A DECISION AID MODEL FOR THE SELECTION OF APPROPRIATE PAYMENT AND PRICING SYSTEMS FOR CONSTRUCTION PROJECTS

By

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ABSTRACT

Construction contracts are fundamental to any project, and the selection of an appropriate payment system is vital given that the ultimate success of any construction project depends on the suitability of the selected payment system to the project's characteristics and client's requirements. The choice of a payment system for construction work is one of the many important decisions that construction clients have to make. In this research, the author has defined the payment system in terms of four layers: Payment Mechanism, Pricing System, Payment Chain (who pays who), and Projects Cash Flow. In order to develop a tool that will help the project managers to select an appropriate payment system, a list of factors that influence the selection process was identified. The most influential factors were identified using a U.K based nation-wide postal survey.

There are several existing methods for pricing and payment. This research 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 the first survey, several factors were identified to influence the choice of the payment system. A second survey was undertaken to determine the extent of suitability of each payment system to these factors. 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 derive utility values. This technology has been successfully applied in construction research and in particular to aid the selection of the procurement system. The model developed in this research will act as a decision aid tool that will assist industry practitioners to select the most appropriate payment system for given sets of project requirements and characteristics.

The cash flow of the construction project is one of the most important factors that could affect the profitability and survival of construction organisations. Research into cash flow has in the main concentrated on two main processes: how to forecast cash flow, and how to manage cash flow. The construction industry has applied many alternative payment methods and pricing systems. Research into cash flow forecasting has focused on what is referred to as the Traditional Payment System". This is where prices are based on unit cost and payments on interim monthly measurements. Alternative payment systems, such as stage payments, and milestones payments have not been fully embedded into cash flow forecasting models. Therefore a new cash flow forecasting model was developed in this research. The main objective of the model is to enable project teams to assess the impact of selecting alternative payment and pricing systems on cash flow. The model is also intended to enable the user to simulate the contract conditions such as the advance payment, retention money, and advance purchases of materials. This will enable project teams to fine tune contract conditions to achieve a favourable and fair cash flow profile for all. The model was developed on a spreadsheet and acted as a simulator of the project cash flow. It was also developed to be accurate and simple to provide the client, the contractor and subcontractors with financial positions during the project period.

DEDICATION

To

My mother and Soul of my father

And

Halima partner ever supportive and all encouraging kind wife

And

Our pleasant and loving children

Amel, Wafa, Ahmed and Mohamed

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Chapter One

Introduction

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Background

The normal practice in the Construction Industry is for the contractor to be paid monthly during the execution of the works. The value of these payments is determined by measuring the amount of work executed up to that point in time and multiplying these by unit prices submitted by the contractor at the tender stage. Advances based on measurement are a system of payment, which requires detailed and time consuming management. It does not reward achievement nor does it distinguish between the inefficient and efficient contractor. Of crucial importance, it does not deliver to the customer best value for money.

It is often said that cash is king and in construction contracting cash is the number one concern of contractors and subcontractors. Over the years, contractors have come up with innovative ways of enhancing cash flow. Some of these ways have been found in more efficient management processes and information systems by which contractors minimise outstanding balances owed by clients. Some have been found through pricing policies (e.g. unbalancing and front end loading) or somewhat unfair procedures such as over-measurement and delaying payments to subcontractors and suppliers.

In recent years, there has been an international consensus that the construction industry worldwide needs a major reform and many of these reforms have to come from re-engineering a variety of processes. Clients are not satisfied with the industry's performance and achievements, people working in the industry are not happy and the overall profitability of the industry is low. In the UK, there have been major studies and initiatives related to this (Latham, Egan, Best Practice programmes, M4I, etc.) and subsequently the research community has reassessed and examined the ways in which the industry works, including management processes, procurement routes, supply chain issues, etc. One component that has yet to be looked at within this new culture of reassessing and re-engineering is the payment mechanism.

Research into cash flow has in the main concentrated on two factors: how to forecast cash flow and how to manage cash flow, with the former receiving significantly higher attention than the latter. Cash flow as a research topic at present is seen as being somewhat mature and out of fashion. Nevertheless, cash flow remains one of contractors' top priorities and any factor affecting cash flow would be looked at with a great deal of seriousness. To this end, it is apparent that the current payment mechanism is not making use of this important factor and literally wiping off any link between project performance and clients' satisfaction on one hand and contractors' cash flow on the other.

In the UK, Sir Michael Latham's report entitled "Constructing the Team" contained some radical proposals regarding contracts and the current practice of monthly valuations.
It was suggested that negotiated payments based upon stages (milestones) would be a fairer system of valuation and payment. Other proposals include the abolition of retentions, the abolition of "pay when paid" practices and the amendments to the New Engineering Contract (a requirement that clients pay project monies into a trust fund and the revision of payment schedules which at present prevent subcontractors from obtaining their money until three months after finishing work).

The UK government has echoed the above in their application of the Government Public Procurement Form of Contract (GC WKS1 Edition 3) which recommends two alternative payment mechanisms: stage payment chart and milestone payments. The MOD's policy (for example) is to deploy payments as a factor in Incentivising satisfactory and timely completion. This policy is endorsed by the Treasury and is claimed to have achieved significant benefits. The objective behind milestones is not to affect profitability or cash flow adversely but rather to facilitate management of the project. The aim is to define milestones which, if achieved, secure payments which cover the contractor's likely outflow of cash at any point in the programme when a milestone becomes due.

In the US, a new type of contract is emerging and the Department of Energy is already adopting it for its own projects. Performance-Based contracts, sometimes referred to as Performance-Based Incentives, are gaining momentum in the US and to a lesser extent in Europe. The concept of these contracts is to align targets and clients' satisfaction with payments. Clients and contractors agree on specific objectives to be followed by formulae on how payments are to be dispatched in a manner that will encourage the achievement of the pre-set objectives.

The UK Trust and Money model is a radical and new model developed by the Movement for Innovation initiative and will soon be applied to a number of projects. Its concept is very similar to that of the DOE in the US, but it goes further to suggest radical ways for setting up a virtual company consisting of different members of the supply team being seconded from their own companies.
It seems apparent from the above that a thorough study of payment mechanisms is both timely and necessary.

1.1 AIMS AND OBJECTIVES

This research is designed to contribute to the development of a model for the suitable selection of construction projects payment systems, including the payment mechanisms, and pricing methods. In general terms, the research aims to develop a decision aid tool which helps project teams to select the most appropriate payment system for construction projects and their impact on project cash flow forecasting.

Objectives

The principal objectives of the study are to:

- identify the different construction projects' payment systems currently being adopted in industry;
- identify the factors influencing the selection of a suitable payment system;
- develop a decision aid tool for selecting payment and pricing methods;
- develop a cash flow model that will enable project teams to forecast their individual cash flow based on different types of payment systems.

1.2 RESEARCH METHODOLOGY

The determination of an appropriate research design for any study needs to take account of several factors. In natural science, the research methodology adopted conventionally reflects a positivist or scientific approach, whereas in the arts and humanities field the approach used in the research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the researcher collects data. Specific research methods also imply different skills. Three traditional research approaches, namely questionnaire survey, experiment theory by simulation and case studies were used in this research.

Quantitative research is associated with a number of different approaches to data collection. It is often conceptualised by its practitioners determining the problems to which researchers address themselves in the form of hypotheses derived from general theories. Quantitative researchers may observe strong statistical relations between two or more variables, connect these relations into a theory, but still not know if the mechanisms producing the statistical relations are the same as those described in the theory. One of the most common methodologies for collecting data for quantitative analysis is the postal questionnaire.

The use of qualitative research methodologies to challenge conventional views, though not unique to qualitative research, is one of the most common applications of qualitative methods. In this way, qualitative research prompts a critical evaluation of existing theory that is based on the detailed observation of mechanisms. Qualitative methods are also used to investigate cases that are theoretically anomalous. Qualitative research that accepts concepts of cases, analysable case aspects, and the possibility of cross-case analysis should be seen as being situated more towards the midpoint of the qualitative- quantitative continuum.

Both qualitative and quantitative methods may be used appropriately with any research paradigm (Tashakkori, 1998). In many ways, a major trade-off between quantitative methods and qualitative methods is a trade-off between breadth and depth.
Although a clear distinction between data gathering and data analysis is commonly made in quantitative research, such a distinction is problematic for many qualitative researchers. The analysis affects the data and the data affect the analysis in significant ways. Therefore it is perhaps more accurate to speak of "modes of analysis" rather than "data analysis" in qualitative research. These modes of analysis are different approaches to gathering, analysing and interpreting qualitative data.

A case study allows the investigation to retain the holistic and significant characteristics of real life events, such as organizational and managerial processes. It may be used to explain links in the real life involvements that are too complex for surveys or experimental strategies. Alternatively, case studies can prove to be very useful in testing or evaluating a developed model. Typically, a case study researcher uses interviews and documentary materials first and foremost, without using participant observation.

It is owing to the nature of the research that the main data for this study had been generated through a postal questionnaire survey. The survey was carried out in two stages: first, a questionnaire to determine the influential factors affecting the choice of payment systems, and second, a follow-up questionnaire to determine the extent of suitability of each payment and pricing system to each of the influential factors.

The findings of the questionnaires, once analysed, were discussed with an expert practitioner in an interview (qualitative methodology) who explained the logic of the results and hence by doing this confirmed the finding of the survey (triangulation). The experimental methodology (computer simulation) was selected to help project teams to assess the impact of selecting an alternative payment system on the cash flows of clients, contractors and subcontractors. This helps project teams to fine-tune the selected payment system to ensure fairness among the different members of the supply chain. Finally a case study methodology was selected to validate the reliability and applicability of the cash flow simulator. Figure 1.1 illustrates the thesis strategy, which includes the literature reviews phase, the data collection phase, the data analysis phase, the development of the decision aid selection tool for the payment methods and pricing systems and the development of the cash flow forecasting model. The thesis finally concluded by indicating the main findings of the work, reflecting on the limitation of the study and providing recommendations for the further works.

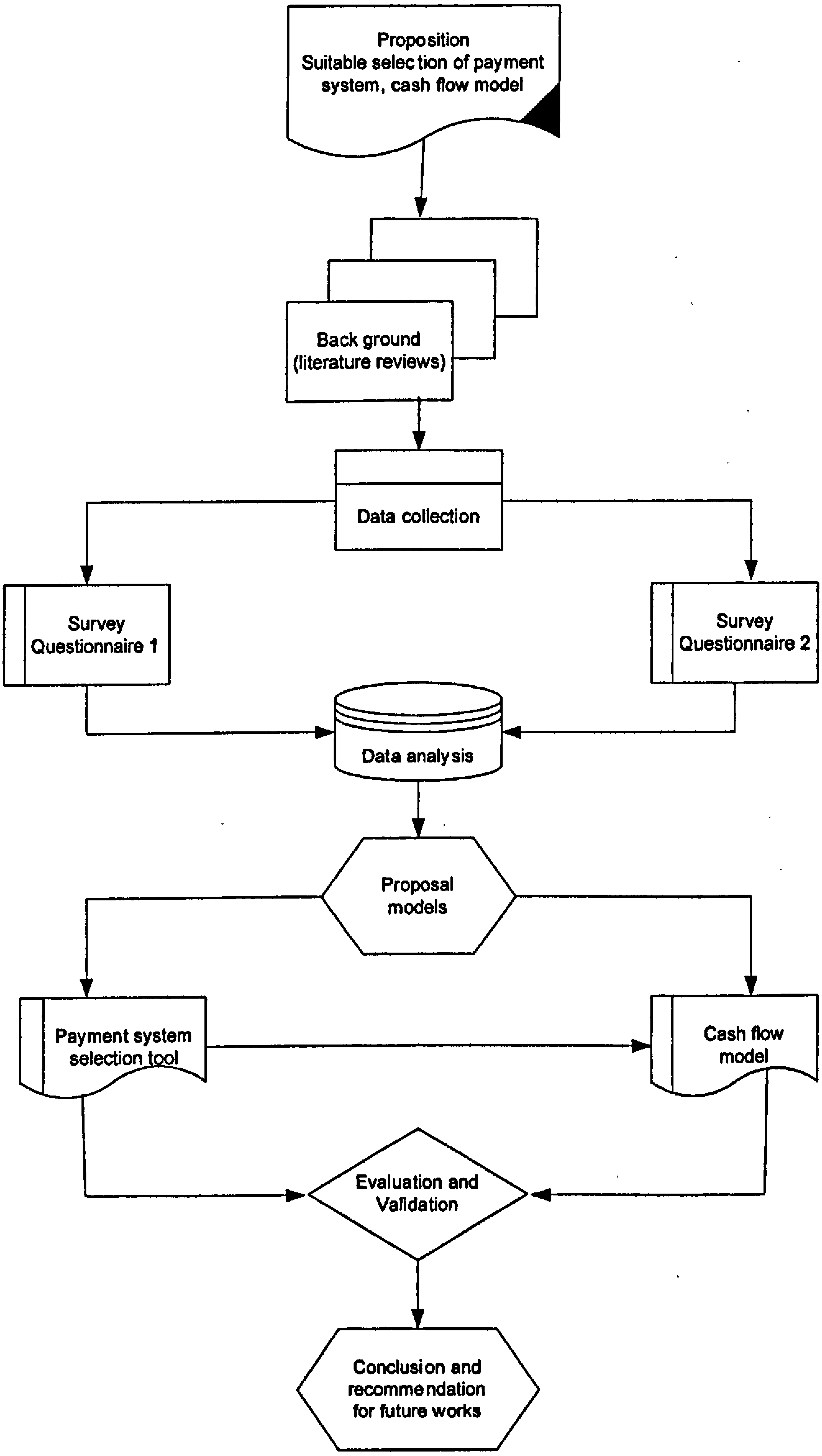

Fig. 1.1 Research strategy.

1.3 STRUCTURE OF THE THESIS

The thesis consist of nine chapters reflecting the process indicated in fig 1.2. Each chapter is briefly summarised as follows:

Chapter 2 Literature reviews

This chapter reviews the literature on general procurement systems, forms of contracts, tendering methods, payment and pricing systems, and projects financial management. The ways in which the relationships of the clients, contractors and subcontractors are managed have become increasingly important and the selection of the procurement and payment systems and the forms of contracts must be integrated with the overall project execution strategy. The choice must be made at an early stage as it will affect the way in which the contract documents are prepared.

Chapter 3 Cash flow forecasting

This chapter provides general reviews for the construction cash flow forecasting models and discusses the previous models and approaches for forecasting the cash flow and cash flow controlling and management. Although cash flow has been much studied and much researched in recent years, not enough of a link has been made between cash flow and payment systems.

Chapter 4 Research methodology

This chapter provides a rationale for the research methodology adopted and details the development, piloting and general survey. It also provides discussion of the multi-attribute decision making theory, and other research approaches and data collection methods. Three traditional research approaches, namely survey, experiment and case studies, were used in this research. Also the chapter described in detail the questionnaire survey as one of the most common methodologies for collecting data.

Chapter 5 Identifying the factors influencing the choice of payment systems

This chapter contains a description of the factors that influence the choice of payment systems of construction projects. It also aims to provide an appropriate systematic procedure to determine the order of payment and/or pricing system that is /are suitable for selection according to the characteristics of each project.

Chapter 6 Analysis and discussion of Survey results

The first section in this chapter considered the nature of the data collected in order to confirm the hypotheses that were to be determined in the statistical analysis. The chapter brings together all the analysis of the findings for the first questionnaires. The results of the analysis of the influencing factors and their impact on the payment system elements were discussed within the limitation of the data collected.

Chapter 7 Survey and development of the aid selection tool

This chapter deals with the important issues of the second questionnaire design for data collection and develops the selection aid tool for payment and pricing systems by identifying the utility factors for the variables identified in the first survey results. The multi-attribute utility theory (MAUT) has been used to develop the aid selection tool that will help project teams to select the most appropriate payment and pricing systems.

Chapter 8 Development of cash flow model

This chapter initially discusses the concept of the flexible cash flow forecasting model developed in this research. The requirements for a new model and the information collected to build the model are presented. The proposed model provides the client, the contractor and subcontractor with their individual cash flow profiles resulting from the payment and pricing systems being considered and the other influencing contract conditions.

Chapter 9 Testing the cash flow model

The chapter provides the validation of the model by using testing tools such as case studies and qualitative testing to validate the benefits of the model. First, the model was used to simulate real case studies by using past entry dates and checking output with actual cash flow. The model user also used to assess the influence of changes in the payment system on cash flow. Second, the model was evaluated by an expert who was asked to comment on the model's design, behaviour and value.

Chapter 10 Conclusion and discussion

Chapter 10 concludes the thesis by indicating the main findings of the work. Finally, the chapter includes a reflective statement on the limitation of the study and provides recommendations for further work.

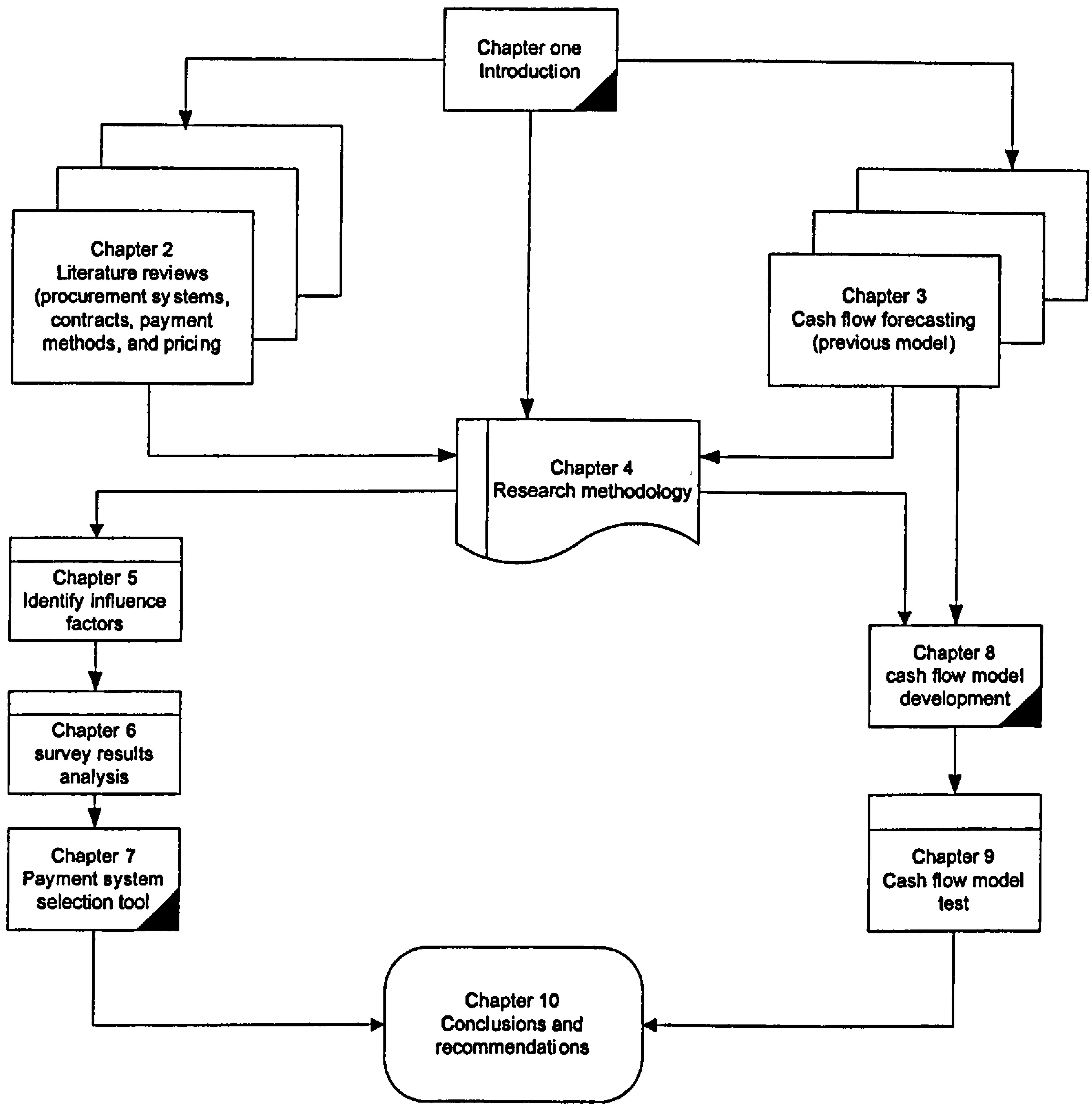

Figure 1.2 Thesis structure

Chapter Two

Literature Review

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2.1 Introduction

This chapter presents an updated classification of the procurement routes, payment and pricing systems, and also some of the available forms of contract of building projects. The ways in which the relationships of the client, engineering consultant, and contractor are managed have become increasingly important, and the selection of the procurement systems and types of contract must be an integrated part of stabilizing the overall project execution strategy. The selection of an appropriate procurement system is very important. It will have an impact on the financial and administrative structure of the project, and could contribute crucially to its success or failure. The construction industry offers many different procurement routes by which customers may obtain their buildings, and the proliferation of procurement routes has led to different roles and relationships being established between clients and their contractors. New forms of contracts defining the supply chain relationships are being used to manage these new procurement situations.

The choice must be made at an early stage, as it will affect the way in which the contract documentation is prepared. This chapter also demonstrates the fact that procurement routes and their corresponding forms of contracts process individually alternative payment and pricing systems. A choice will have to be made between the payment systems that could be independent from the selection of the procurement system.

2.2 Procurement system

The construction industry offers many different procurement routes by which the customers may obtain their buildings. Davidson (1998) defined procurement as a strategy to satisfy the client's development and operational needs with respect to the provision of constructed facilities for a discrete life cycle. Building procurement has also been identified as the combination of activities undertaken by a client to obtain a building (Franks, 1992). In the United Kingdom, the construction industry has over the years moved to a position where there is a lack of mutual respect and honesty between professionals. The industry has now reached the stage where litigation and other onerous practices are the norm (Matthews *et al.*1996).

The type of procurement system must be selected by the client (or his/her advisor) according to the needs and characteristics of the individual project, and broadly falls into one of the following categories identified by Masterman (1992) (see Figure 2.1).

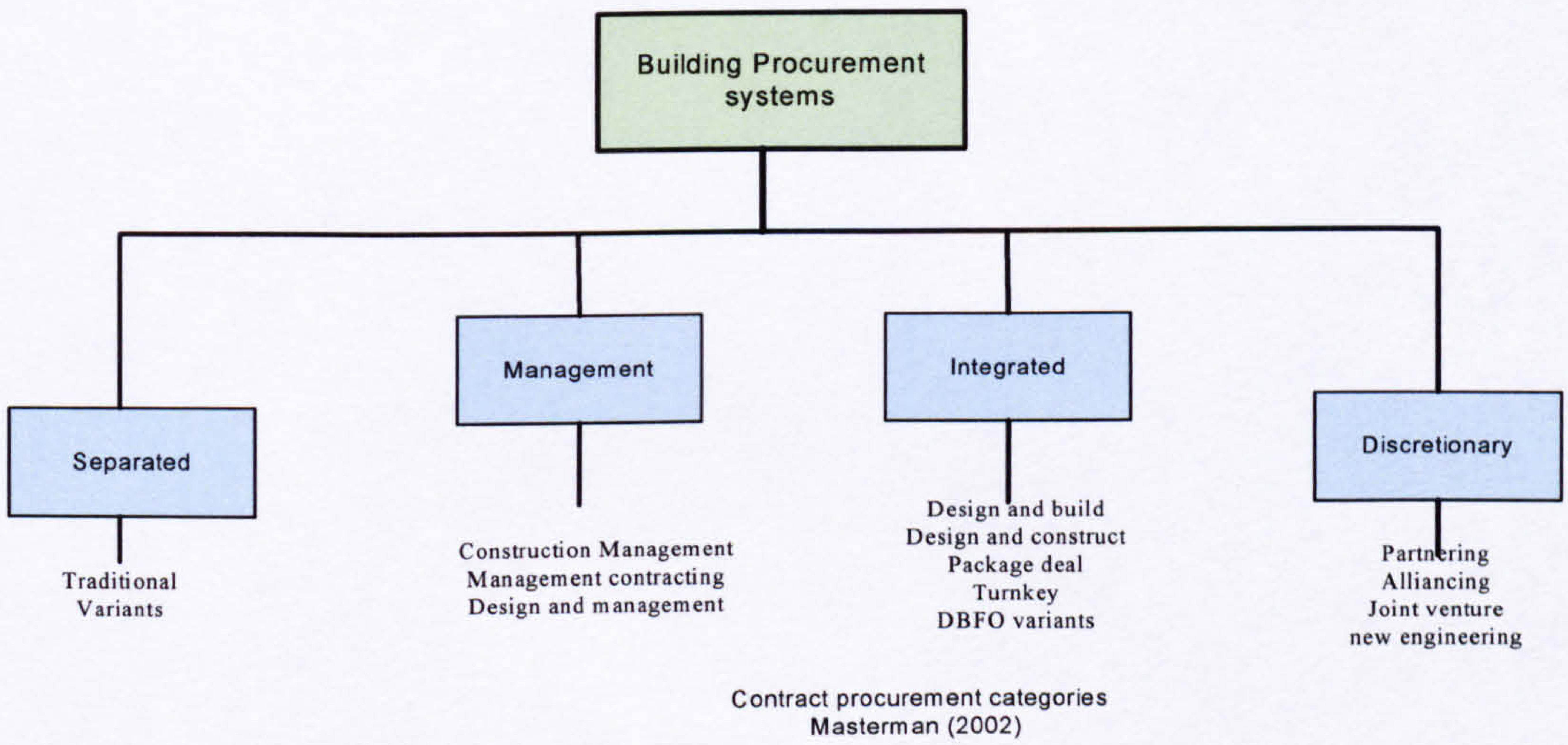
1- Separated (e.g. traditional method).

2- Management oriented contracts.

3- Integrated (e.g. Design and build contracts).

4- Discretionary (e.g. Partnering).

Fig. 2. 1 Construction procurement



2.2.1 Separated Procurement Systems (Traditional)

This method of procuring building projects is usually referred to within the construction industry as the "traditional method". Clients have to implement their building projects by using a main contractor, with the design and supervision being carried out by an architect assisted by other specialist consultants. The responsibility for managing the projects is divided between the client's consultant and contractor, which means that the client would be involved in a number of differing relationships with several organisations. Also, the designers would be working in isolation and far removed from the contractor who would eventually be responsible for carrying out the construction work. The use of this method provides a higher degree of certainty that quality and functional standards will be met, than when other systems are used. Whilst the cost of tendering is reduced, the sequential, fragmented and argumentative nature associated with this system could result in lengthy design and construction periods, and poor communication between client and the project team.

In this arrangement the owner first hires design and quantity surveying professionals who would then prepare the product design and the complete contract documents. In this traditional process the design team remains alongside the client and administers the terms of the building contract from commencement on site through to completion.
The client is able to select the most appropriate design team for his project, based on its experience of similar projects. The designer is typically paid a fee that is a percentage of the estimated construction cost, a lump-sum amount or an agreed-upon billing rate.

The main contractor is employed to build what the designers have specified. The owner selects the contractor on the basis of competitive bidding, negotiation, or some combination of the two. The project cost can be estimated, planned and monitored by the quantity surveyor from the inception stage through to completion of the project (Franks, 1992). The prices quoted by the bidding contractors most often constitute the principal basis by which selection of the successful contractors is made. The price submitted by the contractor is usually based on the Bill of Quantities, a document that itemises and quantifies as far as possible every aspect of work to be carried out. The Bill of Quantities not only defines the pricing document but also, owing to its comprehensiveness, forms an important mechanism for controlling cost as the project progresses. One of the most important documents in the traditional method is the bill of quantities. It cannot be produced unless the design is completed. This very aspect has been criticised as being not always practicable when preparing the complete design because of the long time needed. However, when this is done the system usually results in a high degree of certainty that quality and functional standards will be met. This system is common (i.e. widely used) and hence is understood by many clients and by all the participants in the construction industry itself.

Payment to the contractor for the work that has been satisfactorily completed is made by means of interim certificates (monthly) which equates to the value of work carried out, and is signed off by the architect on the recommendation of the quantity surveyor. An agreed percentage is retained until final completion and the amount is further reduced until the defects liability period is satisfactorily completed. This is discussed in more detail under section 2.6 of this chapter.

2.2.2 Management oriented procurement systems

The common feature in these systems is that a client enters into a contract with an external management organisation, which is responsible for the management and co-ordination of design and construction of the proposed works. There are several variations on this theme, including: -

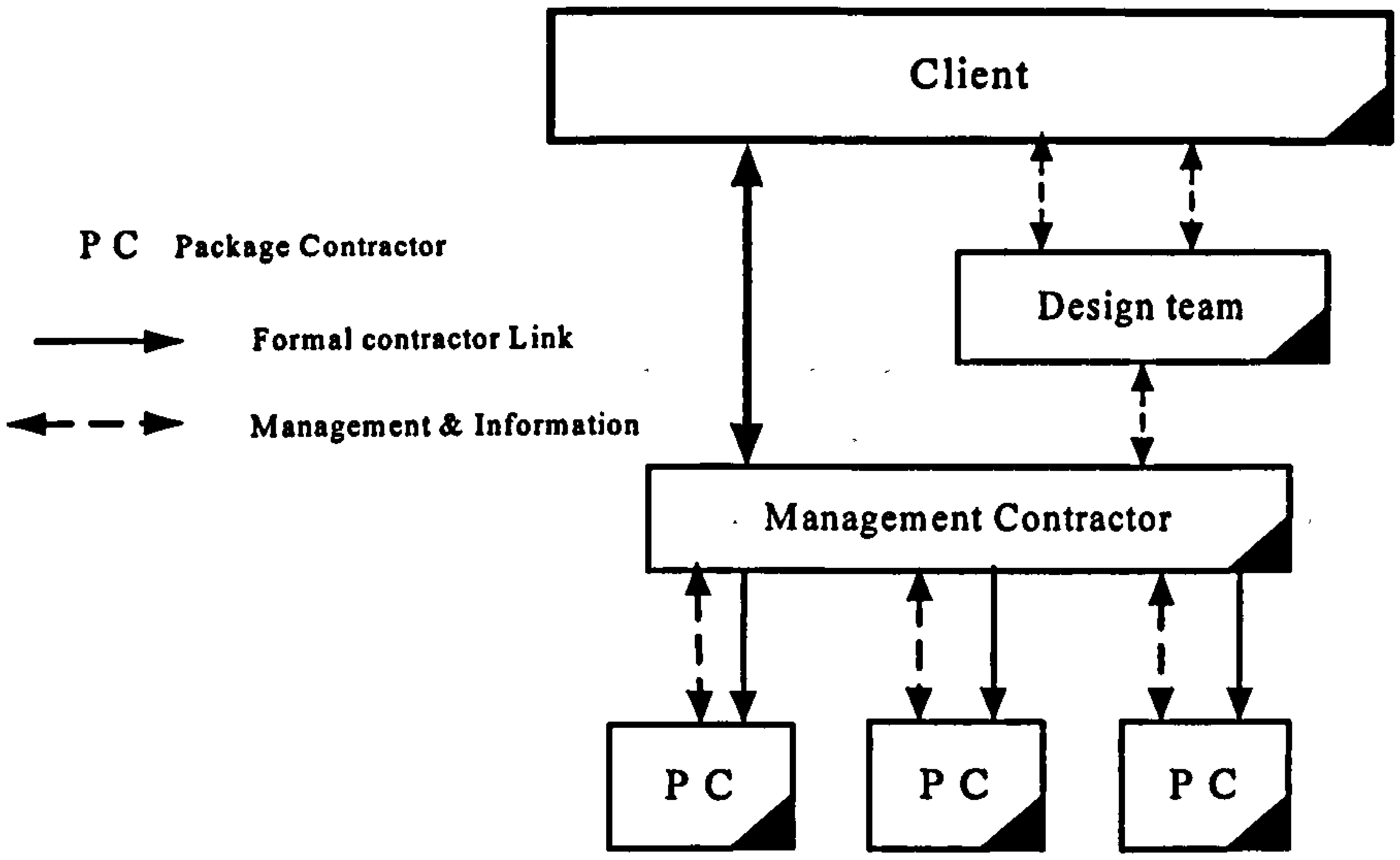
- Management contracting.
- Construction management.
- Design and management.
- Project management services.

Generally the most commonly used systems are management contracting and construction management. These are discussed below.

a) Management Contracting

The management contractor does not normally undertake any of the permanent construction work, but provides management services to control and co-ordinate all site activities; the actual work is subcontracted on a competitive basis to suitable contractors. Management contracting services may be utilized on a pre-construction and/or post-contract award. The management contractor provides accommodation for the site management team, together with the general site facilities such as canteens, offices, stores, and possibly plant (Morton and Jaggar, 1995). The mechanism for payment is usually on a cost-reimbursable basis, plus a management fee (usually a percentage of the prime cost) resulting in a low risk to the management contractor. The balance of risk may, however, be re-distributed by the use of target costs, with appropriate risk/reward incentives. This approach gives guidance as to the best conditions for allocating risk on large/complex projects, where there is a greater requirement for flexibility on design changes than in conventional systems. This system is also suitable when there is a need for an early start during the construction phase (but where the design is insufficiently developed); a need for early completion, and a need to consider different construction methods with insufficient management resources (where a large number of different contractors are required, resulting in many interfaces for co-ordination).

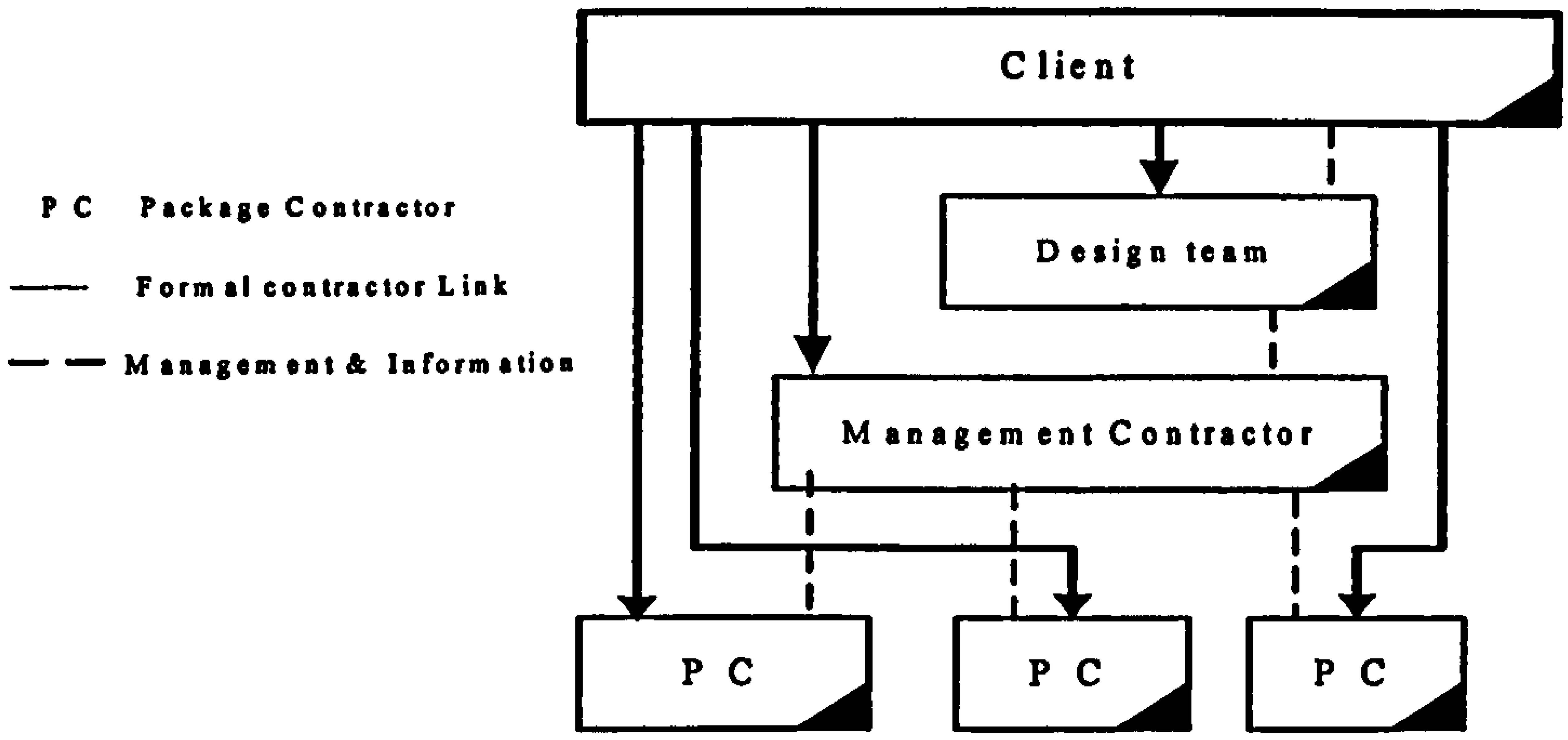
Fig.2. 2 Management contracting



b) Construction management

The appointed construction management organisation provides the service of managing for a fee all the works undertaken by the contractors who are to deliver the project. The individual works' contractors enter into direct contracts with the client (Turner, 1995). Indeed, in Construction Management, the client enters into separate contracts with a designer, a construction manager and the works contractors. This approach allows clients to have their project constructed quickly and to play a more active role in the total process, however at the expense of cost uncertainty (without a fixed lump-sum price). Construction management is best used when the client wishes to have separate contractual responsibilities for the professional management of a construction project, or flexibility to use competitive tendering and/or negotiation for procuring separate elements of construction. Clients may also wish to have an early start on site, which is particularly desirable during periods of rising inflation. Finally, this system is appropriate when there is a fast-track project, a less adversarial form of contract, and large scope for variations throughout the project.

Fig.2. 3 Construction Management



2.3 Integrated systems

Integrated systems can be divided into three categories: design and build, build own operate transfer, and partnering. These categories are discussed in detail below:

2.3.1 Design and Build

The design and build arrangement entails the client, instead of approaching architects for a separate design service, choosing to go directly to the contractor for both the design and the construction commission. It may be necessary to employ independent professional advisers to monitor the progress and quality of the contractor's works and to formulate valuations for payment purposes. The design and build approach enables the contractor to be more certain about the final cost to the client at an earlier stage, although cost certainty can be achieved only if the clients' requirements are unambiguous and comprehensive, and are not subject to alteration during the construction phase. "Design and build is therefore the procurement route that enables clients to employ one firm that takes single-point responsibility for delivering the required building and associated services in accordance with defined standards and conditions"(Bennett *et al.*, 1996).

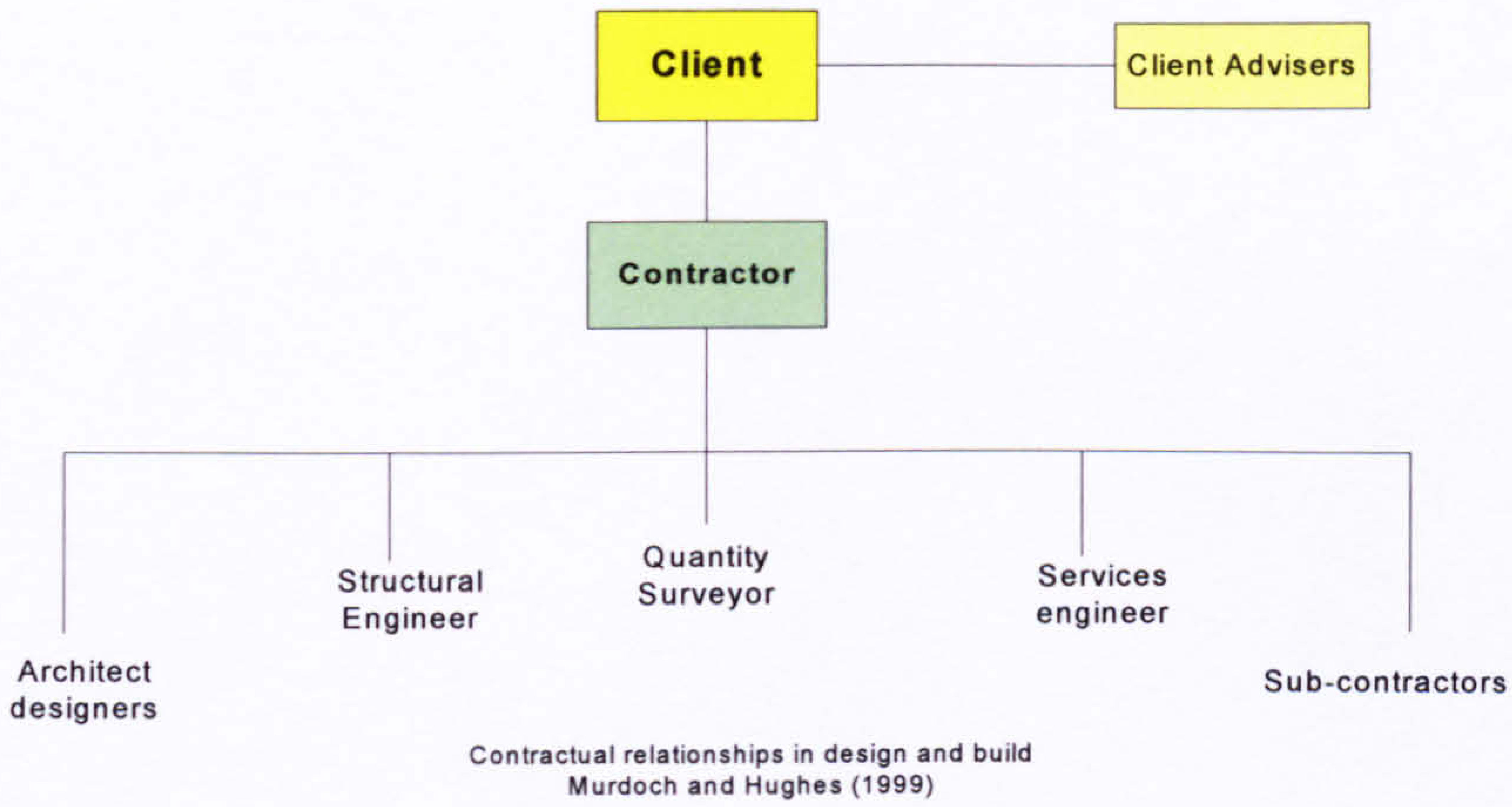
Two main parties are involved in design and build projects. The first is the client, who may engage a project manager to be his/her representative. The second is the contractor, who will provide a construction manager to manage the design and construction process of the whole project. The parties are expected to aim for a successful project outcome. Project success is usually defined as meeting time, cost, and quality objectives and satisfying project participants.

The survey carried out by Bennett *et al.* (1996) provides the following findings:

1- Design and build projects are 50% more likely to be completed on time than traditional projects.
2- Certainty of completion on time increases significantly the earlier the contractor is involved in the design process.
3- The construction speed of design-build projects is 12% faster than traditional projects.
4- The total speed of project delivery, including design and construction, is 30% faster.

It could be concluded that the significant advantages for this system to the client are: shorter overall time; reduction of the risk as major risks are passed to contractor; single point responsibility (as shown in Figure2.2, Murdoch and Huges1999); greater certainty of price; and economic design for construction. On the other hand, contractors using design and build have been accused of producing lower quality buildings than would be the case in other procurement methods.

Fig.2. 4 Contractual relationships in design and build



a) Types of design and build

There are several types of Design and Build procurement arrangements in existence. The four main types from which most of these evolved are:

i) Direct design and build

In this case, the client negotiates with a single contractor who is then charged with designing and constructing the required facility. No direct competitive tenders are sought, and the contractor involved in this type of procurement usually has an established track record with the client organization.

ii) Competitive design and build

This type of design and build procurement allows for competition between several firms interested in a given project.

The client normally retains the services of a consultant (usually an architect) who develops an outline design, which forms the basis of tenders. Pre-qualification of tenderers may be required to reduce the number of tenders to a manageable size.

iii) Novated Design and Build

In Novated design and build, the successful contractor is obliged to retain the services of the client's designers (architects and/or or engineers) in order to develop the detailed design. The contractor will have to accept responsibility for the total design of the project, including the initial work carried out under the client's consultant, together with the construction stage. This approach sometimes results in a conflict of interest and is not highly favoured by contractors, despite it requiring the successful contractor to be fully responsible for developing an initial, fairly well-developed design (together with the client's designers), and then for undertaking the construction work (NEDO, 1985). Many projects have been carried out using this method of procurement. However, Bennett *et al.* (1996) found that this variant led to the worst possible outcome for design and build projects. This is owing to the fact that a number of consultants considered that the involvement of a contractor at development of design stage in the process caused a conflict of interests between meeting the client's objectives and the commercial interests of contractors. On the other hand, it was found that this particular system has been the fastest growing of all design-build systems, accounting for up to 50% of all new design-build projects (Konchar and Sanvido, 1999).

iv) Develop and construct

In this system, the contractor takes on the design produced by the employer's design team and then develops it into a working design, using either an in-house architect or consultants. This method of procurement has a flexibility that enables the client to decide how much of the design is to be carried out by his own team and thus what remains to be done by the developer and construct contractor. One of the advantages of this system is that a contractor's expertise in buildability can be used to the advantage of both parties. The develop and construct system is also a major part of the design-build market, accounting for just over 20% of all new design and build projects (Bennett *et. al.*, 1996).

b) Limitations of Design and Build

Several limitations need to be addressed if the increasing popularity of design and build procurement is to be sustained (Evbuomwan and Anumba, 1996). Some of these limitations are as follows:

- clients incur an extra cost in retaining a set of consultants at the early stages of the project

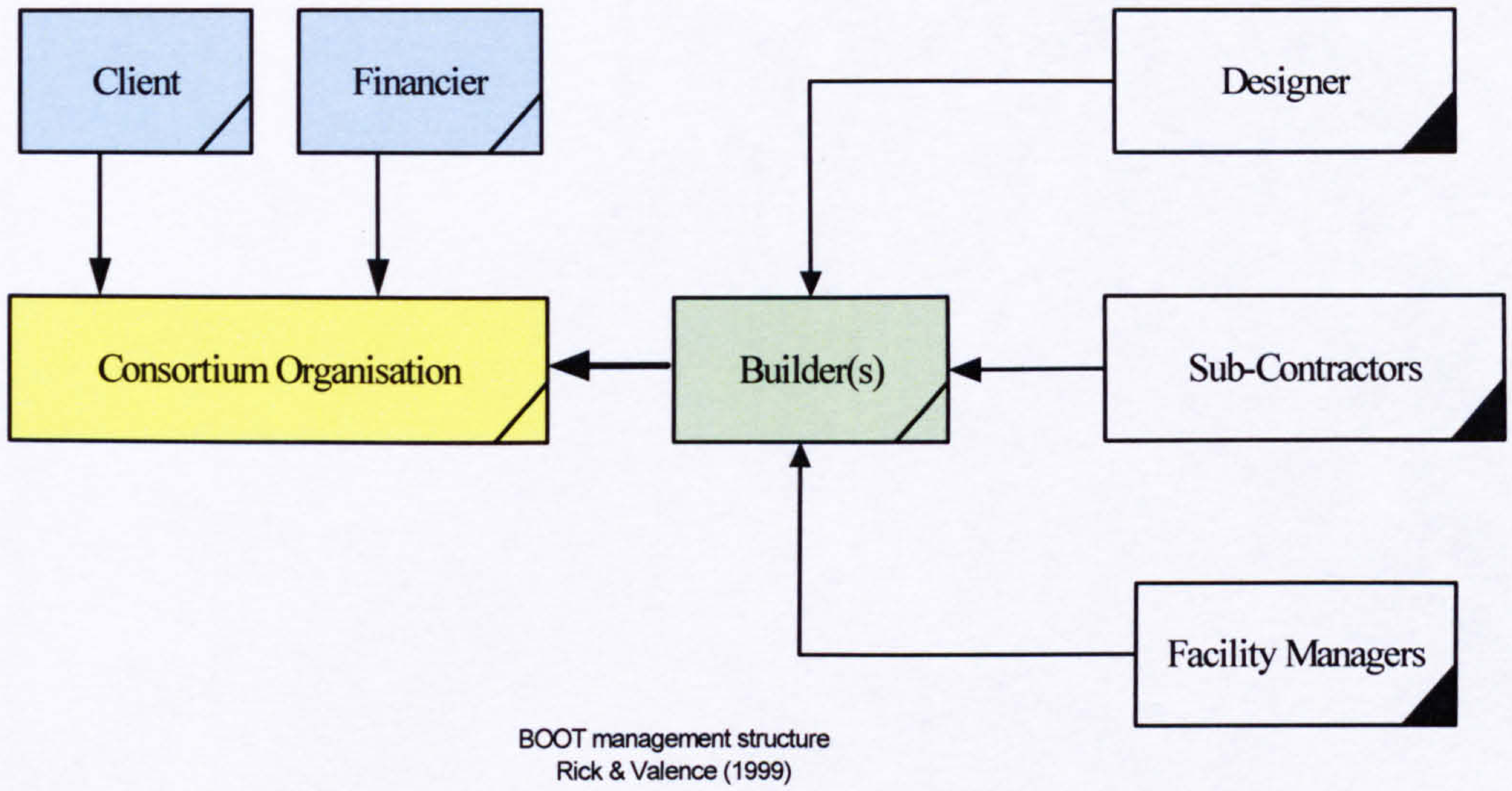
- there is a significant amount of rework and duplication inherent in existing procedures; particularly where the initial consultants are not novated to the successful contractor.
- delays often arise owing to the initial time spent in developing the outline design, the time spent by the successful consortium in clarifying client requirements, and the time spent sourcing and seeking approval for alternative materials and design changes.
- Quality, value for money, and client satisfaction are not guaranteed using existing procedures.

