 Complexity of application	0.345
2.12 Undefined RE process	0.048
2.13 the actual requirements	0.514
2.14 Poor user understanding	0.484
2.15 Incomplete requirements	1.000
2.16 Inconsistent (changing) requirements	0.381
2.17 Inadequate requirements traceability	0.308
2.18 Ambiguous requirements	0.715

## 4 Top-Ten RE Practices

As described in subsection 2.1, section C of the questionnaire aimed at obtaining information on the current RE practices of the practitioners via the list of 82 items. According to Sommerville and Sawyer [12], there are ten basic practices which are so important that they should be implemented on all organisations at any level of RE process maturity. In our study, we do not measure any RE process maturity level of the companies involved. In the following paragraphs we performed analysis limited to these ten practices.

In section C of the questionnaire, the respondents were required to rate each RE practices according to a different 4-point measurement scales (0 = never, 1 = used at discretion of project manager, 2 = normal used, 3 = standardized). The points of the ten practices by each company in the survey were then calculated based on the score of the four types of the REAIMS assessments [12]. From Fig. 1(a), we can see the typical points obtained by the companies in the study is somewhere between 14.73 and 25.7. Furthermore, we can see that half of the companies score 21 points or less, the most common score is 22 and the range is from 8 to 30 points. We performed a detail analysis of the points scored by two types of companies in the study: companies appraised with CMMI and companies without CMMI appraisal as shown in Fig. 1(b). From Fig. 1(b), we can see that these different groups of companies scored quite differently except the maximum score points. Interestingly, even though typical companies appraised with CMMI score higher points (between 21.18 and 29.32, with most common companies of this kind score full points 30) in the ten practices, these

Statistics			Statistics			
			Points: Companies appraised with CMMI		Companies without CMMI appraisal	
Points			N	Valid	12	51
N	Valid	63		Missing	0	1
	Missing	1	Mean		25.2500	20.7059
Mean		20.4286	Median		25.5000	21.0000
Median		21.0000	Mode		30.00	22.00
Mode		22.00	Std. Deviation		4.07040	5.54001
Std. Deviation		5.70714	Minimum		19.00	9.00
Minimum		8.00	Maximum		30.00	30.00
Maximum		30.00				

(a)

(b)

**Fig. 1.** (a) Points scored (b) Points scored for companies with and without CMMI appraisal

companies still experienced almost all the RE problems as described in the subsection 3.3 and other general project problems as discussed in [23].

## 5 Discussion

Results in our study show that the pattern of RE problems experienced by software development companies in Malaysia is similar to the findings reported in [5]. However, the result is the opposite from the results reported in [3], [4]. Our results suggest that RE problems experienced by the companies in our study can be attributed more to factors inherent within the RE process rather than to factors external to the RE process. This means problems, such as changing requirements, incomplete requirements, ambiguous requirements, and poor user understanding, are still the challenges faced by the software development companies apart from the common human-based organizational problems. One possible explanation for this pattern probably is because of the ability to adapt to increasingly rapid and unpredictable change is still one of the challenges facing 21st-century organizations as mentioned by Boehm in [21]. These findings imply that we must consider both human and technical problems, with extra care should be given to the technical issues, in re-building a specialized RE process improvement model which is discussed in [22].

Our results also suggest that statistically there is no difference in the RE problems faced by companies appraised with the CMMI and companies without the CMMI appraisal. It is not surprising for the companies without the CMMI appraisal. Points scored for the ten practices indicate that the RE practices are not widely followed. However, it is exciting to know that companies which claimed that they widely followed and checked, at least, the ten practices as part of the companies' quality management process, still experience almost all the RE problems as discussed in the subsection 3.3 and other general project problems in [23]. This finding shows another confirm case where high-maturity ratings do not indicate effective, high-maturity practices as in [24]. However, as further explained by Humphrey in [24], "it is not the

appraisal process is faulty or that organizations are dishonest, merely that the maturity framework does not look deeply enough into all organizational practices". This provides justification and motivation to the work described in [22].

## 6 Conclusion

In this paper, the results of a study done on investigating the current state of RE problems and practices amongst Malaysian practitioners are presented. The study was accomplished through mailed, self-administered questionnaires distributed to 500 sampled software development companies throughout the country. Despite the low response rate (13%) for the complete and valid responses, we decided to proceed with the data analysis. Analyses performed to the valid responses received are then compared with findings from similar studies reported in [3], [4], [5]. Although not all the RE problems patterns in this study are the same, they still indicate that software companies are currently facing great challenges in getting their requirements right due to organizational and technical factors. Also, we found out that high-maturity ratings do not generally correlate better performance and do not indicate effective, high-maturity practices especially to the RE practices. These findings provide justification and right direction to work on enhancing and improving a specialized RE process improvement framework called R-CMM [25] as described in [22] by looking more deeply into all the RE practices.

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