香港城市大學
City University
of Hong Kong

Quantity Surveying Division,

Hong Kong Institute of Surveyors

Research Report 2011-2012

An Investigation of the Role of QS in Infrastructure Projects

Prepared by:

Dr. Ellen H.L. Lau
Division of Building Science and Technology,
City University of Hong Kong
Tat Chee Avenue, Kowloon Tong, Hong Kong
Tel: Int + (852) 3442-7690
Fax: Int + (852) 3442-9716
E-mail: bsellenl@cityu.edu.hk

December 2012, Revised June 2013

Table of Contents

1. Introduction

Traditionally, quantity surveyor (QS) is responsible for the cost and contract management functions in building projects, including preparation of construction contract documents, provision of cost advice and construction cost and contract administration. In a common building contract, the major role of quantity surveyors in cost management generally covers cost planning, cost estimation, value management, feasibility studies, life-cycle costing, cost-benefit analysis, tendering, valuation and cost-estimation. However, the cost significant activities in engineering projects may be different from that in building projects, and such differences may shed some light to the development of the role of QS in infrastructure projects. Thus, it is the intention of this study to investigate the role of QS in engineering projects and to find out how QS is involved in these cost significant activities in a typical engineering project. The objectives of this research are therefore:

(1) To describe the role of QS and the meaning of the independent role
(2) To find out how QS is involved in engineering projects
(3) To compare the cost significant activities in building projects with engineering projects
(4) To identify the problems underlying the development of independent QS role in infrastructure projects
(5) To identify the contributing role of QS in different phases of engineering projects

The research investigation thus includes the following components:

(1) A literature review about the role of quantity surveyors in respect of cost management, contract management and the independent role.
(2) A questionnaire type of survey (web-based) to be conducted to investigate the quantity surveyors' role in "Engineering Contract".
(3) Data collected will be analysed with basic statistic tools so as to achieve the aforesaid aims and objectives via using the software IBM SPSS 19.0.
(4) An in-depth interview to be conducted with the Quantity Surveyors and/or related professions to verify the data results and uncover knowledge.
(5) Recommendations as to improve the cost control aspects in the "*Engineering Contract*" from QS perspective.

2. Background of the Study

Cost overrun is not an uncommon phenomenon for infrastructure projects. Flyvberg et al. (2003) state that the problem of cost overruns are common for large projects in the public sector and cannot be resolved by simply placing projects in the private sector even the mode of privatization is adopted. They advocate that cost overruns of 36% have happened even before construction is started. Their work showed that the cost overrun for transport infrastructure projects was mostly in the range of 40-60% for rail projects, 20-40% for fixed links projects, and 0-20% for road projects in Sweden. While in Hong Kong, a cost overrun of 23% for public sewage project was noted in 1999/2000 and the legislative council had brought this to the attention of the government and put forward the suggestion of an independent role of QS. The problem of cost overrun has an important implication for the highly expensive and highly consequential field for public policy, as the project cost is frequently debated for the public, politicians, administrators, bankers and media (Flyvberg et al., 2003). The situation is more or less the same in Hong Kong. There requires an institutional check and balances for the cost estimation and the foreseeable estimation errors. In effect, there are many different ways to increase the transparency of the foreseeable estimation errors as risk analysis has been mandatorily necessary for infrastructure projects. While the pattern of cost overrun is often similar between projects although the causes of overrun may differ, the role of QS in infrastructure projects is reviewed herewith to find out how the impact of the problem of cost overrun for engineering projects can be minimized from QS's perception.

2.1 Role of QS in Infrastructure Projects

QS can work with developers, clients, consultants and contractors. Presently, the QS involvement in engineering projects is limited by the right of action determined in terms of engineering contract provisions. In effect, similar to that of a building contract, QS can fully involve in engineering projects from inception to completion stages including conceptual design, detailed design, tender preparation and assessment, contract administration, valuation of claims and variation and preparation of final account etc.

Infrastructure refers to the basic physical and organizational structures required for the operation of a society. Infrastructure projects are therefore referred as construction projects covering building works, civil engineering works, mechanical and facilities services. Measurement for building projects is very detailed, precise and specific, and is measured by trades; whereas civil engineering jobs are measured by items due to different classification in the measurement rules. Similarly, measurement of mechanical engineering works basically comprise of pipework and equipment items. It is important to define the scope of the work as the measurement of engineering project requires analyze of the steps and procedures involved in constructing the item. Thus, the persons who have experience in doing the job and understand the scope of work would have better knowledge of the process of arriving at the cost. However, the settlement of the final account constitutes a number of negotiating meetings in discussing the claims and variations involved in the works. In this respect, good technical knowledge in monitoring work activities is essential to help converting the process into monitoring terms.

The Role of QS in engineering projects is generally divided into two stages: pre-contract and post-contract stages. In the pre-contract stage, the role of QS is limited. In the consultant side, QS is often employed as consultant or sub-consultant to prepare estimate and tender documents. Moreover, QS have to rely heavily on engineers' information in handling work duties and project cost management (including comparing the tenders and advising on the selection of the tenderer). When working with the contractor, QS is an employee of the contractor company and will be involved in the project cost control matter, including the budget review and cash flow planning in the pre-contract stage.

In the post-contract stage, the present QS consultancy is mainly about project cost and contract management including administering interim payments, assessment of claims and variation orders, preparation of final account and final account settlement. For the contractor QS, he has to monitor the performance of the sub-contractors for payment and changes in variation order.

2.2 Meaning of the Independent Role

Independent role of Quantity Surveyors in infrastructure works project was mentioned in 1999 when there is a cost overrun of 23% of a public sewerage project. As it had been pointed out that it was customary for building contracts to have a check and balance in the preparation and administration of contracts, the government agreed to consider the same for infrastructure projects (Ho, 2000). While it was contended also that it was convention to have engineering consultant to train up their QS, there was a feeling that QS's work was independent and there is no urgency to have an independent role. Twelve years to now, different requirements and practices may have evolved in the administration system and from changes in industry, and the independent role of QS in infrastructure projects should be reviewed.

There are two interpretations of the '*Independent role*' in the construction industry: the independent contractor (IC) and the independent engineer (IE). According to the term of IC, it is a role in seeking to employ alternative work arrangements in response to economic, technological and social changes. It implies that the employment is not permanent and the job is not stable and is subject to changing conditions. Independent contractors are sometimes called ICs, consultants, freelances, free agents or just contractors who are all self-employed for tax reasons in the U.S. Essentially the same in practice, IC is normally referred to self-employed agent. Thus, there are two distinctions of independent contractor based on the employment structure: one is for tax reasons, and the other is for reason at law.

At law, it is about the status of a worker as an employee or as an IC. The distinction dictates an employer's obligations and responsibilities to those retained by him, and to those affected by the action of the employees (Mau, 2006). The jurisdiction of the employment law provides a duty of care which exists towards employees under the law of tort, the existence of vicarious liability, the terms of the employment contract, the taxation system, the operation of the Mandatory Provident Fund Schemes and an employer's insolvency.

To distinguish an employee from an IC, a dyadic relationship can be referred. One is commonly known as an employer-employee relationship in a contract of employment whereas the other a work role relationship in a contract of service. Under a contract of service, the general rule is that an independent contractor provides a particular service and is retained from outside the employer's organization for the purpose of producing a particular result (Mau, 2006). There is no general obligation to serve the employer except for the performance of the contract, and there is no requirement from the employer to supervise the assigned task. However, it is beyond the content of this study to compare the contract of service
with the agency contract.

As for the independent engineer, in reviewing the FIDIC Forms of Contract, Bunni (2005: p.73) points out that the independence of a consulting engineer is outlined in the Statues and By-Laws of FIDIC which were first published in 1955. On a similar basis like that of ICE Form of Contract for civil engineering works, an independent consulting engineer, who is entrusted with the duties related to feasibility, design and supervision during construction of the project, is referred to as the ‘*Engineer*’ in the contractual arrangements between the developer and the contractor. The developer of such a project is referred to in these forms as the ‘Employer’.

According to the private building contract SFBC 2005 (p.11), the ‘*Engineer*’ is ‘*a person engaged as a member of the Employer’s design team for the design and supervisions of one or more of the geotechnical, civil, structural or building services elements of the Works*’. Based on Clause 1.7 in this building contract, the Architect may from time to time, delegate any of his duties and powers under the Contract to an Engineer. This means that there is a scope for delegating particular duty to a relevant professional whose competence is required for the Works. This role is usually termed as a sub-consultant role.

3. Literature Review

3.1 Cost Management

3.1.1 Perceptions of Cost Management Functions

In the construction industry, cost management is processes involves in cost planning, estimating and budgeting and controlling so that the project can be completed within the client approved budget for project success (PMI, 2008). In the management process, cost management is divided into cost planning and cost control of which cost planning is further divided into three elements, namely cost estimating, cost budgeting and cost modeling (Kyeong, 2008). Relationships of the elements are shown in Figure 1.

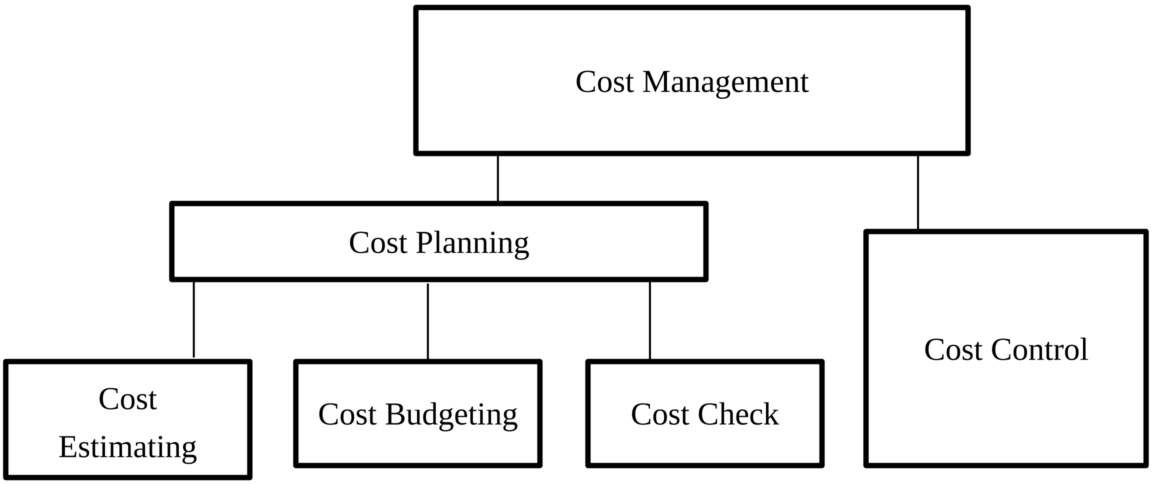


Figure 1: Cost Management Elements
Source: Project Management Body of Knowledge (PMI) (2008)

According to PMI (2008), cost planning is an inevitable step in the cost management process as it helps all members of the design team to ensure the project design is realistic and the estimated project cost is sufficient to contain any cost incurred by uncertainties. In general, the framework for cost planning in cost management is divided into three stages: pre-construction cost management, construction stage management and operation management.

Cost planning is the costing work that the quantity surveyors usually involve in the pre-construction cost management stage. Cost planning enables the control of project cost to within a predetermined sum at the outset of the project implementation (Ng et al. 1997). In general, the information needed for planning are obtained from the cost study and cost analysis of previous projects. Cost study refers to the breakdown of the total cost of building to establish its relationship whilst cost analysis is the systematic breakdown of cost data, which usually occurs in the form of elements (Ng, 1997). Ferry et al. (1999) also have similar idea and consider that a good cost planning system should ensure the tender figure is as close as possible to the preliminary estimate, or that the difference between the two is anticipated and within an acceptable range.

According to PMI (2008), cost planning includes 3 major processes: cost estimating, cost budgeting and cost check. Cost estimating is normally done in the project initial stage as to develop an approximation of resource costs about project completion. The estimation is normally produced by three appraisals, including economic, financial and commercial appraisals, which are used to capture capital cost, operational cost, whole life cycle cost and the funding to be made available. The aggregation of the cost estimation is about the cost budgeting of which the project cost baseline is established. The establishment of the project cost baselines helps for measuring project performance. Cost modeling techniques are also used for cost planning to reflect the process of construction as well as the product of construction. Different cost models are often used in different stages during the design process to make the cost prediction for cost management (Jaggar, 2002). Cost check, as defined by Seeley (1996), is the total process which ensures that the contract sum is within the client's approved budget or cost limit. In other words, the cost check is to ensure the tender received from the contractor is within the client project cost budget.

From the construction stage onwards, cost management is mainly about the cost control and cost monitoring for the contract sum. The monitoring of the contract sum is to ensure the cost is within the client's approved budget or cost limit during the construction process. The purpose of the cost control in this construction stage is mainly "*to give the client/project good value of money; to achieve the required balance of expenditure between the various parts of the project; and to keep expenditure of the amount allowed by the client*" (Flanagan and Tate, 1997, pp. 28). In other words, it is to ensure that resources are used to best advantage (Seeley, 1997). PMI (2008, pp. 179-180) points out that there are several key advantages to have the cost control in the project, which are listed as follows:

- Influencing the factors that create changes to the authorized cost baseline;
- Ensuring that all change requests are acted on in a timely manner;
- Managing the actual changes when and as they occur;

- Ensuring the cost expenditures do not exceed the authorized funding, by period and in total for the project;
- Monitoring cost performance to isolate and understand variances from the approved cost baseline;
- Monitoring work performance against funds expended;
- Preventing approved changes from being included in the reported cost or resource usage;
- Informing appropriate stakeholders of all approved changes and isolated cost; and
- Acting to bring expected cost overruns within acceptable limits.

Moreover, three basic principles are highlighted from the cost control techniques pointed out by Flanagan and Tate (1997, pp. 31):

(1) There must be a frame of reference or set conditions which must be adhered to
(2) There must be a method of checking or a feedback system
(3) There must a means of remedial action

Whilst the basic principles of cost control mainly apply to building projects, it is considered that they are also applicable to civil engineering projects, with consideration is made for the nature of the project.

The perspective of cost management functions are mainly viewed at two stages: pre-contract and post-contract stage. The cost management in the pre-contract stage involves cost planning and the establishment of a realistic first estimate, which is to ensure that the amount is correctly spent among the various project parts/elements. In the post-contract stage, the cost management function is mainly about cost control, which is to ensure the various elements are constructed within the cost plan.

3.1.2 Cost Risk

Risk has different meanings to different people, which is also generally seen as an abstract concept whose measurement is difficult (Raftery, 1994). Baloi and Price (2003, pp. 262) point out that the concept of risk often varies according to viewpoint, attitudes and experience. In general, the Oxford Advanced learner’s Dictionary (1995 ed.) defines risk as “*the chance of failure or the possibility of meeting danger or of suffering harm or loss*”. In construction projects, risk is regarded as the likelihood of a detrimental event occurring to the project (Baloi and Price, 2003).

By reviewing literatures, it is found that there are many classifications of risk. For instance, Thompson and Perry (1992) and Flanagan and Norman (1993) classifying construction project risks according to the source criteria, and consider the risks could be: technical, construction, legal, natural, logistic, social, economic, financial, commercial and political. On the other side, Tah et al. (1996) classify the risks by taking into account the location of the impact of the risks in the elements of the project. Thus, the risks are classified as internal/external; controllable/uncontrollable etc. External risks are those that are prevalent in the external environment and uncontrollable, including the economic, physical, political and technological risks (Tah et al. 1996). Internal risks are those risks that are related to the management of internal resources, more controllable and vary between projects. Examples of internal risks include design risk, construction-related risk, labour and materials risks etc.

Risk management has been regarded as a critical factor to successful project management, as construction project is becoming more complex with high competition. Risk assessment is therefore used to assess the uncertainty with regard to the costing decisions. Several studies have shown that number of risks in various aspects will constitute impact to project cost. For instance, Wood and Ellis (2003) consider that in civil engineering project, variety of risks is needed to take into account in anticipating the project cost. The risks include project buildability, design, construction, health and safety, logistics, business continuity, political risk, contractor and subcontractor performance, contract specific issues etc. Grimsey (2004) identify six areas of risks associated with the PPP project cost, namely public risk, asset risk, operating risk, sponsor risk, financial risk and construction risk. Chan et al. (2011) identified several key risk factors inherent with the contract values. The risks include variation nature, change in the scope of work, unforeseen ground conditions, fluctuation of materials price and approval from regulatory bodies for alternative designs.

3.1.3 Cost Modeling

In the past two decades, a number of scholars have provided some definitions for the term "*cost modeling*". Seeley (1996) defined it as "*a procedure developed to reflect, by means of derived processes, adequately acceptable output for an established series of input data*". Ferry et al. (1999) regarded it as "*the symbolic representation a system, expressing the content of that system in terms of the factors which influence its costs*". Ashworth (1999) considered it as the "*techniques used for forecasting the estimated cost of a proposed construction project*". Ashworth revised his definition in 2010 and considered the term as "*the symbolic representation of some observable system which* *exists in terms of its significant cost, features for the purposes of display, analysis, comparison and control*" (Ashworth, 2010, pp. 381). From these definitions, it is considered that "*cost modeling*" is a systematic representation of a procedure that delivers adequately acceptable output for an established series of input data. The procedure is determined through extensive analysis of data of an item that has influence on its cost and after being satisfied with the ability of the procedure to give a good representation of costs (Kirkham, 2007).

In construction industry, cost modeling technique is generally used to forecast construction costs for clients and estimate resource costs for contractors. According to Seeley (1996), the aim of the cost models is to represent accurately the whole range of cost variables inherent in the design as to secure improved cost forecasts and/or design optimization. All methods, techniques, or procedures that used by quantity surveyors for cost estimation or cost forecast are termed as cost models. By reviewing literatures, it is found that there are different classifications of the cost modeling techniques. For instance, Ashworth (1986) and, Fortune and Lees (1996) indicate that the models that used for cost predictions for building design could be traditional models (e.g. approximate quantities, unit cost estimating etc.), statistical models (e.g. regression analysis) and risk models (e.g. Monte Carlo simulation, knowledge-based, resource-based and whole life cost models). Nor (2007) state that the cost estimation models are classified into three main generations, including the traditional models (e.g. approximate quantities, functional unit, bills of quantities etc.), non-traditional models (e.g. Monte Carlo simulation, knowledge-based, resource–based and life cycle model) and new wave model (e.g. artificial intelligent system, fuzzy logic etc.).

In a similar vein, Jaggar et al. (2002) point out that the cost models that generally used within construction can be classified into deductive, inductive, optimization and stochastic. The deductive cost model (e.g. regression analysis) is about making inference and trends of cost by using statistical techniques. Under this type of cost model, cost prediction is expressed as a cost per square meter of the floor area. The limitation of use depends on the availability of the hard cost data and the high correlations exist between the variables. The inductive cost model (e.g. elemental estimating, bills of quantities) is based upon the algebraic expression of physical dimensions such that casual relations can be made between the cost data and the project information available. This model is more accurate in project cost prediction as the cost data/rates for construction components or building elements is obtained from historical database. The optimization cost model tends to seek the optimal solutions against given criteria. This model is difficult to adopt as the sizes and construction methods has to be obtained for getting an optimal design solution for the model. The stochastic cost model (e.g. Monte Carlo simulation) is used to assist QS to take into account of economic risk by using risk analysis technique in forecasting the project cost.

Different cost models are to be used at different stages during the design process and for different purposes. The choice of a method depends on many different factors, including the user's familiarity, information and time available, amount and form of cost data, purpose of the estimate and confidence with the results expected and achieved etc. (Nor, 2007) Researchers (e.g. Ashworth, 2010; Jaggar et al. 2002) suggest that all the above mentioned cost models are able to provide good predictions for cost management for building projects, and there also seems no problem in adopting those models for engineering projects.