2.3.2 Build own operate transfer (BOOT) strategies

Build own operate transfer (BOOT) strategies have become particularly popular with public clients in the provision of infrastructure projects such as roads, and public services such as hospitals and prisons.

These forms of procurement are especially popular in developing countries where governments use them as a means of securing private sector funding to offset their own capital expenditure requirements. These strategies expand on the design and build concept and generally include a period of ownership and/or operation of the facility by the contracting organisation. The operation phase commonly varies from between 15 and 25 years, depending upon the type of facility and the financial return expected from the completed facility. In some cases the facility may never be transferred to public ownership, and the incentive may simply derive from a client's need for a facility which it otherwise would not be in a position to provide.

Fig.2. 5 BOOT Management structure



To initiate the project, the client will normally invite consortia to bid for the right to enter into negotiations for the work. The client will normally provide the potential consortia with detailed performance criteria, including design, construction and operational requirements.

The consortia bids are normally required to include information that sets out the fundamentals of the project, including the design concept, contract form, transfer period, ability of the consortium to provide the required level of service from the facility during the period of operation, financial security to complete and operate the facility and the operational costs of the facility upon transfer. The client selection of the preferred partner should be based on the conditions which best suit the client's requirements.

BOOT arrangements provide a single point of responsibility for the client who, through the establishment of clear and concise performance criteria, can procure the design, construction and operation of a facility, including all financing, simply by creating an investment incentive for interested consortia members.

2.3.3 Discretionary (Partnering and PFI)

(a) Partnering

The Reading Construction Forum (RCF) (1995) and the Construction Industry Institute (CII 1991) define partnering as:

"...a long-term commitment between two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant's resources".

This requires changing traditional relationships to a shared culture without regard to organizational boundaries. The relationship is based on trust, dedication to common goals, and an understanding of individual expectations and values. Expected benefits include improved efficiency and cost effectiveness, increased opportunity for innovation, and the continuous improvements of quality products and services. Also, governments believe that PPP/PFI procurement can provide a wide variety of net benefits for society, including: enhanced government capacity; innovation in delivering public services; reduction in the cost and time of project implementation; and transfer of major risk to the private sector, in order to secure value for money for taxpayers (Li *et al.*, 2005).

An alternative to the above definition is that put forward by the National Economic Development Council (NEDC): "Partnering is a contractual arrangement between a client and a chosen contractor which is either open-ended or has a term of a given number of years rather then the duration of a specific project". During the life of the arrangement, the contractor may be responsible for a number of projects, - large or small - and continuing maintenance work and shut downs. The arrangement has either formal or informal mechanisms to promote co-operation between the parties. The Project Partnering process creates a new team-building environment, which fosters better communication and problem solving, and a mutual trust between the participants. The basis of partnering can be project-specific or "strategic", and many in both the private and public sector have successfully applied it (HM Treasury, 2003). For partnering to be successful, it requires a more flexible attitude and approach than has traditionally been the case in the construction industry. It also requires an acceptance that organisations and individuals are entitled to receive a reasonable return for their efforts. It requires people to accept that the cheapest price does not necessarily provide best value for money. The approach is based on mutual objectives, an agreed method of problem resolution and an active search for continuous measurable improvements, Latham (1994).

Mutual objectives may include many issues such as:

- improvement in efficiency;
- cost reduction;
- fast construction;
- sharing of risks;
- lower legal costs;
- time and cost certainty;
- guaranteed profits;
- reliable product quality,
- problem resolutions aimed at understanding the problem correctly, and then resolving it at the lowest possible level within the organisation as quickly as possible.

This is achieved through seeking solutions, not parties to blame, and is based on win-win solutions with equality of rights between the parties within more and better discussion. Continuous improvement should be the concern of all the parties involved in the project, as it is effective only when all parties are motivated to its achievement. The nature of construction is such that all too often cut-throat competition drives down initial prices, quality, safety and management competence which in turn results in claims, disputes, poor performance and firms going out of business. The main key subjects for continuous improvement include quality, certainty of time and cost, elimination of waste, better value, and efficiency in all stages of the construction process.

The steps to building a successful partnership can be summarised by Latham (1994) in four steps as follows:

Step (1) Understanding the need for partnership.

- Establish a need of partnership as strategic planning.
- Build a cross-functional team to work on it.
- Define potential opportunities.
- Approach top management.

Step (2)

- After deciding their selection criteria, list potential suppliers.
- Involve cross-functional team members in the selection process.
- Make suppliers visit and understand suppliers

Step (3)

- Prepare partnership contract.
- Establish a charter with mission, objectives, goals, milestones,
- measurements, roles, responsibilities and incentives to meet and exceed goals.
- Identify the means to minimize conflict to build a process of resolution.
- Establish the tools for both measurement and sharing of gains / liabilities, meeting the firm's needs overall.

Step (4)

- Check action and act.
- Evaluate changing needs and expectations
- Plan for application of lessons learned for progress.
- Periodically prepare a join assessment plan.

Construction partnering offers contracting parties benefits such as: prevention of unfair risk and benefits allocation; an endeavour to drive win-win solutions; value being placed on the long-term relationship; partners being encouraged to address any problem openly, and also innovation is encouraged. Contracting parties could gain better mutual understanding of the needs of each other; partnering also improves both the site management and project coordination owing to the commitment of all parties. Furthermore, it reduces the risks of project delay, over budget, poor quality and safety management.

(b) Private Finance Initiative (PFI)

The UK government introduced the Private Finance Initiative (PFI) in 1992 for the procurement of facilities to improve the level of public services. The Private Finance Initiative is seen as an alternative route for government to procure facilities and services without undue effect on the public sector borrowing requirement (Construction Industry Council, 1998). Construction organisations play a crucial role in the development and operation of infrastructure facilities central to the PFI strategy. Leading construction organisations are responding to the opportunities created as there are benefits to be gained (Birnie, 1999).

PPP/PFI ensure that contractors are bound into long-term maintenance contracts and shoulder the responsibility for the quality of the work they do. With PFI, the public sector defines what is required to meet public needs and remains the client throughout the life of the contract. The public sector also ensures, by contract, delivery of the outputs it sets and has rights under those contracts to change the output required from time to time.

The essence of PPP/PFI can be summarized as a long-term contract arrangement between private and public sector entities. On the basis of input and output sharing, the private sector carries out the delivery of a service or project development. Part of the objectives of PFI is to attract private sector funds, resources, management skills, expertise and innovation to the provision of public sector infrastructure and services (Mustafa, 1999).

The benefits PFI can offer, in terms of time and budget delivery and whole-of-life costing, all flow from ensuring that the many different types of risks inherent in a major investment programme

Problems reported with PPP/PFI procurement include issues such as: high costs in tendering, complex negotiation, cost restraints on innovation, and differing or conflicting objectives among the project stakeholders. Also other problems identified by this set of PFI participants as affecting Best value (Akintoye *et al.*, 2001).

- lack of relevant experience in PFI, on the part of clients, who were seen to be 'walking in the dark';
- unclear client priorities and objectives;
- Slow negotiation;
- less open communication with the client, especially on the pricing of specific risks;
- high bidding costs, mainly attributed to the cost of consultancy services, of which the legal services are usually the most expensive, Due to the complexity of the PFI process and lack of appropriate expertise, both public and private sector project teams rely on external advice (Akintoye *et al* 2003).

2.4 The selection of a procurement system

The selection of a procurement system can have a significant impact on the success of a construction project. The choice of building procurement systems 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. However, determining which is the most appropriate procurement system is not a straightforward process. The choice of the procurement route should be made based on the relative advantages and disadvantages of the alternatives against the criteria defined by the client. This will ensure that the outcome will best match the client's requirements. The needs of the client and the characteristics of the project should be considered to be as important as the features of the procurement systems options themselves in determining the effectiveness of the chosen procurement system to meet those needs and characteristics. The choice of a procurement route for construction work is therefore one of the many important decisions that construction clients have to make. It must be based on the nature of the project and the clients' wishes for the extent to which they are willing to share the risk (Latham, 1994).

Currently, it is widely felt by many authors in the field that the traditional route to procuring construction is inherently less efficient and more confrontational than the alternatives (Hardcastle and Tookey, 1998). Naoum and Coles (1991) found that traditional procurement was more likely to over-run in terms of cost and time than other routes, such as management contracting. Historically the traditional approach to procurement has been prone to extensive confrontation and what has been termed a culture of litigation (Hardcastle and Tookey, 1998). Elliot and Palmer (1997) argue that the two major procurement systems, traditional and design and build, both separate the early stages of project planning from the construction stage. They emphasise the fact that "traditional" procurement does this to a much greater extent than design and build, but from the environmental viewpoint the effect of the separation is the same.

Many projects suffer from inadequate or inappropriate procurement decisions. 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 that the level of client experience determines the main influencing factor of procurement selection.

Skitmore and Marsden (1988) and NEDO (1985) described two basic approaches to developing a universal method for procurement selection: first a multi-attribute analysis technique, and secondly a discriminant method. They suggest employing the following criteria to establish a profile of the clients' requirements:

1- Speed (during both design and construction).
2- Certainty (price and the stipulated time and knowledge of how much the client has to pay at each period during the construction phase).
3- Flexibility in accommodation design changes.
4- Quality (contractors' reputation, aesthetics and confidence in design).
5- Risk allocation/ avoidance.

6- Complexity (client may specify particular sub-contractor, or constructability analysis).
7- Responsibility (completion of programme, price, product quality, design and construction).
8- Price competition (covering such issues as value for money, maintenance cost and competitive tendering.
9- Disputes and arbitration.

It is important for clients to assess and prioritise their requirements objectively in order to enable a rational comparison of the alternative procurement routes. The selection and use of an appropriate procurement system must involve the analysis of complex and dynamic criteria. The importance weightings assessment also enables decision makers to take into account the project characteristics. The final selection is then based on the relative importance of selection criteria.

NEDO (1975) suggests that to ensure a successful choice of building procurement methods, the client's brief must be clear and comprehensive in specifying the specific needs and objectives. The range in choice of a procurement system is now wide and projects are becoming so complex that the selection process needs to be carried out in a disciplined and objective manner within the framework of the client's overall strategic project objectives (Love *et al.*, 2002).

2.5 Pricing Systems

The price for doing the construction work partly reflects the contractor's perception of risk involved. Selection of the pricing system to be used must be made on a case-by-case basis, considering contract risk, incentives for contractor performance, and other factors such as the adequacy of the contractor's accounting system. The selection of the pricing system is generally a matter for negotiation and requires the exercise of sound judgment. The objective is to negotiate a contract price or estimated cost and fee that will result in reasonable contract risk and provide the contractor with the greatest incentive for efficient and economical performance. There are many factors that the contract participants should consider in selecting and negotiating the pricing system. These may include the following: price competition (price analysis may provide a basis for selection); cost analysis; type and complexity of the project, (the likelihood of changes makes it difficult to estimate performance costs in advance); concurrent contracts (if performance under the proposed contract involves concurrent operations under other contract); and extent and nature of proposed subcontracting (if the contractor proposes extensive subcontracting).

The following sections discuss the most commonly used pricing systems in the UK.

2.5.1 Cost plus fee contracts

Cost-plus fee contracts provide that the owner will compensate the contractor for all construction costs, and pay a fee for its services. Usually the fee would be a fixed percentage of the total direct cost of the construction, or it can be a fixed sum. Advantages of this system are that material costs are limited to what is actually purchased; the contractor cannot make profits from a high-risk premium given that the possibility of a potential loss by the contractor leading to unfavourable effects is avoided. However, the contractor's motivation to carry out the work efficiently and effectively is considerably weakened. It is therefore important that all the project costs are correctly identified and included at appropriate charging rates in the contract. The client's primary risk is one of financial loss through excessive costs. Cost items are defined in the bidding documents as all the costs incurred in doing the work other than those costs incurred by the contractor at his/her head office overhead costs, and the fee will cover the office overhead costs and the contractors' profits. In most cost plus fees contracts, some design information is known at the outset prior to signing a contract with a contractor. The amount of design information provided should determine the nature of the cost plus contract, as it is necessary for the designer to prepare the bidding documents accordingly. If the contractor is efficient and careful, the costs will turn out to be less than estimated, whilst if the contractor is inefficient and careless, the costs will turn out to be more. There is no reason why a contractor should apply less construction expertise in a cost plus fee contract. This system would likely put the client and contractor in a less adversarial situation, which smoothes working relations during construction of the project and helps to reduce litigation costs. However, cost plus contracts make the client liable for any mistakes the contractor may make and in this type of contract no final price is guaranteed for the client.

2.5.2 Lump-sum contract (fixed price)

A fixed price contract provides for a price that is not subject to any adjustment and is based on the contractor's cost experience in performing the contract. With the lump sum contracts, the contractor agrees to complete a fixed package of work in exchange for a single lump sum of money. Use of this contract is obviously limited to those construction projects where both the nature and quantity of each work type can accurately and completely be determined before the contract sum is set. The standard forms for lump-sum contracts give the contractor a duty to indemnify and hold harmless the owner and the designer, together with their agents and employees, from and against all claims, damages, losses and expenses arising out of the performance of the work with certain qualifications (Collier,1987). The contractor with this type of contract usually has complete control of the work and is solely responsible for its organization and division among the subcontractors he or she employs. The total sum of money paid to the contractor for each work item is determined by multiplying the contract unit price (including the contractor's estimates of all direct costs, indirect costs, overheads, and profit) by the number of units actually done on the job. The plans and specification for a lump sum bid must essentially be complete to enable all bidding contractors to analyse the project in detail before preparing their estimates. The contractor is obligated to perform the quantities of work required in the field at the quoted unit prices, whether the final quantities are greater or less than those initially estimated by the quantity surveyor. The total value of work done to date is obtained in different ways, depending on the type of contract. The progress of under lump-sum contracts is normally measured in terms of estimated percentages of completion of major job components (Clough, 1991). The amount paid to the contractor by the client will vary from the bid amount, only in the case of changes to the project specifications to those described in the contract documents.

2.5.3 Unit-price contract

Unit-price contracts are especially useful in projects where the nature of the work is well defined but the quantities of work cannot be accurately forecast in advance of construction. In this system, the items are those that are paid for on the basis of a contractor's predetermined estimate of the cost of the work. For example, when items are defined in the Bills of Quantities, the contractor will determine the cost of the raw materials, the rates of pay for the skilled and unskilled labour, the number of hours needed, the amount of money for supervision, plant and so on. These amounts are added together to calculate a price for that particular item, after adding profit and an allowance for the risk involved. This rate is then inserted into the bill of quantities. The client will pay the rate in the bill multiplied by the quantity of that item used. The estimated price is paid by the client; irrespective of the actual cost incurred by the contractor.

2.5.4 Incentive contracts:

Incentive contracts are appropriate when a fixed price contract is not appropriate and the required services can be procured at low costs in certain instances with improved delivery or technical performance by relating the amount of profit or fee payable under the contract to the contractor's performance. Incentive contracts give the supplier an incentive for success. They have been widely adopted in the construction industry as an alternative to cost plus contracts in cases where the cost can be estimated roughly, so that a figure for target cost can be agreed, but not with sufficient accuracy to arrive at a fixed contract price. Incentive contracting is a method of converting the way of the contractors and client share revenues. It aims to enhance performance on all five-project parameters (cost, schedule, quality, safety, customer satisfaction) in order to promote a win-win situation. Incentive contracts also offer the possibility of sharing the risk between the client and the contractor. The arguments for risk sharing will depend on whether the risks are best managed by the contractor, the client, or both. In the case where both parties best manage risks, a risk-sharing strategy should determine the incentives to be set. Incentives contracts are there to create a better balance between risk allocation and payment to the parties that take on the risk of construction. This balance of risks is reflected within the incentive structure, bringing the focus towards aligning the goals between client, contractor and all other parties involved. The purpose of incentive contracting is to motivate the contractor to enhance performance, which is in the best interest of the client, and to discourage inefficiencies and waste. This is accomplished by adjusting the profit of the contracting term target line to the value (to the client) of the actual performance target profit and performance goals expressed in the contract document. Profit is often the basic motivating force behind the incentives, but it should be appreciated that maximizing profit on individual projects may not always result in the maximisation of profit at the company level. Issues such as quality of services and client satisfaction often lead to repeated work and growth.

2.6 Payments systems

The mechanism by which clients pay contractors for the work they carry out is defined in the contract documents. There are several alternative payment mechanisms available in contract conditions. Recently, there has been a major concern as to whether these systems are effective and efficient. Concern has also been raised about the extent to which clients and subsequently contractors are adhering to what is stipulated in these conditions, including delays of payments, and practices such as over measurement and under measurement.

The likelihood of a major change in payment methods being achieved within the foreseeable future is remote, but in the meantime it is incumbent on clients to ensure that certified payments are promptly honoured, and that the subsequent reimbursement of all subcontractors by the main contractors is made with the same alacrity. Such action will ensure that the contractor's efforts are more effectively engaged in actually managing the project rather than pursuing outstanding payments, and serve to ensure good relations and thus improve project efficiency. The following sections discuss some of the different payment systems currently applied in the industry.

2.6.1 Interim payment

In this system payment to the contractor for work that has been satisfactorily completed is made by means of interim certificates, generally monthly, issued by the architect on the recommendation of the quantity surveyor. An agreed percentage is retained until completion of the construction work when a proportion of this accumulated amount is released to the contractor. The remaining amount then is released after the defects liability period is satisfactory completed. Interim payments are a feature of all major forms of contract, and the valuations mechanism represents the only source of income to the contractor for the project. The interim payments are of critical importance to a contractor's cash flow. The contractors are faced with undertaking interim payments, usually at monthly intervals. The contractor shall submit to the project manager a valuation, usually monthly, which contains the estimated value of permanent works executed up to the end of the month, and value of the materials on the site provided for the next works. The project manager or supervisor would check and verify the valuation against the progress reports submitted by the contractor. The project manager has to issue a certificate of assessment for the work done to date to the contractor, typically within one week of the assessment of works so that the client can pay the contractor, usually within two weeks. The interim payments made to the contractors are subject to the deduction of retention as detailed in the contract, usually 5%.

2.6.2 Stages payments:

Here, the actual stages defined will be based on the characteristics of the project. One of the aims of the stage payment method is to give the contractor an incentive to push progress up to a stage, produce less frequent payments, and hence save much of the administration effort associated with the other methods (Turner, 1995). On the other hand, the disadvantage of this payment system is that the frequency of payment tends to be less, leading to the contractor requiring larger working capital to support the project cash flow. It could be argued therefore that contractors may be forced (because of unfavourable cash flow) to apply greater profit margins at the early stages of the project, leading to overpayment and higher sensitivity to the risk of contractor business failure. It could also be argued that stage payment may lead to disputes, primarily about the decision concerning whether the stages were complete to warrant payment or not. The stage payment may also not represent the total value of the work in progress, leading to difficulties in undertaking accurate cost control procedures.

2.6.3 Milestones payments

Here the milestones dates describe significant stages of the construction process. Milestones provide the data to support control procedures and form the basis for budgeting, scheduling, and resources management. The contract participants agree on the milestones to be set for the milestones payment schedule. Contractors are also required to submit a detailed network diagram for the execution of the project to meet the milestones dates. The schedule of milestones, which is incorporated into the contract, is the key factor determining the pattern of payment. It needs to be prepared by the client's experienced programmers in consultation with the constructors, and it should accurately reflect the contractor's method of construction and the required rates of progress (Potts, 1988).

2.6.4 Incentives Payments

The traditional payment mechanism adopted widely in construction projects does not support and encourage achievement of the various goals set by the client. Ideally, payment systems should reward constructors and indeed others for meeting or exceeding the client's goals. Incentives should be put in place to create a better balance between risk allocation and payment to the parties that take on the risk of construction. In traditional methods, contractors often are forced to take on risks, owing to the competitive nature of the industry, which might result in bankruptcy and business failure. When incentive schemes are used it is possible to keep the contractor committed and motivated and at the same time reduce both project time and cost overruns considerably, without adverse effect on quality.

Also, contracting incentives are aimed at discouraging the contractors to charge high premiums to bear these risks, so that the challenge to the client in designing the incentives becomes one of balancing real gain in the contractor's performance against the cost of risk transfer to the contractor. There are three categories of incentive contracts: cost, schedule and quality. Cost incentives may be applied through the application of sharing ratios which revolve around a target cost, which includes contractor's estimated actual cost and profit. If contractors manage to reduce the total cost of the project to a level below the target price, then the price of this difference will be paid to the contractor. If the contractor exceeds the target price, then the same percentage will be applied on the difference, but in this case it is a contribution to the extra cost. The incentive sharing scheme should be large enough to motivate the contractor.

Schedule or time incentives are set in direct relation to preset milestones within the project and should be awarded only if early completion results in client saving. The amount of compensation or bonus towards the contractor should be considerably greater than the cost of providing the additional resources necessary to achieve the desired completion date.

The third category is that of incentives for quality. It is important to incorporate a wide range of client's objectives into performance evaluation and incentives to prevent pinpoint resource allocation and attention only to those areas where the incentives are to be found (i.e. cost and time). It is difficult for a client to set acceptable levels of performance but it is relatively easier to judge which contractor's performance is preferred. Performance measurement may be a problem, because, for example, a high number of sub contractors may or may not mean a high number of administration systems, different ways of working etc. Performance levels should therefore be based on similar projects using the client's past experience, benchmarking or other sources for information. The client's fairness in assessing performance will ultimately decide the amount of incentive paid.

2.6.5 Bonus payments

Bonus payments are provided when the client is interested in the completion of construction and the commencement of the operation of the project as early as possible. The client will pay a higher price in the form of a bonus payment if the construction is successfully completed by the contractor prior to the date fixed for completion in the contract. The amount of the bonus may be a percentage of the contract price or it may be a fixed amount to be paid if the contractor completed the project quickly by a certain time prior to the completion date fixed in contract. It is not usually suitable to provide for a bonus payment for early completion of the project if the cost reimbursable pricing method is used in the contract. On the other hand, it is used for the unit price method and the amount may remain as a fixed amount per day and/or week of earlier completion and must be limited to a maximum amount. A contractor may decide to pay similar bonuses to his own employees, given the positive and significant impact these may have on the productivity. Consequently, by increasing the productivity, contractor profits will be increased and construction time reduced.

2.6.6 Penalty payment

If the contractor fails to complete the whole or any specified section of the works by the due date, the employer may deduct or recover from the contractor the daily amount specified in the contract up to a given maximum amount (Corbett, 1991). Most building contracts provide that a contractor who is guilty of delay beyond the contractual completion date shall pay or allow a certain amount of liquidated damages for every day or week of delay. The amount of penalty in most contracts is limited to a maximum percentage of the contract price. When the works are handed over on a piecemeal basis, the amount of penalty payment is proportionally calculated. In cases where the contractor has a legitimate claim for a delay that is due to unpredicted causes (such as bad weather conditions that prevent him from completing a certain activity according to the project-scheduling plan). A contractor may also complain that the client's engineer has not provided the necessary details and drawing to execute the works on time. In these circumstances, contractors argue for an extension of time and reimbursement of costs. If the client engineer refuses an extension of time, the payments of liquidated and ascertained damages for delay should be issued, after which the contractor may ask an arbitrator to decide on the case by reviewing the facts.

2.7 Forms of Contracts

The purpose of the contract is to establish the rights, duties, obligations, and responsibilities of the parties, and to allocate the risk. Greater potential for change in the way contracts are procured, assigned and administered now emanates from recommendations of the recent Latham Review (Latham, 1994). New forms of contracts are being used to manage this new procurement situation between client and contractor, thus stabilizing the contractor-client relationship. 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 advice he/she receives from his professional advisers.

The choice must be made at an early stage, as it will affect the way in which the contract documentation is prepared. A building contract is a trade off between the contractor's price for undertaking the work and his willingness to accept both controllable and uncontrollable risks. There are numerous types of contracts forms which provide the flexibility needed to construct the projects. Construction clients are faced with a wide choice of standard and non-standard forms of contract for any building project (Latham, 1994). Standard forms of construction contracts ensure that certain fundamental practices are followed, and better agreement is achieved by using a protocol with which the project parties are already familiar. Institutes of architects, engineers and other related professional bodies generally publish these forms. For example, the Joint Contracts Tribunal published the JCT forms of contracts, and the Institution of Civil Engineers published the NEC (New Engineering

Contract) form of contract. The selection of a particular form of contract is dependent upon a number of different circumstances, such as type of project (size, complexity) and authority and responsibility.

2.7.1 JCT (Joint Contracts Tribunal)

The Joint Contracts Tribunal (JCT) is an association of interest groups within the construction industry which operates as a forum for discussing and determining the content of the clauses of standard forms of building contracts (Murdoch and Hughes, 1999). The JCT forms of contract have been developed specially for building works in the UK. It is the most comprehensive form available for building projects. The latest version, JCT 98, is a long and complex document, which consolidated all the revisions to the earlier forms of contract (JCT63, JCT80). It has also made some fundamental modifications to accommodate changes in contract policy (Latham, 1994). The JCT 80 replaces the much-criticized JCT63, which was described by one commentator as overly long, complex and obscure (Eggleston, 1997). There are six variants of the JCT80 to reflect public/ private clients and different types of reimbursement (Cox and Thompson, 1998). These variants are:

1- JCT '80 Local Authority without Quantities;
2- JCT '80 Private without Quantities;
3- JCT '80 Local Authority with Approximate Quantities;
4- JCT '80 Private with Approximate Quantities;
5- JCT '80 Local Authority with Quantities;
6- JCT '80 Private with Quantities.

The next issue of the JCT form of contract was JCT81, which is closely based on JCT80. The JCT has published guidance to advise practitioners when to use the various forms of JCT contract. The JCT 81 form is not as popular as the JCT 80, because it does not promote strong hands-on supervision or management of the contractor. It does not provide for the client to have a programme to monitor and there are no requirements to check or approve the contractor's detailed design. The client has limited power to change the details of works except through the use of the Employer's Agent. On the other hand, any failure in the client's ability will result in a fundamental switch of power to the contractor.

The most recent popular forms of contract in the JCT are: -

1- The standard form of contract with quantities, 1998 (JCT98)

2- The intermediate form of building contract, 1998 (IFC98)

3- The standard form of building contract with contractor's design (WCD98)

The JCT 98 is suitable for use with any size of building works where the design is undertaken by the client, whereas the IFC 98 is more appropriate for use on medium size projects, and the WCD 98 is a lump sum contract applied to design and build (Kashyap 2001).

2.7.2 New Engineering Contract (NEC)

The NEC was created and drawn up by an Institution of Civil Engineers working group in 1986. The main philosophy behind the development of NEC was to produce a simple flexible form of contract which can stimulate good project management practices. The NEC is a major innovation in contract forms and the first to offer a choice of contract strategy. This is achieved by a combination of core clauses that are supplemented by further secondary clauses, depending upon the chosen main option. One of the aims of the NEC was to create mutual trust and stimulate collaborative working. The basic concept has been to develop a post-construction pleasant relationship between the project partners and thus reduce costly disputes. The authors of the NEC aimed to achieve clarity by using simple language, setting out duties and responsibilities clearly, using engineering terminology common to all disciplines and avoiding complicated text. The important feature of the NEC is that it provides six main options of contract type for clients to choose from:

Option A Priced contract with activity schedule

Option B Priced contract with bill of quantities

Option C Target contract with activity schedule

Option D Target contract with bill of quantities

Option E Cost reimbursable contract

Option F Management contract

Another feature is that it also includes other parties such as subcontractors and suppliers to the modes. The NEC has attempted to find another way of contracting in the construction industry by formalising management procedures and determining a governing relationship. It has a contribution to make to the construction industry and may serve to be fit for purpose, in particular in pre-determined collaborative circumstances. The NEC has subsequently been renamed the Engineering and Construction Contract (ECC) together with supplement for subcontract as (ECS), both of which were reissued at the end of 1995 (Turner, 1997).

2.7.3 FIDIC

FIDIC is an acronym for the Federation International Des Ingenieurs-Counseils, which is an association of national consulting engineers. They have been in existence since 1913 in Lausanne, Switzerland. The first edition of this form of contract was produced in 1957. The FIDIC drafting committee, following advice from clients and contractors, introduced further modifications and produced the 2^{nd}, 3^{rd},and 4^{th} editions, and subsequently further modification was made to the 4^{th} edition in 1991 (Corbett 1991). Standard forms of FIDIC contracts advocate the principle of balanced risk sharing. It is a traditional form in the sense that it has bills of quantities, and allows for re-measurement given that the quantities in the bill are approximate. In 1998, FIDIC published test editions of four new standard forms of contract. This confirms the continuing development of the FIDIC forms of contract. It became an example of a balanced and fair form of contract for a number of reasons, such as:

1- It is the result of continuous development works over a number of years by experts in the field of international construction.
2- It has been widely used in many types of contract in different legal jurisdiction in different parts of the world.
3- It is based on informed advice from practitioners in many fields associated with international construction, including lawyers, bankers and insurers as well as clients, contractors and engineers.
4- Successive editions have taken account of problems, disputes and arbitration and litigation cases which have arisen following the use of earlier editions.
5- It is regarded by the World Bank as acceptable for projects funded by the bank.

The provisional sum in the contract means that an amount is included in the contract for the execution of any part of the works (or for the supply of goods, materials, plant or services) for items that are difficult to determine precisely at the tendering stage. The contract part (I) 4th edition allows for the reduction of or addition to the contract price, such as sums arising from a rise or falling in the cost of labour and/or materials, or any other matters affecting the cost of the execution of the works. However, an amendment can be introduced to part II which may stipulate that the contract price shall not be subject to any adjustment caused by a rise or fall in the cost of labour, materials or any other matters affecting the cost of execution of the contract. Generally, the engineer is obliged to issue certificates of payment within the times required by the contract, and is not permitted to withhold any certificate unless it is expressly stated in the contract. Sawyer and Gillott (1985) concluded that the engineer is responsible for determining the measurement and value of work performed by the contractor and nominated subcontractors, and, in his own right, issues a certificate of payment due to them on both an interim and final basis.

2.7.4 ICE (Institution of Civil Engineering)

The ICE Condition of Contract was first issued in December 1945, having been endorsed by the Institution of Civil Engineers and the Federation of Civil Engineering Contractors. The fifth edition was issued in June 1973, revised in January 1979 and reprinted in 1986. The sixth edition was introduced in January 1991, and the latest 7th edition was launched in 1999. The changes between the 6th and 7th editions are not very significant. The main reason for producing the 7th edition was to make sure that the conditions complied with the Housing Grants, Construction and Regeneration Act. 1996. In most cases the 7th edition incorporates interim changes to the 6th edition that was drafted to take account of the Act. There are also several changes in the language and layout of the conditions that are designed merely to make matters clearer, not to change the meaning. The essential feature of the ICE 7th edition is that it provides a contract between a promoter and a contractor.

There are four types of conditions of contract under the title of ICE as follows:

- ICE condition of contract 7th edition 1999.
- ICE design and construct for minor works 2nd edition 1995.

- ICE condition of contract for ground investigation 1983, and
- Standard form of civil engineering subcontract published by The Civil Engineering Contractors Association.

The general obligations of the contractor are to construct and maintain the works and provide all labour, materials, plant and transport services required for construction completion and maintenance period agreed in the contract. Also, the contractor shall take full responsibility for the adequacy, stability and safety of all site operations. At the signing of contract the contractor shall supply to the client a copy of the fully priced bills of quantities; if no bills are used for the works, a fully priced specification and schedule of rates upon which the tender was based shall be supplied and shall form part of the contract documents.

The ICE 7th edition stipulates that the interim payment be made on a monthly basis. However, it allows the contractors to propose an alternative payment schedule. Clause 60 (1) stated that the contractor must submit statements to the engineer at monthly intervals commencing one month after the works commencement date, showing the estimated contract value of the permanent works carried out up to the end of that month, while the final payment is determined as stated in clause 60 (4).

Summary

The chapter demonstrates the fact that procurement routes and their corresponding forms of contracts process alternative payment and pricing systems individually. The construction industry offers many different procurement routes by which customers may obtain their buildings. The proliferation of procurement routes has led to different roles and relationships being established between clients and their contractors. A choice will have to be made between the payment systems that could be independent from the selection of procurement system. New forms of contracts defining the supply chain relationships are being used to manage these new procurement situations. The choice must be made at an early stage, as it will affect the way in which the contract documentation is prepared.

Chapter 3

Cash Flow Forecasting

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Introduction

The previous chapter outlined and discussed procurement systems, payment systems, pricing systems and forms of contracts commonly used in the construction industry. It provided a review of some of the previous research associated with the selection of an alternative procurement system. It argued that there has been little work so far concerning what payment or pricing system is appropriate to what project. Whilst some of the advantages and disadvantages of these systems are outlined, any meaningful decision as to what system should be used would have to be based on the cash flow to be expected from each one. This chapter addresses the need for cash flow forecasting and management. The need for cash flow forecasting among others (contractors, subcontractors and suppliers) is given as providing a good warning system to predict possible insolvency, which enables preventive measures to be considered and taken at the right time. It also details some of the previous cash flow forecasting models such as those of Nazem (1968), Peer (1982), Bromilow (1978) and the corporate financial model of Kaka (1990). The literature review shows that there are two main approaches to cash flow forecasting. The detailed approach to cash flow forecasting was established with emphasis on how the cumulative value vs. time curves and cumulative cost vs. time curves are derived. Simple approaches are based on standard cost or value curves. Both of these approaches are primarily designed for "traditional" payment systems, where fixed or unit prices together with interim payments are adopted.

3.1 General overview

The study of construction project cash flow has become increasingly popular over the last thirty years. Cash is the most important of the construction company's resources, because more construction companies fail as a result of lack of liquidity to support their daily activities than because of inadequate management of other resources (Navon, 1995). Kenley (1991) stated that an excess of 60% of construction contractors' failures are caused by economic factors. Kaka and Price (1991) concluded that the construction sector usually experiences a proportionally greater number of bankruptcies than other industries. A company can survive a transitional period, or even with a loss; however, it may fail owing to lack of cash during the operation, even if it has a good financial statement. In the construction industry it is often said that 'cash is king' and in construction contracting cash is the number one concern of contractors (and subcontractors). Over the years, contractors have come up with many innovative ways of enhancing cash flow. Some of these ways have been found through implementing more efficient management processes and information systems, thereby allowing contractors to minimise the outstanding balances owed by clients. Others have been found through adapting pricing policies (e.g. unbalancing and front-end loading) or somewhat unfair procedures such as over-measurement and the delaying of payments to subcontractors and suppliers.

Many models have been developed to assist contractors in their pre-tender cash flow forecasts. The majority of these have been based on the standard value S-curve, developed using actual data from past construction projects. The accuracy of cash flow forecasts generated from standard value curves depends on whether the adopted S-curve accurately represents the project to be constructed. From a corporate viewpoint, cash flow forecasts should be made at all stages of a project from the planning stage to the operation and maintenance stages. A good forecasting technique should include both historical trend-based data supported methods and competent judgments based on construction experience and knowledge.

Research into cash flow has in the main concentrated on two main processes: how to forecast cash flow (Kaka, 1996; Kenley and Wilson 1986; Khosrowshahi, 1991; Navon, 1996) and how to manage cash flow, (Kenley, 1999; Kaka, 1995; Cheetham, Kaka and Humphreys, 1996) with the former receiving significantly higher attention than the latter. Cash flow management is significant in the relationship between client and contractors. Contractors can undertake cash flow forecasting at two levels. One is at the estimating and tendering stage when the forecasting is for a single project. The other level is the prediction of cash flow for the whole company. From the contractors' perspective the cash out (expenditure) consists mainly of the cost of labour, materials, plant and machinery, subcontractors, office and site overheads. There are several methods whereby contractors' expenditure flow can be estimated or forecast (Harris and McCaffer, (2001). The most logical method consists of deriving the monthly payments from the schedule of work and estimated cost of individual activities.

The majority of cash flow forecasting models, however, have been based on standard S-curves, which represent the running cumulative value of contracts. These are used to produce a running cumulative cost commitment curve by deducting the overall mark-up applied. Several approaches to the analysis have been used and early models may be characterised as nomothetic in that they attempted to discover general laws and principles across categorised or non-categorised groups of construction projects with the purpose of a priori prediction of cash flows (Kenley, 2001). Based on the standard S-curves, a net cash flow profile is developed (by estimating all cash payments into and out of the project). These net cash flow models usually involve a complicated procedure and large number of variables; for example, Kaka (1996) incorporated more than 50 variables in his model. Although cash flow has been much studied and much researched in recent years, there has not been enough of a link made between cash flow and payment mechanisms. In fact, although cash flow is seen as being one of the major concerns for contractors, its link with payment mechanisms is almost completely neglected. This link is discussed under 'cash flow model' in Chapter 6.

3.2 The Need for Cash Flow Forecasting

One of the causes of bankruptcy is inadequate cash resources and failure to convince creditors and possible lenders of money that inadequacy is only short-term. The need to forecast cash requirements is important in order to make provision for these difficult times before they arrive (Harris and McCaffer, (2001). Project cash flow is calculated on a project-by-project basis and aggregated totals of cash flows from all projects and head office form the overall company cash flow. According to Calvert (1986), a cash flow forecasting can give early indication of shortages or surplus of cash and therefore gives time to assess and arrange borrowing requirements, adjust programmes of works to equalise borrowing and avoid peak demand, reduce or increase expenditure, implement credit control, move surplus funds to an interest bearing account, and plan payment and repay loans as soon as possible. Nunnally (1998) observed that cash flow forecasting is important in determining the capacity of a company to undertake additional projects. He further observed that the project income is behind the project expenditure and that the difference must be provided in cash from company assets or borrowed funds for this purpose. According to Nunnally (1998), each project requires a minimum working capital of about 10% of the contract value to cover the difference between project income and expenditure. This depends, however, on the contract conditions applied and the extent of price competition and over measurements exercised by the client.

A cash flow forecast can help companies to mange the daily cash flows, estimate overdraft requirements and invest any surplus cash (Coyle, 2000). Cash flow affects a company's liquidity. A company's liquidity is liquid if it has sufficient cash or has assets that will be or could be converted into cash in the future, in order to meet its payment obligations. Lack of liquidity can pose serious financial risk; whether episodic or chronic it implies an inability to meet payment obligations when they fall due. A company needs sufficient and continuous cash coming in to meet payment liabilities. As a general rule, it should be possible to sustain sufficient liquidity from day-to-day operations, provided that these operations are profitable and that debtors are less than creditors. Measures could be taken to fund shorten, cash deficit by borrowing, or by postponing or cancelling a capital expenditure project. A company's liquidity therefore must be forecast and monitored by proper cash flow forecasting procedures. Although both profit and loss affect cash balance, it does not give any indication of potential liquidity problems (Upson, 1987). The industry has expressed a need to predict construction project cash flows, and will continue to do so, despite any arguments that present methods are valid. The desire of the industry to forecast cash flows is fully understandable.

3.3 Previous Cash flow Models

A contractor must be able to sustain a sufficient cash flow to perform the contract. When there is doubt regarding the sufficiency of a contractor's cash flow, the project manager should require the contractor to submit a cash flow forecast covering the duration of the contract. A contractor's inability or refusal to prepare and provide cash flow forecasts or to reconcile actual cash flow with previous forecasts is a strong indicator of serious potential contract cost or performance problems. Only by comparing a series of previous actual cash flows with the corresponding forecasts, and examining the causes of any differences, can one establish the reliability of cash flow forecasts (Kenley 2003).

Cash flow forecasts must show the origin and use of all material amounts of cash within the company for contract performance, period by period, for the length of the contract, and provide an audit trail to the data and assumptions used to prepare it. Cash flow forecasts can be no more reliable than the assumptions (Kenely 2003, Kaka 1990, Khosrowshahi 1991, and Kaka and Price 1993) on which they are based such as:

- estimated amounts and timing of purchases and payments for materials, services;
- amounts and timing of fixed cash charges such as debt instalments, interest, rentals, taxes, and indirect costs;
- estimated amounts and timing of payments for projected labour, both direct and indirect;
- estimated amounts and timing of billings to customers (including progress payments), and customer payments;
- estimated amounts and timing of cash receipts from lenders or other credit sources, and liquidation of loans; and
- estimated amounts and timing of cash receipts from other sources.

3.3.1 Nazem's Model

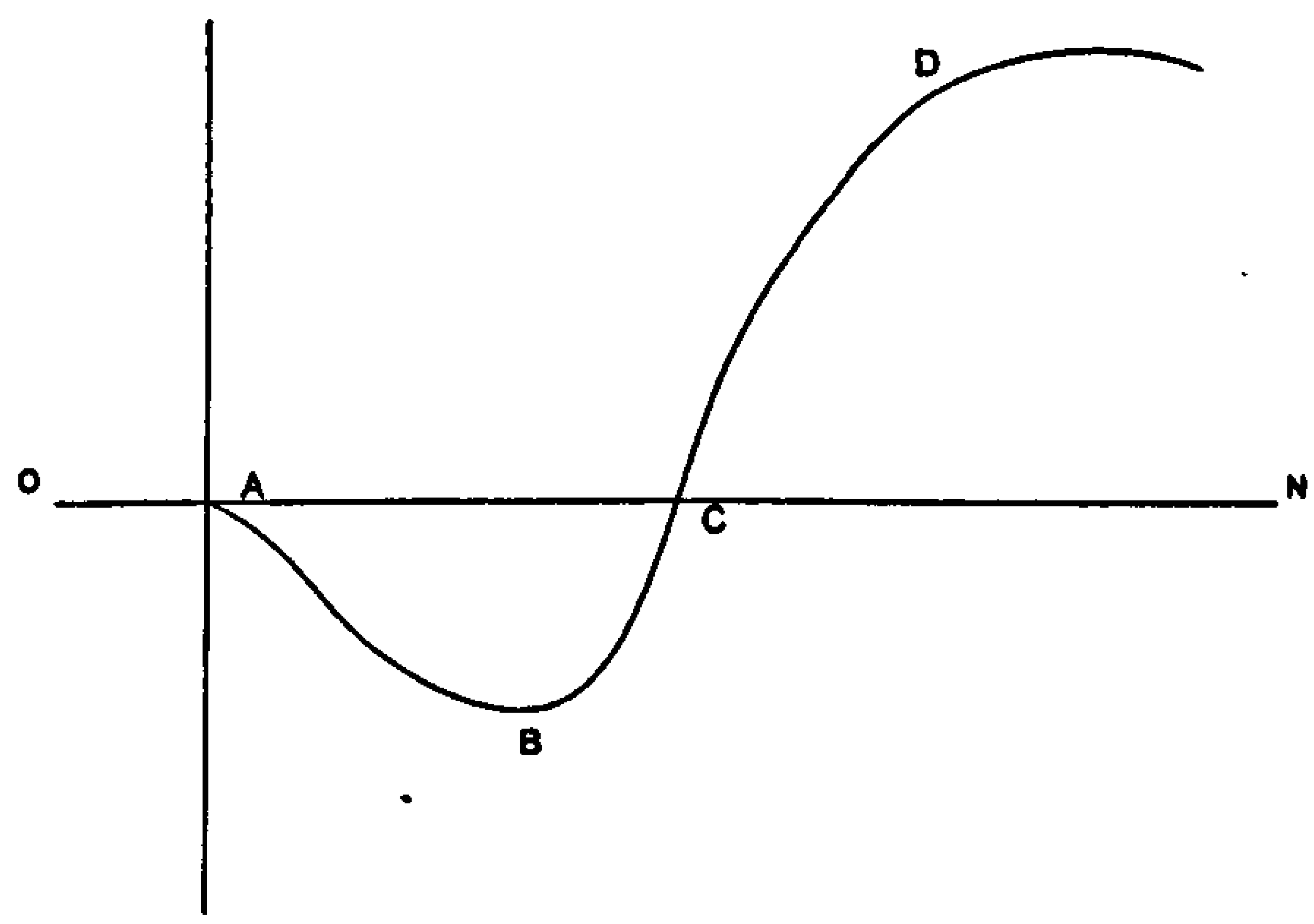
Nazem (1968) made an attempt to establish methods of examining the capital structure of projects and of forecasting capital requirements to finance contracting activities. He found that in the initial stage, contractors incur some expenses in the preparation of tender documents even when they are not certain about securing the contract. Also, after they have obtained the contract, they need to finance the project for a certain period to cover costs, direct costs and indirect costs until they have prepared their first valuation which is made available to their client to be paid. This process of project finance is shown in Figure 3.1. As shown, the curve starts at point "A" and moves steadily to trough at point "B". At this period it is clear that the contractor was paid the expenses for preparing and commencement of the work. Then the curve changes its direction, moving steadily upwards to the point "D" cutting across the horizontal line ON at point "C". This gives the contractor repayment of his expenditure for the project and the project starts financing itself. He determines curves for individual projects by using the ratio of contract sum to the difference between the cumulative repayment and expenditure. This is shown in equation 3.1 below.

$$\textit{Cash flow variable} = \frac{CR-CE}{CS} \qquad \text{(Equation 3.1)}$$

Where CR is cumulative repayment, CE is cumulative expenditure and CS is contract sum of the project.

Nazem used the above equation to determine the ideal reference curve, utilising cash flow curves for a reasonably sized sample of projects to measure the cash flow of different sizes of projects as a ratio of the contract sum at a certain time rather than as an actual amount of the project. By using the average values of percentile points of different projects, he provided percentile points for ideal cash flow curve and by joining these points the curve was obtained.

