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Managing Employers' Requirements in Construction Industry – Experiences and Challenges

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Category of Paper

Research Paper

Structured Abstract

Purpose – To explore existing problems and potential solutions of managing Employer's Requirements in the project development process of construction projects under traditional procurement systems.

Design/methodology/approach – Two research instruments are used: semi-structured interview and questionnaire survey to investigate the problems and potential solutions to Requirements Management in the construction industry.

Findings - The research revealed that Requirements Management is crucial to the successful delivery of construction projects. However, the current practice of Requirements Management in the industry is informal and there is a lack of a systematic approach to tackle the problems. The authors also propose potential solutions to Requirements Management as well as a vision for further research.

Practical implications – This paper presents the problems of managing Employer's Requirements, and the potential solutions to improve the Requirements Management process that need to be addressed.

Originality/value – This paper improves our comprehension of the nature, characteristics, problems and potential solutions of Requirements Management in the project development process under the traditional procurement systems in the construction industry, relevant to both practitioners and scholars. A model is proposed as a "preliminary framework" to show the processes involved.

Keywords Employer's Requirements, Requirements Management, Traditional Procurement Systems

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Introduction

Facing increased competition, greater project complexity and demands for higher quality requirements, the construction industry is constantly seeking ways to gain client satisfaction and improve project performance. Requirements are the basis for every project, defining what the stakeholders need from it and also what the end product must meet in order to satisfy that need. Requirements therefore form the basis for project planning, risk management, acceptance testing, tradeoff and change control (Hull et al., 2005). They are the essential elements of the briefing process as well as the whole development process. The briefing process in construction is the process through which a client informs others of his or needs, aspirations and desires for a project (CIB, 1997). Previous research reveals that there is a lack of identification, management and traceability of the requirements during the project development process in construction projects (Newman et al., 1981; Kelly et al., 1992; Barrett and Stanley, 1999; Kamara and Anumba, 2001; Yu et al., 2005, Arayici et al, 2006). Thus the management of requirements in the whole development process in the construction industry is inadequate.

Research on Requirements Management (RsM) in the construction industry is very limited in comparison with Requirements Engineering (RsE) in the system and software world. Thus, the aim of this paper is to summarise the challenges, problems, and solutions of managing Employer's Requirements in the traditional procurement systems of construction projects. Further, a vision for future research directions on RsM is also provided. This research is likely to be of significant value to professionals and academics in the construction industry for improvement of RsM processes in traditional procurement systems of development projects.

What are Requirements?

A requirement is a necessary attribute in a product or system, a statement that identifies a capability, characteristic, or quality factor of a product or system in order for it to have value and utility to a client or user (Young, 2004). It is a statement of need, something that some classes of clients, users or other stakeholders' want (Alexander and Stevens, 2002) 'Requirements' in the computer engineering world are defined during the early stages of a system development as a specification of what should be implemented (Sommerville and Sawyer, 1997). They are descriptions of how the system should behave, application domain information, constraints on the system's operation, or specifications of a system property or attribute (Kotonya and Sommerville, 1998). Requirements are the foundations of any development project. Good requirements are complete, unambiguous, consistent, feasible, solution neutral, traceable, necessary, not used for wrong purpose, concise, correct and verifiable (Kamara and Anumba, 2000; Young, 2004; Zielczynski, 2008). The importance of good requirements and the underlying dynamic nature of the requirements processes means that it is necessary to investigate and implement a systematic approach to understand and practice RsM for any project.

In the construction industry, there are different types of project requirements. They are (Kamara, et al., 2002):

1. Client requirements – Requirements of the client which describe the facility that satisfies his or her business need. These incorporate Employer's Requirements, developer's requirements, user requirements and the lifecycle requirements for operating, maintaining and disposing of the facility. This paper is focused on the

aspects of Employer's Requirements (ER). The Employer is the party who pays for the project.

2. Site requirements – These describe the characteristics of the site on which the facility is to be built (e.g. ground conditions, existing services, history, etc.)

3. Environmental requirements – These describe the immediate environmental (e.g. climatic factors, neighbourhood, environmental conservation, etc.) surrounding the proposed site for the facility.