3.1.4 High cost impact items

An extensive literature review has found that there are numerous items that can influence or determine the magnitude of construction costs (Elhag et al. 2005; Akintoye, 2000; Mochtar and Arditi, 2001). Chan and Park (2005) study point out that the project construction cost is affected by a number of items as the industry is multi-disciplinary and its work is done by a lot of parties. Generally, the construction project cost is affected by a cluster of variables that are related to the characteristics of the project as well as the market conditions (Warsame, 2006).

In the past few decades, a number of studies have done in-depth investigations about factors affecting project cost. For example, Akinci and Fisher (1998) group the factors that affect project cost into three dimensions, namely factors affecting the cost estimate; final cost and contract-specific factors. Factors that affect cost estimates are estimator–specific factors, and design and project specific factors such as the estimator's biases, vagueness in scope, design complexity and project size etc. Factors that affect the final cost are gathered into two major groups: construction specific factors as well as economic and political environment-specific factors. The construction specific factors include unknown geological conditions, weather conditions and client- and sub-contractor-generated risk factors. The economic and political environment-specific factors are about the economic and political risks such as the price fluctuation, high inflation rate, change in exchange rate, political instability and taxation changes etc. Akinci and Fisher (1998) consider that contract specific factors affect the project cost as the type of contract adopted affect the allocation of risk between the owner and contractor. Moreover, the contract clause included may result in ambiguity and disputes between project parties, which will lead to decrease in cost effectiveness in the project (Akinci and Fisher, 1998). Likewise, Akintoye (2000) presents 24 variables that affect project cost estimation and found that most of them also have impact on the final project cost. The variables are grouped under seven factors, namely project complexity, technological requirements, project information, project team requirement, contract requirement, project duration and market requirement.

In addition, Elhag et al. (2005) state that most of the significant factors affecting project cost are qualitative such as client priority on project time, contractor's planning capability, procurement methods, market conditions as well as the level of construction activity. Elhag et al. (2005) study results also found that technological and project design, contractor's expertise and management ability, and the client's desired level of construction sophistication play a role in determining the cost of the project.

Many authors also consider that there are some other factors affect the project construction cost. For instance, Williams (2003) claimed that the quality and constructability of the project design, contractor management techniques, project location and macroeconomic conditions have influence on the price of the project during construction. In Iyer and Jha (2005) study about factors affecting cost performance of Indian construction projects, it is found that the conflicts between project participants, poor project specific attributes, holistic socio-economic relations and climate conditions, aggressive contractor competition and short bid preparation time affect construction costs. Warsame (2006) systematize the factors that influence construction costs into four groups, namely project-specific factor, client and contractor-related factor, competition and market condition, and macroeconomic and political factors. The project-specific factor contains elements that are related to the project issues such as the size, quality and complexity of the project. The elements that include in the client and contractor-related factor are about the procurement method selected, contractor-client relationship etc. The competition and market condition comprises elements that are difficult to control by the client and contractor but can have a high impact on the costs and mark-up, such as the level of competition and market condition (Warsame, 2006). Macroeconomic and political factor includes elements about the economic situation and political issues such as inflation, interest rate fluctuation and government regulations.

After carefully studied about the items influencing project costs, three groups of factors, namely contract management factor, economic and financial factor and, project issue factor, are formed as to examine their impact to project cost. The contract management factor contains items that are considered to be related to the administration of the clause that stated in the construction contract. The elements include valuation of variation, assessment of claims, re-measurement of the provisional quantities etc. The economic and financial factor comprises that are difficult to control by the construction parties but can have a huge impact on the construction cost in the project. Examples of the economic and financial factor include inflation rate and exchange rate. The project issue factor contains items that are related to a particular project such as the contract management, programme and site condition of the project.

3.1.5 QS Involvement in Cost Management Functions

Presently, QS involvement in cost management functions in engineering projects is limited by the right of action determined in terms of engineering contracts provisions. The involvement of QS in cost management functions is generally divided into two stages as the pre-tendering and post-tendering stage. However, the present QS consultancy provided is mainly at the post-contract stage via administrating interim payments, assessment of variation orders and preparation of final accounts.

3.1.6 Relationships between Cost Management Features, Cost Risk, Costing Methodologies, and High Cost Impact Items

In general, it is considered that there are some relationships between cost management features and cost risk involved in civil engineering projects. For example, change in project design, disputes over claims and variations lead to the difference between the final contract amount and the contract award amount (McKim et al. 2000). The contractor capability and economic factors such as interest rate affects the final cost of the project (Akinci et al. 1996). On the other side, the use of different cost management mechanism may reduce the cost risks involved in the civil engineering projects. For example, Kerzner and Belack, (2010) point out that contingency reserve is maintained in the project budget for scope changes and to compensate for unforeseeable risks. Ashworth (2010) indicate that the cost checking of the project design can ensure the design is cost-comparable and nothing has been overlooked, which minimizes the disputes and change in project design in the construction stage.

In addition, it is considered that the costing methodologies adopted and items having high cost impact in civil engineering projects are also influenced by the cost management features and cost risks involved in the civil engineering projects. For example, Ashworth (2010) point out that value management assessment is often conducted in the design process for a construction project as to provide value for money for the client/owner of the project. Sensitivity analysis is often conducted to assess the effects of different types of risks on the project. Concerning items having high cost impact, it is found that the design complexity leads to the adoption of advanced technology and specialized equipment, which often leads to increased total cost of the project (Akinci et al. 1996). The environmental issues (e.g. weather condition) can cause additional costs of claims, variations and provisional amount, which leads to the increase in actual cost during construction (Nkado, 1995). Moreover, it is reasoned that QS demographic status may also affect their perception to different aspects, of which are also taken into account for relationship examination. Considering all of the above, a research framework is developed to examine the relationships between various aspects.

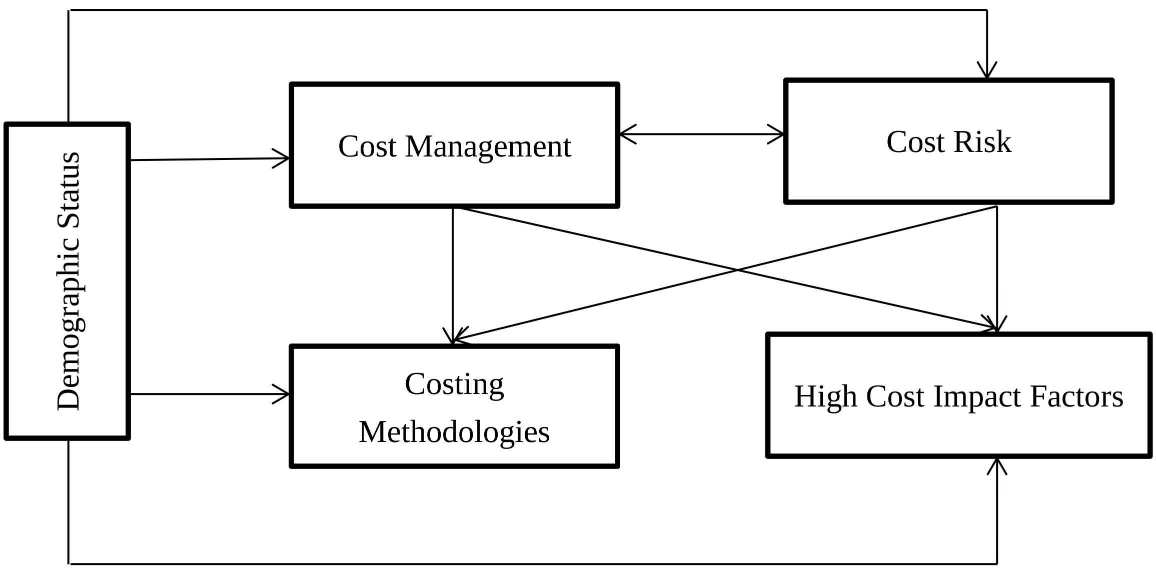


Figure 2: Research framework of the Relationships for QS Profession

3.2 Contract Management

Since QS is in charge of preparing the construction contract documents, offering cost advice and monitor the construction cost and construction contract, the role of QS differs in a building contract from an engineering contract because of certain specific contract clauses. The independent role of QS in contract management is characterised by its neutral position in making decisions about money. Thus it is important to acknowledge whether there is procedural justice and fairness in the process of handling cost matters and the integrity of the person involved in the process. In view of this, contract clause and the underlying principles including procedural justice and fairness, ethical principles concerning proportionality and accountability are discussed here.

3.2.1 Contract Clauses

In reviewing the contract references in connection to payment, clauses relating to payment, variations and claims are discussed. A building contract and an engineering contract are adopted here to facilitate a comparison of the understanding of the independent of QS described under the contract. The building contract (A) used for this comparison is based on the 2005 edition of Agreement and Schedule of Conditions of Building Contract for use in Hong Kong Private edition (with quantities). The engineering contract (B) is based on the General Conditions of Contract for Civil Engineering Works 1999 edition in use for government projects, and the General Conditions of Contract for Building Works 1999 edition (C) will also be referred when deemed necessary.

3.2.1.1 Clauses relating to payment

(A) Clause 32.1(5) the Quantity Surveyor shall make an interim valuation of the work in progress in accordance with clause 32.3 to determine the estimated amount due in an Interim Certificate……

And

Clause 32.1(1) the Architect shall issue an Interim Certificate ……

(B) Clause 79.(1) ….the Engineer shall value and certify and within a further 21 days the Employer shall pay to the Contractor after deducting previous payments on account and any other sum deductible by the Employer under the Contract the sum which in the opinion of the Engineer is due, based on the rates in the Contract where appropriate….

(C) Clause 79.(1) Same as (B), but 'Engineer' is replaced by 'Surveyor'.

In the building contract, Architect is the decision-maker for the final approval of payment and is the certifier, but it is QS to value the amount of payment. When referring to the government building contract, the Surveyor is the decision-maker for payment, in terms of both valuation and certification, whereas in the engineering contract, the Engineer is the decision-maker for payment. Comparing these contracts, it can be seen that the lead consultant in the building contract is the Architect whereas the lead consultant in the engineering contract is the Engineer, but in the government building contract, perhaps due to financial accountability, there is a separate leading role for financial matters.

3.2.1.2 Clauses relating to variations etc.

(A) Clause 13.3 The Quantity Surveyor shall measure and value work carried out by the Contractor in response to an Architect's instruction ……

(B) Clause 61.(1) The Engineer shall determine the sum which in his opinion shall be added to or deducted from the Contract Sum as a result of an order given by the Engineer ……

(C) Clause 61.(1) The Surveyor shall determine the sum which in his opinion shall be added to or deducted from the Contract Sum as a result of an order given by the Architect ……

In the building contract, QS is explicitly described with the responsibility for measurement and valuation for variations and such like, whereas in government contracts, the responsibility for the adjustment of the contract sum is vested with the Engineering in an engineering contract and in Surveyor in a building contract.

3.2.1.3 Clauses relating to claims

(A) Clause 27.2(1) ….the Architect shall instruct the Quantity Surveyor to ascertain the amount of any additional payment for direct loss and/or expense incurred by the Contractor……

(B) Clause 63. If upon written application by the Contractor to the Engineer is of the opinion that the Contractor has been or is likely to be involved in expenditure for which the contractor would not be reimbursed by a payment made under any other provision in the Contract by reason of the progress of the works or any part hereof having been materially affected by ……… then the Engineer shall ascertain the Cost incurred and shall certify in accordance with Clause 79.

(C) Clause 63. Same as (B), but 'Engineer' is replaced by 'Surveyor'.

For the assessment of additional payment for claims, loss and/or expenses and such like, the decision-making role and designated responsibility are the same as for payment, variations and claims.

3.2.2 Procedural Justice and Fairness

Procedural justice is normally referred as a legal procedure to provide the party facing an unfavourable outcome an opportunity to seek further judgement for his/her case. Thus the court appeal system and judicial review are some of these forms in the law of court carrying this duty. By the same token, the procedural justice provided in the contract is to provide the suffered party this opportunity. Therefore the procedural justice can be seen in the dispute resolution clause for which negotiation with senior persons, mediations, adjudications, dispute panel/board and arbitration are one of these channels for procedural justice at contract level. All contracts are equipped with the clause provision for dispute resolution and the point is who is in the lead of making the final decision at each tier of the dispute resolution method without going to legal procedural or nowadays the semi-legal procedure. Such administrative system is to provide fairness to the suffered party. According to the case ***R v. Home Secretary, ex parte Doody*** [1994] 1 AC 531, at 560, in considering judicial review, Lord Mustill has stated that:

> *"Fairness will very often require that a person who may be adversely affected by the decision will have an* ***opportunity to make representations*** *on his own behalf either before the decision is taken with a view to producing a favourable result; or after it is taken, with a view to procuring its modification; or both".*

What if the suffered party has no knowledge that he/she is facing an unfavourable result without someone speaking it out, and for that reason suffered from financial losses as mentioned in the case that:

> *"Since the person affected usually cannot make worthwhile representations without knowing what factors may weigh against his interests fairness will very often require that he is* ***informed*** *of the gist of the case which he has to answer".*

It is considered that QS has the knowledge and skill to identify problems when the issues are unaware by others, and for this reason, we start to question how the independent role of QS will help to achieve this in different contracts.

3.2.3 Ethical Value and Principles

In recent years, professional organizations in the construction industry have been advocating the code of ethics specific to the construction industry. The Union of International Architects explicitly spells out competence as rudimentary requirement in the profession. Professional competence is referred by the Engineering Council (2007) as integrating knowledge, understanding, skills and values that go beyond the ability to perform specific tasks. Similarly, the Royal Institute of Chartered Surveyor (2009) in U.K. defines surveyor's standard of care as "*strategic advice on the economics, valuation, law, technology, finance and management of all the world's* *physical assets*" ranging from building construction to infrastructure and property portfolio management. In most cases surveyors are contractually bound to the owner and interact frequently with the designer through construction document and bidding, and, with contractor through construction to project closeout. As an economic gatekeeper of construction project, the surveyor has an influence on the proper use of construction funding. The principles of proportionality and accountability (RICS, 2009) are taken here as values for exercising judgment at work.

3.2.3.1 Proportionality

The first principle, proportionality, refers to the amount of information a professional chooses to withhold or to disclose (Fewings, 2009, p. 22). The judgment to proportionate information access is a matter of both competence and accountability. A crucial difference between a professional and a "*laymen*" is one's capability to make sound judgment and act in a prudent way. Profession is considered as an occupation group with some special skill and to distinguish a profession from the community, it is expected that certain ethical standards can be found in a professional, and these ethical standards are generally regarded as high standard in the society (Abott, 1988; Engineering Council, 2007). The principle of proportionality is originally a political maxim, initially developed in the German legal system, which states that no layer of government should take any action that exceeds that which is necessary to achieve the objective of government. Bortoluzzi (2008) takes this further to relate proportionality to the principle of reasonableness in considering the sources of contract disparity in the relational concept in the Italian Community law. Although it has been regarded as a judicial criterion for state functions, it is however a valid base for regulating the professional code of ethics. Fewings (2009) thus refers proportionalism to the responsibility of a manger to consider the outcomes: an act may be morally right, but one needs to distinguish between good or right outcomes.

3.2.3.2 Accountability

The second principle, accountability, refers to having a clear purpose and understanding of the professional role (Fewings, 2009, p. 22). The understanding dictates to whom the knowledge workers are managing for and to whom they are being held accountable. The sense of purpose carries an ethical dimension and determines the extent of its impact in the society. Similarly, Gardner (2007) pointed out that for a society to thrive, professionals need to have the psychological contract of their social obligation and professional obligation. Professional obligation includes one's standard of care as understood in the industry. The purpose is to ensure professionals do not adhere only to basic job description, but extend accountability to own competence, client's expectations and needs, legal and ethical standards. Klatt (1999) consider accountability as the foundation for an ethical business culture. They add that accountability and empowerment are inseparable and are about shared achievement. It is acknowledged that misunderstandings to be uncovered and resolved quickly before time and resources are wasted is also a form of accountability in team working.

3.3 The Meaning of Independent QS Role

3.3.1 The Independent Engineer

The concept of the independent role is firstly referred to in engineering contracts such as the ICE form of Contract and FIDIC. The definition, qualities and independence of a consulting engineer are outlined in the Statues and By-Laws of FIDIC which were first published in 1955 and developed in years. Bunni (2005) points out that "*independence*" refers to "*a strictly fiduciary manner, one of trust, which is essential not only to the whole relationship between the employer and the consulting engineer but also to that between the employer and the contractor*", and in particular the role of the engineer in dispute resolution. This means that the independent role is firstly referred to an '*Independent Engineer*'. Bunni (2005) further points out that the first two questions the Contractor will ask himself are: "*Who are my competitors and who is the Consulting Engineer?*" and for this reason, an experienced contractor will include his price calculation a factor for the way he expects the Engineer to function. This suggests that there is a different level of independence even there exist a definition and a quality requirement of a consulting engineer.

In the ICE form of Contract, the duties related to feasibility, design, and supervision during construction of the project are entrusted to an independent consulting engineer who is referred to as the '*Engineer*' in the contractual arrangements between the '*Employer*' and the '*Contractor*'. This indicates clearly three stages of independence takes place in the design and construction process. The major difference in the NEC contracts when comparing with other engineering contracts is that the availability of the payment options based on the six main formats of pricing mechanisms each with different levels of price certainty and varying risk allocation. The pricing mechanisms are:

(1) Option A (priced contract with activity schedule);
(2) Option B (priced contract with bill of quantities) provides that the contractor will be paid attender prices;
(3) Option C (target contract with activity schedule);

(4) Option D (target contract with bill of quantities) provides that the financial risks are shared between the contractor and the employer in agreed proportions;
(5) Option E (cost reimbursable contract); and
(6) Option F (management contract) is a cost reimbursable contract, where the risk is largely taken by the employer. The contractor is paid for his properly incurred expended costs together with a margin.

For the NEC Conditions of Contract, the project manager is the main party involved in the management of the contract administration. There are express duties of the project manager described under different clauses in the contract. The payment options, valuation of variations and assessment of claims are thus varied with the type of pricing documents adopted for the project. Regarding payment, the project manager is required to assess the amount due for payment and to certify the same within one week of each assessment date (Cl.50.1, Cl.51.1). This project manager is also required to assess a compensation event (Cl.64.1) and to certify final payments within 13 weeks of final payment (Cl.94.4). As for contract strategy, Eggleston (1996) considers two major determination factors, employer's concern about the certainty of price and the procurement method for selecting the contractor and the form of contract. Thus the following issues are to be addressed in selecting a pricing option:

(1) Which party is to be responsible for design?
(2) How important to the employer is certainty of price?
(3) What views prevail on the allocation of risk?
(4) How firmly known are the employer's requirements and what likelihood is there of change?
(5) What operating restrictions apply on the employer's premises or in the construction of works?
(6) What emphasis is to be placed on early; commencement and/or rapid completion?
(7) What flexibility does the employer need in the contractual arrangements?
(8) How anxious is the employer to avoid or to minimize formal disputes and legal proceedings?
(9) How important to the employer is the concept of single point responsibility?

Besides the consultant contract and the contractor contract in the NEC contracts, there is also an adjudicator's contract. The employer is entitled to name the adjudicator before or during the tendering period, and the appointment of the adjudicator is subject to acceptance of the relevant parties based on an independent contract or as in a professional service contract with a joinder provision per Cl.91.3. This arrangement puts forward the possibility of having an adjudicator to work in the spirit of independence (Eggleston, 1996).