Fig. 3. 1 Net cash flow



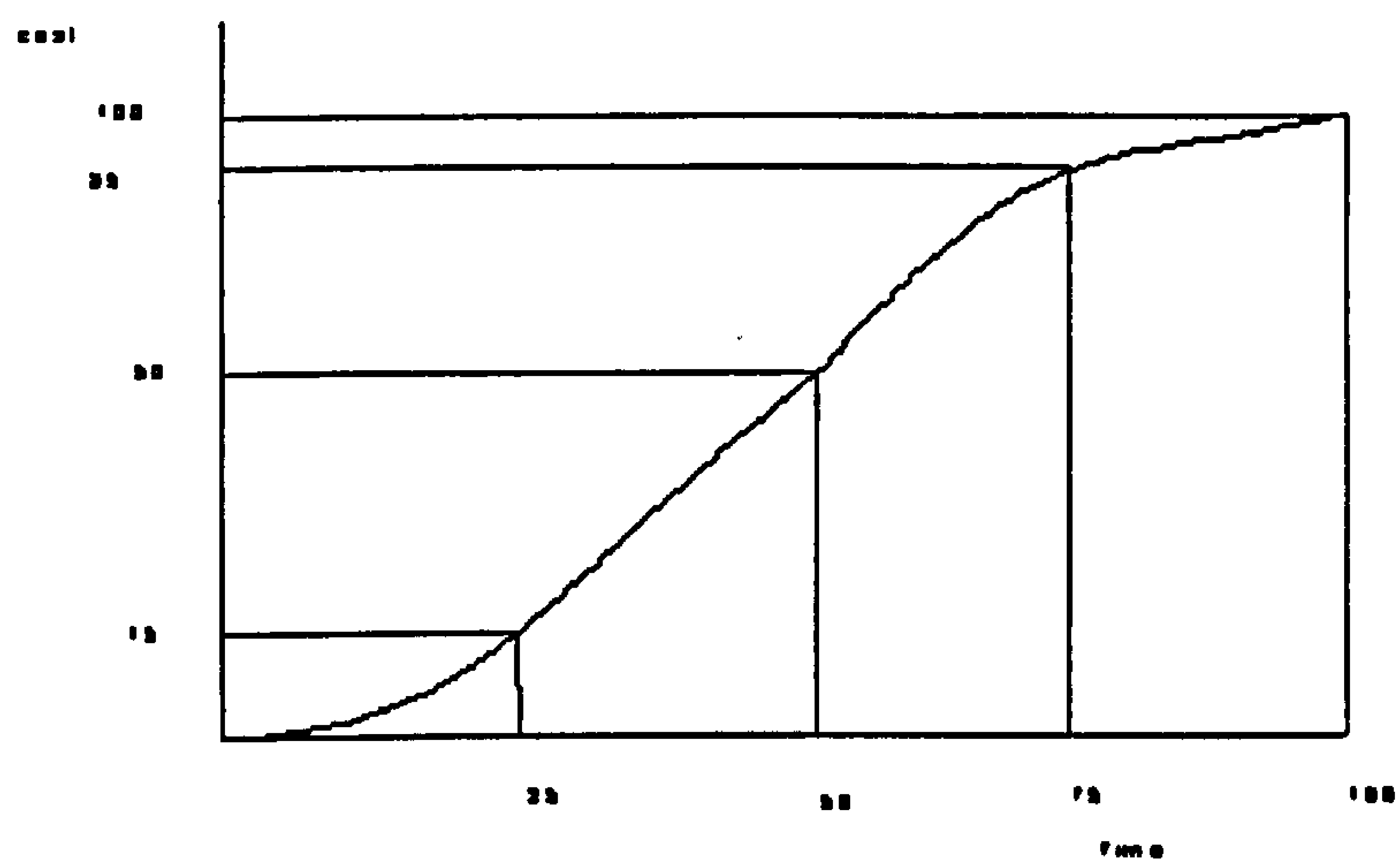
Source: Nazem (1968)

Nazem proposed a net cash flow model based on historical data, with the aim of discovering balance curves. He emphasized the overall requirements of the firm, not the individual position for a project. His proposal required that the ideal reference curve be derived as an average of a reasonable sample of projects, but this method has not been successfully followed up owing to problems in deriving such an average. He suggested that a cash balance curve could be obtained indirectly from the inward and outward cash flow curves. With both curves a net cash flow curve could be provided.

3.3.2 Standard 'S' Curve

Cash or value flow commitments curves are often represented cumulatively rather than as periodic commitments. The cumulative representation is most common in the construction industry, and is often confused with periodic representation (Kenley, 2001). This presentation form the cumulative curve approximates an elongated "S" shape. For this reason, it is commonly referred to as the "S" curve. The slope of the curve will be changed proportionally to payments or expenditures amounts. Peer (1982) found that the cumulative curve of project field cost is mostly an "S" shape graph with slow acceleration at the beginning, a steady but faster rate of work during the middle period and a gradual tailing-off towards the end. S-curves are used to present the running cumulative expenses of each project. Time is on the horizontal axis (X) and the cumulative expenses on the vertical axis (Y). Similarly, Nunnally (1987) claimed that typically only 15% of the project is completed in the first 25% of the project time. After that, progress is made at a rather constant rate until 85% of the work is completed at the end of 75% of project time. Then progress again slows towards finishing the project works, as shown below in Figure 3.2. Over this assumed consistency in the profile, previous researchers have attempted to analysis the cost or value profiles of previous construction projects with the aim of developing standard profiles that can be used to forecast the cash flow of future projects.

Fig. 3. 2 Normal progress curve



Source: Nunnally (1987)

3.3.3 The Bromilow's Model

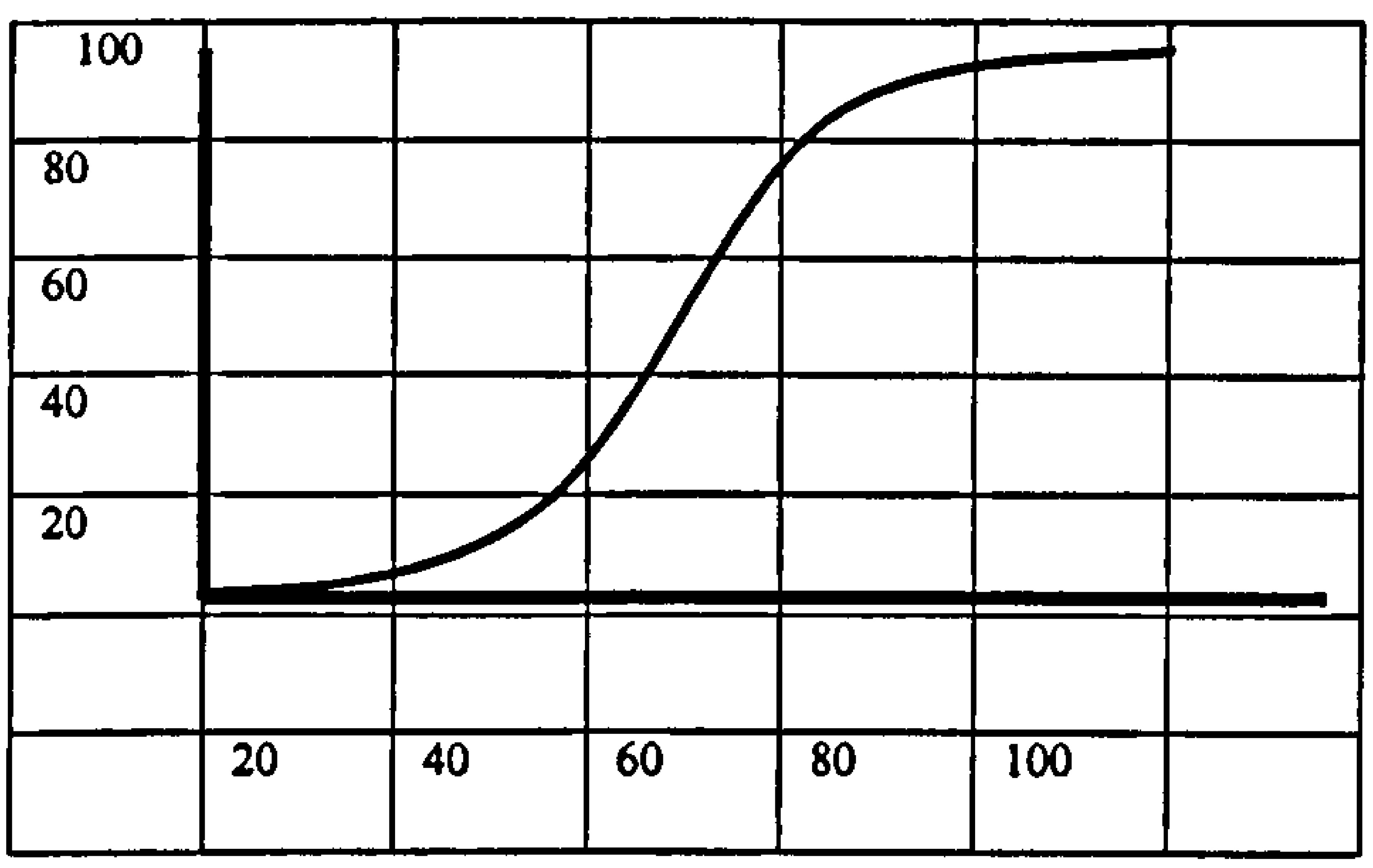
The Bromilow (1978) model was developed at the Division of Building Research, Commonwealth Scientific and Industrial Research Organisation (CSIRO) in the 1960s. Although Bromilow did not publish the method or results of his analysis he used the conclusion to illustrate his later work. The model aimed at satisfying the needs of client bodies that need to forecast their cash flow commitments during the life of a project. This model was developed at time of relatively stable economic conditions before contractors became interested in these models. Subsequently, practical refinements have been incorporated, such as allowances for retention (Tucker and Rahilly, 1985). Kenley (2003) summarised that Bromilow used polynomial regression (least squares) to find equation of best fit for the curve. An inverted cubic function X= F (Y) was found to have the smallest residual variance, and, as no systematic differences were found between the four projects, only one curve was generated. The equation derived is of the form:

$$T = C_0 + C_1P + C_2P^2 + C_3P^3 + C_4P^4 \qquad \text{(Equation 3.2)}$$

Where T is the percentage of construction time since start to practical completion, P is the target cumulative payment expressed as a percentage of planned, and C_s are constants.

Fig. 3. 3 Bromilow's S curve

%Planned cost



% Planned time

Source: Kenley (2003)

3.3.4 Ashley and Teicholz's Model

Ashley and Teicholz (1977) suggested a cash flow forecast based on detailed methods for cost flow. They classified the direct cost by a number of cost categories such as labour, materials, and subcontractors, etc., which are specified as percentages of total cost. This approach is very reasonable because it considers the nature of budget and cost. However, the problem is project duration. Moreover, this method also does not consider the effect of time lags on the costs.

3.3.5 Peer's Model

Peer (1982) defined the main input data in cash flow budgeting at the project level as follows: field cost; non-cash; expected profit or loss; client payments and the time lags for disbursements and receipts. It should be borne in mind that cash flow forecast is often already essential at the bidding stage.

Peer was influenced by the Bromilow model and he supported the use of standard curves. He pointed out that the cash flow forecast is often required before any detailed time schedule can be given. He found that the cumulative curve of project field cost is mostly an "S" shaped graph with slow acceleration at the beginning, a steady but faster rate of work during the middle period and a gradual tailing-off towards the end. Bearing in mind that management is concerned with the overall company cash flow rather than with that of a single project, he examined the cumulative ogives for such factors as labour, materials, general costs and subcontractors, etc. He tested three equations: a fourth degree polynomial, a tanh and an error function as below. The standard deviation was found to be less for the fourth degree polynomial, which therefore yielded a more accurate estimate.

$$Y = 0.567\{\tanh[3.2495(\tfrac{t}{T}) - 2.038] + 0963\}C \qquad \text{(Equation 3.3)}$$

$$Y = 0.5487[erf[2.8822(\tfrac{t}{T}) - 1.7972] + 0.986]C \qquad \text{(Equation 3.4)}$$

3.3.6 The Kenley and Wilson's Logit Model

The logit cash flow model is extremely flexible mathematically. It allows for the development of a net cash flow model. The cash flow ogive is sigmoid and similar curves have been found in connection with growth patterns in economics. Investigations in these areas have found that specific transformations of sigmoid curves can produce linear equations. The parameters of the linear equation are found in turn through linear regression and substitution of the linear parameters into sigmoid function. The linear equation is found by a logit transformation of both the independent and dependent variables. The logit cash flow model uses scales from 0.0 to 1.0 where 1.0 is equivalent to 100%. The logit cash flow model is suitable and accurate in idiographic *post hoc* analysis of project cash flows and for comparative analysis of other cash flow models (Kenley 2001).

The linear equation according to Kenley and Wilson (1986) was given as

$$Logit = \ln\frac{z}{1-z} \qquad \text{(Equation 3.5)}$$

Where z is the variable to be transformed and logit is the transformation, the logistic equation for cash flows can be expressed using value (v) as the dependent variable and time (t) as the independent variable

$$\ln\frac{v}{1-v} = \alpha + \beta X \qquad \text{(Equation 3.6)}$$

$$\text{where } X = \ln\frac{t}{1-t} \qquad \text{(Equation 3.7)}$$

$$\text{Therefore: } \ln\frac{v}{1-v} = \alpha + \beta\left(\ln\frac{t}{1-t}\right) \qquad \text{(Equation 3.8)}$$

This forms the sigmoid curve.

The aims of the logit model was summarised by Kenley (2003):

1- consideration of the ideograph-nomothetic;
2- a multiplicity of factors and influence and affect project cash flow;
3- regression analysis for grouped data associated with a nomothetic methodology is of questionable validity for construction projects;
4- to determine an optimum exclusion range for data points;
5- to examine the model for goodness of fit and to identify projects where the model has failed to adequately fit the data;

6- to support the contention above by contrasting the two methodologies quantitatively; and

7- to use the model to support the hypothesis.

8- to allow for the subsequent development of a net cash flow model.

The procedure for testing the model involved the calculation of α and β values. The SDY measure was used as an indicator of comparative accuracy.

$$SDY = \sqrt{\left\{\sum (Y - Y_E)^2 / N\right\}} \qquad \text{(Equation 3.9)}$$

where *SDY* is..... *Y* is ....., Y_E is ..... and *N* is ......

This measure permits models to be compared. The model has achieved excellent results over large samples, and the model rejected only two of 72 projects. The model development would be possible for in-progress cash flow forecasting. There would be a tendency for the project cash flow to adopt its final sigmoid form at an early stage in its development, which would imply that the final profile could be known before completion. The model has been found suitable and accurate in idiographic *post hoc* analysis of project cash flows.

3.3.7 Net Cash flow Models

It is necessary to develop models for the net cash flow of individual projects. Empirical analysis of net cash flow is difficult to achieve because financial data is highly sensitive, perhaps more so in construction than other industries (Kenley, 2002). Kenley and Wilson (1986) studied the variability of net cash flow profiles by collecting the cash in and cash out data from 26 commercial and industrial projects. Comparisons of the results indicated that there was a wide degree of variation between the individual project profiles. MacKay's (1971) sensitivity analysis of net cash flow profiles to different value curves implies that either net cash flow curves conform to predictable patterns or they are sensitive to the selection of systematic delays. A net cash flow model must be more sensitive to the early stages of a project, and the assumption that all gross cash flow curves should start at original point (0,0) is inadequate in net cash flow analysis, and the net cash flow so far described is limited in its ability to handle the early stages of a project.

Kaka and Price (1991) made a significant contribution toward investigating and modelling the properties of net cash flows on construction projects in developing an organisational financial system for contractors. They adopted the Kenley and Wilson (1986) logit cash flow model mentioned above. They pursued an ideal net cash flow, and the main aim of this model is to forecast the net cash flow of a single contract, taking into account all the effective variables. The basic concept of the model is that an ideal cost commitment curve could be developed more accurately than a value curve. They tested the model in two levels: first the accuracy of the calculation net cash flow by analysing the data of past projects, and the second test examined the possibility of building an ideal cost curve to be used for cash flow forecasting for an average cost curve from the projects analysed. The result curves were used in the model to determine the net cash flow for each project and then the result was compared with the actual data. They concluded that a simple net cash flow model was developed to help the contractors forecast cash flows at the tender stage. It was based on the cost schedule rather than the value schedule. It included other variables which were not taken into account in previous models.

The model produced good results, as the difference between the estimated and actual net cash flows was relatively small. It was proven to be highly flexible and adaptive to the profiles of individual projects. Finally, the model proved to be a simple, fast and accurate forecasting tool to be used by contractors who appreciate the importance of cash flow forecasting at the tender stage.

3.3.8 Company level cash flow Model

The model that was developed by Kaka (1990) was needed at the time it was developed. The main objectives of the research were: to investigate the contractors' practices regarding the financial planning and financial budgets; to develop an accurate single cash flow model; to develop a reliable corporate financial model; and to evaluate the developed model. In order to develop the model the following works were undertaken:

1- The failure of previous models to produce accurate results in general and the variability of value curves in particular were investigated.
2- A net cash flow model was developed based on standard cost commitment curves.
3- The spread sheet was used to produce the construction model;
4- Estimating plant rate hire rates were developed into a form suitable for computer implementation.
5- Other models were developed for the plant and machinery and changes in land.

The model is in two parts: the first is the single cash flow model, and the second is the cost commitment vs. time model. A cost commitment model was developed and successfully tested. The actual cost flow of 150-construction projects from five companies was used in the analysis. The degree of accuracy produced by the model covered a major part of the work. SDY measures, including the market growth, were used to evaluate the variables. The single net cash flow model developed was a simple and accurate solution to forecasting the cash flow for individual projects to estimate the financing cost of contracts at the tendering stage. The single net cash flow forecasting model was tested on five actual case studies, and it produced excellent results.

The Corporate Financial Model. (CFMCC) was an attempt to overcome the difficulty of unreliability between the financial planning and the budgeting for the construction contractors, by combining corporate strategies with both of them. The model was developed on a computer to assist medium-to-large construction contractors and evaluate strategies and environments for producing a comprehensive financial report to control performance. It provides a viable tool for contractors to simulate, evaluate and control strategies. The model fulfilled forecasting the contractors' cash flows for different firms' sizes. The results confirmed that the model had a high degree of accuracy.

3.4 Cash flow Control and Management

Cash is the most important of the construction company's resources, because more construction companies fail as a result of lack of liquidity for supporting their day-to-day activities than because of inadequate management of other resources (Singh and Lakanathan, 1992). An adequate cash flow management system is necessary to persuade construction lenders to lend money. Cash flow control is concerned with ensuring the viability, liquidity and financial flexibility of a business organisation. In large companies, the problems of control are more acute because responsibilities are shared between more people and between business units. For multinationals there are the added complexities of tax and banking regulations and currency risk (Coyle, 2000). The operational cash management responsibilities are summarised by Coyle (2000b) as follows: maintain the capability to meet payments, control borrowings and interest costs, monitor and improve credit control, optimize cash collection, reduce tax liabilities, monitor and control foreign currency and interest rate exposures, and control the finance charges. The cash flow position of a firm is determined by the cash inflow and outflow of its operations, investment, and financing. A change of cash flow from financing must be met with corresponding changes of cash flows from operations and investment, such as earnings and capital expenditure (Kato *et al.*, 2002). They found that firms announcing a dividend increase are characterised by higher earning, lower debt ratios, and increased investment levels. In other words, the internal financing through earnings and external financing through debt seem to substitute each other. Mawdesley *et al.* (1997) represented the project finance planning through three elements as expenditure or liability, income or earnings and cash flow. Expenditure is included in the materials supply, subcontractors, plant and equipments, labour and the overheads could be the payments made to the labours, subcontractors, suppliers etc. as the work is done. The earnings are the money flowing into the company's account and the cash flow is the money flowing into or out of the company's account. Coyle (2000b) concluded that unless cash is managed actively and efficiently, there could be a liquidity risk for companies that are not cash rich or cash generative. Upson (1987) concluded that cash flow forecasting is an essential tool of the financial management of a company. Long-term cash flow forecasts provide essential guidance to management, and indicate possible future shortfalls or surplus of cash. He suggested updating cash flow forecasts regularly so as to ensure sufficient time to meet the shortfalls and maintain liquidity of the company.

3.5 Summary

This chapter gives the detailed approach to cash flow forecasting. It also reviewed previously developed cash flow models. Most of the models were based on mathematical and statistical formula. Some of the recent approaches are computer-based models. It was found that many of the models were developed to assist contractors in their pre-tender cash flow forecasts. The majority of these have been based on the standard value S-curve, developed using actual past construction projects. The accuracy of cash flow forecasts generated from standard value curves depends on whether the adopted S-curve accurately represents the project to be constructed. A good forecasting technique should include both historical trend-base data supported methods and competent judgments based on construction experience and knowledge. Although cash flow has been much studied and much researched in recent years, not enough of a link has been made between cash flow and payment mechanisms. In fact, although cash flow is seen as being one of the major concerns for contractors, its link with payment mechanisms is almost completely neglected on the other hand. The details of the link between cash flows and payment system are discussed in Chapter 7.

Chapter 4

Research Methodology

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4.1 INTRODUCTION

This chapter describes the methodology used to provide the data investigation and model development. It is also aimed at providing assurance that appropriate procedures were followed. The chapter describes the data collection methods and the model development strategy, as well as the data processing procedures used to help project teams select the pricing and payment mechanisms under investigation in this research.

4.2 RESEARCH METHODS

Csete and Albrecht (1994) make the important point that 'Quantitative and qualitative paradigms may be used to complement one another because they embrace two fundamentally similar research principles'. First, both paradigms ascribe to the same basic goal of research, to gain a better understanding of the world. Second, both quantitative and qualitative paradigms attempt to demonstrate (even though in different ways) the "trustworthiness" of their findings by striving for truth, value, consistency, applicability and neutrality in the application of their research methods (Raftery *et al.*, 1997).

In Table (4.1) Csete and Albrecht show that 'although quantitative and qualitative research establishes the trustworthiness of their respective approaches in different ways, at the core, both are concerned with the same basic issues, the overarching criteria. The duality of the Csete and Albrecht approach is, if researchers may be permitted to use the word, a more rational way for research in the construction industry to proceed, and indeed this is the way that research in the industry has been proceeding for many years.

Table 4.1 Criteria for establishing trustworthiness of research

	Quantitative research	**Overarching criteria**	**Qualitative research**
1	Internal validity	Truth value	Credulity
2	Replicability	Consistency	Dependability
3	External validity	Applicability	Transferability
4	Objectivity	Neutrality	Confirm-ability

Source (Csete and Albrecht 1994)

The above example of the work of Csete and Albrecht has been chosen to demonstrate that there can be compatibility between two paradigms, viz. quantitative and qualitative research, two approaches that are often seen as mutually exclusive.

There are various philosophical perspectives which can inform qualitative research, so there are various qualitative research methods. A research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the researcher collects data. Specific research methods also imply different skills; assumptions are action research, case study research, ethnography and grounded theory.

Each of the research methods discussed above uses one or more techniques for collecting empirical data (many qualitative researchers prefer the term "empirical materials" to the word "data", since most qualitative data is non-numeric). These techniques range from interviews, observational techniques such as participant observation and fieldwork, through to archival research. Written data sources can include published and unpublished documents, company reports, memos, letters, reports, email messages, faxes, newspaper articles and so forth.

4.2.1 Quantitative methods

The quantitative method is one of the most important survey methods, using the questionnaire or structured interviews as an objective of data collection. Quantitative data can be analysed statistically. Qualitative research is especially valuable for generating and evaluating theory in the social sciences, revealing the workings of micro and macro processes, illuminating the mechanisms underlying quantitative empirical findings, and critically examining social facts. It is possible to examine complicated theoretical problems, such as the relative importance of many causes of delinquency far more powerfully than with the verbal analysis of qualitative data (Hirshi and Selvin, 1973). Quantitative research is associated with a number of different approaches to data collection. Quantitative researchers are routinely asked questions about statistical significance, theory testing, and hypothesis confirmation.

Quantitative researchers have often been skeptical about focusing on necessary and sufficient causes, believing that interval-level or ratio-level variables and a probabilistic (as opposed to deterministic) framework are much better suited to causal assessment.

4.2.2 Questionnaire survey

One of the most common types of methodology used for collecting data for quantitative analysis is the postal questionnaire. Nachmoas(1996) gives the advantages of the postal questionnaire as follows: low cost; error is reduced; high degree of anonymity for respondents; respondents have time to think, and a questionnaire can provide wide access to geographically dispersed samples at low cost. On the other hand, the use of the postal questionnaire as a method of data collection has received several criticisms from a number of quarters (Dillman 1977, and Kerlinger 1973). These criticisms include poor response rates, response bias, wording of questions as well as the inability of the investigator to verify the information provided. Questionnaires offer to clarify answers but cannot control who fills out the questionnaire, and response rates are often low. Weisberg and Bowen (1977) claim that response rates to postal questionnaires are typically low, usually 10% to 50%. Warwick and Lininger (1975) claim that two basic goals should be used when designing a questionnaire:

1- relevance: to obtain information relevant to the survey.

2- accuracy: to collect this information with maximal reliability and validity.

Nevertheless, other writers such as Moser and Kalton (1979) have suggested that the demerits of postal questionnaire methods could be overcome by utilizing a variety of techniques, such as piloting the questionnaire, sending a covering letter, addressed envelopes, etc., each technique having the effect of increasing the response rate. Dillman (1978) recommended that pre-testing of the questionnaire should be carried out and that it should include different groups, such as colleagues and potential users of the data. The questionnaire should also be accompanied by a covering letter, which contains the objectives of the study, benefit of the study to respondents, as well as self-addressed freepost envelopes to stimulate response. Also, formal headed paper should also be used. In designing the postal questionnaire, the researcher should consider the questionnaire contents, questionnaire phrasing, response format, question sequence and characteristics of questionnaire.

The contents of the questions asked should be limited to what is really needed but sufficient to generate the required information. The phrasing of the questions should also be carefully designed to be clear and non-offensive to the respondents. The questions should be simple and the wording used being unambiguous to all the respondents. The questions used in the study are to be found in appendices (a and b).

4.2.3 Qualitative research

Qualitative research is a research design which reveals many different emphases from quantitative research. Considerations of the scientific foundations of qualitative research often are predicated on acceptance of the idea of "cases" and the notion that cases have analyzable features that can be considered as "variables".

Quantitative research is often conceptualised by its practitioners determining the problems to which researchers address themselves in the form of hypotheses derived from general theories. One of the reasons why quantitative research is often criticized is precisely the difficulty of carrying out replications of its findings (Bryman1992, Yin 1984).

Such a minimalist definition of qualitative research includes the following:

- Qualitative research involves in-depth, case oriented study of a relatively small number of cases, including the single-case study.
- Qualitative research seeks detailed knowledge of specific cases, often with the goal of finding out "how" things happen (or happened).
- Qualitative researchers' primary goal is to "make the facts understandable," and often place less emphasis on deriving inferences or predictions from cross-case patterns.

Qualitative researchers often analyse data at higher levels of measurement without utilizing statistical tests. Qualitative research is often used to assess the credibility or applicability of theory. A quantitative researcher may observe strong statistical relations between two variables, connect this relation to theory, but still not know if the mechanisms producing the statistical relation are the same as those described in the theory. In effect, the theory provides a framing device for the quantitative researcher to use when describing statistical results, but the key mechanisms in this framework may not have been observed directly.

Qualitative research can be used to test for the existence of these mechanisms through in-depth investigation of selected cases.

This use of qualitative research methods to challenge conventional views, though not unique to qualitative research, is one of the most common applications of qualitative methods. In this way, qualitative research prompts a critical evaluation of existing theory that is based on the detailed observation of mechanisms. Qualitative methods are also used to investigate cases that are theoretically anomalous. In quantitative research, data collection typically occurs well in advance of data analysis. If data analysis indicates that additional data collection is needed, it usually occurs in a subsequent study (e.g., another survey of the same population).

In qualitative research it is often a challenge to specify a structured data collection and analysis plan in advance, although the logic of data collection and analysis can be resented in a proposal. Qualitative researchers face the task of articulating in advance the contours and logic of a data collection and analysis plan, but one that allows for the flexibility needed as the research is conducted.

In adopting a qualitative investigation the researcher must have in mind the following issues:

- Articulate the theoretical contribution the research promises to make by indicating what gaps in theory this project will fill, what argument motivates the research, what findings might be expected.
- Outline clearly the research procedures, including details about where, when, by whom, what and how the research will be conducted.
- Provide evidence of the project's feasibility, including documentation of permission to access research sites and resources, and approval of human subjects.
- Provide a description of the data to be collected, including examples of the kinds of evidence to be gathered, the different modes of data collection that will be used, and the places from which data will be obtained.

- Situate the research in relation to existing theory, whether the research goal is to challenge conventional views of some phenomenon or to develop new theory or chart new terrain.
- Discuss the plan for data analysis, including a discussion of different strategies for managing the various types of data to be gathered, how data will be stored and accessed, and the procedures for making sense of the information obtained.

4.2.4 Combined method (mixed method)

Qualitative and quantitative methodologies are not mutually exclusive. Differences between the two approaches are located in the overall form, focus, and emphasis of study (Maanen, 1979). Qualitative research that accepts concepts of cases, analysable case aspects, and the possibility of cross-case analysis should be seen as situated more towards the midpoint of the qualitative- quantitative continuum. Here one finds ambiguity regarding the cut-point between qualitative and quantitative, and also contrasting views of the leverage achieved by different levels of measurement. Some scholars label data as qualitative if it is organized at a nominal level of measurement, and as quantitative if it is organized at an ordinal, interval, ratio, or other "higher" level of measurement (Vogt,1999). Alternatively, scholars sometimes place the qualitative-quantitative threshold between ordinal and interval data (Porkess, 1991). This latter cut-point is certainly congruent with the intuition of many qualitative researchers that ordinal reasoning is central to their enterprise (Mahoney, 1999). With either cut-point, however, quantitative research is routinely associated with higher levels of measurement. In this middle range of the qualitative-quantitative continuum, it is possible to specify a minimalist definition of qualitative research. This definition identifies many of its essential elements while still allowing for the vast array of qualitative approaches used today to study a range of topics, such as the examination of the fleeting interactions among individuals, the study of dysfunctional families, the analysis of innovative organizations, and the investigation of large-scale macro historical transformations.

By contrast, qualitative research focuses not on relationships between variables or on problems of inference and prediction, but rather on the problem of making sense of cases, selected because they are substantively or theoretically important in some way.

Both qualitative and quantitative methods may be used appropriately with any research paradigm. In many ways, a major trade-off between quantitative methods and qualitative methods is a trade-off between breadth and depth. Qualitative methods permit the researcher to study selected issues in depth and detail; the fact that the data collection is not constrained by predetermined categories of analysis contributes to the depth and detail of qualitative data. Quantitative methods, on the other hand, require the use of a standardised approach so that the experiences of the respondent are limited to certain predetermined categories (Tashakkori, 1998).

Although a clear distinction between data gathering and data analysis is commonly made in quantitative research, such a distinction is problematic for many qualitative researchers. For example, from a hermeneutic perspective it is assumed that the researcher's presuppositions affect the gathering of the data - the questions posed to informants largely determine what one is going to find out. The analysis affects the data and the data affect the analysis in significant ways. Therefore it is perhaps more accurate to speak of "modes of analysis" rather than "data analysis" in qualitative research. These modes of analysis are different approaches to gathering, analyzing and interpreting qualitative data. The common thread is that all qualitative modes of analysis are concerned primarily with textual analysis (whether verbal or written).

This research will be carried out by using two methods: Qualitative methods and Quantitative methods. This was decided because qualitative methods permit the researcher to study selected issues so that data collection is not constrained by predetermined categories of analysis contributing to the depth and detail needed for qualitative data, while quantitative methods, on the other hand, require the use of a standardised approach so that the experiences of the respondent are limited to certain predetermined categories.
The advantages of the quantitative approach are that it measures the reactions of many subjects to a limited set of questions, facilitating comparison and statistical aggregation of the data.

4.2.5 Experimental research

The experimental style of research is suited best to bounded problems or issues in which the variables involved are known or at least hypothesised with some confidence (Fellows and Liu, 1997). Experimental research allows the researchers to identify causal relationships because results are observed when systematically changing one or more variables under controlled conditions.

Accordingly, an experiment could be defined as a situation in which a researcher objectively observes phenomena which are made to occur in a strictly controlled situation where one or more variables are varied and the others are kept constant.

- The observations are made in an environment in which all conditions other than the ones the researcher presents are kept constant or controlled.
- The conditions which the researcher presents are systematically varied to see if the results vary in these conditions.

Usually experiments are carried out in laboratories to test relationships between identified variables, ideally, by making constant all except one of the variables, and changing one independent variable only. Ideally, variables should be isolated through the design of an experiment such that only one of the possible of the very many independent variables is changed and the consequences on the isolated variable values is monitored and measured accurately. A common approach is to undertake comparative studies on a similar project executed at about the same time by similar firms employing similar organizational arrangements. Such a study could investigate the impact of difference management styles of project managers on project performance, measured values of time, cost, quality, etc. A major consideration in designing an experiment is the method used to change the independent variable in order that any consequential changes in the dependent variable can be measured. The changes in the independent variable are employed in three approaches, namely, randomized change, selected ranges, and the most appropriate approach. Stone (1978) points out that the major advantages of the experimental design research are:

- The measurement is generally more precise because it takes place under highly controlled conditions.

- Causality can be inferred from the results since threads to internal validity may be reduced through control groups.
- The independent variables of the study can be precise through the manipulation techniques.
- The laboratory experiments can be replicated.

4.2.6 Computer simulation models

The rapid development of simulation during this century has come about because of the computer revolution, so that now at one extreme, simulation provides a powerful operation research tool. Simulation is a formalisation model but without entire manipulation of the model by the discipline's techniques in order to yield an analytic solution. Simulation involves the use of a model to represent the essential characteristic of a reality, either a system or a process. Simulation offers a unique opportunity to observe the dynamic behaviour of complex systems (Fellows and Liu, 2003). Simulation is used to assist and revise a model to enhance its predictive accuracy or capability. Also it may be used to represent the behaviour of a precise model in a realistic way or to evaluate the behaviour of a system of random variables in which the distributions are unknown. Morgan (1984) suggests using it to evaluate the behaviour of complex random variables, the precise distributions of which are unknown.

4.2.7 Case Study

The case study method is one approach to inductive research. Case studies can provide a deeper understanding, and fuller contextual sense of the phenomena being studied, (Miles, 1979). It is principally effective methodology when, how or why questions are being created. Yin (1984) defined the case study method as 'an experimental enquiry that investigates a contemporary phenomenon within its real life circumstance, when the boundaries between phenomenon and framework are not clearly evident, and in which multiple sources of verification are used'. Also, Yin maintained that the unique strength of the case study method is its ability to deal with a variety of data sources, including documents, personal interviews and observation.

A case study allows the investigation to retain the holistic and significant characteristics of real life events, such as organizational and managerial processes. It may be used to explain links in the real life involvements that are too complex for surveys or experimental strategies.

Typically, a case study researcher uses interviews and documentary materials first and foremost, without using participant observation. The distinguishing feature of ethnography, however, is that the researcher spends a significant amount of time in the field. The fieldwork notes and the experience of living there become an important addition to any other data gathering techniques that may be used.

4.3 THE RESEARCH STRATEGY

The main aim of this research is to develop a model that helps project teams to select an appropriate payment system. The choice of payment system is influenced by two levels of factors, characteristics and objectives, and cash flow (Potts 1988). As a result, two types of tools had to be developed in this research: -

a) a decision support tool that recommends an appropriate payment system based on payment characteristics and objectives.
b) a cash flow simulation model to enable project teams to assess the impact of the selected payment system on their cash flow.

As indicated above, there are three traditional research strategies; survey, experiment; and case study (Robson, 1993). Each strategy represents different ways of collecting data and analysing empirical evidence. Each has its particular strengths and weaknesses. This research needs to obtain opinion and information from the construction industry. It needs to collect information from the expert people in the subject of the research. The postal questionnaire approach was selected to identify the relationship between project characteristics and objectives and the alternative payment systems. The findings of the questionnaires, once analysed, were discussed with an expert practitioner in an interview (qualitative methodology) who explained the logic of the results and hence confirmed the finding of the survey (triangulation).

The experimental methodology (computer simulation) was selected to help project teams to assess the impact of selecting an alternative payment system on the cash flows of clients, contractors and subcontractors. This helps project teams to fine-tune the selected payment system to ensure fairness among the different members of the supply chain.
Finally, the case study methodology was selected to validate the reliability and applicability of the cash flow simulation.

The questionnaires consisted of two phases: phase (a) is concerned with the identification of influencing factors that can potentially be used when selecting the payment system, and phase (b) was concerned with the utility factors for each significant factor. Factors influencing the payment system were selected as a result of the questionnaire. The questionnaire was intended to obtain the views or attitudes of the construction industry. These are based on the itemized rating scale that required the respondent to select one of a limited five numbers (Likert scale of 1 to 5). The Likert scale is one of the most widely used methods of recording responses in survey questionnaires (Yin 1994). Likert scales usually require a respondent to indicate a degree of agreement or disagreement with each of a series of statements related to the attitude object. In the case of this research it is used to determine the degree of influence a factor would have on the choice of a payment system. Likert scales are usually reliable owing to the range of responses they are able to record for closed questions. They usually adopt a five-point scale, the points of which represent varying responses: no influence, very low influence, low influence, medium influence, and significant influence.

There has been limited work aimed at eliciting information on how the payment system selections are made and what factors influence these selections. The preliminary stage of the research consisted of planning an approach in order to develop a checklist of factors that may influence the process of selecting project payment systems. This involved a review of current literature in the procurement system, risk management; project cost control and pricing system. At the preliminary stage of the study, a review of current literature revealed a number of factors that may influence the process of selecting project payment systems. The factors selected were based on several past related studies. First, in terms of the procurement selection by NEDO (1985), Skitmore and Marsden (1988) and Singh (1990) identified factors such as speed (during both design and construction), flexibility in accommodating design changes, contractors' reputation, project complexity, risk allocation/avoidance, value for money, and disputes and arbitration. However, the procurement selection process involves the analysis of complex and dynamic criteria such as cost certainty, time certainty, flexibility, responsibility, complexity and quality (Luu et al., 2003). In reality, decisions in selection are usually derived from intuition and past experience.

Secondly, in terms of cash flow risk assessment, Odeyinka (2003) considered the following additional factors influencing the extent of risk associated with project cash flow: project type, project size. Thirdly, in terms of the project pricing, Fortune (1999) identified some factors which influence the building project prices forecasting selection model; these include project size, project type, timescale, project data, and size and type of organisation. Mochtar and Arditi (2001) found that the significant factors in pricing strategy are: project size, project complexity, owner's characteristics, project location, competition and economic conditions.

Given that this research defined the payment system in terms of three layers, namely: payment methods, pricing system, and project cash flow, the structure of the questionnaires was designed to take into account these three layers by identifying the influence factors for each of these layers (factor payment methods, factor pricing systems, factor cash flow).

It has been suggested that, owing to the nature of the research, data for the study had been generated through a postal questionnaire survey.

4.3.1 Questionnaire phase (a)

Dillman (1978) recommended that pre-testing of the questionnaire should be carried out and that it should include different groups, such as colleagues, and potential users of the data. Each questionnaire was also accompanied by a covering letter, which contained the objectives of the study, benefit of the study to respondents as well as self-addressed freepost envelopes to stimulate response, and Heriot-Watt University letter-headed paper was used. The respondents were asked to check the factors list and add any comments, or if they think that there are other factors which have a significant influence on the payment system, then they should be added. In total the questionnaire was piloted with 10 contracting companies and as a result 4 additional factors were added. Once the piloting stage was completed, 80 potential respondents were selected from the top one hundred construction contractors contacted to complete the questionnaires. The respondents were asked to score their opinion for the listed factors on a Likert scale 1-5 where (1) has no influence and (5) has significant influence on the choice of payment system (in its three components). In total, twenty four respondent completed the questionnaires; hence a response rate of 30% was achieved.

4.3.2 Questionnaire phase (b)

The responses from the first questionnaire were analysed and as a result a reduced list of influencing factors was produced. The second survey was designed to calculate the utility factors for those criteria. To facilitate data collection, a postal questionnaire was sent to 80 construction contractors. The contractors were asked to score the payment methods and the pricing system against the factors perceived to have an impact on the selection of a payment methods or pricing system, using a scale 10-110 where 10 represents low suitability and 110 represents significant suitability. Twenty-four responses of eighty were collected and analysed. The utility factors were calculated by using the mean averages of the response scores, and summarised as shown in chapter 5. The overall mean utility factors of the selection payment systems were calculated.

4.3.3 Development of the selection tool

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-making problem, there exists a real utility factor (UF) defined along a set of feasible alternatives which 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).

Multi-attribute utility theory MAUT (sometimes referred to as Multi-attribute decision-making (MADM)) became one of the most active areas of interdisciplinary research in operations research management science (Keeney and Raiffa, 1998). Most of the MADM methodologies that have been developed could be implemented as computer software or embedded in some computer-based decision-making systems. This software would allow more users to apply the MADM method to their decision-making problems without being overwhelmed by the underlying mathematics. 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, 1984).

In this study, MADM is used to integrate both priority rating and the utilities derived from the respective payment system criteria. It focuses on the development of a MADM-based selection model for a construction project payment system. The model consists of a set of selection criteria, utilities factors and a categorisation of various payment methods or pricing systems used in construction projects.

Four steps are carried out for the model, as follows:

I. Determination of selection criteria.

II. Determination of payment methods or pricing system.

III. Collection of utility factors throughout the questionnaires.

IV. Collection of the selection criteria weightings.

I) Determination of selection criteria

As indicated above, the search of the critical selection criteria (factors influencing the payment system) was conducted through a literature review and then followed by the first questionnaire (Questionnaire a) survey with the construction contractors, where they were asked to score the weightings of each factors on a scale of 1-5, where 1 is very low influencing and 5 is significantly influencing. The contractors completed the questionnaire by scoring each factor of the scale. It was anticipated that some factors would be considered more influential than others because of the unique nature of the construction projects and also the different viewpoints of the respondents.

II) Collection of utility factors

This stage involved the formulation for a mean utility factor for each of the influential factors against several of the payment methods or pricing systems. The mean utility factors produced reflect the overall views of the respondents. To facilitate data collection, a second questionnaire (Questionnaire b) was sent to 80 construction contractors. In this questionnaire the selection factors derived from the first round questionnaire were used to draw up the utility factor. The contractors were asked to enter a utility factor by scoring on a scale from 10 to 110 (zero was not used to avoid mathematical errors), to assess the degree of influencing of each factor against a selection of payment methods or pricing systems to be used in a project. The overall mean utility factors of the selection payment systems were calculated.

III) Collection of selection criteria weightings

Selection of the suitable payment system is based on multiple factors influencing the selection; therefore it is necessary to derive a set of priority ratings representing their relative importance. As far as priority ratings are concerned (Love *et al.*, 1998), ratings for the selection of a procurement route were used to select the suitable procurement method for a building project. The same approach has been adopted in this research to determine the priority rating for the payment system.

IV) Selection of suitable system

Using the above results, a spreadsheet-based model was designed to assist the project manager to define the 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 this particular project and the model calculates the priority rating for each payment system by multiplying the factors ratings by established utility coefficients. Summing up the weighted priority variables of each payment method or pricing mechanism will yield the one with highest score. This is explained in more detail in chapter 6.

4.3.4 Developing the cash flow model

A new design of cash flow model is needed to provide a link between changes in contract conditions and the project cash flow for client, the main contractors and his subcontractors taking into account the alternative payment systems that could be applied.

The main objective of the model is to enable project teams to assess the impact of selecting alternative payment and pricing systems on cash flow. The model is also intended to enable the user to simulate the contract conditions such as the advance payment, retention money, and advance purchases of materials. This will enable project teams to fine tune contract conditions to achieve a favourable and fair cash flow profile for all. The model was developed on a spreadsheet and acted as a simulator of the project cash flow. It was also developed to be accurate and simple to provide the client, the contractor and subcontractors with financial positions during the project period.

4.3.5 Testing the model using case studies

The validity of the model depends on the degree to which the relationship between cash flow and payment systems can be accurately estimated. To achieve this, all influencing factors had to be taken into consideration. The cash flow model was designed so that cash flow calculations were based on the programme of works rather than the simplified standard S-curve. Two case studies were used to test the accuracy of the model. The model was used to simulate the cash flow of two projects with different payment systems and contract conditions being applied. The comparison was made between the forecast cash flow and the actual cash flow for the same project. By analysing two past projects the model's accuracy was tested, by comparing the output results with the actual data provided from the both projects. The results generated by the model compared favourably with the actual data.

4.4 SUMMARY

This chapter reviewed the literature of research methodologies and also described the methodologies used in this research to provide the data investigation and cash flow model development. Three traditional research approaches, namely, survey, experiment and case studies, were used in this research. Also, the chapter described in detail the questionnaire survey as one of the most commonly used methodologies for collecting data. A decision aid tool model was designed to assist the project manager to define the suitable payment system for the project, taking into account project characteristics and client requirements. Also, a new cash flow forecasting model was proposed to enable project teams to assess the impact of selecting alternative payment and pricing systems. The next chapter will contain a discussion of the identified influence factors on the payment systems that were generated through the questionnaire survey.

Chapter 5

Identifying the factors that influence payment systems

Table of contents

INTRODUCTION

This chapter contains a number of identified factors that influence the selection of payment systems of construction projects. It also aims to provide an appropriate systematic procedure to determine the order of payment and/or pricing system that would be suitable for selection according to the characteristics of each project. The chapter will first highlight the influential factors and provide a discussion of these factors in detail. The survey methodology and the analysis tools used to develop the selection model (selection utility factor tools) for both payment and pricing systems will also be discussed. The chapter ends with a section summary.

5.1 FACTORS INFLUENCING PAYMENT SYSTEMS

At the preliminary stage of the study, a review of current literature revealed a number of factors that may influence the process of selecting project payment systems. The factors are selected depending on the extent to which they influence the construction projects. In terms of the procurement selection by NEDO (1985), Skitmore and Marsden (1988) proposed factors such as speed, certainty in time, flexibility in accommodating design changes, contractors' reputation, project complexity, risk allocation/ avoidance, responsibility allocation, value for money and disputes and arbitration. However, the procurement selection process involves the analysis of complex and dynamic criteria. In reality, decisions in selection are usually derived from intuition and past experience. In the area of risk, Odeyinka (2003) identified project type, project size, delays in payment, settling claims, changes in design, and project complexity as factors influencing the cost flow.

Thirty-one factors formed the basis for a pilot study undertaken with ten construction industry organisations. The pilot study was executed with a view to confirming these factors, and also as an opportunity to add other factors. Four of the selected companies agreed with the list proposed whilst the others added three more factors, namely: integrated project team, investment in briefing, no blame culture, and authority of the project manager. The factors total thirty-five and are discussed in detail below.

5.1.1 Cost certainty

Cost certainty represents the probability of completing a project within the budget agreed between the client and contractor at the contract signature stage. Cost certainty is one of the most important performance criteria for construction clients. A large majority of projects end up costing more than the original tender price. Cost overruns and delays are a symptom of poor management. Cost estimating is crucial to providing a good basis for establishing the likely cost of resources for 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 lead to the tender being unacceptable to the client. On the other hand, 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 associated with the physical construction of the project, and include the purchasing of building materials, equipment operations, and all costs related with labour. As long as work is proceeding, direct costs continue to accrue. Once the work stops, direct cost generally stops as well. Indirect costs include overheads, costs associated with bidding, site preparations, etc. Cost and cost certainty are known to be among the top priorities of construction clients (Davenport, 1997). However, a low price is not always the main concern of clients today; instead cost certainty is becoming increasingly important (Flanagan *et al.*, 1998). Cost certainty 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 costs, and the higher number of design variations in construction projects contributes to lower cost certainty. Changes in design during construction have been perceived as one of the main problems facing project cost certainty (Branes, 1988). The survey was aimed at determining the impact of the cost certainty on the selection of the most suitable payment system. Pricing systems, in particular, affect these criteria where cost plus systems are expected to be associated with contracts where price certainty is not a key objective. Lump sum prices are more suitable for projects where cost certainty is a high priority, but on the other hand it may result in overestimating the cost owing to the high risk for the cost changes.

5.1.2 Time certainty

This is the degree of certainty that the project will be completed on the date agreed by the client and contractor when signing the contract. One of the primary requirements is to be able to predict the time for completion with some degree of reliability. Time is an extremely important issue in construction. Therefore, general contracts are very definite about time. There will be a date by which the contract must be completed or a period within which it must be completed (Murdoch and Hughes, 1999). The client will normally need to have some degree of confidence about precisely when to expect completion, which is defined in the contract as the date for completion. However, it is standard practice in building and civil engineering contracts to state in advance what the damages shall be for delay. The time for completion can be extended only where the contract permits and strictly in accordance with the contract provisions. It is also standard practice in construction contracts to state in advance the bonus payment for the early completion. The payment system could play an important role in incentivising the contractor to progress the work according to that scheduled. In the case of stage payments and milestones, contractors are paid only when completing a target stage.

5.1.3 Contractor cash flows

Both clients and contractors must prepare for each project cash flow that covers the record from the planning stage to the end of the project. Payments received by a contractor are considered as positive cash flows whilst expenditure is considered negative cash flow. The net cash flow at any point in time within the project duration is the sum of the positive and negative cash flows. The contractor continually attempts to receive as much cash as possible and as early as possible. His or her ability to continue the work on the project may depend on the progress with which payments are received. For the client, payments to the contractor represent expenses, and the client would therefore prefer to delay the payments for as long as possible. This is because client out cash flow is deferred more to ensure that the contractor has not been paid a greater amount than necessary (risk of contractor walking away from the job is always a real possibility). A payment system is obviously a very influential factor affecting the cash flow of contractors and subcontractors. Monthly interim payments are expected to generate a more favourable cash flow (than for example stage payment), and where advanced payments are applied, a negative working capital is often experienced by the contractor. This helps the contractor to fund the work more easily; however, clients need to trust the contractor. It is not uncommon for the construction industry to use funds generated from one project to another. This is often called cash flow farming (Kenley, 2003).

