A FACTOR APPROACH TO THE ANALYSIS OF RISKS INFLUENCING CONSTRUCTION COST FLOW FORECAST

Published Proceedings of the

RICS Construction and Building Research (COBRA) Conference

held at

Nottingham Trent University, Nottingham, UK.

September 5 – 6, 2002, Pp 120 -131

Editor: Morledge, R.

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ABSTRACT

Construction cash flow forecasting has attracted a lot of research interests over the last two decades. Researchers have employed forecasting methodologies, which include mathematical formula-based, statistical, computer simulation and artificial intelligence applications. In spite of the quantity of research efforts, accuracy of the forecast is still a major problem, largely due to risks and uncertainties inherent in construction. This paper presents part of three-year year programme of research aimed at evaluating the impacts of risk on construction cost flow forecast. The study which is at the end of the second year identified and assessed the risk factors responsible for the variation between the forecast and actual cost flow. The study was conducted through a questionnaire survey administered on contracting organisations. On a project by project basis, contractors' opinions were sought on the extent of occurrence of 26 risk variables considered in the study. An initial analysis was carried out using mean response analysis. This shows that the main factors responsible for variation between the forecast and actual cost flow are client's changes to initial design, inclement weather, variation to works (AI), labour shortage, production target slippage, delay in agreeing variation/day works, delay in settling claims, problems with foundations and underestimating project complexity. Further analysis based on factor analysis showed that the identified risk variables could be grouped into six generic groups; the most important factor group being delayed payment and variation to works. Other generic factors are economic changes, project disruption, project complexity, shortage of construction resources and natural inhibitions. These groupings are of significant value in providing a parsimonious reduction of the risk variables and they subsequently provide direction for developing a cost flow risk assessment model.

Keywords: Construction cost flow, contractor, factor analysis, mean response analysis, risk variable,

1. INTRODUCTION

Financial management has long been recognised as an important management tool and proper cash flow management is crucial to the survival of a construction company because cash is the most important corporate resource for its day to day activities. The need to forecast cash requirements is important in order to make provision for the difficult times of inadequate cash resources before they arrive (Harris and McCaffer, 2001). Cash flow forecasting according to McCaffer (1976) provides a good warning system to predict possible insolvency. This according to him enables preventive measures to be considered and taken in good time. A lot of research efforts have gone into modelling standard

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curves to forecast cash flow. Researchers have employed forecasting methodologies, which include mathematical formula-based, statistical, computer simulation and artificial intelligence applications. In spite of the quantity of research efforts, accuracy of the forecast is still a major problem as there have been considerable variations between the modelled cash flow profiles and the actual ones in many instances. Reasons for this have been found to be due to the uncertainties and risk factors inherent in construction project.

The issues of risks and uncertainties as they impact on construction cash flow forecast have been addressed by the authors in pilot studies (Odeyinka and Lowe 2000 and 2001). The studies identified the risk factors and assessed contractors' perception of the likelihood and impact of occurrence of the risk variables. The assessment was done on sectorial basis of small, medium and large firms. This present study identified many more risk variables on a wider scale and attempts to group them into related factor groupings using factor analysis. This factor grouping is an attempt to represent the 26 identified risk variables with fewer factors so as to achieve the objective of parsimony, which is *sine qua non* to model building. This step is a pre cursor to developing a construction cost flow risk assessment model.

2. RISKS IN CASH FLOW FORECASTING

Cash flow forecast is of great importance to construction contractor as well as the client to prevent unsavoury consequences of liquidation and bankruptcy. However, an accurate forecast of construction cash flow has been a difficult issue due to risks and uncertainties inherent in construction projects. According to Flanagan and Norman (1993), the environment within which decision making takes place can be divided into three parts: certainty, risk and uncertainty. According to them, certainty exists only when one can specify exactly what will happen during the period of time covered by the decision. This, they concluded of course does not happen very often in the construction industry. Bennett and Ormerod (1984) also concluded that an important source of bad decisions is illusions of certainty. They submitted that uncertainty is endemic in construction and needs to be explicitly recognised by construction managers.