3.3.2 Independent Role of QS

What then is an independent role of QS generally refers to? With an information search from Google search which nowadays provides a quick source of information, the following statements provide some indication after some screening:

- The QS acts in a position as "*an independent contractor and is a trusted and respected source for professional consultation*". [1]

- The QS's traditional *independent* role on the *team* comprising client, architect, engineers and contractor has given him a reputation and appreciation for fairness. [2]

- In answering to a question of "*Describe how the independent quantity surveyor's role developed*?" even though a direct answer is not given, an indirect answer implies that independent role of QS is developed from a proper education and training, with a working profile that they can both standalone and be working with both clients and building contractor. [3]

- *independent* quantity surveying *services* to public and private sector [4]

Although the source may not be considered reliable for the study, this provides a general view that QS services can be applied to consultant and contractor, public and private clients and are considered to be a trusted service. Hiew and Ng (2007) suggest that QS will take up the role of a lead consultant and key adviser at strategic levels of organizations

1. http://ezinearticles.com/?The-Role-of-the-Quantity-Surveyor&id=3850546
2. http://vexiflex.blogspot.hk/2012/05/role-of-quantity-surveyor.html
3. http://wiki.answers.com/Q/Describe_how_the_independent_quantity_surveyor's_role_developed
4. http://www.rpsgroup.com.au/service/quantity-surveying

4. Research Design and Methodologies of the Study

4.1 Research Design and Methodologies of the Study

The research would employ both quantitative and qualitative techniques, based on information obtained from literature reviews and through discussions with people in the construction industry. The proposed project is intended to provide a comparative dimension by collecting data/text information and comparing the industry experience of the professionals such as Quantity Surveyors.

Questionnaire survey is sent to individual QS to examine his/her view to the cost management issues. Questionnaire survey is used for data collection as the individual view can aggregate group view about QS perception on cost management issues with more accuracy. This is supplemented with a qualitative study (semi-structured interviews) for obtaining an in-depth understanding about the independent role of QS in engineering projects. The semi-structured interviews with QS professions working in the industry facilitate the focusing of the problem, sample grouping and interpreting the quantitative results obtained in questionnaire survey in a richer context. On the other hand, QS involvement in contract administration and the development of independent role are also investigated in the semi-structured interviews. Quantitative data will be analysed with basic statistic tools and factor analysis via using the software IBM SPSS 19.0. Qualitative data will be discussed and inferred with respect to cost management, contract management and the independent role. It is believed that the adoption of both questionnaire surveys and interviews in data collection can help to provide a better understanding about the current situations and the independent role of QS in engineering projects.

4.2 Quantitative Method – Questionnaire Survey

The questionnaire survey is sent to the targeted respondents (i.e. quantity surveyors working in the Hong Kong construction industry) by e-mail through relevant professional and associated institutions with internet-link provided. The respondents can fill in the questionnaire directly by click in the internet-link using "*Survey Monkey*". The questionnaire is used to examine quantity surveyor's view on cost management aspects in civil engineering project.

4.3 Questionnaire Description

An exploratory survey is conducted with quantity surveyors working in the Hong Kong construction industry. The questionnaire used in this study consists of five parts: demographic background of the respondents, QS view on: (a) cost management aspects, (b) cost risks involved, (c) costing methodologies frequently used and (d) high cost impact items, in engineering projects.

The first and last parts focus on collecting the background information of the respondents, including working fields, nature of works they are working in the past three years, working position, working sector and working experience in the profession. The questions are asked in close-ended format, with a number of options provided for respondents to select that best indicated their particulars.

The second part consists of 48 items, which are focused on examining QS perception on cost management aspects for civil engineering projects. The items are developed based on the thorough literature review in cost management references, such as Ashworth (2010); Griffth et al. (2004); Kerridge et al. (1984); Seeley (1996) etc. All items in this part use a 5-point likert scale ranging from strongly disagree (1) to strongly agree (5).

The third part consists of 17 items and is used to examine QS perception about the risks that frequently take place and have cost impact in civil engineering projects. The items are developed based on the risk factors documented in previous research studies by related scholars, such as Shen (1997); Grimsey and Lewis (2004); Ng and Loosemore (2007) and Chan et al. (2011) etc. All items in this part use a 5-point likert scale ranging from strongly disagree (1) to strongly agree (5).

The fourth and fifth parts focus on measuring QS perception about the costing methodologies frequently used and high cost impact items in civil engineering projects respectively. The costing methodologies that included for measurement are obtained from previous studies such as Ashworth (2010); Jackson (1984) and Seeley (1996) etc. The high cost impact items are developed based on the project cost factors documented in previous studies by related scholars such as Akinci and Fischer (1998); Akintoye (2000); Iyer and Jha (2005) and Warsame (2006) etc. All items in the two sections adopt a 5-point likert scale ranging from strongly disagree (1) to strongly agree (5).

4.4 Qualitative Method – Interviews

According to Creswell (2003) and Tuuli (2009), observations, interviews and document studies are the common methods that used for collecting qualitative data. Because the main purpose of using qualitative method in this study is to explore QS considerations about their independent role in engineering projects in a richer context, observations or document analysis are therefore not suitable to be used. Regarding interviews, they can be conducted in the setting of telephone interview, face-to-face interview or focus group interview with the form of unstructured or semi-structured. Following Bryman (2001) suggestion that semi-structured interview is an appropriate method for exploring issues with clear focus, this study adopts face-to-face semi-structured interview in collecting QS views on the independent issues. Semi-structured interview allow flexibility in probing insights by follow up questions and provides both interviewers and interviewees with opportunities to make constant clarifications.

4.5 Description of Semi-structured interview

Semi-structured interview is carried out with the help of an interview guide, which contains a number of themes related to the research topic and includes a list of relevant questions. The interview is normally recorded and transcribed. The transcriptions are used as materials for analysis and interpretations.

Ethnical issues are also taken into account in interviewing. At the beginning, interviewees are informed about the purpose, procedures and usage of the interview. The nature of the topic is also explained in general. Confidentially is also assured to the interviewees i.e. the personal information of the interviewees would not exist in the report.

4.5.1 Profiles of Interviewees

Based on the research design, 10 experienced QS working in the Hong Kong construction industry are invited to participate in the interviews. The main method for identifying interviewees is through the contact obtained from the questionnaire survey respondents. All the 10 interviewees are experienced QS and have more than 20 years working experience in the construction industry. This implies they have very deep understanding about the profession and their views about QS independent role and involvement in civil engineering projects are representative. All the interviews are conducted with English, and Cantonese is used as supplementary for necessary explanations. The profiles of the 10 interviewees are listed in the following table.

Interviewees	Position Level	Company Nature
1	Former QS Director	Quantity Surveying Consultant
2	Former QS Director	Quantity Surveying Consultant
3	Professor	Tertiary Institution
4	QS Director	Engineering Consultant
5	QS Director	Engineering Consultant
6	Quantity Surveyor	Quantity Surveying Consultant
7	Senior Contracts Administration Manager	Engineering Consultant
8	Senior Resident Quantity Surveyor	Contractor
9	Quantity Surveyor	Engineering Consultant
10	Quantity Surveyor	Client/Development Office

Table 1: Profile of Interviewees

5. Analysis and Discussions of Findings

5.1 Cost Management

5.1.1 Demographic Information of Survey Respondents

When the survey is closed, 165 responses are collected and a preliminary analysis is carried out for the understanding of their background. The demographic information of the survey respondents is provided in Table 2.

Items	Label	Frequency	Percentage
Working Fields	QS Consultant	38	26.2%
	Civil Engineering Consultant	17	11.7%
	Contractor	**56**	**38.6%**
	Client	34	23.4%
Nature of Works	Civil Engineering	44	28.0%
	Building	**64**	**40.8%**
	Building and Civil Engineering	49	31.2%
Working Position Level	Policy making (planning) level	14	8.9%
	Project management (group of projects) level	63	39.9%
	Project (single project) level	**81**	**51.3%**
Company Attribute	Public	16	20.8%
	Semi-public	6	10.4%
	Private	**53**	**68.8%**
Working experience in the profession (Years)	1-3 years	7	9.1%
	3-5 years	1	1.3%
	5-7 years	2	2.6%
	7-10 years	4	5.2%
	More than 10 years	**63**	**81.8%**

Table 2: Description of demographic information of survey respondents

A number of characteristics are identified from the demographic information of survey respondents. The majority of the respondents (more than 80%) have more than 10 years working experience in the profession. Nearly 70% of the respondents are working in the private sector. However, more than 50% of the respondents are working in the project (single project) level. In addition, a high portion of the respondents (over 40%) involves in building projects, rather than civil engineering projects in the last three years. The number/percentage of respondents working with contractors and consultants are nearly the same; whilst more than 20% of the respondents are working for the client.

5.1.2 Data Analysis for Questionnaire Results

The IBM SPSS 19.0 is used for data analysis. Reliability and factor analyses are conducted to examine the internal consistency of the items. The analysis is narrowed down the list of items as to obtain meaningful constructs or factors for each question. In addition, the mean scores of three highest and lowest scored items in each question are also examined in relevant tables. The analysis of variance (ANOVA) is carried out at the 95% confidence interval to examine whether there are significant views between means of groups on the items. Following ANOVA, the t-test is carried out at the 95% confidence interval to examine which two groups of respondents are having significantly different perceptions on the relative importance of items in the questions. Correlation analysis is also carried out in the later stage to examine the relationships between different aspects in the questions.

In examining whether the difference in demographic status would affect QS perception to the items in the questions, it is found that some demographic groupings have only small number of respondents. Thus, some groupings of the demographic variables are re-arranged to provide a representative analysis. The demographic findings show that there is only a small number of respondents consider themselves as working in the "*Policy making level (planning)*" group. Thus, this group is combined with the "*Project management (group of projects) level*" group and labeled as "*Project planning and management (group of projects) level*" in the analysis. In the "*company attribute*" issue, the data findings show that there is only a small number of respondents consider themselves as working in the semi-public sector. Thus, this group is added in the "*public sector*" group in the analysis. Moreover, the demographic findings also show that there are only a small number of respondents having less than 10 years of working experience in QS profession. Thus, these respondents are grouped together under a group called "*less than 10 years working experience*" in the analysis.

5.1.2.1 Quantity surveyor's view on cost management aspects in engineering projects

Identification of cost management factors

Reliability and factor analysis are conducted to obtain meaningful constructs of cost management features. The 48 items about cost management in the questionnaire (see Question 4) are analyzed. 23 items are excluded from the factor analysis due to their low internal consistency (Alpha < 0.70). The factor analysis is conducted by principal component analysis using Varimax maximization (Eigenvalue = 1 is used as the cut-off value). To ensure the construct validity, only those items that have obtained factor loadings greater than 0.40 are accepted and retained for further analysis (Stevens, 1996). After several rounds of factor analysis exercises, 11 items are eliminated as they have low factor loading or having significant loading on more than one component. The remaining 15 items are classified into 4 factors as shown in Table 2.

Factor	Label	Reference	Item	Factor Loading	Alpha
F1	QS work duties in project management	19	We usually have a detailed arrangement of the logistics for the project.	.832	0.842
		17	Health and safety issues are always our priority for the project.	.735	
		8	We aim to achieve the required balance of expenditure between the various parts of the project.	.731	
		34	We are usually commended for effective cost monitoring.	.652	
		7	Our work is to maintain good value of money for the project.	.648	
F2	Team influence on cost management	45	We recognize that project management of construction work is a multi-disciplinary art requiring professional services.	.883	0.771
		46	We require a cohesive working team of people with different management expertise for this project.	.856	

Factor	Label	Reference	Item	Factor Loading	Alpha
		20	Somehow there are a lot of political risks for engineering projects and they affect cost.	.580	
		2	There are set conditions to be adhered to for cost control.	.518	
F3	Costing methodology	33	We have a formula or certain comprehensive methodology for forecasting future cost.	.804	0.736
		30	We have the knowledge to manage these monetary reserves.	.770	
		24	Risk management or risk assessment process will continue throughout the design and construction stage.	.710	
F4	Pre-contract cost review	12	The cost is thoroughly reviewed during a period after tendering and before the contract is awarded.	.874	0.825
		11	The cost is thoroughly reviewed at the pre-tendering stage	.866	

Note: All items are measured on a 5-point scale

Table 3: Factor Analysis of Cost Management Items

Table 3 shows that four factors (F1, F2, F3 and F4) of cost management aspects are obtained in the factor analysis. The four factors include QS work duties in project management, team influence on cost management, costing methodology and pre-contract cost review, with Cronbach's alpha values of 0.842, 0.771, 0.736 and 0.825, respectively, indicating reliable internal consistency.

Highest and Lowest average rating cost management aspects

Table 4 shows that Items 48, 5 and 45 have obtained highest average rating amongst all the cost management aspects, with a mean score of 4.1235, 4.1149 and 4.1084, respectively. This implies that QS consider that the provision of warning signal, project cost factors and parties involved in managing the engineering project are important for cost management in engineering projects. On the other hand, the table also shows that Items 39, 37 and 35 have obtained lowest average rating amongst all the cost management aspects, with a mean score of 2.6463, 2.7229 and 2.7470, respectively. This implies that QS consider that the project cost estimate is often provided by the in-house staff and both time and cost performance cannot be predicted at 25% completion.

Rank	Reference	Item	Mean
Highest			
1	48	There are cost factors such as site location, programme, procurement strategy, contract management, market conditions, contractor's workload and technology etc. requiring judgment for preparing the cost estimate.	4.1235
2	5	A warning signal will be provided if it is anticipated that there is cost over-run.	4.1149
3	45	We recognize that project management of construction work is a multi-disciplinary art requiring professional services.	4.1084
Lowest			
1	39	The estimate is usually not provided by the in-house staff but by people not affiliated with the project.	2.6463
2	37	We can accurately predict the time performance at 25% completion of the project.	2.7229
3	35	We can accurately predict the final cost at 25% completion of the project.	2.7470

Table 4: Cost management aspects having highest and lowest average rating amongst QS

Comparison of QS perceptions to cost management aspects between demographic groups

An ANOVA test is conducted at the 95% confidence interval to examine whether there are significant differences between means of groups on the question items. Table 4 is the Tukey Multiple Comparison Table developed from ANOVA, which shows the cost management aspects that have significant different means between groups under different demographic status. It is found that in a number of cost management aspects, there are significant mean differences between QS working in the Consultant and, Contractor and Client (see Table 5). Concerning the project involvement, it is found that there are significant mean differences between QS mostly involved in "*building project*" and "*civil engineering project*" in several cost management aspects. Furthermore, the ANOVA results also show that QS difference in other demographics (e.g. working experience, working position etc.) also contribute to significant mean differences in some cost management aspects (e.g. value of money, speed of construction etc.). Details of QS different perceptions on the cost management aspects are shown in Table 6.

Multiple Comparisons

Tukey HSD

Item	(I) Which of the following best describe the field you are in?	(J) Which of the following best describe the field you are in?	Mean Difference (I-J)	Sig.
1	Consultant	Contractor	.58081	.019
2	Consultant	Contractor	.46465	.042
4	Consultant	Contractor	.90446	.000
18	Consultant	Contractor	.59048	.024
34	Consultant	Contractor	.49048	.040
40	Consultant	Contractor	.63810	.007
		Client	.70000	.015
42	Consultant	Contractor	.56667	.044
44	Consultant	Client	.82222	.016
9	Building	Building and Civil Engineering	.54545	.046
12	Civil Engineering	Building	-.59039	.046
17	Civil Engineering	Building	.57604	.038
29	Civil Engineering	Building	.69816	.037
26	PPM	PL	.4151	.032
41	Public Sector	Private Sector	.5383	.007
4	WE (less than 10 years)	WE (more than 10 years)	.6762	.024
7	WE (less than 10 years)	WE (more than 10 years)	.6638	.006

Note: PPM – Project Planning and Management (Group of Project) Level; PL – Project (Single Project) Level; WE – Working Experience

Table 5: Cost management aspects having significant different mean scores between groups

Reference	Item	Consultant	Contractor	t-value	p-value of t-test
1	There are guidelines for preparing the cost estimate.	3.9697[1] 0.80951[2]	3.3889 0.93435	2.748	0.008
2	There are set conditions to be adhered to for cost control.	3.9091 0.52223	3.4444 0.93944	2.566	0.013
4	Our role is focused on issues to	4.2188	3.3143	4.020	0.000

	give the client good value of money.	0.75067	1.05081		
18	The environmental issues always cause us alarm in the engineering design.	3.9333 0.73968	3.3429 0.99832	2.671	0.010
34	We are usually commended for effective cost monitoring.	3.8333 0.74664	3.3429 0.80231	2.537	0.014
40	There is usually a problem when the clients have to stipulate a maximum cost.	3.8667 0.68145	3.2286 0.87735	3.233	0.002
42	Our clients would consider engaging cost consultants as a strategic partner such that a consultant can become a solution provider for any cost matters.	3.5667 0.93526	3.00 1.00	2.346	0.022

Reference	**Item**	**Consultant**	**Client**	**t-value**	**p-value of t-test**
40	There is usually a problem when the clients have to stipulate a maximum cost.	3.8667 0.68145	3.1667 0.92355	3.011	0.004
44	Quality of the construction work is seldom a problem.	2.7333 1.01483	3.5556 0.85559	-2.876	0.006

Reference	**Item**	**Civil Engineering**	**Building**	**t-value**	**p-value of t-test**
12	The cost is thoroughly reviewed during a period after tendering and before the contract is awarded.	3.3793 0.94165	3.9697 0.76994	-2.680	0.010
17	Health and safety issues are always our priority for the project.	4.2857 0.7629	3.7097 0.86385	2.702	0.009
29	Such reserves are usually more than 10% of the contract value.	3.2143 1.03126	2.5161 1.12163	2.480	0.016

Reference	**Item**	**Building**	**Building and Civil Engineering**	**t-value**	**p-value of t-test**
9	We have to keep expenditure of the project within that allowed by the client.	4.2424 0.61392	3.6970 1.10354	2.481	0.016

Reference	Item	PPM	PL	t-value	p-value of t-test
26	Speed of construction is usually our pride for the project.	3.2128 0.85811	3.6279 0.91577	-2.176	0.032
Reference	**Item**	**Public Sector**	**Private Sector**	**t-value**	**p-value of t-test**
41	There is always a problem when the brief or the client requirement is not detailed enough for the design team to work out the cost.	3.5417 0.93153	4.0800 0.69517	-2.785	0.007
Reference	**Item**	**WE (less than 10 years**	**WE (more than 10 years)**	**t-value**	**p-value of t-test**
4	Our role is focused on issues to give the client good value of money.	3.3077 0.75107	3.9839 0.99987	-2.301	0.024
7	Our work is to maintain good value of money for the project.	3.3846 0.50637	4.0484 0.81838	-2.805	0.006

Note: PPM – Project Planning and Management (Group of Project) Level; PL – Project (Single Project) Level; WE – Working Experience; [1]- Figures in the upper part are the mean scores, which represent degree of agreement on the items, "1" means strongly disagree and "5" means strongly disagree; [2] – Figures in the lower part are standard deviations of the mean scores

Table 6: QS different perceptions to cost management aspects

The t-test results indicate that the mean scores for a number of items given by QS working in the Consultant are significantly higher than those QS working in the Contractor and Client (see Table 6). This implies that QS working in the Consultant generally considers that the features are important for cost management as compared to those working in the Client and Contractor. In addition, the mean scores for "*value of money*" (see Table 4, Items 4 and 7) of QS having more than 10 years of working experience are significantly higher than those with less than 10 years of working experience. This indicates that QS having more working experience generally considers that "*value of money*" aspect is important for cost management as compared with those having less working experience. Furthermore, the results of the t-test found that the different in some other demographic status would lead to QS different perceptions on whether some items are important in cost management, such as the perception about speed of construction amongst QS working in different position (t =

2.176, p = 0.032) and project brief details amongst QS working in different company sector (t = 2.785, p = 0.007).

