Understanding Chinese Characteristics of Requirements Engineering

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Abstract

Rapid changes in the social and technical environment bring about many new challenges to system requirements engineering, amongst which out-sourcing or off-shoring of certain design tasks to countries with more human resources and broader markets becomes promising business leverage. This paper reports the results from a survey of requirements practices in China and points out their implications. The survey aims to understand the current state of RE practice in China, and investigate the impacts that Chinese culture has on requirements engineering activities. We collected data from 149 participants in 97 Chinese companies and 15 research institutes. We also analyzed the impact of Chinese culture on requirements engineering practices. We hope our results are useful for industrial practitioners and academic researchers wishing to improve current practices, and for foreign software companies wishing to better understand their Chinese customers.

1. Introduction

Requirements Engineering (RE) has emerged as a critical area in software and system engineering, as many systems fail due to poorly understood, ill-defined or ill-conceived requirements. Over the years, a significant amount of research has been devoted to the improvement of requirements engineering activities. However, there are only a few empirical studies on the status of the RE practices, especially in rapid developing countries such as China. Requirements engineering activities involve cognitive activities that are social-technical. As human groups think, feel, and act differently under different circumstances, understanding the impacts of specific culture to requirements engineering, or even software engineering practice is necessary for the reference of engineers coming from different cultural background. In 2008 we conducted a survey to investigate the state of RE practice in China. The types of involved organizations include state-owned enterprises, multi-national corporations, domestic private companies and universities. The survey consists of two phases: the focus of the first phase is to survey the general status of RE practices in China, including the RE efforts, requirements elicitation techniques, and requirements representation techniques; the focus of the second phase is to survey the impact of Chinese culture on RE practices. We hope the outcomes of the survey could provide useful guidelines for researchers and industrial practitioners to better understand the requirements engineering status in China, and to improve the practices of RE and the quality of requirements.

2. Current status of RE practices in China

During the first phase, we contacted 149 survey subjects in 97 software companies and 15 research organizations in order to get an overall understanding about the RE status in China. The business areas of the involved companies cover various industry segments including banking, healthcare, power generation, telecom, retail, electronics, etc. All the survey participants are software professionals whose daily work is closely related with requirements. Most of the survey questions concerned with three major requirements engineering activities: elicitation, specification and management.

2.1 Requirements engineering efforts

In our questionnaire, we surveyed the effort that is spent on RE-related activities in participants' organizations. In 78% of the surveyed organizations, the time spent on RE is more than 10% of their entire project duration, and 22% organizations spend more than 20% of their time on RE. We also asked subjects if it is worthwhile to spend much time on writing and maintaining requirements specification.

Most participants (74%) valued the importance of requirements specification and believed that sufficient time should be spent on delivering a high quality document. Only 10% of them thought that spending time on specification is not worthwhile. The rest 16% of the participants believed that only limited time shall be allocated to produce a roughly OK document.

We then asked the subjects' opinion about the relationship between requirements specification and software quality. Most participants (78%) believed that the quality of requirement documents has strong impact on the quality of final software system. Only 10% of them thought that there is no relationship between specification and software quality. The rest 12% reported a moderate impact of specification on software quality. There is a high correlation between this question and the previous one – in general, if people do not think requirements specification has big impact on software quality, they will not invest time to develop the specification.

2.2 Requirements elicitation techniques

We designed several questions to investigate the usage of requirements elicitation techniques in China. One question is "*Which requirements elicitation method do you use?*" The survey results are shown in Fig.1.
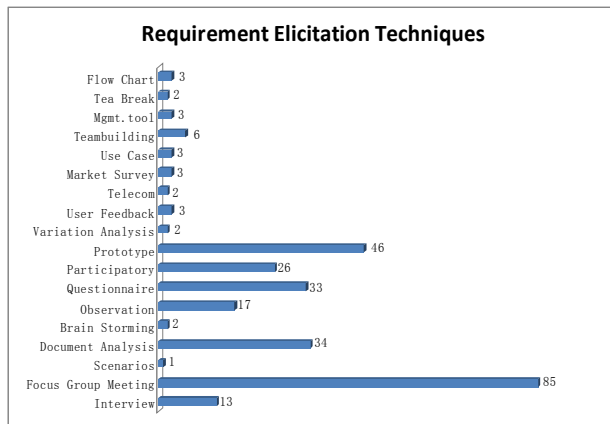

