Investigating the Intentional Quality Risks in Public Foundation Projects:

A Hong Kong Study

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Abstract

Since foundation projects are one of the most complicated construction activities, many unforeseeable and invisible conditions and uncertainties will be investigated during the construction processes. The importance of examining risk management in foundation projects had pressing harder as short-piling experiences gained from the Hong Kong construction. Various types of quality risk should not be avoided throughout the construction development, including site condition, managerial and contractual factors. This paper identifies the typical factors affecting the three main categories defined in risk management in conducting foundation projects from various construction professionals. Intentional quality risk found to be difficult in handling the real responsibilities. This study will also present alternative solutions for controlling these quality risks and the effectiveness of these solutions has been tested. The findings from the study provide useful references to the construction industries.

Keywords: Risk allocation, factors, contractual, managerial, construction, Hong Kong

Introduction

Risk and uncertainty cannot be avoided in the construction development particularly in the foundation projects. The Hong Kong Housing Authority (HKHA) being one of the largest clients in the Hong Kong construction industry has emphasised on minimizing the risk and uncertainties in the foundation project in order to provide a high quality of housing to the public [1]. Owing to the complexity and the short contract period, foundation projects bear the highest risk among construction stages [2-5]. Prior to the commencement of a foundation project, the estimate of its construction cost is one of the most important activities. An appropriate strategy such as risk management system is essential for reducing and controlling the risk [6-12]. Currently, HKHA has adopted certain measures to manage the risk like the change of contractual arrangement and risk sharing with contractors. All these approaches as well as the risk management system would increase the quality of works and provide a positive image to the public [13-17].

In recent years, some of the public housing projects have been found the problems of substandard piles in the foundation. Most of the public may consider as contractor's fault and the insufficiency of client's supervision [18-22]. However, according to the Report of the Selected Committee on Building Problem of Public Housing Unit, these factors only form parts of the failure. On the other hand, one of the most serious problems is the underestimate of the project cost. Owing to the keen competition of tendering, most contractors would try to lower their tender price in order to bid the tenders [23-29]. However, they almost forgot that foundation project is the highest risk bearing stage among all the construction activities. The uncertainties encountered within the projects are usually uncontrollable such as the inclement weather, ground water level and the

unforeseeable underground condition. Moreover, there are many limitations and restrictions which may increase the degree of risk in construction. Once the uncertainties exceed their expectation, the project cost will over-run and the contractor may suffer serious loss in the project [18-22].

Besides, the contractual arrangement may also lead to the underestimate of the project cost. In the beginning, HKHA tend to use the engineer's design for foundation contract [30-31]. It can provide a higher accuracy for the contractor to estimate the project cost and thus a better quality can be obtained. However, the uncertainties and variations arise during the construction period will give the contractors a chance to claim for extension of time (EOT) and loss or expenses. As a result, the final contract sum will exceed the project budget. HKHA therefore start to use the design and build as an alternative contractual arrangement. The advantage of using design and build contract is freely transfer certain risk to the contractor. The contractors have to take up the cost and design liability. Therefore, the efficiency and budgetary control can also be improved. However, most of the contractors may try to reduce the allowance of risk in order to win from the keen competitive tendering [18-22,25,26]. Once the uncertainties exceed they expected, the contractor would suffer a serious loss which may lead to the construction of faulty piling. After the occurring of substandard foundations occurs, HKHA adopt the engineer's design again. Meanwhile, in order to reduce the risk bearing and minimize the claims, the HKHA would like to share the risk with the contractors. Although the project cost may increase, the quality will be improved which is curial gain the public confidence.

Since the poor quality found from the current practices, this paper will focus on:

- i) Investigating the major problems in the current public foundation projects in Hong Kong construction;
- ii) Examining the responsibilities of various construction professionals in foundation works;
- iii) Identifying the various quality risk factors affecting the performance in public foundation projects;
- iv) Exploring the behaviour different between intentional quality risks and real responsibilities from various construction professionals; and
- v) Suggesting some measures for improving the current construction situations.

Problems in the Current Public Foundation Projects

For the situations of the traditional foundation projects, five main elements in the foundation projects can be highlighted [18-22]:

- 1) Higher risk, as foundation contract suffers relative higher risk than other types of projects, many unforeseeable factors, such as ground condition, inclement weather and plant availability will be easily across. If the lowest price tendering still adopted for this type of project, a series of poor quality or construction scandal will be happened.
- 2) Critical activities, foundation contract is highly allocated with critical construction activities. Piling activities is nearly allocated 85% of the construction activities in foundation contract.
- 3) Alternative design, as the site condition is a higher variable factor for foundation works, the more realistic foundation location can be provided for various foundation design. To reduce the risk of design negligence occurs, alternative design for

foundation design during construction phase will be addressed.

- 4) Higher flexibility needed, as higher flexibility required for foundation projects, many unforeseeable conditions will be encountered; design and build contract will usually be applied. The party undertaking the project is responsible for taking both the design and construction of the facility in accordance with certain performance-based specifications laid down by the client. This approach allows designers, engineers, contractors and suppliers to work altogether from an early stage of project development through detailed design to construction. Given the greater flexibility allowed for the design, thus constructability is improved.
- 5) Programme and cost, planning, programming techniques and past experience contributed in varying measures to such guidelines for fresh assessments. However, the overall timescales of many projects often appear to be decided on the basis of commercial and political considerations. Planning and programming methodologies together with resource inputs are then designed to meet such time targets.

Responsibilities from Various Construction Professionals

On the common local practices of foundation contracts, two main parties of the engineer's design and the contractor's design can be divided. On the side of the engineer's design, choosing foundation types may be more objective and are less likely to be restricted by plant availability and past expertise in particular pile types. Normally, engineers are less influenced by cost considerations and concentrated on the technical grounds. For projects with difference site and ground conditions required, the use of the engineer's design approach is particularly warranted. This is because the contractor's chosen scheme may involve undue risk of failing to comply with the specified

performance criteria. Therefore, engineer's design is a common practice on foundation works.

Contractor's design is the favoured contractual option for foundation works; the project designer may, in some instances, choose to rule out those foundation types that are obviously unsuitable for the project's specification [30]. If an estimator gained more experience from foundation contracts, the more accurate bidding strategy can be submitted. Under this arrangement, the contractor is required to choose the foundation type and design a lump sum to meet the acceptance criteria and bear all the high risks in respect of design, construction, cost and programme of the works. Contractor's design based on experience, technical expertise and their knowledge on availability and costs of material, plant and labour associated with a particular foundation type can be utilized. The aspect of buildability can be properly assessed by the contractor, particularly proprietary foundation systems are involved. There is comparatively less ambiguity in terms of the respective liability of the project designer and the contractor for the performance of the works. On the need of the engineer's design and the contractor's design, the tenderers for foundation contracts are usually allowed to submit alternative designs in order to provide a more cost-effective and suitable solution. The alternative design will be subjected to the agreement of the project designer. In practice, it is usual to undertake preliminary inquiries with potential specialist foundation contractors prior to tendering and discussing the range of suitable foundation options given the specific constraints on the project.

