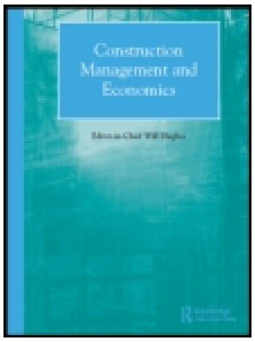

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The principal factors affecting construction project overhead expenses: an exploratory factor analysis approach

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Estimation is the first step in the project development process. Information technology provides an efficient platform for estimators to obtain quotations and specifications for their bid estimates. However, in practice, project overhead estimation relies heavily on the professional judgement and intuition of the estimators. This reduces the overall accuracy and reliability of the bid and a better understanding of the factors affecting project overheads is fundamental before any improved estimating methods can be devised. Unfortunately, the published literature on this topic is very limited. Using exploratory factor analysis, we aim to bridge the current knowledge gap by highlighting the principal factors affecting project overheads. Questionnaires detailing 27 variables were sent to quantity surveying managers of large contractors in Hong Kong. Seventy-nine valid responses were analysed by exploratory factor analysis. From the results, eight factors were extracted with their latent properties identified with reference to the expert opinions collected from telephone interviews. The findings clarify some misconceptions about the factors affecting project overheads and provide useful evidence for practitioners and researchers to understand project overheads. Estimators who address the identified factors when assessing future project overhead costs can improve the accuracy of their cost estimates and project budgets.

Keywords: Cost control, cost estimating, overheads.

Introduction

The construction industry is a highly competitive market mainly controlled by prices. To maintain competitiveness, construction companies have to continuously seek to reduce their project cost while simultaneously providing quality products and service to their clients. Although the major part of the project cost comes from the trade work, large and medium-sized general contractors often sublet most of the trade work to subcontractors in order to minimize their risks and operating costs. With the advancement in information and communication technology especially the world wide web, they can easily source the best prices from specialist or trade contractors and suppliers.

The remainder of the project cost comes from project overheads. Project overheads is the common term used to describe the overall project administration costs incurred by a general contractor. Such costs are also regarded as preliminaries, general conditions or general requirements. The major expenses in project overheads include project staffing costs, mechanical plant, insurances and bonds, temporary works, site accommodation and miscellaneous outgoings (Chan and Pasquire, 2006). Unlike trade work, project overheads relate to matters directly provided by the main contractor and thus any associated risk is non-transferable.

Even when contractors have devoted a lot of time and manpower to estimating project overheads during the bidding process, the accuracy level is much lower than the trade work estimation (Chan and Pasquire, 2004). This reflects the dearth of understanding of the factors affecting project overheads. With the

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increasing complexity of many projects, project overheads requirements have become more complicated and demand great expertise from the contractor's management team. A deep understanding of how project overhead costs are incurred is vital for the overall success in project cost management.

This study is aimed at investigating the principal factors affecting project overheads. In order to identify new factors from a multi-level perspective, the Delphi method was used to generate the factors that might affect project overheads ranging from project level to economic level. By adopting these factors in the questionnaire survey, quantitative data were collected from large contractors in Hong Kong. The data were analysed by exploratory factor analysis to identify the principal factors affecting project overheads. In particular, the latent properties of these principal factors were explained with reference to the opinions collected from telephone interviews with the survey respondents.

Factors affecting project overheads

Theoretically, project overhead cost is calculated by breaking down the cost systematically into various cost centres such as plant, labour, staff, materials, etc. (RSMeans, 2001; Pratt, 2004; Chartered Institute of Building, 2009). Detailed checklists are available in most textbooks and manuals. However, these checklists are only exemplars and have to be adjusted to suit different project requirements. Unfortunately, the adjustments required in respect of the overhead costs for each project are not extensively reviewed in the existing literature.

Although project overheads deserve no less attention than direct costs, very few empirical studies can be found. Past research relating to the determination of the cost of project overheads is even more scarce. From the existing literature, most of the studies emphasize that *project time* is an important factor affecting project overheads (Mansfield, 1983; Taylor, 1994; Geddes, 1996; Brook, 1998). However, their suggestion was based mainly on the rationale that some project overhead cost items such as the telephone tariff, electricity bill, staff salaries, plant rental, etc. were time related. Cooke (1981) highlighted that the *location of site* could affect a number of project overhead items including travelling expenses, provision of site transport, access, temporary hardstanding for plant, importation allowance, and protection of public property. Brook (1998) indicated that the *method of work* was a critical factor affecting the amount spent on project overheads. Chen *et al.* (2008) suggested eight factors which determined onsite supervision manpower cost, comprising *building type*, *owner type*, *structure type*, *contract price*, *floor area*, *structure height*, *construction location* and *project duration.* Supervision manpower costs however were the most significant single cost in establishing project overhead expenses (Solomon, 1993; Chan and Pasquire, 2006).

