An Exploratory Study of Requirements Engineering Practices in Indonesia – Part 1: Concepts and Problems

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Abstract. This paper provides the first part of statistical research findings of an exploratory study of the requirements engineering practices implemented in software development processes in Indonesia. This first part attempts to reveal facts regarding concepts and problems exist in such requirements engineering practices. We developed a comprehensive online questionnaire consisting of both closed- and open-ended questions in order to capture such facts. We invited 158 participant candidates representing industry and higher education institutions, however, 31 of them joined our web-based survey. Results show that most of participants confirm that requirements engineering must be properly performed in order to clearly define the valid product. They, however, encounter some difficulties in implementing requirements engineering concepts in practice due to a tight schedule, inappropriate skill of the analysts and inadequate tools used.

1   Introduction

Requirements engineering (RE) becomes a critical phase in a software development life cycle. It attempts to produce high quality software requirements specification documents, both software requirements (SRS-Software Requirements Specification) and interface requirements (IRS-Interface Requirements Specification). Both functional and nonfunctional requirements of a software system are completely described in a SRS document. Such valid and accurate specifications will be an important basis in designing a software that will be implemented using a certain programming language. In contrast, invalid and inaccurate software specifications will have a serious impact on such development which may produce a fail product. This has been an important problem in a software project since 1970s [1].

Theoretically, improvements to the RE process will have potential impacts on reducing costs and time, as well as improving the quality of the software product itself. Researchers have been performing many improvements to the process, techniques and methods in order to conduct RE in a better manner (e.g. [2] [3] [4] [5]). There, however, are still many software project failures caused due to poor process in defining what kind of system to be built. A study performed by the Standish Group in 2015 (based on 50 thousand projects throughout the world) showed that the failure rate of software projects was 71% (consisted of 52% partial failures and 19% total failures) and 29% success rate [6]. In addition, it was found

that client involvement and support from executives contributed significantly to the success of the project [6]. This study confirms that the role of RE is very important in order to determine the software system requirements based on information gathered from the clients.

There exist a few number of exploratory studies dealing with the RE practices in the software development (e.g. [7] [8] [9] [10]). Further, this study becomes more important as there is no such study in Indonesian software development. This research attempts to conduct an exploratory study of RE practices in software development in Indonesia by conducting an online survey. More specifically, this study aims to find out the following concerns in RE practice: (a) RE concepts understanding; (b) problems which are encountered; (c) efforts, processes and techniques which are used. We distributed a questionnairy to the selected agencies, both from industry and higher education, that are directly related to the software development processs. In addition, we conducted a limited focus group discussion with a software industry in Indonesia. Due to limited space, we, however, present the survey findings of the first two concerns in this paper (Part 1) and let the rest concern be discussed in the other paper (Part 2).

The rest of this paper is structured as follows. Section 2 briefly discusses the related works on survey of RE practices in software development. Section 3 presents research methodology including survey preparation, data collection and limitations. In Section 4, we describe the results of the survey. We discuss all findings in Section 5. Finally, Section 6 presents the conclusion and future work of this survey.

2   Related Work

There is a number of researches in evaluating requirements engineering practices in software industries. Sadraei *et al.* [7] conducted an exploration of qualitative and quantitative data using semi-structured interview and questionnaire to find out the workload distribution and requirement engineering activity in Australian software industry. The results show that the project characteristic has an effect on workload distribution and there is a tradeoff on distributing workload in the series of requirement engineering activity. Juristo *et al.* [8] performed a RE survey using 150 practitioners from several industries in Europe. This research confirms that the RE is practically used and some problems appear in the RE process. However, the industries had not found a way to work on these RE problems yet. Karlson *et al.* [9] took a qualitative research using semi-structured interview with 14 workers from 8 software companies in Sweden. This research attempted to find out challenges in RE practiced in market-driven software development. Aranda *et al.* [11] explored RE practices in small business in Toronto, Kanada. This research shows that there is a variance of RE implementation characteristic between small and large businesses. Liu *et al.* [10] investigated the RE application and effect of society culture in software industry in China by surveying 149 practitioners from 97 companies and 15 research institutes. The results show that there exist various RE implementations in software companies, and the social culture has significant effects on RE processes in China. The advanced settings [12] of this research was performed by involving 400 experts with various levels and actions.