Other than the common practices of the engineer's design and the contractor's design in

the local foundation contracts, a most serious financial risk in foundation projects is delay to project completion and consequential increase in financing charges combined with revenue slippage, such costs can be much greater than the value on the foundation contract. Different foundation types should not be the sole reason for rejection as these can generally be overcome by adherence to good foundation practice and adoption of precautionary measures. Choice of foundation types should be used for minimizing the potential construction problems in the given site and ground conditions, and limiting the risk of possible delays. Delays are especially undesirable, where the project owner is paying financing cost.

Intentional Quality Risk Factors

When estimating a foundation project, many factors would affect the design and the construction process. These risk and uncertainties are divided into three categories including site conditions, managerial aspects and contractual aspects. These factors are not only affect the estimate cost but also the decision making of the professionals. Once the risk cannot be ascertained at the time of estimating, the professionals may require having a large allowance in the budget to deal with these uncertainties. These allowances may include the varied design factors from the structural engineers and architect or the amount allowed in the contingency by the quantity surveyors.

Site Conditions

Site condition is the one of the most important factors in affecting the estimate of a foundation project. In Hong Kong, underground soil condition is complicated and various in different locations. The degree of difficulties in executing a foundation project will

highly depend on the location of the site. Moreover, the existing site situation including the underground utilities and adjoining structures are also the factors which affecting the foundation project.

- Abnormal ground condition: In a foundation project, the underground soil condition is a major risk factor. If the soil condition is deviate from the site investigation report, the foundation contractor may dramatically decrease the profit. Once the contractor found that there were any adverse underground conditions, the whole piling level would become deeper than the original design so as to satisfy the requirement as stated in the specification. As a result, the accuracy of soil information is crucial for structural engineer to design the type of foundation. In order to reduce the risk of underground soil condition, large number of boreholes should be extracted to increase the accuracy of soil information. Afterwards, the structural engineer can design the most suitable type of foundation such as bored pile, H-pile and the footings to avoid the risk to the client.
- Location of site: The degree of variety and complexity in underground soil condition is significant among different location in Hong Kong. Normally, it can be divided into reclamation site and redevelopment site. Owing to the scarcities of land, most of the HKHA projects nowadays were executed from redevelopment of existing estate. On the other hand, the government still provides certain places for the HKHA to develop some new public estates, such as West Kowloon reclamation area, in order to maintain the annual production of housing units. In the redeveloped area, site condition can be ascertained easily. However, some of the areas still contain unforeseeable ground conditions and those contractors may require making certain allowance to cover these uncertainties. Moreover, some of the areas such as Tung

Chung, Ma On Shan and Tseung Kwan O, the underground may consist cavern, which will largely affect the execution of piling works. Under these circumstances, contractors will enlarge the risk allowance to cover these uncertainties. In the new reclamation site, although the possibility of adverse ground condition is relatively lower, contractors still consider the water table and the settlement of the whole area as a problem. Therefore, risk and uncertainties still exist in the development.

- Existing underground utilities and adjoining structure: In the redevelopment area, there are numerous existing utilities in the underground. The removal or diversion of these services is normally not consisted in the demolition contract. Therefore, the foundation contractors are required to take up the necessary site works prior to the commencement of the piling works. Meanwhile, if the existing foundation is too complicated, large number of borehole logs should be obtained in order to have sufficient information about the obstruction. Obviously, the investigation may affect the whole construction period or in the worse case, the design of the foundation may be required to change. Nevertheless, the contractors should bear the whole risk under the contract provisions. If the contractor underestimates the difficulties encountered in the obstruction, a huge amount of loss will be suffered. Furthermore, the adjoining building structures may also affect the construction of piling works. In this connection, contractors have to construct temporary shoring to protect the adjacent structures and prevent the collapse of it. In some urban areas, foundation contractor have to further consider the protection of underground railway tunnels and structures during the execution of piling works.

Managerial Aspects

For the managerial aspects, it is divided into two major parts:

- Contractor's experience: In the HKHA foundation project, the client mainly concerns the experience of contractor. Most of the contracts were executed under selective tendering. Although the selective tendering will slightly increase the tender sum, it can avoid the poor performance and reduce the risks to the client. In order to maintain the performance of contractors, HKHA using the Performance Assessment Scoring System (PASS) to facilitate the continuation of quality improvement for the listed contractors. This system was designed to reward the contractors with higher bidding opportunities. The provision is that the contractors are required to execute the work to the standard as stated in the specification in order to fall into the upper level of the overall PASS scores. Once the contractor fails in the PASS score, the company will loss the chance to bid the new project until the contractor pass the PASS score again. In 1999, the HKHA carried out certain improvement by introducing a new tendering and reward scheme called Preferential Tender Award System (PTAS). It is a percentage ratio weighting to the price score and performance score. A preferential tender score will be calculated from each of the submitted tender sum and the contractor's past performance in the authority's project. This score is also derived from the latest six-month composite PASS score with adjustments based on the score of the best performing tender. Moreover, a bonus system is introduced to encourage contractors to produce high quality works, to complete all outstanding works quickly and to rectify defects in accordance with contract requirements. The contractor will be awarded a direct monetary bonus of 0.05% of the net contract sum for each point scored above the benchmark.
- Variation of foundation and superstructure design: Although most of the HKHA

buildings are standardized in nature, there are various types for different purpose such as carparks and commercial complex. Moreover, some buildings would be constructed for social welfare purpose such as care centre for senior citizens and etc. It will fully affect the engineer's design in the foundations and the allowance to the contract. Furthermore, different contractual arrangements would have different design factors. If engineer's design is used in the contract, the design will be various and more flexible since the varieties of purpose of the superstructure can be changed. Sometimes, the engineers may have over design.