RSMeans (2012) commented that a contractor's overhead costs, though varying from trade to trade, were dependent on *annual volume of work*, *job type*, *job size*, *local economic conditions*, *support staff* and *equipment requirements*. Assaf *et al.* (1999) surveyed 61 large Saudi Arabian contractors on the significant factors that affect project overheads. They chose eight factors and analysed their impact on determining project overheads by descriptive statistics. The chosen factors were: *project complexity, location and size*; *percentage of subcontracted work*; *payment schedule*; *the need for work*; *the client's strictness in supervision*; *type of contract*; *number of competitors*; and *how much cash the contractor has available*. However, there is not any explanation as to how the above factors are generated, nor any validation of the significance of those factors. The validity of the proposed factors is thus questionable.

Objectives

Empirical studies relating to project overheads are very scarce despite their importance to the overall project cost performance. Although contractors can seemingly estimate the project overhead cost systematically, in what way the project overhead estimate should be adjusted under different situations is ill-defined. Therefore, the main objective of this paper is to ascertain the principal factors affecting project overhead costs in construction projects and to understand the latent properties of these factors. With a better understanding of the critical factors affecting project overheads, appropriate estimating strategies can be devised to cater for different project environments.

Method

Data collection

To meet the objectives of this study, primary data on the significance of factors affecting project overheads have to be collected from contractors. Among the various data collection methods, the questionnaire survey is the most popular and most cost-effective means to collect information about attitudes, opinions and behaviours (Gravetter and Forzano, 2012) and is widely used by researchers in the construction management discipline. A questionnaire survey was therefore considered as an appropriate tool for this study.

The survey was conducted in Hong Kong where the Works Bureau of the Hong Kong Government maintains a list of Approved Contractors and Suppliers for Public Works which is accessible by the public. The Approved Contractors on the list can, depending on their category, tender for public works of value HK $30 million or more. According to the list dated 12 April 2011, the total number of contractors was 217. The list serves as a representative list of contractors actively engaged in medium and large-sized projects in Hong Kong. Questionnaires were sent to quantity surveying managers of these companies by fax, followed by telephone interviews with those who were willing to participate. During the interviews, the results obtained from the questionnaires were discussed. The purpose of the telephone interviews was to derive a proper understanding of the latent properties of identified factors from the contractor's perspective.

Identification of variables

Considering the lack of empirical studies relating to this subject, both the existing literature as well as practitioners' opinions were taken into account when developing the list of factors affecting project overheads in the questionnaire. The Delphi method was adopted in order to consolidate a comprehensive list of possible factors affecting project overheads. This method can be characterized as a method for structuring a group communication process in allowing a group of experts to explore consensus on a complex or disputed topic (Iqbal and Young, 2009). The Delphi method was chosen as it allows communication among the invited experts to take place so that new ideas can be brought in, beyond the currently known or believed (Iqbal and Young, 2009). More important, the opinions generated can be revised in order to arrive at a satisfactory degree of consensus (Dalkey and Helmer, 1963; Okoli and Pawlowski, 2004). In this way, the invited experts can explore new factors from different perspectives and reach an agreed list of possible factors affecting project overheads for the questionnaire.

The Delphi study was conducted among 10 senior quantity surveyors, which is regarded as a desirable group size to facilitate the exchange of ideas and to arrive at consensus (Okoli and Pawlowski, 2004). All of the invited quantity surveyors have over 10 years' industrial experience. The Delphi study was arranged in two rounds. The first round focused on exploring the subject and inviting the group to suggest possible factors contributing to overhead costs. Since the existing literature on this topic is limited, the experts were encouraged to propose factors that might affect project overhead costs from different perspectives such as project, economic and social environments. This enables the group to review new factors which have been overlooked in the existing literature. The second round provided each expert with the factors identified in the last round together with those from the literature. The group then continued the discussion to achieve consensus. After about three hours of discussion in each round, 27 variables were identified. The full list of variables is given in Table 1. A questionnaire was subsequently designed to survey the impact of these variables on project overhead expenditure.