In general, it is considered that the team influence and project issues are most important factors on cost management in civil engineering projects as they have obtained highest average rating amongst all items (see Table 4). Thus, QS should pay attention to these two areas as to provide good cost management for civil engineering projects. On the other hand, it is found that the different demographics (e.g. structure of the industry/work nature/working experience etc.) contribute to different views amongst QS on several cost management aspects. The major difference of views are within certain aspects, including guidelines for cost control/estimate, value of money, environmental and site conditions problems/issues, time element (speed of construction), project design and quality, business relationship and project cost/expenditure/reserve. In general, the main reason for QS to have significant different views on the items is due to the difference in their responsibilities, works nature and views to cost control and risks that may encounter in managing civil engineering projects.

5.1.2.2 Risks that frequently take place and have cost impact in a project

Identification of risks involved and has cost impact in civil engineering projects

Similar to what have been mentioned in the above section, reliability and factor analysis are carried out as to obtain meaningful constructs of cost risks involved in engineering projects. The 17 items about risks involved in engineering projects (see Question 5) are analyzed. The factor analysis is conducted by principal component analysis using Varimax maximization (Eigenvalue = 1 is used as the cut-off value). After two rounds of factor analysis exercises, 6 items are eliminated as they have low factor loading or having significant loading on more than one component. The remaining 11 items are classified into 3 factors as shown in Table 7.

Factor	Label	Reference	Item	Factor Loading	Alpha
F1	Design and cost risk	6	Dispute over variations	.828	0.761
		5	Design changes	.777	
		4	Confliction or incompatibility of design/technical principles	.706	
		9	Lack of contingencies or fallbacks to cover delays, errors, damage,	.521	

Factor	Label	Reference	Item	Factor Loading	Alpha
			catastrophes in general		
		12	Loss due to financial charges via increased interest rates	.499	
F2	Contractor capability	7	Inadequate contractor capability in terms of management, labour, skills, plant, etc.	.839	0.731
		8	Incompetence of project management team	.828	
		3	Inconsistent performance of contractor	.653	
F3	External factors	1	Accidental event leading to environmental 'damage' during site operation	.769	0.666
		2	Accommodating utilities and services authority requirement	.758	
		15	Public opposition to proposals	.698	

Note: All items are measured on a 5-point scale

Table 7: Factor Analysis of Risk Measurement Items

Table 7 shows that three types (F1, F2 and F3) of cost risks that frequently take place in engineering projects are obtained in the factor analysis. The three types of risks include design and cost risks, contractor capability and external factor, with Cronbach's alpha values of 0.761, 0.731 and 0.666, respectively, indicating reliable internal consistency.

Highest and Lowest average rating of risks that have cost impact in civil engineering projects

Table 8 shows that Items 14, 5 and 4 have obtained highest average rating amongst all the risk items, with a mean score of 4, 3.9737 and 3.8831, respectively. This implies that QS consider that the project delay, project design and costing issues are the risks that frequently exist and have cost impact in civil engineering projects. This also implies that QS consider that project issue matters are high risk issues that frequently involved in civil engineering projects. This finding echoes a recent study by Olawale and Sun (2010) suggesting that project delay and design changes are important factors inhabiting the ability of industrial practitioners in controlling the project cost. It is because due to the tight schedule of project development, the design is often immature before tender invitation. Thus, it is inevitable for the issue of the variation order at the post-contract stage. Moreover, disputes may arise about the variation order if the change is a design change or a design development of which time and cost compensation is not provided (Olawale and Sun, 2010). On the other hand, the table also shows that Items 12, 17 and 10 have obtained lowest average rating amongst all the risk items, with a mean score of 3.0658, 3.3289 and 3.3421, respectively. This implies that QS consider that the financial charges and contractor-related issues are less risky issues in civil engineering projects.

Rank	Reference	Item	Mean
Highest			
1	14	Project delay	4
2	5	Design changes	3.9737
3	4	Confliction or incompatibility of design/technical principles	3.8831
Lowest			
1	12	Loss due to financial charges via increased interest rates	3.0658
2	17	Subcontractor’s low credibility	3.3289
3	10	Lack of contractor experience in technology, design or construction process.	3.3421

Table 8: Risks having highest and lowest average rating amongst QS

Comparison of QS perceptions to cost risks involved in civil engineering projects between demographic groups

An ANOVA test is conducted at the 95% confidence interval to examine whether there are significant differences between means of groups on the question items. Table 9 is the Tukey Multiple Comparison Table which shows the risks that have significant different means between groups under different demographic status. It is found that in two risk items, there are significant mean differences between QS working in the “*public sector*” and “*private sector*” (see Table 9). Concerning the industry structure, it is found that there are significant mean difference between QS working in the “*consultant*” and “*contractor*” in the risk items. Details of QS different perceptions on the risk items are shown in Table 10.

Multiple Comparisons

Tukey HSD

Item	(I) Which of the following best describe the field you are in?	(J) Which of the following best describe the field you are in?	Mean Difference (I-J)	Sig.
7	Consultant	Contractor	.5373	.027
5	Public Sector	Private Sector	.5417	.002
14	Public Sector	Private Sector	.5043	.029

Table 9: Risks having significant different mean scores between groups

Reference	Item	Consultant	Contractor	t-value	p-value of t-test
7	Inadequate contractor capability in terms of management, labour, skills, plant, etc.	3.9615[1] 0.66216[2]	3.4242 0.83030	2.692	0.009
Reference	**Item**	**Public Sector**	**Private Sector**	**t-value**	**p-value of t-test**
5	Design changes	3.6250 0.82423	4.1200 0.84853	-2.765	0.008
14	Project delay	3.7083 0.85867	4.1200 0.71827	-2.164	0.034

[1]- Figures in the upper part are the mean scores, which represent degree of agreement on the items, "1" means strongly disagree and "5" means strongly disagree; [2] – Figures in the lower part are standard deviations of the mean scores

Table 10: QS different perceptions to the cost risks involved in civil engineering projects

The results of the t-test indicate that the mean scores for "*design changes*" and "*project delay*" for QS working in the "*private sector*" are significantly higher than those QS working in the "*public sector*" (t = 2.731, p = 0.020; and t = 2.164, p = 0.034, respectively). This indicates that QS working in the private sector considers that design changes and project delay are high cost risk items in civil engineering projects as compared with those working in the public sector. Moreover, the results of the t-test also indicate that the mean score for "*contractor capability*" for QS working in the Consultant are significantly higher than those for working in the contractor (t = 2.692, p = 0.009). This indicates that QS perception whether "*contractor capability*" is a high risky item in civil engineering projects is different in the two working fields.

In general, it is considered that the project issue factors (especially the design and cost matters) high risk matters in civil engineering projects as they have obtained highest average rating amongst all items (see Table 8). QS should pay attention to the matters as to reduce the influence that the risk would place on cost management in civil engineering projects. On the other hand, it is found that the differences in demographics (e.g. work nature/company attribute etc.) contribute to different views amongst QS on several aspects, including the project issues and contractor capability. This implies that some QS may overlook the risks involved in these aspects. Thus, it is considered that QS should pay more attention on these aspects as to obtain better risk management in the civil engineering project. In general, one possible reason for QS to have significant different views on the items is due to the difference in works nature and views to risks that they may encounter in managing civil engineering projects.

5.1.2.3 Costing Methods frequently used for civil engineering projects

Identification of costing methods factors

Similar to previous sections, reliability and factor analysis are conducted as to obtain meaningful constructs of the costing methods. The 18 costing methods in the questionnaire (see Question 6) are analyzed, of which 4 items are excluded from the factor analysis due to their low internal consistency (Alpha < 0.70). The factor analysis is conducted by principal component analysis using Varimax maximization (Eigenvalue = 1 is used as the cut-off value). After three rounds of factor analysis exercises, 6 items are eliminated as they have low factor loading or having significant loading on more than one component. The remaining 8 items are classified into 2 factors as shown in Table 11.

Factor	**Label**	**Reference**	**Item**	**Factor Loading**	**Alpha**
F1	Pre-contract cost modeling method	12	Payback method	.783	
		14	Break-even analysis	.787	
		3	Designers' cost model	.751	0.853
		11	Present worth method	.747	
		6	Whole life costing model	.730	
F2	Post-contract cost modeling method	16	Sensitivity analysis	.827	
		18	Productivity based study	.807	0.790
		8	Resource-based model	.799	

Note: All items are measured on a 5-pont scale

Table 11: Factor Analysis of Costing Methods

Table 11 shows that two costing methods factors (F1 and F2) are obtained in the factor analysis. The two costing methods factors include the pre-contract cost modeling method and post-contract cost modeling method, with Cronbach's alpha values of 0.853 and 0.790, respectively, indicating reliable internal consistency.

Highest and Lowest average rating costing methods

Table 12 shows that Items 2, 7 and 1 have obtained highest average rating amongst all costing method items, with a mean score of 3.9701, 3.6818 and 3.6471, respectively. This implies that QS consider that the "*approximate quantities estimating*", "*cash flow analysis*" and "*unit cost estimating*" are the costing methods that most frequently used in civil engineering projects. On the other hand, the table also shows that Items 17,6 and 18 have obtained lowest average rating amongst all the costing method items, with a mean score of 2.7059, 2.8333 and 2.8939, respectively. This implies that QS consider that the "*Monte Cario stimulation*", "*Whole life costing method*" and "*Productivity-based study*" are the costing methods that least frequently used in civil engineering projects.

Rank	Reference	Item	Mean
Highest			
1	2	Approximate quantities estimating	3.9701
2	7	Cash flow analysis	3.6818
3	1	Unit cost estimating	3.6471
Lowest			
1	17	Monte Carlo simulation	2.7059
2	6	Whole life costing model	2.8333
3	18	Productivity-based study	2.8939

Table 12: Costing methods having highest and lowest average rating amongst QS

Comparison of QS perceptions to costing methods between demographic groups

An ANOVA test is conducted at the 95% confidence interval to examine whether there are significant differences between means of groups on the question items. Table 13 is the Tukey Multiple Comparison Table that shows the costing methods that have significant means difference between groups under different demographic status. It is found that there are significant mean differences between QS working in the "*public sector*" and "*private sector*" in two costing methods. Concerning the project involvement, it is also found that there are significant mean differences between QS mostly involved in "*building project*" and "*civil engineering project*" in a costing method. Furthermore, the ANOVA results also show that QS difference in working experience also contribute to significant mean differences in two costing methods. Details of QS different perceptions on the costing methods are shown in Table 14.

Multiple Comparisons

Tukey HSD

Item	(I) Which of the following best describe the field you are in?	(J) Which of the following best describe the field you are in?	Mean Difference (I-J)	Sig.
8	Civil Engineering	Building	.6754	.029
9	Public Sector	Private Sector	.4260	.043
16	Public Sector	Private Sector	.4311	.045
3	WE (less than 10 years)	WE (more than 10 years)	.5554	.029
6	WE (less than 10 years)	WE (more than 10 years)	.8712	.005

Note: WE – Working Experience

Table 13: Costing methods having significant different mean scores between groups

Reference	Item	Civil Engineering	Building	t-value	p-value of t-test
8	Resource-based model	3.8421[1] 0.89834[2]	3.1667 0.86811	2.495	0.017
Reference	**Item**	**Public Sector**	**Private Sector**	**t-value**	**p-value of t-test**
9	Value management assessment	3.1250 0.79741	3.5510 0.84314	-2.064	0.043
16	Sensitivity analysis	2.8750 0.79741	3.3061 0.87092	-2.041	0.045
Reference	**Item**	**WE (less than 10 years**	**WE (more than 10 years)**	**t-value**	**p-value of t-test**
3	Designer approach cost model	3.5385 0.51887	2.9831 0.86086	2.231	0.029
6	Whole life costing model	3.6000 0.84327	2.7288 0.88728	2.890	0.005

Note: WE – Working Experience; [1]- Figures in the upper part are the mean scores, which represent degree of agreement on the items, "1" means strongly disagree and "7" means strongly disagree; [2] – Figures in the lower part are standard deviations of the mean scores

Table 14: QS different perceptions to the costing methods

The results of the t-test indicate that the mean scores for "*value management assessment*" and "*sensitively analysis*" for QS working in the private sector are moderately significantly higher than those QS working in the public sector (t = 2.064, p = 0.043; and t = 2.041, p = 0.045, respectively). This indicates that QS perception about the application of the two costing methods in civil engineering projects is different. Moreover, another t-test results also indicate that the mean scores for "*designer approach cost model*" and "*whole life costing model*" for QS having more than 10 years working experience are significantly higher than those having less than 10 years working experience (t = 2.231, p = 0.029; and t = 2.890, p = 0.005, respectively). This indicates that QS working experience in the profession would lead to different perception about the application of the two costing methods in civil engineering projects. In addition, the results also indicate that the mean scores for "*resource-based model*" of QS mostly involved in civil engineering projects are significantly higher than those QS mostly involved in building project (t = 2.495, p = 0.017).

In general, it is considered that QS frequently used the costing methods that rely on past cost data information in civil engineering projects as those methods have obtained highest average rating amongst all items (see Table 12). In addition, it is found that the difference in demographics (e.g. work nature/company attribute/working experience etc.) contribute to different views amongst QS on the usage of costing methods in civil engineering projects. The reason for the difference in views of QS to the costing methods may be due to the difference in their nature of works amongst QS and the related responsibilities. When classifying the usage of the costing modeling methods in pre and post-contract stages according to the results obtained through the validity analysis, the findings also show that the different views of QS exist in both pre and post-contract stage cost modeling methods. This implies that the involvement of QS in different stages of construction project may also affect its views to the usage of costing methods in civil engineering project, which can be further addressed in future research.

5.1.2.4 Items having high impact on cost in civil engineering projects

Identification of high cost impact factors

The 19 high cost impact items (see Question 7) are analyzed by reliability and factor analysis as to obtain meaningful constructs for future analysis. The factor analysis is conducted by principal component analysis using Varimax maximization (Eigenvalue = 1 is used as the cut-off value).

Factor	Label	Reference	Item	Factor Loading	Alpha
F1	Contract management factor	6	Valuation of variations	.793	0.920
		5	Tender pricing or contractor's pricing (whatever method)	.780	
		10	Re-valuation of provisional sums and prime cost sums	.776	
		11	The negotiation process taken at final account stage	.756	
		8	The negotiation process taken at post-contract stage	.739	
		4	The tender negotiation process	.739	
		7	Assessment of claims	.734	
		12	The overall settlement of the final account	.718	

Factor	Label	Reference	Item	Factor Loading	Alpha
		9	Re-measurement of provisional quantities	.715	
		13	The profit margin	.710	
F2	Economic and financial factor	1	Inflation rate	.876	0.786
		2	Exchange rate	.868	
F3	Project issue factor	18	Contractor's workload	.821	0.871
		19	Technology	.783	
		15	Procurement strategy	.781	
		17	Market conditions	.768	
		13	Site location	.722	
		16	Contract management	.694	
		14	Programme	.688	

Note: All items are measured on a 5-pont scale

Table 15: Factor analysis of high cost impact factors

Table 15 shows that three high cost impact factors (F1, F2 and F3) are obtained in the factor analysis. The three high cost impact factors include the contract management factor, economic and financial factor and, project issue factor, with Cronbach's alpha values of 0.920, 0.786 and 0.871, respectively, indicating reliable internal consistency.

Highest and lowest average rating of high cost impact items

Table 16 shows that Items 17, 1 and 7 have obtained highest average rating amongst all high cost impact items, with a mean score of 4.1250, 4.1061 and 3.9697, respectively. This implies that QS consider that the "market conditions", "*inflation rate*" and "*claim assessment*" are high cost impact items in civil engineering projects. On the other hand, the table also shows that Items 10, 9 and 4 have obtained lowest average rating amongst all the high cost impact items, with a mean score of 3.5152, 3.5758 and 3.6515, respectively. This implies that QS consider that the "*re-valuation of provisional sums and prime cost sums*", "*re-measurement of provisional quantities*" and "*tender negotiation process*" are the low cost impact items in civil engineering projects.

Rank	Reference	Item	Mean
Highest			
1	17	Market conditions	4.1250
2	1	Inflation rate	4.1061

Rank	Reference	Item	Mean
3	7	Assessment of claims	3.9697
Lowest			
1	10	Re-valuation of provisional sums and prime cost sums	3.5152
2	9	Re-measurement of provisional quantities	3.5758
3	4	The tender negotiation process	3.6515

Table 16: Costing factors having highest and lowest average rating amongst QS

Comparison of QS perceptions to high cost impact items between demographic groups

Similar to previous sections, an ANOVA test is conducted at the 95% confidence interval to examine whether there are significant differences between means of groups on the question items. Table 17 is the Tukey Multiple Comparison Table that shows the costing items that have significant means difference between groups under different demographic status. It is found that in a number of high cost impact items, there are significant mean differences between QS working in the "*public sector*" and "*private sector*" (see Table 17). Furthermore, the ANOVA results also show that QS working in the Consultant and Contractor also contribute to significant mean differences in a high cost impact item. Details of QS different perceptions on the high cost impact items are shown in Table 18.

Multiple Comparisons

Tukey HSD

Item	(I) Which of the following best describe the field you are in?	(J) Which of the following best describe the field you are in?	Mean Difference (I-J)	Sig.
5	Consultant	Contractor	.69167	.003
3	Public Sector	Private Sector	.5417	.002
15	Public Sector	Private Sector	.8462	.001
17	Public Sector	Private Sector	.7671	.004
18	Public Sector	Private Sector	1.0342	.000
19	Public Sector	Private Sector	.5043	.029

Table 17: High cost impact items having significant different mean scores between groups

Reference	Item	Consultant	Contractor	t-value	p-value of t-test
5	Tender pricing or contractor's pricing (whatever method)	4.1250[1] 0.61237[2]	3.4333 0.85836	3.450	0.001
Reference	**Item**	**Public Sector**	**Private Sector**	**t-value**	**p-value of t-test**
3	The profit margin	3.3333 0.79582	3.8750 0.56962	-2.819	0.009
15	Procurement strategy	3.1538 1.06819	4.000 0.58554	-2.713	0.016
17	Market conditions	3.5385 0.87706	4.3056 0.74907	-3.025	0.004
18	Contractor's workload	3.0769 0.86232	4.1111 0.74748	-4.106	0.000
19	Technology	3.3846 0.86972	3.8889 0.62234	-2.246	0.029

Note: [1]- Figures in the upper part are the mean scores, which represent degree of agreement on the items, "1" means strongly disagree and "7" means strongly disagree; [2] – Figures in the lower part are standard deviations of the mean scores

Table 18: QS different perceptions to the high cost impact items

The results of the t-test in Table 18 indicate that the mean scores for a number of project issue items for QS working in the private sector are significantly higher than those QS working in the public sector. This indicates that QS working in the private sector has higher agreement than those working in the public sector that the items would have high cost impact in civil engineering projects. In addition, the results also indicate that the mean scores for "*tender pricing or contractor's pricing method*" of QS working in consultant are significantly higher than those QS working in contractor ($t = 3.450$, $p = 0.001$). This indicates that QS working in different companies would lead to different perception about whether project pricing method would have high cost impact in civil engineering projects.

In general, it is considered that QS considers the market conditions, inflation rate and claims assessments are issues that have high cost impact in civil engineering projects as those items have obtained highest average rating amongst all items (see Table 15). Generally speaking, QS should minimize the changes in these three issues as to reduce the cost change and attain better cost control in civil engineering projects. On the other hand, it is found that the difference in demographics (e.g. company attribute/structure of the industry etc.) contribute to different views amongst QS about items having high impact on cost in engineering projects. In general, the main reason for QS to have significant different views on the items is due to the difference in views to project cost/budget concept and the difficulties included in the items. When classifying the high cost impact items according to the results obtained in the validity analysis, the findings also show that the different views of QS exist in two factors: project issues and cost management factors. This implies that some QS may overlook the items that may have high cost impact in engineering projects. As such, it is considered that QS should pay more attention on these items as to obtain better cost management in the civil engineering projects.