Figure 1. Requirement elicitation techniques

We were also interested in the roles of the people who perform the requirement elicitation activities. The results show that in these surveyed organizations requirements acquisition and management tasks are assumed by project manager (35%), system designer (20%), and requirements engineer (20%), general manager (6%), marketing staff (6%), programmer (10%), others (3%). This indicates that senior staffs (e.g. project manager and system designer) are often directly involved in requirements engineering process. We also surveyed the knowledge and skill background of the people performing requirements engineering

tasks. The results show that 36% of the subjects have taken formal requirements engineering related courses in universities, 24% have taken short informal training, 28% acquired RE knowledge by self-learning, and 12% did not receive any training.

We were interested in knowing with whom the surveyed subjects need to communicate during the phase of requirements elicitation. From the results, we can see that these people are: leaders of related business department (34%) and leaders of IT department (28%), leaders in customer organization (10%), system operators (10%), IT staff (6%), marketing staff (4%), others (8%). Therefore we can draw a conclusion that most people are willing to communicate directly with the leaders in order to get exact and determinative messages.

We also surveyed the attitude of the participants towards changes in requirements. We asked a question "*The customers keep changing requirements even after the development contract has been signed. How do you deal with this situation?*" Most participants (90%) think that the changes to requirements are normal and 80% of them said that they will negotiate with customers to come up with a compromised plan, 7% do what the customer asks, 14% follow the contract.

In the survey, we also encouraged the participants to report the problems they encountered during requirement elicitation process. The most common problem reported was, that the customers often don't precisely understand what they really want. For example, one participant told us that:

"*I have participated in projects for a large domestic commercial bank and for a small/medium-sized domestic commercial bank in mainland China. Staffs in large domestic commercial banking have a deep understanding of business, but lack the ability of describing the whole system requirements, and have only a little understanding about the links among the functionalities. Staffs in domestic small/medium-sized commercial banks have a partial understanding of business and lack of experience in how to automate business process by using information technologies. They can only provide part of function description, and cannot read documentation describing system function. They always provide supplementary explanation after system implementation. The changes are more frequent during and after system implementation, partly because of functional misunderstanding, and partly because of function deficiencies.*"

The above problem suggests that the system analysts and requirements engineers need to equip with both domain knowledge and IT knowledge in order to obtain good requirements that can satisfy customer's real business goals.

There are also quality-related problems reported by survey participants, especially with the frequent changes of requirements. As one elaborated:

"Our staffs in R&D sector often complain that the marketing department never turned down customer's demands, resulting in a lot of pressure for R & D. As new demands keep coming, we are forced to develop and maintain several versions at the same time, although some old versions are no longer planned to be continued. This definitely would lead to many bugs, and then we again need to develop another new version to resolve those bugs. Thus we entered a vicious circle and customer satisfaction is falling down…" This story tells us that frequent changes of requirements may lead to chaos in software development and in turn result in low quality and customer satisfaction. Therefore, better strategies for dealing with customers' ever-changing demands are needed. Or perhaps, better software development methods and tools that can effectively handle high degree of variability and uncertainty are required.

2.3 Requirements representation techniques

We designed several questions to investigate the usage of requirements representation techniques. One question is "*Which representation techniques do you use most frequently?*" This is a multiple-choice question. The results are shown in Figure 2. We also asked about the tools that are used in their RE practices. Only 14% participants reported that they use tools such as RequisitePro and DOORS. The rest (86%) do not use any RE tools. This indicates that commercial RE tools are still not widely used in practices.