Design of questions

The questionnaire was divided into two parts containing closed type questions. Part 1 was used to collect general information about the respondents. Part 2

Table 1 List of variables affecting project overheads expenditure used in the questionnaire

Item	Variables
1	Estimated value of project works
2	Gross floor area of proposed structure
3	Project type (commercial/residential/industrial/institutional/infrastructural)
4	Duration of project
5	Number of storeys above ground level (of proposed structure)
6	Number of basement levels (in proposed structure)
7	Use of special construction techniques/plant/technicians
8	Shape of site (regular/irregular)
9	Shape of structure (regular/irregular)
10	Site coverage of proposed structure
11	Location of site (city centre/suburban/rural/outlying island)
12	Required quality level of trade works
13	Tendering method (negotiation/competitive tendering)
14	Project delivery method (e.g. traditional/design and build/management contracting)
15	Type of contract (standard form/domestic form)
16	Payment terms (monthly/milestone)
17	Extent of contractor's design input/proposal
18	Extent of bond/warranty requirement
19	Soil conditions
20	Building information modelling (BIM) requirement
21	Extent of variations
22	Level of neighbourhood awareness/public interest
23	Economic condition of the worldwide market during project period
24	Economic condition of the city during project period
25	Volume of work in the local construction market during project period
26	Interest rate during project period
27	Inflation trend of the city

contained the 27 variables for respondents to evaluate. Respondents were asked to rate the significance of each variable on project overhead expenditure. Since the opinions at the negative pole (i.e. slightly insignificant to strongly insignificant) are not applicable in this study, the conventional seven-point bipolar scale (measured from strongly insignificant = –3 to strongly significant = 3) is not appropriate (Spector, 1992). A three-point unipolar ordered scale was thus adopted which ranged from slightly significant (= 1) to strongly significant (= 3). The same scale was used by Elhag and Boussabaine (1998) in their questionnaire to survey the factors affecting project cost. In addition to the three-point ordered scale, each respondent could assign a zero rating to the attribute if he/she thought that the attribute has no impact on project overhead expenditure.

Data analysis method

Analysis of relative importance of variables

To study the order of importance of the variables, the relative importance of each variable as perceived by the respondents, represented by a relative importance index (RII_v), was calculated. This method was recommended by Shash (1993) to analyse the ordinal data collected in a Likert scale, and subsequently adopted by other researchers to rank factors in a similar manner (Kometa *et al.*, 1995; Chan and Kumaraswamy, 1998; Chan and Pasquire, 2004; Ghosh and Jintanapakanont, 2004). The relative importance index (RII_v) for variable v was calculated using the following formula:

$$RII_v = \frac{\sum w_v}{A \times N_v} \times 100$$

where:

w_v is the score assigned to variable v by the respondent, ranging from 0 to 3;

A is the highest score, i.e. 3; and

N_v is the total number of responses.

Identification of principal factors

To bring the interrelated variables together and to identify the underlying principal factors affecting project overheads, the data were then analysed by exploratory factor analysis using SPSS v.10. Exploratory factor analysis was employed because it is a statistical tool useful in bringing insights regarding the relationship among numerous correlated, but seemingly unrelated variables in terms of relatively few underlying factors (Overall and Klett, 1972). The tool is widely used by researchers of different disciplines to identify and interpret non-correlated clusters of variables (Fang *et al.*, 2004; Trost and Oberlender, 2003; Öcal *et al.*, 2007; Lee and Lee, 2011).

Responses

Seventy-nine valid responses were received, representing a response rate of 36% which was considered satisfactory (a minimum response rate of 30% from a minimum sample size of 107 is recommended by Fellows and Liu, 2003). Out of the valid responses, 80% of the respondents were quantity surveyors working for general contractors engaged in civil engineering, building and retrofitting works. The rest of the respondents were from civil engineering contractors specializing only in civil engineering, foundation and site formation works. Twenty-eight respondents agreed to participate in the follow-up telephone interview.

Data analysis

Relative importance index

The relative importance indices of all variables are tabulated in Table 2 in descending order. As shown in the results, the mean scores of all variables are above 1.0, indicating that respondents were generally in agreement as to the impact of these variables on project overheads expenditure but with different extent of agreement only. Out of the 27 variables, 8 of them are perceived as moderately to strongly significant (above 2.0). These variables include (1) *gross floor area of proposed structure*; (2) *use of special construction techniques/plant/technicians*; (3) *estimated value of project works*; (4) *duration of project*; (5) *location of site*; (6) *number of basement levels (in proposed structure)*; (7) *project delivery method* and (8) *required quality level of trade works.*

Factor analysis

Preliminary test

Before extracting the factors, two basic assumptions of factor analysis, namely multivariate normality and sampling adequacy, should be tested (Grimm and Yarnold, 1995; George and Mallery, 1999; Lattin *et al.*, 2003). With SPSS, Bartlett's test of sphericity can be used to measure the multivariate normality of the variables. In addition, it tests whether the correlation matrix is an identity matrix (i.e., a spherical set of multivariate data) (George and Mallery, 1999; Lattin *et al.*, 2003). The Kaiser-Meyer-Olkin (KMO) test which is available in the software can measure whether the distribution of values is adequate for conducting factor analysis (George and Mallery, 1999).