5.1.2.5 Correlation Relationships between Cost Management Features, Cost Risk, Costing Methodologies, and High Cost Impact Items

Relationships between Demographics, Risk Involved, and Cost Management Aspects

Demographic	**Cost Management Aspects**			
Variables	**WD**	**TI**	**CostM**	**PCCR**
Working Field	.076 (.497)	-.134 (.230)	.006 (.959)	.153(.169)
Project Types	-.056 (.600)	.231 (.028 **)	.068 (.524)	.229 (.030**)
Working Position	.123(.252)	.075 (.483)	.077 (.476)	-.068 (.526)
Company Attribute	.026 (.825)	.127 (.282)	-.097 (.410)	.026 (.828)
Working Years	.182 (.121)	.044 (.712)	-.022 (.849)	.020 (.865)
Risks Involved				
D&C Risk	.012 (.916)	.298 (.007**)	.278 (.012**)	-.050 (.657)
CC	.360 (.001***)	.056	-.001	.147
External Factors	.143	.287***	.287***	-.118

Notes: WD – QS work duties involved in project management; TI – Team influence on cost management; CostM – Costing Methodology; PCCR – Pre-contract cost review; D&C Risk – Design and Costing Risk; CC – Contractor Capability

*- significant at the 0.1 level (2-tailed); **- significant at the 0.05 level (2-tailed); ***- significant at the 0.01 level (2-tailed)

Table 19: Relationships between Demographics, Risk Involved, and Cost Management Aspects

Table 19 shows the relationships between Demographics, Risk Involved, and Cost Management Aspects. The analysis found that the demographic status of the respondents have only limited significant relationships with the cost management aspects. The “*project types*” are significantly related to the “*team influence on cost management*” and “*pre-contract cost review*” (r = .231 and .229, $p < 0.05$). This implies that the respondent’s particular nature of works involved has significant effect in determining the team influence and pre-contract cost review in cost management. However, there are no significant relationships between other demographic variables and the cost management aspects.

The results demonstrated significant relationships between the risk involved and cost management aspects. Both “*design and costing risk*” and “*external factors*” are significantly related to the “*team influence on cost management*” (r = .298, $p < 0.05$ and r = .287 $p < 0.01$) and “*costing methodology*” (r = .278, $p < 0.05$ and r = .287, $p < 0.01$). Furthermore, the “*contractor capability*” is also significantly related to the “*QS work duties involved in project management*” (r = .360, $p < 0.01$). However, no significant relationships are found between the three types of risks and the “*pre-contract cost review*” in cost management. The strong correlations imply that the risks involved play significant roles in determining the cost management aspects in civil engineering projects.

Relationships between Demographics, Cost Management Aspects and Risk Involved

Demographic Variables	Risks Involved		
	D&C Risk	CC	External Factors
Working Field	.019	-.181	-.187
Project Types	.114	.088	.185*
Working Position	-.064	-.053	.208
Company Attribute	.216*	.038	-.049
Working Years	-.074	.093	-.059
Cost Management Aspects			
WD	.012	.360***	.143
TI	.298**	.056	.287***
CostM	.278**	-.001	.287***
PCCR	-.050	.147	-.118

Notes: WD – QS work duties involved in project management; TI – Team influence on cost management; CostM – Costing Methodology; PCCR – Pre-contract cost review; D&C Risk – Design and Costing Risk; CC – Contractor Capability

*- significant at the 0.1 level (2-tailed); **- significant at the 0.05 level (2-tailed); ***- significant at the 0.01 level (2-tailed)

Table 20: Relationships between Demographics, Cost Management Aspects, and Risk Involved

Table 20 shows that the demographic status of the respondents has only limited significant relationships with the risk involved in civil engineering projects. The "*project types*" is moderately related to the "*external factor*" risk involved in civil engineering projects ($r = .185$, $p < 0.1$); whilst the "*company attribute*" is also moderately related to the "*design and costing risk*" that involved in civil engineering projects ($r = .216$, $p < 0.1$). No other demographic variables have shown significant relationships with the three types of risks included.

The results demonstrated that there are significant relationships between the cost management aspects and the risks involved in civil engineering projects. Both "*team influence on cost management*" and "*costing methodology*" adopted are significantly associated with the "*design and costing risk*" ($r = .298$, $p < 0.05$ and $r = .278$, $p < 0.01$) and "*external factors*" involved in civil engineering projects ($r = .287$, $p < 0.01$ and $r = .287$, $p < 0.01$). Furthermore, the "*QS work duties involved in project management*" is also significantly related to the "*contractor capability*" ($r = .360$, $p < 0.01$). However, no significant relationships are found between the "*pre-contract cost review*" and the three types of risks that involved in civil engineering projects. The strong correlations imply that the cost management aspects play significant roles in determining the risks involved in civil engineering projects.

Relationships between Demographics, Cost Management Aspects, Risks Involved and Costing Methodologies

Demographic	Costing Methodologies	
Variables	**Pre-Contract CMM**	**Post-Contract CMM**
Working Field	.145	-.012
Project Types	.024	-.127
Working Position	.035	.141
Company Attribute	.073	.228*
Working Years	.274*	.157
Cost Management Aspects		
WD	.185	.243*
TI	.041	-.040
CostM	.089	.326***
PCCR	.163	.149
Risks Involved		
D&C Risk	.198	.239*
CC	.168	.245*
External Factor	.013	.137

Notes: WD – QS work duties involved in project management; TI – Team influence on cost management; CostM – Costing Methodology; PCCR – Pre-contract cost review; Pre-Contract CMM – Pre-contract cost modeling method; Post-Contract CMM – Post-contract cost modeling method; D&C Risk – Design and Costing Risk; CC –Contractor Capability;

*- significant at the 0.1 level (2-tailed); **- significant at the 0.05 level (2-tailed); ***- significant at the 0.01 level (2-tailed)

Table 21: Relationships between Demographics, Cost Management Aspects, Risks Involved and Costing Methodologies

Table 21 shows that the demographic status of the respondents has only limited significant relationships with the costing methodologies adopted in civil engineering projects. The "*company attribute*" is moderately significantly related to the "*post-contract cost modeling method*" used in civil engineering projects ($r = .228$, $p < 0.1$). No other demographic variables have shown significant relationships with the two types of costing methodology adopted in civil engineering projects.

Concerning the relationships about the cost management aspects and costing methodologies adopted in civil engineering projects, the results revealed that none of the cost management features are significantly associated with the "*pre-contract cost modeling method*". On the other hand, the "*costing methodology*" is found to have significant relationship with the "*post-contract cost modeling method*" ($r = .326$, $p < 0.01$); whilst "*QS work duties involved in project management*" is also found to be moderately associated with the "*post-contract cost modeling method*" ($r = .243$, $p < 0.1$).

Table 21 shows that there is no significant relationship between the "*external factor*" risk and the "*pre-contract cost modeling method*" used in engineering project. Furthermore, both "*design and costing risk*" and "*Contractor capability*" are only moderately related to the "*post-contract cost modeling method*" ($r = .239$ and $.245$, $p < 0.1$).

Relationships between Demographics, Cost Management Aspects, Risks Involved and High Cost Impact Factors

Demographic	**High Cost Impact Factors**		
Variables	**CM Factor**	**EF Factor**	**PI Factor**
Working Field	-.055	.127	-.176
Project Types	-.016	-.106	-.112
Working Position	.081	.204*	.113
Company Attribute	.169	.179	.481**
Working Years	-.057	-.023	-.006
Cost Management Aspects			
WD	.201*	.153	.370***
TI	.256**	.119	.447***
CostM	.304**	.252**	.273*
PCCR	.239**	.176	.185
Risks Involved			
D&C Risk	.422***	.391***	.589***
CC	.284**	.241**	.345**
External Factors	.243**	.186	.468***

Notes: CM Factor – Contract Management Factor; EF Factor – Economic and Financial Factor; PI Factor – Project Issue Factor; WD – QS work duties involved in project management; TI – Team influence on cost management; CostM – Costing Methodology; PCCR – Pre-contract cost review; D&C Risk – Design and Costing Risk; CC – Contractor Capability

*- significant at the 0.1 level (2-tailed); **- significant at the 0.05 level (2-tailed); ***- significant at the 0.01 level (2-tailed)

Table 22: Relationships between Demographics, Cost Management Aspects, Risks Involved and High Cost Impact Factors

Table 22 shows that the demographic status of the respondents has only limited significant relationships with the high cost impact factors in civil engineering projects. The "*company attribute*" is significantly related to the "*project issue factor*" ($r = .481$, $p < 0.05$). No other demographic variables have shown significant relationships with the three types high cost impact factors in civil engineering projects.

Analysis of the results found that all cost management aspects are significantly related to the "*contract management factor*" in civil engineering projects (see Table 13, r = .201, .256, .304 and .239 and; p < 0.1, 0.05, 0.05 and 0.01, respectively) and that "*costing methodology*" is significantly related to the "*economic and financial factor*" and "*project issue factor*" ($r = .252$, $p < 0.05$ and $r = .273$, $p < 0.1$). Moreover, both "*QS work duties involved in project management*" and "*team influence on cost management*" are significantly related to the "*project issue factor*" ($r = .370$ and $.447$, $p < 0.01$). The strong correlations imply that the cost management aspects play important role in determining the high cost impact factors in civil engineering projects.

In addition to cost management aspects, the results also demonstrate that risks involved in civil engineering projects have significant relationships with high cost impact factors. Both "*design and costing risk*" and "*contractor capability*" are significantly correlated to the three high cost impact factors (see Table 4, $r = .422$, $.391$ and $.589$, $p < 0.01$; and $r = .284$, $.241$ and $.345$, $p < 0.05$). Furthermore, the "*external factors*" is strongly significantly correlated to "*contract management factor*" and "*project issue factor*" ($r = .243$, $p < 0.05$ and $r = .468$, $p < 0.01$). The strong correlations imply that the risks involved play important role in determining the high cost impact factors in civil engineering projects.

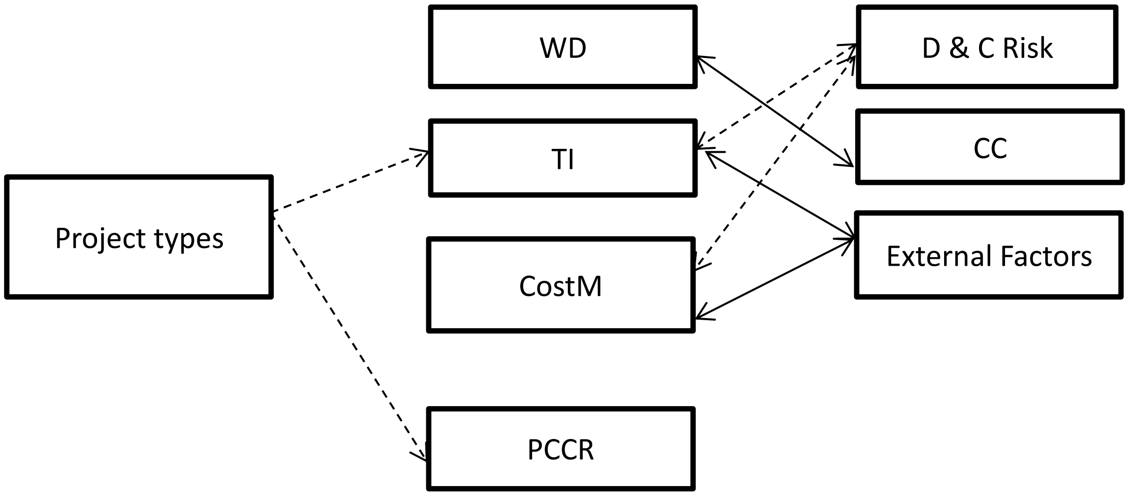
5.1.3 Discussions of Questionnaire Survey Findings

This study examines QS perception to different aspects, such as cost management and cost risks, as well as the costing methods they frequently used and high cost impact factors in civil engineering projects.

The mean scores results indicate that the team influence and high cost impact factors are most important for cost management in civil engineering projects. The profession should pay attention to these two areas as to provide good cost management in civil engineering projects. On the other hand, it is found that the difference in demographic status contribute to different views amongst QS on several cost management aspects. One possible reason for QS in different demographic status having different perceptions on the items is related to the difference in the responsibilities, works nature and views to cost control and risks that may encounter in managing civil engineering projects.

In addition, the mean scores results also reveal that the project issue (design and costing issues) are high risk factor in the civil engineering projects. The profession is suggested to pay more attention to the project issue as to reduce the influence that the risk would place on civil engineering projects. On the other hand, it is found that the differences in demographic status contribute to different views amongst QS on several aspects, including the project issues and competency of contractor. This implies that some QS may overlook the risks involved in these aspects. On possible reason for QS to have significant different views on the items is due to the difference in works nature and views to risks that they may encounter in managing civil engineering projects. Thus, it is considered that QS should pay more attention to these aspects to obtain better risk management in the civil engineering projects.

The relationships between various aspects are also examined in this study. The factors included in different aspects are obtained through reliability and factor analysis, though the variables included in each factor may not be identical with the variables of the factors which are originally designed to be measured. The relationships between demographics, risk involved, costing methodology, high cost impact factors, and cost management aspects are illustrated in the following figures.



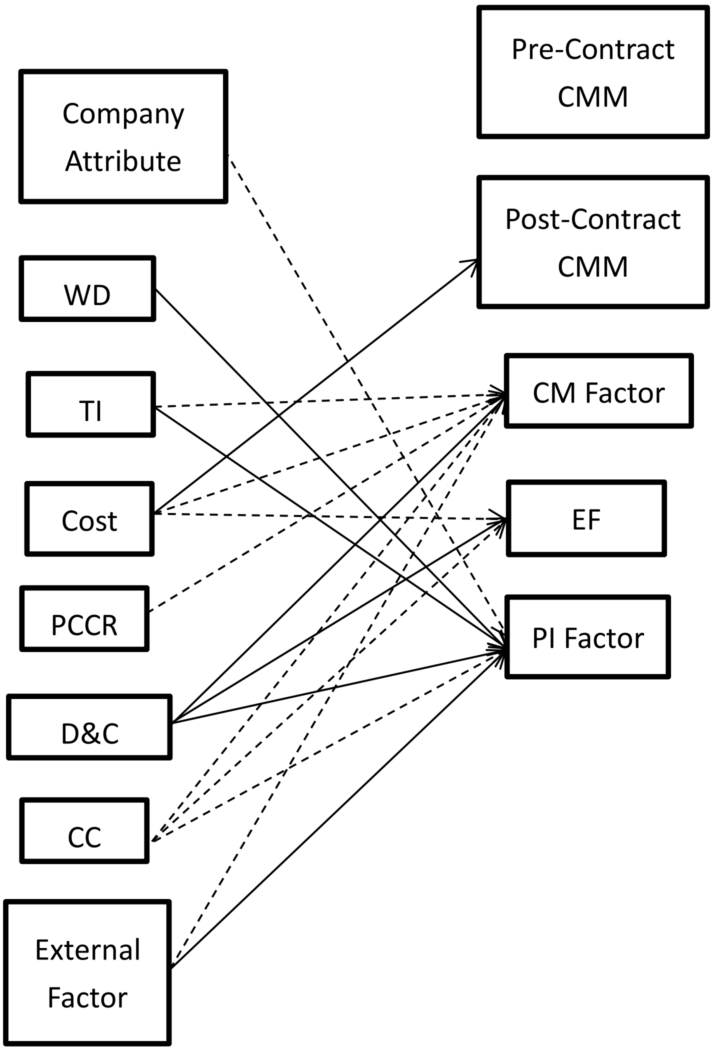
Notes: WD – QS work duties involved in project management; TI – Team influence on cost management; CostM – Costing Methodology; PCCR – Pre-contract cost review; D&C Risk – Design and Costing Risk; CC – Contractor Capability

--------> – correlation coefficient at the significant level less than 0.05;

————> - correlation coefficient at the significant level less than 0.01.

Figure 3: QS perception about cost risks and cost management aspects in engineering projects

The results in Figure 3 reveal that the "*team influence on cost management*" and "*costing methodology*" are the two cost management aspects that mostly affected by the "*design and cost risk*" and "*external factors*" that exist in civil engineering projects. The result obtained is reasonable as the expectation of the existence of different kinds of design and cost risk, and external factors (e.g. change/confliction of project design, disputes, variations, site condition, environmental problems etc.) affect the inclusion of multi-disciplinary working team members with different management expertise as to better manage project cost. Moreover, the expectation of the existence of those risks also affects the adoption of different formula and costing methods for project cost assessment. In fact, the results also confirm that the existence of the "*design and cost risk*" and "*external factors*" in the civil engineering projects are affected by the "*team influence on cost management*" and "*costing methodology*". It is because the inclusion of multi-disciplinary working team members and the adoption of suitable costing formula in project cost assessment can reduce the existence of the design and cost risks and better handling the external factors. In addition, the study result confirms that there is strong correlation between the "*contractor capability*" and "*QS work duties involved in project management*". It is reasonable as the expectation of the contractor incompetency (e.g. under performance in the project, incapability in labour, plant and management etc.) may need to QS to take up additional work duties in project management (e.g. health and safety management, project logistic arrangement plant and materials etc.) in civil engineering projects.



Notes: WD – QS work duties involved in project management; TI – Team influence on cost management; CostM – Costing Methodology; PCCR – Pre-contract cost review; Pre-Contract CMM – Pre-contract cost modeling method; Post-Contract CMM – Post-contract cost modeling method; D&C Risk – Design and Costing Risk; CC – Contractor Capability; CM Factor – Contract Management Factor; EF Factor – Economic and Financial Factor; PI Factor – Project Issue Factor;

- - - - - - -> – correlation coefficient at the significant level less than 0.05;

———————> - correlation coefficient at the significant level less than 0.01.

Figure 4: QS perception model about costing methodologies and project cost factors in engineering projects

Figure 4 shows the relationships between cost management aspects, cost risks, costing methodologies, and high cost impact factors. In relation to cost management features, the results in Figure 4 reveal that the "*project issue factor*" is mostly affected by "*QS work duties involved in project management*" and "*team influence on cost management*". The result obtained is reasonable as QS work duties in project management and the inclusion of multi-disciplinary working team members with different management expertise affects the cost impact that the project issues (e.g. contractor's workload, procurement strategy, contract management etc.) in civil engineering projects. Moreover, the impact that the "*contract management factor*" in civil engineering projects is significantly affected by several cost management aspects, including the "*team influence on cost management*", "*costing methodology*" and "*pre-contract cost review*". The result obtained is reasonable as the inclusion of multi-disciplinary working team members, adoption of different formula and costing methods for project cost assessment and review of project cost in the pre-contract stage affects the influence that the contract management matters (e.g. contract negotiation process, measurement and valuation of provisional and prime cost items, valuation of claims and variations etc.) place on civil engineering projects.

The results also reveal that there are significant relationships between risk involved and project cost factors in civil engineering projects. The "*design and cost risk*" and "*incompetence of contractor*" have significant influence on the three high cost impact factors. It is because the expectation of the existence of the two risk factors (e.g. change/confliction of project design, disputes, site condition, environmental problems, contractor competency etc.) affects the valuation of a number of costing issues (such as contract negotiation process, project work programme, contractor's workload, measurement and valuation of provisional and prime cost items; claims and variations, financial charges etc.) that exist in civil engineering projects. In addition, the "*external factor*" is also found to have significant influence to the cost impact that "*contract management factor*" and "*project issue factor*" place on civil engineering projects. It is because the existence of the external risks in the project (e.g. accidents, environmental damage, public opposition etc.) may lead to the change in the costing of the project-related issues (e.g. project work programme, technology usage, tender pricing, measurement and valuation of provisional and prime cost items; claims and variations etc.) in civil engineering projects.