We also wanted to know the actual contents included in the requirement specifications. According to the survey results, the contents that are most usually included in requirements related document are Project and goal description (88%), Functional requirements description (86%), Overall scheme (66%), Non-functional requirements description (54%), and change log (40%). In requirements documents, project plan and goals and functional requirements description are usually concluded, while information about risk analysis, changes and schedule are often omitted.
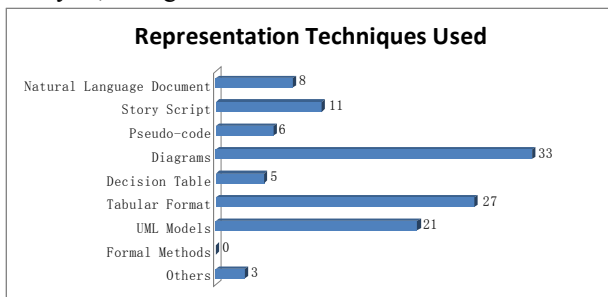

Figure 2.   Representation techniques used

3. Cultural impacts on RE practices in China

In the second phase of our survey, a web-based questionnaire was sent to 87 selected participants to further investigate how Chinese culture impacts requirements engineering activities. Same as many existing studies, we also applied the culture framework defined by Hofstede [3] in our analysis.

Power distance: the Power distance index is about the relationship to authority. In this survey, we investigate the relationship between subjects and leaders of their organizations. We asked a question "*What will you do when your boss asks you to do unreasonable changes to the system?*" to see how the subject deals with their leader's order. 8% of the participants choose the answer "Just does what the boss asked to do without complaining" and 75% of the surveyed person chose the answer "To confirm with the boss and point out the unreasonable requirements. However, if the boss insists, just do as he/she asked." The results show that when employees' opinion confronts with their boss's, most employees will obey their boss even they know the boss may have made a mistake.

In another question, we investigate the relationship between the survey subjects and the leaders of customers' organization. We asked a question "*During requirements acquisition, how do you treat the leaders of the customers' organization*?" Nearly all of the participants (96%) chose the answer "We need to establish good and long-term personal relationship with them." It can be illustrated that in China, personal relationship with leaders of customers' organization is very important, and to some extent, the leaders have a strong impact on the success of the project. One participant also elaborates: "*I am doing requirement elicitation in a government agency. We need to seek support and attention from our customers' leaders. As the requirements elicitation is time consuming and our customers are always busy, it is hard to make them accept our interview requests without their leaders' support.*"

In summary, our survey results confirm that China is a high power distance index country. It is due to the inherent societal manner and the long feudal history. The leaders can have a direct and strong impact on the whole RE process. It is a very important point for people practicing RE in China. Understanding this point could help improve the efficiency of the RE work. When it comes to operationalize the power distance factor in RE practice, we suggest the following general guidelines:

- Evaluate the level of power distance in the customer's organization at the very beginning of the project. Find a way to keep informed of any political change in the organization.

- Always engage members from the top-management team in the requirements engineering effort. Ask member from the top-management team to confirm and sign major requirements documents.

- Identify all key stakeholders of the systems under design. When it comes to the moment of collecting requirements from stakeholders who are not high up in the power hierarchy, we should give the people a chance to express his true opinions with/without the boss in presence.

Uncertainty avoidance: Uncertainty avoidance is about ways of dealing with conflicts/uncertainty. In this survey, we investigated how subjects deal with ambiguous situations and unfamiliar risks in RE practices by asking a question "*During requirement elicitation, how do you respond to a difficult/ unrealistic requirement raised by the customers?*" 70% of the participants answered that they will explain the reasons why they think the requirements are unrealistic and reject them. Some participants also point out that the software developers tend to reject the requirements, while the marketing staffs tend to accept them in order to get the contract.

