Meta-requirement Method Towards Analyzing Completeness of Requirements Specification

Muhamad Idaham Umar Ong[1](✉), Mohamed Ariff Ameedeen[2], and Imran Edzereiq Kamarudin[3]

[1] Software Engineering Research Group (SERG),
Faculty of Computer Systems and Software Engineering,
University Malaysia Pahang, 26300 Gambang, Malaysia
idaham@ump.edu.my

[2] IBM Centre of Excellence, Universiti Malaysia Pahang, Pahang, Malaysia

[3] Systems Network and Security (SysNetS),
Faculty of Computer Systems and Software Engineering,
University Malaysia Pahang, 26300 Gambang, Malaysia

Abstract. In software development project, requirements validation plays an important role to ensure all requirements are captured as required. With the correct sets of requirements, producing a highly desired system is possible. However, due to time constraint, requirements validation steps are commonly ignored by developer. The objectives of this research are to identify the major factors in validating user requirements, development of a reverse engineered meta-requirement algorithm and validating with expert panel in requirements engineering of the algorithm usefulness. Expected result will be that the solution should be able to reverse engineer the meta-requirements of a set of user requirements. By building a repository of meta-requirement, this will enable comparison of meta-requirements of two different system within the same domain and producing a meta-requirement gap analysis. With this, requirement validation steps can be done within a small amount of time. The contribution of this research should be beneficial to industry and researchers.

Keywords: Meta-requirement · Requirements specification · Validation Requirements completeness

1 Introduction

Over the years, efforts to produce high quality requirements specification artifact, mainly in the form of document and its content through the processes of elicitation, documentation, validation and negotiation and management has been the main priority for requirements engineers [1, 2]. To produce the desired requirement specifications, the efforts relies on an effective method of how information is being obtained, sources that is relevant, understanding and translating those information in the correct context and based on those result, reaching a mutual agreement from different parties with highly diverse experience, knowledge and characteristic. This process itself is far from perfect and prone to errors.

K. Arai et al. (Eds.): FTC 2018, AISC 881, pp. 444–454, 2019.
https://doi.org/10.1007/978-3-030-02683-7_31

Much previous research was conducted with different approach to ease the challenges faced by requirements engineers [3–5]. According to [1], acknowledge that requirements must be communicated, and yet the way we human usually express those word to communicate with each other are most of the time confusing and sophistication. This also have yet to take any consideration in terms of different context of which how the information is intended to be digest, for example the inclusion of body language and sarcasm terms. Communication is one of the main issues when discussing the topic of requirements engineering.

According to [6], based on National Geographic documentary title Air Crash Investigation episode “Turning Point”, the case of Air China flight 129 from Beijing Capital International Airport, Beijing, People’s Republic of China to Gimhae International Airport, Busan, South Korea; the main problem found was the miscommunications between the pilot and the air traffic controller. This tragedy is an example of clearly the problem of natural language communication arise in the scope of information receiver ignorance, information receiver biasness, lack follow up of information passing successfulness between information sender and receiver, missing of vital information such as weather condition at that crucial time period.

The word requirement plays a crucial role in the life of a software developer. To them, requirement is the heart and soul of a system. Development of a comprehensive and highly desirable software product will be achieved if the listed requirements are fulfilled. The task of studying, creating, checking and finalizing requirements are being uphold by person who called themselves Requirements Engineer. The process starts by collecting requirements, usually originated from the system owner with the intention of producing a comprehensive documentation that will contain a list of all agreed behaviors that the system will behave based on the boundaries that are defined, best known as User Requirements Specification (URS). But this is easier said than done. Requirements usually represent itself in an unstructured form and it is highly difficult for requirements engineer to settle down with their task even during the stage of delivering the finished system to the owner. Depend on the nature of a system itself, the task of software engineer to create the URS could be as easy as pie or their worst nightmare if it’s being taken lightly.

In the world of large enterprise operating their daily task with high complexity and highly integrated business processes, it is a necessity to be able to generate optimal revenue by serving the needs of their valuable customers. Thing could go wrong in a blink of an eye and organizations could be losing more, rather than achieving their daily profit goals. In overcoming this obstacle, it is essential for them to utilize software to ease their burden in maintaining optimal daily business operation. Software could be originated or developed from within the organization IT department, it could be outsourced to an external organization during its development or it could also be off-the-shelves. Depends on the nature of organization of itself, software could have developed in house or procure through software development companies. Explaining more on procuring software from an external organization, further discussion will focus on the definition, objective and process of procurement in the scope of software. In a nutshell, procurement is defined as the action of obtaining something in the matter of psychical objects or services that are being offer by external organizations for the purpose of achieving certain functions.