Risk has also been defined as the chance of exposure to the adverse consequences of future events (CCTA, 1993). Bufaied (1987) described risk in relation to construction as a variable in the process of a construction project whose variation results in uncertainty as to the final cost, duration and quality of the project. Moreover, Fong (1987) asserted that it is generally recognised that those within the construction industry are continually faced with a variety of situations involving many unknowns, unexpected, frequently undesirable and often unpredictable factors. These factors according to Lockyer and Gordon (1996) include production and timing schedule slippage of the project tasks, technological issues, people-oriented issues, finance, managerial and political issues.

The major problem that construction managers encounter in making financial decisions involves both the uncertainty and ambiguity surrounding expected cash flows (Eldin, 1989). In the case of complex projects, the problem of uncertainty and ambiguity assumed even greater proportion because of the difficulty in predicting the impact of unexpected changes on construction progress and consequently, on cash flows. The uncertainty and ambiguity are caused not only by project-related problems but also by the economical and technological factors (Laufer and Coheca, 1990). Lowe (1987) maintained that the factors responsible for variation in project cash flow could be grouped under five main headings of contractual, programming, pricing, valuation and economic factors. Kaka and Price (1993) and Kaka (1996) in developing a model for cash flow forecasting identified other risk factors affecting cash flow profiles to include estimating error, tendering strategies, cost variances and duration overrun. Khosrowshahi (2000) also identified other risk factors that impact on cash flow to include delay payment and difficulty in obtaining the right amount of funds at reasonable interest rates. While these risk factors have been recognised in cash flow literature and their likelihood and impact of occurrence assessed, an understanding and grouping of these risk variables using the factor analysis approach is yet to be documented. This then is the concern of this study.

3. DATA AND METHODOLOGY

Data were obtained through a questionnaire survey of contracting organisations. The questionnaire identified 26 risk factors from literature and from discussion with other researchers in construction cash flow as well as from discussion with construction practitioners. These factors were perceived to have potential impact on cost flow forecast. The questionnaire was then administered on a project by project basis to 350 randomly selected small, medium and large-scale contractors. A reminder letter subsequently followed this. In all, 96 responses fit for analysis were received, which represents a 27.4% response rate which is typical of the norm of 20-30% response rate in most postal questionnaire survey of the construction industry (Akintoye, 2000). The contractors were asked to score on a Likert type scale of 0-5, the extent of occurrence and perceived impacts of the identified risk factors on a recently completed or on-going building projects.

The firms involved in the survey have been classified into three groups based on the turnover of the firm, as a measure of size grouping. Table 1 shows the grouping of the firms and the number of firms in each group. Tables 2 and 3 show the designation and the construction experience of the respondents, respectively. The respondents are mainly at the senior management level, with an average construction experience of about 26 years (standard deviation = 9.63). This background information regarding the respondents indicated that responses provided by them could be relied upon for this study.

Kline (1994) maintained that for simple structure factor analysis heterogeneous samples should always be used as homogeneous samples by definition lower variance and thus lower factor loadings. As evident from Tables 1 and 2, the sampled subjects are

Table 1: Size of construction firms by annual turnover

Grouping	Turnover (£ million)	Frequency	Percentage
Small	5-25	40	41.70
Medium	25-100	31	32.20
Large	Over 100	25	26.10
Total		96	100.00

Table 2: Designation of respondents

Position	Frequency	Percentage
Managing Director	10	10.4
Directors	54	56.3
Senior Managers	20	20.8
Managers	12	12.5
Total	96	100

Table 3: Respondents' experience

Years	Frequency	Percentage
1 - 10	7	7.3
11- 20	15	15.6
21 - 30	44	45.8
Over 30	30	31.3
Total	96	100