Table 2 Relative importance index of variables

Rank	Variables	Relative importance index (RII_v)	Mean score	Standard deviation
1	Gross floor area of proposed structure	91.561	2.747	0.5423
2	Use of special construction techniques/plant/technicians	80.591	2.418	0.7091
3	Estimated value of project works	73.840	2.215	0.7954
4	Duration of project	73.418	2.203	0.6865
5	Location of site (city centre/suburban/rural/outlying island)	71.308	2.139	0.7635
6	Number of basement levels (in proposed structure)	68.776	2.063	0.8218
7	Project delivery method (e.g. traditional/design and build/ management contracting)	67.089	2.013	0.8696
8	Required quality level of trade works	66.667	2.000	0.7845
9	Volume of work in the local construction market during project period	65.401	1.962	0.8979
10	Project type (commercial/residential/industrial/institutional/ infrastructural)	64.557	1.937	0.7397
11	Number of storeys above ground level (of proposed structure)	62.025	1.861	0.8279
12	Economic condition of the city during project period	60.759	1.823	0.9304
13	Extent of bond/warranty requirement	60.338	1.810	0.8177
14	Interest rate during project period	59.916	1.797	0.8530
15	Level of neighbourhood awareness/public interest	59.494	1.785	0.8270
16	Extent of variations	59.072	1.772	0.7998
17	Extent of contractor's design input/proposal	57.806	1.734	0.8429
18	Inflation trend of the city	55.696	1.671	0.8875
19	Soil conditions	55.274	1.658	0.8147
20	Site coverage of proposed structure	52.321	1.570	0.7793
21	Type of contract (standard form/domestic form)	49.789	1.494	0.7824
22	Payment terms (monthly/milestone)	49.367	1.481	0.8602
23	Economic condition of the worldwide market during project period	48.945	1.468	0.9176
24	Tendering method (negotiation/competitive tendering)	47.679	1.430	0.8425
25	Shape of site (regular/irregular)	47.257	1.418	0.7614
26	Building information modelling (BIM) requirement	46.414	1.392	0.8230
27	Shape of structure (regular/irregular)	43.460	1.304	0.7400

In this study, the KMO value of the variables is 0.73, higher than the acceptable threshold of 0.5 which indicates that the distribution of the values in the matrix is adequate for conducting factor analysis (George and Mallery, 1999). The Bartlett's test of sphericity result is high enough (value = 909.435) with significance <0.05, implying that the data are approximately multivariate normal (George and Mallery, 1999; Lattin *et al.*, 2003). The result also confirms that the correlation matrix cannot be construed as an identity matrix (Lattin *et al.*, 2003) and it is, therefore, acceptable for factor analysis.

Number of components extracted

Components (or factors) were extracted by principal component analysis with varimax rotation. This method can help achieve a simple structure by minimizing any tendency towards a 'general' component in the solution (Gorsuch, 1983). The number of components extracted was based on their respective eigenvalues. As a general rule applied in most factor analysis studies, the criterion for factor extraction is eigenvalue ≥ 1 (Gorsuch, 1983).

As a result, eight factors were extracted as indicated in Table 3. The eight factors explain 67% variance.

Interpretation of components

To interpret the meaning of a factor, the salient variables in each factor were identified and used as the indicators for explanation. These salient variables were selected by two criteria. First, their loading values should be significantly high (minimum 0.4) and second, they should only be loaded on the extracted factor (Gorsuch, 1983). As shown in Table 3, the salient variables identified for each extracted factor

Table 3 Factor structure of the principal factor extraction on the 27 factors affecting project overheads expenditure