For the purpose of this research, it is to propose a different approach of solving the problem of measuring a set of requirements in the aspect of completeness through the use of meta-requirement. Meta-requirement is not so different with normal requirement. The main objective of requirements is described as functionalities of a system to solve a specific problem. For example, problem A will be solving with the help of requirement X and problem B will be solved by requirement Y. On the other hand, meta-requirement addresses a class of problem. In other word, meta-requirement is the requirement of a requirement. Rather than assessing the completeness of a set of requirements by going through a whole thick document that may take days or even months, referencing to meta-requirement could help to assess on this matter. By summarizing thousands of requirements to possibly around hundreds of meta-requirements, this will give the requirement engineer a bird's eye view of the system and will ease the task of assessing the requirements completeness by referencing to meta-requirement. This will be significant in executing early assessment requirement analysis in the context of requirements completeness.

In conclusion, it is the attention of this research to ease the burden of requirement engineers in the task of analyzing and validating requirements completeness by introducing a different approach with the help of meta-requirement. With high hopes, everything will be produce when this research reaches the end of the tunnel and a bright of cheerful will shine

1.1 Problem Statement

Textual requirements satisfactory can be consider related closely to textual requirements whereby both uses similar measurements to produce the desired result. The lack of formal criteria and standard practice, which requires large amount of monetary resource when involving high assurance domain [7, 8] are the disadvantages of current techniques to access textual requirement satisfactory.

To ensure the completeness of requirements, current practice involve "a tedious process of reading requirements and looking for linguistic errors" [7, 9, 10]. The term tedious process is described through the study of different methodology of requirements validation in the scope of completeness.

Using algorithm in requirements validation technique to solve the problem of requirements validation has not been evaluated for the objective of overall completeness. With the development of the proposed algorithm to reverse engineer user requirements to its originated requirements (meta-requirement), it will help software developer practitioners to analyze with a better outcome.

1.2 Objective

The objectives for this research are as followed:

- To identify major features, factor, characteristic and attributes that influence towards requirement validation.
- To develop a model, method and technique for textual requirements validation.

- To evaluate the proposed technique for textual requirements validations based on expert opinion approach.

2 Related Literature

This chapter will describe the literatures that are relevant to the research that will the foundation of this research.

2.1 Holistic View of Software Engineering

In software engineering [11], requirements engineering is considered as a sub activity. This sub activity main focus is to ensure that a complete documentation of stakeholder requests in the form of user requirements is prepared and finalized before the design and implementation kick off. This documentation contains all the deliverables where an overwhelming amount of information describing the expectation set by the stakeholders.

In order for the design and implementation team gets a clear and complete view of the stakeholder's desired end-product, requirements engineer puts in a rigorous and complex methodology of requirements collection and analysis to make sure that the outcome of requirements engineering will be highly comprehensive and understandable.

Requirements validation is the process of making sure that a complete list of agreed requirements to be included in the project. Similar to a furniture instruction manual, requirements engineers must ensure that they are building the correct "furniture", or the correct software and by making sure they are following the "manual instructions", or correct method in creating the correct software.

2.2 Meta-Requirements in Information System Design Theory

The meaning of the term "meta-requirement" was described as classes of goals to which the theory (kernel theory) applies. The term "meta-requirement" [12] was to simplify requirements in a sense that instead of addressing a single problem, meta-requirement address a class of problem.

The function of information system design theory (ISDT) is to describe to the software developers about the initial draft of establish relationships between components of a system to achieve a specific result. Design theory must be able to address how to combine components and relationships to make subsystem and how to combine subsystems and relationships to make systems [12].

According to [13], in regard to meta-requirements research, a framework for categorizing meta-requirements for the development of a Requirements and Release Management Systems (RRMS) has been produced based on the knowledge and implementation of ISDT. Details of the framework is shown in Table 1.