5.1.4 Procurement systems

Davidson (1998) defined procurement as a strategy to satisfy client's development and/or operational needs with respect to the provision of constructed facilities for a discrete lifecycle. 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. 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 that the level of client experience determines the main influencing factor of procurement selection. The choice of building procurement systems 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 remains that such a course of action is not adopted by the majority in the construction industry. The procurement method can be chosen in relation to project type. Skitmore and Marsden (1988) described two basic approaches to developing a universal method for procurement selection: first by a multi-attribute analysis technique, and second, by a discriminate method. The choice of a procurement route for construction work is one of many important decisions that construction clients have to make. The 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 important for clients to assess and prioritise their requirements objectively in order to enable a rational comparison of the alternative procurement routes.

Prime Contracting is an example where a single contractor acts as the sole point of responsibility to a public sector client for the management and delivery of a construction project on time, within budget (defined over the lifetime of the project) and fit for the purpose for which it was intended. This includes demonstrating, during the initial period of operation, that operating cost and performance parameters can be met in accordance with a pre-agreed cost model.

Design and Build also uses a single contractor to act as the sole point of responsibility to a public sector client for the design, management and delivery of a construction project on time, within budget (taking account of whole-life costs) and in accordance with a predefined output specification using reasonable skill and care. The traditional payment system is an old system and has been designed to cater for the "traditional" procurement system. As alternative procurement systems emerged, the suitability of the traditional payment system was less apparent. Today, new payment and pricing systems are being applied in the construction industry. It is yet unclear as to what payment system is appropriate for which procurement system. It is also unclear whether the industry consciously considers what procurement systems they have decided upon, when selecting a suitable payment system. This is investigated in the survey presented at the end of this chapter.

5.1.5 Duration of the Tendering Process

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

Traditionally, duration and money were the main criteria for selecting a contractor. Whilst this is true in the broadest terms, there are many other factors which affect either time or the financial outcome of the contract. These factors are often assessed at the pre-qualification stage (which is before the tendering stage and, in the case of experienced clients, updated on an annual basis); the client will determine and invite only contractors who are deemed to be suitable for a tender. This significantly reduces the time required to assess the tenders. However, the time needed to generate the tender (from the contractor's point of view) may still be considerable. There are three types of tendering methods: competitive (open tendering), selected contractor and short list method. Payment systems, and in particular the pricing system to be adopted in the contract, should affect this timing. In order to produce a tender, the cost of the project must be agreed upon. Different pricing systems require different levels of flexibility in terms of cost estimation, and certainty in terms of fixed prices. Cost plus for example, requires less tender time given the risk associated with costs estimation.

5.1.6 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 affects 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 with the lender a schedule for the borrowed money to be released. A long-term capital budget plan is considered to be incorporated in a company's business plan. Usually it covers either a three- or five-year view of the investments and financial prospects of a firm. Prediction and consideration of inflation and risks are essential to controlling cost within a planned budget. The same concept and need apply to contractors. A few construction contractors, especially the smaller ones, undertake long-term planning in capital budget. Budgeting by contractors at a company level is a complex task and often requires experienced teamwork (Kaka and Lewis, 2003). 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 apply to, and between, the supply chain; an important part of the budgeting process requires the contractor to forecast cash flow needs accurately for individual projects.

The payment system influences the degree of certainty in the level of financing and cash flow profile required. For example, in interim payment, contractors are paid according to their progress; whether they adhere to the planned progress or not is not an issue that is addressed by the payment system. This is not the case for milestones. In terms of pricing, the degree of certainty required at the budget stage must affect the choice of whether to go for high certainty (lump sum or fixed price) or in the case of flexibility clients would go for cost plus.

5.1.7 Risk allocation

No construction project is risk free. Risk can be managed, minimised, shared, transferred or accepted. It cannot, however, be ignored (Flanagan and Norman,1993).
The identification of risk must be linked to a clear statement of the client's priorities for the project. There is usually a large number of parties involved in a construction project,

all with different responsibilities. It is important to consider the extent to which certain parties can control the risk. Contractors tend to want to be paid as much as possible and with the minimum risk. Clients generally want to pay as little as possible and transfer as much risk as possible. If all risks are passed onto contractors, these will most likely 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 the risks which 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 aim of contract choice should always be to distribute risk clearly and unambiguously. Payment systems play a key role in defining how risk is allocated. For example, lump sum contracts enable the client to let go of the risk altogether. On the other hand, cost plus contracts tend to help the contractor avoid the majority of risks. In the case of milestone payment systems, contractors are more sensitive to variations between progress and the planned programme. This is because contractors will be issued a payment only when completing a milestone.

5.1.8 Forms of contract

The choice of contract type is one of the most important strategic decisions because it governs the method of payment for the contractor and the risk allocation between the parties. The choice of contract type should aim to give the maximum likelihood of achieving the client's objectives. Construction projects are very complex, which implies that a high level of expertise is necessary for formulating an appropriate contract strategy. The purpose of the contract is to establish the rights, duties, obligations, and responsibilities of the parties and to allocate the risk. Which form of contract to use depends upon a further set of criteria. Murdoch and Hughes (1999) noted that the following consideration must be given to:

- the amount of design that needs to be done before the contractor is selected;
- the level of nomination required;
- the need of 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 design and construction stages;
- the ability of the client and/or architect to manage and co-ordinate;
- the novelty of the project; and
- 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 he or she receives from professional advisers. The choice must be made at an early stage, as it will affect the way in which the contract documentation is prepared. How forms of contracts affect the choice of the payment system is unclear. Often, standard forms (such as JCT, FIDIC, NEC, etc.; for details see section chapter 2, section 4) accommodate more than one pricing or payment system. A relationship between the payment system and contract type selection does exist. This may imply that some payment systems are more suited for particular contracts. Alternatively the choice is dictated by the availability of the payment options in each form of contract.

5.1.9 Speed (during design and construction)

Speed is important to all parties (particularly clients) involved in the construction project. It is becoming common in the construction industry to shorten the duration of the design and construction 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 phase individually (particularly construction) is only possible through improved management processes and technology. Lean construction, in particular the use of off-site activities such as prefabrication and pre assembly, is playing a major role in shortening project duration. A payment system that is based solely on progress on site would discourage contractors from promoting off-site activities. The choice of payment system does, therefore, influence the construction technology to be adopted and subsequently the project duration. Defined milestones encourage the contractor to speed up the work progress on the site; also, the target incentive contracts provided incentives for early completion. Traditional contracts provide bonus payments for the early completion of the work. These types of contract encourage the contractor to speed up the progress of the works.

5.1.10 Contractor experience

Contractor experience is becoming increasingly common in the selection of the construction contractors to include an assessment of their past project performance. Most construction contracts in the private sector are awarded through a competitive bidding process that is based on invitation to select bidders only. Prequalification criteria will typically emphasize the experience that the owners have had with specific construction firms on previous projects. Clients always prefer a contractor who has had more experience using the payment system to be adopted because it saves time and avoids conflicts. It is not clear, however, whether contractors' experience in using particular payment systems is currently being taken into consideration when selecting the system to be used.

5.1.11 Client experience

The experience of construction clients is dependent on some factors, as Russel and Skibnie (1988) maintain, such as the number of projects completed, client involvement with construction activities, client personnel experience, and the consultant experience if the client is using a consultant. Client experience will undoubtedly influence the selection of the payment system. This decision will be discussed with client advisors and possibly the contractor in the early stages to prevent any disputes during the construction stage. It is, however, necessary for clients to consider other influencing factors when making this choice. Past experience alone should not be a barrier for change.

5.1.12 Qualification of Contractor

Prequalification procedures used by clients to assess the qualification of contractors vary in level of detail and extent, depending on the characteristics of the client evaluating the contractor, the nature of the work, and the size of the project.

Assessment of contractors' qualifications is done to ensure that contractors possess the required skills and experience to perform the works. The qualification of contractors depends on many variables such as reputation, experience, financial stability and management expertise. The choice of payment system, if made prior to the contractor's involvement, may dictate the qualification process and only contractors with past experience in the selected system would be invited.

5.1.13 Client reputation

Reputation is an important variable that a contractor can use to evaluate the client's inequality towards finance, management contract and litigation. If the owner is not financially stable, his/her ability to cover liability due on time, and other obligations for the project participants, may be a question. More particularly, he/she should be able to pay current obligations promptly. The financial stability of the client can be determined by evaluating their credit rating, banking arrangements to cover the obligations required etc. In terms of litigation and a client's record for claims resolution, proper evaluation of a client prior to signing a contract is essential. The payment system defines the way in which clients would pay the contractor and the risks associated with the payment system are therefore forced on the contractor. Interim valuations coupled with limited or retention will ensure a minimum payment of outstanding money from clients (and reduces the impact of clients' business failure. Lower cost plus contracts may put inexperienced clients in an unexpected position leading to difficulty in meeting the financial requirements of the payments.

5.1.14 Project complexity

Construction projects are generally complex in nature. The complexities of the construction of the building significantly affect the suitability of procurement systems. Perroul (1995) defined the complexity of a task as the degree of difficulty of the process in performing the task, the amount of thinking time required to solve work related problems and the body of knowledge that may provide guidelines for performing the task. Woodward (1995) suggests that having a multitude of inherent technically difficult parts is "complex" and it is arduous to predict the result of the works in terms of cost or time. Mohr (1971) considered processes that include the execution of tasks which are not very well understood by the present state of advances in science and technology as complex processes. These comprise operations that are innovative and conducted in an uncertain situation or which involve operations that are not clearly defined or lack a complete specification. Gidado and Millar (1992) regarded complexity as factors that hinder performance on site, including technical complexity of the task, amount of overlap and

interdependencies in construction stages, project organisation, site layout, and unpredictability of work on site. It is considered that project complexity affects contract duration, availability of unit prices and consequently the construction cost.
The above views and opinions of practitioners on the issues of project complexity could be summarised as follows:

- Projects have a large number of different systems or large number of interfaces between elements.
- Projects require efficient coordinating, control and monitoring from start to finish.
- Projects are required to be understood by current advances in construction technology.
- Projects need a great deal of intricacy which makes it difficult to specify clearly how to achieve goals or how long it will take.

It can be concluded that the effect of some complex activity can increase the duration of an element or the overall project duration. Complexity and uncertainty may, however, be reduced to an extent by expenditure on additional information, special resources: for example, better definition of requirements, site investigation and skilled labour.

Construction can be divided into two types. The first type is simple buildings such as houses, offices and warehouses. The second is buildings required for industrial processes such as chemical plants, car-making plants and the like. The contractors will investigate carefully the type of building and its specification before tendering. In the case of complex buildings the risk and uncertainty cost will be extensive. Project complexity makes it difficult to predict the result of the works in terms of cost or time; this will lead to consideration of the suitable payment and/or pricing system. If the consultant and the client can appreciate the complexities that exist in the project, they will both perform their respective roles better and ensure a successful project outcome. In terms of payment method, cost plus is a more suitable system in payment and pricing the entire or part of the project. When other systems are used, contractors will force a higher risk which will be reflected into project cost. This depends on the degree of project complexity being perceived.

5.1.15 Likelihood of disputes

Construction is a complex process that requires the coordinated effort of a temporarily assembled multiple member organization of many discrete groups, each having different goals and needs, and each expecting to maximize its own benefits (Walker, 1996).
As a result of increasingly complex construction projects, the number of construction disputes has increased dramatically. At project level, unsolved disputes can lead to programme delay, increased tension, and can damage long-term business relationships. Cost and time are interrelated and probably directly affected by disputes. The speed with which disputes are resolved generally leads to a reduction in overall expenses. Dispute avoidance may be accomplished through teamwork programmes, such as the partnering concept, which requires frequent meetings of the owner, design professional, construction manager and major contractor representatives working together to identify potential problems and develop practical solutions. Negotiation is the most common form of dispute resolution. All parties in construction projects are urged to minimize the role of lawyers, because construction problems usually relate to fact and customary industry practice rather than emphasis on legal issues. A good relationship is established on the basis of trust, common interests and mutual respect. It requires effort and the commitment of the parties involved in order to sustain a continuing strategic relationship. Payment systems may be associated with a different level of likelihood of disputes. For example,

milestones may lead to more disputes if they are not very clearly defined, whereas the interim payment creates a conflict if the contractor's quantity surveyor did not agree with the client's representative on the extent of the works completed.

5.1.16 Project flexibility accommodating design changes

It was suggested by Atkinson (1984) that there are three kinds of flexibility: functional flexibility, numerical flexibility, and financial flexibility. Functional flexibility may require multi-skills, craft workers who can apply a number of skills covering, for example, both mechanical and electrical engineering, and maintenance activities. Financial flexibility provides for pay levels to reflect the state of supply and demand in the external labour market and also means the use of flexible pay systems, which facilitate either functional or numerical flexibility.

Armstrong (1995) suggested that a firm should have flexible arrangements, which aim to achieve increased organization effectiveness, and should consider the following types of flexibility: contract-based; time-based; job-based; skills-based; organization and pay-based. Contract-based flexibility is concerned with terms and conditions. Time-based flexibility can be achieved by the use of flexible hours of work. Job-based flexibility means that workers can be moved from task to task and may be expected to use a range of skills within their capability. Firms may want to introduce this type of flexibility because they need to make the fullest use of their workforce, especially when they are using increasingly sophisticated equipment and systems which must be properly maintained if they are to produce at their optimum level. Pay-based flexibility can be achieved by avoiding the use of a rigid pay structure; introducing skill-based pay systems; allowing employees greater choice in the benefits they receive, and organizations must respond quickly to the problems caused by skill shortage and flexing the pay arrangement accordingly. As a result of increasing the flexibility of facilities, the value and consequently the useful life of buildings will increase.

In terms of payment systems, projects where flexibility (particularly in the case of potential changes in the design) is required, lump or fixed price may not be a suitable option. Cost plus will enable the contractor to deal with design changes or quantity variations and still maintain a preset profit margin.

5.1.17 Type of the competition

Competitive bidding has been encouraged in order to give an equal chance of bidding for all contractors, and to ensure competitive bid prices. This is often qualified by classification of contractors according to their experience and financial position in order to guarantee that projects are awarded to suitable contractors only. In open or selected tenders, contractors have to be given complete specification and documentation about the project. Flexibility is often limited as clients (particularly public ones) have to be seen as fair and specific. Given the objective of competition tendering (award contract to lowest bidder), projects using this type of tendering processes often go for a more traditional payment system where pricing is fixed, or lump sum, and payments are based on interim measurements. Negotiated tenders, on the other hand, allow clients and contractors a degree of flexibility in terms of pricing or defining criteria for payment that suit both parties.

5.1.18 Working time flexibility

Construction work is variable; the difference between the standard time and basic time for a job can be quite large. For building work and other activities of a more stable nature, basic times are useful in estimating and planning. Usually the working time on site is five days per week; the normal working time in summer is between 8:00am and 5:30 pm, whereas in winter the work will end one hour early (4:30pm). Accurate time data is essential to estimators and planners in contracting organisations, but for such data to be of value it must have been measured in a planned environment, and not obtained from a disorganised site with inefficient working practices (Harris and McCaffer, 1995). This means that if the client has a restriction on the working time, owing to some circumstances, the working time will be changed accordingly and an increase in the cost to cover the new working time is required. Contractors that are not meeting their planned schedule may require their workers to work overtime. In the case of fixed price contracts, the extra cost incurred will have to be absorbed by the contractor. In cases where flexibility in terms of duration of project is required, the client may decide to finance any extra cost of accelerating the work, in which case it may be more appropriate to use a cost plus system.

5.1.19 Project duration

Kaka and Price (1991) found that a relationship exists between the cost and the duration of construction projects. This relationship can be used in a contractor's budgeting system and the estimating of project cost could be used to derive the expected duration and vice versa. In terms of the payment system, duration and size tend to influence the choice in as far as large projects will require deeper understanding of the relationship between payment systems and project objectives. Small projects are often priced and paid on a lump sum basis. Projects with long duration are often associated with higher risks such as inflation, client variations, and exposure to unforeseen circumstances. In such circumstances, the client may opt for a cost plus pricing system or unit prices, but adjusted for inflation. Large value projects may on occasions be executed in relatively shorter durations (where certain items are very expensive but quickly installed in the building). It is unclear as to what pricing system is suitable but the client and contractors may use the milestones payment system where important components can be dealt with and monitored in a specific way.

5.1.20 project size

In this study projects are categorised as small-size projects when they are worth less than 0.5 million pounds; medium-size projects when worth 0.5-10.0 million pounds and the larger size in the case of more than 10.0 million pounds

5.1.21 Project type

Project types could be divided into the following categories:

- House buildings.
- Office buildings.
- Commercial buildings
- Roads and transport projects (airports, railways, harbours, underground, bridges, tunnels, etc.)
- Recreational projects.
- Water and sewage projects.
- Workshops and warehouse buildings.

- Educational buildings.
- Hospitals.
- Manufacturing projects.

It is not clear as to whether project type affects the choice of payment systems directly or through the other factors being discussed in this chapter.

5.1.22 Value for money

Lowest capital cost is not a reliable measure of value for money, since it takes no account of how well buildings perform. When auditing construction projects to assess their value for money, auditors should check that the Achieving Excellence principles are being followed. As has been acknowledged by both HM Treasury and the NAO, sound and creative design is an essential ingredient in achieving value for money. Value for money in construction is about more than delivering a project on time and within cost. A good building project must also contribute to the environment in which it is located, deliver a range of wider social and economic benefits and be adaptable to accommodate future uses. For example the Design Quality Indicator (DQI) is an online tool that helps define and evaluate design (Lipton, 2001). It is based on these three aspects of design quality: -

1. Impact – the building's ability to create a sense of place and have a positive effect on the local community and environment.
2. Build Quality – the engineering performance of the building, which includes structural stability and the integration, safety and robustness of the systems, finishes and fittings.
3. Functionality – the arrangement, quality and interrelationship of spaces and how the building is designed to be useful to all.

Good design can also contribute to staff recruitment, retention and motivation, and increase value for money across the life of the asset. It should also account for how the design will impact on the business effectiveness issues considered in value driver. Buildings that cost more to build and/or run than is budgeted will adversely affect the user's business. The budgets for both capital and whole-life costs should be stated in the business case and be sustainable and affordable over the life of the asset.

The purposes for which the building and the parts of a building will be used are likely to change over its lifetime. The technologies it contains will also change. A good design will be flexible – able to accommodate changing requirements without major alterations where possible – and adaptable, that is, capable of being altered or extended conveniently when necessary.

The methods and materials used in construction should be well thought through, particularly with regard to ease of construction and safety. The building should be designed for minimum waste and energy use during construction.

Given the above, it seems clear that project teams should all play an important role in adding value to the project. Payment systems can be used to encourage or ensure that project teams do operate in an integrated way. In the case of a project with high potential for innovation, flexibility is necessary and hence a cost plus pricing system together with an interim payment system (where no definition of stages are required) may be used.

5.1.23 Site condition

Most contractors who are willing to bid for a project arrange a site visit for themselves. As a result of the site visit, the contractor's representative prepares a set of notes which include notes on the following: -

- Site description.
- Ground conditions.
- Site topography.
- Other comments.

Again, uncertainty and risk are key issues in determining the payment system to be used.

5.1.24 Allocation of responsibility

In single point responsibility, there are several options available to the client through choice of procurement route: for example, design and build using a single contractor to act as the sole point of responsibility to a public sector client for the design, management and delivery of a construction project on time, within budget (taking account of whole-life costs) and in accordance with a pre-defined output specification using reasonable skill and care. PFI and turnkey are also forms of procurement offering the client a single point of responsibility for the delivery of the facility (Langford and Male, 2001).

Allocation of responsibilities dictates the contractual chain on a project and, hence, as far as the payment system is concerned, who pays who. This in itself should influence the choice of whether fixed or cost plus pricing systems are more suitable. For example, if contractors are responsible for the management and not the actual design work, he or she will be expected to claim a management fee (cost plus) rather than a fixed price or lump sum payment. Furthermore, stage payments may be more appropriate in the case of several constructors being responsible for different parts of the projects, (too complex to use interim payments).

5.1.25 Project security level

Different projects require different levels of security. The level of security depends on the project type and location of the project, such as the medical information system, and banking, each with its specific access requirement and authorisation. The level of project security needs special requirements in terms of cost and time, which in turn require a suitable selection for the payment system. Project security may be divided into two parts: first, site-based security where the aim is to avoid defects and other risks during the construction stage; second, security where the aim is to accommodate changes in technical specifications to develop the security level according to the owner request. When the owner wants to improve the security level (for example, if the owner requests that a CCTV system be added to improve the security level) this change may not have been considered during the bidding stage. In such cases, it is clear that a cost plus pricing system together with an interim payment may be preferred.

5.1.26 Availability of documents

Bid documents should be complete before they are issued. Bidding documents include all the instructions and forms that are part of the bidding process. Bidding documents will be accompanied by general conditions, supplementary conditions, drawings, and specification to enable contractors to determine the full scope of their obligations should they undertake the construction (Neil, 1982). They should be made available to a sufficient number of bidders to foster competition. In addition, the owner should provide each prime bidder with at least four sets of bidding documents for his use and the use of its subcontractors and suppliers. Recent developments in the use of "electronic plan rooms" have increased the availability of project information to multiple users. Owners and general contractors are encouraged to investigate and implement web-based plan access to maximise plan availability while minimising cost. It is important that all bidders on the project have access to the most accurate and complete plans and specifications. It is in the interest of owners to provide sufficient sets of drawings and specifications to permit all interested contractors, subcontractors and materials suppliers to prepare accurate bids. On the other hand, large companies or public authorities implement some form of e-procurement on the Web. Benefits sought are to have a wider choice of suppliers, which is expected to lead to lower cost, better quality, improved delivery and reduced cost of procurement. Electronic negotiation and contracting and possibly collaborative work in specification can further enhance time and cost saving and convenience. E-Tender integrates collaborative technologies with procurement automation to enable purchasing teams to compile detailed tender documents and simultaneously invite tender submissions online by a specified open date. E-Tender could reduce tender periods to days rather than weeks, providing significant improvements to current construction working practices. It will revolutionise construction procurement and is likely to pave the way toward a change in contractual legislation, saving project time, risk and costs. As indicated in the case of risk allocation and duration of the tendering stage, lack of documentation would lead to the cost plus system being more appropriate.

5.1.27 Peer relationships

In a typical case, the general contractor will perform the basic operations and subcontract the remainder to various specialty contractors. On many projects, especially building projects, it is common for 80 to 90% of the work to be performed by subcontractors (Hinze and Tracey, 1994). The relationship between some subcontractors and some general contractors is sometimes characterised as partnering. The adoption of partnering between subcontractors and general contractors may be motivated by the desire to establish a relationship based on trust, respect and honesty, as well as to reduce procurement problems, claims, and litigation. According to Kumaraswamy and Mattews (2000), prime contractors and subcontractors believe that there is benefit in developing partnering arrangements between prime contractors and key subcontractors.

In terms of payment systems, partnering allows for project teams to negotiate and contribute to the choice of the system to be used. Partnering allows for trust and hence more flexibility in terms of the completeness of information available at each stage. For example, construction can start before all of the detailed design is completed. The consequence of this would be the use of payment systems that will allow for more flexibility (e.g. cost plus and interim payments).

5.1.28 Tendering Strategies

The purpose of any tendering procedure is to select a suitable contractor, at a time appropriate to the circumstance, and to obtain from him or her at the proper time, an acceptable tender or offer upon which a contract can be let (Murdoch and Hughes, 1999).

The tendering process follows certain procedures, including the announcement of a project or invitation to bid, preparation of bids, submission and, finally, the evaluation and awarding stage. Invitations mostly include information such as type and size of the work that will be tendered, project location, name of project owner, consultant and designer and the date and place of submission. In addition, selected firms provide their qualification and price using the two-envelope system, which involves the submission of the contractor's justification in one envelope and price in the other.

The traditional view of the construction process is that once the lowest tender has been accepted and a contract has been signed and agreed between the contractor and the employer, then the work commences on site and most of the risk will reside with the contractor – that view might have been true in times when a general contractor employed his own labour to undertake most of the construction operations, but it is not true today. The changes in technology that have resulted in new skills and changes in craft skills have all combined to cause contractors to cease employing large numbers of directly employed craftsman and labour.

(a) Open Tendering

Where an open tendering arrangement is adopted, an invitation to tender is advertised publicly for any interested contractor to submit a tender, given that they can demonstrate that they meet client requirements. The number of contractors permitted to tender is unrestricted, and this method provides an excellent basis for ensuring high levels of competition in the tender process.

From the contractor's perspective, open tendering is less desirable, as the greater the number of tenders the greater the probability that success will not be forthcoming. It may also have the effect of discouraging contractors who may otherwise be quite suitable for the project.

(b) Selective Tendering

Under these arrangements, a select group of contractors is invited by the client to tender for the works. Tenderers are pre-selected based on their reputation and ability to carry out the works.

The system of traditional tendering is based on the rigid separation of the design and construction activities. The client appoints a team of consultants, usually following the feasibility study in order to develop the detailed design. The design team prepares all drawings, specifications and bills of quantities, before the process of tendering for the selection of a suitable contractor takes place. The two main mechanisms for tender are "single-stage" or the accelerated "two-stages" system. The contract is usually awarded on the basis of the lowest bid-price, although some of the more enlightened clients are now starting to consider a range of criteria, weighted in accordance with the potential impact on successful project outcome.

Single stage selective tendering is where the client invites a number of contractors to submit a tender for the works. The tenders are based on completed designs and specifications or comprehensive performance specifications, where the works are being carried out under a single source delivery system, such as design and construct. The client will evaluate the tenders and, if accepted, a contract is formed between the client and contractor.

Two-stages selective tendering is where the client will invite expressions of interest from suitably qualified and experienced contractors. The expression of interest will normally include details of the contractor's relevant experience and capability to handle projects of the size and nature being considered. The client will then select a number of these tenderers to submit a complete bid, and assess them.

(c) Negotiated Tendering

Where negotiated tendering is adopted, the client and a preferred contractor will enter into a contract through direct negotiation. This method is ideal where the work is of a unique nature and the client is confident that there is only one contractor suitable to undertake the work or where the client has a strong preference to use a particular contractor.

5.1.29 Project Quality

The construction industry has too often in the past been discredited by bad publicity resulting from sometimes dramatic failures of both the design and construction of its products (Ashworth 2004). The achievement of an acceptable standard in buildings is a combination of quality of design and quality of construction.

The project quality can be defined as a systematic way of guaranteeing that all activities within the project processes take place in the way they have been planned in order to meet the defined needs and requirements of the client. Good quality control is achieved by setting the right standards to meet the needs of the client. Project quality is then not conceptually limited to the product process, but incorporates relations between suppliers and clients within the project supply network. Concern must be given to nurturing a culture of innovation and continuous improvement (Love *et al.*, 1998). Quality often implies that the project teams go beyond what is stipulated in the contract and not simply meet project specification. Given this definition, payment systems can play an important role in encouraging project teams to innovate, and aim to satisfy clients. Fixed price contracts are more about contractors executing what is stipulated in the contract for a fixed sum of money. Cost plus allows the contractor the flexibility to cope with changes and any innovation that arises during the project.

5.1.30 Economic conditions

Construction project prices have a strong relationship with the market prices. This relation will be continuous during the project duration, and any change in the economic conditions will directly affect the financing of the project. Economic conditions that encourage clients and contractors to work together towards a common purpose may be essential and much will thus depend upon prevailing market conditions.

In the short term, of course, suppliers or contractors may be willing to absorb any extra costs caused by economic conditions changes in order to develop or maintain a relationship. As indicated before, periods with high inflation or economic uncertainty necessitate the use of the more flexible payment or pricing systems.

5.1.31 Site Location

Most contractors who are willing to bid for a project arrange a site visit for themselves. As a result of the site visit, the contractor's representative prepares a set of notes which include notes on the following: -

- Site location description of nearest city.
- Site security.
- Site access and roads.
- Position of existing services.
- Assessment of availability of labour and resources.

5.2 PILOTING THE QUESTIONNAIRE

The list of factors described above was included in a questionnaire aimed at determining the extent to which they affect the choice of payment systems.

The questionnaire was structured in two main parts: the first part is about the payment methods, and the choice was:

(a) Interim payment, which is well known by most construction contractors and widely used by them; it is done on a monthly basis of valuation of work done, as explained in chapter 2, section 2.6.1.

(b) Stages payment: stages are defined based on the characteristics of the project and contractors are paid on completion of each stage (see chapter 2, section 2.6.2).

(c) Milestones payments: the milestone dates are related to significant stages of the construction process; Milestones provide the data to support control procedures and form the basis for budgeting, and scheduling. (See chapter 2, section 2.6.3).

The second part addressed three of the mostly used pricing systems in construction projects (Dissanayaka and Kumaraswamy 1999). These three systems are as follows:

(a) Cost plus fees: cost-plus fee contracts provide that the owner will compensate the contractor for all construction costs and pay a fee for his services (see chapter 2, section 2.5.1).

(b) Lump sum price (fixed price): a fixed price contract provides for a price that is not subject to any adjustment and is based on the contractor's cost experience in performing the contract (see chapter 2, section 2.5.2).

(c) Unit price contract: in this system, the items of work are those that are paid for on the basis of a contractor's predetermined estimate of the cost of the work (see chapter 2, section 2.5.3).

Dillman (1978) recommended that the questionnaire should by tested or piloted by different groups, such as colleagues and potential users of the data.
The initial draft of the questionnaire, after its discussion with the author's supervisor, was presented to senior researchers in the school to obtain their comments and suggestions. The modified questionnaire was subsequently sent to ten selected construction contractors, asking them to provide their comments or any suggestions to improve the questionnaire. Four respondents accepted the proposed questionnaire and the fifth one added four factors suggested to have an influence on the choice of the payment system. These factors were: integrated project team, investment in briefing, no blame culture, and authority of the project manager. These factors are discussed below:

Investment in briefing

Perry (1987) has identified the impact by reference to an unidentified Swedish study of work carried out by the client and his consultants, up to and including the design stage, as influencing 90% of the construction cost, with only 15% of the actual project expenditure having been incurred; it can be seen that, although the client may be anxious to see work commence on site, progress during this stage should be carefully controlled and not unreasonably forced.

No blame culture

A further difficulty with culture concerns the complex dynamics associated with implementing change (Bresnen and Marshall, 2000).
Blame is of concern whenever systems break down and an error incident or accident occurs. Multiple public as well as the internal organizations and individuals directly involved, seek to allocate, accept and avoid blame and the potential social shame

emotionally involved within circumstances of ongoing risk that unexpectedly stands revealed. Moreover, one important complicating factor in the study of culture is that it operates at many different levels, from outward behavioural manifestations to much more deep-seated attitudes, values and beliefs (Schein, 1985).

Integrated teams

The client action must support the development of integrated teams to achieve maximum value and optimum performance; the creation of value should be a focussed objective of integrated teams, which include the client (Egan, 1998).

Construction management teams need to achieve a high capacity to plan and execute work in a manner that allows them to identify problems before any detrimental impact becomes evident, and to overcome such difficulties if they arise (Walker, 1996).

There are opportunities to maximise value and minimise waste at every stage of the construction and procurement process, from the minute that the need for a building is identified to when it is ready for use. Effective management by an integrated project team is essential to achieving this value.

The project team should be selected because they have the necessary technical competence to produce a building that is well designed and constructed. They should not be selected on the basis of cost alone.

Team working becomes more significant when the technology or operating processes require considerable interaction between people carrying out different functions but with a common purpose. Effective team working is more important during periods of rapid change or crisis. The degree of ability of construction management teams to implement flexibility options during construction to prevent unexpected problems is influenced by two key factors, the ability to be flexible and the commitment to do so. Team and individual ability to be flexible is influenced by the degree of understanding of project complexity and flexibility to adopt options to overcome unexpected problems. Waterman (1988) noted that teamwork is a tricky business; it requires people to pull together toward a set of shared goals or values. However, teamwork, as Peter Wickens (1987) has said, is not dependent on people working in groups but upon everyone working towards the same objectives. Construction teams should better communicate and co-coordinate with client's representatives and other consultant teams to achieve quick solutions about the client's variances and design changes through a flexible management performance. According to

Wickens (1987) the general principles of team work are: to promote mutual trust and cooperation between the company, its employees; to recognize that all employees at whatever level have a valued part to play in the success of the company; to seek actively the contributions of all employees in furthering these goals. Effective construction teams are rated by their ability for planning, communication and decision-making.

In addition to working well together, the project teams should communicate well with all stakeholders. They should involve users, contractors and other members of the supply chain at appropriate times throughout the design and construction of the project to benefit from their expertise. No blame culture can act as enabler for the adoption of more flexible payment systems. On the other hand payment systems can take out the pressure faced by the construction team in making sure they maintain the profitability required for the project (by use of cost plus for example). This helps the team to have less reasons for blaming each other and focus more on delivery.

5.1.35 Project Manager's Authority

This was a factor added during the pilot questionnaire by one of the respondents.

The project manager must manage across functional and organisational lines by bringing together activities required to accomplish the objectives of a specific project. The project manager should not attempt to describe fully the exact authority and responsibilities of his/her project office personnel or team members. Instead, he/she should encourage problem solving rather than role definition. Authority is the key to the project process. The authority of the project manager could be broken down into three areas: legal authority, reality authority, and project charter authority. How this affects the choice of payment system is unclear. It may be argued, however, that projects with designated project managers (who exercise high authority) may be able to adopt the more flexible payment systems, given their role of controlling cost and progress.

5.3 SUMMARY

This chapter described the factors that influence the choice of the payment systems of the construction projects. The pilot survey was executed with selected contractors to confirm these factors, and also an opportunity was given to them to add other factors. Four respondents accepted the proposed and the fifth one added four factors suggested as having an influence on the choice of the payment system. These factors were: integrated project team, investment in briefing, no blame culture, and authority of the project manager. The questionnaire was structured in two main parts: first, payment methods, and second, pricing system. The next chapter will contain a discussion of the survey results and analysis of the influence factors.

Chapter 6

Analysis and Discussion of Survey Results

Table of contents

INTRODUCTION

Chapter 5 discussed the factors which were supposed to have a possible effect on the choice of payment systems. These factors were included in a questionnaire aimed at assessing the extent to which each factor affected this choice. This chapter presents the result of the questionnaire together with the list of influential factors selected for inclusion with the decision aid tool. The first section in this chapter considered the nature of the data collected in order to confirm the hypotheses that were to be determined in the statistical analysis. The chapter brings together all the analysis of the findings for the first questionnaires. Also, statistical calculations using the rank test and correlation coefficient at 0.05% probability were carried out for validation the first survey results.

6.1 DATA COLLECTION PROCEDURES

As indicated in chapter 4, two postal questionnaires, together with covering letters and stamped addressed envelopes, were distributed to construction organisations across the UK. Copies of these are provided in Appendices A and B. The aim of the first questionnaire was to identify the influencing factors in the payment system. The second questionnaire was aimed at determining the utility factors for each influential factor identified as a result of the statistical analysis of the first questionnaire.

In the first questionnaire, a five-point Likert scale (1-5) was designed in order to structure the views of respondents, with scales 1 and 2 representing low levels of influence, scale 3 representing medium level of influence and 4 and 5 significant influence. Accordingly, respondents were asked to tick the appropriate score for each variable on the Likert scale. The Likert scale is possibly the most popular because it is easily constructed and managed which makes it possible for the use in mail surveys (Leming, 2002). In construction management literature, Likert scales are often treated as interval scales (Akintoy and Fitzgerald, 2000; Chenng and Yeung, 1998).

6.2 ANALYSIS OF FACTORS INFLUENCING PAYMENT SYSTEMS

The mean score of the response was employed to analyse data captured from the respondents by many construction management researchers (Kululange et al., 2001; Wang et al., 2000; and Akintoye, A.2000).

Respondents were asked to score the extent of influence of each factor against each of the three layers of payment system (name by payment methods, pricing system and cash flow). The mean score is determined as follows: -

$$MeanScore = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{n_5 + n_4 + n_3 + n_2 + n_1}$$

Where: N_5 = number of respondents who score the factor significant influential by (5)

N_4 = number of respondents who score the factor high influential by (4)

N_3 = number of respondents who score the factor medium influence (3)

N_2 = number of respondents who score the factor low influence (2)

N_1 = number of respondents who score the factor no influence (1)

6.3 FACTORS INFLUENCING THE PAYMENT METHODS

The follow sections discuss the questionnaire results for factors influencing the choice of payment methods.

Cost certainty

The level of cost certainty required by clients varies from one client to another and from one payment method to another. Cost estimating is crucial to all parties involved with any construction project, providing a basis for establishing the likely cost of the resource elements of construction work. The impact of inaccurate cost estimating on contracting business is significant, since the client may not be able to provide enough money to pay when the payment is due. This will lead to conflict between the client and contractor, especially if the payment is made monthly.

The respondents were asked to assess the extent of influence cost certainty has on the choice of payment method.

$$MeanScore = \frac{5*6+4*9+3*4+2*2+1*2}{5+7+6+3+2}$$

$= 84/23=3.65$

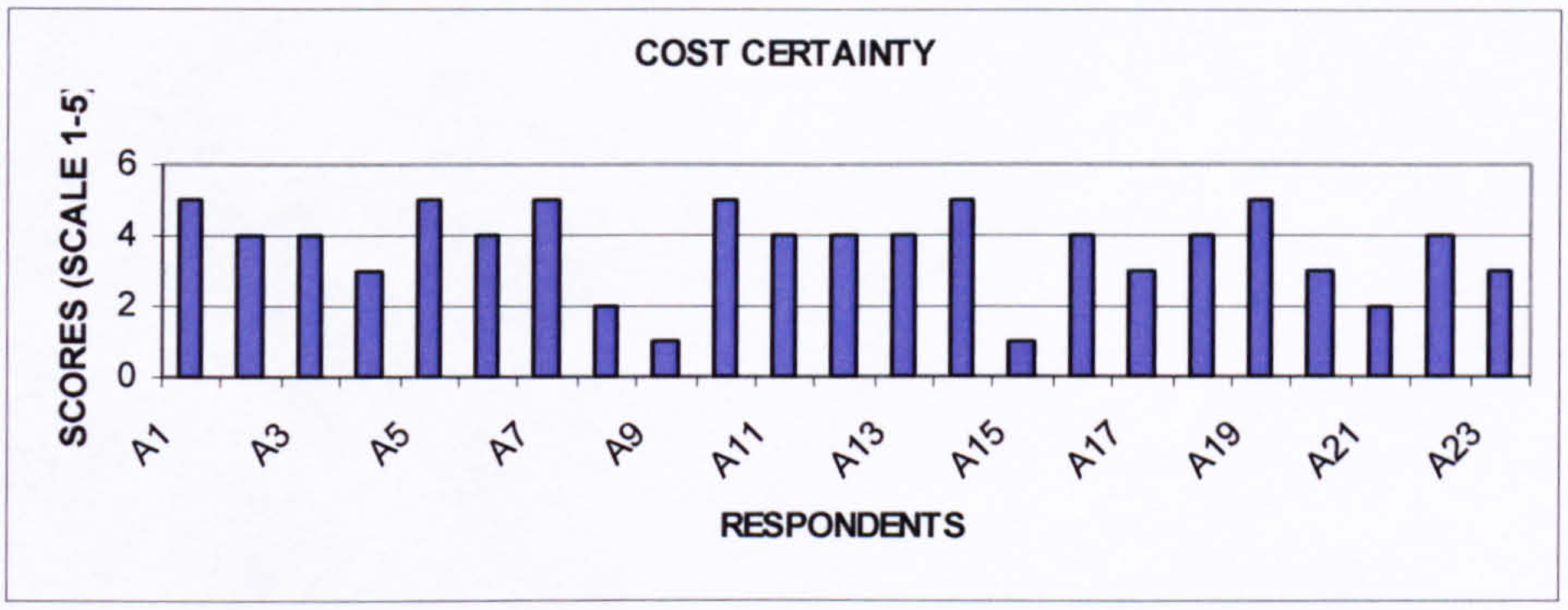

Fig. 6. 1 Cost certainty

The survey shows that 64% of the respondents see cost certainty as a significant factor, while 18% scored its influence as medium, and the remaining 18% think that the issue of cost certainty is of low influence. It can be concluded therefore that cost certainty is a major factor that influences the decision on the payment system.

Time certainty

This is the degree of certainty that the project will be completed on the date, which is agreed by client and contractor when signing the contract.

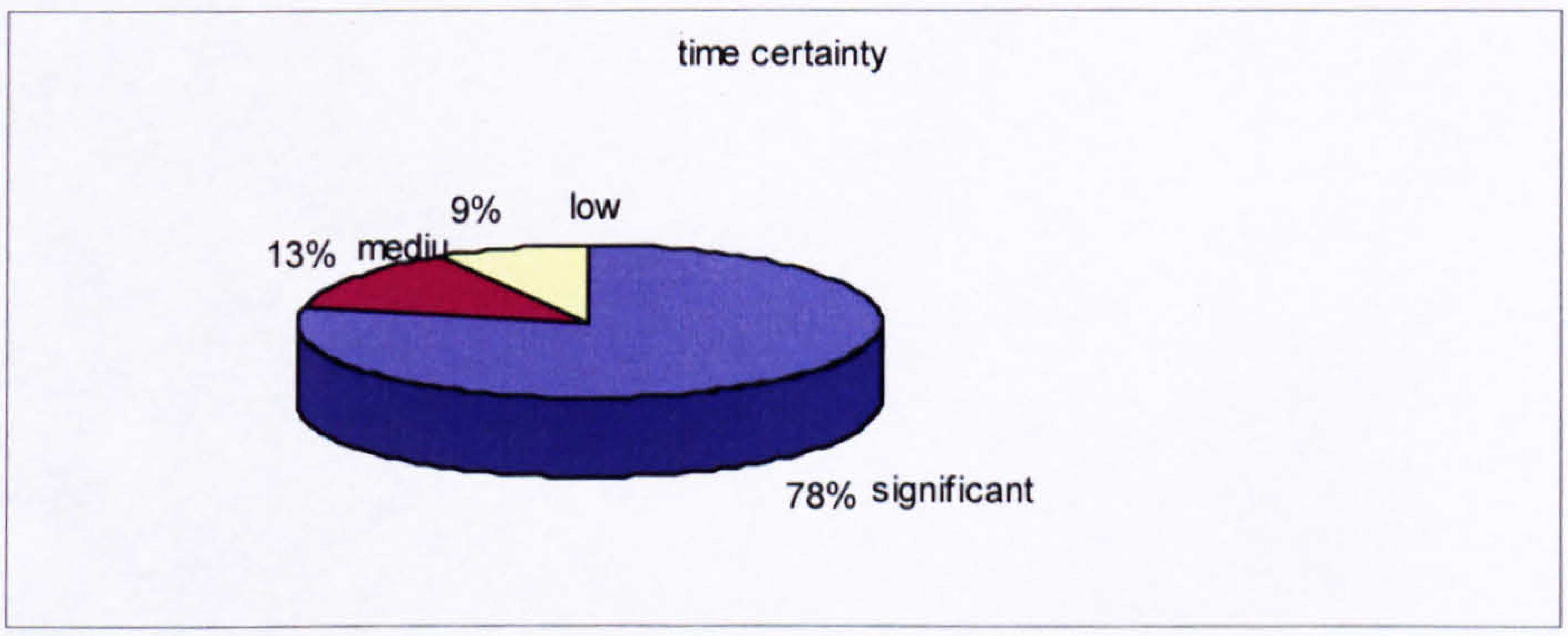

Fig. 6. 2 Time certainty

From the survey; it is clear that 78% of the respondents see time certainty as a significant factor, while 13% scored its influence as medium, and the remaining 9% think that time certainty is of low influence in the choice of payment methods.

Procurement system

The correct choice of building procurement method will lead to the success of a building project. According to Love et al. (1998), selecting a suitable procurement method for a construction project is a key factor contributing to overall client satisfaction and project success. Inappropriate procurement strategies may lead to cost and time overruns, claims and disputes on projects, as highlighted by Masterman (1992) and Abdel-Maguid and Davidson (1996).

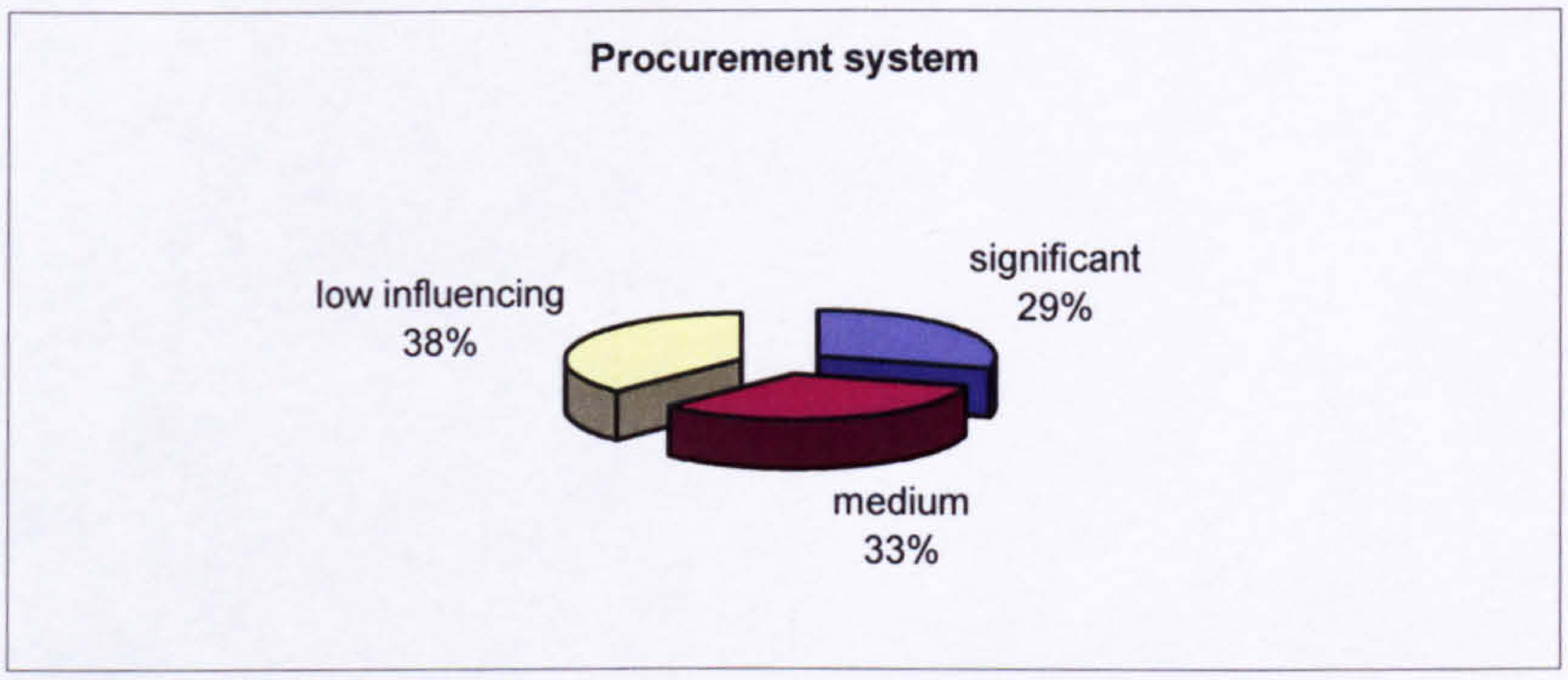

Fig. 6. 3 Procurement system

Figure 6.3 shows that the procurement system has low influence on the choice of payment methods. The survey results show that only 29% of the total respondents consider the procurement system to have a significant influence on payment methods, whereas 33% of respondents think that its influence level is medium and 38% of respondents consider the issue of the procurement system as a low influence factor. The mean score of the procurement system selection is 2.79. Hence, the procurement system selection issue is considered to be of low influence in the decision on payment method selection.

Project complexity

Project complexity consists of type of structure, scale and scope of construction, complexity of design and site constraints. Gidado and Millar (1992) regarded complexity as factors that hinder performance on site, including technical complexity of the task, amount of overlap and interdependencies in construction stages, project organisation, site layout, an unpredictability of work on site. It is considered that project complexity affects contract duration, and consequently the construction cost.

