AN EVALUATION OF METHODOLOGICAL ISSUES FOR ASSESSING RISK IMPACTS ON CONSTRUCTION CASH FLOW FORECAST

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Cash flow forecast is of great importance to construction contractors to prevent unsavoury consequences of liquidation and bankruptcy. Researchers over the last two decades have employed forecasting methodologies, which utilize the various elements of the cash flow equation. However, in spite of the quantity of research efforts, an accurate forecast of construction cash flow has been a difficult issue due to risks and uncertainties inherent in construction projects. This paper reports part of an on-going research concerned with assessing the impacts of risks and uncertainties on construction cash flow forecast. It attempts to clarify the terminological issues surrounding construction cash flow and use that as a basis to develop a construction cash flow concept. In addition, based on a literature review of previous researches in cash flow modelling, a conceptual classification of cash flow forecasting methodologies is developed. An evaluation of these methodologies assisted in developing a framework for assessing the impacts of risk on construction cash flow profile.

Keywords: cash flow, forecasting, risk, uncertainty

INTRODUCTION

Contractors who undertake cash flow forecasting do so at two levels. One at the estimating and tendering stage, when the forecast is just for the single project being estimated. The other level is the calculation of a cash flow forecast for the company, division or area (Harris and MacCaffer, 2001). There are numerous techniques for cash flow forecasting, differing in their levels of accuracy and detail, the degree of automation in compiling them, the method they use to integrate the time and the money element, etc. Some of the techniques are probabilistic, but most of them are deterministic (Navon, 1995). Various approaches have also been adopted in cash flow forecasting, ranging from the detailed approach to the 'short cut' approaches of statistical, mathematical, simulation approach and the use of artificial intelligence techniques. Most of these approaches employed the individual elements of the cash flow equation to model their forecasts. These invariably imply the use of the various curves available in cash flow analysis such as the use of standard single net cash flow curves, value curves and cost commitment curves. The study reported in this paper looks at cash flow forecasting at the tendering and estimating stage and considers the methodologies employed for the 'short cut' approaches. This paper is a follow-up to a previous study (Odeyinka and Lowe, 2000) that assesses the risk factors involved in

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modelling construction cash flow forecast. Its aim is to develop a framework for assessing the combined impacts of risk factors on construction cash flow profiles.

PHILOSOPHY OF CASH FLOW

Construction cash flow is viewed in two different ways in construction management literature. The first view defines cash flow as the net receipt or net disbursement resulting from receipts and disbursements occurring in the same interest period (Oxley and Poskitt, 1996, etc.) Algebraically, this definition is expressed as:

Cash flow = Receipts - Disbursements

Thus, according to this school of thought, a positive cash flow indicates a net receipt in a particular interest period or year, while a negative cash flow indicates a net disbursement in that period.

The second view defines cash flow as the actual movement or transfer of money into or out of a company (Cooke and Jepson, 1986, etc.)

According to this school of thought, money flowing into a business is termed positive cash flow (+ve) and is credited as cash received. Monies paid out are termed negative cash flow (-ve) and are debited to the business. According to them, the difference between the positive and negative cash flows is termed the net cash flow. This is represented algebraically as:

Net Cash flow = Positive cash flow (receipts) - Negative cash flow (disbursements)

According to the two schools of thought, within a construction organization, receipts (positive cash flow) are mainly derived from monies received in the form of monthly payment certificates, stage payments, release of retention and final account settlement. Disbursements (negative cash flow) according to them are related to monies expended on a contract in order to pay wages, materials, plant, subcontractors' accounts rendered, preliminaries and general overheads expended during the progress of the work.

The view expressed by the second school of thought is adopted in this study and it is conceptualized as shown in Figure 1. According to this school of thought, on a construction project, the net cash flow will require funding by the contractor when there is a cash deficit and where cash is in surplus the contract is self-financing. The positive cash flow is referred to variously in literature as earnings, income, value, receipts or cash in. The negative cash flow is also referred to variously as liability, expenditure, payments, cost committed or cash out (Mawdesley *et. al*., 1997). These are shown in Figure 1. Many researchers in the past have concentrated on either the positive cash flow (value) or negative cash flow (cost) in order to model cash flow forecast. Others have also attempted to model the net cash flow forecast.