Item	Factor	Variables included in the factor	Factor loading	Eigenvalue	Variance explained %	Cumulative variance %
1	Contractor's design requirement	Extent of contractor's design input/proposal	0.800	5.943	9.386	9.386
		Building information modelling (BIM) requirement	0.714			
		Extent of variations	0.600			
2	Regional economic condition	Economic condition of the city during project period	0.901	2.882	9.276	18.662
		Volume of work in the local construction market during project period	0.888			
3	Financial and insurance charges	Interest rate during project period	0.796	2.012	8.960	27.622
		Extent of bond/warranty requirement	0.732			
		Inflation trend of the city	0.713			
4	Project complexity	Use of special construction techniques/ plant/technicians	0.715	1.730	8.793	36.415
		Number of basement levels (in proposed structure)	0.672			
		Project type (commercial/residential/ industrial/institutional/infrastructural)	0.656			
		Number of storeys above ground level (of proposed structure)	0.615			
5	Procurement arrangement	Type of contract (standard form/domestic form)	0.741	1.636	8.476	44.891
		Tendering method (negotiation/competitive tendering)	0.731			
		Project delivery method (e.g. traditional/ design and build/management contracting)	0.629			
6	Site layout	Shape of site (regular/irregular)	0.752	1.522	8.208	53.099
		Shape of structure (regular/irregular)	0.721			
		Gross floor area of proposed structure	–0.510			
		Site coverage of proposed structure	0.505			
7	Stakeholders' interest	Level of neighbourhood/public interest	0.721	1.300	8.179	61.278
		Location of site (city centre/suburban/rural/ outlying island)	0.708			
		Required quality level of trade works	0.6846			
8	Project duration	Duration of project	0.746	1.165	6.086	67.364

are higher than 0.5, reflecting a substantial degree of contribution of each variable to its extracted factor.

An appropriate collective label was given to each extracted factor so as to reflect the correlation of all the variables within. Referring to the opinions collected from the telephone interviews with the quantity surveyors, the meanings of the eight extracted factors are interpreted as follows according to the descending order of variance explained by each factor.

Factor 1: Contractor's design requirement

This factor accounts for the largest amount of total variance (9.386%). It encompasses three variables: *extent of contractor's design input/proposal*, *extent of variations* and *building information modelling (BIM) requirement*. Since designer-led is the most popular project delivery method in Hong Kong (Oyegoke *et al.*, 2008), most of the main contractors do not employ designers. However, the drawings coordination and shop drawings preparation are typically the main contractor's responsibility. If the project design is complex or uncertain with lots of variations, the main contractor will need to bring in extra manpower to handle the design coordination and drawing tasks properly. Failure to do so can easily lead to delays or abortive work, the associated costs of which are unrecoverable.

The emergence of building information modelling (BIM) has changed the expectations and requirements of the project owners. Currently, BIM implementation is only required by a few large developers and some government departments (Wong *et al.*, 2011). From the telephone interviews, some of the respondents with BIM experience commented that the local BIM application is mainly client-driven which starts from the builder's side. On receiving the computer-aided design (CAD) drawings, contractors have to spend extra money to employ BIM experts to convert the CAD drawings into 3D models via the BIM environment. Since the setup cost for BIM is large, the implementation will remain as project-based until BIM application is more mature in the local industry. Nevertheless, all respondents agreed that BIM can prepare the shop drawings more effectively and eliminate all possible design clashes. It enables accurate scheduling which is extremely helpful in a project environment with lots of variations. The respondents perceived that BIM will bring a closer collaboration between the contractor and the designers in the long run. Therefore, the three constructs, *extent of contractor's design input/proposal*, *extent of variations* and *building information modelling (BIM) requirement* will together determine the cost impact and potential risk faced by contractors under different contract requirements for contractor's design.

Factor 2: Regional economic condition

Factor 2 accounts for 9.276% of the total variance. It comprises two items: *volume of work in the local construction market during project period* and the *economic condition of the city during project period*. The combination of the two variables confirms the proposition of the prominent relationship between regional economy and the volume of construction work (Nistorescu and Ploscaru, 2010). In 1997, Hong Kong and many Asian countries experienced a drastic recession after the financial crash. The gross domestic product of Hong Kong dropped from HK$1 365 024 million to HK$1 234 761 million (–9.54%) while the gross value of construction work performed declined significantly from HK$242 843 million in 1997 to HK$163 883 million in 2003 (–32.51%) (Census and Statistics Department, Hong Kong SAR Government, 2011). Subsequent to the financial crisis in 2008, a lot of countries including the United States and parts of Europe experienced recession with the construction sector recording a substantial decrease in activity (Nistorescu and Ploscaru, 2010; The Associated General Contractors of America, 2011).

Many interviewed respondents agreed that a lot of local contractors manage their projects on a portfolio basis. To maximize their returns, they often shift their resources from lower priority projects to those that are overdue. In good economic times, when companies are healthy and have more projects, such 'portfolio management' techniques can be indulged with sufficient resources to act as a buffer. However, when bad economic times come, companies will have fewer projects and may need to cut overheads and headcounts to survive. Project teams will then have fewer recovery options to offset the impact of time and cost overruns, thus making the project overhead costs more vulnerable to escalation.