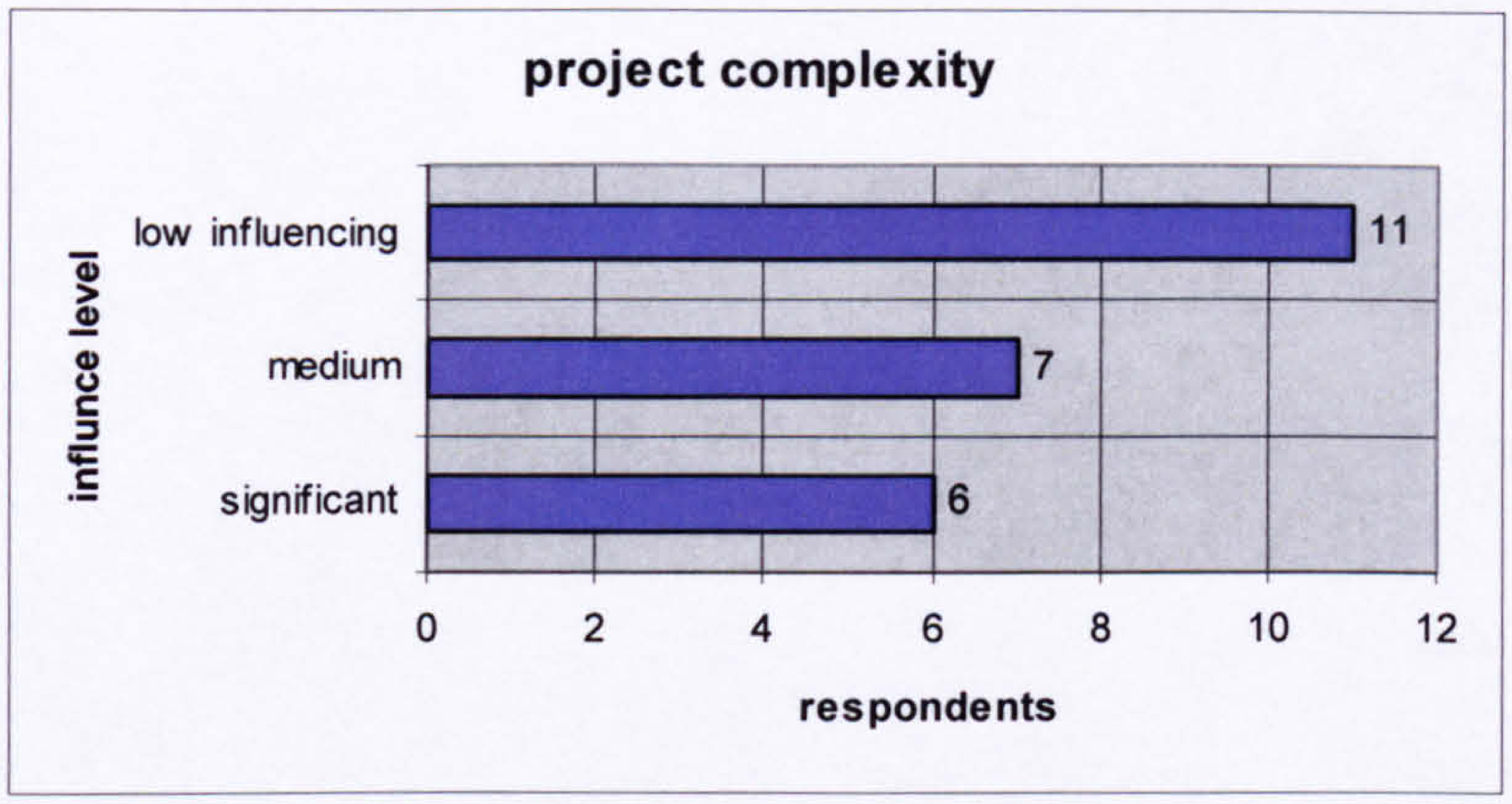

Fig. 6. 4 Project complexity

Figure 6.4 shows that six of the 24 respondents consider the issue of project complexity to be a significant factor influencing the payment methods, whereas seven respondents think that the effect of the project complexity is medium, and eleven respondents think that this issue has low influence. Hence the project complexity is a low influential factor in the selection of payment method.

Contractor cash flow

Contractors at the tendering stage forecast cash flow to estimate financing cost. In large construction projects financing can be crucial to company resources. The frequency by which clients value the work undertaken and the time it takes to pay the cash affect the cash flow profile of the contractor. Front-end loadings over measurements are often practised by contractors to enhance their position on cash flow.

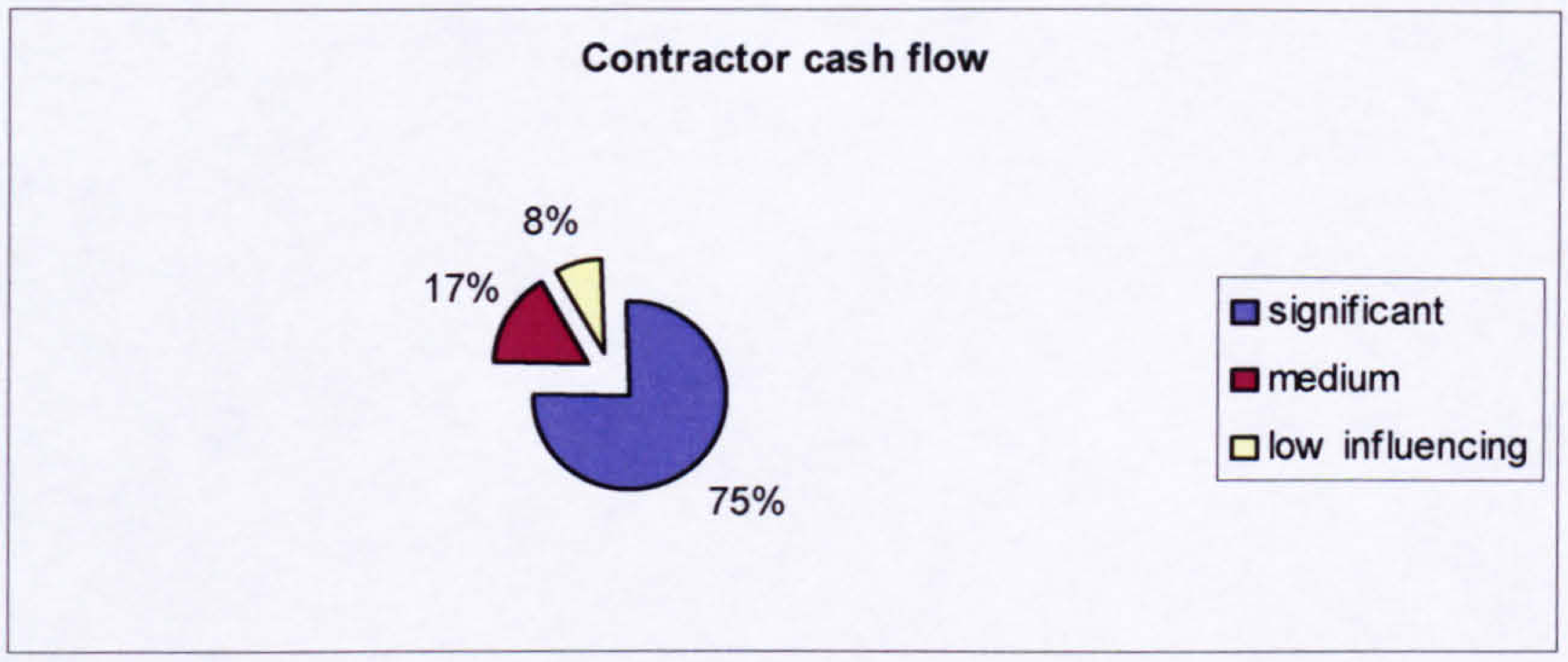

Fig. 6. 5 Contractor cash flow

Figure 6.5 shows that 75% of the total respondents consider the issue of the contractor cash flow to be a significant influence factor in the choice of payment method, whereas 17% of the total sample score its influence as medium, and only 8% think that contractor cash flow is of low influence. The mean score of the contractor cash flow is 3.96. Hence, contractor cash flow is considered to be a significant factor influencing the decision on payment method selection.

Form of contract

As indicated in chapter 6, the choice of which form of contract to use depends upon a further set of criteria (Murdoch and Hughes, 1999). The choice must be made at an early stage, as it will affect the way in which the contract documentation is prepared. The construction industry offers many forms of contracts that can be used, such as JCT, NCE, ICE, and FIDIC forms. For more details refer to chapter 2, section 2.4.6

Figure 6.6 shows forms of the contract as a significant influential factor in the payment methods. Fifteen respondents of a total of twenty-four consider that the form of contract has a significant influence on the payment methods, where six respondents think that its influence is medium and only two respondents consider the effect of the contract form on payment methods as a low influence.

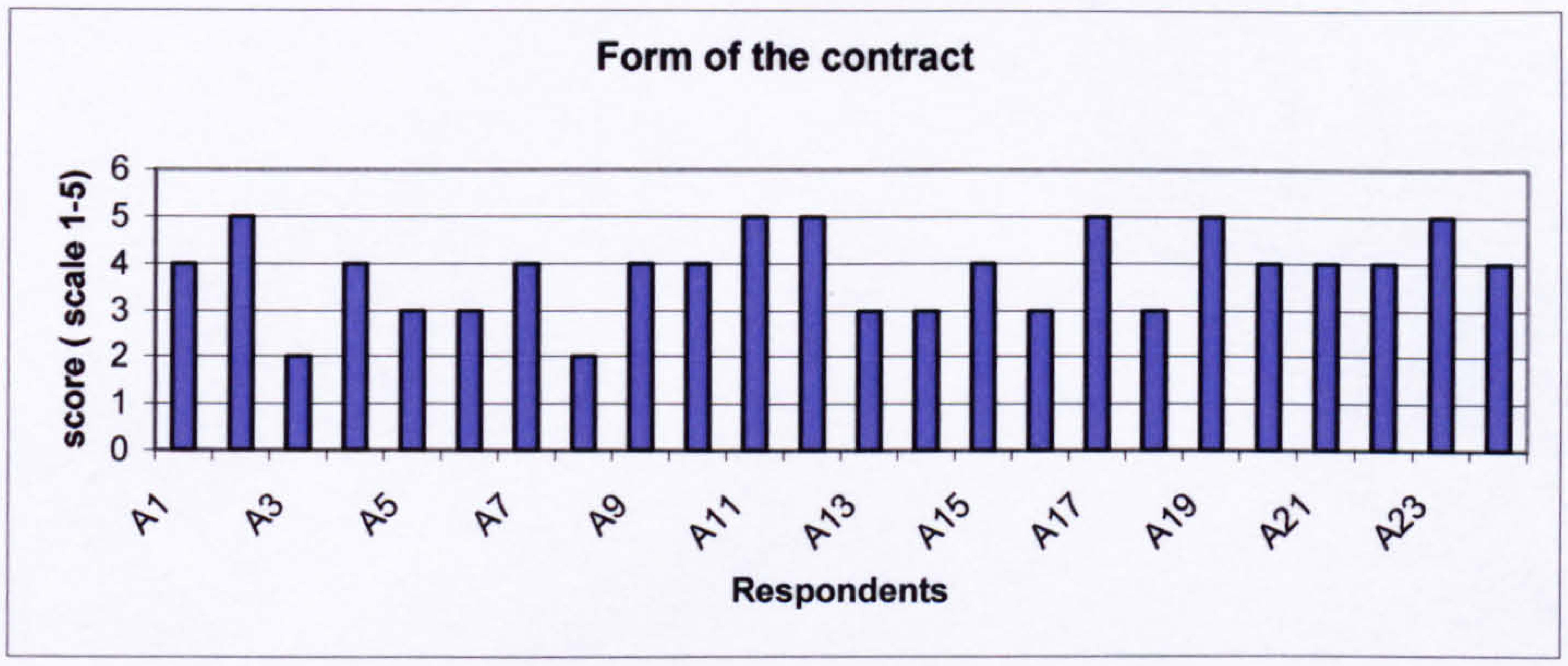

Fig. 6. 6 Form the contract

Contractor Experience

The previous experience of contractors in a particular type of payment method may be used as an indicator of the contractor's future performance and his ability to avoid claims. The types of projects executed by the contractor and number of years in business are also relevant items in assessing a contractor's experience.

It is becoming increasingly common for the selection of the construction contractors to include an assessment of their past projects performances. Most construction contracts in the private sector are awarded through a competitive bidding process that is based on invitation to select bidders only. Prequalification criteria will typically emphasize the experience that the owners have had with specific construction firms on previous projects. The question was: should a contractor's past experience with a particular payment method influence choice?

Fig.6.7 shows that contractor experience is perceived to have a low influence on the choice of payment methods. The survey results show that 29% of all respondents consider that the contractor's experience has a significant influence, whereas 38% of respondents think that its influence is medium and 33% respondents consider the effect of the contractor experience to be of low influence. The mean score of the contractor experience is 2.83. Hence, the issue of contractor experience is considered to be of low influence on the decision on payment system. It can be interpreted that the differences between the payment methods are such that experience in them should not be a critical issue.

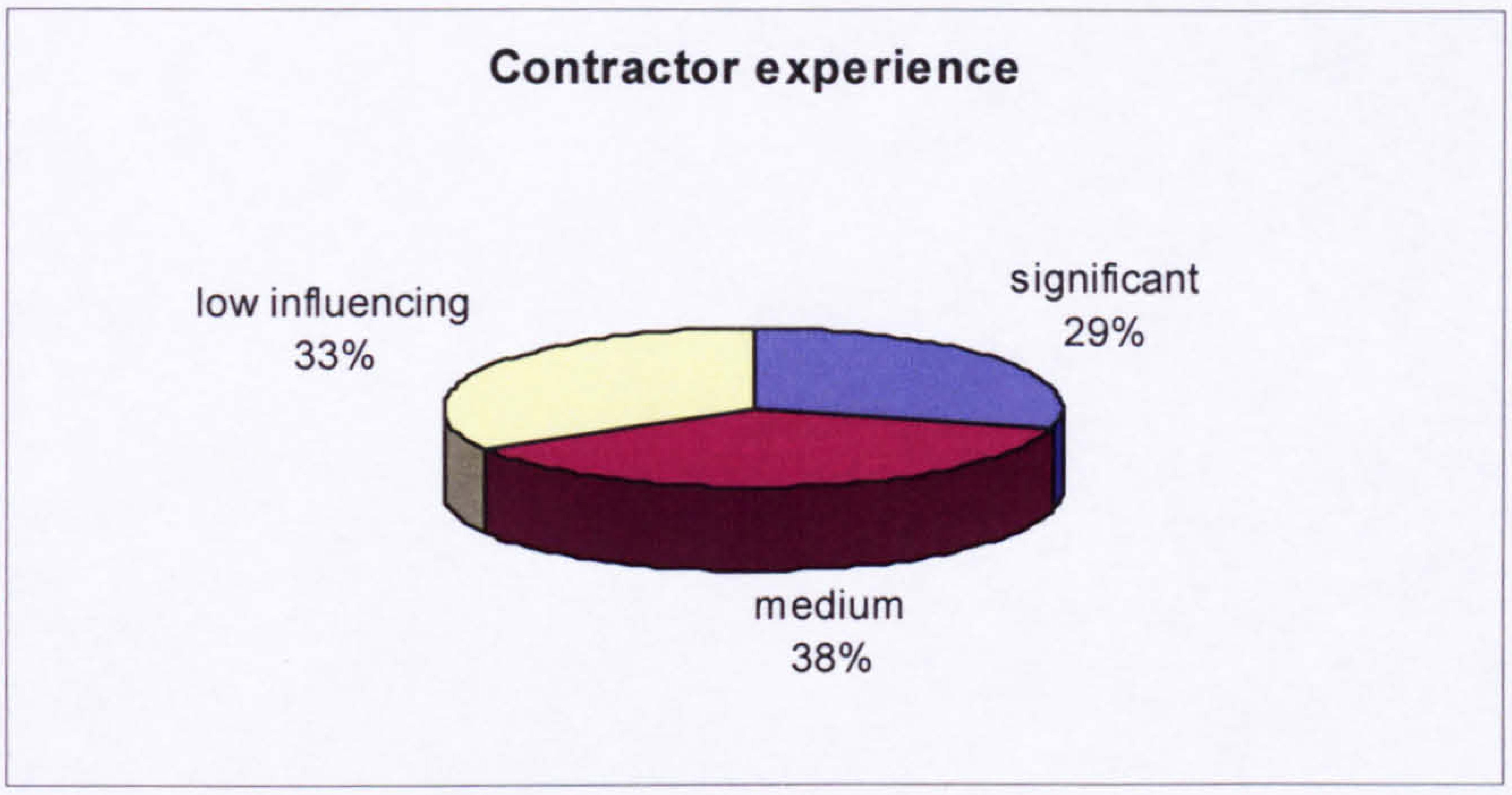

Fig. 6. 7 Contractor experience

Client experience

The experience of construction clients is dependent on some factors, as Russel and Skibnie (1988) asserted, such as the number of projects completed; client involvement with construction activities; client personnel experience, and the consultant experience if the client used a consultant.

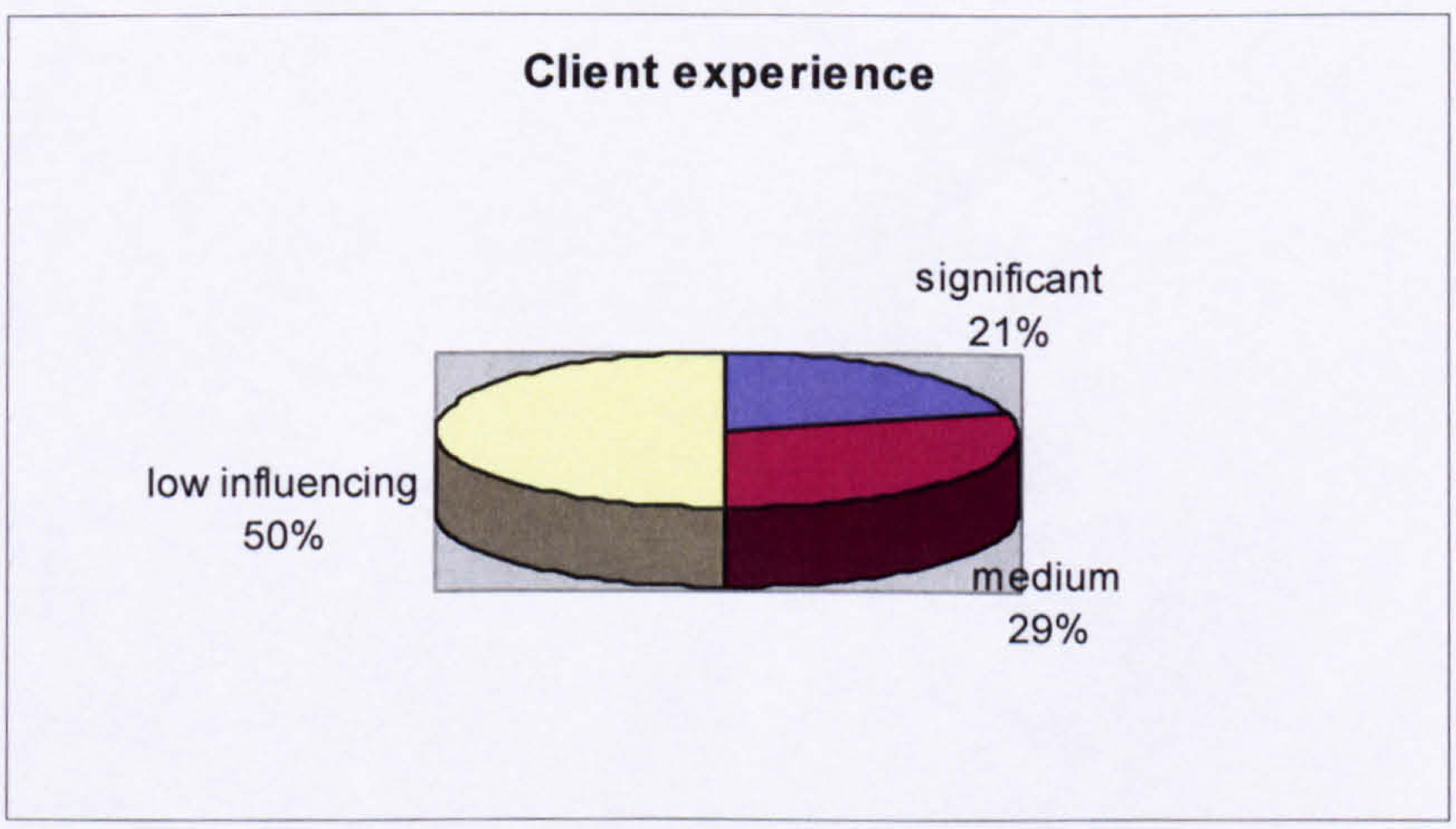

Fig. 6. 8 Client experience

Figure 6.8 shows client experience to have a low influence on the choice of payment methods. The survey results show that 21% of the respondents consider that client experience has a significant influence on the payment methods, whereas 29% think that its influence level is medium and 50% consider the effect of the client experience as a low influence. Hence, client experience is considered as having low influence on the decision concerning the choice of payment method.

In addition, the experience of clients in the construction industry varies significantly, and a reasonable proportion of them tend to be one-off clients.

Qualification of Contractor

The qualification of contractors must be established. Current prequalification procedures used by clients to assess the qualification of contractors vary according to the level of detail and extent, depending on the characteristics of the client evaluating the contractor, the nature of the work, and the size of the project.

The assessment of contractors' qualifications is done to ensure that contractors possess the required skills and experience to perform the work. Also, clients have a vested interest in the contractor's ability to meet specific project objectives, such as schedule, safety and quality. The qualification of contractors depends on many variables, such as reputation, experience, financial stability and management expertise.

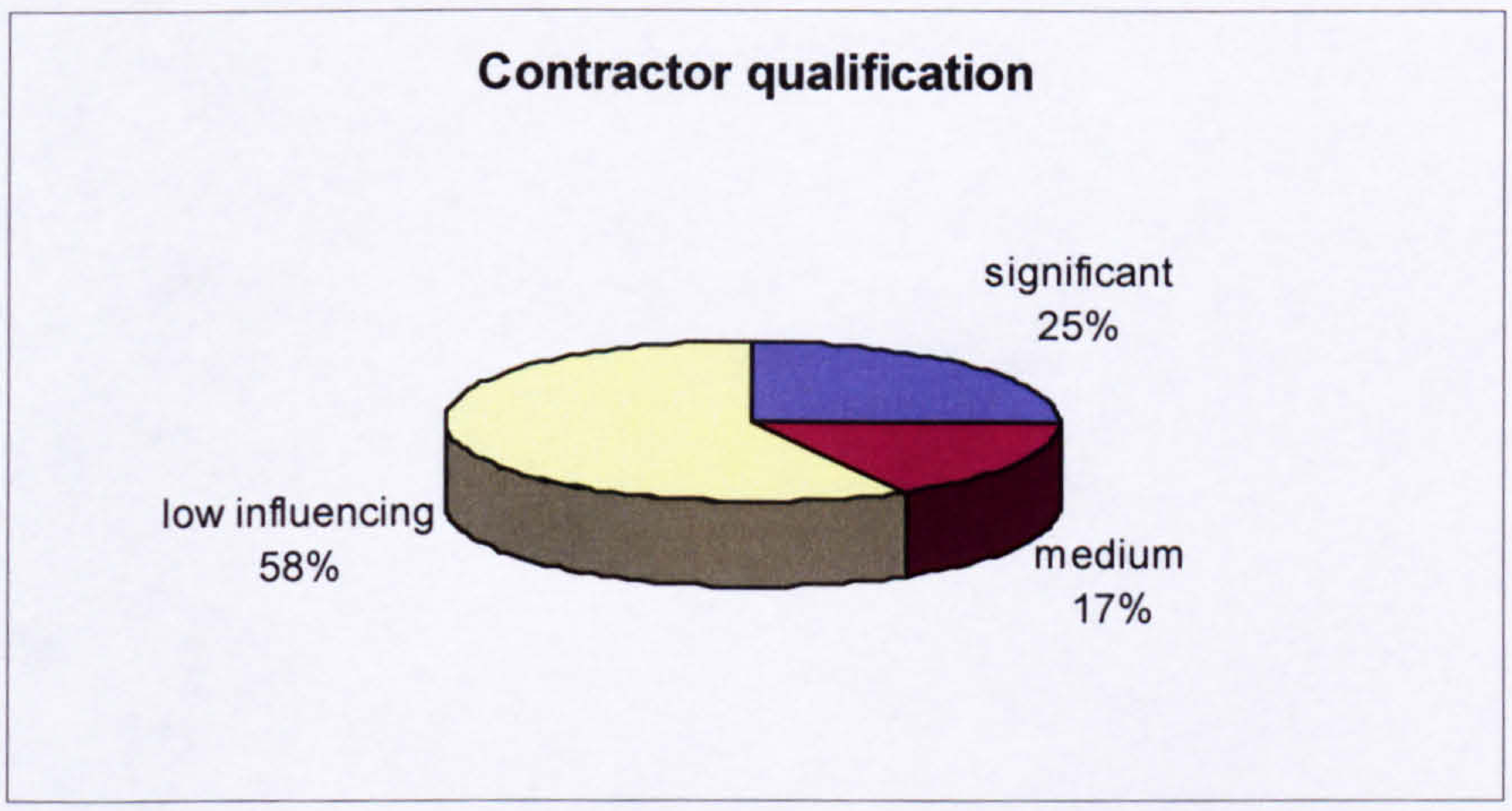

Fig. 6. 9 Contractor qualification

Figure 6.9 shows that the qualifications of a contractor are a low influential factor in the payment methods, as it is clear from the survey results that 25% of the respondents consider that qualifications of the contractor have a significant influence on the payment methods, while 17% scored its influence as medium and 58% of the respondents consider the effect of qualification of contractor as a low influence factor. Hence, the issue concerning the qualification of contractor is considered as a low influence on the decision on payment methods selection.

Client reputation

Reputation is an important variable that a contractor can use to evaluate the client's inequality toward finance, and litigation. If the owner is not financially stable, his/her ability to meet the obligations will cause a critical financial situation for the project participants. More particularly, he/she should be able to pay finance obligations promptly. The financial stability of the client can be determined by evaluating their credit rating and banking arrangements to cover the obligations required. Regarding their ability to manage litigation, owners should consider claims resolution as one of the top priorities. Proper evaluation of a client prior to signing a contract is essential. Because many clients contractually assume responsibilities for liability and may even provide some from of indemnification, the contractor's protection depends on the solvency and continued existence of the client. Therefore, it is essential for the contractor to make sure that the client fully accepts his/her obligations and he/she is not looking for a quick solution.

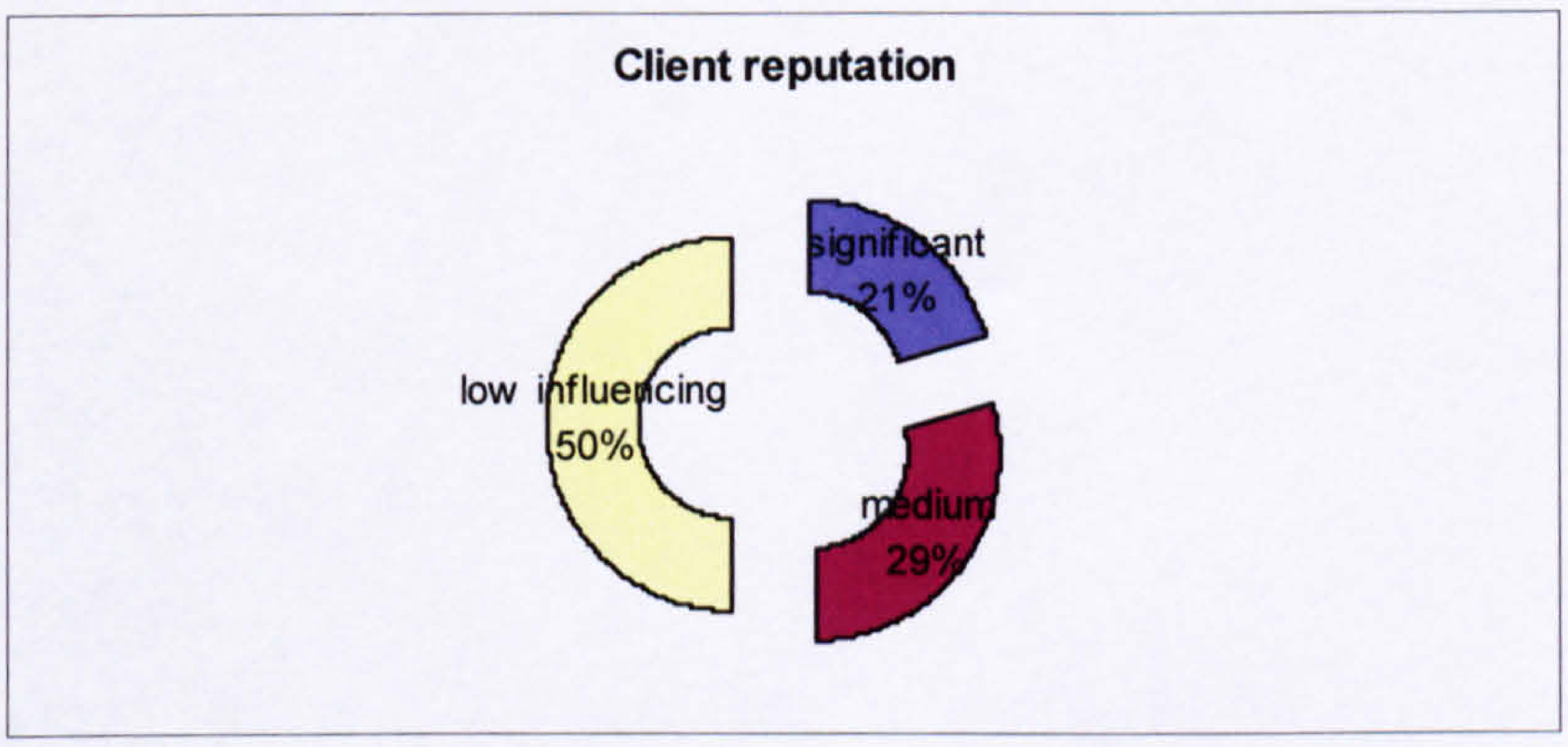

Fig. 6. 10 Client reputation

Figure 6.10 above (exploded doughnut) shows that client reputation is a low influential factor in the payment methods; the survey results show that 21% respondents consider that client reputation has a significant influence on the payment methods, while 29% scored its influence as medium and 50% respondents consider the issue of client reputation as a low influence factor. Hence, the issue concerning client reputation is considered as a low influence on the decision regarding the payment system.

Project Flexibility

Flexibility in accommodating design changes is crucial to the success of the project and client satisfaction. Armstrong (1995) suggested that a firm should have flexible arrangements which aim to achieve increased organization effectiveness. The extent to which payment methods affect project flexibility is to be determined by this questionnaire.

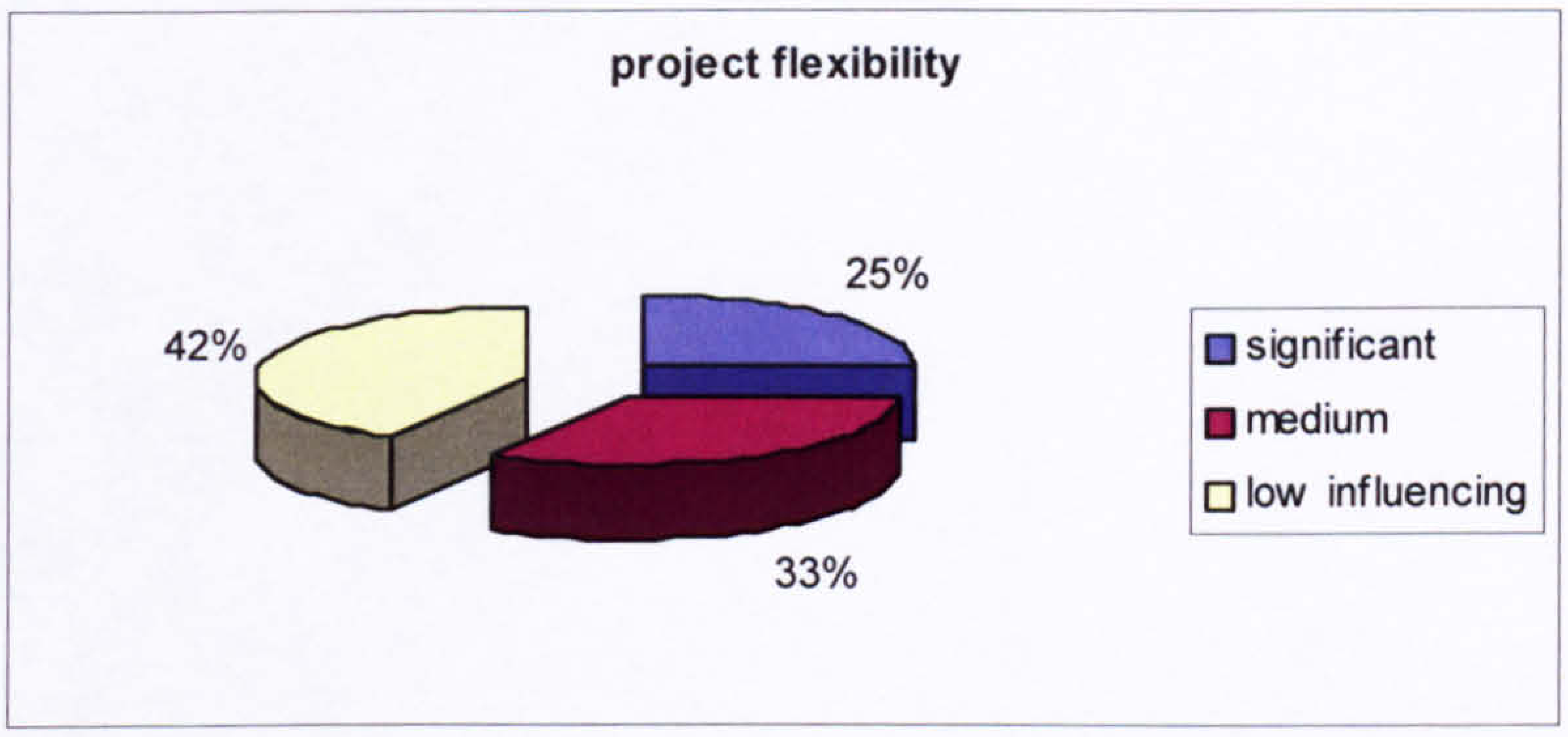

Fig 6. 11 Project flexibility

From the survey, figure 6.11 above (exploded pie chart) shows clearly that 25% of the respondents see project flexibility as a significant factor, while 33% of respondents think that its influence level is medium, and the remaining 42% state that the issue of project flexibility is of low influence on the payment methods. Hence the project flexibility issue is considered as a low influence factor in the payment method selection.

Project size

The project categories are as follows: small size project - less than 0.5 million pounds; medium project size - 0.5-2.5 million pounds and the large size more than 2.5 million pounds. The suitability of different payment method to the different project size was the subject of this questionnaire.

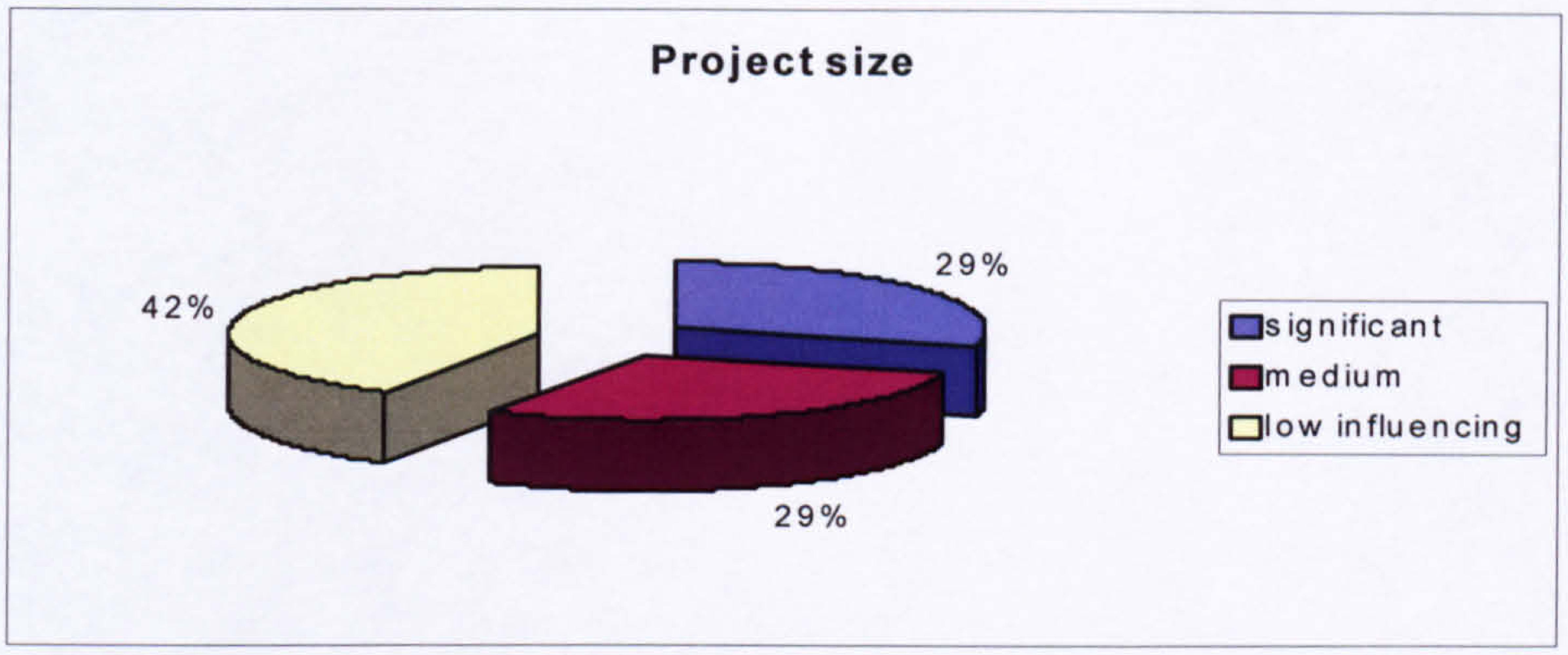

Fig. 6. 12 Project size

From the survey, as shown in figure 6.12, it is clear that concerning the issue of project size, 29 % of the respondents consider the project size as a significant factor in the payment methods, whereas 29% of total respondents think that the effect of the project complexity is medium, and the remaining 42% think that the issue of project size is of low influence on the payment methods.

It is therefore clear that project size has a low influence on the selection of payment methods.

Value for Money

Value for Money in construction is about more than delivering a project to time and cost. A good building project must also contribute to the environment in which it is located, deliver a range of wider social and economic benefits and be adaptable to accommodate future uses.

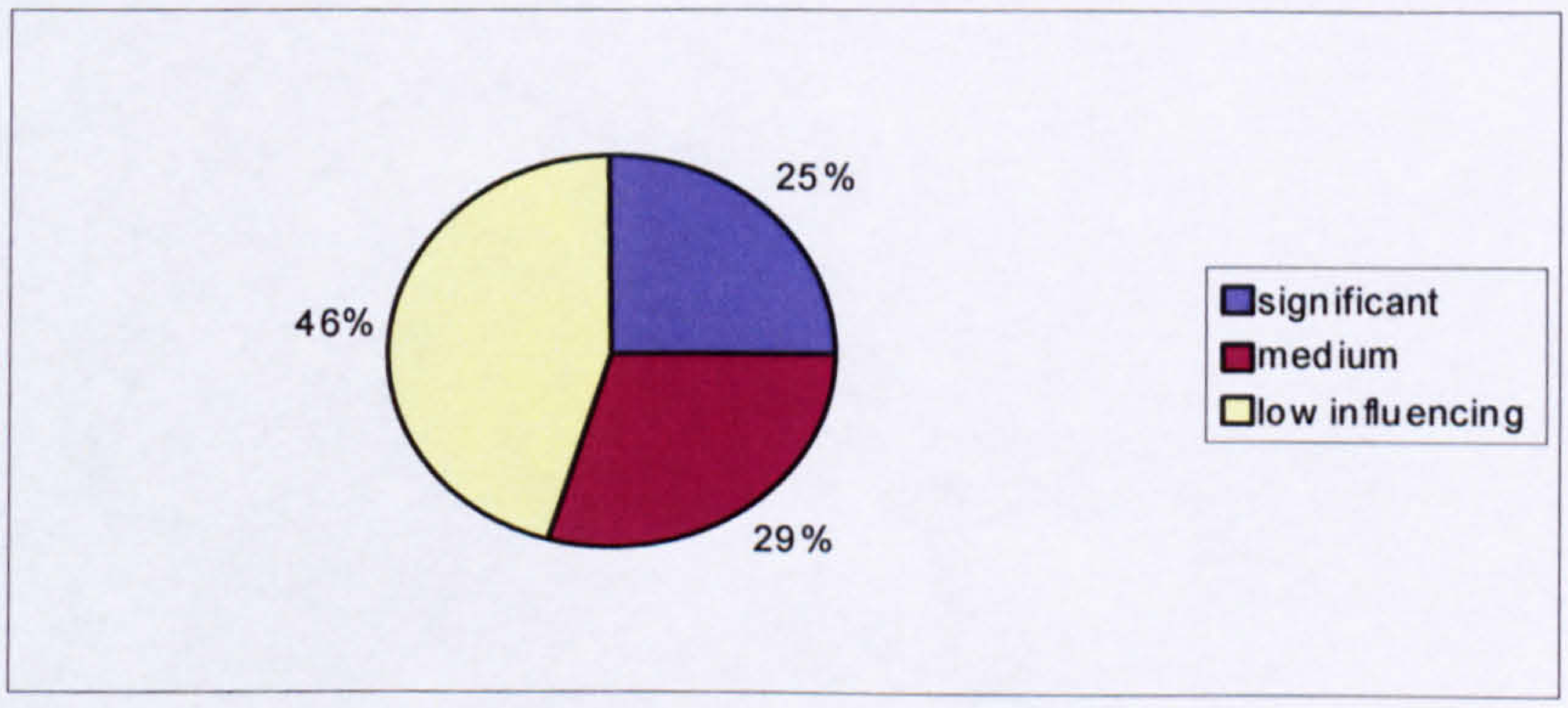

Fig. 6. 13 Value for money

Figure 6.13 above (pie chart) shows that Value for Money has a low influence on the choice of payment methods. The survey results show that 25% respondents consider Value for Money to have a significant impact on choice of the payment methods, while 29% of respondents think that its influence level is medium and 46% of respondents consider it to be low. Hence, Value for Money is considered as a low influence factor in the decision on payment system.

Project duration

This is the total time needed to complete the project. Figure 6.14 below shows that the project duration is not a significant factor when selecting the payment methods. The survey shows that only 17% of the respondents perceive the issue of the project duration to be significant on the payment methods, whereas 29% of the respondents think that its influence level is medium, and 54% of the survey results believe that project duration has a low influence on the choice of payment methods. Hence this factor may be considered not to be an influential factor in the payment methods selection.

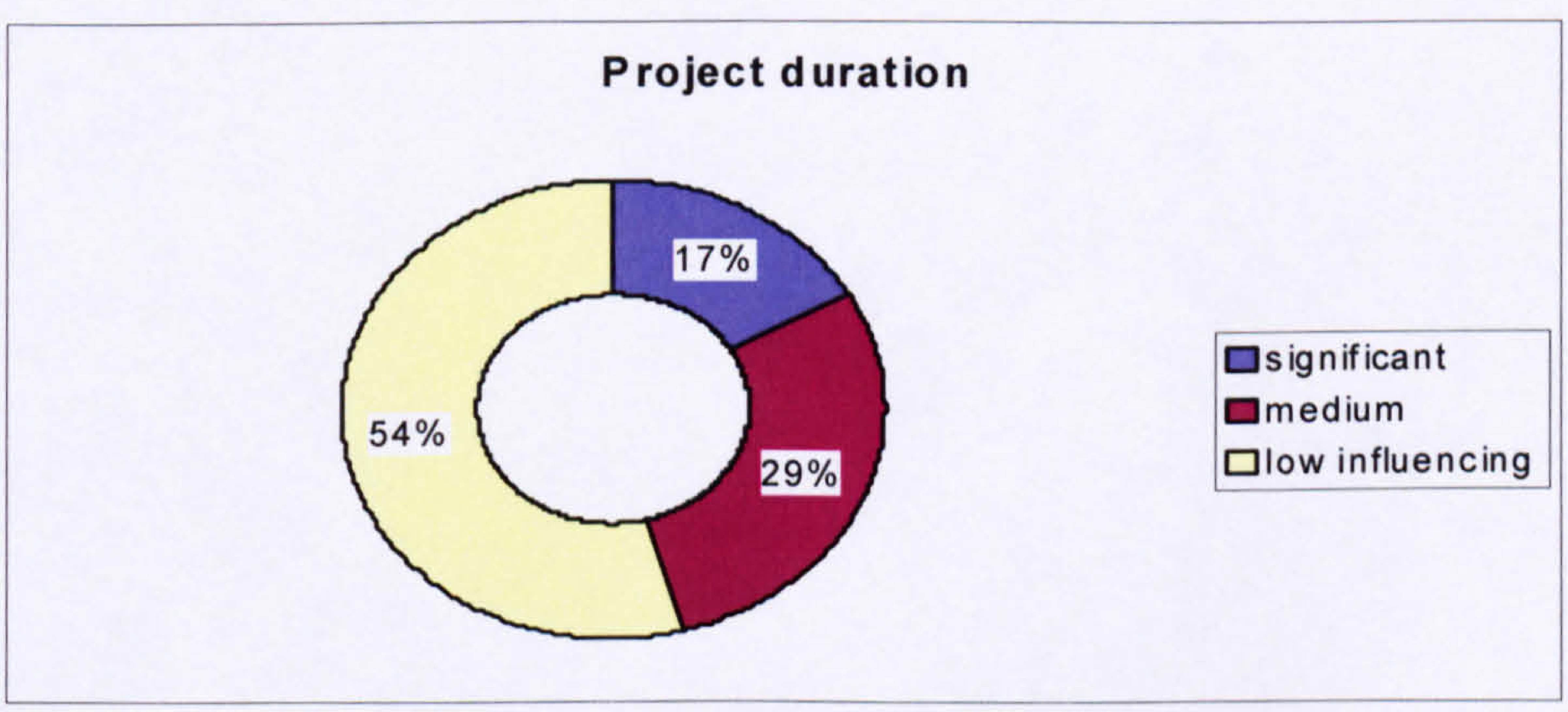

Fig. 6. 14 Project duration

Tender time

The availability of sufficient time for tenders is crucial when studying the project document and this leads to a good understanding of the project items so that the tenderer will price these items in a logical way.

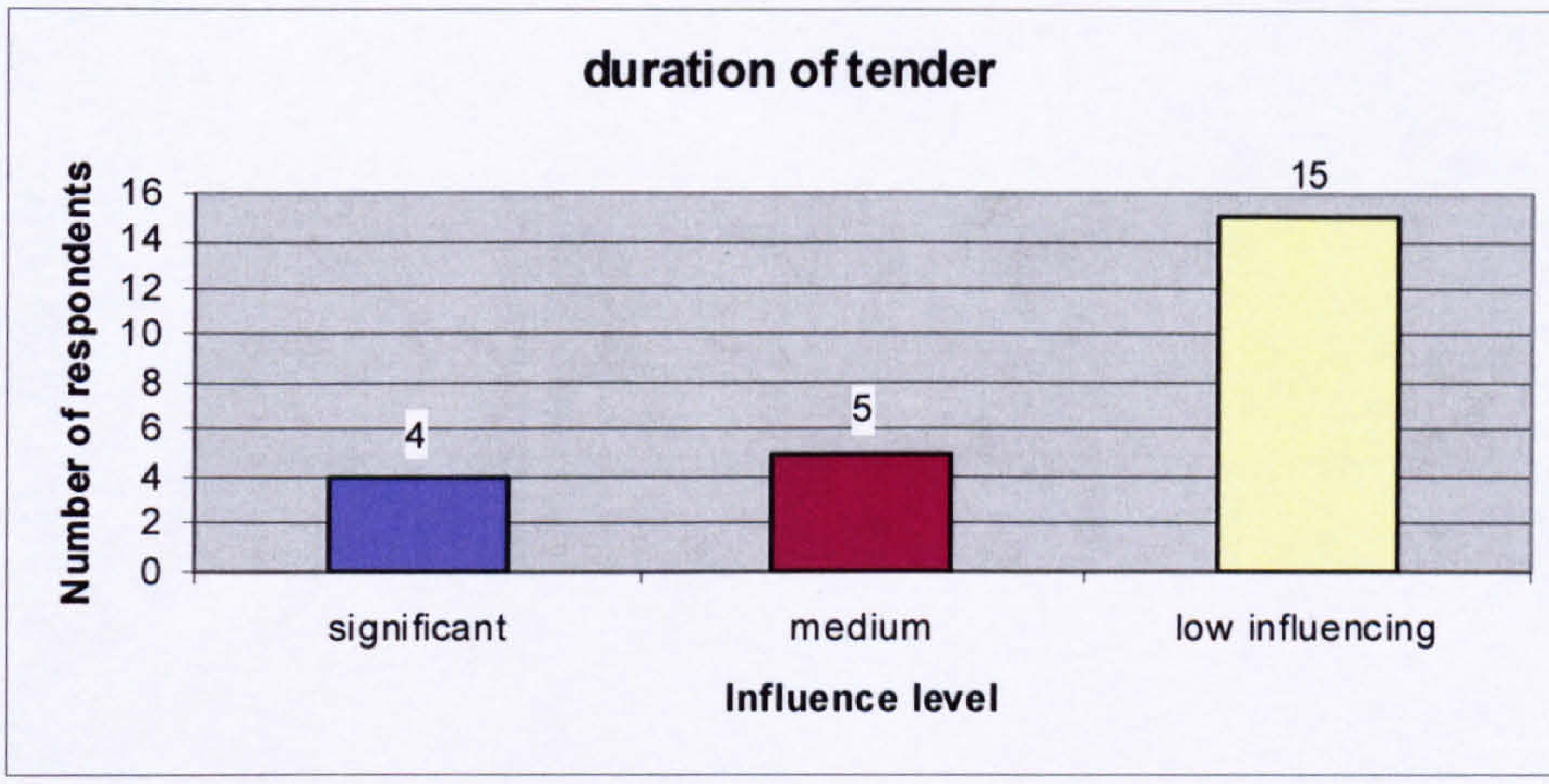

Fig. 6. 15 Duration of tender

Figure 6.15 shows that 15 of the 24 respondents believe that the tender time is not an influence factor in the payment methods, whereas only 4 respondents consider it to be a significant influence factor, and only five respondents think that its effect is medium. As a result of the survey it can be concluded that the duration of tender is not an influential factor when it comes to the selection of the payment methods.