3   Research Methodology

3.1   Survey Preparation

A survey is a systematic approach for collecting data from a sample of entities in order to contruct quantitative description of the bigger population of such entities [13]. This can be performed by asking people structured and predefined questions [14]. This study used an online questionnaire as the most common field study method [15]. We attempted to collect RE concepts understanding, problems which are encountered, as well as RE practices (i.e. efforts, processes and techniques) which are applied in software developments in Indonesia.

We developed a comprehensive online questionnaire consisting of 40 questions grouped as follows: participants profiles (4 items), organization profiles (10 items), RE concepts understanding profiles (7 items), RE practices profiles (12 items), and problems profiles (7 items). For objective purposes, we put questions related to participants and organization profiles at the end of the questionnaire [16]. In general, the questionnaire consisted of closed-ended questions with a set of descriptive particular answers per question. Some of them, however, were added with an 'Other' answer option followed by a written description allowing respondents to express their own answer. In particular, we provided the closed-ended questions for gathering the problem profiles with 5-point Likert scale to measure how often a problem in question happened. In such setting, each respondent indicated a range of 'Very often' to 'Never' which were then converted to a score on a scale from 1–5. Further, we provided an additional open-ended question to capture other problems a respondent encountered in practice.

In regard participants profiles, we asked them about their technical role, work experience in software development, field of formal education and education level. We also asked participants about their organization profiles: operational time, line of business, number of employees, major domain of application, application product type. Additional questions to this type included headquarters location, services scope, software developer size, project value per annum. The participants were asked about their RE concepts understanding profiles including understanding level, knowledge source, urgency of RE, responsible role in RE, RE objectives, urgency of specification document. Questions related to RE practices profiles were project activities distribution, RE efforts, software analyst role, specification document availability, type and standard, RE competency improvement, RE methods, elicitation techniques, documentation tool, requirements representation and modeling tool. According to problems profiles, the participants were asked about requirements pre- and post-traceability, user involvement, requirements volatile, lack of specification document, inappropriate tool used, as well as an.

Feedback, from a selected software company to improve the questions, was also taken into account to evaluate the preliminary draft of the survey. Initially, we also invited some software engineering experts to examine such draft, however, none responded. As such, we reviewed such a draft by our own approach.

3.2   Data Collection and Elaboration

The questionnaire was available online through a commercial survey software, i.e. SurveyMonkey[1], for a period of one month during August to September 2018. Prior to joining such online questionnaire, the participant candidates were contacted via

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[1] https://www.surveymonkey.com/

email for confirmation. Initially, we listed 159 software companies and 20 higher education institutions based on our assessment to their information (i.e. url, email, location, line of business) provided on their respective websites. Based on such list, we had 138 software companies and 20 higher education institutions committed via email to provide a relevant person to join the survey. Then, we personally sent emails to 158 persons for joining our survey through the given url. We defined such samples using a non-probabilistic approach since the target population was very specific and they were chosen based on their availability [17].

After 1-month surveying period, a total of 31 participants responded by joining our online questionnaire, while complete information were provided by 30 participants. It means that feedback rate of this study was approximately 19.6%. As this online survey was designed under non-probabilistic sampling and governed based on the incentive-free participation approach, such feedback rate was taken into account as a reasonable result. Further, we arranged a focus group discussion with a selected software company for elaborating the survey data.

The internal consistency of the questionnaire was tested using Cronbach Alpha assessment. This test was only carried out for the relevant questions in which scoring answer provided, i.e. problem profiles. Our Cronbach Alpha was 0.8 which was higher than minimal Cronbach Alpha 0.6 in exploratory research. It indicated our questionnaire was reliable.

3.3   Limitations

This survey successfully addressed our research questions by inviting a number of participants representing software companies and higher education institutions in Indonesia. We, however, need to explicitly state the limitations of this survey. First, the sample of this study was selected from software companies and higher education insititutions in which their organization size were classified as large, medium and small based on our own assessment according to the information provided on their website, respectively. It may contribute bias in selecting the sample of the survey. Secondly, each participant, who joined this survey, were recommended by the organization without any selection based on our certain criteria. This may not lead to a suitable person who has requirements engineering background.