Contractual Aspects

In the contractual aspects, three major parts are included:

- Contractual arrangement: Traditionally, contractor's design and build arrangement is a popular option for the HKHA foundation projects. In this arrangement, the client has to provide the relevant and necessary information to contractors. The information includes ground conditions, loading schedules, specification, testing requirement, specific constraints, together with the acceptant criteria of pile test and so on.
- Change of statutory requirement and specification: When estimating the cost of a foundation, the statutory requirement would affect the overall profit of the project. All the construction activities are restricted with noise control and particular on the foundation project. This restriction would affect the selection on the type of foundation as well as the programme of work. If the percussive H-pile is selected, only three period of time in a day can carry out the work due to the noise control by the environmental protection department. Therefore, the design professionals should consider these issues prior to the selection of foundation. On the other hand, the

testing of piling and foundation works should be taken into account when preparing the estimate of a project.

- Contract period and liquidated and ascertained damages (LAD): The contract period of a foundation project is last for nine months to twelve months depends on the site condition and programme of the whole development. Under the tight contract period, the contractor may not have many amendment in the design because anything affect the construction programme may cause delay of works. The programme of superstructure may also be scheduled since it may handover to other government department. If there are delays of work, the contractor may suffer a large amount of liquidated and ascertained damages. As a result, the overall profit will be decreased substantially.

Research Methodology

For the data collection, 154 questionnaires were sent and 48 are returned. The response rate is 31.2%. This survey is examining the level of significance in these risk factors on different construction professional. The target group has mainly focus on the professionals who worked at the housing department and some other consultant firms. These professionals include project manager, architects, quantity surveyors, structural engineers and other relevant parties. Moreover, all these professionals were selected from the development branch of the housing department [1]. It is because the development branch is mainly responsible for construction of new housing units and most of these professionals are presumed to have the experience of handling a foundation project. Furthermore, some of these professionals are managing the foundation projects as well.

On the 48 returned responses, 12 respondents are architects, 20 respondents are engineers and the remaining 16 are surveyors. The overall percentage shared by architects, engineers and surveyors are 25.0%, 41.7% and 33.3% respectively. In the 48 respondents, 34 professionals are working in the housing department and the remaining 14 professionals are working in consultancy firms, which represented 71.8% and 29.2% respectively. Therefore, the respondents can be classified into three categories:

- i) G1 – Architect;
- ii) G2 – Engineer; and
- iii) G3 – Surveyor.

In the survey, each professional is required to weight the relative significant with five levels, namely, least significant, fairly significant, significant, very significant and extremely significant, in the developed twenty-four risk factors with the relative significant.

Data collected from questionnaires were analyzed using the Statistical Package for Social Sciences (SPSS) Version 10.0 for Windows. The mean values of the three groups (G1, G2 and G3) were derived first. Then the values were tested for concordance between groups and F-test was performed with a demarcation level of significant at 0.05. The test is used to assess any similarity of opinion between groups on the issues of risk management.

To determine the relative ranking of factors, the scores were transformed to important indices based on the following formula [32]:

$$\text{Relative important index} = \Sigma w / (AN)$$

In this formula, w is the weighting given to each factor by the respondent, ranging from 1 to 5 where '1' is the least significant and '5' is the extremely significant; A is the highest weight, in this study will be 5; N is the total number of samples. The relative important index will range from 0 to 1.

Occurrence of Risk Factors

In finding the occurrence of each risk factor in foundation projects, it is presumed that these occurring changes are reflecting the professionals' consideration in the tendering stage. Various construction professionals' results will be discussed in the following:

Architect

In analysis the ranking of the risk factors, the upper class includes inclement weather, abnormal ground condition and others (see Table 1). It indicated that most of the architects would concern about the ground condition of site and the design of foundation and superstructure. As mentioned before, underground condition is an uncontrollable risk factor as well as the inclement weather. Moreover, the geographic report could not reflect the actual condition sufficiently. The variance in site condition will affect the design parameter and the decision to the type of foundation. Furthermore, as the client's representative, an architect must consider not only the foundation but also the superstructure in order to complete the whole project for the client.

<Table 1>

In the middle class of the architects' data, most of them concern about the matters in

respect of contractors. These matters include contractors' workmanship and experience. Apart from the site conditions, contractors' related matter would affect the execution of project as well. In the worst case, if the contractor has less experience to execute a foundation, an under-estimate of project cost would occur. As a result, this contractor may win the tender due to the lowest tender price and the risk of client will be increased. As the importance of that, the HKHA has established the PASS and PTAS in order to assess the performance of the contractors. Moreover, the contract particulars such as LAD and contract period are also considered. It is reasonable that the architects should take these into account for clients' consideration.

Meanwhile, in the lower class, architects mainly concern about the statutory requirements and other miscellaneous items such as determination of contractors and fluctuation of material cost. These items are given less concern because the contractors have been examined with PASS system so that the chance of determination of contractor and strike of labour are relatively lower. Moreover, the duration of a foundation contract is relatively short when comparing with the superstructure so that the probability of the change of statutory requirement within construction period is less. In addition, the specification and code of practice for executing a foundation project has been well established for a long time and therefore the variance for these items may not affect the construction.

Engineer

Table 2 is the ranking generated by the data received from the engineers. The upper class includes inclement weather, abnormal ground condition, contractor's design and

performance. It indicated that most of the engineers are mainly concern on the site condition and design parameter of foundation. It seems reasonable because the main responsibilities of the engineers are providing underground information to contractors to design and provide specification and contract particulars to surveyors for preparation of the bills of quantities. Apart from these, the main duty of engineers is to calculate whether the safety of foundation design is sufficient to support the superstructure. Once the adverse ground condition occurred, they may need to increase the safety factor or increase the depth of piling. Therefore, abnormal ground condition is a serious problem to the engineers. Moreover, if design and build arrangement applied, engineers have to approve the design details and the relevant calculation.

<Table 2>

In the middle class it includes experience of contractor, variation of design and so on. Apart from the site condition, the engineers will focus on the executed work. Since the contractor's experience will affect the quality of work directly, the engineer should have the liability to monitor the work being executed carefully. Moreover, variation of design will cause plenty of abortive work, which may also cause delay to the project. In the arrangement of design and build, contractors usually propose variation of design thus the engineer shall examine the risk of this variance.

However, in the lower class, it consists of certain contract particulars and factors related to the statutory requirements and specification. It indicated that the engineers might fully aware of the variance from the change of specification and code of practice. Moreover, when dealing with factors related to site administration, the engineer may consider it is

architect's liability and therefore pay less attention on these factors.

Surveyor

Table 3 is a perceived idea from the surveyors. In the upper class, certainly, the variation of design, information for tendering and LAD are all concerned by the surveyors. Most of the surveyors are acting as cost and contractual advisor at the same time. They are responsible to advise the client for any variation of design which may cause significant change in the estimate so that a better budgetary control can be obtained. Apart from these, preparation of tender documents and the bills of quantities are the major duties of the surveyors. Insufficient information may increase the allowance for the provisional sum and contingency. Therefore, it will largely affect the budgetary control of the client.