Site condition

It is very important for the contractor to investigate the project's site conditions, such as the type of the soil, the water level, the contamination level, and the topography of the site. These factors have a significant effect on the cost of the project and also on the cost estimate.

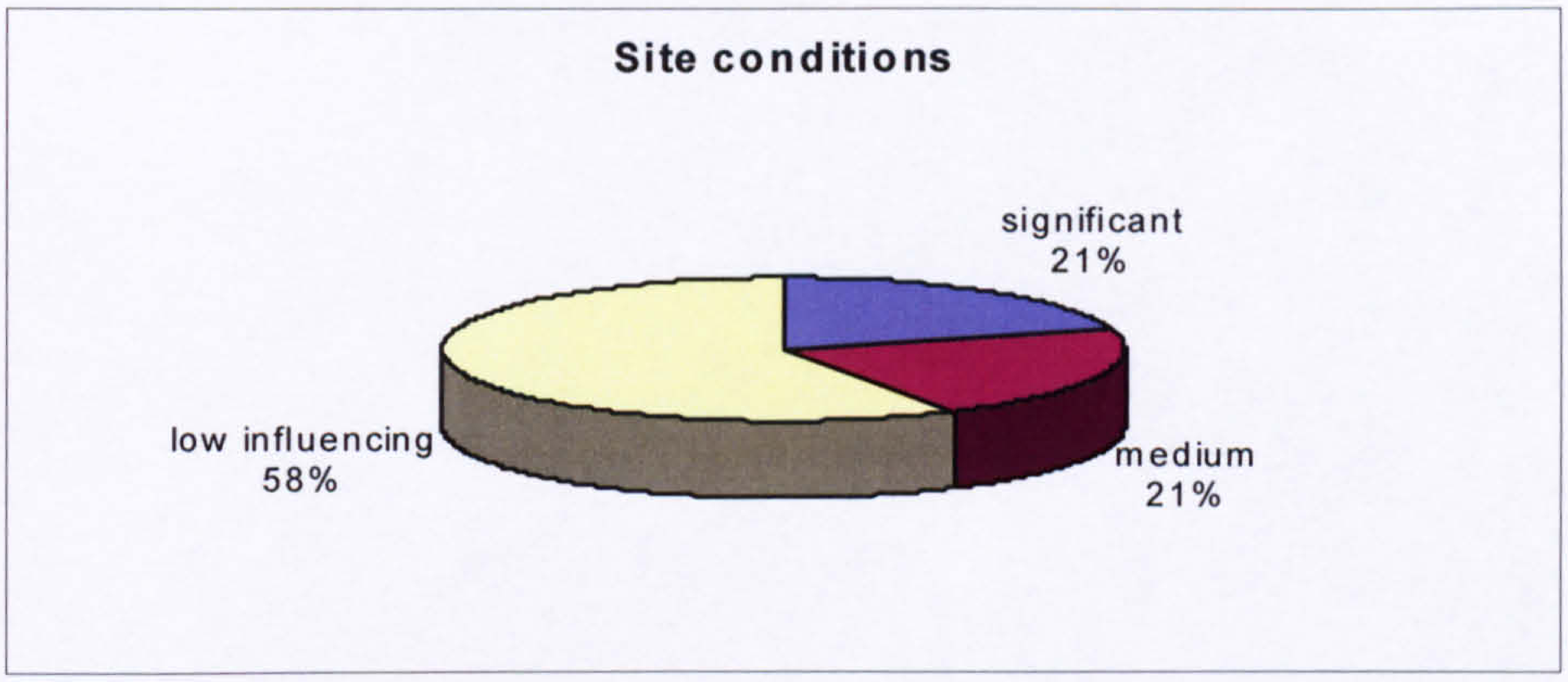

Fig. 6. 16 Site conditions

Figure 6.16 shows that the site conditions are a low influential factor in the payment methods, as it is clear from the survey results that 21% of the respondents consider that the site conditions have significant influence on the payment methods. Also, 21% of the respondents consider its effect level to be medium, whereas 58% of the respondents consider the site conditions as a low influence factor. It can be concluded that the site conditions are considered to be of low influence on the decision on payment methods selection.

Site location

As with the site condition, the project site location is also very important. The site location issues, such as distance to existing services, access to and from the site, roads and transport facilities, site security etc., have significant impact on the cost estimate.

It is clear from the survey results that site location has a low influence on the payment methods.

Figure 6.17 shows that 67% of the respondents see the site location as being of low influence on the payment methods, while 25% of the respondents scored its influence as medium, and only 8% consider that site location is a significant factor in the payment methods. Hence, as a result of the survey, it can be concluded that site location has no influence on the payment methods selection.

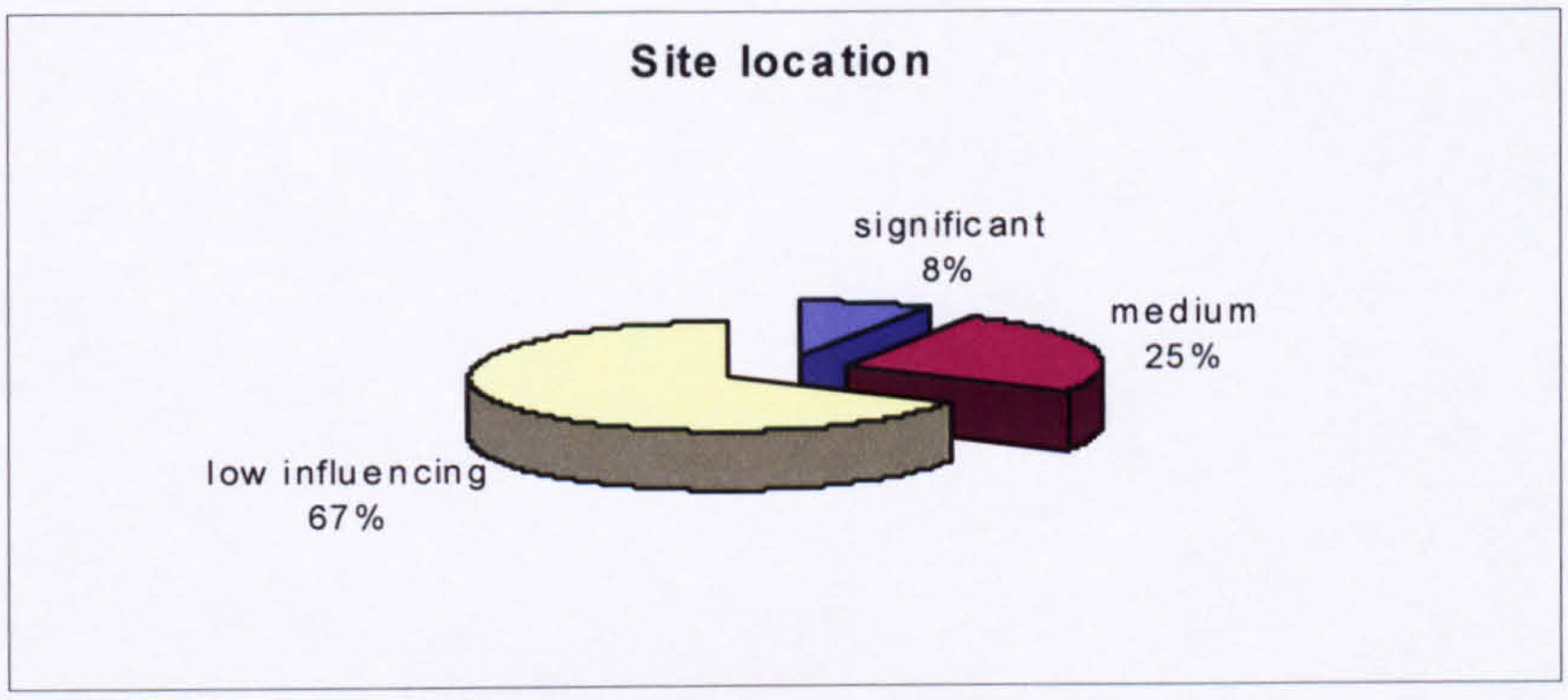

Fig. 6. 17 Site location

Project security level

The project security level depends on the project type, such as medical information system, banking, special projects, each with its specific access requirement and authorisation. Figure 6.18 shows that the project security level factor is not a significant factor in the payment methods. As a result of the survey, it is clear that only 8% of the respondents see that the project security level is a significant factor in the payment methods, while 25% of the respondents think that its influence level is medium, and 67% of the survey results show that the project security level is a low influence factor on the selection of payment methods; hence this factor should not be considered as an influence factor in the payment methods selection.

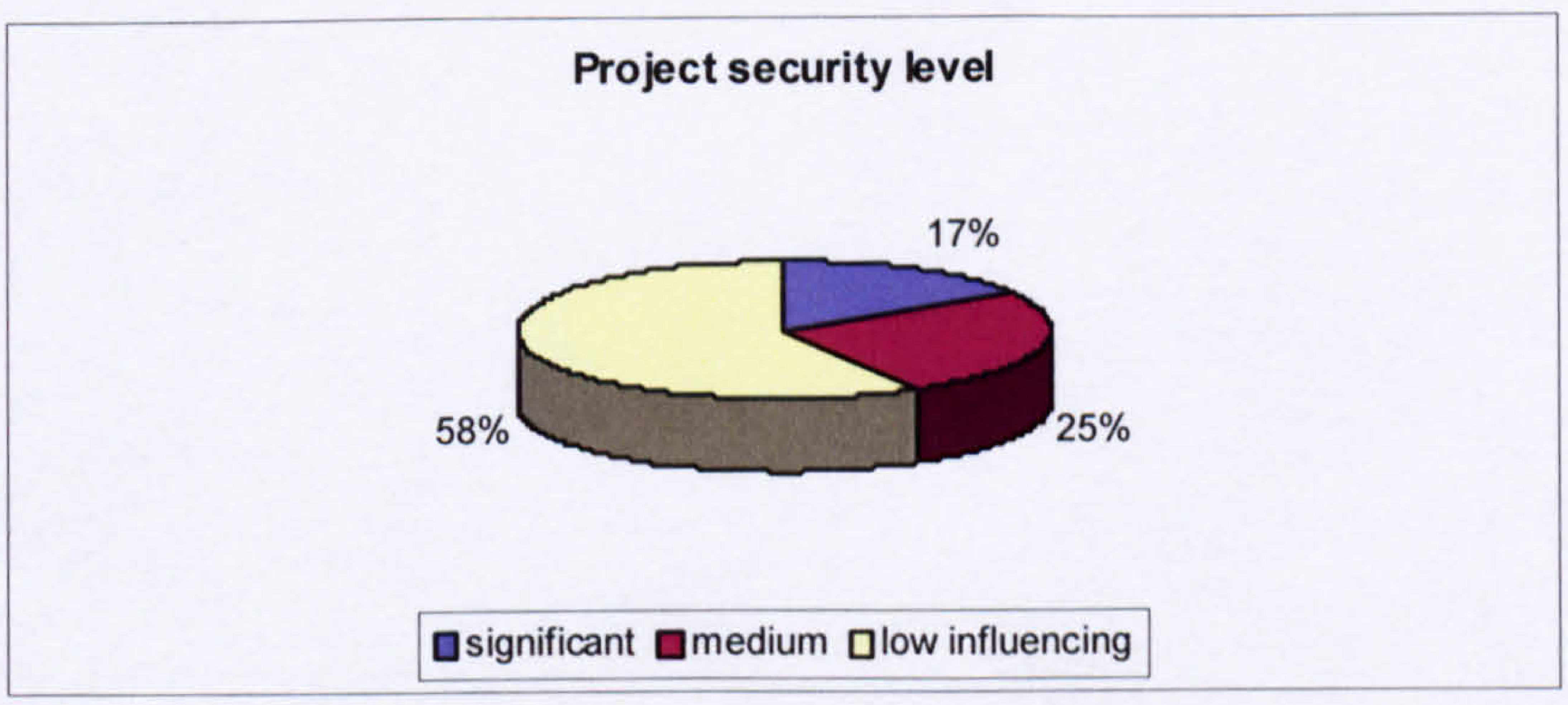

Fig. 6. 18 Project security level

Risk allocation

Risk management is essential to construction activities to minimise losses and enhance profitability (Akintoye and Macleod, 1997). Construction risk is generally perceived as the probability of occurrence of events whose impacts influence project objectives of cost, time and quality. The scope of risk management, according to Ward and Chapman (1995), is to cover and require consideration throughout the four phases of the project life cycle involving the conceptual, planning, execution, and termination phase. The aim of contract choice should always be to distribute risk clearly and unambiguously. Payment systems play a key role in defining how risk is allocated. Clients generally want to pay as little as possible and transfer as much risk as possible.

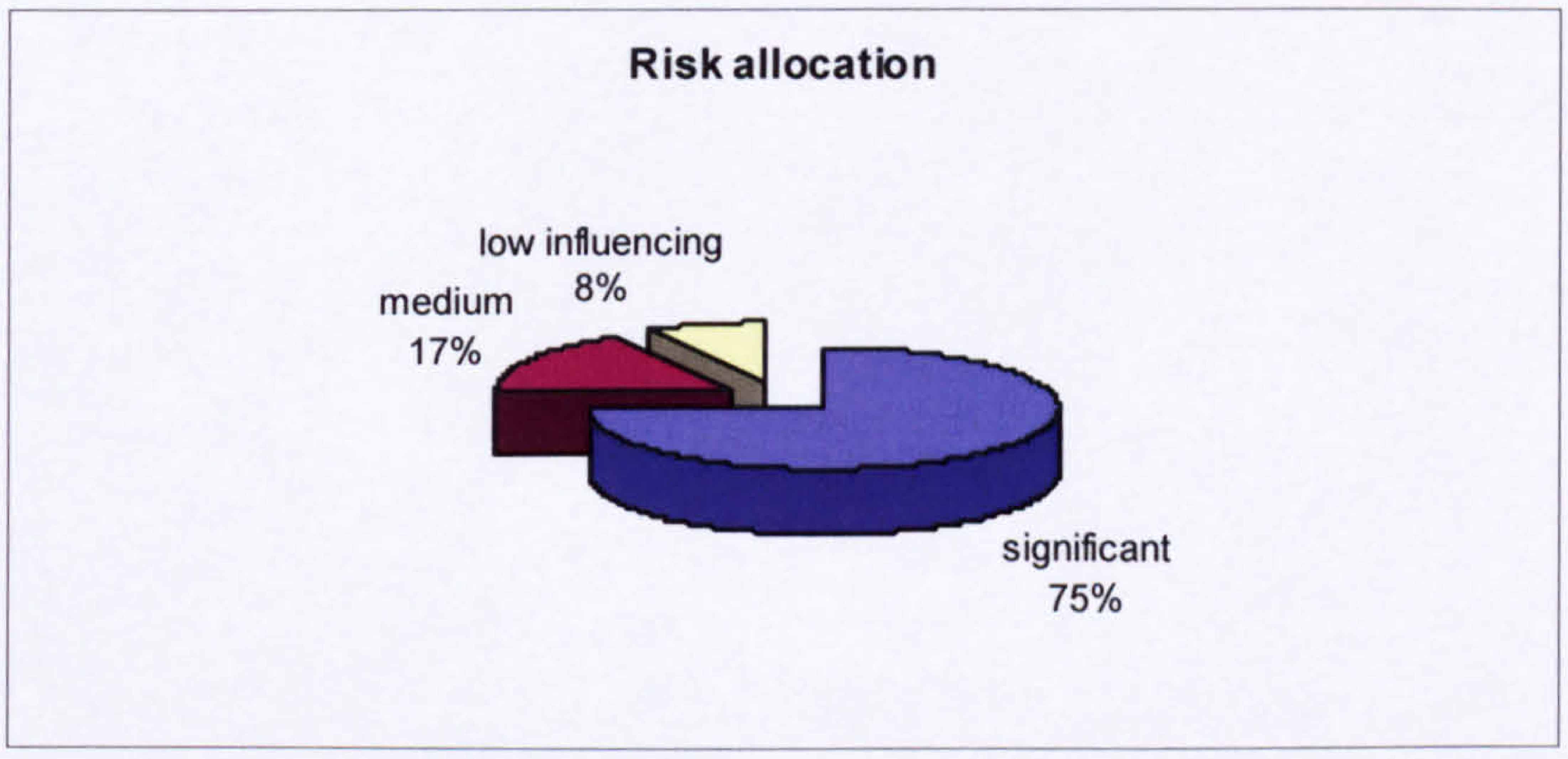

Fig. 6. 19 Risk allocation

Figure 6.19 represents the risk allocation factor as being significant to the payment methods. As a result of the survey, 75% of the respondents see that risk allocation is significant on the payment methods, whereas 17% of the respondents score its influence as of medium level, and only 8% of the survey results see that risk allocation is a low influence factor in the payment methods; hence this factor should be considered to be a significant influential factor in the payment methods selection.

Integrated Project Team

Willoughby (2005) indicates that a good improvement process in construction would involve a better teamwork spirit in a project. This could involve improved teamwork among the representatives of the project client, consultant, contractors and suppliers. According to Veil and Turner (2002), the concept of teamwork is important to achieve successful outcomes for a project. Working together in a project group brings more security in overcoming problems and uncertainty, and improvement of the project performance could be obtained. Construction management teams need to achieve a high capacity to plan and execute work in a manner that allows them to identify problems before any detrimental impact becomes evident, and to overcome such difficulties if they arise (Walker, 1996). The project team should be selected because they have the necessary technical competence to produce a building that is well designed, and constructed. It provides opportunities to maximise value and minimise waste at every stage of the construction.

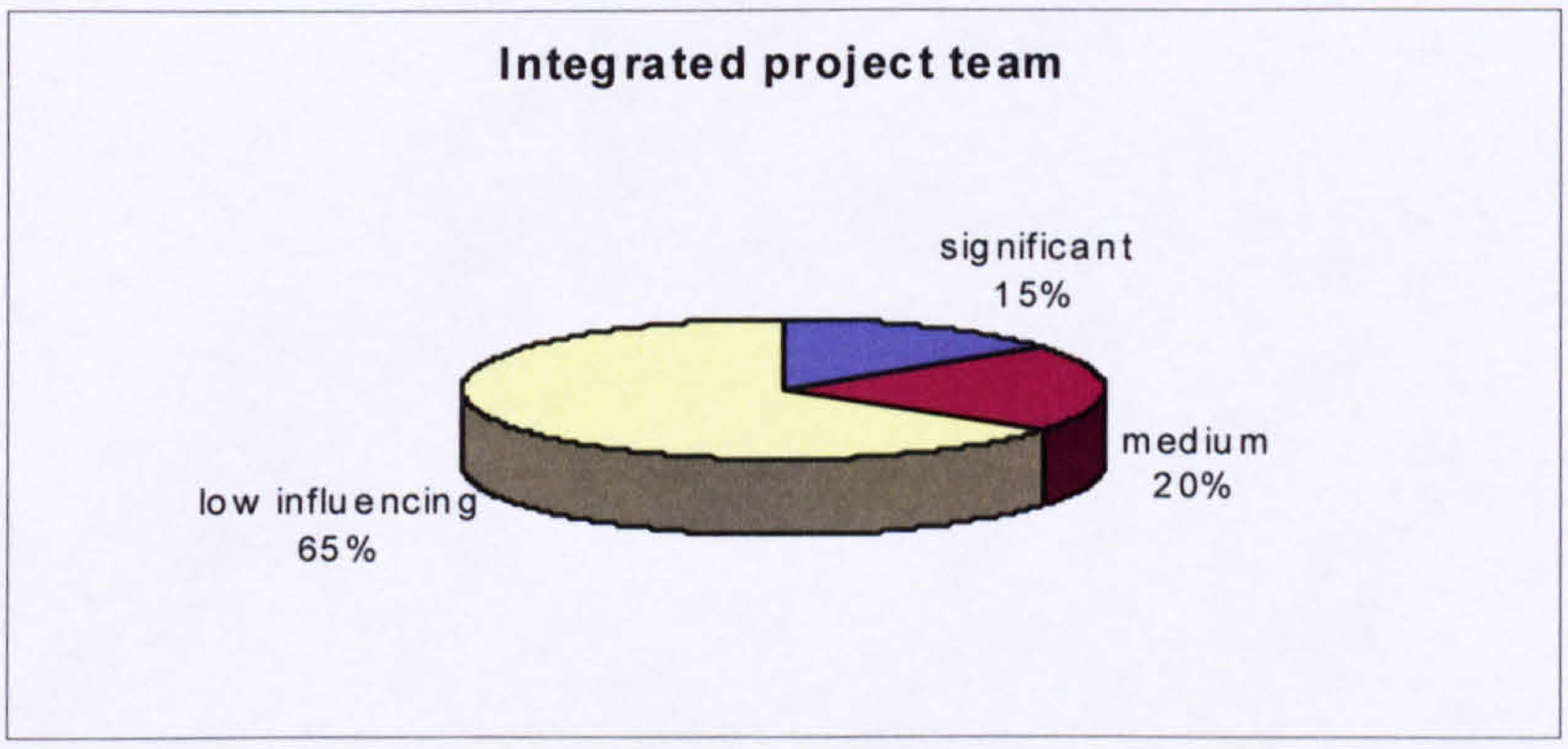

Fig. 6. 20 Integrated project team

Figure 6.20 shows that the project team is a low influential factor in the payment methods, as it is clear from the survey results that 15% of the respondents consider that the project team significantly influences the payment methods, while 20% of respondents considered it as of medium influence and 65% of the respondents consider the effect of the project team as a low influence factor. Hence, the project team is considered as a low influence factor concerning the decision on payment methods selection.

Responsibility allocation

Clear allocation of responsibilities between project parties is very important and helpful to avoid claims and disputes; for example, it is the responsibility of the client to appoint a planning supervisor as early as possible to allow adequate time to address issues during the planning and design stages.

According to Kerzner (1998), the project manager creates project planning and controlling, coordinating and negotiating requirements between sponsor and performing organisation, and overall leadership toward implementing the project plan. The general contractor is responsible for the job performances of the subcontractors and becomes liable if a subcontractor fails to pay for materials and labour, since the general contractor is obligated to complete the project free and clear of all defects.

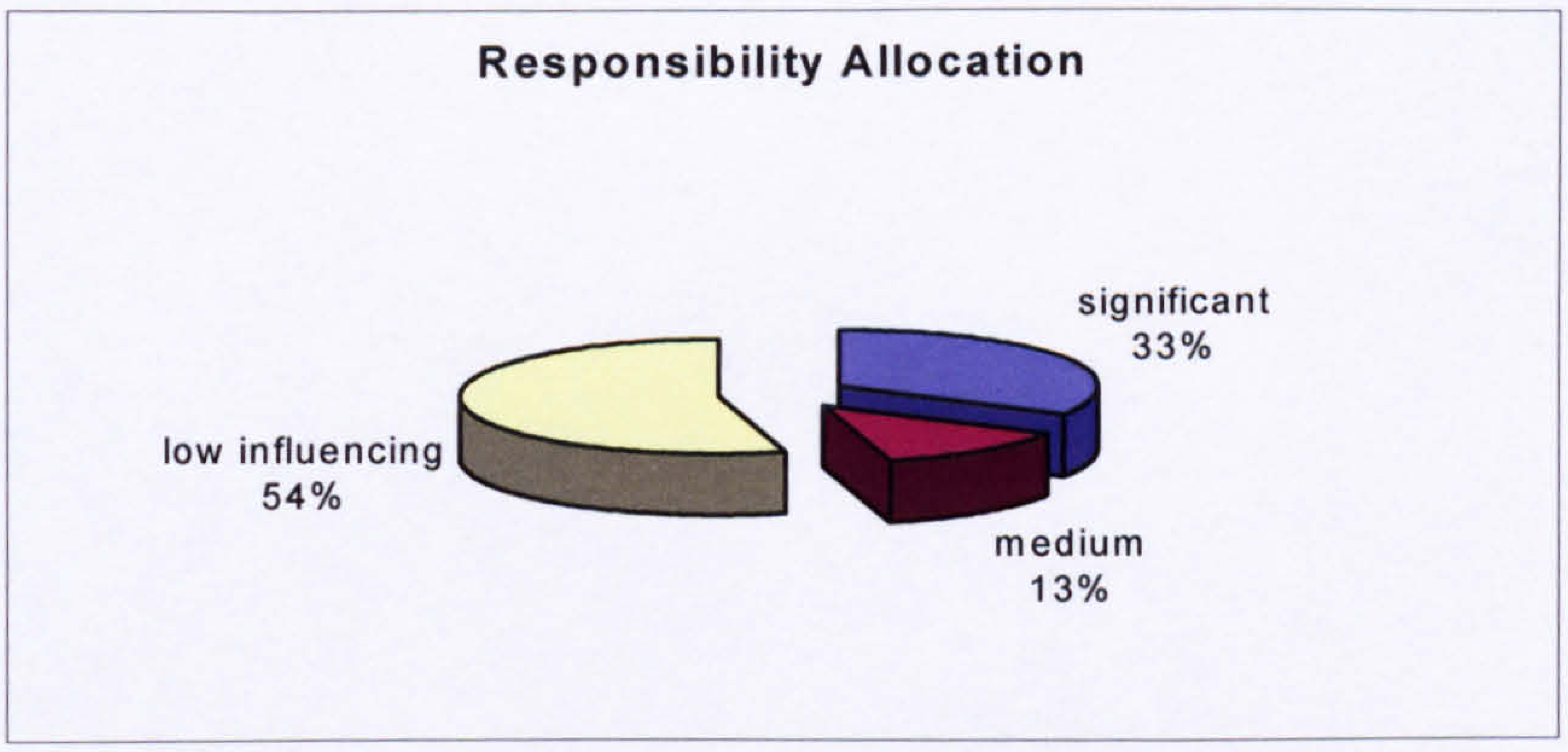

Fig. 6. 21 Responsibility allocation

It is clear from the survey results that the responsibility allocation issue is of low influence on the payment methods. Figure 6.21 above shows that 54% of the respondents see the responsibility allocation as being of low influence on the payment methods, while 13% of the respondents score its influence as medium, and only 33% consider that responsibility allocation is a significant factor in the payment methods. The mean score of the survey result is 2.83. Hence, as a result of the survey, it can be concluded that the responsibility allocation is not an influence factor in the payment methods selection.

Project Manager Authority

Kerzner (1998) defined the project authority as the legal or rightful power to command, act, or direct the activities of others. Authority is the key to the project process. The authority of the project manager could be broken down into three areas: legal authority, reality authority, and project charter authority. The project manager must manage across functional and organisational lines by co-ordinating the activities required to accomplish the objectives of a specific project. The project manager should not attempt to describe fully the exact authority and responsibilities of his/her project office personnel or team members. Instead, he/she should encourage problem solving rather than role definition.

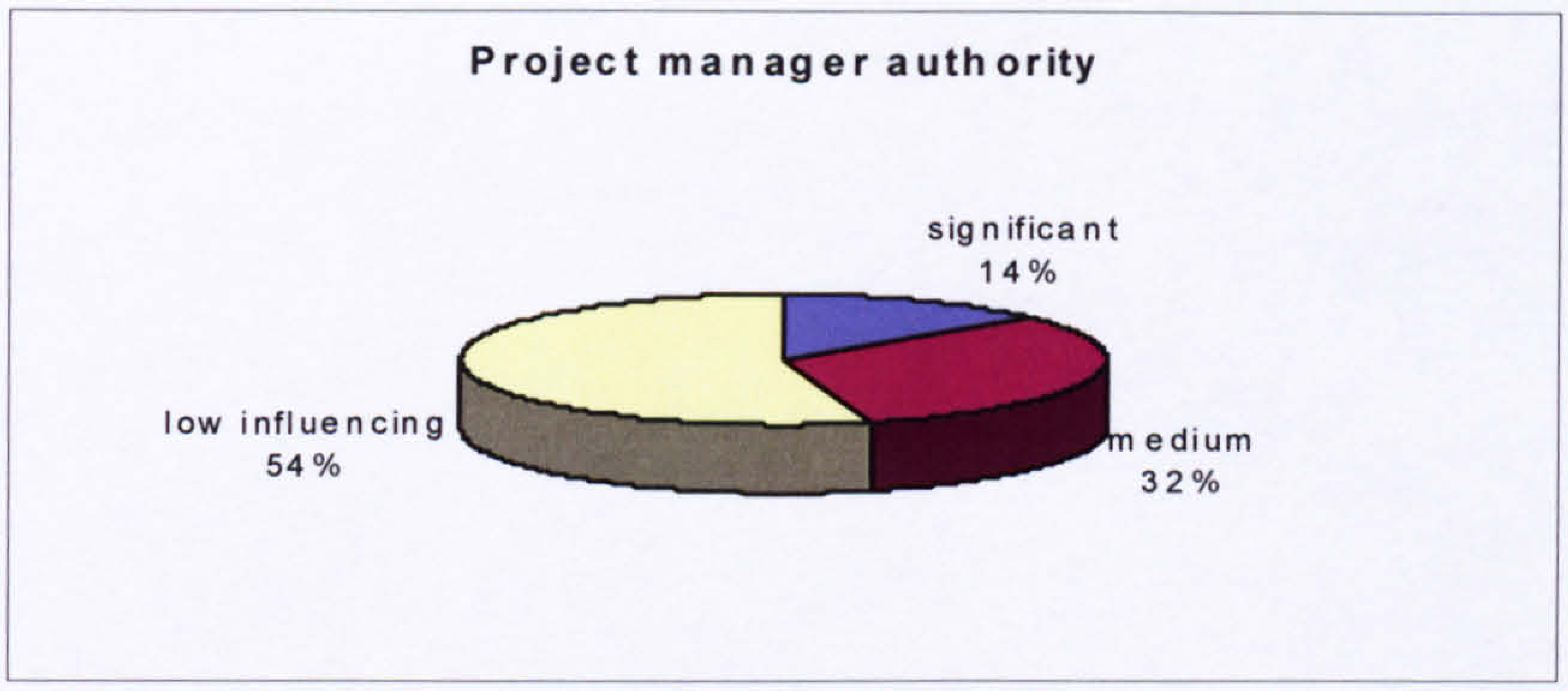

Fig. 6. 22 Project manager authority

It is clear from the survey result that project manager authority has a low influence effect on the payment methods. Figure 6.22 (pie chart) below shows that 54% of the respondents see project authority as being of low influence in the payment methods, while 32% of the respondents score its effect level as medium, and only 14% consider that the authority of the project manager is a significant factor in the payment methods. The mean score of the survey result is 2.68. Hence, as a result of the survey, it can be concluded that the authority of the project manager does not influence the payment methods selection.

Peer relationships

In most construction projects, subcontractors who are hired to perform specific tasks on a project play a vital role. In a typical case, the general contractor will perform the basic operations and then subcontract the remainder to various specialty contractors. Subcontracting is used much more extensively in housing and building construction projects than in engineering and industrial projects (Clough and Sears, 1994). In many projects, especially building projects, it is common for 80 to 90% of the work to be performed by subcontractors (Hinze and Tracey, 1994).

The relationship between some subcontractors and some general contractors is sometimes characterised as partnering. The adoption of partnering between subcontractors and general contractors may be motivated by the desire to establish a relationship based on trust, respect and honesty as well as to reduce procurement problems, claims, and litigation. According to Kumaraswamy and Mattews (2000), prime contractors and subcontractors believe that there is benefit in developing partnering arrangements between prime contractors and key subcontractors.

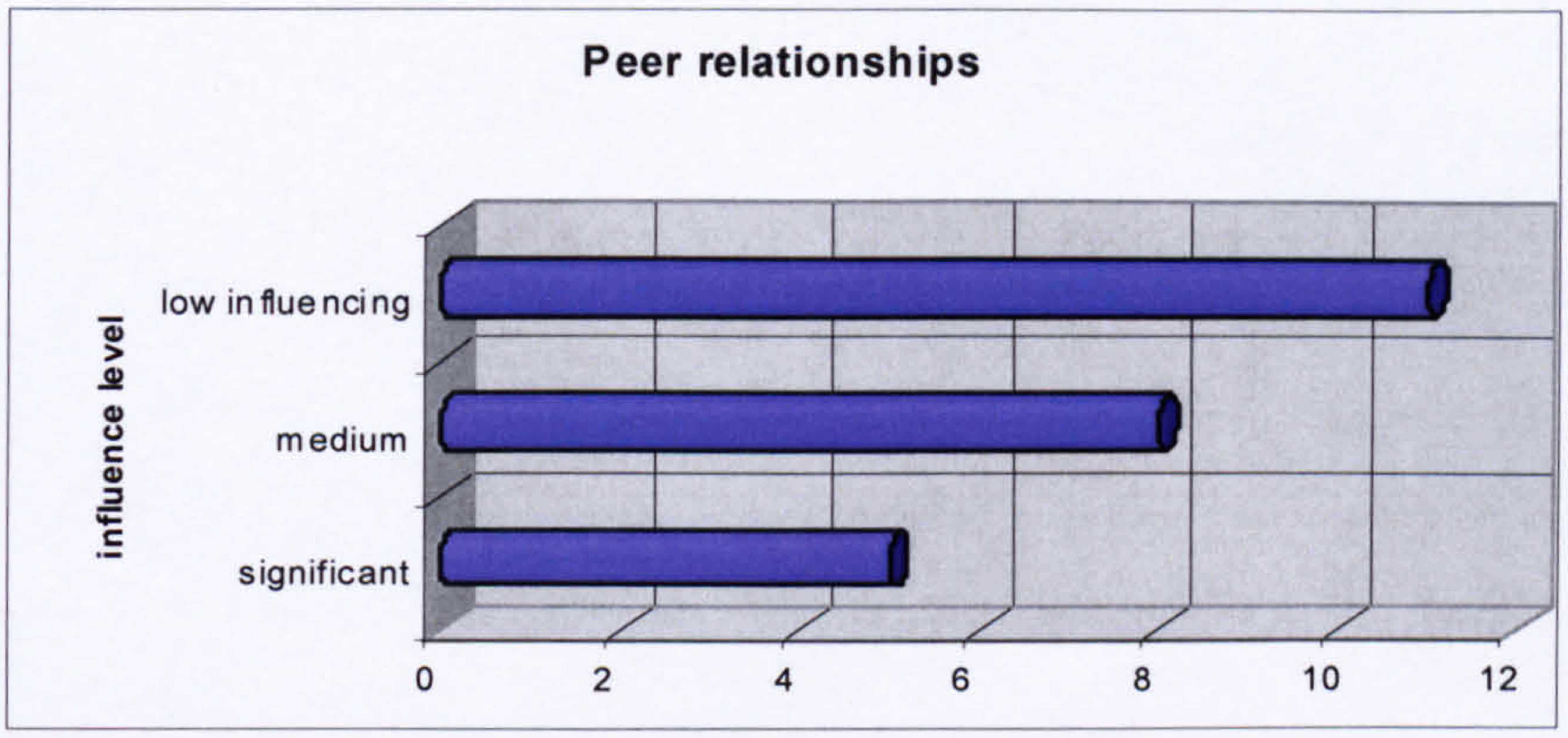

Fig. 6. 23 Peer relationships

Figure 6.23 above shows peer relationship to be a low influence factor on the payment methods; it is clear from the survey results that 21% of the respondents consider that peer relationships are a significant influence factor on the payment methods, while 33% of respondents consider its effect as medium and 46% of the respondents consider peer relationship to be a low influence factor. Hence, it can be concluded that peer relationship is of low influence in the decision on payment methods selection.

Flexibility in working time

Construction work is variable: the difference between standard time and basic time for a job can be quite large. For building work and other activities of a more stable nature, however, basic times are useful in estimating and planning. Usually the working time on site is five days per week; the normal working time in summer is between 8:00 am and 5:30 pm, whereas in winter the time will end one hour early (4:30pm). Accurate time data is essential to estimators and planners in contracting organisation, but for such data to be of value it must have been measured in a planned environment, and not obtained from a disorganised site with inefficient working practices (Harris and McCaffer, 1995). This means that if the client has a restriction on the working time owing to some circumstances, the working time will be changed accordingly and an increase in the cost to cover the new working time is required.

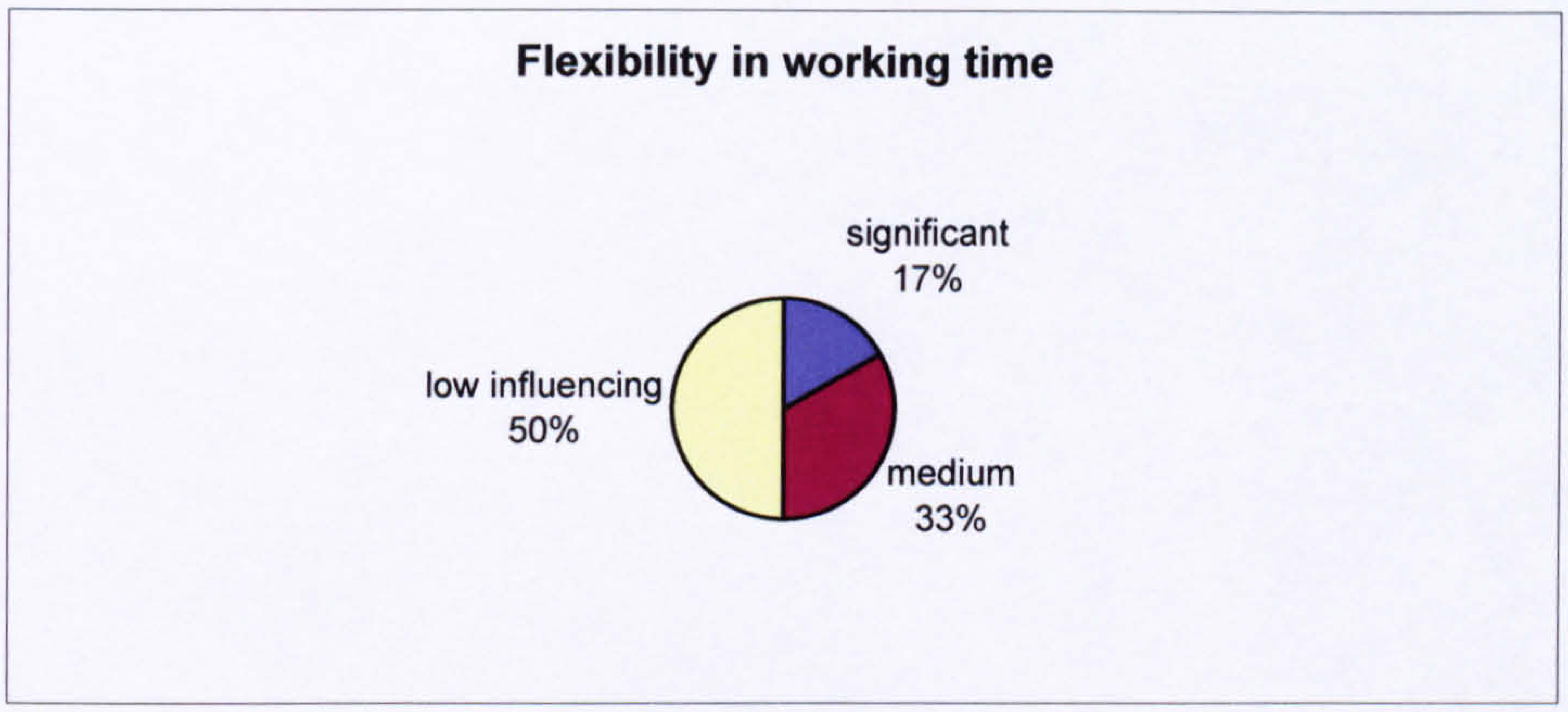

Fig. 6. 24 Flexibility in working time

It is clear from the survey results that the flexibility of working time is of low influence on the payment methods. Figure 6.24 above shows that 50% of the respondents see flexibility of working time as being of low influence on the payment methods, while 33% of the respondents considered its effect as medium, and only 17% consider that the flexibility of working time is a significant factor on the payment methods. The mean score of the survey result is 2.50. As a result of the survey, it can be concluded that the flexibility of the working time is not an influence factor on the payment methods selection.

Project budget availability

A budget is an estimate of the costs and incomes to be generated if a proposed project is undertaken. Budgets are predictions and are thus subject to accuracy constraints in respect of the techniques employed, information available, expertise of personnel, etc. (Fellows et al., 1998). The budget should provide the required information at an acceptable level of accuracy and for a reasonable cost to enable management to make a decision and control the project. Budgets are usually based upon limited information and so require updating and amending as more information becomes available and as circumstances affecting the budgets change.

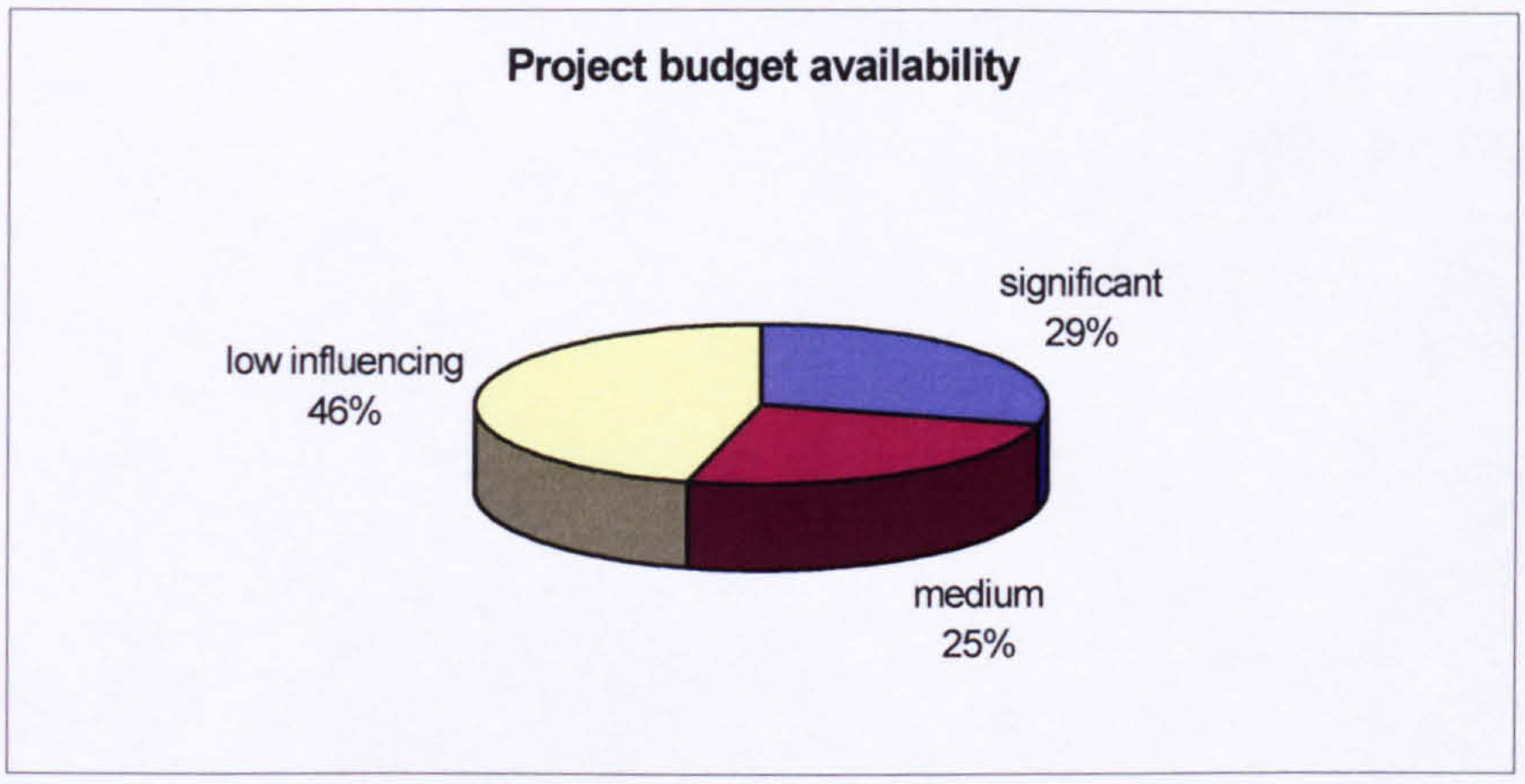

Fig. 6. 25 Project budget availability

It is clear from the survey results that the issue of project budget availability is of low influence on the payment methods. Figure 6.25 above shows that 46% of the respondents see project budget availability as being of low influence in the payment methods, while 25% of the respondents score its influences as medium, and 29% consider that the project budget availability is a significant factor in the payment methods selection. The mean score of the survey result is 2.68. Hence, as a result of the survey, it can be concluded that project budget availability is not an influence factor on the payment methods selection.

Project type

The survey results shows that project type has no effect on the choice of payment systems. Figure 6.26 above shows that 29% of the respondents see project type as being of low influence on the payment methods, while 38% of the respondents score its influence as medium, and only 33% consider that project type is a significant factor in the payment methods. The mean score of the survey result is 2.92. Hence, as a result of the survey, it can be concluded that project type is not an influence factor in the payment methods selection.