The importance of the regional economic situation gives a clear message that contractors have to stay alert in the dynamic business environment. It is worth noting that the *economic condition of the worldwide market* variable is not extracted in this factor and explains the fact that construction output has a more direct relationship with the regional economic condition. In the case of the worldwide financial crisis triggered in 2008, construction output from the main contractors in Hong Kong still recorded growth of 1.5% and 9.9% in 2009 and 2010 respectively (Census and Statistics Department, Hong Kong SAR Government, 2011).

Factor 3: Financial and insurance charges

This factor accounts for 8.96% of the total variance. Three variables exhibit high loading in this factor: *extent of bond/warranty requirement*, *interest rate during project period* and *inflation trend of the city*. In recent years, public and private clients in Hong Kong have escalated their requirements significantly for surety bonds/warranties to reduce their risk of latent defects after occupation. Such sureties are often valid for 10 years or even 15 years. The premium charges from insurance companies have also skyrocketed by two to five times in different countries over the past years (Savicky and Kashiwagi, 2004; Insurance Division, Oregon State Government, US, 2008).

The rise in inflation rate undoubtedly stimulates a surge in insurance premiums as the financial claims on insurance companies increase. In addition, the changes in the interest rate environment also lead to increased premiums as the investment return is reduced. This explains the underlying close relationship among the three variables and their accumulation brings a substantial burden of project overhead cost to the contractors. According to an empirical study by Chan and Pasquire (2006), insurance and bonds cost around 10% of the total project overheads expense and are ranked as the fourth most expensive project overhead item. It thus becomes one of the most critical concerns of the contractors when the premiums are so costly and vulnerable to fluctuations.

Factor 4: Project complexity

Contributing 8.793% of the total variance, this factor covers four variables: *use of special construction techniques/plant/technicians, number of basement levels (in proposed structure), project type (commercial/residential/industrial/institutional/infrastructural),* and *number of storeys above ground level (of proposed structure)*. The four variables are primarily related to project complexity. According to Maylor (2003), level of project complexity is a function of three features: organizational complexity (the number of people, departments, etc. involved); resource complexity (the volume of resources involved); and technical complexity (the level of innovation involved in the project or process). Each of the extracted variables in this factor measures one or more of the described features of project complexity. *The use of special construction techniques/plant/technicians* variable corresponds to organizational and technical complexities. The *number of basement levels (in proposed structure)* and *number of storeys above ground level (of proposed structure)* variables relate largely to resource complexity. The last variable, project type, associates with all three complexity features. Thus, these variables can be classified under the 'project complexity' factor.

Maylor's definition for project complexity portrayed a clear relationship between project complexity and resources requirements. Although the impact of project complexity on resources requirements, including project overheads, is logical, the lack of objective and quantitative assessment of project complexity often results in varying interpretations of project complexity. Such variations often lead to inconsistent estimation and cost overruns (Alarcón and Ashley, 1999). As noted by some respondents, the judgement of complexity level was highly subjective and varied substantially between professionals. To improve the estimating accuracy and cost control of project overheads within the company, contractors should maintain a company-wide database to establish the optimal overhead pattern, such as project staffing under different complexity scenarios.

Factor 5: Procurement arrangement

Factor 5 reflects the cost impact arising from the procurement arrangement of the main contractor and accounts for 8.476% of the total variance, including the *type of contract*, *tendering method* and *project delivery method*. As indicated by the importance indices of the three variables, *project delivery method* ranks the highest. This illustrates the importance of the project delivery method from which the fundamental role, obligations and powers of the main contractor are determined. For example, a design-and-build contractor will have more flexibility to control the standard of site accommodation than a contractor employed under a traditional designer-led procurement system. The other two variables, *type of contract* and *tendering method*, also impose or remove a noticeable extent of contract requirements on or from the main contractor. Some respondents believed that negotiation normally provides a better opportunity for the contractor to trim the project overhead requirements with the project owner and his representatives. The domestic form of contract often has built-in non-standard requirements which are comparatively more stringent (e.g. extra drawings submission) and result in higher project overhead costs.

Factor 6: Site layout

The sixth factor is related to site layout which accounts for 8.208% of the total variance. This factor contains four variables: *gross floor area of proposed structure*, *site coverage of proposed structure*, *shape of site (regular/irregular)* and *shape of structure (regular/irregular)*. Construction site layout is a facility layout problem concerned with finding the most efficient arrangement of unequal area requirements within a site of any shape. It is viewed as a complex and dynamic problem because the facility requirements and spatial constraints vary at different project stages (Mawdesleya and Al-Jibouri, 2003). While the provision of site accommodation including temporary facilities is one of the major items in project overheads cost (Solomon, 1993; Chan and Pasquire, 2006), a larger, regular-shaped site with lower site coverage can certainly provide more flexibility to project planners when designing site layout in a dynamic manner. Therefore, the four extracted variables represent the most critical constructs that relate to site layout design.