4   Research Findings

4.1   Participants Profiles

The following information describe the backgrounds related to persons joining the survey. Concerning the technical role of the participants, as shown in Table 1, the majority of the participants (23.33%) works as general manager. Other technical roles with a significant number of responses are: software programmer (16.67%) and software designer (13.33%). There, however, exist an interesting fact in which 30% of the participants select the other option to write their own role specifications. In term of work experience (Table 2), most participants (36.67%) have more than 10 years, while 33.33% of participants have 5-10 years. It means most of the participants is characterized as professionals, permanent employment relationship.

Table 1. Participants technical role

Technical roles	Participants (%)
General manager	23.33
Software programmer	16.67
Software designer	13.33
IT manager	10.00
Project manager	6.67
Software quality engineer	3.33
Software analyst	3.30
Other	30.00

Table 2. Participants work experience in software development

Work experience (years)	Participants (%)
0-2	13.33
2-5	16.67
5-10	33.33
> 10	36.67

Concerning the field of formal education (Table 3), the majority of the participants (36.67%) holds informatics engineering background. While, the other participants hold computer engineering (13.33%) and information system (13.33%). In term of the educational level (Table 4), the study indicates that 66.67 % of participants hold bachelor honours degree, while 26.67% hold master degree.

Table 3. Participants field of formal education

Field of formal education	Participants (%)
Informatics engineering	36.67
Computer engineering	13.33
Information system	13.33
Software engineering	10.00
Business and management	10.00
Electrical engineering	3.33
Mathematic and natural science	3.33
Economic	0.00
Other	10.00

Table 4. Participants education level

Education level	Participants (%)
Doctoral degree	0.00
Master degree	26.67
Bachelor honours degree	66.67
Associate degree	0.00
Senior high school	6.67
Other	0.00

4.2 Organization Profiles

This sub-section presents information related to the organization of the participants. In regard line of business (Table 5), most organization of the participants (83.33%) are from information technology or software business area. Concerning the major domain of application (Table 6), the majority of the organizations developes business applications (53.33%). Concerning the product type (Table 7), most organizations produce customized products (43.33%).

Table 5. Organization line of business

Line of business	Participants (%)
Information technology or software	83.33
Education	13.33
Banking	9.00
Manufacture	0.00
Telecommunication	0.00
Health	0.00
Other	3.33

Table 6. Organization major domain of developed application (multi-selections)

Major domain	Participants (%)
Business	53.33
Education	40.00
Government	30.00
Management	26.67
Banking	23.33
Manufacture	16.67
Telecommunication	13.33
Health	10.00
Insurance	3.33
Defense	0.00
Other	33.33

Table 7. Organization application product type

Major domain	Participants (%)
Customized product	43.33
Customized and generic product	36.67
Generic product	20.00
Other	3.33

In term of operational time (0), we have interesting facts that most of the organizations are categorized as startup company, i.e. operational time around 0-10 years. Concerning the number of employees (Table 9), the top two options with the larger number of responses are: 11-20 employees (30%), 21-50 employees (23.33%). That is to say, the findings of this survey stem mainly from participants who work for small- and medium-sized enterprises.

Table 8. Organization operational time

Operational time (years)	Participants (%)
0-5	33.33
5-10	26.67
10-15	6.67
> 15	33.33

Table 9. Number of employess in the organization

Number of employees (persons)	Participants (%)
1-5	10.00
6-10	6.67
11-20	30.00
21-50	23.33
51-100	10.00
101-250	0.00
251-500	6.67
> 500	13.33

4.3   RE Concepts Findings

The following information depict facts related to RE concepts understanding of the participants. Concerning the understanding level (Table 10), the majority of participants (74.19%) understands RE concept and its applicability in the software development. While, Table 11 confirms that most of the participants get their RE concepts from their formal course (50%).

Table 10. Understanding level of RE concepts

Understanding level	Participants (%)
Understand concept, and applicable	74.19
Understand concept, but not applicable	12.90
Know concept, but do not understand	9.68
Do not know at all	3.23
Other	0.00

Table 11. Knowledge source of RE concepts

Knowledge source	Participants (%)
Formal course	50.00
Self-learning	30.00
Organization-funded training	13.33
Self-funded training	3.33
Other	3.33