<Table 3>

In the middle case, the statutory requirements or code of practice is taken into account. Any change of specification and contract particulars may cause amendments to the tender documents. Moreover, the contractors' performance and experience may affect the cost of estimate. In accordance with PTAS, some of the lowest tenderers may be excluded from the list due to the past poor performance and therefore, it is reasonable that the surveyors should concern these factors as the risk.

However, the method statement and variation of superstructure design fall into the lower class. It seems that the surveyors have less concern on the execution and the design variation. In the normal practice, most of the surveyors are concern on the budgetary control of the project. They may believe that the problem created from the method

statement and the superstructure design will not much affect the estimate.

From the F-statistics result show in Table 4, six risk factors are significant, namely, “d: determination of the contractor”; “g: late information or site instruction by the architect or structural engineer or other parties”; “m: responsibility of contractor’s design”; “n: insufficiency of design information for tendering”; “p: design fault”; and “v: variation of superstructure design”.

<Table 4>

In comparing the values on the factors of “d: determination of the contractor”; “g: late information or site instruction by the architect or structural engineer or other parties”; and “n: insufficiency of design information for tendering”, the mean values of these factors on the engineers are different from other professionals. Since engineers are always working closely with the contractors with similar working directions and on-site activities, the factor on the determination of the contractor will be much more concerned by the engineers with a higher average value measured; while the factors on the late information and insufficiency of design information may not be much concerned.

Furthermore, architects are measured relatively lower mean value on the risk factor of “m: responsibility of contractor’s design” than other professionals. This is easy to understand that each professional wants to preserve their own goods. And, the surveyors ranked “p: design fault” and “v: variation of superstructure design” different from other professionals. This can be explained that the surveyors intended to put more consideration on the information of the contract.

Outcome Impact of Risk Factors

The outcome impact of risk factors presumed to reflect their opinions in the construction stage.

Architect

The inclement weather and existing underground services were not included in the upper class of the results and replaced by determination of contractor as well as communication and management skill (see Table 5). The architects considered that the inclement weather is unforeseeable and the contractor should bear the risk of existing underground services. Once the tender is awarded, the contractor has to make allowance to overcome these kinds of risk. Meanwhile, architects are concern about determination of contractor and communication skill since it will highly affect the construction of work. If the contractor terminates the contract, the client may require employing other parties to execute the remaining work. It not only causes delay of programme but also suffers a loss. Moreover, the communication and management skill is essential because a well-established management system can benefit the client and improve the quality of works. As a result, both the client and contractor would increase their profit.

<Table 5>

Engineers

The engineers considered the design fault and the extension of contract period are more important (see Table 6). Once the tender is awarded, the contractor has to execute the work according to the engineer's approved design. If the piling design is insufficient to

support the loading of the superstructure or not comply with the actual site conditions, engineers will be liable to carry out remedial works, for example, modification of design and other necessary measures. Moreover, the engineers must ensure that the approved design is complied with all the required specification and satisfied all the testing as required by the HKHA. At the same time, contract period is also concerned by the engineers since any variation to the foundation project would cause delay to the programme of work. If there are extensions to the contract period, engineers have to provide sufficient evidences for the delay and report to the client. Furthermore, engineers would take consideration on the factor of late instruction issued by them. If engineers issue site instruction late, contractor may claim the client against unexpected abortive works and hence the cost of construction will be increased. In addition, many complaints may be raised by other parties such as cost advisor and contract advisor. This complaint include the increase of construction cost may deviate the budgetary control of the project. If the cost exceeds the allowed amount in the contingency, the cost advisor has to report to the client. It may largely increase the workload of the cost advisor. Besides, if the contractor does not agree the reimbursed amount, legal action such as dispute or arbitration would be taken and the contract advisor has to prepare for the settlement of this kind of issue.

<Table 6>

Surveyor

During the superstructure design stage, most of the works in foundation have been fixed. However, the design of superstructure can be various depend on the architects' expectation. Sometimes, the architects may request the engineers to change the design of

foundation to suit for the variation of superstructure. As a result, surveyors have to prepare many budgetary portfolios for advisory. Moreover, the design fault is also taken into account as an important issue (see Table 7). Once failure of design occurred and the contractor is not willing to solve the problem, the contract advisor may suggest employing a third party to take up the works. In this connection, surveyors have to prepare the supplemental agreement or any necessary documentation for re-tender purpose. Consequently, the contractor's experience during construction stage is quite important in surveyor's viewpoint because it can simplify the workload of surveyor and reduce any unexpected claims or dispute for the works.

<Table 7>

From the F-statistics results on Table 8, three risk factors are significant, namely, “d: determination of the contractor”; “f: change in specification, or code of practice”; and “y: existing underground services”. The mean values of these three factors on the surveyors are different from other professionals. The surveyors will pay more concern on the change of contractual information and existing services; those will directly affect the requirements and design for the particular project.

<Table 8>

Perceiving Suitability by Professionals

The data perceived by the architects, engineers and surveyors are shown in Tables 9, 10 and 11 respectively. In comparing Tables 9 and 10, an identical pattern was obtained from these two professional parties. Most of them have the same ideas for the professional

suitability of risk factors. Moreover, apart from the experience and performance of contractors as well as the site control and management, most of the design, statutory requirements and factors related to the provision of information are responsibilities of the engineers. It is reasonable that the major responsible party for controlling and monitoring a foundation project is the engineer among different professional disciplines. As a result, the engineer and contractor are the most important parties in a foundation project.

<Table 9>

<Table 10>

<Table 11>

However, when comparing with the results on the surveyors, a large difference can be observed. Unlike the opinion from the architects and engineers, most surveyors considered the factors concerning the design, statutory requirement and factors relating to the provision of information for tendering are the responsibilities of the architects. This reason may be due to the contractual arrangement of the project. Normally, most of the foundation projects are executed under the contractor's design. Contractors are responsible for the design of foundation and comply with the required specification. The engineers are act as an advisor in the project and monitor to the works. However, most of the information and contract particulars are provided and decided by the architects. Therefore, majority of the surveyors had selected the architects as the most suitable professional to deal with these risk factors in a foundation project.

