A MULTI CRITERIA MODE FOR THE SELECTION OF THE PAYMENTS SYSTEMS IN CONSTRUCTION PROJECTS

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The choice of payment system for construction work is one of the many important decisions that construction clients have to make. Yet there has been only limited work aimed at eliciting information on how these choices are made and what factors influence these choices. The term payment system in this context entails how construction work is priced and paid for, and there are several existing methods for pricing and payment. This paper focuses on lump sum, unit rates and cost plus for pricing methods and lump sum payment, interim measurements and milestones for payment methods. As a result of an earlier survey, several factors (such as the time available, cost certainty, contractor's cash flow, contract form, disputes likelihood and risk allocation) were identified as influencing the choice of payment system. In this paper, a new survey is undertaken to determine the extent of suitability of each payment system to these factors. These factors are in the main either project specific or client specific, hence each project client or project manager needs to objectively assess and prioritise these factors, so that a rational comparison of the suitability of alternative payment systems can be made. The multi-attribute utility technology was applied to provide a spreadsheet model to assess the relative importance weightings of the payment systems selection criteria and to derive utility values. This technology has been successfully applied in construction research in particular to aid procurement system selection. The model developed in this paper will act as a decision aid tool that aims to assist industry practitioners when selecting the most appropriate payment system for given sets of project requirements and characteristics.

Keywords: cash flow, multi-attribute, payments system, pricing, selection criteria

INTRODUCTION

The choice of a payment system for construction work is one of the many important decisions that construction clients have to make. Yet to date there has been only limited work aimed at eliciting information on how these choices are made and what factors influence these choices. Kaka (2001) calls for the re-engineering of payment mechanism arguing that the current payment mechanism offers no advantage to the client.

Several significant factors influencing the selection of the payment mechanism were identified as a result of a survey undertaken. These factors were related in the main to project characteristics and client requirements (Sherif and Kaka 2003).

Historically speaking, the traditional payment mechanism was designed when the architect was essentially the project manager, contractors being asked to tender only after a complete set of drawings were available and projects had been commissioned.

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However today, the construction industry is completely different and comprises many different types of delivery systems that use more flexible supply chain organizational arrangements. The contractor has to attempt to plan and manage cash flow according to the scheduled payments over the duration of the project and not just until its commissioning. Several factors such as the method of payments and project deadline can affect the number of payments as well the amount and timing of each payment.

One of the key issues in scheduling payments is choosing an appropriate system for distributing payments over the duration of the project. The contractor and client usually agree on some criterion to determine the amount of each payment.

Contractors and sub-contractors often purchase and request delivery of construction materials and equipment soon after a contract is signed and well before the equipment and materials are needed. The purpose of these advance purchases is to ensure that specified materials and equipment are available for installation or use in accordance with the construction schedule.

RESEARCH METHODOLOGY

A structured questionnaire was designed as a follow up to an initial survey (Sherif & Kaka 2003). The first questionnaire was designed and posted to construction contractors and other practitioners in the UK to determine what significant factors influenced the payments system, and as a result of this, a list of influencing factors was selected. These factors were identified as the significant factors influencing the payment mechanism in construction projects, and it is on these factors that the structured questionnaire was designed to calculate the utility factors for these criteria. This was done by asking the contractors to score the payment methods and the pricing system against the factors they perceived to have an impact on the selection of a payment method or pricing system using a scale 10-110 where 10 represented low suitability and 110 represented significant suitability. Twenty-one responses (from eighty-five questionnaires sent) were received and analysed. The second step was to design this spreadsheet to determine the suitability of the payment methods or the pricing mechanism. Multi-attribute utility technology was applied to provide a spreadsheet model to assess the relative importance weightings of the payment systems selection criteria and to thus derive utility values. This technology has been successfully applied in construction research and in particular to aid procurement system selection. The procedure involved the following steps: the project manager assessed the relative importance of each criterion (cost certainty, time certainty, complexity,) on scale of 1-20 (column 2 priority rating). Rational priority ratings were then calculated by dividing each priority rating by the sum of all the ratings, the sum of rational ratings being equal to one. Following this, each rational priority rating was multiplied by a utility factor connecting each criterion to each payment method or pricing mechanism. The rational priority rating –utility factor products were added for each payment method or pricing mechanism and the resulting total then ranked in descending order. The most appropriate payment or pricing method was taken to be the one with the highest total. All the above calculations were modelled on the spreadsheet; in order to give the results once the priority ratings for each criterion were given. This is shown in table (1).