As shown in Table 2, the *gross floor area of proposed structure* was considered the most important factor affecting project overhead cost by the contractors. This is reasonable as gross floor area is directly related to the volume of work as well as project costs. As in most densely populated cities, the construction sites in Hong Kong are highly congested. Site layout planning becomes more problematic when the resources required increase with the volume of work. The higher the gross floor area and site coverage, the more difficult it will be to accommodate the site offices, material storage and other site facilities within the limited site. As a result, a lot of alternative methods like offsite storage, just-in-time deliveries, or renting nearby office premises as site offices are used in local projects which substantially increase the project overhead cost. Many respondents have commented that different site layout arrangements will result in significantly different project overheads; this is why an experienced planner is critical to determine the optimal site layout solution.

Factor 7: Stakeholders' interest

This factor contributes 8.179% of the total variance. Three variables are contained in this factor: *level of neighbourhood/public interest, location of site (city centre/suburban/rural/outlying island)* and *required quality level of trade works*. These three variables are apparently independent from each other, but the results successfully revealed their underlying relationship. Conventionally, the project owner is the most important stakeholder and so the contractor has to make every endeavour to fulfil the project owner's requirements. However, today a lot of public pressure groups also have vested interests in construction works, particularly in infrastructural projects and institutional projects where public funding is used.

In Hong Kong, a lot of the controversial projects are located in urban renewal districts. These projects arouse much public interest, mainly because of the adverse impact on the neighbourhood, unresolved disputes regarding land compensation or resettlement and the weak justification for huge public spending. More violent cases are found in Mainland China, where protests and disputes over housing demolition and resettlement have been rife in the past few years as a result of massive urbanization. Chinese researchers have asserted that the problem of land disputes is now the main cause of peasant grievance leading to complaints and social unrest (Great Britain-China Centre, 2011).

The quality of a project is often associated with its location. Premier locations with paramount views or harbour-front sites are often used to build first-class office buildings or deluxe houses. In these prestigious locations it is reasonable to impose more stringent inspection and handover procedures by the project owners for the benefit of future tenants. This potential risk will give rise to additional project overhead expenditure from, for example, extra mock-ups, closer supervision by the contractor, additional drawings/samples submission.

According to some respondents, stakeholders including pressure groups are becoming a more prominent problem than before, as project information is easily available to the general public. Nowadays, project surveillance is done not only by the project owners, but also by pressure groups. If the project arouses protests or strikes from the public, both the image of the project owner and the normal progress of work will be adversely affected. Even if extension of time claims are successful, any additional project overhead expenses due to prolongation or disruption of work will have to be borne by the contractor. This explains why the relative importance of this factor is very high.

In the past, most theorists considered 'site location' as critical to project overheads simply because of the necessity of providing temporary roads or facilities by the contractor in case of remote sites. The findings here reveal a new perspective of the relationship between site location and stakeholders' interests.

Factor 8: Project duration

Although the last loaded factor accounts for the least total variance of 6.08%, it contains only one salient variable, *project duration*. The result highlights the significance of this single variable from the point of view of contractors. According to some past studies, the two major time-related project overhead items, namely site staffing costs and mechanical plant hiring charges, account for more than 45% of the total project overheads cost (Solomon, 1993; Chan and Pasquire, 2006). It is therefore reasonable to find such a strong relationship between project duration and project overheads. In addition, time overrun is a common problem in most projects. The high potential risk of project delay also contributes to the significance of this factor to project overheads.

Considering the significant importance of project duration to project overheads expenses, contractors should pay more attention to mitigating delays. With respect to the standard form of contracts in most countries, contractors are not entitled to recover prolongation costs for delays attributable to 'Acts of God', such as excessively adverse weather. Careful pre-contract and post-contract scheduling is therefore critical to control the project overheads expenditure.

Discussion

The results presented in this paper affirm the classical thought that *project duration* affects project overheads cost. Although project complexity is conventionally regarded as a factor affecting project overheads by many theorists, the findings here provide a clearer interpretation as to the critical components that are more related to project overheads cost. Although some of the variables identified in the Delphi method including *economic condition of the city*, *volume of work in the local construction market*, *inflation trend* and *interest rate during project period* are apparently remote from project overheads estimation, the findings indicate that the regional or local economic situation is one of the significant factors affecting project overheads. Factors like *contractor's design requirement*, *financial and insurance charges*, *procurement arrangement*, *site layout* and *stakeholders' interest* are new constructs which have been overlooked by theorists. From these results, we can observe that some of the recent developments in the industry and in society such as utilization of BIM, awareness from pressure groups, demanding insurance policies and premiums are having a significant influence on project management and overhead cost expenditure.