Table 1. Framework for categorizing the meta-requirements of the ISDT for RRMS [13]

Communication	Control	Change	Platform development	Process integration
Prioritization and valuation of requirements and the allocation of requirements into releases Traceability Single capture of information	Content ownership and accountability Management and coordination Creating and sharing of metrics information Access rights and information security	Version management of requirement documents Release re-planning Change management and impact analysis Defining and maintaining the requirements baseline	Creation and reuse of reusable assets Knowledge creating capacity	Process transparency Providing information at the right level of detail Providing high quality information

The same researchers with the help of [14], they represented their framework of meta-requirement analysis in two dimensions, as shown in Table 2. Similarity to the framework in [13], this framework for analyzing meta-requirements also use for describing the meta-requirements of a Release Management System (RMS). This research was done in the environment of Nokia Research Center (NRC) and Business Unit (BU) for providing a groupware-based RMS for new product development (NPD).

Table 2. Framework for analyzing meta-requirements for RMS.

RMS use	RMS support		
	1. Communication	2. Control	3. Change
A. Context	Development and application of domain models to support information sharing, storage, and retrieval across the functional units involved in NPD	Use of domain models in the allocation of responsibilities for the further processing of requirement information	Explicit definition of interfaces to other RMS instantiations Enforcement of controlled procedures for the revision of domain models
B. Process	Enforcement of jointly approved milestones for workflow support	Separation of processes for knowledge acquisition and decision making Clarification of decision criteria and rules for applying the criteria	Instantiation of alternative sub-processes for different kinds of requirements information

(*continued*)

Table 2. (*continued*)

RMS use	RMS support		
	1. Communication	2. Control	3. Change
C. Content	Adoption of standard representational schemes in the description of requirements information	Accumulation of a full revision history with each requirement	Controlled introduction of revised guidelines for describing requirements

In another research done in [15], it includes two dimensions of categories and its being mapped to the meta-requirements of the Automated Teller Machine (ATM) system. When compared to Tables 1 and 2, information shown in Table 3 displays strong resemblance to the framework that was produce by previous researches.

Table 3. Meta-requirement analysis to develop ATM system.

The three aspects of requirement for developing ATM system	The five requirement categories for developing ATM system				
	Communication	Control	Change	Development platform	Process integration
Environment	Support information sharing, storage, and retrieval across the functional units involved in ATM system	Use the domain model in the allocation of responsibilities of ATM system, for further address the requirement information	Explicit definition of interface of ATM system to other instances of the system Different	Knowledge and innovative capability Reuse	High-quality information The support to relevant technical and policy
Process	The support to the workflow of ATM system	The decision criteria to develop the ATM system	Different kinds requirement information to alternative sub-processes	Reuse to creation and assets available	Transparency in the development process to ATM system
Content	Adoption of standard representational schemes in the description of requirements information	The accumulation of comprehensive revision history for each requirement	Controlled introduction of revised guidelines for describing requirement	The effect of knowledge and innovation to ATM system	Provide the appropriate detailed

In conclusion, the meta-requirements produced by previous researches depend on the nature of the system itself. Different system utilizes different sets of meta-requirement category. This knowledge will be applied with great awareness within this research. With the use of category in meta-requirement analysis, the result will be much more comprehensive and clear.

3 Proposed Methodology

The research focuses in the area of validation, specifically in requirements validation. As shown in Fig. 1, a thorough process of literature review on related works is being conducted. This will define the base knowledge and recent advancement in the current research interest. This will also define the existing gap or area of improvement that will be the main theme of this research outcome.