According to Table 12, it is the contractual preference perceived by the architects, the majority of professionals are likely to use engineer's design as the favourable

arrangement except the projects in reclamation site. In the types of piling, over 75% of the architects preferred to using engineer's design as the contractual arrangement to run the project since using this arrangement will obviously reduce the risk bearing by the architects. For the project in reclamation site, the percentage of preferring contractor's design and engineer's design are the same. Both the contractual arrangements got 50% of the architects' opinion. One of the reasons is both contractual arrangements have the same effect to that condition. Another reason is that they cannot find the most suitable contractual arrangement to dealing with this condition. In fact, execution of foundation project in a reclamation site is more risky than that of a redeveloped site. As a result, a fifty-fifty percentage was appeared in this situation.

<Table 12>

On the other hand, from the data perceived by the engineers as shown in Table 13, majority of professionals would like to adopt contractor's design as the contractual arrangement for a foundation project. In lump sum basis contract, up to 90% of engineers preferred to choose contractor's design. Using the contractor's design can reduce the workload and the liability to the engineers because all the risk bearing falls onto the contractors. Moreover, the engineers can provide a function of risk reduction and risk avoidance to the project. However, 65% of engineers would like to select engineer's design for the re-measurement basis contract. It indicated that the engineers prefer to take up the design and control the project under a re-measurement contract since the contractors may claim for substantial change when there are large different from the original quantities. In the types of piling, 80% of engineers preferred to use contractor's design for H-pile foundation but 50% of engineers selected this arrangement for bored

pile foundation. It may be due to the construction H-pile is relatively simple than that of bored pile and therefore the risk bearing of H-pile is less than that of bored pile. As a result, some engineers would like to choose engineer's design for bored pile since the degree of controlling the design and monitoring of construction is higher in this arrangement.

<Table 13>

Besides, from the data perceived by the surveyor in Table 14, a sharp contrast and consistent selection has been obtained. Most of surveyors would like to choose engineer's design for a foundation project in general. It means that engineer's design may effectively reduce the risk of surveyors. In re-measurement basis contract, more than 75% of surveyors preferred to use engineer's design as the favourable arrangement to handle a foundation project. Although a re-measurement of provisional quantities is required to be carried out, most of surveyors still tend to choose this arrangement. Obviously, in the engineer's design the contractor should follow the engineer's instructions, drawings and specification to execute the works. When there are any changes or variances, the engineer is liable to issue variation order to the contractor. Moreover, using the engineer's design seems that the project will go on smoothly than the others so that it is more popular within the surveyor's preference.

<Table 14>

Recommendations

Risk Sharing with the Contractors

From the interview discussions, one of the recommendations is to release the contractor

from the specification requirement and granting of EOT. The release of the specification is not a reduction of quality. To a certain extent, it is a method of sharing risk with the contractors. Since the specification requires the contractor to execute the piling work to a bedrock level, if abnormal ground conditions occurred within the site, the contractor has to comply with the requirement by lowering all the piles to fulfil the specification. If the client can release the specification and allow the contractor to submit a safety proposal or change the design of piling, the contractor may not suffer a huge amount and bear that risk. Moreover, the schedule completion date may not be affected. On the other hand, they may grant the EOT to the contractor when any unforeseeable ground condition occurred. Although the client may not release the specification and the contractor is obligated to comply with required contract conditions, granting of EOT in this case can reduce the loss to the contractor. In addition, an alternative way of waiving the LAD to the contractor can reduce the loss to the contractor. All of these methods can provide risk sharing with the contractors.

Implementation of Partnering

Partnering in construction has been developed as an important way of improving construction project performance through its direct benefits brought to both clients and contractors. The Hong Kong Housing Authority (HKHA) has committed to deliver high quality housing for customers, partnering is the main strategy to enhance building quality. In order to tackle the quality problems effectively, the HKHA set out their vision for reform according to the Consultative Document "Quality Housing: Partnering for Change" in 2001 [1].

In 2001, the partnering approach had been strengthened to improving the quality of the piling contract such as to reinforce the partnership relationship between the Building Committee and the Housing Department by reviewing Building Committee's structure and operations. Moreover, the HKHA has been working closely with the Hong Kong Construction Association (HKCA) in the implementation of this approach. Furthermore, a quality task force was established to implement the partnering approach. Most of the senior management staff agreed that partnering has already assisted to improve the workflow, working environment and output.

Besides, sharing information about the site is particularly critical for the foundation projects, as complexity of ground conditions of a site will affect the cost and the construction period, which in turn will affect the tender price. Once the contractors have the sufficient information, they can well plan their programme and accurately estimate the construction cost, hence submit an adequate tender price.

Adequate project duration is an important factor affecting the quality of construction. Currently EOT will be granted for unanticipated complex ground conditions in the HKHA project. If EOT is also granted in other reasonable circumstances, such as the preservation of heritage found underneath or at the site, then this measure could ensure adequate project duration.

Conclusion

Risk can be defined as controllable and uncontrollable those may cause losses to the

clients and contractors. The suggested way is to minimize or reduce or even to avoid it by means of risk management. Risk management is a sequential system consisting of risk identification, analysis and evaluation and response management. A proper implementation of risk management can assist the client and contractor to improve the accuracy of estimation to minimize or control the risk and uncertainties. From the questionnaire development and data analysis, most of the professionals consider the abnormal ground condition as the most important risk factor within the foundation projects. It obtained the highest significant rank among the three professionals' opinions. This is no doubt that abnormal ground condition could cause the largest variance to the design of piling and foundation. Consequently, it is highly affect the estimate of construction cost. On the other hand, the importance of risk factors perceived by the professional discipline is also different.

The implementation of risk management system is a solution to solve the problem through the identification, reduction, transfer and avoidance of risk and uncertainties. Throughout the significant ranking, the major risk factors within a foundation project are identified and a general trend of importance is obtained. It would provide a reference to the professionals for the allowance to estimate a foundation project. Moreover, the most suitable party of controlling the risk in a foundation project is also obtained. The client could select the most suitable risk factor for transfer or avoidance in a foundation contract. However, the risk management technique of the HKHA within a foundation project is still insufficient. It is better to have a standardize manual for the procedure of risk management to handle the risk and uncertainties in a foundation project. Once the risk management system has been fully utilised, it could assist to produce a higher quality of

works in the public housing development.