We also surveyed the subjects if they would like the requirements specification to be fully documented in a very detailed manner. A large percentage of the participants (64%) prefer requirements specification to be fully documented without any uncertainty. 32% participants allow a small percentage of vague parts in the requirements specification so that developers have limited degree of freedom in deciding the details. It can be concluded that in RE practices in China, uncertainty is to be largely avoided. Sometimes, it is the customer, not the software developer, who tries to avoid uncertainty. One participant told us a story as follows:

"*I am doing requirement elicitation for an e-government project. As the system is not requested by the end-users but by the high-level officials in the government, the end-users are not enthusiastic about the project. Particularly, some elder staff didn't know the details about what to do and thus became very cautious. It is hard to collect required information from them*". To sum up, in China, people usually avoid conflicts and uncertainties, and they tend to use gentle and indirect methods to deal with conflict. In order to operationalize the uncertainty avoidance factor in RE practice, we suggest the following general guidelines:

- Evaluate the level of openness to change and innovation in the customer's organization at the very beginning of the project.

- Always specify rules to govern the behavior of system users and operators, which should be held accountable from the top-management team.

- Make thorough plans for engineering activities in advance. Work out requirements to the level of details until design variation points no longer exists.

- When it comes to the moment of collecting requirements from stakeholders, prototypes or a running system should be available for demonstration.

Collectivism/individualism: Collectivism and individualism represents symbols and values of individual and organization. Collectivistic culture means that people are integrated into strong, cohesive groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty. For an individualist, people would like to protect his personal time. For a collectivist, when making decisions, collective concerns prevail over personal views. Chinese culture is normally with low individualism and high collectivism index. In this survey, we asked if the subjects have ever performed RE-related work after office hours and if they are willing to do so. 54% of the participants answered that they worked during non-office hours and they were willing to do so. While 24% participants said they never worked after office-hours and they are not prepared to do so. The results show that in China, a large percentage of people have the experience of working over time and to them there is no clear boundary between work time and spare time. What's more, people do not feel that their individual independencies are sacrificed by organization's collective value. There are also a certain number of people who lean towards individualism as shown by their attitudes to over time working. This also reflects that the individualism has gain more awareness together with the modernization of the society. To operationalize the individualism/collectivism factor in RE practice, we suggest the following general guidelines:

- Evaluate the level of obligation, privacy and freedom the customer expects.

- Identify requirements that make easier to reach consensus in the Chinese society. E.g., environmental protection, energy saving, reduction of cost, security, safety, when it is applicable to the business area.

Masculinity/femininity: Masculinity/femininity is about gender preference and behaviors traditionally

associated with gender roles. In our survey, we asked the question "*Do you proactively suggest additional requirements to customers?*" 80% of the participants answered "yes", exhibiting more masculine-like behavior. As one participant elaborate: "*Clients are usually unclear about their requirements, so we often need to spend much time consolidating, analyzing and representing the requirements in the form of prototype and system structure diagram, before we communicate with clients*". It is commonly believed that, compared with males, female engineers are usually good at communication and not easily get rejected when they acquire requirements. In our survey, we also asked if the RE work in their organization is usually done by female employees. 62% participants answered that there is no obvious gender preference in RE practice. Who to be chosen to perform RE related work is decided by experience and work capability, not by gender. While there are 32% participants answered that their RE work is done by male engineers. Only 6% results show that the work is done by their female colleagues. The result is contradictory to what we assumed. Our survey shows that the masculinity tends to play more important role in RE practices in China, although the impact is moderate. To operationalize the masculinity/femininity factor in RE practice, we suggest the following general guidelines:

- Evaluate the level of masculinity within customer's organization. E.g., what is most effective way to resolve a conflict of requirements? By compromise or confrontation?

- Evaluate the degree women are regarded as assertive and ambitious in customer's organization. Identify if there are woman business partner present in the project, and prepare proper way to resolve the different perceptions of different genders.