Factors		Rating	Priority rating	Interim payment		Lump-sum (one payment)		Milestone payment	
				U.F	Result	U.F	Result	U.F	Result
Time certainty				49		76		75	
Cost certainty				58		75		74	
Contractor cash flow				89		53		73	
Contract form	JCT(BQ)			104		30		48	
	JCT(DB)			75		54		92	
	NEC			75		30		55	
	FIDIC			71		24		55	
	GC			71		31		61	
Speed(during D&B)				52		79		71	
Disputes likelihood				83		73		69	
Risk allocation				42		69		66	
Total									
Rank order									

Insert the rating 1-20

Table (1) The multi-attribute utility technology applied in selection of payment system

FACTORS INFLUENCING THE PAYMENT MECHANISM

Cost certainty

A large majority of projects end up costing more than the original tendered price, and cost estimation is therefore crucial to the tendering prices, as it provides a basis for establishing the likely cost of resources of a given project. The impact of inaccurate cost estimating on contracting is significant, overestimated costs result in higher tender prices being submitted by contractors, which could in turn lead to the tender being unacceptable to the client. Conversely, an underestimated cost could lead to a situation where a contractor incurs losses on the contracts awarded by the clients.

The costs involved in the construction of a project can be broken down into two major categories: direct and indirect. Direct costs are those associated with the physical construction of the project and include such things as the purchasing of building materials, equipment operations, and all installation labour. As long as work proceeds, direct costs continue to accrue. Once work stops, direct cost generally stops as well. Indirect costs include such things as office overheads, costs associated with bidding and others.

Cost and cost certainty are known to be one of the top priorities of construction clients (Davenport, 1997). However, low price is not always the main concern of clients today; instead cost certainty is becoming increasingly important (Flanagan et al, 1998), and it is more likely to be within the control of contractors and is very important to clients (Construction Industry Board, 1996). Higher cost certainty is associated with contractors who are better able to predict and control construction cost, and the higher number of design variations in construction projects contribute to the lower cost certainty. Also changes of design during construction have been

perceived as one of the main problems facing project cost certainty. The survey discussed in this paper was aimed at determining the impact of the cost certainty on the selection of the suitable payment system. Pricing systems in particular affect this criteria where cost plus systems are expected to be associated with contracts where price certainty is not a key objective.

Project complexity

The degree of complexity of building construction is usually significant. Construction can be divided into two types; the first type is simple building such as houses, offices and warehouses, the second is buildings required for industrial process such as chemical plants, car-making plants and the like. The contractors will investigate the type of building and its specification carefully before tendering. In the case of complex buildings the risk and uncertainty cost will be extensive.

Contractor cash flows

Several models have been developed to generate a forecast of project expenditure flows; some based on elemental costing and others on activity-based costing.