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Table 1 – Occurring Change of Risk Factors Perceived by the Architects

	Risk Factors		Mean	Rank
Upper Class	a	Inclement weather	4.20	1
	b	Abnormal ground condition	4.18	2
	v	Variation of superstructure design	4.05	3
	y	Existing underground services	3.98	4
	j	Variation of design	3.87	5
	g	Late information or site instruction by the architect or structural engineer or other parties	3.85	6
	n	Insufficiency of design information for tendering	3.75	7
	t	Method statement/technical experience	3.70	8
Middle Class	u	Liquidated and ascertained damages	3.52	9
	c	Substandard workmanship require repetition of works	3.43	10
	l	Poor site control	3.24	11
	m	Responsibility of contractor's design	3.18	12
	s	Contractor's experience	3.05	13
	w	Communication and management skill	2.94	14
	q	Contract period of the project	2.92	15
	h	Late handover of site	2.87	16
Lower Class	e	Availability of labours, plants and materials	2.64	17
	f	Change in specification, or code of practice	3.69	18
	i	Late possession of site	2.58	19
	r	Change of statutory requirement	2.47	20
	x	Fluctuation or exchange rate	2.38	21
	p	Design fault	2.13	22
	d	Determination of the contractor	2.11	23
	k	Strike of labour	2.09	24

Table 2 – Occurring Change of Risk Factors Perceived by the Engineers

	Risk Factors		Mean	Rank
Upper Class	a	Inclement weather	4.18	1
	b	Abnormal ground condition	4.05	2
	c	Substandard workmanship require repetition of works	3.87	3
	m	Responsibility of contractor's design	3.74	4
	u	Liquidated and ascertained damages	3.68	5
	v	Variation of superstructure design	3.58	6
	d	Determination of the contractor	3.54	7
	s	Contractor's experience	3.48	8
Middle Class	t	Method statement/technical experience	3.28	9
	j	Variation of design	3.18	10
	l	Poor site control	3.04	11
	y	Existing underground services	3.02	12
	w	Communication and management skill	2.95	13
	e	Availability of labours, plants and materials	2.91	14
	q	Contract period of the project	2.84	15
	n	Insufficiency of design information for tendering	2.75	16
Lower Class	g	Late information or site instruction by the architect or structural engineer or other parties	2.67	17
	f	Change in specification, or code of practice	2.62	18
	h	Late handover of site	2.60	19
	r	Change of statutory requirement	2.58	20
	i	Late possession of site	2.35	21
	p	Design fault	2.18	22
	x	Fluctuation or exchange rate	2.12	23
	k	Strike of labour	2.05	24

Table 3 – Occurring Change of Risk Factors Perceived by the Surveyors

	Risk Factors		Mean	Rank
Upper Class	j	Variation of design	4.05	1
	n	Insufficiency of design information for tendering	4.02	2
	a	Inclement weather	3.98	3
	u	Liquidated and ascertained damages	3.97	4
	b	Abnormal ground condition	3.85	5
	g	Late information or site instruction by the architect or structural engineer or other parties	3.74	6
	m	Responsibility of contractor's design	3.58	7
	y	Existing underground services	3.37	8
Middle Class	w	Communication and management skill	3.29	9
	f	Change in specification, or code of practice	3.24	10
	l	Poor site control	3.18	11
	p	Design fault	3.13	12
	r	Change of statutory requirement	3.04	13
	q	Contract period of the project	2.98	14
	c	Substandard workmanship require repetition of works	2.84	15
	s	Contractor's experience	2.78	16
Lower Class	t	Method statement/technical experience	2.47	17
	v	Variation of superstructure design	2.35	18
	h	Late handover of site	2.31	19
	e	Availability of labours, plants and materials	2.25	20
	i	Late possession of site	2.15	21
	d	Determination of the contractor	2.11	22
	k	Strike of labour	2.07	23
	x	Fluctuation or exchange rate	1.87	24

Table 4 - F-Statistics on Occurring Change of Risk Factors

Factors*	Overall average value	Mean values			Standard deviation	F value	Significant p
		G1	G2	G3			
a	4.12	4.20	4.18	3.98	0.983	0.447	0.774
b	4.20	4.18	4.05	3.85	0.992	0.538	0.708
c	3.42	3.43	3.87	2.84	0.882	0.779	0.543
d	2.71	2.11	3.54	2.11	0.939	2.844	0.032
e	2.62	2.64	2.91	2.25	1.104	0.239	0.915
f	3.09	3.69	2.62	3.24	0.913	0.222	0.925
g	3.32	3.85	2.67	3.74	0.846	2.718	0.038
h	2.57	2.87	2.60	2.31	1.084	0.706	0.591
i	2.34	2.58	2.35	2.15	0.959	0.359	0.837
j	3.64	3.87	3.18	4.05	1.172	0.627	0.710
k	2.07	2.09	2.05	2.07	0.954	1.901	0.122
l	3.14	3.24	3.04	3.18	0.960	1.947	0.114
m	3.55	3.18	3.74	3.58	1.129	3.248	0.014
n	3.42	3.75	2.75	4.02	0.921	2.697	0.035
p	2.48	2.13	2.18	3.13	0.945	3.478	0.037
q	2.91	2.92	2.84	2.98	1.128	0.538	0.708
r	2.71	2.47	2.58	3.04	0.954	1.596	0.187
s	3.14	3.05	3.48	2.78	1.052	0.988	0.421
t	3.12	3.70	3.28	2.47	1.017	1.698	0.162
u	3.74	3.52	3.68	3.97	0.984	1.377	0.253
v	3.29	4.05	3.58	2.35	0.868	3.364	0.015
w	3.06	2.94	2.95	3.29	0.884	1.684	0.165
x	2.10	2.38	2.12	1.87	0.943	0.447	0.774
y	3.38	3.98	3.02	3.37	0.885	1.545	0.201

Note:

a: inclement weather;
b: abnormal ground condition;
c: substandard workmanship require repetition of works;
d: determination of the contractor;
e: availability of labours, plants and materials;
f: change in specification or code of practice;
g: late information or site instruction by the architect or structural engineer or other parties;
h: late handover of site;
i: late possession of site;
j: variation of design;
k: strike of labour;
l: poor site control;
m: responsibility of contractor's design'
n: insufficiency of design information for tendering;
p: design fault;
q: contract period of the project;
r: change of statutory requirement;
s: contractor's experience;
t: method statement/technical experience;
u: liquidated and ascertained damages;
v: variation of superstructure design;
w: communication and management skill;
x: fluctuation or exchange rate; and
y: existing underground services.