4. Regulatory requirements – Building, planning, health and safety regulations, and other legal requirements that influence the acquisition, existence, operation and demolition of the facility.

5. Design requirements – Requirements for design, which are a translation of the client needs, site and environmental requirements.

6. Construction requirements – Requirements for actual construction, which derive from the design activity.

The interrelationship between these project requirements is illustrated in Figure 1. Client requirements combine with site, environmental and regulatory requirements to produce design requirements, which, in turn, generate construction requirements. Other project requirements are generated from the business need of the client that is to be satisfied by the proposed facility. The end product of the building construction, the building, should fulfill the needs and requirements of all stakeholders in a comprehensive manner. This is the ultimate target of RsM in the construction industry.

Insert Figure 1

Requirements are important because they provide the basis for all of the development work that follows. In the construction industry, once the requirements are set, developers initiate the other technical work: design, tendering, construction, commissioning and operation. The practice of RsM is critical to the successful delivery of any development project (Robertson and Roberson, 2005).The dominant storyline in the literature of construction industry exhorts the adoption of RsM with reference to a number of longstanding problems that are common in the construction industry (Fernie, et al., 2003): failure to deliver projects within budget; late delivery of projects; failure to consider project decisions from a whole life cycle perspective and poor customer satisfaction.

What is Requirements Engineering/Management?

Requirements Engineering (RsE) was a relatively new term in System and Software Engineering in the 1990s. It has been invented to cover all of the activities involved in discovering, documenting, and maintaining a set of requirements for a computer-based system (Sommerville and Sawyer, 1997). The use of the term 'engineering' implies that systematic and repeatable techniques should be used to ensure that system requirements are complete, consistent, relevant, etc. RsE is also about management and hence issues in relation to requirements and management blend to show how requirements can be used to manage systems development. The main purpose of RsE is to create better requirements and to manage these requirements. RsM in the System and Software Engineering is only the process of managing changes to the system requirements. Requirements for a system always change to reflect the changing needs of system stakeholders, changes in the environment in which the system is to be installed, changes in the business which plans to install the system, or changes in laws

and regulations, etc (Kotonya and Sommerville, 1998). These changes have to be managed to ensure that they make economic sense and contribute to the business needs of the client. The technical feasibility of change proposals must be assessed and it must be possible to make the changes within budget and schedule.

Requirements management is a critical part of the development process, not only for software, but for all products (Turk, 2005). In the construction industry, the Requirements Management process means that we know what the client's needs and that the design solution and the end product efficiently meet these requirements. The end product of the building construction, the building, should fulfill the needs of all stakeholders in a comprehensive and logic manner. In order to attain this, the Employer's Requirements need to be identified and captured. This is the first target of RsM. Since it is impossible to satisfy all needs of all stakeholders, for various reasons, the second target of RsM is to identify each stakeholder's requirements and put the different stakeholders' requirements together. When requirements of the various stakeholders contradict, it is difficult to judge whose need is more important than others. Robertson and Robertson (2006) suggested that the ranking of stakeholders' opinion is based on the power, interest and proximity of the stakeholder. This may be the third target of RsM in the construction industry. In addition, the compliance of design with the requirements should be verified constantly during project. Finally, it is necessary to ensure the final product complies with the requirements of the client. Because of the limited time and budget of the research, this project focuses on the processes, problems and solutions of managing Employer's Requirements of traditional procurement systems in construction projects.

The Challenges of Requirements Management

The challenge in writing requirements is mainly to communicate reliably and adequately between groups of project stakeholders who may have never met, and who have quite different viewpoints. For example, it may be difficult for the sub-contractors to meet users: their direct boss is the main contractor of the construction projects. The problems of RsM may be as follows (Alexander and Stevens, 2002):

1. Gaps between people - There are various groups of stakeholders who need to communicate well to make a new project a success. In the construction industry, there are bound to be gaps between developers and marketing managers, users and developers, project participants and clients, designers and contractors, contractors and sub-contractors.