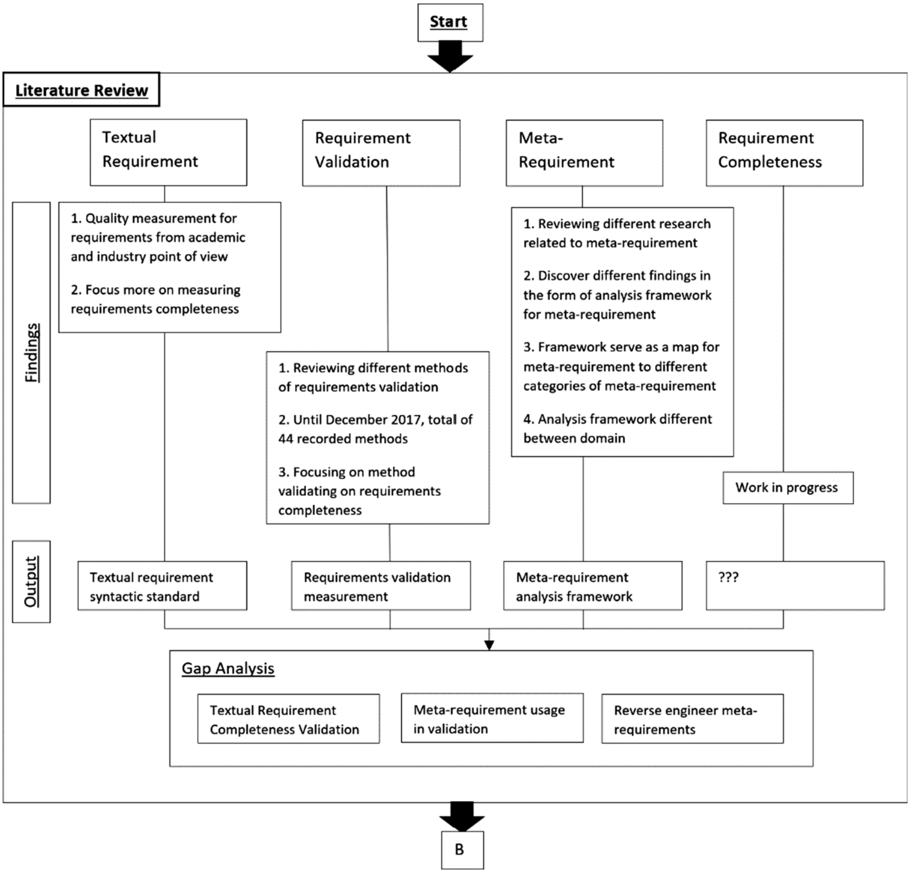
Start
Literature Review
Textual Requirement
Requirement Validation
Meta-Requirement
Requirement Completeness
Findings
1. Quality measurement for requirements from academic and industry point of view
2. Focus more on measuring requirements completeness
1. Reviewing different methods of requirements validation
2. Until December 2017, total of 44 recorded methods
3. Focusing on method validating on requirements completeness
1. Reviewing different research related to meta-requirement
2. Discover different findings in the form of analysis framework for meta-requirement
3. Framework serve as a map for meta-requirement to different categories of meta-requirement
4. Analysis framework different between domain
Work in progress
Output
Textual requirement syntactic standard
Requirements validation measurement
Meta-requirement analysis framework
???
Gap Analysis
Textual Requirement Completeness Validation
Meta-requirement usage in validation
Reverse engineer meta-requirements
B

Fig. 1. Research methodology flow chart part 1.

In Fig. 2, the process continues to develop a proposed solution that will be based on the problem statement, and scope of research define in this research with reference to the review of related work in Sect. 2. By implementing the proposed algorithm in the proposed overall solution, the desire results of meta-requirement gap analysis between two different within the same domain should be achieved.