Table 5 – Outcome Impact of Risk Factors Perceived by the Architects

	Risk Factors		Mean	Rank
Upper Class	b	Abnormal ground condition	4.18	1
	v	Variation of superstructure design	4.04	2
	d	Determination of the contractor	3.97	3
	j	Variation of design	3.95	4
	m	Responsibility of contractor's design	3.85	5
	q	Contract period of the project	3.74	6
	w	Communication and management skill	3.71	7
	n	Insufficiency of design information for tendering	3.65	8
Middle Class	l	Poor site control	3.47	9
	p	Design fault	3.31	10
	s	Contractor's experience	3.25	11
	t	Method statement/technical experience	3.21	12
	y	Existing underground services	3.16	13
	g	Late information or site instruction by the architect or structural engineer or other parties	3.01	14
	u	Liquidated and ascertained damages	3.00	15
	h	Late handover of site	2.95	16
Lower Class	r	Change of statutory requirement	2.74	17
	c	Substandard workmanship require repetition of works	2.61	18
	f	Change in specification, or code of practice	2.54	19
	a	Inclement weather	2.49	20
	e	Availability of labours, plants and materials	2.31	21
	i	Late possession of site	2.28	22
	k	Strike of labour	2.17	23
	x	Fluctuation or exchange rate	2.04	24

Table 6 – Outcome Impact of Risk Factors Perceived by the Engineers

	Risk Factors		Mean	Rank
Upper Class	b	Abnormal ground condition	4.37	1
	p	Design fault	4.24	2
	q	Contract period of the project	4.17	3
	s	Contractor's experience	4.08	4
	v	Variation of superstructure design	4.03	5
	n	Insufficiency of design information for tendering	3.84	6
	t	Method statement/technical experience	3.75	7
	g	Late information or site instruction by the architect or structural engineer or other parties	3.67	8
Middle Class	l	Poor site control	3.44	9
	m	Responsibility of contractor's design	3.31	10
	c	Substandard workmanship require repetition of works	3.24	11
	j	Variation of design	3.21	12
	d	Determination of the contractor	3.17	13
	u	Liquidated and ascertained damages	3.04	14
	e	Availability of labours, plants and materials	3.01	15
	a	Inclement weather	2.97	16
Lower Class	y	Existing underground services	2.77	17
	i	Late possession of site	2.64	18
	h	Late handover of site	2.51	19
	k	Strike of labour	2.47	20
	w	Communication and management skill	2.35	21
	r	Change of statutory requirement	2.24	22
	f	Change in specification, or code of practice	2.17	23
	x	Fluctuation or exchange rate	2.14	24

Table 7 – Outcome Impact of Risk Factors Perceived by the Surveyors

	Risk Factors		Mean	Rank
Upper Class	v	Variation of superstructure design	4.32	1
	b	Abnormal ground condition	4.28	2
	j	Variation of design	4.24	3
	p	Design fault	4.17	4
	y	Existing underground services	4.09	5
	n	Insufficiency of design information for tendering	4.04	6
	f	Change in specification, or code of practice	3.97	7
	s	Contractor's experience	3.85	8
Middle Class	t	Method statement/technical experience	3.64	9
	m	Responsibility of contractor's design	3.57	10
	w	Communication and management skill	3.52	11
	g	Late information or site instruction by the architect or structural engineer or other parties	3.47	12
	e	Availability of labours, plants and materials	3.41	13
	q	Contract period of the project	3.38	14
	u	Liquidated and ascertained damages	3.24	15
	i	Late possession of site	3.16	16
Lower Class	r	Change of statutory requirement	3.01	17
	l	Poor site control	2.94	18
	c	Substandard workmanship require repetition of works	2.91	19
	a	Inclement weather	2.75	20
	h	Late handover of site	2.71	21
	d	Determination of the contractor	2.64	22
	x	Fluctuation or exchange rate	2.41	23
	k	Strike of labour	2.34	24

Table 8 - F-Statistics on Outcome Impact of Risk Factors

Factors*	Overall average value	Mean values			Standard deviation	F value	Significant p
		G1	G2	G3			
a	2.78	2.49	2.97	2.75	0.879	0.647	0.846
b	4.29	4.18	4.37	4.28	0.974	0.571	0.941
c	2.97	2.61	3.24	2.91	0.757	0.971	0.782
d	3.19	3.97	3.17	2.64	1.057	3.547	0.047
e	2.97	2.31	3.01	3.41	0.953	0.573	0.348
f	2.86	2.54	2.17	3.97	0.971	2.476	0.016
g	3.44	3.01	3.67	3.47	0.876	0.971	0.578
h	2.69	2.95	2.51	2.71	0.834	0.378	0.178
i	2.72	2.28	2.64	3.16	0.759	0.294	0.642
j	3.74	3.95	3.21	4.24	0.947	0.379	0.583
k	2.35	2.17	2.47	2.34	1.048	0.476	0.394
l	3.28	3.47	3.44	2.94	0.971	0.691	0.842
m	3.53	3.85	3.31	3.57	0.896	0.782	0.678
n	3.86	3.65	3.84	4.04	0.738	0.681	0.259
p	3.98	3.31	4.24	4.17	0.947	0.573	0.347
q	3.80	3.74	4.17	3.38	1.167	0.276	0.946
r	2.62	2.74	2.24	3.01	0.975	0.397	0.851
s	3.80	3.25	4.08	3.85	0.989	0.579	0.647
t	3.58	3.21	3.75	3.64	0.758	0.679	0.671
u	3.10	3.00	3.04	3.24	1.017	0.281	0.289
v	4.13	4.04	4.03	4.32	0.964	0.379	0.671
w	3.08	3.71	2.35	3.52	0.943	0.947	0.378
x	2.21	2.04	2.14	2.41	0.853	0.671	0.679
y	3.31	3.16	2.77	4.09	0.978	3.187	0.004

Note:

a: inclement weather;
b: abnormal ground condition;
c: substandard workmanship require repetition of works;
d: determination of the contractor;
e: availability of labours, plants and materials;
f: change in specification or code of practice;
g: late information or site instruction by the architect or structural engineer or other parties;
h: late handover of site;
i: late possession of site;
j: variation of design;
k: strike of labour;
l: poor site control;
m: responsibility of contractor's design
n: insufficiency of design information for tendering;
p: design fault;
q: contract period of the project;
r: change of statutory requirement;
s: contractor's experience;
t: method statement/technical experience;
u: liquidated and ascertained damages;
v: variation of superstructure design;
w: communication and management skill;
x: fluctuation or exchange rate; and
y: existing underground services.