RISK AND UNCERTAINTIES IN CASH FLOW FORECAST

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 (Boussabaine and Elhag, 1999). 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) grouped the factors responsible for variation in project cash flow under five main headings of contractual, programming, pricing, valuation and economic factors. Kenley and Wilson (1986) maintained that individual variation between projects' cash flow profile is caused by a multiplicity of factors, the great majority of which can neither be isolated in sample data, nor predicted in future projects. According to them, some existing cash flow models hold that generally two factors, date and project type, are sufficient to derive an ideal construction project cash flow curve. Such convenient division according to them ignores the complex interaction between such influences as economic and political climate, managerial structure and actions, union relations and personality conflicts. According to Kenley and Wilson (1986), models, which ignore all these factors in cash flow research, must be questioned. Odeyinka and Lowe (2000) identified and assessed the risk factors involved in modelling cash flow forecast. The major risk factors identified to cause variation in cash flow profile include architect’s instructions, provision for interim certificate, receiving interim certificates, agreeing interim valuations on site, retention release, delay in agreeing variations/ day works, delay in settling claims, inclement weather, etc. and problem with the foundations. Other factors include delays in

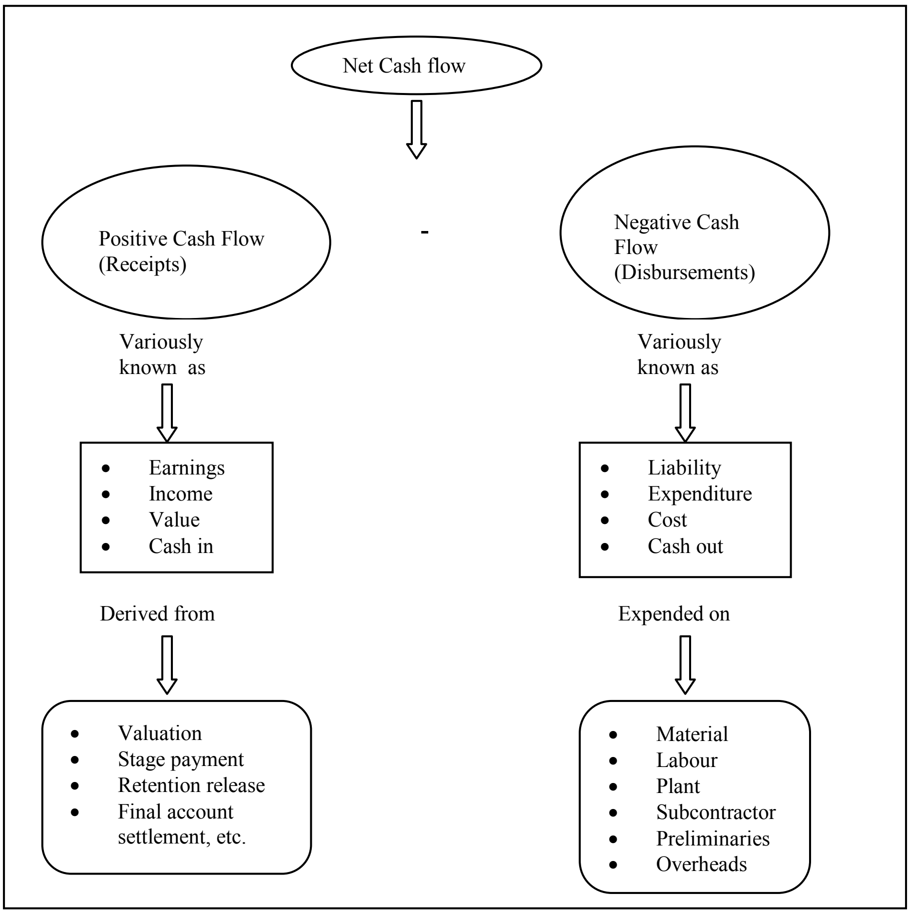

Figure 1: Construction Cash Flow Concept

payments from client, extent of float in contract schedule, tender unbalancing, estimating error, provisions for phased handover, level of inflation, listed buildings, archaeological remains, changes in interest rates, provision for fluctuation payments, tree preservation orders and changes in currency exchange rates. An analysis was carried out of the likelihood of occurrence of these risk factors using project characteristics such as project duration; procurement option employed in project execution and size of construction firm that executed each project considered. The analysis revealed that cash flow forecasting that would take into consideration, risk and uncertainties would need to group cash flow data along the groupings of firm size, construction duration and procurement option employed. These groupings are considered in developing a framework for investigating the impacts of the combined risk factors on cash flow profiles.

A REVIEW OF CASH FLOW FORECASTING METHODOLOGIES