Furthermore, it is found that the "*costing methodologies*" that adopted for cost management has significant influence on the "*post-contract cost modeling method*" that used in civil engineering projects. The result obtained is reasonable as the selection of usage of different kinds of cost modeling methods are normally affected by the costing methodologies that QS have developed for cost management.

To summarize, it is found that both "*external factors*" and "*contractor capability*" have significant influence about cost management aspects in civil engineering projects. Thus, QS should pay attention to these issues as to obtain better cost management in civil engineering projects. Moreover, it is found that the effect that "*project issue factor*" on project cost is significantly influenced by the cost management aspects ("*QS work duties on cost management*" and "*team influence on cost management*") and cost risks involved in civil engineering projects ("*design and cost risk*" and "*external factor*"). Thus, it is considered that QS should pay attention to the cost management aspects and cost risks involved as to have better cost control in the civil engineering projects.

5.1.4 Interview Findings and Discussions

Semi-structured questions are asked during the interview to examine QS involvement in cost management in engineering projects. Several issues are brought up from the ten responses collected from the interviews. The following summarizes these issues together with specific statements descriptions provided by the respondents. All of the respondents have more than 15 years of QS work experience in the industry.

5.1.4.1 Respondents' perception of QS involvement in civil engineering projects for cost management

According to the response of the interviewees, QS involvement in civil engineering projects for cost management is viewed in two perspectives: work stages and the extent of involvement.

Work Stages

On the consultant side, QS either work as an independent consultant or work under the engineering company as a sub-consultant. On the contractor side, QS generally involve in the project cost control matter. It is understood that QS involvement in cost management is not the same in the pre- and post-contract periods. Several semi-structured questions are asked during interview to examine QS involvement in cost management in engineering projects in different stages (pre-tendering, post-tendering, post-contract and completion stages) in the two periods.

<u>Pre- and Post-tendering Stages</u>

The majority of the respondents consider that QS does not have much involvement at the two stages in the pre-contract period for engineering project cost management as the work duties involved can be taken up by other professionals due to the work arrangement of the project. Some respondents point out that even there is QS involvement, QS are often employed by engineers or engineering firm to assist for the costing matters, rather than employed by the client/developer. Moreover, QS have to rely heavily on engineers' information in handling the work duties such as measurement, preparation of tender documents and preliminary cost estimate. In general, whilst QS are responsible for project cost management (including comparing the tenders and advising on the selection of tenderer), engineers are the final decision makers in engineering projects, rather than QS as in building projects.

Post-contract and Completion Stages

Regarding the post-contract and completion stages in post-contract period, 40% of the respondents point out that there is QS involvement for cost management in the two stages, whilst 40% of the respondents have opposite views and the other 20% have neutral standpoint about QS involvement. Some respondents point out that whether there is QS involvement in the completion stage depends on the project scale and project funding. When there is QS involvement, QS will be responsible for the management of final account, handling claims and variations that exist in the project. However, if there is no QS involvement, the relevant job duties are taken up by engineers.

Extent of Involvement

30% of the respondents consider that the involvement of QS for the cost management matters is the same in both building projects and engineering projects. They consider that the works of QS are to look after the project cost from beginning cost estimate till the end final account. Although there may be minor difference in the working details, the overall QS involvement is the same. One respondent (R9) pointed out that although the area of expertise is somehow different, the skills and methods used for cost management are comparable and can be cross-reference with each other. On the other hand, 70% of the respondents consider that QS involvement in the two types of projects is different, with a view that cost management matters is a team work arrangement for engineering projects. This is because QS may not be familiar with the different construction methods for different engineering projects. According to the contract, engineers play a dominated role in engineering projects, whilst the role of QS is limited.

5.1.4.2 Respondents' opinion about factors affecting the preparation of cost estimate

Here the questions asked the respondents about their opinion about factors that are important for QS to take into account in preparing the cost estimate in engineering projects. According to the respondents, the main factors affecting the cost estimate are project issue factors, rates and cost data, market condition factor and construction issue related factors. The results obtained are comparable with the questionnaire survey results in the previous section of which the project issue factors and, economic and financial factors are found to have high impact on project cost. Two respondents especially consider that the "*technology*" used in construction is important in preparing the cost estimate because of the complexity involved in constructing engineering works. In addition, a number of respondents have also pointed out that QS knowledge about the "*construction method*" is important for them to prepare the cost estimate in engineering projects. It is because in many civil works, the usage of different construction methods will affect the project cost.

5.1.4.3 Respondents' opinion about costing methods frequently used in preparing cost estimate

Here the questions asked the respondents about the costing methods that they often used for preparing the cost estimate for civil engineering projects. A number of respondents point out that the "*approximate quantities*" or the so called "*BQ rate*" is the costing method that is most frequently used in preparing the cost estimate in engineering projects. The results obtained are comparable with the questionnaire survey results in the previous section of which the "*approximate quantities estimating*" is also considered by the survey respondents as the costing method that is most frequently used in engineering projects. In addition, it is acknowledged that the application of different costing methods would depend on the purpose of the estimate and the types of companies that in which QS work. Moreover, it is noticed that the computer software developed up to today to assist QS in preparing a cost estimate for engineering projects can also affect the costing methods frequently used in preparing the cost estimate.

5.1.4.4 Respondents' opinion about accurate estimation of final cost when project is 25% completed

Here the question asked the respondents about their opinion of whether the project final cost can be accurately estimated when the project is at 25% completion. The interview results show that there are diverse views amongst respondents to the issue. 30% of the respondents consider that the project final cost can be accurately estimated, whilst 60% have opposite views, and 10% has neutral standpoint to the issue. Those respondents agree with accurate project cost estimation at 25% completion because they consider that QS can closely monitor the project progress, and the cost risks in construction stage are either handled by the contractor or covered by the contingency sum. On the other side, some other respondents consider that there are a lot of uncertainties, changes, claims, variations and unforeseeable events exist in the project construction stage, which would lead to enormous changes in the project cost. The remaining respondent who has neutral standpoint considers that whether the project cost can be accurately estimated would depend on the types of contract used for the project.

In addition, one respondent (R6) pointed out that the word "*accurately*" creates difficulties for answering the question. It is because the use of the word "*accurately*" may create a meaning that the contract sum/cost estimate and final cost should exactly be the same. The respondent stated that "*whether the estimate is considered as accurate depends on the percentage that the difference between the awarded contract sum and the final cost is accounted for in the final cost".* He considers that if the percentage is within the acceptable range, then the final cost can be reasonably predicted.

5.1.4.5 Respondents' opinion about accurate estimation of project time when project is 25% completed

Here the question asked the respondents about their opinion of whether the project time can be accurately estimated when the project is at 25% completion. The interview results show that there are diverse views amongst respondents to the issue. **40%** of the respondents consider that the time for project completion can be accurately estimated when it is at 25% completion, whilst the remaining 60% have opposite views. Those respondents agree for accurate time estimation at 25% completion because they consider QS will closely monitor the project work programme and the contractor is obliged to complete project on time so as to avoid being charged for liquidates damages. On the other hand, other respondents consider that project time cannot be accurately predicted as there are a lot of uncertainties, unforeseeable events and changes exist in construction work.

5.1.4.6 Respondents' opinion on whether post-contract cost control procedure has high impact on cost

In considering whether post-contract cost control procedure has high impact on project cost, most of the respondents agree that the procedure has positive impact on project cost. The respondents consider that the cost control procedure can enable QS to control the project cost more effectively as the procedure includes assessment/ estimation of the cost before design changes are made. Moreover, the post-contract control procedure enables QS to have better understanding about the project estimate and costing of different items, which facilitates their control of project cost in the construction stage. On the other hand, one respondent disagree that the post-contract cost control procedure itself can have high impact on cost. The respondent considers that whether the procedure works well depends on the contractor and the capability of the site monitoring staff. If the two parties do not perform well, the project can have both time and cost overrun even through the procedure is in place.

5.2 Contract Administration

5.2.1 Interview Findings and Discussions

It has been pointed out by one respondent that QS role in civil projects is rather limited due to three characteristics in civil works. First, the measurement rule of the HKCESMM is too 'simple' as there are many '*items*' to be included for measurement. The technical involvement for interpreting the '*items*' takes more of QS time than contract management for civil works, as the respondent stated that, "*the engineer really needs a "measurer", rather than QS for the measurement work*".

Second, "*Since civil works are in approximate quantities, the payment for each month is in an accumulated format, which will contribute to the final account.*" Thus, civil projects needs more people who know the measurement rule well to be responsible for the quantities, and for this reason, the number of site QS employed in civil projects is more than that in building projects. Third, the site area of civil projects is usually much larger than that of building projects and can therefore able to accommodate more "*temporary*" staff. In this way, QS involvement in contract management would be limited in civil projects if there is no specific requirement stated in the contract.

Three semi-structured questions are asked during the interview to examine QS involvement in contract administration in engineering projects. Several issues are brought up from the ten responses collected from the interviews. The following summarizes these issues together with specific statements and descriptions provided by the respondents.

5.2.1.1 Respondents' perception of QS involvement in civil engineering projects for contract management

According to the response of the interviewees, QS involvement in civil engineering projects for contract management is viewed in three perspectives: work stages, the extent of involvement and the contractual arrangement.

Work Stages

Regarding the stages in contract management, there is more or less the same number of views between QS involvement and no QS involvement at the pre-contract (pre and post-tendering) stage, while it is 7:3 for the involvement at the post-contract and completion stage.

<u>Pre- and Post-tendering Stage</u>

The respondents generally refer the pre-tendering stage to estimates, the preparation of BQ or the tender document, and the post-tendering stage to tender assessment. When it comes to contract management, QS involvement at the pre-contract stage is dependent on whether there is a sub-consultant agreement, whereas at the post-contract stage it is dependent on what is specified in the contract. Regarding the pre-tendering stage and post-tendering stage, one respondent mentioned that "*If QS is at a sub-consultant level, then QS would not have an independent role in contract management*." Another respondent stated that "*If you consider the advisory role, I would say that QS role in engineering project is partially independent.*" However, there is different perspective from working with the employer or working with the contractor. When working with the employer, in-house QS employed by an engineering firm will support cost and contract administration. When working with the contractor, QS is an employee of the contractor company. At the post-tendering stage, the contractor QS has to prepare the sub-letting arrangements, budget review and cash-flow planning. Whichever the case, QS would all have their own roles with the employer. The following is what the respondents have described about the employer-employee relationship and the client role:

> *"I would consider that the role of QS is not independent from their employer. For myself, I am a staff of XXX, my company have the objective, constraints and restraints for the employee to follow. For the contractor, the contractor employs the in-house QS staff, who is used to perform the function of the company, rather than fulfilling the independent role. For example, when I work for the contractor, I would not say I am fulfilling the independent role. I perform as a staff of my employer. If my employer is a contractor, I will work as a contractor QS."*

> *"The client role is more dominant for cost management in this stage. It is because the cost management at that time is to look at the tender price submitted by the contractors and makes decision. The cost management is more driven by the client than QS."*

Post-Contract and Completion Stage

In the post-contract stage, QS will have to monitor the performance of the sub-contractor, payments and the changes in variation matters. Although QS does not usually need to take measurement for the variation matter, he/she needs to assist the engineer to decide whether the scope of variations constitutes any claims and to identify these claims. Furthermore, QS has to decide whether the claims are valid in principle, fix and agree the rates, assess the percentage quantum of the liability of the party, and prepare a claim report.

At the completion stage, QS will be responsible for monitoring the final account of the project. If QS works in the consultant, he/she will firstly collect all relevant information necessary for the preparation of the final account as the site staff will leave the project and the details to verify the cost of the works may no longer be available. Hence, QS has a role for information gathering at the completion stage, particularly when there is no proper record of project information. If the work of organizing project information is done, it can ensure that all parties are aware of the baseline information for assessing variations and claims. Other than variations and claims, the final account is usually based on *re-measurement of provisional quantities unless the quantities are organized as an activity bill,* whereas the practical problem foreseen at the post contract and completion stage is about the accommodation of site staff and record keeping. One respondent described this as,

> *"QS will still be resident on site (RSS) rather than transfer back to the head office to do the work. QS will be transferred to the head office only when the final account has finished. This is also the reason why we are considered as the RSS staff. If the land is available, the site office will still be retained for the RSS staff for the final account and other completion works for the project. In normal situation, the RSS staff will continue to stay in the site office for 12-15 months to wrap up the works for the project, which is enough for the final account settlement. The company will also find other place to re-build the site office after 15 Months even when the works are not yet finished. Thus, many arrangements may exist in the completion stage about the station of the RSS staff."*

Although some respondents take the view that QS involves in all stages of contract management, most of the respondents generally consider that there is QS involvement in civil engineering projects for contract management at the post-contract and completion stage. Contract management hereby refers to post-contract management as distinguishing from contract strategy which involves the selection of the contract form which would cover both pre- and post-tendering stages. When it comes to QS involvement in civil engineering project for contract management, some respondents refer contract management to start from post-tendering. Thus it requires a new look at the stages involving QS in exercising the independent role. Most of the respondents described variations, claims and final account as relevant to contract administration. One of the respondent mentioned that there were difficulties in agreeing rates for confirming variations and analyzing the issues for claims, and considered that QS major involvement in contract management was to overcome these difficulties.

Extent of involvement

The involvement and hence the employment of QS at the post-contract stage depend on the RSS proposals. Starting from a few years ago, most of the RSS proposals will propose the need of QS input no matter whether QS is a professional QS or technical QS. It has become a common practice in the recent years that the engineering project in this stage will, at a minimum, employ a Survey Officer Quantity (SOQ) to take up QS work.

Regarding the work nature, QS role emphasizing for contract administration is related to QS expertise for cost advice and sub-contractor management. Sub-contractor management here refers to monitoring the progress and programme of the works, and minimizing the "*gap situations*" in the contract and construction stages. The "*gap situations*" may exist in the government project as "*grey areas*" when one contract has to work together with another contract, such as the difficulty in fixing working schedules among different "*contracts*". One respondent pointed out that QS involvement in contract management in civil engineering project was almost the same as those in building project, except the status problem. The concern raised was that the relevant contract management works were done by QS, but no QS signature would be seen in the document/certificate.

Contractual Arrangement

Bills of approximate quantities are usually used for engineering projects, although design-and-build contracts and activity bill schedules are sometimes used. In distinguishing the lump sum contract and the re-measurement contract, the respondents expressed the following views:

> *"In the lump sum contract, it is work as a shopping list, and the income of the contractor is not affected as most of the items are confirmed in the early stage….. In the government contract, the contractor has to calculate for the income."*

> *"When it is in re-measurement contract, the contractor can make gambling for the rate as there is an opportunity for the contractor to do the re-measurement."*

> *"In the re-measurement contract, QS have much more involvement in the project as QS have to consider both the cost and quantities in pricing the item. When in the lump sum contract, QS mainly looks at the cost only in pricing the item. Thus, more site QS (around 50% more) is needed for projects using the re-measurement contract. The number of QS involved in civil projects is dependent on the project nature, type of contract used and practice of the company."*

> *"QS is difficult to work in civil works as most of the bills in civil works are re-measured bills. Most of the civil works need to be re-measured when the works are finished. There is still some firmed bills (e.g. activity bills) used in civil works. For example, some of the substations in airport construction taken as civil works are measured provisional. However, there is no reason to make the cover ceiling of the substation to be provisional. The cover ceiling of the substations is a firmed item. When looking into the CPM, the substation is an activity in the airport construction. The bill that used to construct the substation is considered to be an activity bill. It can be seen that there is only a small percentage of the activity bill is included in one civil project. This is why QS is difficult to participate in civil works."*

5.2.1.2 Whether contract administration has high impact on cost

Similar to the previous results obtained for post-contract cost control, most respondents agree that contract administration also have high impact on project cost. Respondents point out that project administration includes day-to-day construction site management, procurement, work programme management and monitoring of contractor, payment, claims, variations and loss and expenses issues. Each party involved in the process has to follow what is stated in the contract in administrating the project, especially the costing issues. Thus, contract administration becomes a vital function in controlling matters relating to project cost. Some respondents even pointed out that if the contract was not well administrated, it could bring negative effects to the party involved, which might also affect the final project cost. On the other hand, one respondent did not agree that contract administration would have high impact on project cost. The reason given was that the contract administration work itself was a kind of standard work. Thus, whether the contract can be well managed is dependent on the monitoring staff. If the monitoring staff does not perform well, the project can have both time and cost overrun even though there are proper contract administration procedures. This can be illustrated by one respondent in stating that "*Even though extra time and cost may be spent on doing cost administration, it is still worthwhile to do it as the final outcome will be much better.*" while another respondent considering that "*I think a proper cost administration is a safeguard for the cost overrun of the project.*"

5.3 Independent Role of QS

5.3.1 Interview Findings and Discussions

Four semi-structured questions are asked during the interview to evaluate interviewees' understanding on the independent QS role in engineering projects. Several issues are brought up from the ten responses collected from the interviews. The following summarizes these issues together with specific statements and descriptions provided by the respondents.

5.3.1.1 Difficulties facing the development of independent role of QS in the engineering projects

According to the response of the interviewees, the difficulties facing the development of independent role of QS in the engineering projects are threefold: the nature of involvement, the nature of employment and the nature of work.

Nature of Involvement

There is historical background for the nature of involvement of QS in engineering projects. One respondent pointed out that **"*c***_ivil engineer has dominated the role in the engineering project. There is no permitted entry. Thus, it is difficult for QS to get into the system to do the work."_ While another respondent said that *"The role of QS in the engineering projects is not as independent as comparing with the building projects. It is because most of the works that QS did rely on the information provided by the engineer.*" As this would affect estimation, it was further referred by the same respondent that

> *"In the consultant company, QS role is to give advice to the engineer about the costing of the item. As the civil works are more complicated and highly uncertain (and nonstandard), QS have to work in collaboration with the engineer for the estimation work. In building projects, QS are familiar with the item cost and method of construction."*

Some respondents referred the QS's involvement as in "*the contract design*". The probable reason given by one respondent is that: "*the government thinks that the inclusion of "engineer" is enough in the engineering contract. If the engineer wants to have QS expertise for assistance, then he can find it in-house. Viewing from outside, any decision made is under the head of the engineer. Thus, the government considers that there is no need to have a separate entity to be stated in the contract……except that when the government considers that there is a need to incorporate and state the role of QS in the engineering contract (in the same arrangement as the building contract).*"

Nature of employment

Since engineering projects are public projects, according to the contract requirement, QS consultant is not directly employed by the client (usually government departments). One respondent pinpointed that although the government (Bureau) did not refuse to make changes, they did not find any advantages of making the changes in the contract. The main concern was whether the changes could safeguard the public interests and the money spent on the project, which was difficult to prove in the current situation. One respondent described the nature of employment as "*the framework that set in the government engineering contracts*" and another respondent referred the practice as:

> "S*ome engineering firms will tend to employ the professional QS in their company or recommend a RSS (resident site staff) proposal that includes more QS involvement to support QS input."*

Presently, the cost consultancy can either be taken up by the engineer themselves or with a sub-consultant arrangement. This means that there is no direct contract between the client and QS, or whether there is a commercial necessity in making the sub-consultant arrangement. One respondent expressed a standpoint for the current arrangement made in the engineering contracts as the preference of the public client to have a single line of control to ease up the additional effort required to control other professionals involved in the project. It was pointed out by the respondents that:

<u>*The problem today*</u>

"*Under the current arrangement, when there are problems exist in the project, the engineer will have to be responsible for all matters in the project (including the design, cost control, contract administration etc.). However, when the duties and responsibilities are divided among professionals in the contract, the government will have to look back to the contract to see who are responsible for specific matters. The government thinks that the supervision role in the project is highly complex; additional works are needed in supervision and more staff is needed to be involved in supervision. Rather than saving money, it would cost more for dividing the responsibilities in the contract to different professionals.*"

"*When there is an additional party, there must be an additional interface; especially when the party is an important party (key player) of the project. When the interface is created, if the interface is not performing well and people are not able to cooperate smoothly with other key parties, then it will definitely obstruct the progress of the work.*"

<u>*The practice today*</u>

"*Generally, QS in the civil engineering project work under the engineer and work together with the engineer as in the project team. QS is also directly employed and under the umbrella of the client. In civil engineering project, the engineer is responsible for the project design and handle of the technical matters. However, when the engineer has little knowledge of the costing matters, then QS (usually is a QS firm) is employed by the client to be responsible for the project costing matters, and representing the client to deal with the contractor about the costing matters. However, there may come to a situation that the contractor does not agree with the client consultant engineer and QS. Then there will be disputes. When it comes to this situation, the contractor will not rely on the consultant QS (as is employed by the client) and object the consultant QS judgment, then an independent (third party) QS will be employed for making the judgment to settle the disputes.*"

Nature of work

In general, the respondents consider that QS should be equipped with technical knowledge to work with engineering projects. Another problem is about the cost information. It is difficult to record and upkeep structured cost data bank for engineering projects like that for building projects if the work is supported mainly by site staff. The problem is that these site staff members are not available after the project is completed. The cost information cannot be traced if it has not been properly recorded and maintained. In other words, there is a problem of sustainability of site staff cum cost information. This is exactly as what one respondent views as, *"there is no regular update and reference of cost data is limited in civil engineering project. QS has to justify the cost himself on a project by project basis. Thus, it also affects the cost control in the project."*

<u>*For cost management*</u>

One respondent pointed out two important issues in cost management which were also supported by other respondents in the same vein. These two issues are cost control and rates.