Table 9: Degree of Professional Suitability Perceived by Architects

Risk Factors		Professionals*				
		A	E	P	Q	C
a	Inclement weather	0%	17%	33%	0%	50%
b	Abnormal ground condition	0%	67%	25%	0%	8%
c	Substandard workmanship require repetition of works	0%	42%	8%	0%	50%
d	Determination of the contractor	0%	25%	25%	0%	50%
e	Availability of labours, plants and materials	0%	17%	0%	0%	83%
f	Change in specification, or code of practice	8%	83%	8%	0%	0%
g	Late information or site instruction by the architect or structural engineer or other parties	8%	75%	8%	0%	8%
h	Late handover of site	0%	0%	83%	0%	17%
i	Late possession of site	0%	0%	75%	0%	25%
j	Variation of design	25%	67%	8%	0%	0%
k	Strike of labour	0%	8%	8%	0%	83%
l	Poor site control	0%	0%	0%	0%	100%
m	Responsibility of contractor's design	0%	0%	0%	0%	100%
n	Insufficiency of design information for tendering	0%	92%	8%	0%	0%
p	Design fault	0%	92%	0%	0%	8%
q	Contract period of the project	0%	25%	67%	0%	8%
r	Change of statutory requirement	8%	92%	0%	0%	0%
s	Contractor's experience	8%	0%	0%	0%	92%
t	Method statement/technical experience	0%	8%	0%	0%	92%
u	Liquidated and ascertained damages	0%	25%	33%	17%	25%
v	Variation of superstructure design	46%	31%	23%	0%	0%
w	Communication and management skill	8%	42%	17%	0%	33%
x	Fluctuation or exchange rate	0%	0%	0%	58%	42%
y	Existing underground services	25%	25%	8%	0%	42%
Note:						
* A: Architect; E: Structural Engineer; P: Project Manager; Q: Quantity Surveyor; and C: Contractor.						

Table 10: Degree of Professional Suitability Perceived by Engineers

Risk Factors		Professionals*				
		A	E	P	Q	C
a	Inclement weather	10%	10%	30%	0%	50%
b	Abnormal ground condition	0%	75%	5%	0%	20%
c	Substandard workmanship require repetition of works	0%	45%	0%	0%	55%
d	Determination of the contractor	5%	19%	0%	0%	76%
e	Availability of labours, plants and materials	0%	10%	0%	0%	90%
f	Change in specification, or code of practice	10%	70%	20%	0%	0%
g	Late information or site instruction by the architect or structural engineer or other parties	20%	65%	15%	0%	0%
h	Late handover of site	20%	15%	60%	0%	5%
i	Late possession of site	20%	20%	55%	0%	5%
j	Variation of design	25%	60%	15%	0%	0%
k	Strike of labour	0%	5%	5%	0%	90%
l	Poor site control	0%	15%	5%	0%	80%
m	Responsibility of contractor's design	0%	20%	0%	0%	80%
n	Insufficiency of design information for tendering	0%	90%	5%	5%	0%
p	Design fault	5%	90%	0%	0%	5%
q	Contract period of the project	15%	25%	60%	0%	0%
r	Change of statutory requirement	5%	75%	20%	0%	0%
s	Contractor's experience	0%	20%	10%	0%	70%
t	Method statement/technical experience	0%	30%	0%	0%	70%
u	Liquidated and ascertained damages	5%	10%	25%	40%	20%
v	Variation of superstructure design	55%	25%	20%	0%	0%
w	Communication and management skill	10%	25%	25%	0%	40%
x	Fluctuation or exchange rate	0%	0%	5%	65%	30%
y	Existing underground services	30%	20%	15%	0%	35%
Note:						
* A: Architect; E: Structural Engineer; P: Project Manager; Q: Quantity Surveyor; and C: Contractor.						

Table 11: Degree of Professional Suitability Perceived by Surveyors

Risk Factors		Professionals*				
		A	E	P	Q	C
a	Inclement weather	31%	0%	13%	0%	56%
b	Abnormal ground condition	6%	50%	13%	0%	31%
c	Substandard workmanship require repetition of works	6%	19%	19%	0%	56%
d	Determination of the contractor	19%	0%	38%	0%	44%
e	Availability of labours, plants and materials	6%	6%	25%	0%	63%
f	Change in specification, or code of practice	69%	25%	6%	0%	0%
g	Late information or site instruction by the architect or structural engineer or other parties	69%	19%	13%	0%	0%
h	Late handover of site	38%	0%	38%	0%	25%
i	Late possession of site	25%	0%	38%	0%	38%
j	Variation of design	63%	38%	0%	0%	0%
k	Strike of labour	6%	0%	6%	0%	88%
l	Poor site control	0%	6%	19%	0%	75%
m	Responsibility of contractor's design	13%	13%	0%	0%	75%
n	Insufficiency of design information for tendering	69%	31%	0%	0%	0%
p	Design fault	56%	31%	6%	0%	6%
q	Contract period of the project	38%	6%	44%	6%	6%
r	Change of statutory requirement	38%	6%	44%	13%	0%
s	Contractor's experience	19%	6%	13%	0%	63%
t	Method statement/technical experience	6%	6%	6%	6%	75%
u	Liquidated and ascertained damages	31%	6%	19%	19%	25%
v	Variation of superstructure design	75%	13%	6%	6%	0%
w	Communication and management skill	6%	6%	63%	0%	25%
x	Fluctuation or exchange rate	19%	0%	6%	56%	19%
y	Existing underground services	13%	44%	13%	0%	31%
Note:						
* A: Architect; E: Structural Engineer; P: Project Manager; Q: Quantity Surveyor; and C: Contractor.						

Table 12: Contractual Preference Perceived by Architects

Quality Risk Factors	Contractor's Design	Engineer's Design
Redevelopment project	17%	83%
Project in reclamation site	50%	50%
Lump sum basis contract	42%	58%
Remeasurement basis contract	17%	83%
Contractor design contract	100%	0%
Engineer (in-house) design contract	0%	100%
Bored pile foundation	25%	75%
H-pile foundation	17%	83%

Table 13: Contractual Preference Perceived by Engineers

Quality Risk Factors	Contractor's Design	Engineer's Design
Redevelopment project	65%	35%
Project in reclamation site	65%	35%
Lump sum basis contract	90%	10%
Remeasurement basis contract	35%	65%
Contractor design contract	100%	0%
Engineer (in-house) design contract	15%	85%
Bored pile foundation	50%	50%
H-pile foundation	80%	20%

Table 14: Contractual Preference Perceived by Surveyors

Quality Risk Factors	Contractor's Design	Engineer's Design
Redevelopment project	31%	69%
Project in reclamation site	44%	56%
Lump sum basis contract	40%	60%
Remeasurement basis contract	25%	75%
Contractor design contract	94%	6%
Engineer (in-house) design contract	0%	100%
Bored pile foundation	31%	69%
H-pile foundation	38%	63%