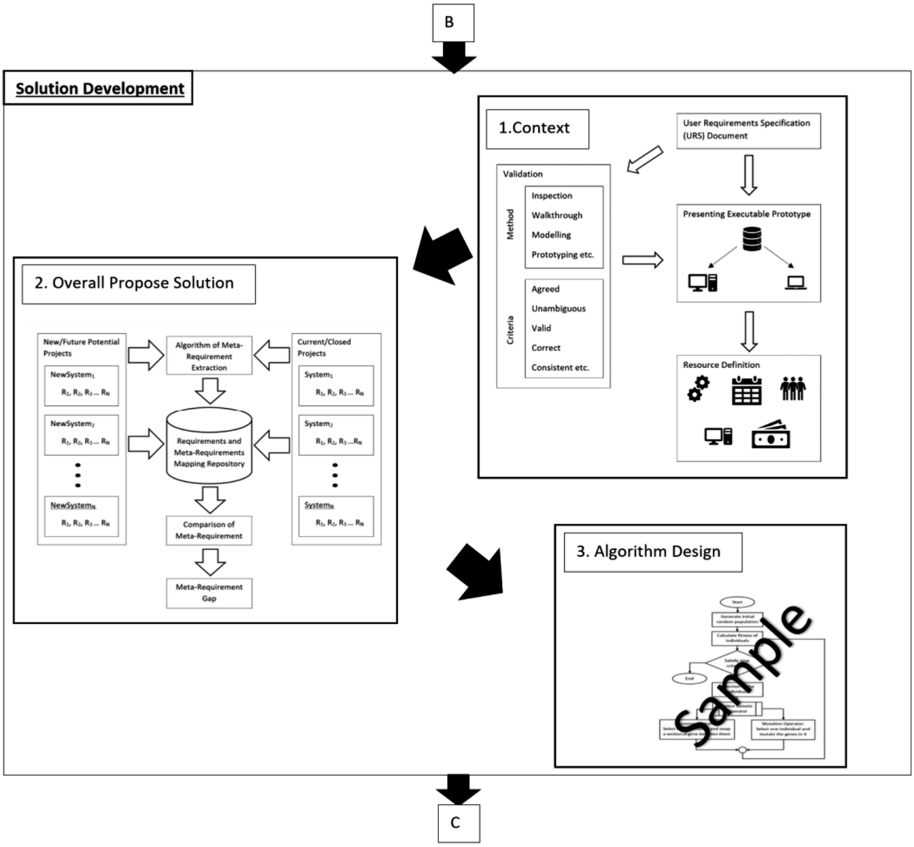

Fig. 2. Research methodology flow chart part 2.

Then finally the outcome of the solution should be validated through a series of experiment. Based on Fig. 3, the research is validated through the use of qualitative and quantitative analysis via expert panel (based on objective 3). This will ultimately define the opinion of expert panel on the knowledge and usefulness of meta-requirement usage in the area of requirement completeness validation.

Lastly, through the result discover through the proposed experiment, it will then be discussed, and suggestion of future works will be derived.

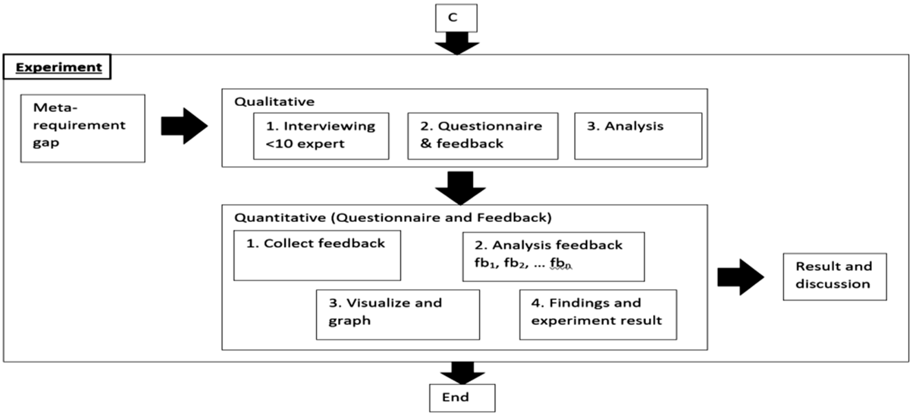
C
Experiment
Meta-requirement gap
Qualitative
1. Interviewing <10 expert
2. Questionnaire & feedback
3. Analysis
Quantitative (Questionnaire and Feedback)
1. Collect feedback
2. Analysis feedback fb1, fb2, ... fbn
3. Visualize and graph
4. Findings and experiment result
Result and discussion
End

Fig. 3. Research methodology flow chart part 3.

4 Limitation of Study

As shown in Table 4, the research will be conducted in abiding and based of the stated scope and limitation. Following are the listed scope that the research will be covering.

Table 4. Scope of research and objective map

No.	Objective	Scope
1.	To identify major factor that influence to requirements validation	1. User requirement specification
		2. Stage of tender biding
		3. English language based requirements specification will be used
2.	To develop an algorithm for textual requirements validation from overall completeness point of view	1. Development of an information system or sub-system
		2. Small to medium scale software development
		3. Advising software engineering side of tender biding in the topic of User Requirements Specification completeness validation
		4. All requirements specification follows the requirements documentation standard
3.	To evaluate the proposed technique of textual requirements validations based on expert opinion approach	1. Expert panel in the area of requirements engineering will be involved in the experiment of this research
		2. The experiment that will be conducted will consist result proof through lemma

5 Expected Result

Requirements are the core essences of a software project end-product. Figure 4 describe the use of requirement throughout the development process and the impact of requirements to future effort in software development.