Cost elements or activities are identified and calculated along a scheduled timeline based on a detailed examination of expenditure sources. Subsequently, in order to generate a forecast, these models require excessive resources, which are not justified when compared with the low degree of predictive accuracy that they generate (Gunner and Betts, 1990). An alternative simplified approach consists of the division of areas of cost into labour, material, plant and overheads, and their breakdown into their respective time series (Harris and McCaffer, 1995). A more practical alternative has been based on the use mathematical/statistical models, some being based on a theoretical analysis of project expenditure flow behaviour (Bromilow and Henderson, 1977), others were based on an analysis of data relating to past projects (Kaka and Price , 1993). The Corporate Financial Model for Construction Contractors (CFMCC) developed by Kaka (1990), attempted to use the simulation principle to forecast companies' cash flow by randomly generating and integrating individual contracts for a given company. This model predicts the monthly cash flow and working capital in terms of ranges. Kaka and Lewis (2003) developed a computer-based model to assist contractors to forecast, plan and control their cash flow. According to the above, it can be concluded that all projects are in need of a tool to aid the forecasting of cash flow before commencing the project or even at the tendering stage. Both clients and contractors must prepare the cash flow for each project from the planning stage up to the end of the project. Although there exist many models developed to assist contractors in their pre-tender cash flow forecasts, the majority of these have been based on traditional payment system. Payments received by a contractor are considered as positive cash flows, the net cash flow at any time being the sum of the positive and negative cash flows at any time. The contractor prefers to receive as much cash as possible as early as possible; the ability to continue work on the project perhaps depending on the progress payments received. For the client, payments to the contractor represent expenses; he/she would therefore prefer to delay the payments as long as possible. A payment system is therefore on extremely influential factor on contractors (and subcontractors') cash flow. Monthly interim payments are expected to generate favourable cash flow and where advanced payments are applied, a negative working capital requirement is often experienced.

Procurement selection

Davidson (1998) defined procurement as follows:" procurement is a strategy to satisfy client's development and/or operational needs with respect to the provision of constructed facilities for a discrete life-cycle." Building Procurement has been identified as "the amalgam of activities undertaken by a client to obtain a building" (Franks, 1984)

Many projects suffer from inadequate or inappropriate procurement decisions, and the most useful protection that can be offered to a client is a sensible policy for choosing a procurement strategy for each building project. Masterman and Gameson (1994) suggest the main influencing factor of procurement selection is determined by the level of client experience. The choice of building procurement system available to clients is now so wide that the need to carry out the selection process in a disciplined and objective manner should be self-evident, but the fact is that such a course of action is not adopted by many in the construction industry. The procurement method can be chosen in relation to project type, Skitmore and Marsden (1988) have described two basic approaches to developing a universal method for procurement selection, first by a multi-attribute analysis technique, second by a discriminant method. The choice of a procurement route for construction work is one of many important decisions that construction clients have to make. This decision is often based on several factors such as the time available, complexity of the project, desired flexibility in making changes, degree of price certainty, performance requirements, the client's adviser, and the balance of risks and responsibilities for various aspects of the project. It is essential for clients to objectively assess and prioritise their requirements in order to enable a rational comparison of the alternative procurement routes available. The 'traditional' payment system is an old system designed to cater for the 'traditional' procurement system, and as alternative procurement systems have emerged, the suitability of the traditional payment system has been less obvious. Today, new payment and pricing systems are being applied in the construction industry, although it is not yet clear which payment system is appropriate for which procurement system, neither is it clear whether procurement systems affect the choice or suitability of the payment system. Nevertheless, a previous survey by the authors of this paper (Sherif & Kaka 2003) indicated that a relationship between the two does exist.

Duration of the Tendering Process

The purpose of any tendering procedure is to select a suitable contractor, at a suitable time and to obtain a suitable tender or offer upon which a contract can be let.

Traditionally, duration and money were the main criteria for contractor selection. Whilst this is true in a broad sense, there are many other factors affecting either time or financial outcome of the contract. These factors are often assessed at the pre-qualification stage before the tendering stage (and in the case of experienced clients, updated on an annual basis) and only contractors considered to be suitable are invited to tender, thus significantly reducing the time required to assess the tenders. However, the time required for tender generation (from the contractor's point of view) may still be considerable. Payment systems and in particular the pricing system to be adopted in the contract affect this timing, and although the full extent of the effect is unknown, the earlier survey demonstrated that it could be significant (results indicated that the desired tendering time should be considered when selecting the pricing system).