Mean = 26.26 years (standard deviation = 9.63)

heterogeneous, making it appropriate to proceed with the factor analysis employed in this study. Kline (1994) also submitted that samples must not only be representative but must be of sufficient size to produce reliable factors. According to him, in data with a clear factor structure, samples of 100 or near were quite sufficient. As such, using a sample size of 96 in this study is considered adequate. Child (1990) also maintained that for algebraic reasons, it is essential that there are more subjects than variables. Where this is not the case according to him, the results are not meaningful. Kline (1994) claims that large factors emerge with clarity with samples with ratios of 2:1 and that the rule is the bigger the ratio, the better. In this study, an achieved ratio of 96:26 (i.e. $\cong$ 4:1) is considered adequate.

4. DATA ANALYSIS AND RESULTS

Data analysis was carried out to explore and detect underlying relationships among the cash flow risk variables using factor analysis. Factor analysis is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1992). The principal component analysis is used in the analysis, the distinctive characteristic being its data-reduction capacity. Its main goal is to represent relationships among sets of variables parsimoniously. That is, it helps to explain the observed correlation using as few factors as possible (Norusis, 1992).

As part of the analysis, the reliability of the scale used for measurement was determined. This was done by computing the Cronbach's alpha reliability coefficient. This is a scale of coefficient which measures or tests the reliability of the six-point Likert-type scale used for the study (Norusis, 1992). The Cronbach's alpha coefficient obtained is 0.9197 (F statistic = 20.454, p = 0.000). The high coefficient obtained indicates that the six-point

Likert scale used for measuring the cash flow risk influencing factors is reliable at the 5% significant level.

Factor Analysis of Cash flow Forecast Risk Influencing Variables

An analysis of the sample results using the mean response analysis is shown in Table 4. This suggests that the main risk variables with high extent of occurrence are changes to initial design, inclement weather, variation to works, labour shortage, production target slippage, delay in agreeing variation/ dayworks, delay in settling claims, problems with foundations, underestimating project complexity, estimating error and under valuation.
In order to capture the multivariate relationships existing between cash flow forecast risk-influencing variables; the factor analysis technique was employed to investigate the cluster of the relationships. According to Hair *et. al.* (1995), this technique is appropriate because of little *a priori* knowledge about the number of different cluster relationships to expect and also, the members of these different tendencies were unknown.

Various tests are required for the appropriateness of the factor extraction, including the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett test of sphericity. The results of these tests are shown in Table 5. Kline (1994) suggests that in order to obtain a simple factor structure, the principal component method and varimax rotation should be used. These approaches have been adopted in subjecting the 26 risk variables to factor analysis.

Barlett's test of sphericity tests the hypothesis that the correlation matrix is an identity matrix. In this analysis, the value of the test statistic for sphericity is large (Barlett's test of sphericity = 717.805) and the associated significance level is small (p = 0.000), suggesting that the population correlation matrix is not an identity matrix. The value of the KMO statistic is 0.743, which according to Kaiser (1974) is satisfactory for factor analysis. Summarily, these tests show that the factor analysis is appropriate for the factor extraction.

The analysis conducted, using principal component method produced a six-factor solution with eigenvalues greater than 1, explaining 74.74% of the variance (Table 5). In order for the factors to be easily interpretable, the varimax rotation method was employed. The factor grouping based on varimax rotation is shown in Table 5. Each of the variables weighs heavily on to only one of the factors and the loading on each factor exceeds 0.5. The factors are interpretable as follows: factor 1 represents variation and delayed payment; factor 2 represents economic changes; factor 3 represents project disruption; factor 4 represents project complexity; factor 5 represents shortage of input resources and factor 6 represents natural inhibition.