Utilizing the three elements of the cash flow equation, researchers have attempted to develop standard single net cash flow curves, standard value curves and standard cost curves in modelling construction cash flow. Kenley and Wilson (1986) have referred to these approaches of developing standard curves as nomothetic approach. They however are the proponents of the idiographic approach, which was based on the premise that since construction projects are unique; it would seem logical that their cash flows should be considered as individual and unique. Figure 2 shows a conceptual classification of these forecasting methodologies.

Nazem (1968), O'Keefe (1971), Kenley and Wilson (1989) and Kaka and Price (1991) attempted to develop standard single net cash flow curves. Their aim was that if the shape of net cash flow curves could be shown to conform to a predictable pattern then this would be a most useful piece of information. However, they all concluded that net cash flow curves tend to fluctuate so much that they appear to be a poor basis upon which to base a forecast. This was an indication that an ideal net cash flow curve was not possible.

A lot of research effort has gone into the possibility of developing an ideal value curve based on historic data. Many researchers (Hardy, 1970; Bromilow and Henderson, 1977; Drake, 1978 Hudson, 1978; Berny and Howe, 1983; Oliver, 1984; Singh and Woon, 1984 and Evans and Kaka, 1998) have adopted mathematical/statistical approach in order to achieve this. Results have been obtained by fitting selected functions (mostly polynomial regression or mathematical formulae) to the available data. As a result of the inaccuracies observed in previous efforts to develop standard value curves, Evans and Kaka (1998) attempted to improve the accuracy of standard value curves by selecting a more specific type of building i.e. food retail building projects. The technique of logit transformation was used to fit the value curves. However, results demonstrated that an accurate standard S-curve was not achieved even when projects were further classified into more detailed groups (i.e. different sizes of superstores).

Computerized approach has also been employed in developing standard value curves. Efforts in this regard include those of Ashley and Teicholtz (1977), Lowe and Lowe (1987), Miskawi (1989) and Khosrowshahi (1991). Some of these models are analytical rather than predictive; some are more suited to the petrochemical projects rather than building. Others are probabilistic rather than deterministic while yet others utilize periodic values rather than cumulative values. The forecasting accuracy of these models is however yet to be documented. Lowe *et. al.* (1993) employed the artificial intelligence technique to model value curve by developing an expert system. The system according to them is however to be re-implemented.