In regard the urgency of RE in a software project (Fig. 1), the majority of the participants (more than 80%) confirms that RE is very important to be implemented. Concerning the responsible role for performing RE (Fig. 2), software analyst (more than 85%) and project manager (more than 65%) are top two roles which are responsible. This fact comes from a question in which the participants were allowed to select more than one option.
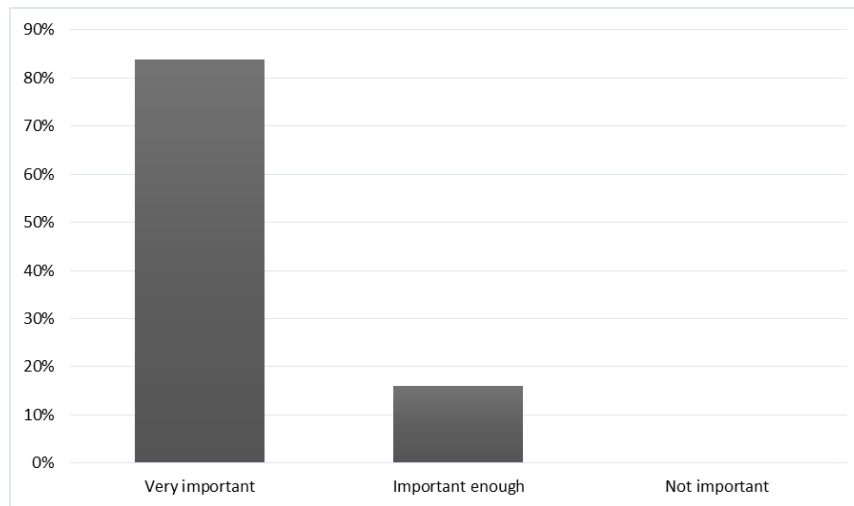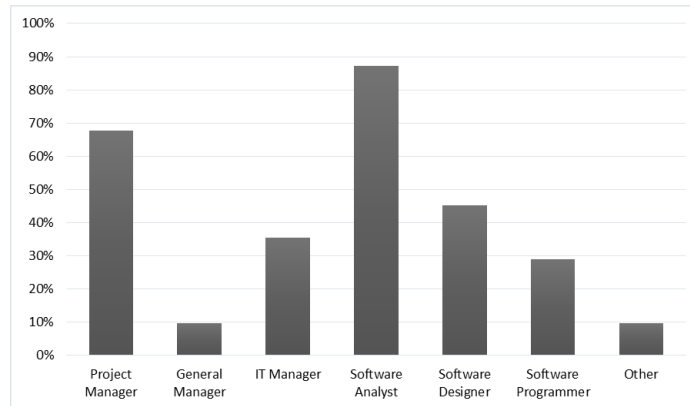
Fig. 1.   Urgency of RE

Fig. 2. Responsible role for performing RE (multi-selections)

Regarding RE objectives (Fig. 3), application feature definition (more than 80%) and project proposal definition (almost 70%) are top two objectives which are undertood by the participants as the objective of RE in software development project. In term of the efforts for identifying the software features (Table 12), the majority of the participants (96.77%) understand that discussion with clients is required to do so, while benchmarking (70.97%) is the second effort which can be leveraged. Data in Fig. 3 and Table 12 come from questions in which the participants were allowed to select more than one option. Further, most of the participants (more than 80%) understand that specification document is important for describing the whole application features, as shown in Fig. 4.
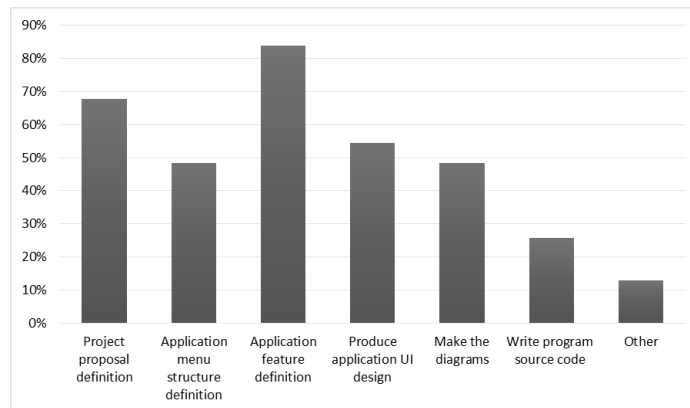

Fig. 3. RE objectives in software development (multi-selections)

Table 12. Efforts for identifying the software features (multi-selections)