Discussion of Factor Analysis Results

Variation and Delayed Payment

Variation and delayed payment factor grouping comprises of delay in settling claims, under valuation, variation to works, delay in agreeing variation/dayworks, delay in

Table 4: Perception of risk occurrence in cost flow forecast

Risk Factors	Overall mean score	Rank
Changes to initial design	3.32	1
Inclement weather	3.00	2
Variation to works (AI)	2.95	3
Labour shortage	2.81	4
Production target slippage	2.70	5
Delay in agreeing variation/dayworks	2.62	6
Delay in settling claims	2.59	7
Problems with foundations	2.46	8
Underestimating project complexity	2.41	9
Estimating error	2.24	10
Under valuation	2.24	10
Delay in payment from client	2.08	12
Shortage of key materials	2.08	12
Delays in interim certificates	2.03	14
Delay in retention release	1.97	15
Inflation	1.86	16
Compliance with new regulations	1.78	17
Subcontractor's insolvency	1.70	18
Changes in interest rates	1.68	19
Shortage of key plant items	1.68	19
Access to funds at reasonable interest rate	1.46	21
Archaeological remains	1.46	21
Changes in currency exchange rates	1.35	23
Civil disturbances	1.24	24
Labour strikes	1.19	25
Client's insolvency	1.11	26

interim certificates, delay in payment from client and delay in retention release. This factor represents 19.33% of the variance explained and it is not surprising that the variables under this factor are loaded together. This is because valuation and payment are the means by which a contractor receives cash in-flows and anything that tampers with their smooth running is expected to affect the contractor's cash flow significantly. It is also worthy of note that most of the variables loaded under this factor ranked high in the contractors' scoring of the risk variables (Table 4). This is not surprising because these variables are project-related. As such, they are inherent in any project with a high likelihood of occurrence. It is therefore not a surprise that they ranked higher in the contractors' scoring of their extent of occurrence.

Economic Changes

Economic changes factor grouping is made up of: changes in interest rates, inflation, access to funds at reasonable interest rate, changes in currency exchange rates and compliance with new regulations. This factor represents 12.25% of the variance explained and it is also not a surprise that the variables under this factor are loaded together. This is because contractor's cash receipt and disbursement are closely tied to economic performance. Where there is economic down turn, resulting in high interest rate,

Table 5: Factor analysis grouping using varimax orthogonal rotation

Risk variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Delay in settling claims	0.89092					
Under valuation	0.86922					
Variation to works (AI)	0.83243					
Delay in agreeing variation/dayworks	0.82036					
Delays in interim certificates	0.75343					
Delay in payment from client	0.65633					
Delay in retention release	0.55485					
Changes in interest rates		0.76778				
Inflation		0.76254				
Access to funds at reasonable interest rate		0.70194				
Changes in currency exchange rates		0.67095				
Compliance with new regulations		0.66328				
Civil disturbances			0.77062			
Archaeological remains			0.74103			
Labour strikes			0.73999			
Subcontractor's insolvency			0.60390			
Client's insolvency			-0.57171			
Underestimating project complexity				0.77860		
Estimating error				0.71739		
Production target slippage				0.65666		
Changes to initial design				0.57790		
Shortage of key materials					0.83243	
Shortage of key plant items					0.76308	
Labour shortage					0.56967	
Inclement weather						0.82848
Problems with foundations						0.82407
Eigen value	9.525	3.217	2.033	1.858	1.549	1.246
Percentage of variance explained	19.33	12.25	12.24	11.54	10.27	9.11
Cumulative percentage of variance	19.33	31.58	43.82	55.36	65.63	74.74

Kaiser-Meyer-Olkin measure of sampling adequacy = 0.743;
Bartlett test of sphericity = 717.805, significance $p = 0.000$.

high inflation, etc., it is expected that this will impact significantly on the contractor's cash flow. It is however noteworthy that the variables loaded under this factor ranked low in the contractors' scoring of the risk variables (Table 4). This is not unexpected, as the UK's economy is stable at the time of this study, with low inflation, low interest rate and stable currency exchange rate.