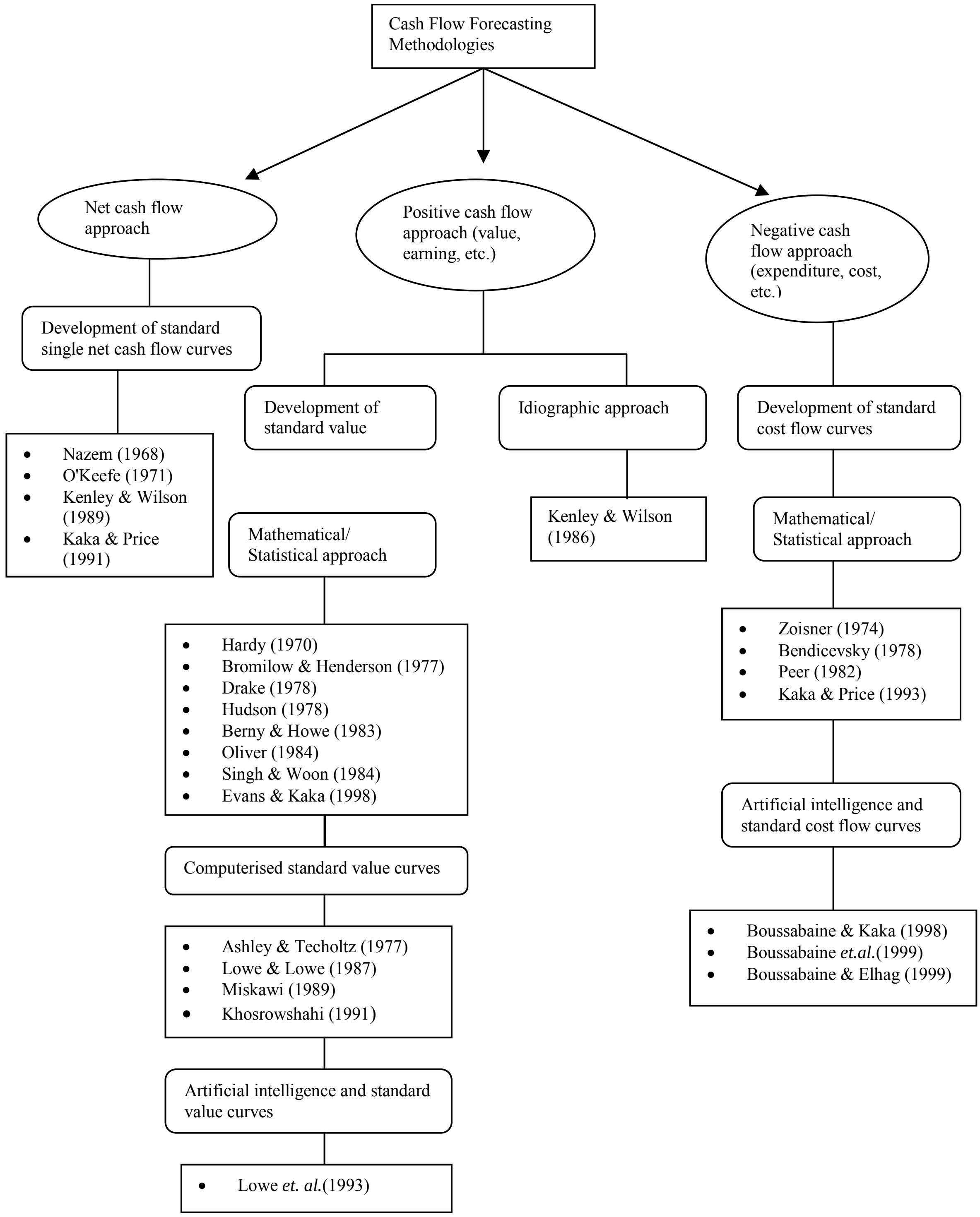

Figure 2: Conceptual classification of cash flow forecasting methodologies

Kenley and Wilson (1986) adopted the idiographic approach to cash flow forecasting. This was based on the premise that since construction projects are unique, it would seem logical that their cash flows should be considered as individual and unique. As such, they applied the idiographic methodology to fit data using the technique of logit transformation. This technique according to Kenley and Wilson (1986) is the simplest of the sigmoid transformations and allows the S-curve to be represented in linear form. The linear equation according to them is found by a logit transformation of both the independent and dependent variables:

$$Logit = \ln\frac{z}{1-z}$$

Where z is the variable to be transformed and Logit is the transformation. The logistic equation for cash flow according to Kenley and Wilson (1986) can be expressed using value (v) or cost (c) as the dependent variable and time (t) as the independent variable such that

$$\ln\frac{v}{1-v} = \alpha + \beta X \qquad \text{Where} \qquad X = \ln\frac{t}{1-t}$$