2. Time to work out a good requirements structure – Getting the requirements structured correctly and precisely takes time because the structure depends on what kinds of user there are, on what each kind of user needs the project to fulfill, and on the nature of the constraints. Time must be allowed for gathering, organizing and checking out the requirements both formally and informally. This is not something that can be rushed.

3. Expected effort and time taken – To put some numbers to all this, Alexander and Stevens (2002) suggested to spend about 5 percent of project effort on the definition and development of requirements and also allow a generous chunk of schedule – up to 25 percent of calendar time – for requirements on shorter projects, but not more than three months on larger ones.

4. Requirements effort throughout the life cycle – Some effort on requirements is needed throughout the project because compromise and change are inevitable. An essential element in any acceptable compromise knows how important each

requirement is to its owner. The issue concerning change of requirements is discussed in the next section.

5. Allowance for change and feedback – The lack of well-documented updates make it difficult to trace the changes in Employer's Requirements (Oberg et al., 1998). Changes from outside are also inevitable. Every project with a lifetime of more than a few months will experience pressures from competitors, market or operational changes, from new technologies, and from stakeholders to change the requirements and the design. The change of requirements should be able to be tracked back, updated and recorded properly for future use and feedback for subsequent projects.

6. Allowance for users' participation and expression of feelings – The lack of adequate end-user's involvement causes failure to manage end-user's expectations (Kujala et al, 2005; Arayici et al., 2006). The users are arguably the most important stakeholders that occupy and perform activities in the building. Their voice towards the requirements must be heard and should be paid attention to as early as possible during the project development process. Some users may be defensive about giving their opinions, especially if, for instance, they think their jobs may be affected by the project being developed. In that situation, it is essential to gain their trust before trying to start developing the project. It is necessary to consider who will really benefit from the use of the building and a win-win situation should be achieved if possible.

Research Methodology

Questionnaire survey

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Given the research objectives to summarise the challenges, problems, and solutions of managing Employer's Requirements in the traditional procurement systems of construction projects, an empirical study was undertaken in Hong Kong in early 2009. The several challenges identified in the literature were re-phrased and expanded into nine statements. Five statements proposed for potential solutions for RsM were also formulated (Table 2 and 3). An industry-wide survey was conducted to explore the perceptions of problems and solutions for RsM by different project stakeholders. Respondents were requested to rate the significance levels for the aforesaid problems or solutions according to a five-point Likert scale (1 = Not significant, 2 = somewhat significant, 3 = fairly significant, 4 = Significant, 5 = Very Significant) with reference to a particular project using traditional procurement system they had been involved in. The Likert five-point scale was selected as it gives unambiguous results and has ease of use (Ekanayake and Ofori, 2004).

In this research study, senior staff of the organisations were identified and a potential list of random samples was drawn up, as observed from Internet information, HKIA directory of Architects Practices 2007, Builders directory 2007 together with personal contacts and relevant sources, The target population of the survey included all client's project managers, architects, engineers and contractors in Hong Kong. In total, 290 questionnaires were delivered to the potential respondents. The respondents were given two weeks to complete and return the questionnaires. Reminders to complete questionnaire were also sent after two weeks. Table 1 shows the detailed breakdown of the received questionnaires. Finally, the response rate of this survey was 25.87%. 62 valid questionnaires were obtained and used for analysis. The 62 valid responses included employer's representatives (20 respondents), consultants (18 respondents)

and contractors (24 respondents). The profiles of the respondents are shown in Figure 2.

Table 1: Summary of data collection process

1	Total questionnaires sent out	290
2	Received questionnaires	67
2.1	Valid questionnaires (62)	
2.2	Invalid questionnaires (5)	
3	Returned mail	31
4	Response rate = 67 ÷ (290-31) = 25.87%	

Insert Figure 2

The experience of the respondents vary from no involvement in RsM (4.8%), 1-2 no. of project involved in RsM (25.8%), 3-5 no. of projects involved in RsM (29%), more than five projects involved in RsM (40.3%). Therefore, nearly 70% of the respondents have much experience in RsM.