Project budget availability
The client's budget for a particular construction project represents the construction cost of the project to be procured and the cost of finance. Thus, the expenditure profile associated with the project affect the total cost and the budget to be allocated. The simplest approach to budgeting is to estimate the expected costs associated with each activity, task or milestone. Based on the project schedule these costs are assigned specific dates and a budget is generated, in the case of borrowing, the client needs to forecast the cash flow of the project and arrange a schedule for the borrowed money to be released with the lender. The payment system therefore influences these arrangements and according to the earlier survey, clients should or do, take their financial budget into consideration when deciding on which system to adopt. Furthermore, contractors are often concerned about the uncertainty (or lack of information) surrounding clients' budgets. Cash shortages may lead to delays in payments and disruption of work. Similar issues also apply to the supply chain itself and to different parts of the supply chain.

Risk allocation
No construction project is risk free and although risk can be managed, minimised, shared, transferred or accepted, it cannot be ignored (Flanagan1993). The identification of risk must be linked to a clear statement of the client's priorities for the project. There are usually a large number of parties involved in a construction project with different responsibilities and it is important to consider the extent to which certain parties can control the risk. Contractors by their very nature tend to want to be paid as much as possible with the minimum amount of risk involved, whereas clients generally want to pay as little as possible and transfer as much of any risk as possible to the contractor. Yet, if all risks are passed onto contractors, these will most likely to be reflected in the profit margins applied by the contractor and the client will probably have paid more than necessary. According to Murdoch and Hughes (1999), the life-blood of a business is to make money by dealing with risks; other people do not want to bear. Ward and Chapman (1991) state that successful and appropriate allocation of risk will create an atmosphere of trust between contracting parties and a deeper mutual understanding of all relevant project risks and their effects. The authors of this paper would argue that the aim of contract choice should always be to distribute risk clearly and unambiguously and that payment systems play a key role in defining how risk is allocated.

Forms of contract
The purpose of the contract is to establish the rights, duties, obligations, and responsibilities of the parties involved and to allocate risk appropriately.

The choice of which form of contract to use depends upon a further set of criteria. Murdoch and Hughes (1999) noted that consideration must be given to the following:

- the amount of design that needs to be done before the contractor is selected;
- the level of nomination required;
- the duration of the contract;
- the need for speed;
- the susceptibility of the contractor's costs to market fluctuation;
- the overall size and complexity of the project;

- the method by which the contractor should be selected;
- the extent to which the client wishes to change the brief during the design and construction stages;
- the ability of the client and/or architect to manage and co-ordinate; and
- the novelty of the project; the skill and experience of the particular consultants being engaged for the work.

The choice of the type of contract and the particular terms and conditions under which the work will be carried out will normally be made by the client in the light of the advice they receive from their professional advisers. This choice must be made at an early stage as it will affect the way in which the contract documentation is prepared. It is unclear as to how forms of contracts affect the choice of the payment system and often, standard forms (such as JCT contract forms) accommodate more than one pricing or payment system. According to the survey undertaken earlier, a relationship between the two does exist.

Speed (during design & construction)
Speed is important to all parties involved in the construction project (particularly the clients) and it is becoming common in the construction industry to shorten the design and construction durations combined by overlapping the two phases. Design and build projects are generally used for projects where design and construction are undertaken concurrently. However, the reduction of the duration of each individual phase (particularly construction) is only possible through improved management processes and technology. Lean construction is now playing a major role in shortening project duration, in particular the use of off site activities such as prefabrication and pre assembly. A payment system that is based solely on progress on site would discourage contractors from prolonging off site activities. Thus, the choice of payment system influences the construction technology to be adopted and the subsequent project duration. This is echoed by the results obtained from the earlier survey.