Project Disruption

Project disruption factor grouping comprises of: archaeological remains, labour strikes, subcontractor's insolvency and client's insolvency. This factor represents 12.24% of the variance explained and it is not a surprise that the variables under this factor are loaded together. This is because a smooth in-flow and out-flow of cash is expected to ensue from the smooth running of a project. However, where there is unexpected project disruption emanating from labour strikes, subcontractor's or client's insolvency, these are expected to impact significantly on the project cash flow. It is also noteworthy that the variables that constitute these factors ranked low in this study (Table 4). This is not unexpected because most of the variables loaded under this factor are presently of infrequent occurrence in the UK construction industry.

Project Complexity

Project complexity factor grouping comprises of: underestimating project complexity, estimating error, production targets slippage and changes to initial design. This factor represents 11.54% of the variance explained. It is not a surprise that the variables under this factor are loaded together. This is because the less complex a project is, the easier it is to predict and manage its cash flow. However, with increasing level of complexity, the more a project is susceptible to changes in initial design, underestimating the project complexity, slippage in production target and estimating error. Where these happen, they are expected to impact significantly on the project cash flow. It is noteworthy that these variables ranked high in the contractors' scoring (Table 4). This is not surprising because the variables have direct impact on productivity rate and hence on cash flow.

Shortage of Construction Resources

Shortage of construction input resources factor grouping is made up of: shortage of key materials, shortage of key plant items and labour shortage. This factor represents 10.54% of the variance explained and it is not unexpected that the variables under this factor are loaded together. This is because contractor's cash flow disbursement and project progresses are closely tied to regular supply of construction input resources. Where the resources of key materials, key plant items and skilled labour are in short supply, it is expected that they will impact significantly on construction progress and by implication, on the contractor's cash flow. It is to be noted from Table 4 that while the shortage of key materials and key plant items ranked fairly low in the contractors' scoring, labour shortage however ranked high (rank of 4). This is not surprising because while shortage of key materials and key plant items are not of serious concern in the UK construction industry, labour shortage is.

Natural Inhibitions

Natural inhibition factor grouping comprises of inclement weather and problems with foundations. This factor represents 9.11% of the variance explained and it is also not a surprise that these factors are loaded together. This is because this factor is not man-made and as such, it is difficult for the contractor to prepare well in advance for it. Moreover, when there are occurrences of inclement weather and problems with foundations, they impact significantly on the contractor's cash flow. It is evident from Table 4 that the variables under this factor ranked high (ranks of 2 and 8). This is not surprising because it has been shown (Odeyinka and Lowe, 2000) that the longer the duration of a building project, the more susceptible it is to inclement weather. It has also been demonstrated (Odeyinka and Lowe, 2001) that the larger the size of a construction company, the more prone it is to encounter problems with foundation. This is because large construction companies undertake large projects with complex foundation structures and also with high possibility of encountering problems with foundation sub-soil.

5. CONCLUSION

The main concern of this study has been the analysis of the risk factors responsible for the variations between the forecast and actual construction cash flow. An exploration of these factors was conducted through a mean response analysis and also through an interrelationship between variables using the factor analysis technique.

An initial analysis using the mean response showed that the main risk variables responsible for variations between the forecast and actual cash flow are client's changes to initial design, inclement weather, architect's variation to works, labour shortage, production target slippage, delay in agreeing variation/ dayworks, delay in settling claims, problems with foundations, underestimating project complexity, estimating error and undervaluation.

A further analysis, using factor analysis technique and using the same data set revealed that the 26 risk variables considered in the study could be grouped into 6 factors. These factors are: variation and delayed payment, economic changes, project disruption, project complexity, shortage of construction resources and natural inhibition. These generic factor groupings of the variables make it easier to represent the 26 risk variables with easily identifiable factors. This six-factor solution therefore summarises the factor groupings of the risk variables influencing variations between the forecast and actual cash flow. It also satisfies the objective of parsimony, a necessary requirement in model building. With this factor solution, it then becomes easier to investigate in detail and develop a model to assess the impact of the risk factors on the variations between the forecast and actual cash flow. This is the concern of the next stage of this research.

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