Semi-structured interviews

In the questionnaire, respondents were requested to provide their contact information if they were willing to attend a follow-up interview. A total of ten interviews were conducted. The interviewees were requested to describe in details their requirements management processes and difficulties in the project development periods. They were also asked to agree or disagree with rationales to explain their viewpoints on the potential solutions of RsM. These interviewees include senior client's project managers, architects and contractors. The interviews were recorded with a recorder pen as MP3 files and transcribed for further analysis.

Statistical analysis

The reliability of the five-point scale used was determined using Cronbach's coefficient alpha, which measures the internal consistency among the statements of problems and solutions for RsM. Reliability analysis studies the properties of any given measurement scale and the items that made them up. The analysis procedure calculates a number of commonly used measures of scale reliability and also provides information about the relationship between individual items in the scale. The result was 0.857 which is above 0.7, indicating that in this sample the scale can be considered reliable (Pallant, 2001).

After checking the reliability of the scale, the student's T-test using the SPSS 16.0 Package was used to test whether the sample could represent the target population. By running student's T-test using the SPSS software, where t ranges from 17.692 to 33.213, and all p = 0.000, indicating it is statistically significant at the 1% level that the respondents can represent the target population in Hong Kong.

The data collected was then analysed using SPSS 16.0 Package to determine whether the respondents were in agreement with our identified statements concerning problems and solutions of RsM. The 'mean score' rating was adopted to establish the relative significance of the perceived problems and potential solutions of managing employer's requirements in the traditional procurement systems of building development projects in the construction industry. The mean score was calculated using the following formula (Ekanayake and Ofori, 2004; Holt, 1997; Yu et al., 2007):

$$Mean = \frac{1(n_1) + 2(n_2) + 3(n_3) + 4(n_4) + 5(n_5)}{(n_1 + n_2 + n_3 + n_4 + n_5)} \tag{1}$$

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where n_1, n_2, n_3, n_4, n_5 represent the total number of responses for attributes as 1 to 5 respectively.

The mean, minimum, maximum, mode and standard deviation of the problems and solutions statements are presented in Table 2 and 3.

Research Findings

Problems associated with RsM

The respondents regarded most of the problems associated with RsM as fairly significant. It seems that they did not understand or could not identify the problems of not having a proper and systematic method for RsM. The most top three significant problems were as follows:

1. Misunderstanding and misinterpretation of Employer's needs could jeopardize the ultimate project success and Employer's satisfaction (mean = 3.84). This coincides with the literature review that the effective communication of requirements is crucial to the success delivery of the project. Roberston and Roberston (2005) stated that the one factor present in every successful project is paying sufficient attention to the requirements.

2. The Changing of Employer's needs produced incomplete and inconsistent requirements (mean = 3.61). This is also in line with Alexander and Steven (2002) challenges that allowance must be provided for organizing, updating, tracing back and recording of requirements for projects.

3. The lack of well-documented updates of Employer's Requirements made it difficult to trace the changes in Employer's Requirements (mean = 3.54). This also agrees with Oberg et al. (1998)'s observations and findings.

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Table 2: Problems in RsM of construction projects in Hong Kong

No.	Problems associated with RsM*	n (Valid)	Min.	Max.	Mode	Mean	Standard Deviation
1	Misunderstanding and misinterpretation of Employer's needs could jeopardize the ultimate project success and Employer's satisfaction.	61	1	4	2	3.84	1.00
2	Changing Employer's needs produced incomplete and inconsistent requirements.	61	1	5	2	3.61	1.02
3	The lack of well-documented updates of Employer's Requirements made it difficult to trace the changes in Employer's Requirements.	61	1	5	2	3.54	1.04
4	The Employer's needs were ambiguous and difficult to identify.	60	1	5	2	3.43	1.16
5	The Employer had poor understanding of Employer's Requirements Management in construction projects.	61	1	5	1	3.36	1.48
6	There was no mechanism to record, manage and trace changes in Employer's Requirements and the reasons behind them.	61	1	5	3	3.34	1.08
7	No formal procedure was used to translate Employer's needs and requirements into specifications.	59	1	5	2	3.29	1.07
8	The main contractor had poor understanding of Employer's Requirements Management in construction projects.	61	1	5	2	3.23	1.36
9	The lack of adequate end-user's involvement caused failure to manage end-user's expectations.	60	1	5	3	3.18	1.13

* Items were rated on a five-point Likert scale with 1 = Not significant and 5 = Very significant.