R1: "*It should be the independence of the cost controller. It is because the cost controller should have technical knowledge and professional skills and integrity and be able to handle the conflict of interest involved in the project. However, QS is not familiar with the construction methods in civil engineering projects and the quantity rates are dependent on the market conditions. Thus, the development of the independent role of QS in the project is affected.*"

R2: "*Regarding cost control, budgeting is confidential. This requires trust from the client." … Sometimes the cost checking process may have been given way to efficiency and quality management if quality management means reducing people.*"

In echoing about the rates, **R2** remarked that "*The market rates are generally more than 10%. The front loading is one issue for which the rates are distorted and erred in this situation. Another issue is about the distribution of prelim and overheads in the labour rates.*" The respondent thus suggested to "*fix*" the rule of the game not by cost distribution, but by deriving rates from the first principle such as fixing labour constants.

<u>*For dispute resolution*</u>

Currently, the government is using a Dispute Resolution Advisor (DRA) System for dispute resolution. Many of the DRA listed in the system have QS background. Since the role of the DRA is to give advice for the dispute between the parties, DRA is an advisory role and both parties of the contract can accept or reject the advice given by the DRA. The respondents have the following views:

"Independent" means third party judgment. If the disputes matters do not exist, then independent QS will not exist. This is similar to the employment of the "independent engineers". If the work submitted by the contractor's engineer is accepted by the client's engineer, then the process for the issue is complete……The problem that affects the development of the independent role of QS is about whether there is a need for the employment of the independent QS, as independent QS only needs to be employed when disputes occur in the project.

"The difficulty that the independent QS may face in settling the disputes is how to get the mutual agreement (compromise) from both the client and the contractor. When the independent QS think that one party is better, the other party will fight against him. For the independent QS, even the decision is neutral and non-bias, it is difficult to have it favoured by both parties. It is sometimes more difficult to convince both parties that the decision is neutral and impartial and on the right track."

5.3.1.2 Respondents' opinions for QS to take up an independent role in managing infrastructure projects

Here the questions asked the respondents about their opinion of whether QS had an independent role in managing infrastructure projects, and if any training would be given. Six of the respondents agree that QS has an independent role in managing infrastructure projects, and consider the following to be the merits of QS:

- Acting in a cost controller role who has the professional skills and integrity to do so, and at the same time capable to handle conflict of interest involved in projects
- The professional judgment
- Providing regularly updated cost information and better cost control for the project, which are of benefit to the client
- Capable for doing risk assessment and know what risks will be involved in the project
- Contractual knowledge together with its practical application

The other four respondents who disagree all consider that training should be provided to help developing independent role of QS for engineering projects. Concerning the training matters, it is considered that the relevant departments should provide training and courses to students about the practice of civil engineering projects in Hong Kong. It is also pointed out that the control of the works programme is one important issue in engineering projects and QS needs to understand the works programme for infrastructure projects. Since many civil works are non-standard, knowledge of the measurement of temporary works and actual work arrangement are essential, and therefore site experience is important for QS too. In addition, collaborative practice is one important requirement for cost management as there may be different opinions regarding the resource input and the method statement in making cost estimation.

One other respondent suggested that there should be rules and guidelines for them to follow in managing the project so that it would minimize the difference in judgment for the same issue and the existence of the confusion. Another respondent suggested that the training for the knowledge of the civil construction technologies, civil engineering practices and procedures can be obtained through working in the engineering consultant firms.

5.3.1.3 Respondents' opinion for the aspects that QS perform better

Regarding the aspects that QS perform well in the present situation, it is worthwhile to record the statements of the key issues referred by the respondents (some statements are originally in Cantonese). The respondents have the following view concerning the significance of QS working experience and the familiarity of QS to the cost management and contract management procedures.

R1: *The development of the rates is more reliable than the others.*

R2: *Technology, common sense and common knowledge*.

R3: *When QS have an independent role to the client, he/she can report the costing issue regularly and directly to the client. Due to the consultant competency, QS can also check against the contract as to minimize the engineer's mistakes made in the design stages. There may also be a reduction on cost due to the settling of claims and variations.*

R4: *"When QS have worked in the civil field for a long period of time and have involved in large projects, it is considered that QS must have experienced in handling variations, disputes and other contingency issues. Thus, QS may have all rounded experience in handling cost management and contract management in the engineering projects."*

R5: "*QS is able to pick up the financial matters more quickly as compared with the engineers and other parties. QS is also more sensitive to numbers and more able to make use of the numbers to do calculation to produce accurate financial analysis.*"

R7: "*In some large projects, the engineering company employs a team of QS to assist the engineer to do the cost management and set up the cost control procedures of the projects. These are the works that QS can do in the engineering projects. Although the overall management and budget view of the project are controlled under the Project Chief Engineer, QS are also included in the controlling issues and contract procedural matters to assist project functioning. Moreover, when contractual disputes arise, the engineer would also like to employ QS or related party to act as an independent party to handle the matter.*"

R8: *QS should have better communication with the engineer; whilst QS should have common language and understanding with the engineer about the civil engineering works. There are different specific terms in different types of civil engineering projects, which make the new comers difficult to follow.*

R9: *I think the understanding about the project is an important issue for QS to perform better in cost management and contract management in engineering project. It is because the cost of the project is only the end result and if the project runs better, there will be less chance to have cost overrun in the project.*

R10: *It is difficult to have performed better in two aspects. This is rather a chicken and egg problem. If you want QS to have performed better, opportunity should be given to QS for participation in the civil projects. However, the current situation is that QS are given limited opportunity in participation in such type of projects. Thus, QS are not able to show his performance in the civil works.*

5.3.1.4 Suggestions for the development of the role of QS in general

The last question asked is "*In support for the development of an independent role of QS, what do you suggest the institutions to do?*" The suggestions made in general are listed as follow:

Promotion of the status and ability of QS

It is suggested to promote QS to the society to raise the status of QS and make the public understand what areas QS are good at. Thus, it needs to demonstrate the capability of QS and their contribution to project management. In doing this, QS should let people know how their role would contribute to project success, and in what way QS would add value to the project. For this reason, successful case and best practice should be acknowledged.

Independent services to the clients

Since the government is the major client for infrastructure projects, it is desirable to make the client understand what works well. "Independent assessment" and "QS audit practice" are two good examples. In doing this, the good points of having "independent assessment" from QS in engineering project to safeguard the project cost for the client in the post-contract stage should be made known to clients and be promoted. The "QS audit practice" is also suggested for use to identify the problems in the engineering projects so that there can be improvement for future projects.

Some best practices were mentioned by the respondents and can be considered for adoption in engineering projects: (1) QS involvement in engineering projects works successfully well in MTR projects. This arrangement has become more and more acceptable that nearly every MTR project will have QS input to it. (2) Some public projects of URA works well with the sub-consultancy contracts in lieu of one project consultancy contract (architect/engineer); and (3) the practice of some companies such as those European Engineering Firms, the cost control function itself is independent.

CPD seminars, training sessions and institutional programmes

It is suggested that the professional institutions should organize CPD seminars and provide sharing sessions relating to civil procedures and practice for individual members. It is also suggested that best practice booklets can be produced for internal circulation. In addition, guidelines and rules can be published in hard copy or on-line for members to follow, or included in the institution website for other professionals to gain knowledge on these subject matters. Furthermore, the institution may also organize discussion forums and task force to lead in-depth research for topics in managing infrastructure projects. It is also suggested that institutions should organize similar training sessions and regularly updating practice information to enhance skills and knowledge. It is considered that training in both engineering consultant firms and on site should both be provided. In addition, one respondent pointed out that the professional institutions should consider providing "*contractor option*" and "*engineering option*" in the APC assessment. Regarding undergraduate training, it is suggested to offer electives in the curriculum to include civil engineering works, civil engineering measurement and engineering contract.

5.3.1.5 Suggestions for the development of the role of QS in particular

Several specific suggestions from the interview findings are consolidated below for the development of the role of QS for infrastructure projects.

Provide more opportunity for QS input for engineering projects

There is a need for QS to take part in the pre-contract stage and act as part of the project team at pre-tendering, tendering and post-tendering stages. When the engineering consultant submits a bid for the engineering project, there is a need for QS to be part of the team, whether it is in-house or in a sub-consultancy contract.

Define a clear role for QS involvement in engineering projects

Now that the work duties of QS in engineering projects may start from the pre-tendering such as the preparation of the tender documents, there is a need to define clearly the role of QS such as when QS will get involved in the project and their job duties in the project. Thus, work duties like making cost estimation based on set requirements, invitation for tender, assistance in the tendering process, tender assessment, contract selection at the pre-contract stage and other duties at the post-contract stage should be spelt out clearly and specified.

Pilot run project for QS role in engineering projects

In view of project cost control, it was suggested to have a trial run of a specified role of QS in the engineering contracts. Whether it is based on NEC or government contract, special clauses can be added to the contract like what has been practiced for building contracts.

Proper adaptation of commercial factor of the industry

The concern is that there exists a commercial factor in the professional services. Construction clients may prefer to have comprehensive charges to cover all professional services, and is reluctant to pay "*extra*" service charges in employing different other professionals. This 'commercial factor' in the consultancy contracts needs to be resolved.

6. Conclusion, Limitation and Recommendation

6.1 Conclusion

The research methods produce both quantitative justifiable results and qualitative results which are rich in context. According to the data findings of the questionnaire survey which have been validated with tests for reliability and internal consistency, the four factors which are found to be cost significant for engineering projects are: *QS work duties in project management, team influence on cost management, costing methodology and pre-contract cost review*. In highlighting the specific cost risk relevant to project cost management in engineering projects, three factors are identified and considered important. They are: *design and costing risk, contractor capability and external factors*. This implies that the risks are not inherent in the practical issues of application, but in uncertainties that are prevailing to different interpretation. It is contended that QS should have the relevant knowledge to handle the risk of cost uncertainties. This implies that QS should be trained with *collaborative skills* to help integrating the design cost and construction cost. Furthermore, since the costing methods frequently used in the pre-contract and the post-contract stages are mostly approximate quantities, cash flow analysis and unit costing, it is considered that new methods and innovative ideas should be attempted to narrow down costing gaps and restrict erroneous costing situations. However, the interview findings confirm that there are limitations in the employment structure and the contract design. Therefore, the employment structure should be reviewed and the contract design should be considered together with the procurement strategy in determining the project cost. In addition, three high cost impact factors are identified in this study: *contract management factor, economic and financial factor and, project issue factor*. This implies that these cost impact factors should be taken as cost gap areas for the improvement of cost estimation and be closely monitored for engineering projects.

In view of the differences in the demographic status of QS in affecting their views on cost management functions, it is found that the differences in the responsibilities, works nature, views to cost control and risks encountered in managing the projects do insert certain impact on the cost functions performed by QS. The findings point to the issues of *team influence and contractor capability,* which are the most significant factors to be considered in managing project cost in engineering projects. In addition, the extent of involvement of QS in different project stages also affects their views to the choice of costing methods in engineering projects.

According to the interview results, it is found that cost control procedure has high impact on cost at the post-contract stage. It is clear to have active QS involvement for payment, variation and claims even though the decision-maker is the "*engineer*", and it is recognized that the continuous monitoring of the cost is important as it leads to the final cost. The limitation in working with an engineering project is that the staff turnover is not infrequent. When people leave the site, there may not be sufficient information or evidence of how the cost is built and recorded, which will cause mis-understanding and difficulties in settling the final account. In addition, there may be difficulty in accommodating the site staff once the project is completed, and dis-continuity of the work process may affect proper handling of the account.

As QS work duties are traditionally divided into stages of pre-contract and post-contract, there is a cut-off line of the legally-bind contract, that is, with or without a contract. Since the post-contract QS work is commonly regarded as contract administration, the contract procedures would not be a problem to QS involved in administering the work process. However, the findings indicate that for complex engineering projects, the works should be further divided into three or four or even more stages to ensure the costing services for infrastructure projects can be properly understood even by laymen to avoid mis-understanding from the public, the politician, the banker and the media. This requires a new look at the components of the cost estimation.

Above all, it can be concluded that the present QS involvement in engineering projects is mostly in the post-contract stage. The research findings confirm that QS work is fairly "*independent*" at this stage. While there requires a lot of engineering input at the pre-tendering and post-tendering stage, QS needs to work closely with the design team and therefore a collaborative relationship is essential for the teamwork. On this basis, there is no reason why the role of QS should not be specified in the contract or other related document as this is clearly a post-contract matter. Thus, a specific role of the "*QS*" should be mentioned in the contract as this is critical for the development of the independent role of QS for engineering and infrastructure projects.

6.2 Limitation

The sample size of QS involved in the questionnaire survey of this study may not be representative of the population. The demographic results show that the number of QS involved in engineering projects in this study is not substantially greater (more than 60%) in comparing to QS involved in other types of projects. This may affect the reliability and validity of the data results. In order to reduce the impact of these limitations, the research methodology used in this study is to verify the quantitative findings with the qualitative results. In addition, reliability and validity analyses are conducted to check the internal consistency of the items included in different measurement scales. The factor loading of the items and alpha values of the factors included are higher than the acceptable level. Thus, the data obtained is valuable for referencing for future research. Future research can therefore be directed the crucial factors such as cost risk, cost modeling and high cost impact items to obtain an in-depth understanding of the cost management aspects in engineering projects.

This study is a cross-sectional design study of which any casual inferences made between the variables are based on supportive evidence in previous studies. The cross-sectional data obtained from quantitative study are analyzed by using bivariate correlation analysis, which has been substantially used in testing casual relationships between variables. But it is yet to find out the casual relationship among these different aspects (cost risk, cost modeling and high cost impact items) in affecting project management. The small number of sample size obtained also restricts the use of other more sophisticated statistical techniques such as Structural Equation Modeling to enhance the model development and to show a more accurate estimation of the causal relationships among the variables. However, the overall findings do shed light on the present development of the role of QS and identify the problems that are required to resolve.

6.3 Recommendations

Based on the above research findings, it is proposed to have the role of QS firstly defined in the engineering contracts. This means to classify the work that QS has to do in the project and the duties that "*quantity surveyor*" have to handle. Such role details can be made to the work duties, included in the contract clauses, or added in a sub-consultancy agreement. Secondly, it is recommended to publicize successful cases and best practices of QS services for infrastructure projects to promote QS input in engineering projects. In order to do this, the following are suggested:

- Organize a series of seminars and training sessions for QS who intend to work for engineering projects;
- Liaises with universities for enhancing existing education programmes with new progarmmes, new courses or electives;
- Encourage more QS to take up the role of QS for dispute resolution so as QS can work as Dispute Resolution Advisor (DRA), Adjudicator and Mediator for infrastructure projects;
- Publicize success cases of independent audit, independent assessment, and particular project arrangements such as those adopted by MTR and URA.

Thirdly, estimating rules and cost databank are to be established so that rates can be derived from the first principle with pre-fixed labour constants for engineering works.

In addition, a clear career path or qualifying route for engineering QS would be meaningful for those who are involved in engineering projects or are interested to join the workforce. Above all, the knowledge and work experiences of individual members are invaluable and would be lost if they leave the industry. Therefore the knowledge should be captured and organized into reference materials to maintain sustainability. Finally, monitor and control is nowadays necessary to upkeep cost and contractual matters. It is worthwhile to devise project governance structures to suit individual infrastructure projects, and within that structure, a clear role of QS can be defined.

Acknowledgement

The work described in this paper is fully supported by a grant from the Hong Kong Institute of Surveyors (Quantity Surveying Division) (Project No. at the City university of Hong Kong: 9231052)

7. References

Abott, A. (1988) *The System of Professions, an Essay on the Division of Expert*, Chicago: The University of Chicago Press

Akinci, H. and Fischer, C. (1998) Factors affecting contractors' risk of cost overrun, *Journal of Management in Engineering*, 14 (1), 67-76

Akintoyo, A. (2000) Analysis of factors influencing project cost estimating practice, *Construction Management and Economics*, 9, 311-25

Ashworth, A. (2010) *Cost studies of buildings (5th Edition)*, London: Prentice Hall

Baloi, D. and Price, A.D.F. (2003) Modelling global risk factors affecting construction cost performance, *International Journal of Project Management*, 21, 261-69

Bortoluzzi, A (2008) *The Principle of Proportionality: A Comparative Approach from the Italian Perspective*, retrieved from http://works.bepress.com/andrea_bortoluzzi/1

Bryman, A. (2001) *Social research methods*, Oxford: Oxford University Press

Bunni, N.G. (2005) *The FIDIC Forms of Contract, (3rd edition)*, London: Wiley-Blackwell

Chan, D.W.M., Chan, A.P.C., Lam, P.T.I., Yeung, J.F.Y. and Chan, J.H.L. (2011) Risk ranking and analysis in target cost contracts: Empirical evidence from the construction industry", *International Journal of Project Management*, 29, 751-63

Chan, S. and Park, M. (2005) Project cost estimation using principal component regression, *Construction Management and Economics*, 23, 295-304

Creswell, J.W. (2003) *Research Design: Quantitative and Qualitative Approaches (2nd Edition)*, Thousand Oaks: Sage Publications

Eggleston, B. (2001) *The ICE conditions of contract (7th Edition)*, Oxford, Malden, MA: Blackwell Science

Elhag, T., Boussabinaine, A. and Ballal, T. (2005) Critical determinants of construction tendering costs: Quantity surveyor's standpoint, *International Journal of Project Management*, 23 (7), 538-45

Ferry, D., Brandon, D. and Ferry, J. (1999) *Cost planning of buildings*, 7th Edn. Oxford, Malden, Mass: Blackwell Science.