Organizational issues that pertain to Chinese context, language and communication norms and patterns related to Confucian Dynamism: Key Principles of Confucian includes that the stability of society is based on unequal relationships between people, e.g., ruler-subordinate; father-son; husband-wife; older brother-younger brother; senior friend-junior friend. These relationships are based on mutual and complementary obligations. The junior owes the senior respect and obedience. The senior owes the junior protection and consideration. The family is the prototype of all social organizations. Harmony is found in the maintenance of everybody's face in the sense of dignity, self-respect, and prestige. Virtuous behavior towards others consists of not treating others as one would not like to be treated

oneself. Similarly, "If you honor me a foot, I will honor you ten feet in return". Reciprocation of greetings, favors and gifts. Virtue with regard to one's tasks in life consists of trying to acquire skills and education, working hard, not spending more than necessary, being patient, and persevering. Moderation is enjoined in all things. There are many general principles in the Chinese culture, based on the latest literature survey. There is a list of 71 principles grouped into 8 categories, and even is not exhaustive [10]. Such value is held by general individuals and it will influence the way they select the mode, means and ends of actions. When these principles are projected to requirements engineering practice, we suggest the follows:

- Understand the social, cultural, economical context of the design problem, and tailor the design in such a way that all major concerns of the key stakeholders can be sufficiently addressed.

- Customization by way of product-line is a good practice to following. Work out all product features, its possible differentiation points, its implications to customer preferences, and quality attributes are desirable also. For some of the customer's preferences and desired properties, we can eventually ascribe to their root in culture.

4. Related work

El Emam and Madhavji performed a field study of RE practices in information systems development [2]. They analyzed 60 cases and found that both technical issues (e.g., whether to prototype) and non-technical issues (e.g., selecting capable personnel) are of importance in the RE process for information systems. Zowghi et al. [5] analyzed a multi-site software development organization in Australia and identified factors that contribute to the success of requirements management in distributed development structure. Sadraei et al [1] surveyed RE practice from 28 software projects in 16 Australian companies.

There are many empirical studies addressing the issue of cultural impact on software development, especially in the context of global software development. For example, researchers at the National University of Singapore [6] examined the relationship between the cross-cultural differences and developer values though a survey of information systems developers in Singapore and US. Ali Babar et al. [9] also surveyed 12 Vietnamese software practitioners and investigated cultural issues in maintaining trust in software outsourcing. Although many people acknowledge the importance of social and cultural aspects of requirements engineering, few work in the

literature have given comprehensive survey to this problem. In [7], Hickey and Davis have conducted a survey to 45 requirements experts to whom four identical cases are presented, and asked what specific requirements elicitation techniques they will use to acquire the requirements right. In [8], Davis surveyed the role of Chinese RE research publication with regard to other Asian countries and the world.

In our work, we investigate the impact of Chinese cultures on RE practices. We feel that one possible next step for our investigation can be to compare our survey results with the above-mentioned related work, and to identify a few differential cases, if it exists, to show whether Chinese RE requires different techniques/tools.

5. Conclusions and lessons learned

It is interesting to understand the current status of industrial practices in a rapid growing market such as China. In this paper, we present the results of a survey made in 2008 about the RE practices in China and how Chinese culture impacts RE practices. In the first phase of the survey, real project experiences and requirements-related stories in various industry domains are collected and analyzed. The results showed that the status of requirements engineering practice in China varies from organization to organization. Also the level of technical knowledge determines efficiency of the requirements engineering activities.

In the second phase of the survey, we analyzed the impact of Chinese cultures on RE practices. The results indicated that cultural and environmental context have influence on the process of RE and the quality of requirements in China. Based on the results, we also proposed the following improvements to the current RE practices:

- Getting strong support from top-management is one of the most effective means for all risky situations. Lousy project management and poor requirements come as twins.
- Domain knowledge, prototypes and demo are necessary conditions of successful RE practice.
- Effective communications between customer and engineers requires that customers have sufficient domain knowledge and engineers have the ability to map business requirements to technical implementations, so that economical and technical feasibilities of the requirements can be evaluated quickly. Emphases on making the customer feel their ownership and responsibility to the process and the future system. Participatory design and observation can also help.

- Current RE tools should better fit the real-world needs of the Chinese customers and engineers.
- Understanding cultural requirements can generate design that better fits for the purpose and context.

Although our survey is limited by its scope and scale, we still hope that these results could be useful for industrial practitioners and academic researchers wishing to improve current practices, and for foreign software companies wishing to better understand their Chinese customers.

Acknowledgments

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