Potential solutions to RsM

The respondents indicated a fair amount of agreement to the potential solutions to improve RsM. The ranking of the potential solutions was as follows:

1. Appoint an experienced project participant as the Employer's Requirements Manager to be responsible for the management of Employer's Requirements (mean = 3.90). A requirements manager may be required (Roberston and Roberston, 2005). In the USA, on some projects, an architectural programmer is appointed to managing the briefing process (architectural programming) of the construction projects.

2. Specify the role and responsibilities of each party on capturing and managing Employer's Requirements clearly and precisely (mean = 3.85). As mentioned before, various parties need to provide input into the requirements of the projects

and therefore their role and responsibilities should be defined and communicated clearly.

3. Provide a formal procedure to record, manage and trace changes in Employer Requirements (mean = 3.77). As change of requirements is inevitable, the traceability of the requirements is important for running the project and for subsequent feedback in Post-Occupation Evaluation.

4. Provide a template of the Employer's Requirements Management Plan (mean = 3.63). To manage requirements, we must begin with a plan (Zielczynski, 2008). This document specifies how requirements are created, organized, modified and traced during the project life cycle. It also describes all requirement types and their attributes used in the project.

5. Provide a formal procedure to translate Employer's needs and requirements into specifications (mean = 3.60). The development of the requirements from a statement of needs, a few pages of brief to specification documents, requires careful planning and a systematic approach to avoid omissions and errors.

Apart from the results of the questionnaire, the interviewees also suggested involving user requirements as early as possible in the project development process. User requirements play an important role in utilization analysis of the facility (Brauer, 1992). If facility or space users prepare user requirements and supporting data, the project manager can depend on such information for utilization analysis. Poor utilization may be a result of not making facilities and space decisions on the basis of current user requirements data or lack of the same. Also, out-of-date requirements lead to incorrect understanding of facilities and space problems.

Table 3: Improvement suggested in RsM of construction projects in Hong Kong

No.	Improvement Suggested*	n (Valid)	Min.	Max.	Mode	Mean	Standard Deviation
1	Appoint an experienced project participant as the Employer's Requirements Manager to be responsible for the management of Employer's Requirements	62	1	5	1	3.90	1.08
2	Specify the role and responsibilities of each party on capturing and managing Employer's Requirements clearly and precisely	62	1	5	2	3.85	0.96
3	Provide a formal procedure to record, manage and trace changes in Employer Requirements Specify the role and responsibilities of each party on capturing and managing Employer's Requirements clearly and precisely	62	1	5	2	3.77	0.89
4	Provide a template of Employer's Requirements Managements Plan	62	1	5	2	3.63	1.12
5	Provide a formal procedure to translate Employer's needs and requirements into specifications	62	1	5	2	3.60	1.08

* Items were rated on a five-point Likert scale with 1 = Not significant and 5 = Very significant.

A Vision for Future Research

After analysing and discussing the empirical data on the processes, problems and solutions of managing Employer's Requirements for the construction industry, the next step is to develop a practical framework for RsM.   This is presented here and is proposed as a preliminary framework of RsM for the construction projects (Figure 3). A more refined version will be developed on the basis of the results of further investigation. The proposed refined framework is likely to comprise some guidelines and critical success factors for managing project requirements, not only Employer's Requirements, in a holistic RsM process.

 A further step will be to develop a practical "how-to" guide which explains the application of RsM principles in construction projects. The guide will provide practical solutions to critical issues frequently encountered by clients, consultants and contractors in the RsM process. Tools, techniques and examples of tasks such as how to elicit project requirements, define the requirements, identify the needs and wants,

prioritise requirements, verify requirements, record and trace the changes of requirements in construction projects will be provided in the guidebook.