As set out in the literature review, many official guidelines for estimating suggest the breaking down of project overhead cost into plant, labour, staff, material and sundry costs. Based on the findings presented, these guidelines are generally insufficient. Facing the rapid changes in the business environment (like technological advancement, escalating stakeholders' expectations, fluctuating interest and inflation rates), project overheads estimation will be much less accurate without considering the impacts from economic and social conditions. The findings contribute to the theories of project overheads and the factors affecting estimation. The results also imply that practitioners must devote sufficient attention and effort in a deeper and wider assessment of the project and economic characteristics when estimating project overheads. Moreover, estimators have to consider the impact of principal factors on each project overhead item individually. For example, the economic condition factor will have more significant influence on site management salaries whereas the site layout factor will affect site accommodation costs. With the underlying variables of the principal factors identified in this study, estimators can assess the associated risk or impact of these factors with reference to their project characteristics and environment. In this way, realistic adjustment to their project overhead estimates can be derived to improve the overall estimating accuracy.

Limitations and future research

This study has empirically identified eight principal factors attributable to project overheads expenditure through factor analysis of the data collected from a questionnaire survey and telephone interviews with contractors in Hong Kong. Though factor labels were carefully chosen to best reflect the underlying relationships of the correlated variables, it has to be emphasized that the suggested labels are subjective in nature and other researchers may have preference for other different labels.

The sample of this study is confined to contractors in Hong Kong. Although industrial practices in Hong Kong are similar to those in many western countries, the construction industry in Hong Kong exhibits some unique characteristics like the independent administration but direct economic and social influence from Mainland China, and the highly congested built environment. These limit the applicability of the findings to other locations. Moreover, although the sample size of 79 is statistically sufficient for factor analysis, a larger sample should produce more confident results. The results in this paper are intended to provide a good empirical basis for future work on project overheads estimation and control. Future studies may replicate the methodology to investigate the factors affecting project overheads in other locations. By comparing the results from different locations, better insights can emerge to allow a more thorough understanding of project overhead costs. In this paper, the principal factors affecting project overheads are identified. In-depth case studies and objective project data can be collected to help comprehend the relationships between the principal factors and project overhead expenses. Further investigation on the risk assessment of the principal factors and the estimating strategies under different risk levels can be carried out to improve the estimating accuracy and efficiency of project overheads.

Conclusions

In this paper, a comprehensive investigation of contractors' project overheads expenditure is presented. From the questionnaire survey conducted with 79 large contractors in Hong Kong and follow-up telephone interviews, factors affecting project overheads were identified by exploratory factor analysis. Eight factors were extracted from 27 variables developed through a synthesis of past studies and opinions from experienced quantity surveyors in the industry. Addressing the objectives, the eight empirically found critical factors affecting project overheads are: *contractor's design requirement*, *regional economic condition*, *financial and insurance charges*, *project complexity*, *procurement arrangement*, *site layout*, *stakeholders' interest* and *project duration*. Although the study was conducted in Hong Kong, the results should contribute positive theoretical and practical insights to the subject. Factors including *contractor's design requirement*, *financial and insurance charges*, *procurement arrangement, site layout* and *stakeholders' interest* are new constructs which have been overlooked by theorists. Through the analysis of the underlying variables with the incorporation of practitioners' comments collected from the telephone interviews, the latent properties of these factors are also explained. The presented results provide sufficient evidence and useful pointers to clarify some misconceptions about factors affecting project overheads. The results also draw attention to the inadequate guidelines on estimating project overheads in the current literature. To enhance the estimating accuracy, practitioners must conduct a more thorough assessment of the project and economic characteristics when estimating project overheads. The improved understanding portrayed in this study enables the development of strategies, methods and tools for better project overhead cost estimation and cost management. Categorization of the variables under different principal factors allows estimators and quantity surveyors to readily assess the associated risk, thereby making more precise adjustments to their project overhead estimates for improved accuracy. Project participants can take appropriate actions to control the effect of these identified factors in order to achieve better budgetary control. Further studies may replicate the methodology in other locations. Investigation of the relationships between the principal factors and project overhead costs can be undertaken to develop appropriate estimating strategies under different risk levels. Since the study was conducted solely in Hong Kong, application of the findings may be limited to places where the construction industries have similar characteristics to the one in Hong Kong.

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