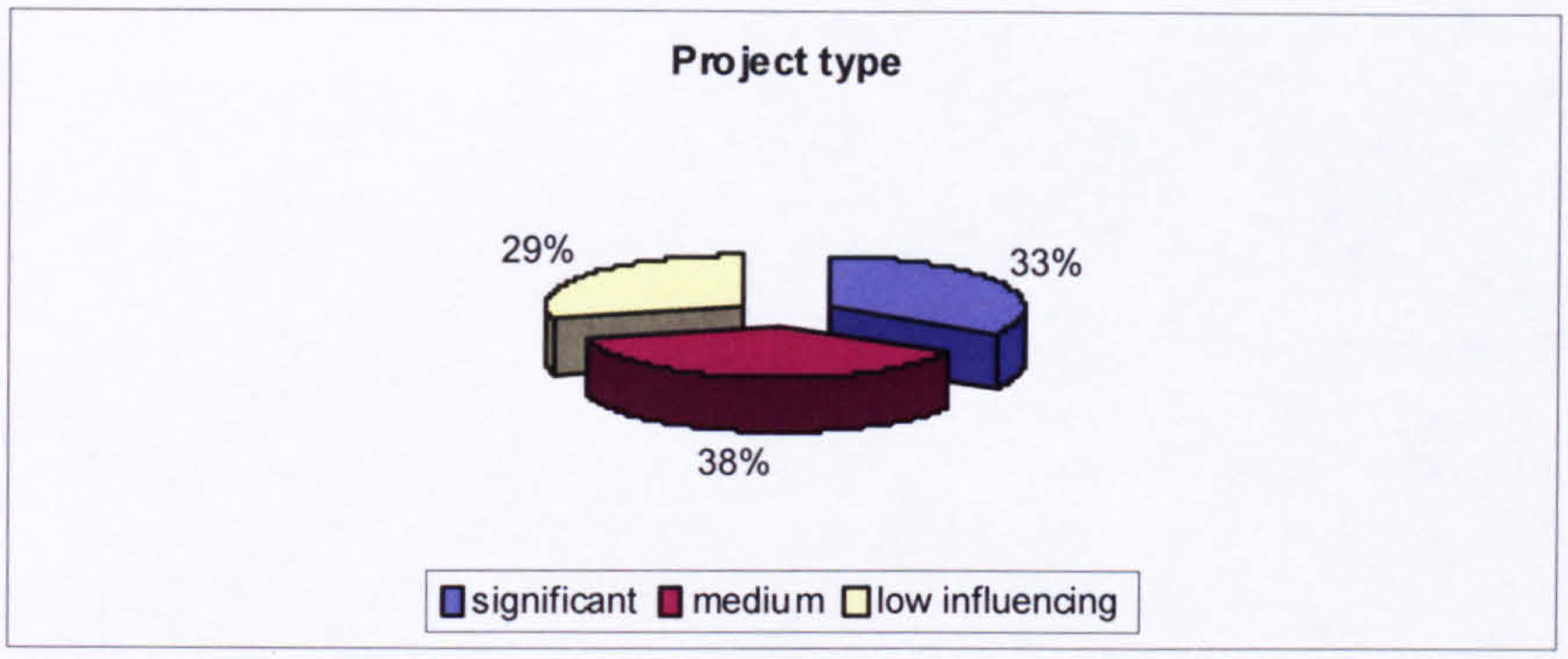

Fig. 6. 26 Project type

Speed during the design and construction

It is becoming common in the construction industry to shorten the duration of the design and construction by overlapping the two phases. A payment system that is based solely on progress on site would discourage contractors from prolonging off-site activities. The choice of payment system does, therefore, influence the construction technology to be adopted and subsequently the project duration.

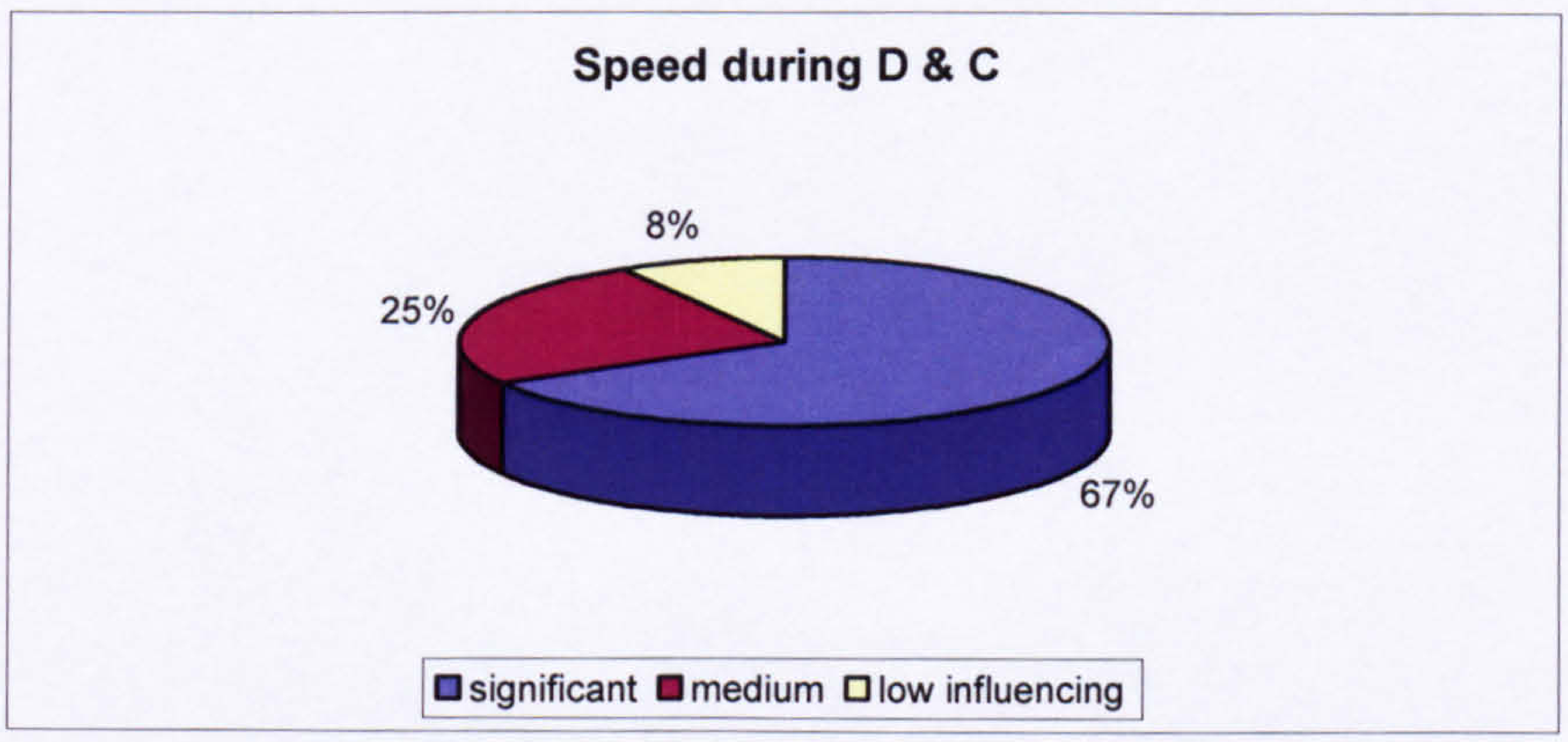

Fig. 6. 27 Speed during design and construction

Figure 6.27 represents the speed during design and construction factor as being significant to the payment methods. As a result of the survey, 67% of the respondents see that speed during design and construction is significant in the payment methods, whereas 25% of the respondents score its influence as medium level, and only 8% of the survey results see that speed during design and construction is a low influence factor in the payment methods;

hence this factor should be considered to be a significant influential factor in the payment methods selection

Tender methods

There are three tendering methods:

1. open tender method.
2. selective tendering.
3. negotiated tendering.

The tendering process follows certain procedures, including the announcement of a project or invitation to bid, preparation of bids, submission and, finally, the evaluation and contract awarding.

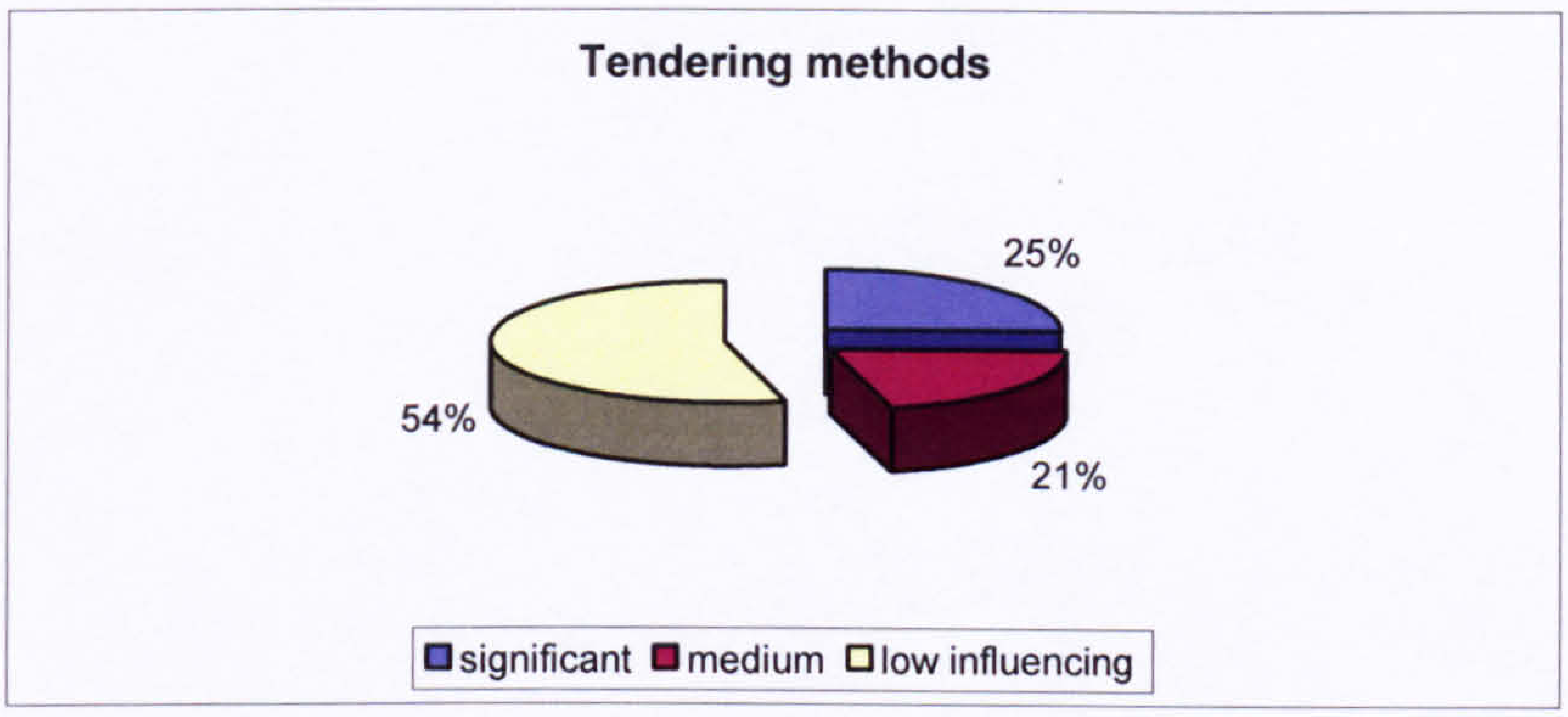

Fig. 6. 28 Tendering method

It is clear from the survey result that tendering method has a low influence effect on the payment methods. Figure 6.28 shows that 54% of the respondents see tendering method as being of low influence in the payment methods, while 21% of the respondents score its effect level as medium, and only 25% consider that the tendering method is a significant factor in the payment methods. Hence, as a result of the survey, it can be concluded that tendering method does not influence the payment methods selection.

Disputes likelihood

As a result of increasingly complex construction projects, the number of construction disputes has increased dramatically. At project level, unresolved disputes can lead to programme delay, increased tension, and can damage long-term business relationships.

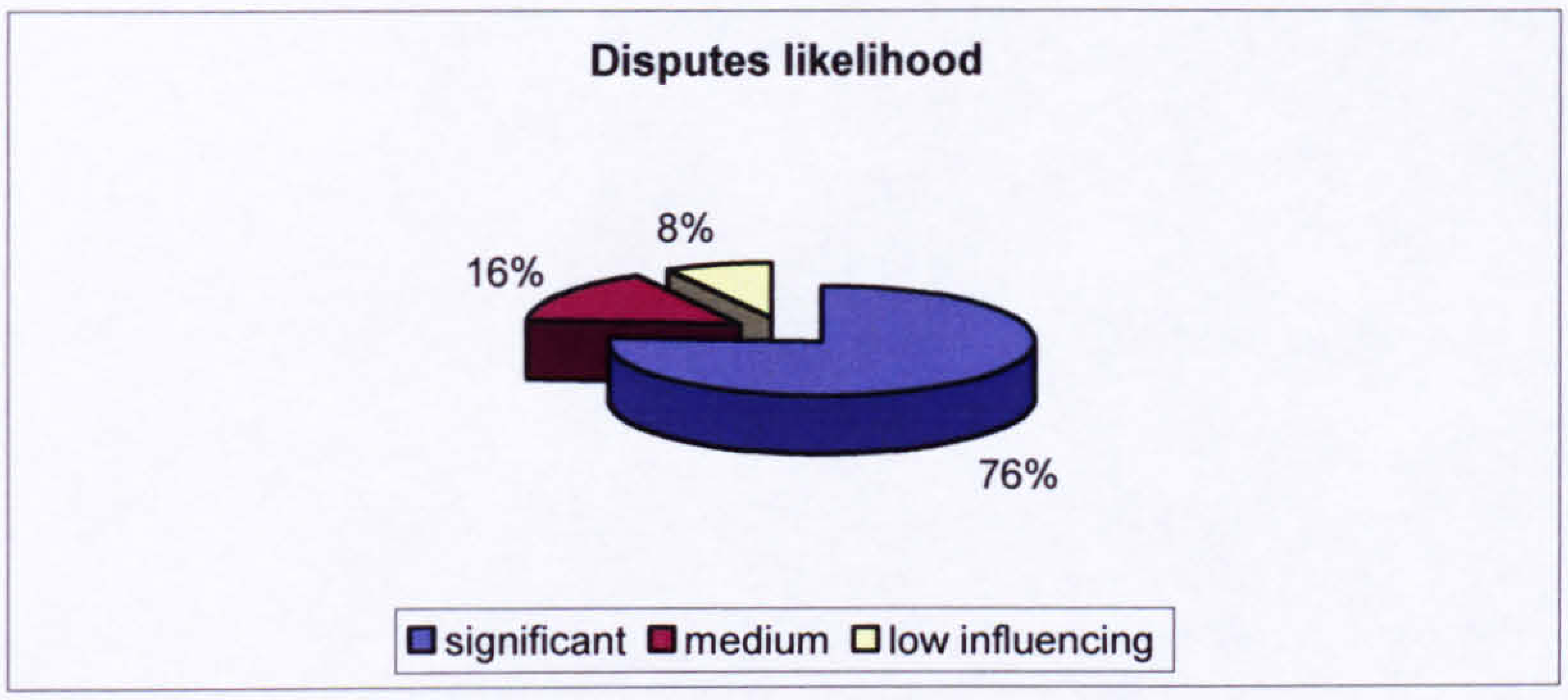

Fig. 6. 29 Disputes likelihood

Figure 6.29 shows disputes likelihood as a significant influential factor in the payment methods. 76% respondents consider that disputes likelihood has a significant influence on the payment methods, whereas only 8% think that its influence is medium and 16% consider the affect disputes likelihood on payment methods as a low influence.

Extent of competition

Competitive bidding has been encouraged in order to give an equal chance of bidding for all contractors, and to ensure competitive bid price.

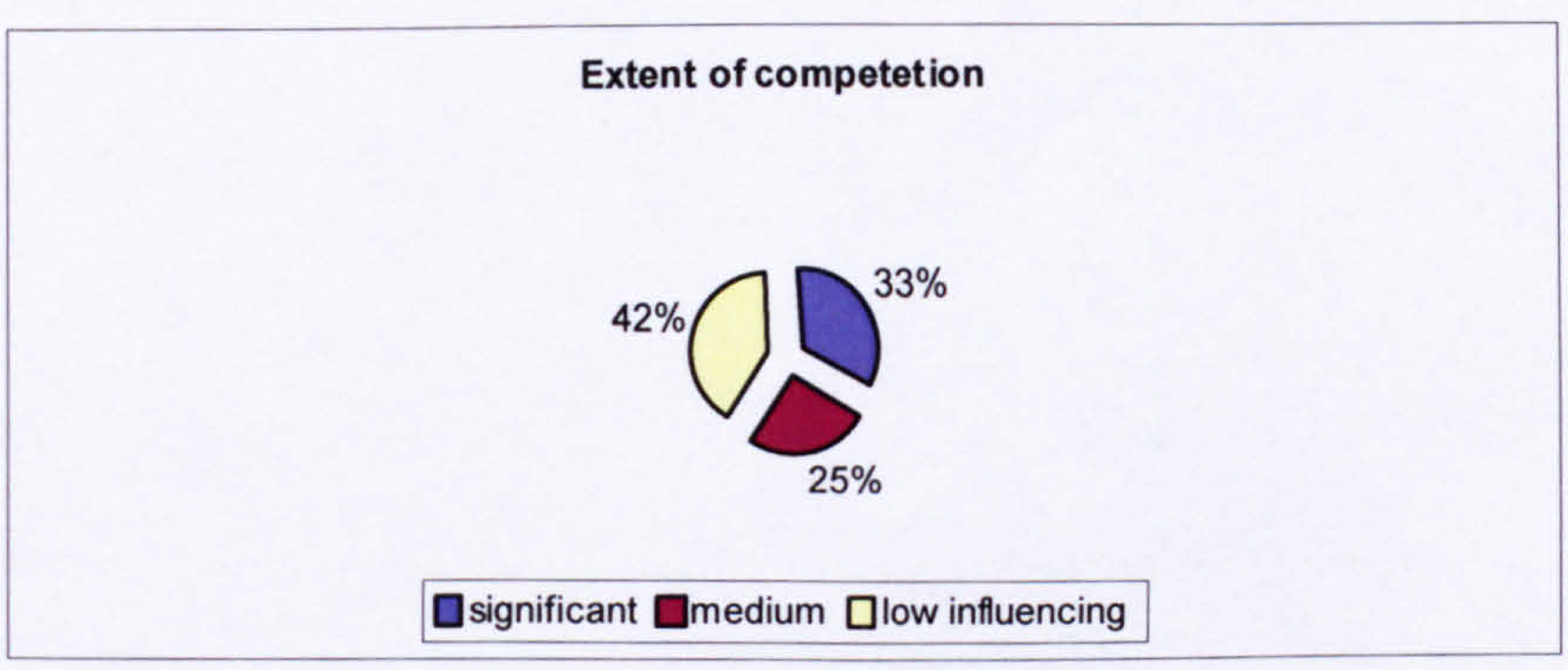

Fig. 6. 30 Extent of competition

It is clear from the survey result that extent of competition has a low influence effect on the payment methods. Figure 6.30 shows that 42% of the respondents see extent of competition as being of low influence in the payment methods, while 25% of the respondents score its effect level as medium, and only 25% consider that extent of competition is a significant factor in the payment methods. Hence, as a result of the survey, it can be concluded that extent of competition does not influence the payment methods selection.

Tender documents availability

Bidding documents include all the instructions and forms that are part of the bidding process. They should be made available to a sufficient number of bidders to foster competition. Recent developments in the use of "electronic plan rooms" have increased the availability of project information to multiple users.

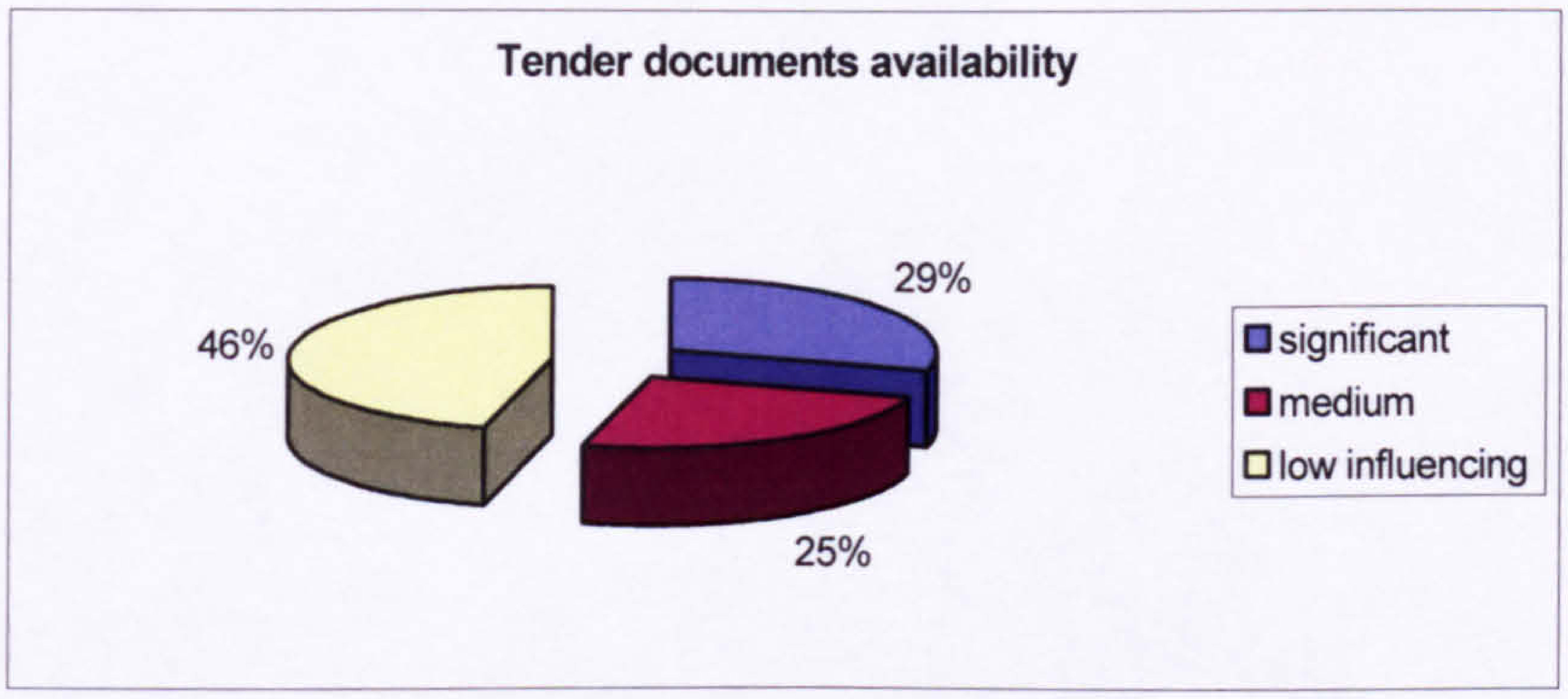

Fig. 6. 31 Tender documents availability

It is clear from the survey results that the issue of tender documents availability is of low influence on the payment methods. Figure 6.31 above shows that 46% of the respondents see tender documents availability as being of low influence in the payment methods, while 25% of the respondents score its influences as medium, and 29% consider that tender documents availability is a significant factor in the payment methods selection. The mean score of the survey result is 2.68. Hence, as a result of the survey, it can be concluded that tender documents availability is not an influence factor in the payment methods selection.

Economic conditions

The construction project prices have a strong relationship with the market prices. This relation will be continuous during the project duration, and any change in the economic conditions will directly affect the financing of the project.

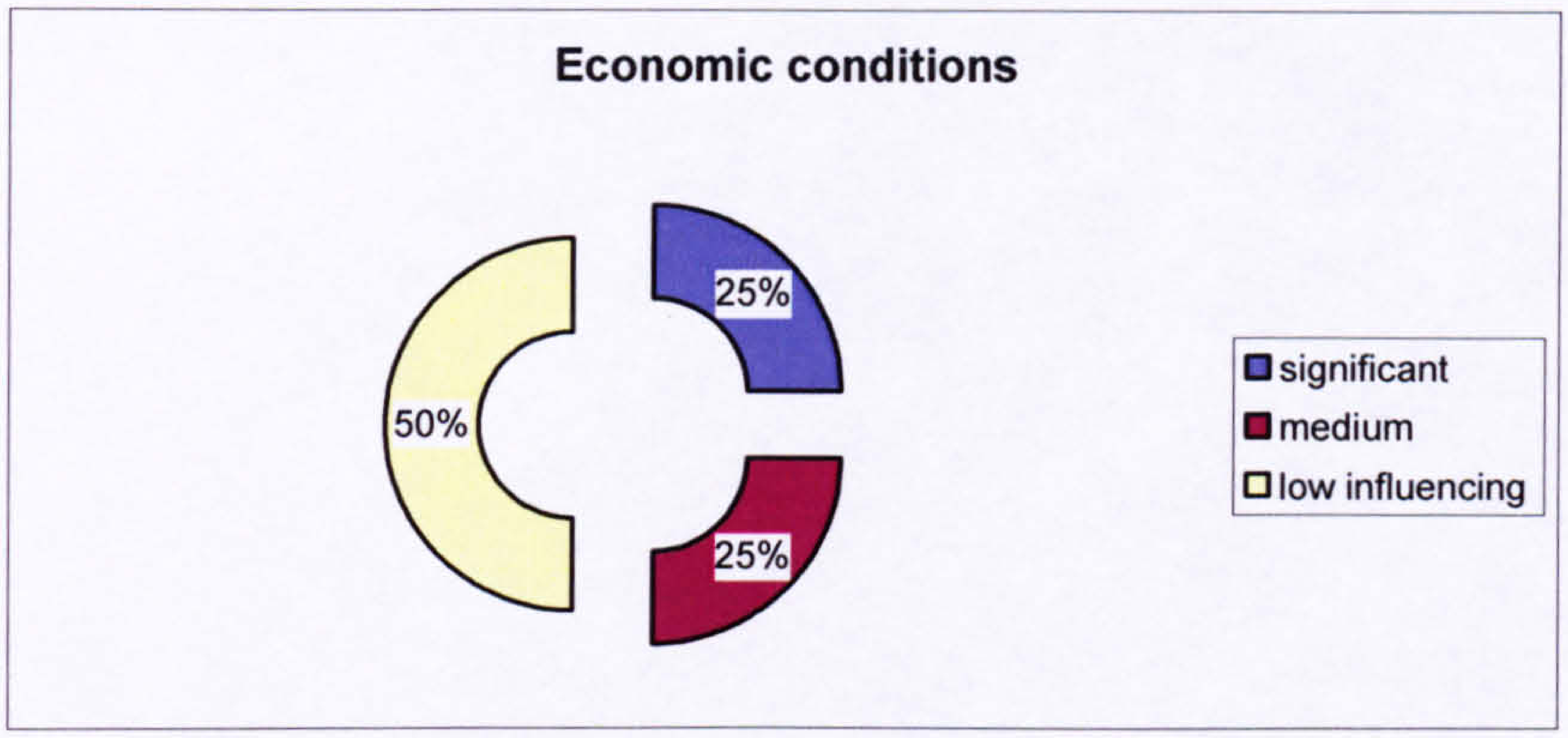

Fig. 6. 32 Economic conditions

Figure 6.32 above shows that 50% of the respondents see economic conditions as being of low influence on the payment methods, while 25% of the respondents considered its effect as medium, and only 25% consider economic conditions to be a significant factor in the payment methods. As a result of the survey, it can be concluded that economic conditions are not an influence factor in the payment methods selection.

Investment in briefing

Perry (1987) has identified the impact by referring to an unidentified Swedish study of work carried out by the client and his consultants, up to and including the design stage, as influencing 90% of the construction cost, with only 15% of the actual project expenditure having been incurred. It can be seen that, although the client may be anxious to see work commence on site, progress during this stage should be carefully controlled and not unreasonably forced.

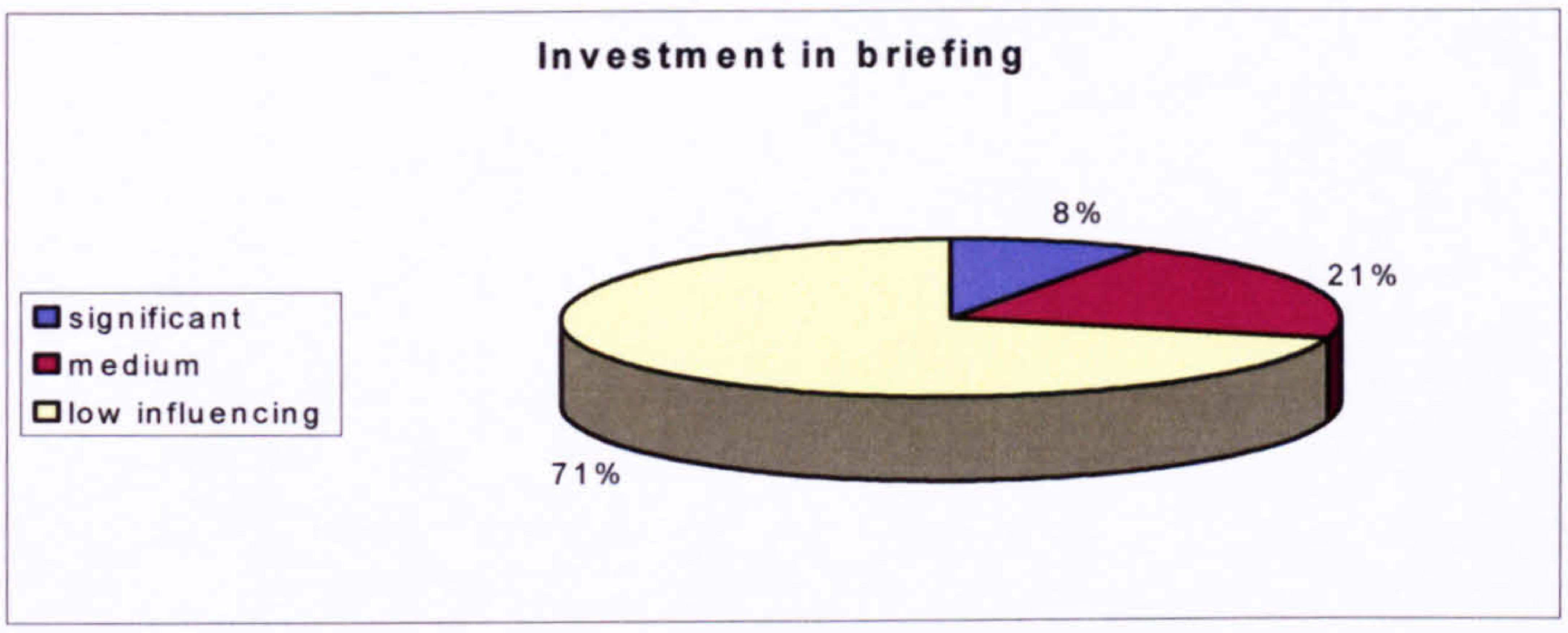

Fig. 6. 33 Investment in briefing

Figure 6.33 above shows that 71% of the respondents see investment in briefing as of low influence on the payment methods, while 21% of the respondents think that its effect level is medium, and only 8% consider that the investment in briefing is a significant factor in the payment methods selection. As a result of the survey, it can be concluded that investment in briefing does not influence the payment methods selection.

Project quality

The achievement of an acceptable standard in buildings is a combination of quality of design and quality of construction. Good quality control is achieved by setting the right standards to meet the needs of the client.

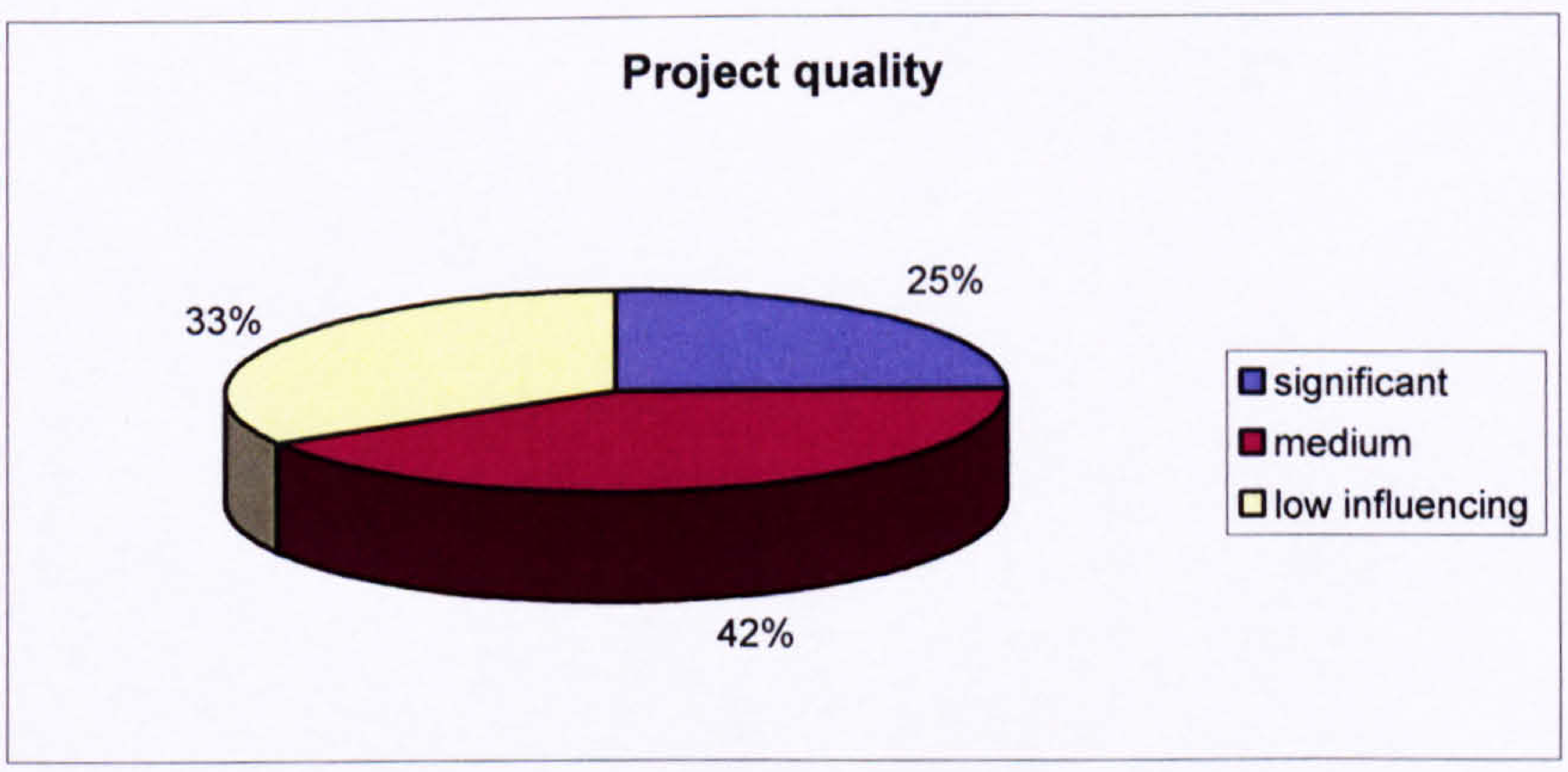

Fig. 6. 34 Project quality

Figure (6.34) shows that the project quality factor is not a significant factor in the payment methods. As a result of the survey it is clear that only 25% of the respondents see that project quality is a significant factor in the payment methods, while 42% of the respondents think that its influence level is medium, and 33% of the survey results show that project quality is a low influence factor in the payment methods; hence this factor should not be considered as an influence factor in the payment methods selection.

No blame culture

Blame is of concern whenever systems break down and an error incident or accident occurs. Multiple public as well as the internal organizations and individuals directly involved, seek to allocate, accept and avoid blame and the potential social shame emotionally involved within circumstances of ongoing risk that unexpectedly stands revealed.

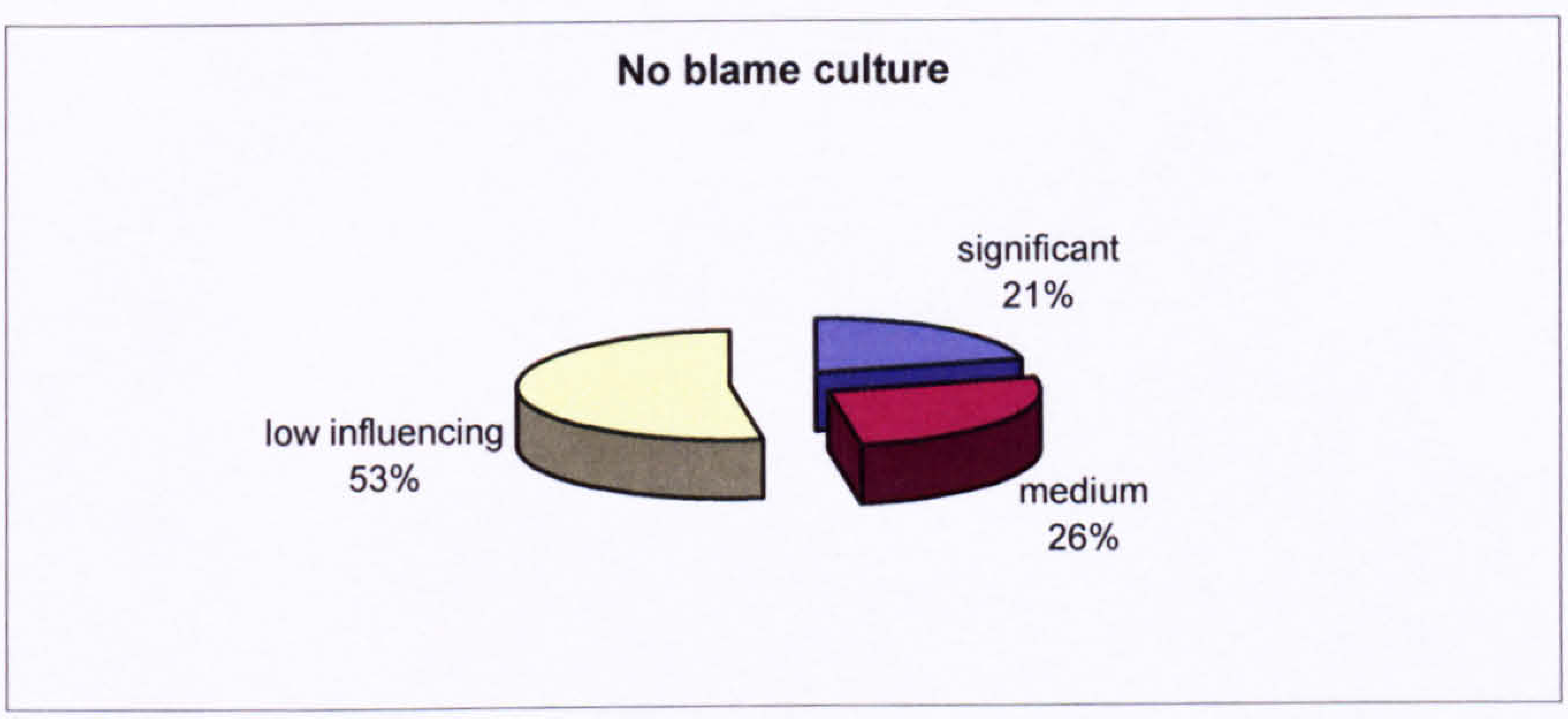

Fig. 6. 35 No blame culture

Figure 6.35 shows that the issue of a no blame culture is of low influence in the payment methods; it is clear from the survey results that 21% of the respondents consider that the issue of a no blame culture has a significant influence on the payment methods, while 26% of respondents score its effect as medium, and 53% of the respondents consider the issue of a no blame culture to be a low influence factor. Hence, the issue of a no blame culture is considered to be of low influence on the decision on payment methods selection.

6.3 FACTORS INFLUENCING PRICING SYSTEM

It is usual to assume that any construction project is priced in such way that the price of each item comprises the cost of that item plus the relevant share of overheads and profit. For a typical construction project the price is based upon a cost prediction and is agreed between the client and contractor prior to the work being commenced. The following discusses the results of the questionnaire in terms of the extent to which the list of factors identified earlier affect the choice of the pricing system.

Cost certainty

For all construction projects, costs must be monitored and controlled whether from the point of view of the owner, designer or contractor (Pilcher, 1994).

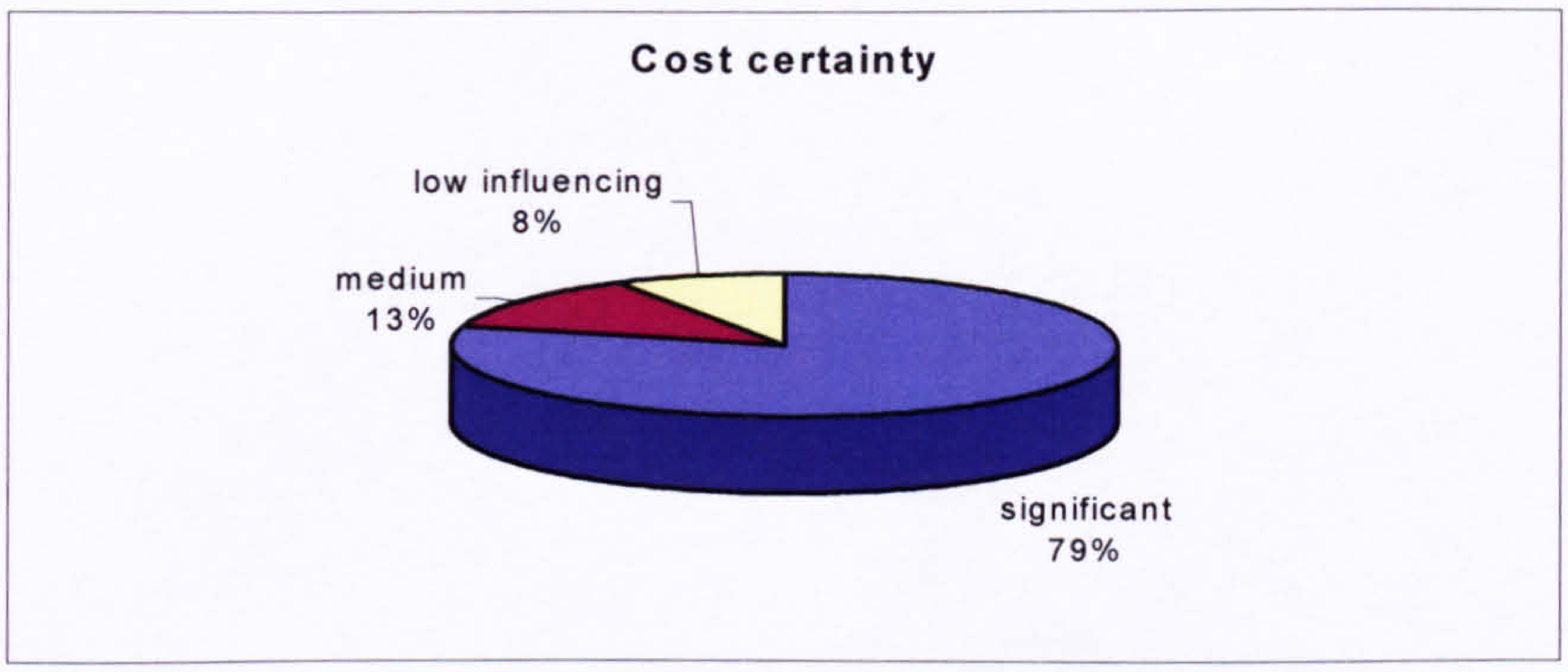

Fig. 6. 36 Cost certainty

Figure 6.36 shows that the cost certainty factor is significant to the pricing system. As a result of the survey, it is clear that 79% of the respondents see that cost certainty is significant to the pricing system, whereas only 13% of the respondents score its influence as medium, and only 8% of the survey results see that cost certainty is a low influencing factor to the pricing system. It can be concluded that cost certainty is a significant influence factor in the pricing system.

Time certainty

An important measurement of success in the management of construction projects is the achievement of the completed project within the prescribed timescale. Projects which are late will typically produce financial penalties, either in lost profits that would have accrued through use of the project, or through expected benefits to the public not being realised.

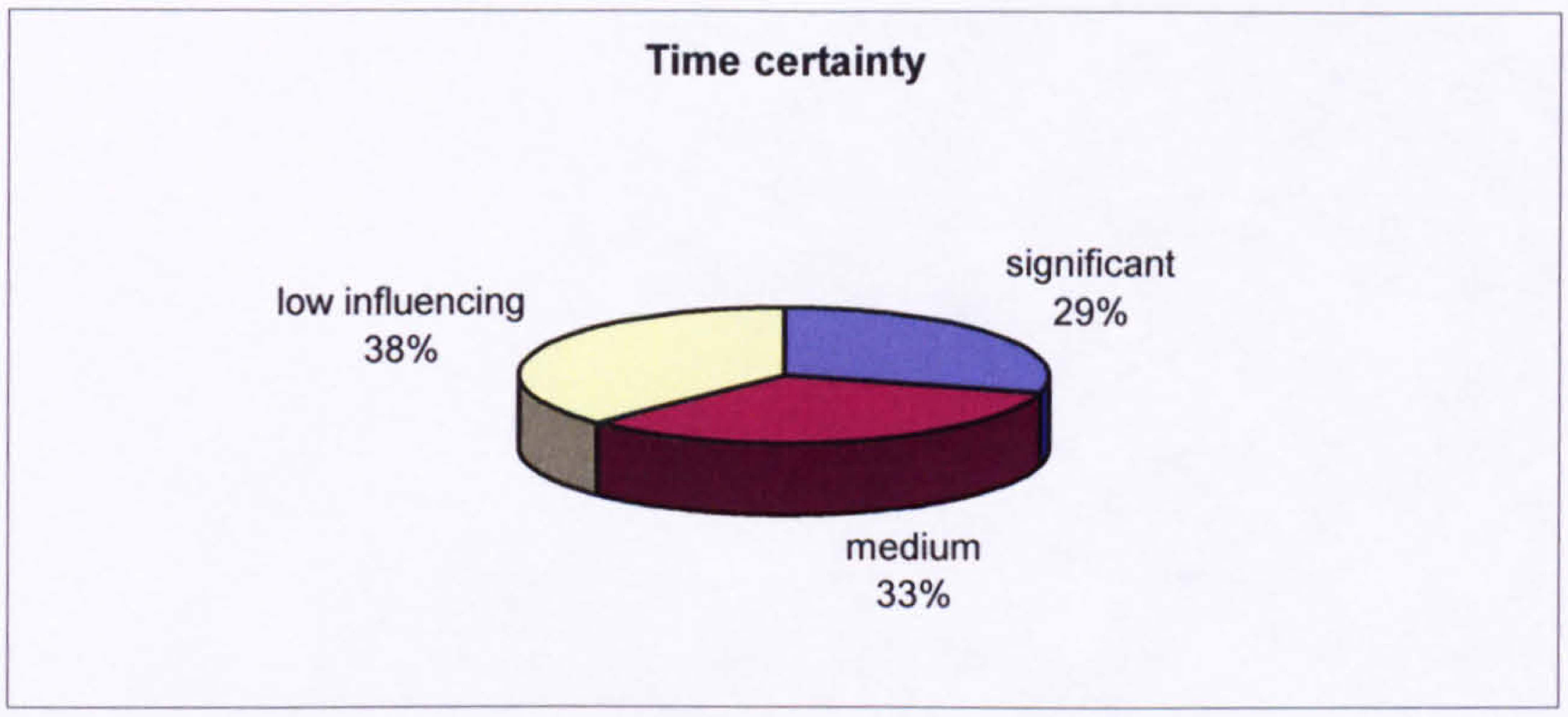

Fig. 6. 37 Time certainty

It is clear from the survey results that the issue of time certainty has a low influence on the pricing system. Figure 6.37 shows that 38% of the respondents see time certainty as being of low influence to the pricing system, 33% of the respondents consider its effect as a medium influence factor, and 29% consider that time certainty is a significant factor in the pricing system. The mean score of the survey result is 2.79. As a result of the survey, it can be concluded that the time certainty does not influence the pricing system.

Project size

One of the first items to be considered in connection with any construction project is its size. This is an important factor in terms of cost. A particular pricing system may be more appropriate for a particular size of project.