Therefore $$\ln\frac{v}{1-v} = \alpha + \beta(\ln\frac{t}{1-t})$$

This then forms the equation of the sigmoid curve, which describes the flow of cash on a specific building project. It may be shown to be equivalent to

$$v = e^{\alpha}\left(\frac{t}{1-t}\right)^{\beta} \Bigg/ \left[1 + e^{\alpha}\left(\frac{t}{1-t}\right)^{\beta}\right]$$

or $$v = \frac{F}{1+F} \qquad \text{where} \qquad F = e^{\alpha}\left(\frac{t}{1-t}\right)^{\beta}$$

A lot of research effort has also gone into the possibility of developing standard cost flow curves based on historic data. Many researchers (Zoisner, 1974; Bendicevsky, 1978; Peer, 1982 and Kaka and Price, 1993) have adopted mathematical/statistical approach in order to achieve this. Based on their evaluation of possible causes of variability in value curves Kaka and Price (1993) concluded that tender unbalancing and overmeasure together with estimating errors, which distort the shape of value curves have no effect on actual cost commitment curve of a project. They also observed that cost commitment curves are not affected considerably by contractual arrangements. These observations informed their choice of cost commitment curve for their models using the logit transformation technique (Kenley and Wilson, 1986).

Artificial intelligence techniques have also been applied in modelling standard cost flow curves. Efforts in this regard include those of Boussabaine and Kaka (1998), Boussabaine *et. al* .(1999), and Boussabaine and Elhag (1999). Boussabaine and Kaka (1998) employed a neural network approach to cost flow forecasting in building projects. Boussabaine *et. al*. (1999) employed a similar approach to model cost flow for water pipeline projects. Boussabaine and Elhag (1999) applied the fuzzy technique to cash flow analysis and concluded that defuzzified cash flow curves were found to be a good compromise between different cash flow scenarios.

After a detailed review of the various forecasting methodologies, it was found that the technique of logit transformation employed by Kaka and Price (1993) and Kenley and Wilson (1986) would prove useful in assessing the impacts of the previously identified risk factors on cash flow profiles.

A CONCEPTUAL FRAMEWORK FOR ASSESSING RISK IMPACTS ON CASH FLOW PROFILES

In previous study (Odeyinka and Lowe, 2000), an analysis of risk factors affecting cash flow modelling suggested that a more accurate modelling of cash flow forecast that takes risks and uncertainties into consideration would need to consider certain groupings. These include firm size, procurement method employed and construction duration. These groupings have been employed in developing a conceptual framework for assessing the combined risk impacts on cash flow profiles (Figure 3). Essentially, the framework considers the firm size, for instance medium firm, it looks into the procurement method adopted for a particular project under consideration, say design and build and the classified duration of the project, say 7-12 months. Cash flow data are then obtained for projects under the various groupings. Kaka and Price's (1993) cost commitment model and Evans and Kaka's (1998) value model suggested that