Fewings, P. (2009) *Ethics for the built environment*, London: Taylor & Francis

Flanagan, R. and Norman, G. (1993) Risk management and construction, UK: Blackwell Science

Flanagan, R. and Tate, B. (1997) *Cost Control in Building Design*, Blackwell Science

Flyvbjerg, B., Bruzelius, N. & Rotherngatter, W. (2003) Megaprojects and Risk: An Anatomy of Ambition, Cambridge University Press

Fortune, C.J. and Lees, M. A. (1996) The relative importance of new and traditional cost models in strategic advice for clients, *RICS research Paper*

Gardner, H. (2007) *Responsibility at work: how leading professionals act (or don't act) responsibly*, San Francisco: Jossey-Bass

Griffth, A. and Watson, P. (2004) *Construction Management: Principles and Practice*, UK: Macmillan

Grimsey, D. and Lewis, K.K. (2004) *Public private partnerships*, Cheltman, UK: Edward Elgar

Hansen, Z. (2011) *Civil Engineer's Handbook of Professional Practice*, ASCE Press: Wiley Publisher

Hiew, H and Ng, P. (2007) How the QS Can Create Values in the Procurement of Construction Works in Hong Kong, *Proceedings of Strategic Integration of Surveying Services in FIG Working Week 2007*, Hong Kong SAR, China 13-17

HKSAR Government (1999), *General Conditions of Contract for Civil Engineering Works*, The Government of Hong Kong Special Administration Region

Ho, E.S.T. (2000) Under the Dome, *Newsletter*, Issue No. 22, June 2000

Iyer, K. and Jha, K. (2005), Factors affecting cost performance: evidence from Indian construction projects, *International Journal of Project Management*, 23, 283-95

Jaeger, A. (2010) *A FIDIC GUIDE for Practitioners*, Prager

Jaggar, D., Ross, A., Smith, J. and Love, P. (2002) *Building Design Cost Management*, Blackwell Science

Kerridge, A.E. and Vervalin, C.H. (1986) *Engineering and Construction Project Management*, Texas: Gulf Publishing Company

Kerzner, H. and Belack, C. (2010) *Managing Complex Projects*, USA: John Wiley and Sons

Kirkham, R. (2007) *Ferry and brandon's cost planning of buildings*, 8th Edn. London: Blackwell Publishing

Klatt, B, Murphy, S. and Irvine, D. (1999) Accountability; Practical tools for Focusing on Clarity in *Commitment Results*, London: Kogan Page

Kyeong, J.H., Lee, H.S., Park, M. and Ji, S.H. (2008) Cost estimation methodology using database layer in construction projects, *The 25th International Symposium on Automation and Robotics in Construction*, June 26-29, 470-75

Lee, Y.S. (2003) *Role of the Engineer under the Framework of General Conditions of Contract for Civil Engineering Works in Hong Kong*, MA (Arbitration and Dispute Resolution), City University of Hong Kong

Mau, S. D. (2006) *Hong Kong Legal Principles*, Hong Kong University Press

McKim, R., Hegazy, T. and Attlla, M. (2000) Project performance control in reconstruction projects, *Journal of Construction Engineering and Management*, 16 (2), pp. 137-141

Mochtar, K. and Arditi, D. (2001) Pricing strategy in the US construction industry, *Construction Management and Economics* 19, 405-15

Ng, C., H., Harun, Z. and Abdul-Rahman (1997), *Cost analysis and formulation of cost models for two-storey buildings construction in Malaysia*, Working Paper, Department of Civil Engineering, Universiti Malaysia

Ng, A. and Loosemore, M. (2007) Risk allocation in the private provision of public infrastructure, *International Journal of Project Management*, 25, 66-76

Nima, M.A., Abdul-Kadir, N.R. and Jaafar, M.S. (1999) Evaluation of the engineer's personnel's role in enhancing the project constructability, *Facilities*, 17 (11), 423-30

Nkado, R. (1995) Construction time-influencing factors: the contractor's perspective", *Construction Management and Economics* 13, 81-9

Olawale, Y.A. and Sun, M. (2010) Cost and time control of construction projects: inhibiting factors and mitigating measures in practice, *Construction Management and Economics*, 28 (5), 509-26

PMI (2004) *Project Management Body of Knowledge (3rd Edition)*, PMI

Raftery, J. (1994) *Risk analysis in project management*, London: E&FN Spon

RICS (1992) *Cost management in engineering construction projects: guidance notes*, London: Royal Institute of Chartered Surveyors

Royal Institute of Chartered Surveyors. (2009), Rules of conduct for members, Retrieved from http://www.rics.org

Seeley, I.H. (1996) *Building Economics (4th Edition)*, UK: Macmillan

Seeley, I.H. (1997) *Quantity Surveying Practice (2nd Edition)*, London: Antony Rowe Ltd.

Shen, L.Y. (1997) Project risk management in Hong Kong, *International Journal of Project Management*, 15(2), 101-5

Stevens, J. (1996) *Applied Multivariate Statistics for Social Sciences*, Mahwah, N.J.: Lawrence Erlbaum Associates

Thompson, P. and Perry, J. (1992) *Engineering Construction Risks: A guide to project risk analysis and risk management*, London: Thomas Telford

Tuuli, M.M. (2009) *Empowerment and control dynamics in project teams: a multi-level examination of the antecedents and job performance consequences*, unpublished PhD Thesis, Department of Real Estate and Construction, The University of Hong Kong

Tah, J.H.M., Thorpe, A. and McCaffer, R. (1996) Contractor project risks contingency allocation using linguistic approximation, *Engineering, Construction and Architectural Management*, 3 (4), pp. 251-69

Warsmae, A. (2006) *Construction Costs: Central Concepts, Categories and Determining Factors*, Royal Institute of Technology

Williams, P. (2003) Predicting final cost for competitively bid construction projects using regression models, *International Journal of Project Management*, 21, 593-99

Wood, G. and Ellis, R. (2003) Existing risk management approaches in civil engineering, in Smith, N.J. (ed.), *Appraisal*, *Risk and Uncertainty*, London: Thomas Telford

URL Address:

Engineering Council (EC) (2007) http//:www.engc.rog.uk

http://ezinearticles.com/?The-Role-of-the-Quantity-Surveyor&id=3850546, retrieved in May 2012

http://www.rpsgroup.com.au/service/quantity-surveying, retrieved in May 2012

http://vexiflex.blogspot.hk/2012/05/role-of-quantity-surveyor.html, retrieved in May 2012

http://wiki.answers.com/Q/Describe_how_the_independent_quantity_surveyor's_role_developed, retrieved in May 2012

Appendix 1 Questionnaire on Cost Management

香港城市大學
City University of Hong Kong

March 2012

Dear Sir/Madam:

Questionnaire Survey on Cost Management of Infrastructure Projects

This is a part of the research to study the cost management aspects of infrastructure projects. The questionnaire is designed to gather your views on the cost control aspects at different stages of the projects. The information collected will be kept strictly confidential and will only be used statistically. Please return the completed questionnaire by e-mail or by fax (3442-9716). If you have any question, please feel free to contact me at 34427690 (or email: bsellenl@cityu.edu.hk).

Thank you for your time and support in advance.

Yours sincerely,

Dr. Ellen Lau
Principal Investigator
Division of Building Science and Technology
City University of Hong Kong
Phone: (852) 3442-7690
Fax: (852) 3442-9716
Email: bsellenl@cityu.edu.hk

Profile

1. Which of the following best describe the field you are in?
   - ☐ QS Consultant
   - ☐ Civil Engineering Consultant
   - ☐ Contractor
   - ☐ Client
   - ☐ Others …………………………………….

2. Which of the following type of projects you mostly involved in the last 3 years?
   - ☐ Civil Engineering
   - ☐ Building
   - ☐ Building and civil engineering

3. Please specify the level of your working position:
   - ☐ Policy making level (planning)
   - ☐ Project management (group of projects) level
   - ☐ Project (single project) level (management and/or operational level)

Section 1 An overview of the Cost Management Aspects

4. Please use the following scale to describe your view on cost management aspects in engineering projects.

For civil engineering projects	*Strongly Disagree*	*Not agree*	*Neutral*	*Agree*	*Strongly Agree*
4.1 There are guidelines for preparing the cost estimate.	1	2	3	4	5
4.2 There are set conditions to be adhered to for cost control.	1	2	3	4	5
4.3 There is a method of cost checking together with a cost feedback system.	1	2	3	4	5
4.4 Our role is focused on issues to give the client good value of money.	1	2	3	4	5
4.5 A warning signal will be provided if it is anticipated that there is cost over-run.	1	2	3	4	5
4.6 There is a means of remedial action for cost over-run.	1	2	3	4	5
4.7 Our work is to maintain good value of money for the project.	1	2	3	4	5
4.8 We aim to achieve the required balance of expenditure between the various parts of the project.	1	2	3	4	5
4.9 We have to keep expenditure of the project within that allowed by the client.	1	2	3	4	5
4.10 There is a cost planning framework to be used at the pre-tendering stage.	1	2	3	4	5

For civil engineering projects	*Strongly Disagree*	*Not agree*	*Neutral*	*Agree*	*Strongly Agree*
4.11 The cost is thoroughly reviewed at pre-tendering stage.	1	2	3	4	5
4.12 The cost is thoroughly reviewed during a period after tendering and before the contract is awarded.	1	2	3	4	5
4.13 The cost is thoroughly reviewed at the post-contract stage.	1	2	3	4	5
4.14 The project is full of design uncertainty: a lot of information is available but it never gives a complete picture.	1	2	3	4	5
4.15 Too many parties are involved in making-decisions for the scope of the project.	1	2	3	4	5
4.16 Constructability is usually the concern in design.	1	2	3	4	5
4.17 Health and safety issues are always our priority for the project.	1	2	3	4	5
4.18 The environmental issues always cause us alarm in the engineering design.	1	2	3	4	5
4.19 We usually have a detailed arrangement of the logistics for the project.	1	2	3	4	5
4.20 Somehow there are a lot of political risks for engineering projects and they affect cost.	1	2	3	4	5
4.21 The social factors surrounding the natural environment of engineering projects have an impact on costs, no matter it is immediate or distant in the future.	1	2	3	4	5
4.22 There are always some forms of risk management or risk assessment process adopted at pre-contract stage.	1	2	3	4	5
4.23 Most of the risks can be accurately expressed in monetary terms.	1	2	3	4	5
4.24 Risk management or risk assessment process will continue throughout the design and construction stage.	1	2	3	4	5
4.25 The time element / program can be controlled comfortably by the person-in-charge.	1	2	3	4	5
4.26 Speed of construction is usually our pride for the project.	1	2	3	4	5
4.27 There are always some problems with the site conditions which we have missed considering before contracting stage.	1	2	3	4	5
4.28 There are a lot of monetary reserves such as contingency sum for the unexpected.	1	2	3	4	5
4.29 Such reserves are usually more than 10% of the contract value.	1	2	3	4	5
4.30 We have the knowledge to manage these monetary reserves.	1	2	3	4	5
4.31 Cost estimate is based on past data and historical standards, and is usually reasonably accurate.	1	2	3	4	5
4.32 We have to use multi-estimating techniques and different cost control method for the items or parts of the construction	1	2	3	4	5

For civil engineering projects	Strongly Disagree	Not agree	Neutral	Agree	Strongly Agree
works.					
4.33 We have a formula or certain comprehensive methodology for forecasting future cost.	1	2	3	4	5
4.34 We are usually commended for effective cost monitoring.	1	2	3	4	5
4.35 We can accurately predict the final cost at 25% completion of the project.	1	2	3	4	5
4.36 Time of construction is usually within our prediction.	1	2	3	4	5
4.37 We can accurately predict the time performance at 25% completion of the project.	1	2	3	4	5
4.38 It takes us a lot of time to predict a reasonably accurate cost.	1	2	3	4	5
4.39 The estimate is usually not provided by the in-house staff but by people not affiliated with the project.	1	2	3	4	5
4.40 There is usually a problem when the clients have to stipulate a maximum cost.	1	2	3	4	5
4.41 There is always a problem when the brief or the client requirement is not detailed enough for the design team to work out the cost.	1	2	3	4	5
4.42 Our clients would consider engaging cost consultants as a strategic partner such that a consultant can become a solution provider for any cost matters.	1	2	3	4	5
4.43 As our projects are highly susceptible to the unknowns and uncertainties, we require a more flexible approach as well as increased contingency allowances for unexpected costs.	1	2	3	4	5
4.44 Quality of the construction work is seldom a problem.	1	2	3	4	5
4.45 We recognize that project management of construction work is a multi-disciplinary art requiring professional services.	1	2	3	4	5
4.46 We require a cohesive working team of people with different management expertise for this project.	1	2	3	4	5
4.47 This project requires a high level of capital investment by the contractors.	1	2	3	4	5
4.48 There are cost factors such as site location, programme, procurement strategy, contract management, market conditions, contractor's workload and technology etc. requiring judgment for preparing the cost estimate	1	2	3	4	5

Section 2 Impact of risks

5. There are many risks faced by all parties in a project. Please use the following scale to describe your agreement on risks that frequently take place and have cost impact. Risks here are defined as: *factors that are predicted to be faced in construction projects.*

Risks in Engineering and Construction Projects	Strongly Disagree	Not agree	Neutral	Agree	Strongly Agree
5.1 Accidental event leading to environmental 'damage' during site operation	1	2	3	4	5
5.2 Accommodating utilities and services authority requirement	1	2	3	4	5
5.3 Inconsistent performance of contractor	1	2	3	4	5
5.4 Confliction or incompatibility of design/technical principles	1	2	3	4	5
5.5 Design changes	1	2	3	4	5
5.6 Dispute over variations	1	2	3	4	5
5.7 Inadequate contractor capability in terms of management, labour, skills, plant, etc.	1	2	3	4	5
5.8 Incompetence of project management team	1	2	3	4	5
5.9 Lack of contingencies or fallbacks to cover delays, errors, damage, catastrophes in general	1	2	3	4	5
5.10 Lack of contractor experience in technology, design or construction process.	1	2	3	4	5
5.11 Lack of effective management control of sub-contractors	1	2	3	4	5
5.12 Loss due to financial charges via increased interest rates	1	2	3	4	5
5.13 Procurement strategy allocates responsibilities to inappropriate parties	1	2	3	4	5
5.14 Project delay	1	2	3	4	5
5.15 Public opposition to proposals	1	2	3	4	5
5.16 Statutory approvals or third-party agreements not in place by required time, leading to program delays.	1	2	3	4	5
5.17 Subcontractor's low credibility	1	2	3	4	5

Section 3 Effectiveness of cost control for engineering and construction projects

6. Do you agree the following costing method(s) are used frequently for civil engineering projects?	Strongly Disagree	Not agree	Neutral	Agree	Strongly Agree
6.1 Unit cost estimating	1	2	3	4	5
6.2 Approximate quantities estimating	1	2	3	4	5
6.3 Designer approach cost model	1	2	3	4	5
6.4 Constructor's production model	1	2	3	4	5
6.5 Tender prediction model	1	2	3	4	5
6.6 Whole life costing model	1	2	3	4	5

6. Do you agree the following costing method(s) are used frequently for civil engineering projects?	*Strongly Disagree*	*Not agree*	*Neutral*	*Agree*	*Strongly Agree*
6.7 Cash flow analysis	1	2	3	4	5
6.8 Resource-based model	1	2	3	4	5
6.9 Value management assessment	1	2	3	4	5
6.10 Cost benefit analysis	1	2	3	4	5
6.11 Present worth method	1	2	3	4	5
6.12 Payback method	1	2	3	4	5
6.13 Internal rate of return	1	2	3	4	5
6.14 Break-even analysis	1	2	3	4	5
6.15 Cost driver method (e.g. activity-based costing)	1	2	3	4	5
6.16 Sensitivity analysis	1	2	3	4	5
6.17 Monte Carlo simulation	1	2	3	4	5
6.18 Productivity-based study	1	2	3	4	5

7. Do you agree the following items have high impact on cost?	*Strongly Disagree*	*Not agree*	*Neutral*	*Agree*	*Strongly Agree*
7.1 Inflation rate	1	2	3	4	5
7.2 Exchange rate	1	2	3	4	5
7.3 The profit margin	1	2	3	4	5
7.4 The tender negotiation process	1	2	3	4	5
7.5 Tender pricing or contractor’s pricing (whatever method)	1	2	3	4	5
7.6 Valuation of variations	1	2	3	4	5
7.7 Assessment of claims	1	2	3	4	5
7.8 The negotiation process taken at post -contract stage	1	2	3	4	5
7.9 Re-measurement of provisional quantities,	1	2	3	4	5
7.10 Re-valuation of provisional sums and prime cost sums	1	2	3	4	5
7.11 The negotiation process taken at final account stage	1	2	3	4	5
7.12 The overall settlement of the final account	1	2	3	4	5
7.13 Site location	1	2	3	4	5
7.14 Programme	1	2	3	4	5
7.15 Procurement strategy	1	2	3	4	5
7.16 Contract management	1	2	3	4	5
7.17 Market conditions	1	2	3	4	5
7.18 Contractor’s workload	1	2	3	4	5
7.19 Technology	1	2	3	4	5

Basic Information of the respondent:

8 Please specify the attribute of your company:

☐ Public

☐ Semi-Public

☐ Private

9 Please specify your working years in this area.

☐ 1-3 years

☐ 3-5 years

☐ 5-7 years

☐ 7-10 years

☐ More than 10 years.

10 Please fill in the following information for our follow-up survey and possible interview selected later on.

Name (anonymous in report):	
Telephone:	
Email:	
Position (Optional):	

You have completed the questionnaire.
Thank you for your time and support.

Appendix 2 Interview Questions

1. What is your understanding on the “the independent QS role” in building projects?

2. What is your understanding on the “the independent QS role” in engineering projects?

3. With respect to your experience in the QS profession, does the QS have an “independent role” in cost management aspects in different stages in an engineering project? The stages are:

    a. Pre-tendering stage Yes / No
    b. Post-tendering stage Yes / No
    c. Post-contract stage Yes / No
    d. Completion Stage Yes / No

4. According to your answers in Q3, please briefly describe what QS does or does not do in cost management at each of these stages.

    a. Pre-tendering stage
    b. Post-tendering stage
    c. Post-contract stage
    d. Completion Stage

5. Do you reckon the involvement of QS for cost management in engineering projects is the same as those for building projects?

6. How is QS involved in civil engineering project for cost management? Is it the same as what you think?

7. With respect to your experience in the QS profession, have the QS performed an “independent role” in contract management in different stages in an engineering project? The stages are:

    a. Pre-tendering stage Yes / No
    b. Post-tendering stage Yes / No
    c. Post-contract stage Yes / No
    d. Completion Stage Yes / No

8. According to your answers in Q7, please briefly describe what QS does or does not do in contract management at each of these stages.

    a. Pre-tendering stage
    b. Post-tendering stage
    c. Post-contract stage
    d. Completion stage

9. How is QS involved in civil engineering project for contract management? Is it the same as what you think?

10. What factors do you think are important for QS to take into account in preparing the cost estimate?

11. What costing methods do you often used for preparing the cost estimate in civil engineering projects?

12. Do you think this costing method helps you to do well? If not, Why?

13. From your viewpoint, can project final cost be accurately estimated when the project is 25% completed?
    Yes / No (Why?)

14. From your viewpoint, can project time be accurately predicted when the project is 25% completed?
    Yes / No (Why?)

15. In your opinion, does post-contract cost control procedure have high impact on cost? Why?

16. In your opinion, does contract administration have high impact on cost? Why?

17. Are there any problems that affect the development of independent role of QS in the engineering projects? (If yes, what are they? Can you describe the problem?)

18. In your opinion, does QS have an independent role in managing infrastructure projects? If yes, how does the training (such as skills and knowledge) give benefits to the QS in managing the projects?

19. In what way do you find QS to have performed better in cost management and contract management for engineering projects in the present situation?

20. In support for the development of an independent role of QS, what do you suggest the institutions to do?