Conclusions

There is an extensive literature on RsM relating to the software sector. It attracted the interest of the authors to investigate the longstanding nature of problems in managing project requirements of construction projects. This paper concentrates on investigating the management of Employer's Requirements in traditional procurement systems in the construction industry. The preliminary investigation comprised of a questionnaire survey and semi-structured interviews.

The research revealed that project participants agreed with the importance of the RsM to the successful delivery of projects. They were not satisfied with the existing practices in the managing of Employer's Requirements in the traditional procurement methods. The top three significant problems of RsM included (1) misunderstanding and misinterpretation of Employer's needs, (2) the changing of Employer's needs produced incomplete and inconsistent requirements, and (3) lack of well-documented updates of Employer's Requirements made it difficult to trace the changes in Employer's Requirements.

The respondents support our proposed solutions to RsM which include (1) appointing an experienced project participant as the Employer's Requirements Manager to be responsible for the management of Employer's Requirements, (2) specifying the role and responsibilities of each party on capturing and managing Employer's Requirements clearly and precisely, (3) providing a formal procedure to record,

manage and trace changes in Employer's Requirements, (4) providing a template of Employer's Requirements Managements Plan, and (5) designing a formal procedure to translate Employer's needs and requirements into specifications. From these suggestions, the authors envisage further research which involves investigating the managing of project requirements in the construction industry and production of a systematic framework/model for successful RsM for construction projects. A preliminary framework for RsM in the construction industry was provided in this paper, which will serve as the basis for further investigation.