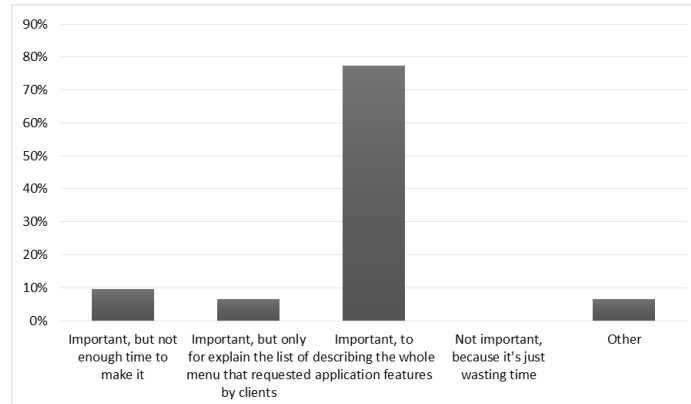| Efforts	Participants (%)
Discussion with clients	96.77
Benchmarking	70.97
Read related documents	45.16
Self-identification	19.35
Other	3.23

Fig. 4.   Urgency of specification document in every software project

4.4   RE Problems Findings

The following information present problems encountered in practicing RE. In regard requirement pre-traceability (Table 13), i.e. requirements traceability to clients, most of the participants (41.94%) believe that such problem is often encountered in software development. While, concerning requirement post-traceability (Table 14), i.e. requirements traceability to design component, the majority of the participants (45.16%) often get such problem.

Table 13. Problems in requirements pre-traceability

Problems intensity	Participants (%)
Very often	3.23
Often	41.94
Seldom	35.48
Rare	12.90
Never	6.45

Table 14. Problems in requirements post-traceability

Problems intensity	Participants (%)
Very often	6.45
Often	45.16
Seldom	22.58
Rare	25.81
Never	0.00

In user involvement problems (Table 15), most of the participants (more than 38%) encounter less involvement. While, problem in requirements volatile (Fig. 5), most of the participants (more than 40%) often meet such problem.

Table 15. Problems in less user involvement

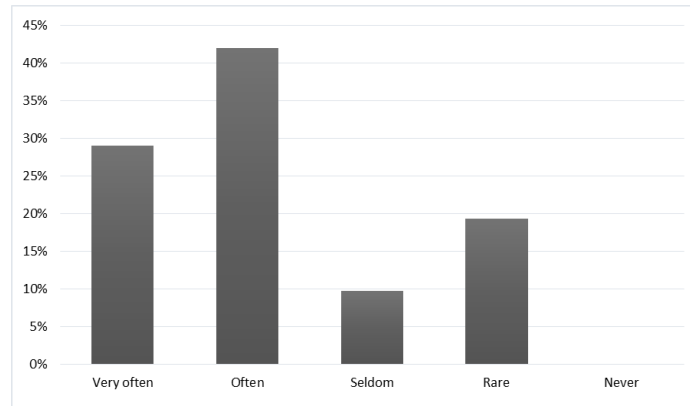| Problems intensity	Participants (%)
Very often	19.35
Often	19.35
Seldom	25.81
Rare	35.48
Never	0.00

Fig. 5. Problems in requirements volatile

In regard problem in lack of specification document (Fig. 6), most of the participants (45%) often meet such problem. While, Fig. 7 confirms that most of the participants do not significantly have problem in RE tool since they already utilize such tool appropriately.
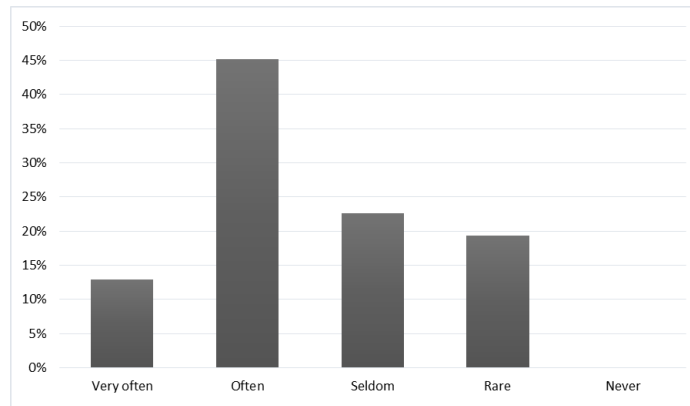