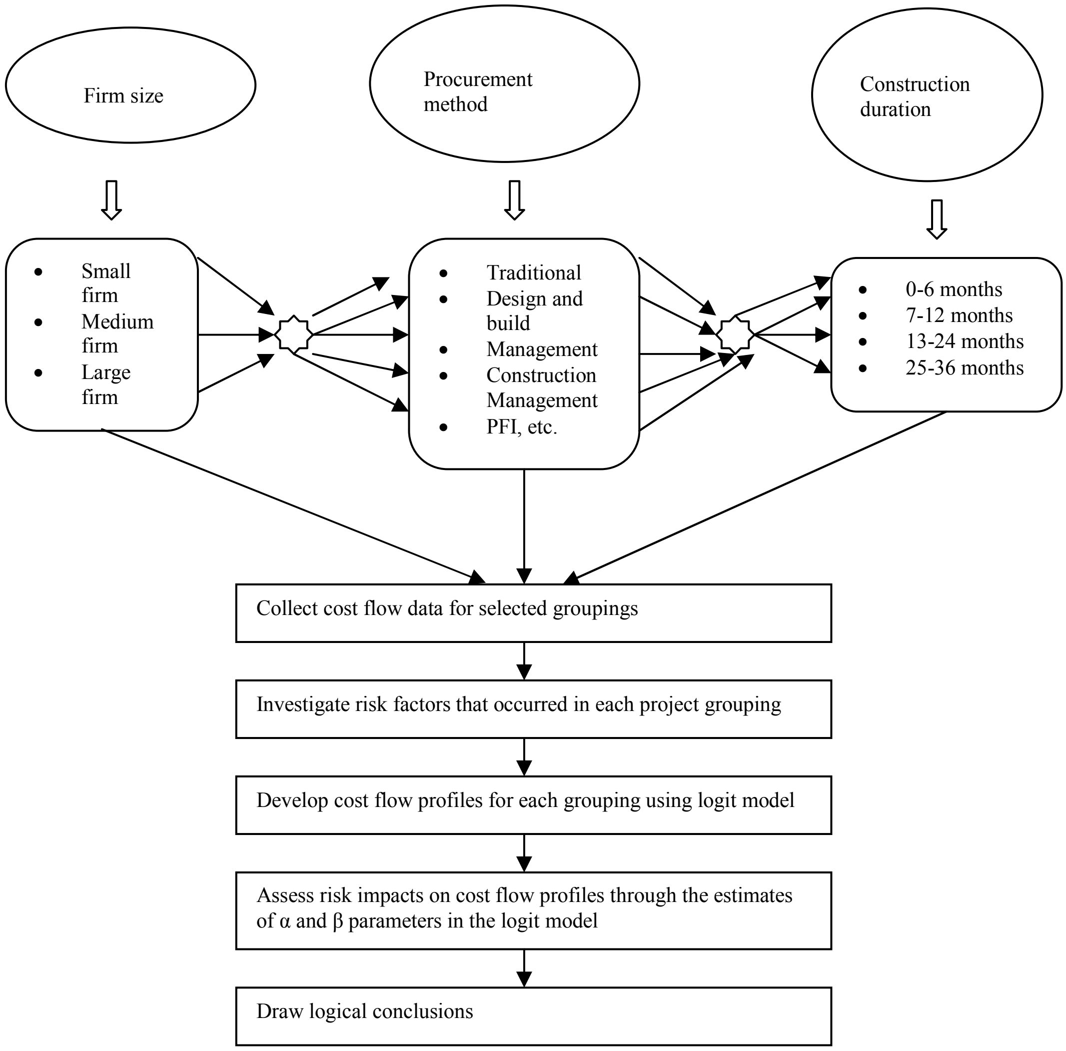

Figure 3: A conceptual framework for assessing risk impacts on construction cash flow forecast

modelling the negative cash flow (cost commitment or cost flow) produces a more accurate result. This suggestion has been taken into consideration and as such, this framework anticipates the use cost flow data to model cash flow profiles along the suggested groupings. Investigations would then be carried out regarding the risk factors that occurred in executing each of the projects. The technique of logit transformation (Kenley and Wilson, 1986 and Kaka and Price, 1993) which has been found to be fast and reliable would be employed in fitting the curves. Following this, an assessment would then be made of the impacts of risk on the developed cash flow profiles. This would be done by estimating the α and β parameters in the logit models. It is expected that this will allow logical conclusions to be reached regarding risk impacts on construction cash flow profiles. In order to achieve the expected result using the framework, a case study approach may be needed in data collection and risk occurrence investigation.

CONCLUSION

This paper has attempted to clarify the terminological issues surrounding construction cash flow, the basis of which is used to develop a cash flow concept. Based on a literature review of previous work I cash flow modelling, a conceptual classification of cash flow forecasting methodologies was developed. A critical evaluation of these methodologies suggested that the logit transformation model, which possesses analytical ability, has the potential of assisting with an objective assessment of risk impacts on cash flow profile. This has been utilized in developing a conceptual framework. The developed framework suggests that case study approach may need to be adopted in collecting cost flow data and investigating risk factors that occurred in each project. This seems to be an effective and practical means of actualizing the concepts and procedures highlighted in the framework.

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