Acknowledgement

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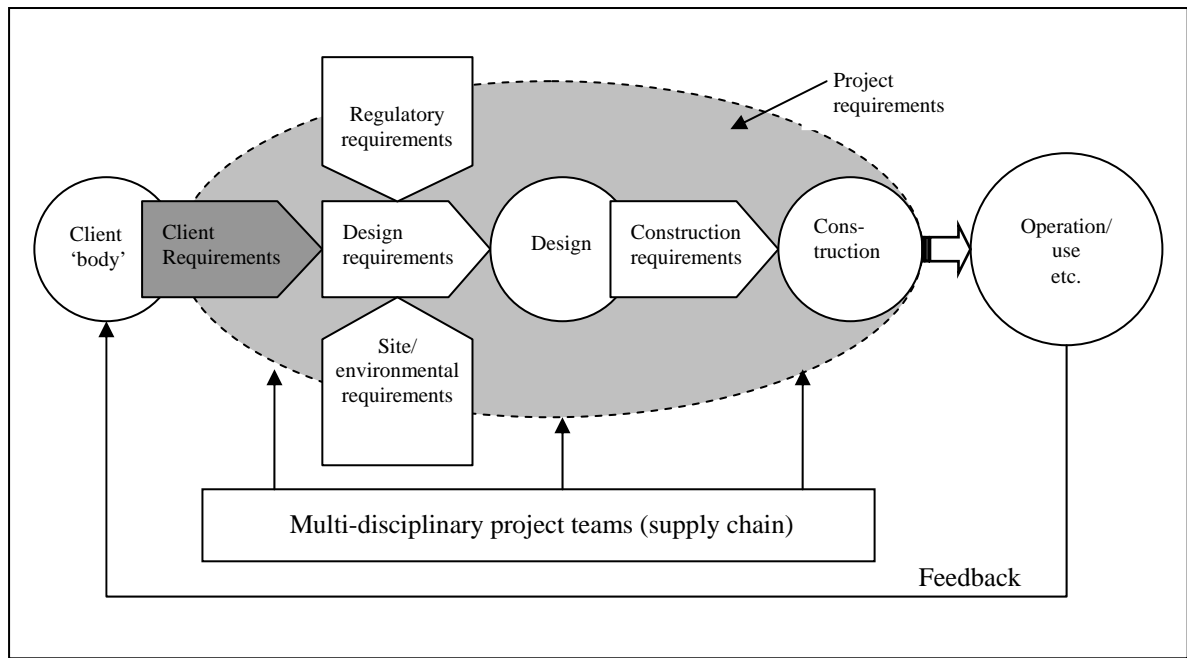
Figure 1   Interrelationship between project requirements
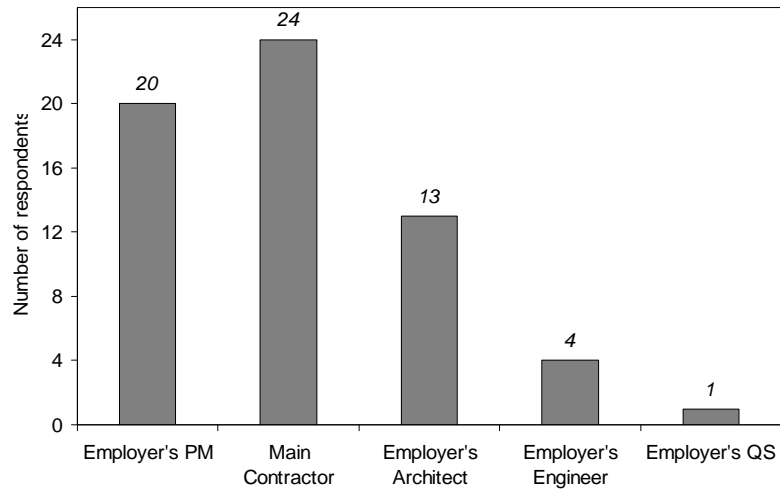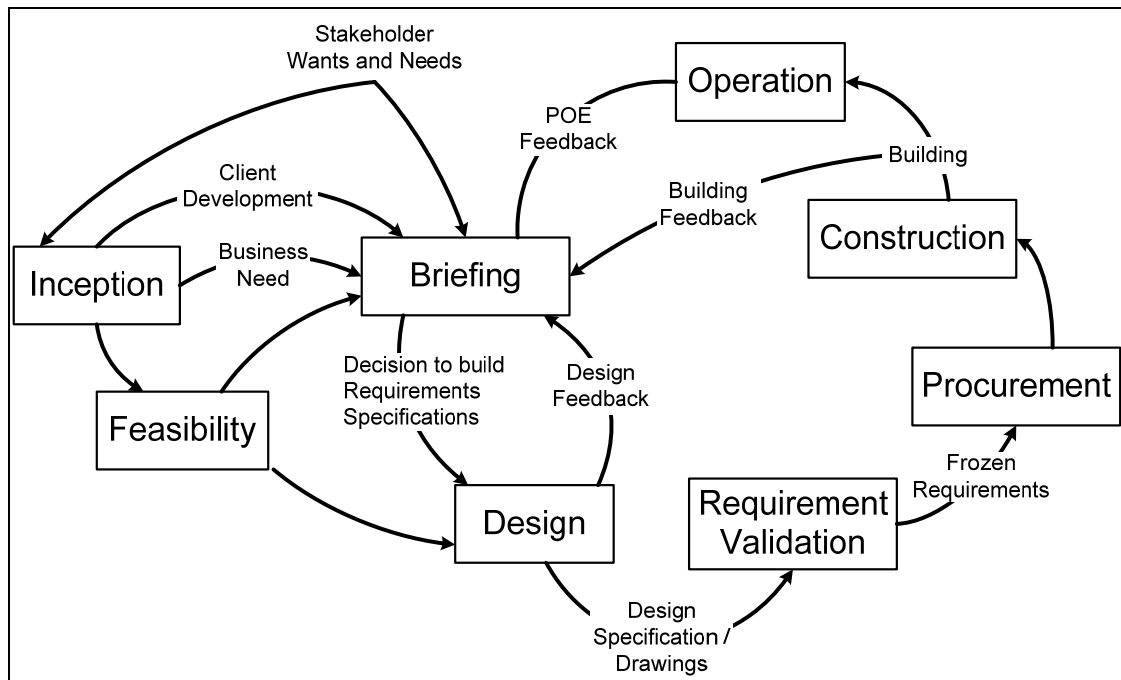**(Source: Kamara et al., 2002)**

Figure 2 Profile of Respondents

Figure 3   Preliminary framework of RsM in construction projects