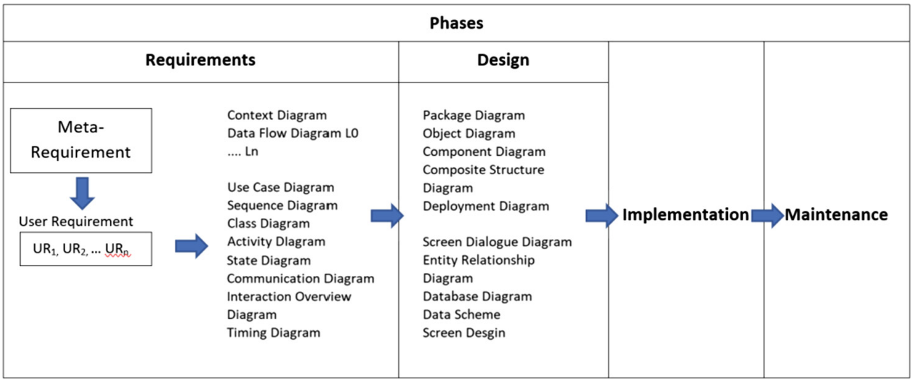

Fig. 4. Expected result of meta-requirements.

At the end of this research, it would be expected that the evidence is clear showing that of every requirement specifications will be able to be mapped to the meta-requirement and those meta-requirement will be the same for each of the different system development within the same domain.

6 Conclusion

By applying meta-requirements during the process of analysing requirements specification completeness should provide us with a more effective method in determining earlier assessment of a software project future. The outcome will be beneficial to the stakeholders that are involved in the institute such as software developer, project manager, OEM, etc.

Future work will be focusing on the importance of using meta-requirements analysis in different are and making them working together to achieve the ultimate goal of making a complete and holistic software experience for the owners and their main users.

Acknowledgment. This work was supported in part by Universiti Malaysia Pahang under Grant RDU1603101.

References

1. Pohl, K., Rupp, C.: Requirements Engineering Fundamentals: A Study Guide for the Certified Professional for Requirements Engineering Exam - Foundation Level - IREB Compliant, 1st edn. Rocky Nook (2011)
2. Pohl, K.: Requirements Engineering: Fundamentals, Principles, and Techniques. Springer, Heidelberg (2010)
3. Zowghi, D., Coulin, C.: Requirements elicitation: a survey of techniques, approaches, and tools. In: Engineering and Managing Software Requirements, pp. 19–46 (2005)
4. Coughlan, J., Macredie, R.D.: Effective communication in requirements elicitation: a comparison of methodologies. Requir. Eng. **7**(2), 47–60 (2002)
5. Maqsood, Aamir: Study of big data: an industrial revolution review of applications and challenges. Int. J. Adv. Trends Comput. Sci. Eng. **6**(3), 4 (2017)
6. Lang, G., Donovan, J.: Air Crash Investigation - National Geographic - Turning Point, National Geographic (2017)
7. Holbrook, E.: Satisfaction assessment of textual software engineering artifacts (2009)
8. Holbrook, E.A., Hayes, J.H., Dekhtyar, A., Li, W.: A study of methods for textual satisfaction assessment. Empir. Softw. Eng. **18**(1), 139–176 (2013)
9. Gnesi, S., Gnesi, S., Fabbrini, F., Fusani, M., Trentanni, G.: An automatic tool for the analysis of natural language requirements. CRL Publ. leicester **20**, 53–62 (2005)
10. Fedorov, E., Alrababah, H., Nehad, A.: The distribution formation method of reference patterns of vocal speech sounds. Int. J. Adv. Trends Comput. Sci. Eng. **6**(3), 35–39 (2017)
11. IEEE Computer. Society: Guide to the software engineering body of knowledge version 3.0 (2014)
12. Walls, J.G., Widmeyer, G.R., El Sawy, O.A.: Building an information system design theory for vigilant EIS. Inf. Syst. Res. **3**(1), 36–59 (1992)
13. Käkölä, T., Koivulahti-Ojala, M., Liimatainen, J.: An information systems design theory for integrated requirements and release management systems. In: Proceedings of the 42nd Annual Hawaii International Conference on System Sciences, HICSS, p. 318 (2009)
14. Salo, A., Kakola, T.K.: Groupware support for requirements management in new product development. J. Organ. Comput. Electron. Commer. **15**, 253–284 (2005)
15. Tang, Z., Liu, S.: The constructing method of meta-requirement analysis model. In: Proceedings of the 3rd International Conference on Business Intelligence and Financial Engineering, BIFE 2010, pp. 118–121 (2010)