DATA COLLECTION AND ANALYSIS

One of the most widely used techniques for deciding between alternatives with multiple objectives is the Multi-attribute utility Theory (MAUT). The basic hypothesis of MAUT is that in any decision problem, there exists a real valued function UF defined along the set of feasible alternatives the decision-maker wishes to maximise. Multi-attribute utility analysis is a methodology that can be used as a tool to measure objectivity in an otherwise subjective area of management (Fellows et al.,1983).

MAUT has been used to select the most appropriate procurement system for a building project (Skitmore and Marsden 1988). Multi-attribute analysis techniques help decision makers evaluate alternatives when conflicting objectives must be considered and balanced and when outcomes are uncertain (Bunn, W. (1984)

Sherif and Kaka (2003) carried out a survey of the construction industry to identify the most important variables influencing of the payment method choice and pricing mechanism. These variables are as listed below.

No	Payment methods	Pricing mechanism
1	Time certainty	Cost certainty

2	Cost Certainty	Project size
3	Contract form	Project complexity
4	Contractor cash flow	Contractor cash flow
5	Speed (during D & C)	Disputes likelihood
6	Disputes likelihood	Risk allocation
7	Risk Allocation	Procurement systems
8		Forms of contracts
9		Flexibility (accommodate the design changes)
10		Tendering time
11		Tendering methods
12		Value for money
13		Project budget availability

Table (2) Factors influencing payment methods & pricing mechanism

A subsequent questionnaire was designed and posted to determine the utility coefficient linking payment systems to the identified factors above. The utility factors were calculated using the mean averages of the responses scores, and summarised as shown in Tables 3a, 3b. An experienced practitioner then validated calculated scores where a rational was given for each result.

Utility Factors (Payment Methods)

Factors	Interim Payment	Lump sum	Milestone
Time Certainty	49	66	75
Cost certainty	59	70	60
Contractor cash Flow	92	50	61
Contract Form JCT	94	26	37
Contract Form D&B	66	43	73
Contract Form NEC	79	35	47
Contract Form FIDIC	66	28	46
Contract Form G.C	71	36	61
Speed(during D&B)	49	67	73
Disputes Likelihood	67	62	52
Risk allocation	41	70	55

Table (3a) Utility factors Payment Method

Utility Factors (Pricing Mechanism)

Factors	Cost plus fees	Unit rates	Lump sum
Cost certainty	23	50	101
Project size small	55	58	81
Medium	46	56	77
Large	35	59	71
Project complexity	63	42	55
Contractor cash Flow	83	67	53
Flexibility	100	68	33
Risk allocation	27	53	83
Disputes Likelihood	87	50	39
Tendering Time	85	41	41
Value for money	42	63	72
Budget availability	38	59	67

Table (3b) Utility Factors Pricing Mechanism

Based on the above results, a spreadsheet-based model was designed to assist the project manager in defining a suitable payment system for the project taking into account project characteristics and client requirements. The user inserts the rate of significance (extent of importance) of each factor to each particular project and the model calculates the priority rating for each payment system by multiplying the factors ratings by using established utility coefficients. Summing up the weighted

priority variables of each payment method or pricing mechanism will yield the one with the highest score and thus, the highest suitability.

CONCLUSIONS

The primary concern of the research study was to investigate the extent to which pre-defined factors of clients' requirements and project characteristics affected the choice of payment and pricing mechanism. The paper argues that selection of an appropriate payment system will result in better performance and improved satisfaction for all project parties. It suggests that the adoption of more comprehensive selection method will help project managers (or clients) to take into account the interests of the wider supply chain and hence reduce the likelihood of disputes and conflicts. Such action will ensure the alignment of interest between project team members leading to a win-win situation. The proposed model will require that each project client to objectively assess and prioritise these influencing factors so that a rational comparison of the suitability of alternative payment systems can be made.

Multi-attribute utility technology was applied to provide a spreadsheet model to assess the relative importance weightings of the payment systems selection criteria and derive utility values. This technology has been successfully applied in previous construction management research and in particular to aid procurement system selection.

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