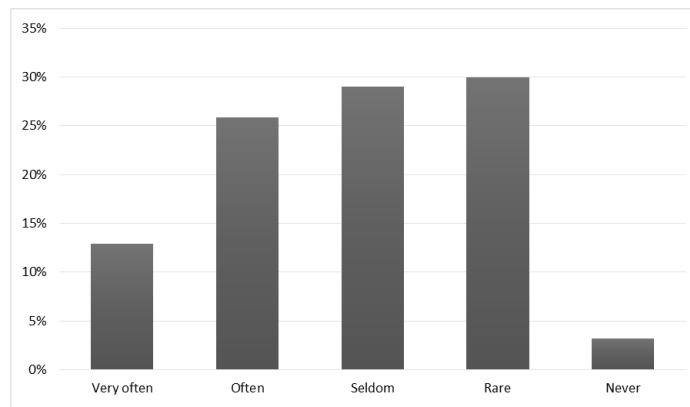**Fig. 6.** Problems in lack of specification document

Fig. 7. Problems in inappropriate tool used

5   Discussion

The findings of the first part of this survey provide facts of the concepts and problems in practicing RE in software development in Indonesia. According to the survey, 74.19% of participants confirmed that they understand and are able to apply RE concepts in software development practices. Most of them (i.e. 50%) obtained their knowledge and skills in RE from formal course at university. Furthermore, based on these findings, it was conducted to find out the importance of developers making requirements engineering. As a result, it was verified that 83.87% stated that requirements engineering activities are very important stages in the software development phase especially for determining software features, defining project proposals as well as displaying interface software designs. This emphasizes that engineering needs greatly affect the success of software projects in accordance with user expectations. In addition, the majority of participants think that software analysts and project managers have a very important role and are required to have extensive knowledge about requirements engineering.

This paper also shows the purpose of requirements engineering is to be able to discuss with clients in gathering features of the software. Such features become a reference in preparing software requirements documents. The interesting thing of this findings is that limited time is an obstacle for participants to document software requirements. Some participants argued that the document was only used as a representation of the menu list desired by the client. According to the survey, 29.03% of participants said that not all projects had the required software requirements documents.

The survey findings show that participants were difficult to track requirements to client (pre-traceability), which was represented by 41.94% of participants. The traceability of a requirement to a component of the design (post-traceability) is also a difficult challenge. The user involvement in defining the objectives and features of the application is very important before the software is built. The findings of this survey revealed that 35.48% of client involvement in the requirements engineering process is very low. This findings occured since the client's active role is lacking in the process of requirements engineering. In addition, the lack of knowledge of the client about the developed software and solutions has an impact on the requirements that are constantly changing.

Based on the survey results, 45.16% of participants often found requirements changes, unclear, ambiguous, incomplete needs specifications and weak documentation to be a problem in managing software projects. This findings occur because in addition to the client's insufficient knowledge and experience of the development team when defining solutions based on the domain of problems that are lacking, the resulting needs cannot reach the expected goals. The involvement of all team members in the requirements engineering process is very important to obtain the same problem domain information.

Based on survey findings, it can be concluded that requirements engineering with various kinds of challenges is the most important and interesting phase in a software development process. The involvement of developers in requirements engineering, of course, is not only thinking about solutions to be built and technical implementation of the software. But, they must be able to understand the characteristics of the problem domain, the goals, and expectations of users. If these capabilities are not comprehended by the development team, then requirements changes will continue to occur. Further, according to RE problems which are written based on the experience of the respondents, in general, the lack of qualified analyst

in sufficient numbers is a dominant problem as well as inappropriateness in documenting all requirements. Finally, lack of documentation, requirements volatile, less skill and insufficient number of the analyst were well confirmed by the selected software company as the main problems in RE practices during our focus group discussion.

6 Conclusion and Future Work

This research makes some results in capturing the RE concepts understanding and problems which exist in software developement in Indonesia. In general, RE concepts have been proportionally understood by the participants. The participants develop their knowledge in RE through formal course at university. The specific role and documentation of RE are two important issues to take into account. Further, problems in RE implementation are obvious. These includes requirements traceability, user involvement, requirements volatile and tool supports.

Future research may be arranged for investigating relationships among the facts in RE implementation. This may potentially contribute in better understanding of RE practices in Indonesia in order to improve RE implementation.

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