From the survey; it is clear that project size a significant influence factor in the pricing system. As shown below in figure 6.38, 71% of the respondents see project size as significant, while 21% think that its influence is medium, and the remaining 8% think that project size is of low influence in the pricing system

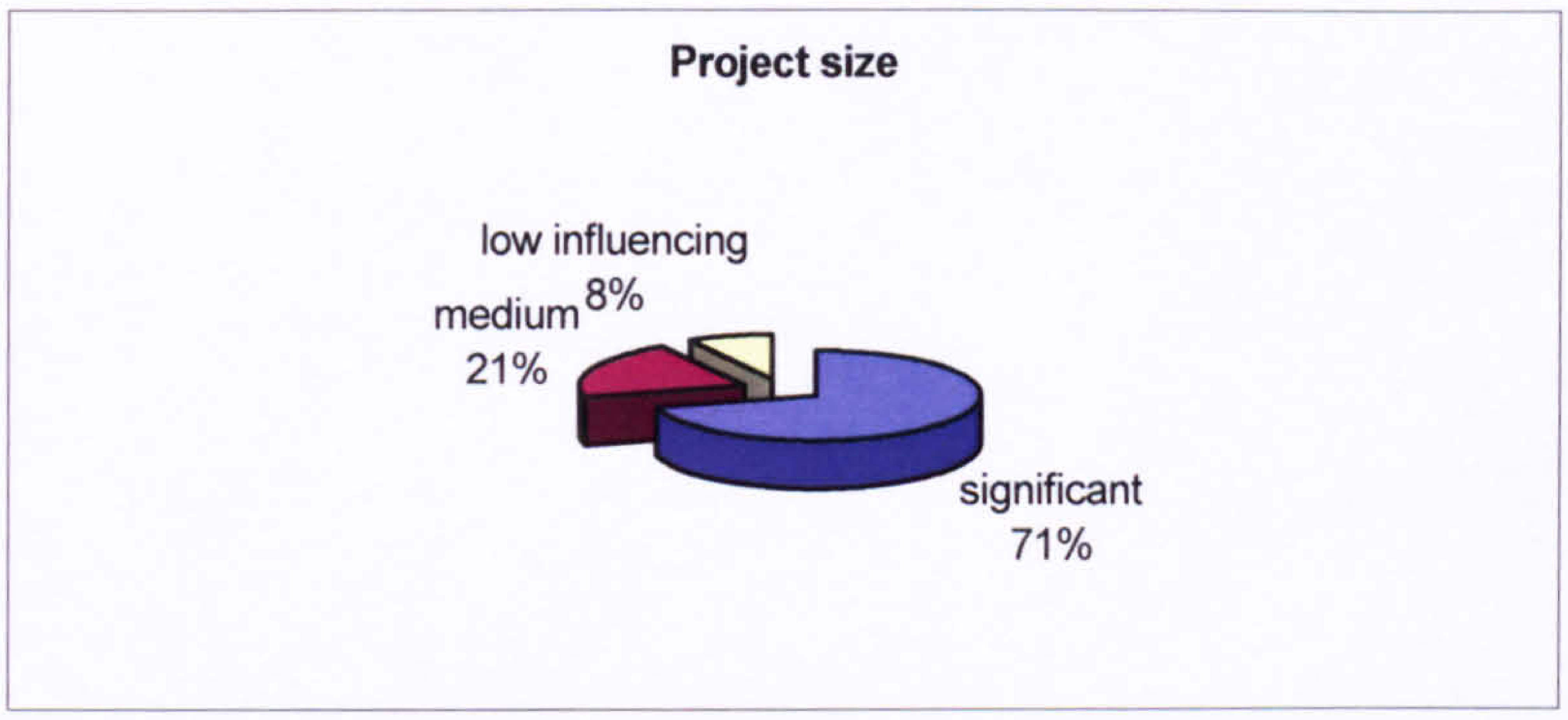

Fig. 6. 38 Project size

Procurement system

Turner (1997) recommended that often the choice of procurement route should be based on the client's objectives and priorities. The most common criteria for the choice of procurement methods include time, certainty, flexibility, quality, complexity, risk, price competition, responsibility, and dispute and arbitration (NEDO, 1985; Skitmore and Marsden,1988; Love *et al.,* 1998). However, Nahapiet and Nahapiet (1985) found that the client and project characteristics as well as the individual project requirements are strongly related to procurement method selection.

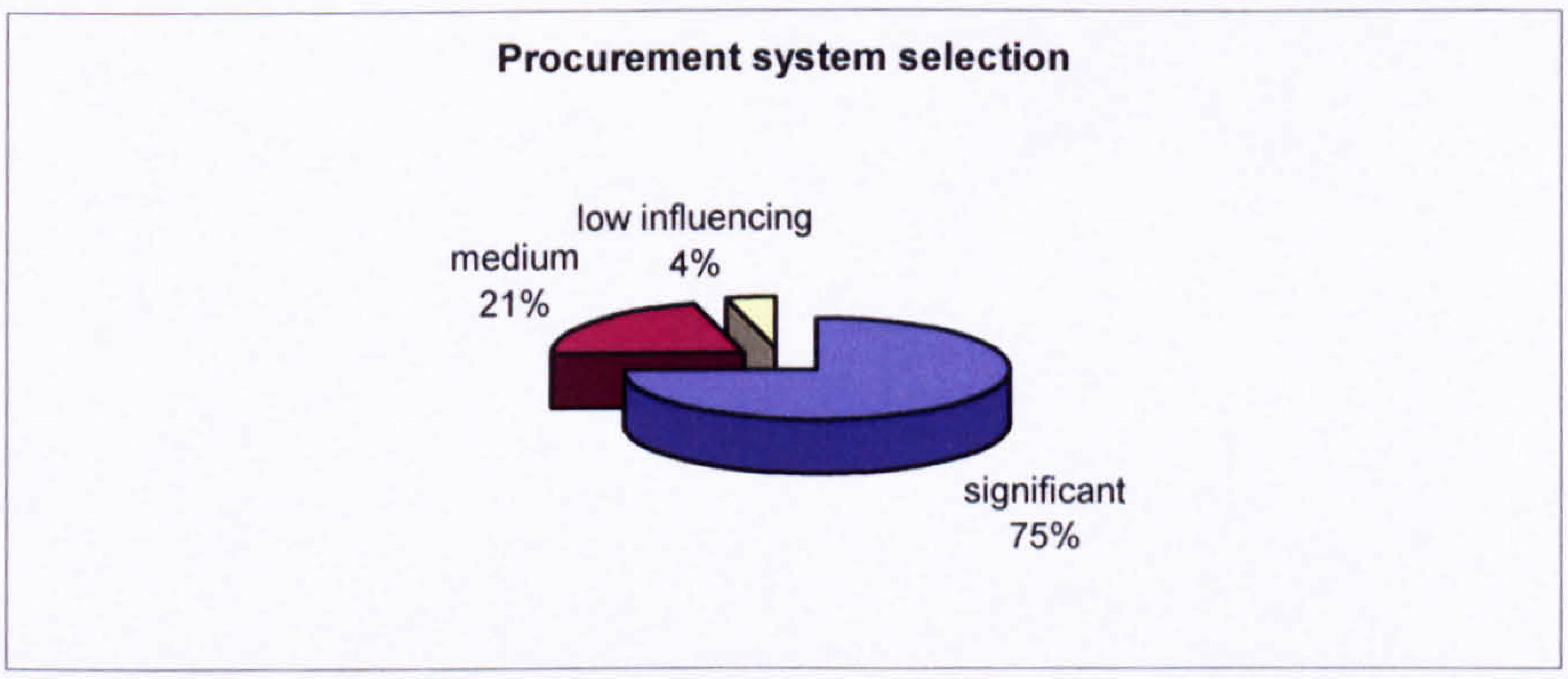

Fig. 6. 39 Procurement system selection

Figure 6.39 above shows that the procurement system selection factor is significant to the pricing system. As a result of the survey, it is clear that 75% of the respondents see the procurement system selection as being a significant factor to the pricing system, 21% of the respondents scored its effect as medium, and only 4% of those surveyed see the procurement system as a low influencing factor to the pricing system; hence this factor should be considered as a significant influence factor in the pricing system.

Form of contract

Contracts create a mutually agreed range of acceptable behaviours, backed by redress to the legal system in the event of a dispute. A complete contract is assumed to produce efficient outcomes. The choice of contract type is one of the most important strategic decisions in contract strategy, because it governs the method of payment for the contractor and the risk allocation between the parties. The choice of contract type should aim to give the maximum likelihood of achieving the client's objectives. Construction projects are very complex, which implies that a high level of expertise is necessary for formulating an appropriate contract strategy. For each project a number of factors can be identified which need to be considered in the process of selecting the most appropriate contract type for the project, such as early start to construction, minimum cost with completed design, and minimum risk allocated to the client.

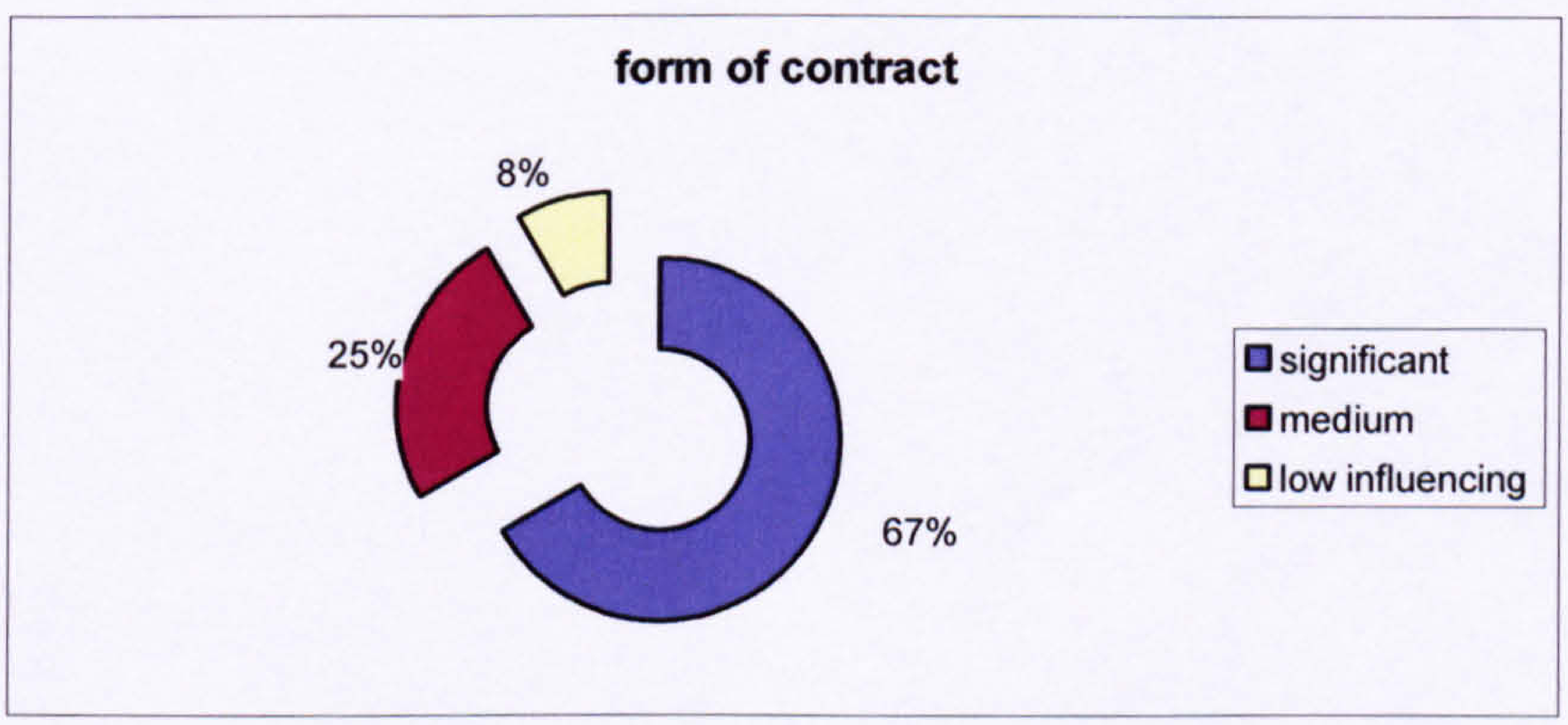

Fig. 6. 40 Form of contract

The above exploded doughnut chart shows that the form of the contract selection is a significant factor in the pricing system. As a result of the survey, it is clear that 67% of the respondents see form of contract as a significant influence factor in the pricing system, 25% of the respondents think that its effect is medium, and only 8% of the survey results see the form of contract as a low influence factor in the pricing system; hence this factor may be considered to be a significant influence factor in the pricing system.

Project Flexibility

It is important to note that successful projects have the flexibility to alter operations as conditions warrant and priorities change. Project agreements are useful for identifying the issues but they should also be sufficiently flexible to address unforeseen circumstances. Planners and engineers will be required to explore ways of including flexibility in the design of a facility.

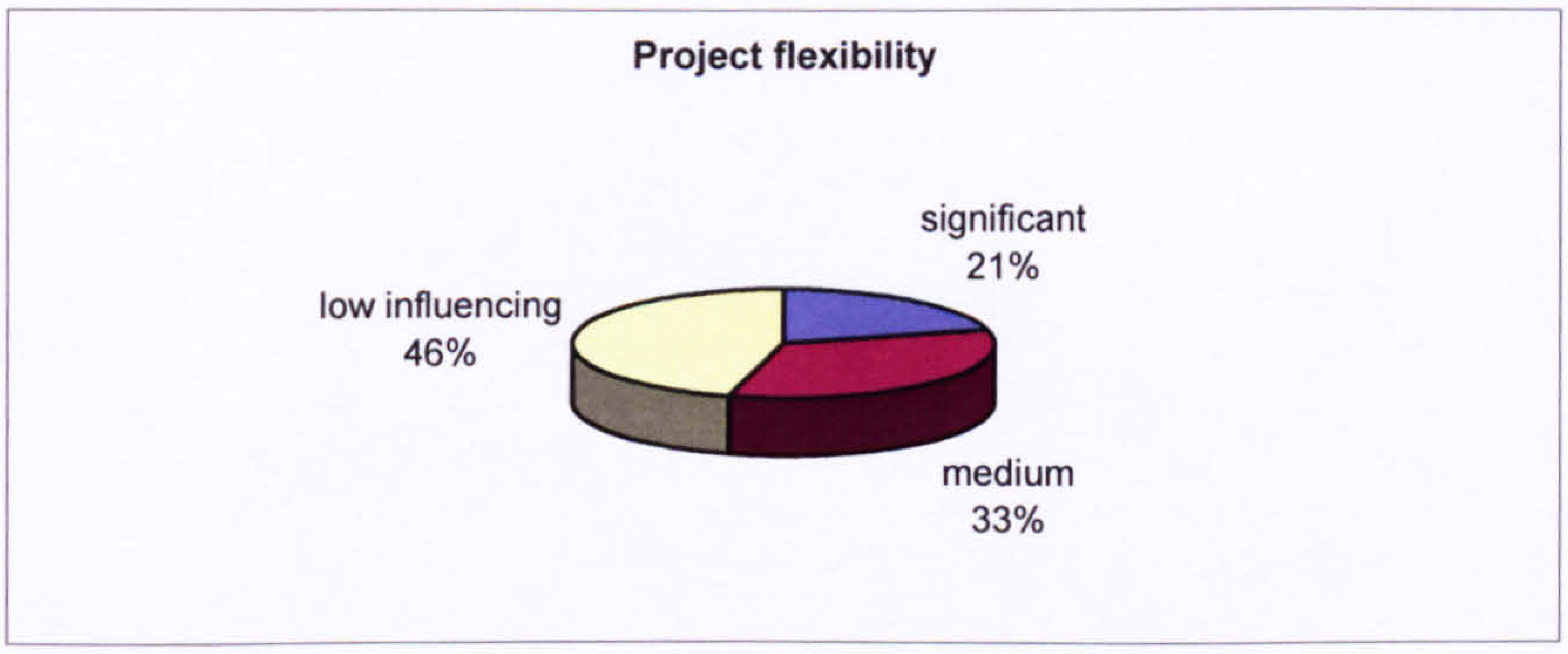

Fig. 6. 41 Project flexibility

Figure 6.41 shows that 46% of the respondents see the project flexibility as being of low influence on the pricing system, whereas 33% of the respondents think that its influence is medium on the pricing system, and 21% consider that project flexibility is a significant factor in the pricing system. The mean score of the survey result is 2.83. Hence, as a result of the survey, it can be concluded that the project flexibility is not an influence factor in the pricing system.

Project complexity

The complexity of a process is the measure of the difficulty of executing the individual tasks that make up the process.

One way to decrease the cost of the early design stages is by reducing the complexity of the design. Since an experienced design engineer usually does the first stages, he will implicitly consider some of the external factors, based on his experience in previous designs.

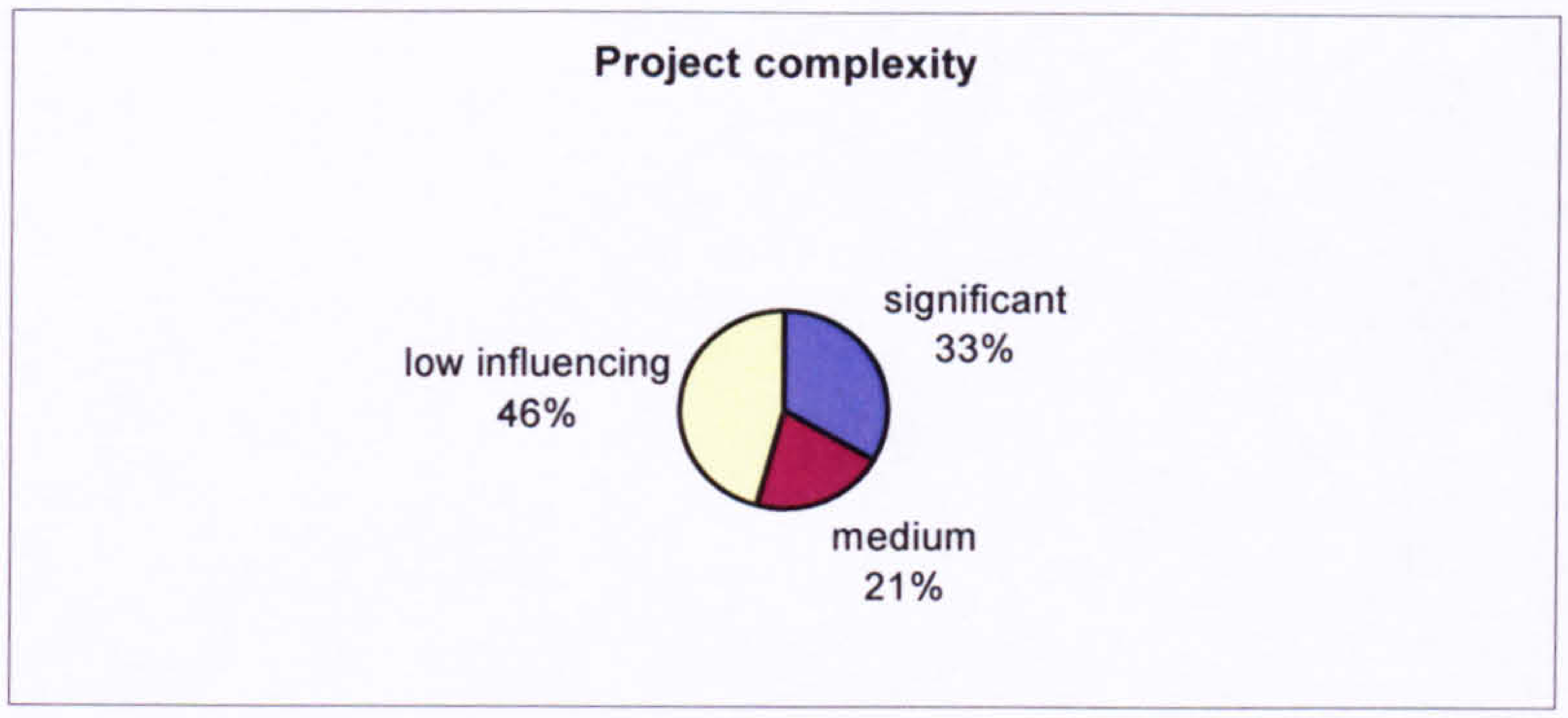

Fig. 6. 42 Project complexity

Figure 6.42 shows that 46% of the respondents see the project complexity a low influence factor in the pricing system, 33% of the respondents score its influence level as medium, and 21% consider project complexity to be a significant factor in the pricing system. The mean score of the survey result is 2.71. Hence, as a result of the survey, it can be concluded that project complexity does not influence the pricing system

Project type

A project type would involve the development and evaluation of new devices, models, techniques or approaches in fields such as technology and engineering. Projects should integrate several technologies, inventions or designs, and construct an original innovative technological system. It is clear that there are different types of projects, such as buildings, bridges, roads, infrastructures, and other services buildings. Each type of the projects mentioned has its own technology system, design, and construct methods, all of which have an effect on the pricing system.

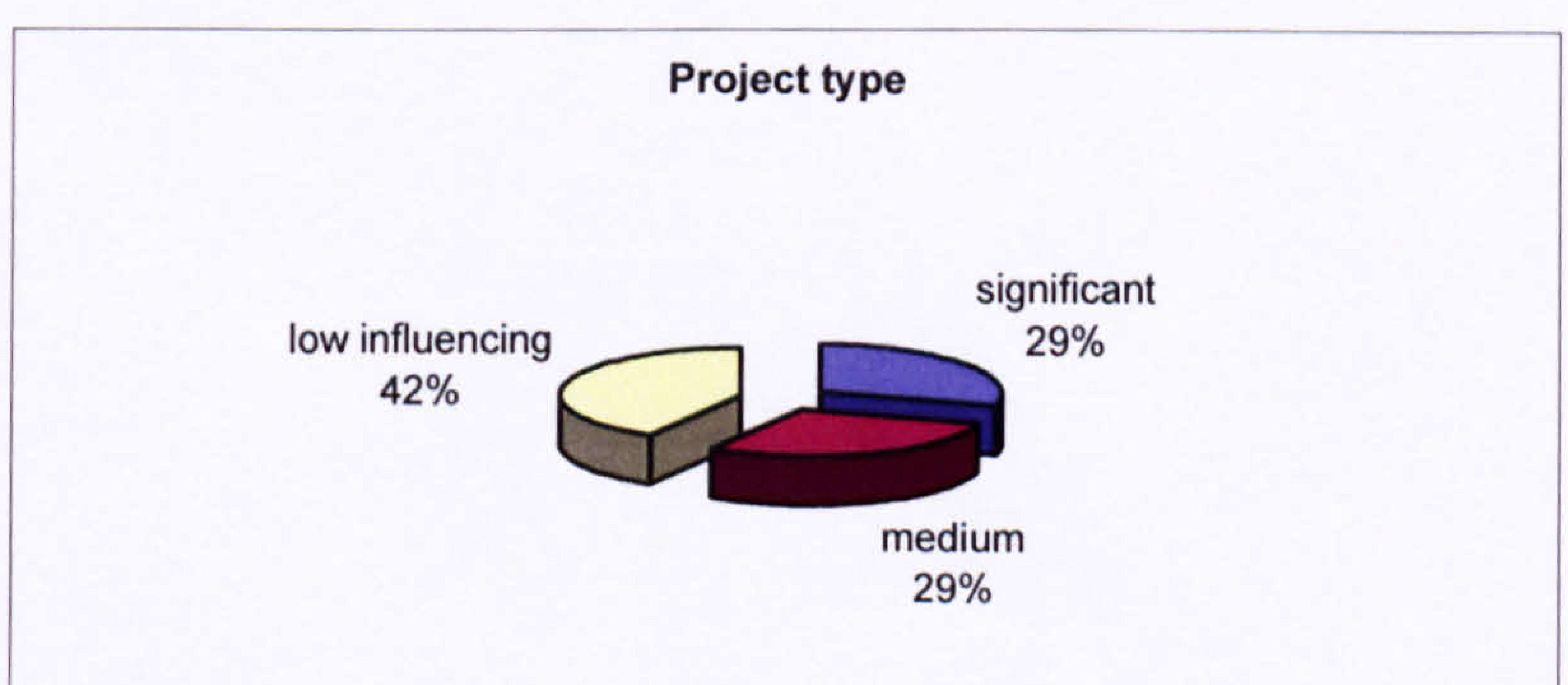

Fig. 6. 43 Project type

Figure 6.43 above shows that the project type selection factor has a low influence on the pricing system. As a result of the survey, it is clear that 42% of the respondents see that the project type is a low influence factor in the pricing system, 29% of the respondents think its influence level is medium, and 29% of the survey results see that project type is a significant influence factor in the pricing system; hence this factor may be considered as a low influence factor in the pricing system.

Risk allocation

The basic principles which should govern risk allocations in construction projects have been developed by the following: Ashley (1977), Porte (1981), Branes (1983), Perry and Hayes (1985). One such principle is that a risk should be given to the party who can best control it, if it occurs. Not adhering to this principle increases the likelihood of conflict. This principle of risk allocation requires that a party's power be commensurate with its responsibilities.

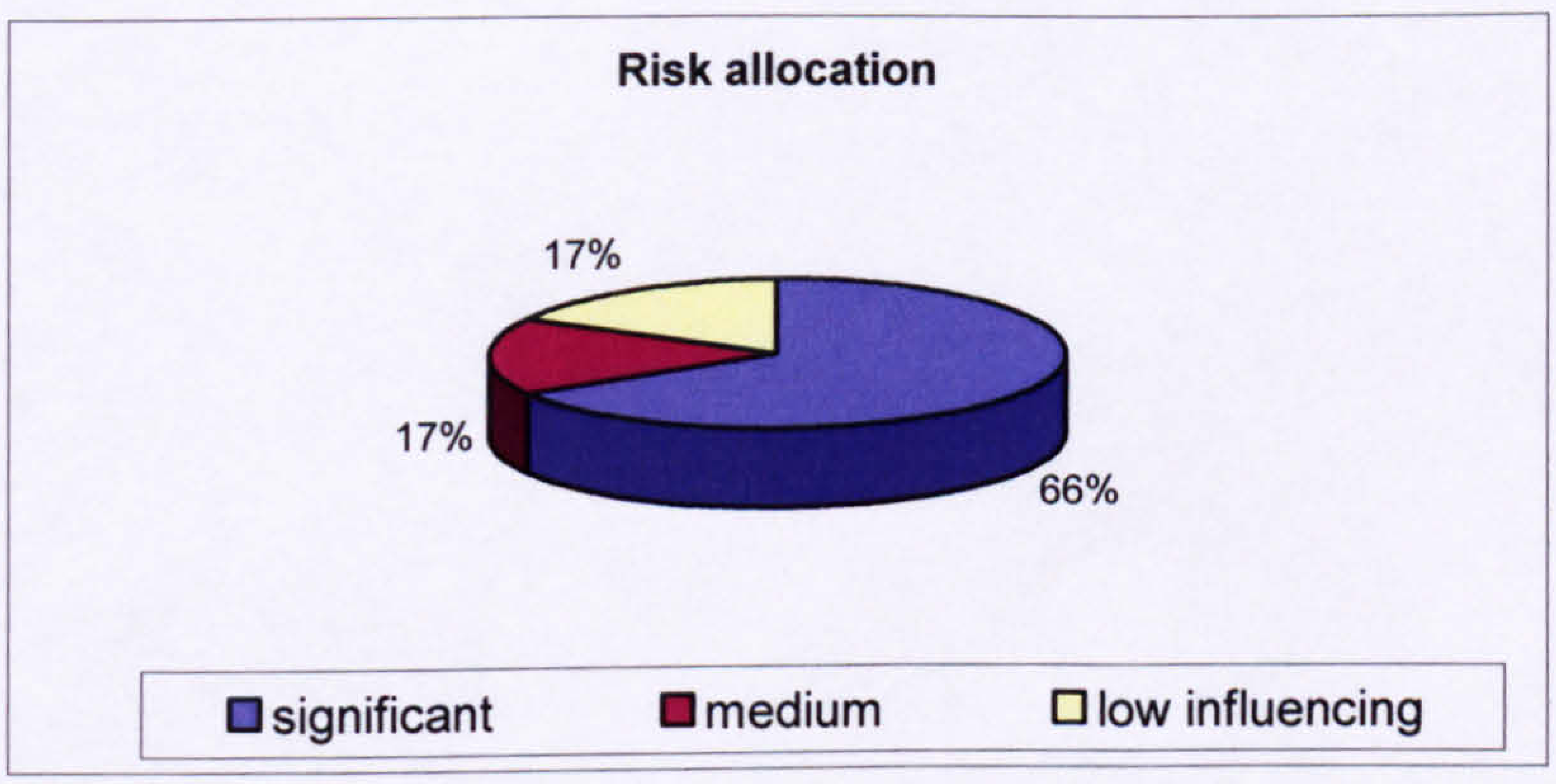

Fig. 6. 44 Risk allocation

Figure 6.44 above (pie chart) shows that the risk allocation selection factor is significant to the pricing system. As a result of the survey, it is clear that 66% of the respondents see that the risk allocation is significant to the pricing system, 17% of the respondents think that its influence is medium, and 17% of the survey results see that risk allocation is a low influencing factor in the pricing system; hence this factor may be considered as a significant influence factor in the pricing system.

Project duration

The project duration depends on the project size, project type and also the contractor's capability and productivity. The project duration is equal to the total time needed for the activity, plus the holidays and the time when work is not being done owing to circumstances such as bad weather, or a major force stopping the work, such as a war. Figure 6.45 (pie chart below) shows that 46% of the respondents see the project duration issue as a low influence on the pricing system, 29% of the respondents consider its effect as medium on the pricing system, and 25% consider that project duration is a significant factor in the pricing system. The mean score of the survey result is 2.75. Hence, as a result of the survey, it can be concluded that project duration does not influence the pricing system.

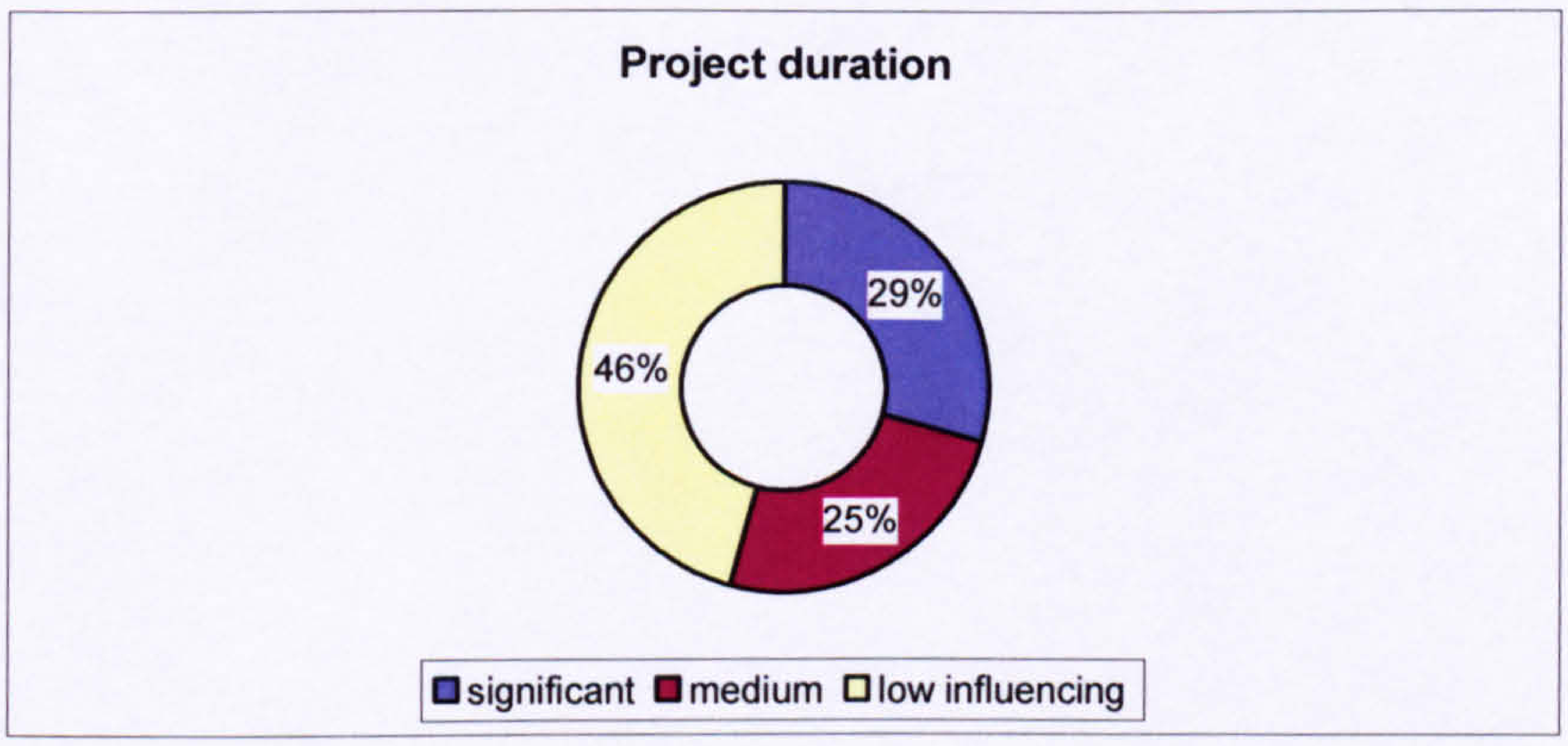

Fig. 6. 45 Project duration

Contractor cash flow

Contractors have become more acutely aware of the need to maintain a flow of cash through the company; some contractors have suffered a downturn not because their work was not profitable but because of insufficient cash in the short term. On the other hand, poor cash flows have resulted in reduced profits.

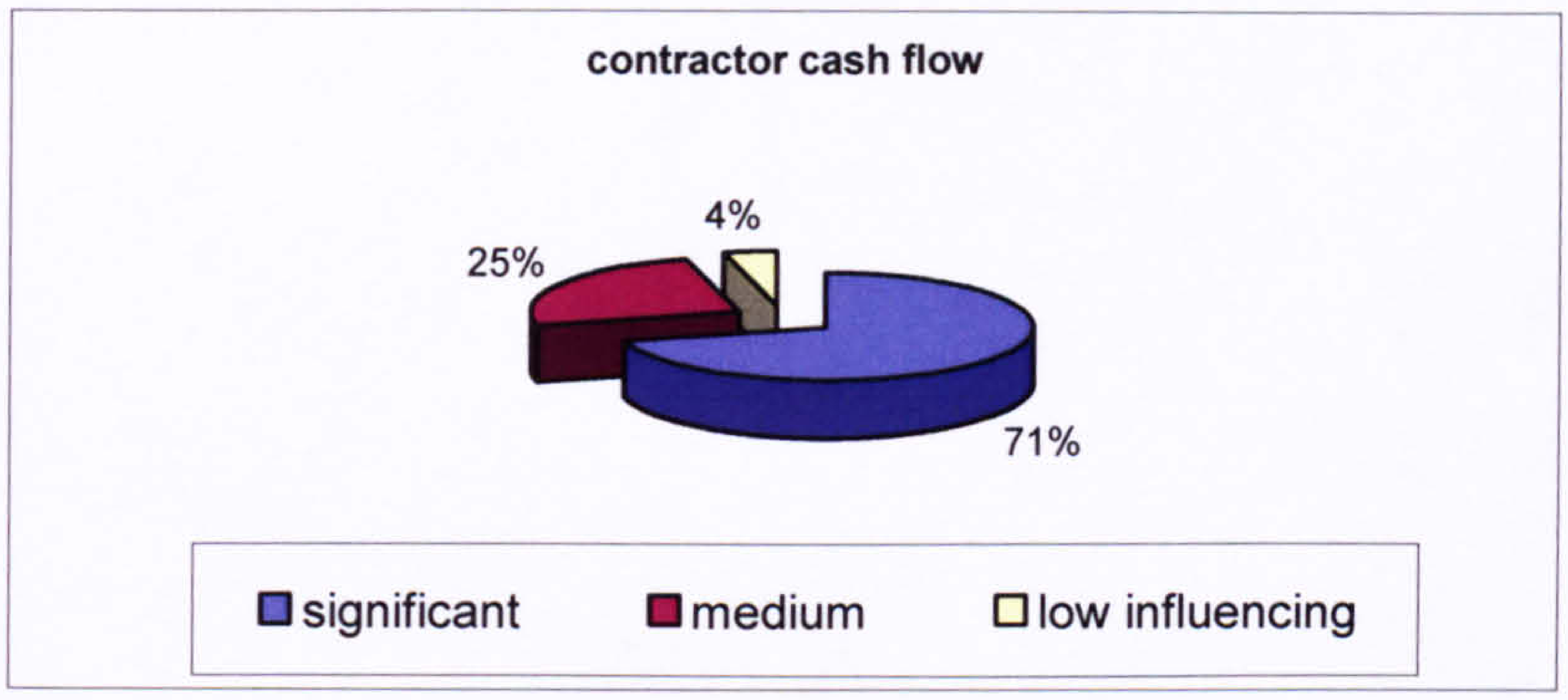

Fig. 6. 46 Contractor cash flow

Figure 6.46 above (exploded pie chart) shows that contractor cash flow is a significant factor in the pricing system. As a result of the survey, it is clear that 71% of the respondents see that contractor cash flow is significant to the pricing system, 25% of the respondents consider its effect as medium, and only 4% of the survey results see the contractor cash flow as a low influence on the pricing system; hence this factor may be considered as a significant influence factor in the pricing system.

Contractor Experience

Contractor experience depends on the accumulated experience from past projects executed and also the personnel skills within the company.

Figure 6.47 (exploded pie chart below) shows that 33% of the respondents see the contractor experience issue as a low influence on the pricing system, 38% of the respondents score its influence as medium, and 29% consider that contractor experience is a significant factor in the pricing system. The mean score of the survey result is 2.88. Hence, as a result of the survey, it is clear that contractor experience does not influence the pricing system.

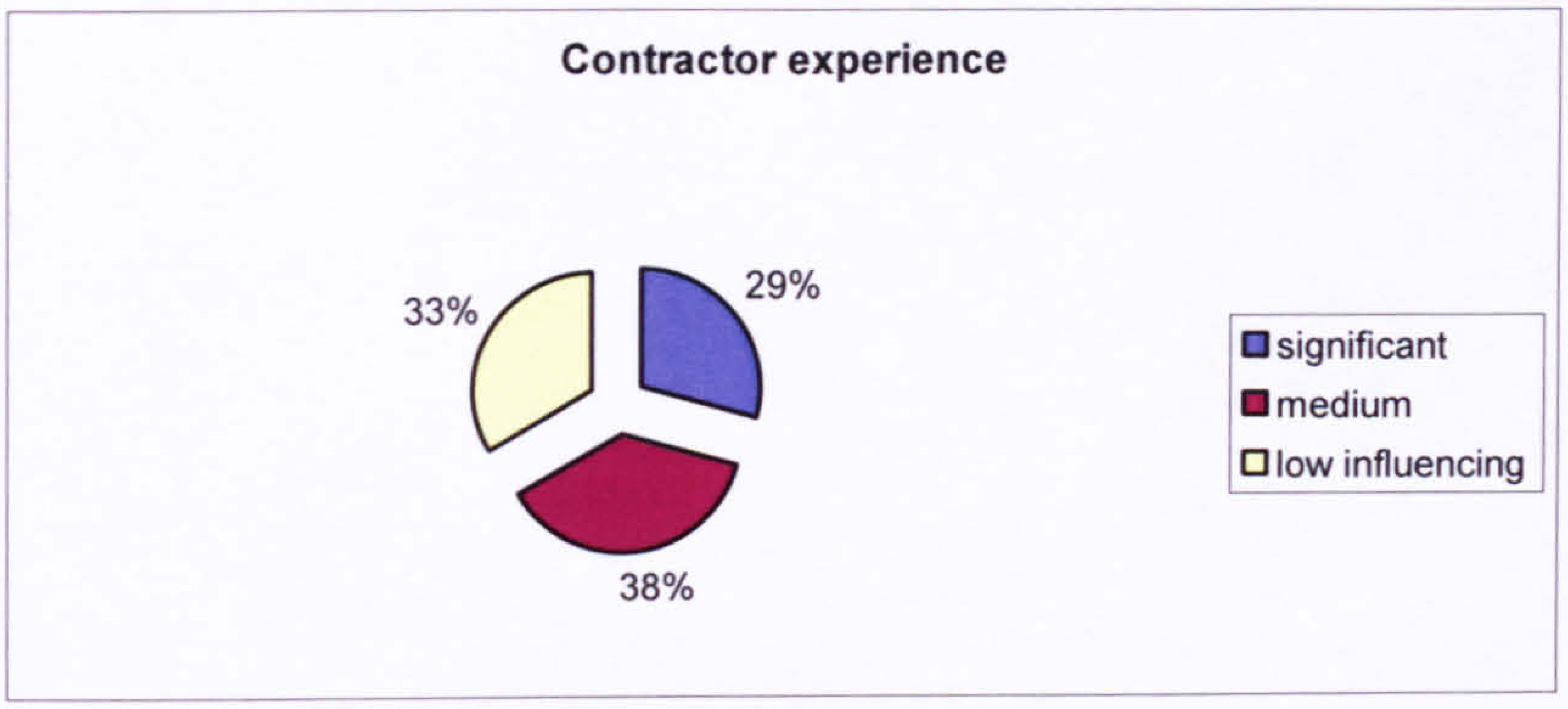

Fig. 6. 47 Contractor experience

Tendering duration

Tendering time is the time between the announcing of the project tendering and the introduction of the company offers. The time required should be enough to study the project documents and specification, visit the site, and prepare the bidding offers. Figure 6.48 shows that 50% of the respondents see the tendering duration as a low influence on the pricing system, 17% of the respondents think that its influence is medium on the pricing system, and 33% consider that the tendering duration is a significant factor in the pricing system. Hence, as a result of the survey, it is clear that the tendering duration is not an influence factor in the pricing system.

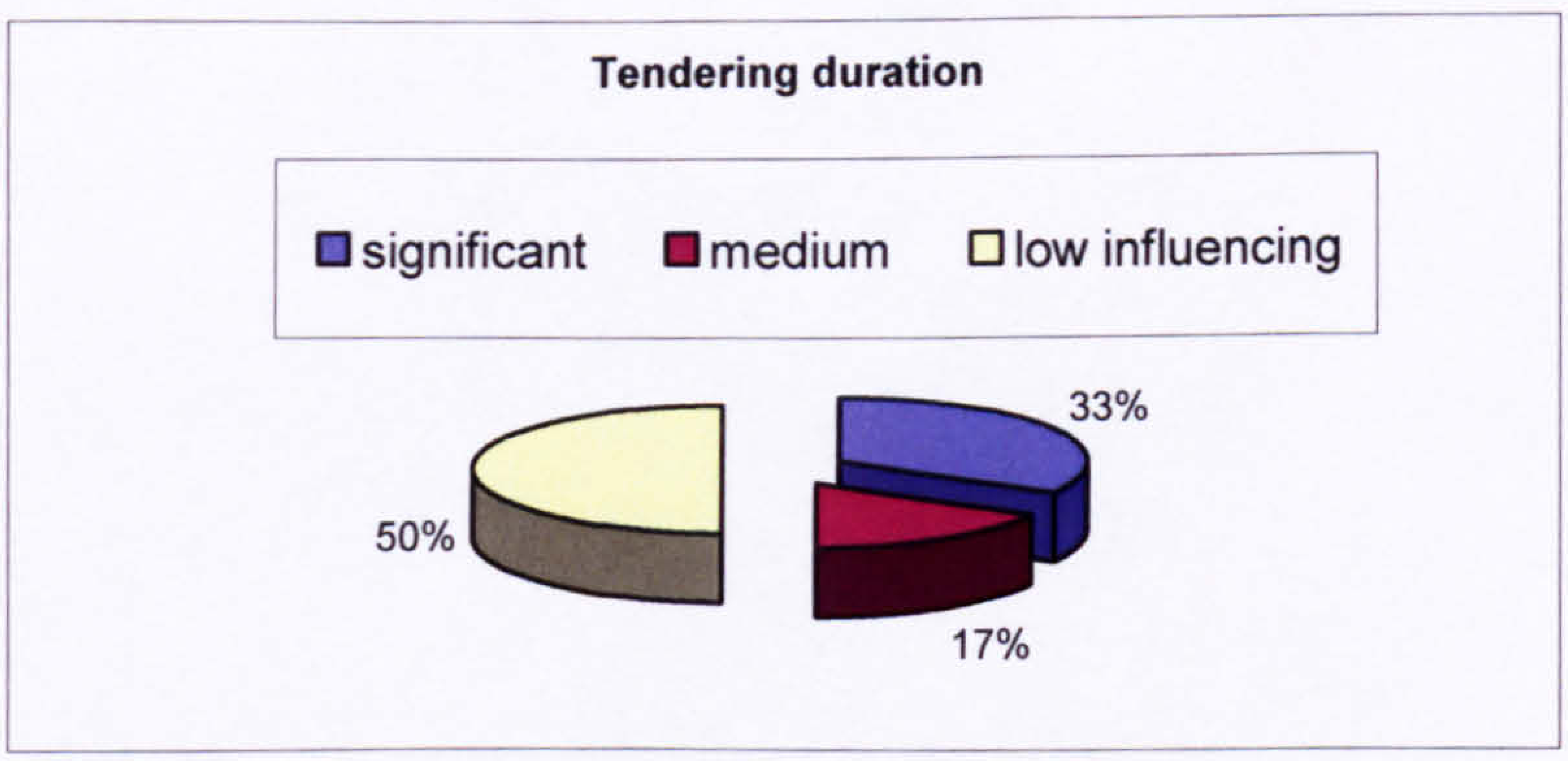

Fig. 6. 48 Tendering duration

Project Quality

The construction industry has too often in the past been discredited by bad publicity resulting from sometimes dramatic failures of both the design and construction of its products (Ashworth, 2004). The achievement of an acceptable standard in buildings is a combination of quality of design and quality of construction.

The project quality can be defined as a systematic way of guaranteeing that all activities within the project processes take place in the way they have been planned in order to meet the defined needs and requirements of the client. Good quality control is achieved by setting the right standards to meet the needs of the client. Project quality is then not conceptually limited to the product process, but incorporates relations between suppliers and clients within the project supply network. Concern must be given to nurturing a culture of innovation and continuous improvement (Love *et al.,* 1998).

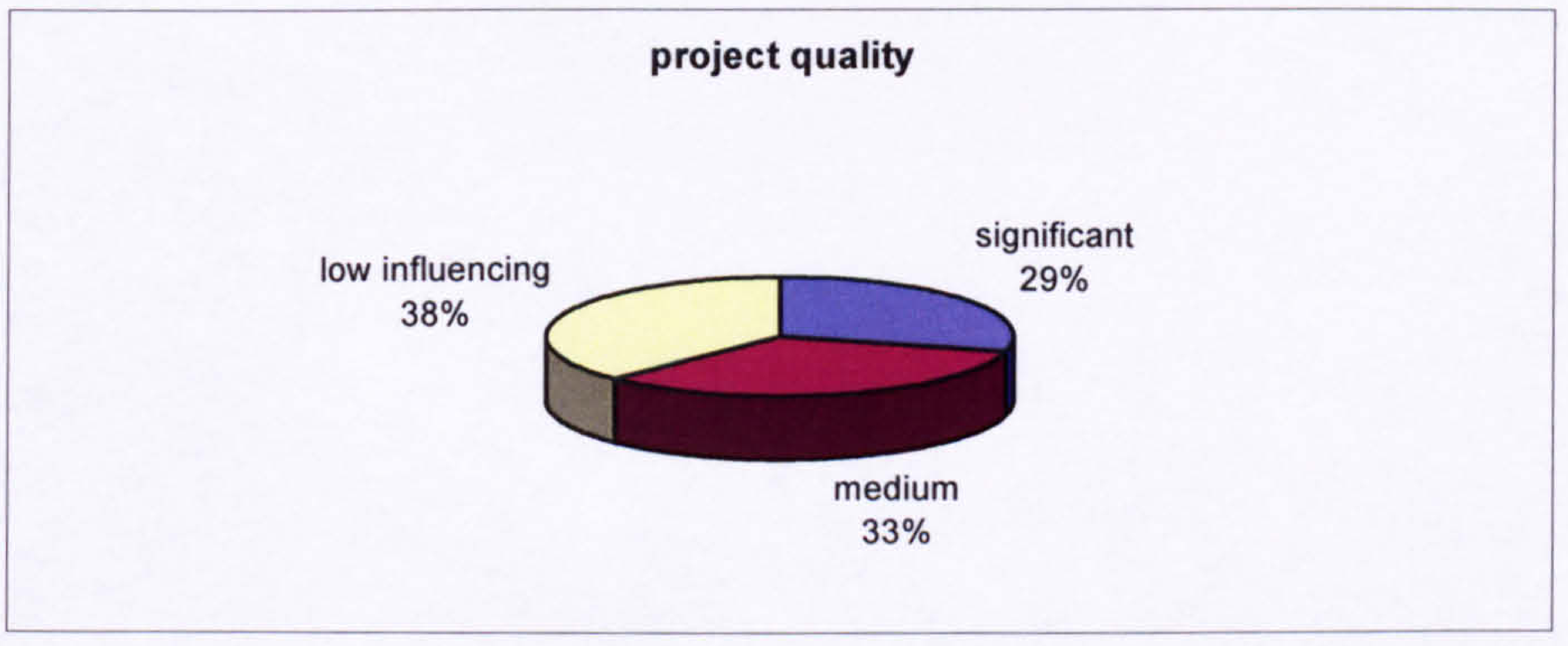

Fig. 6. 49 Project quality

Figure 6.49 shows that the project quality factor has a low influence in the pricing system. As a result of the survey, it is clear that 38% of the respondents see that project quality is of low influence on the pricing system, 33% of the respondents score its influence as medium, and 29% of the survey results see that project quality is a significant influence factor in the pricing system; hence the issue of project quality is considered to be a low influencing factor in the pricing system.

Economic Condition

The construction project prices have a strong relationship with the market prices. This relation will be continuous throughout the project duration, and any change in the economic conditions will directly affect the financing of the project.

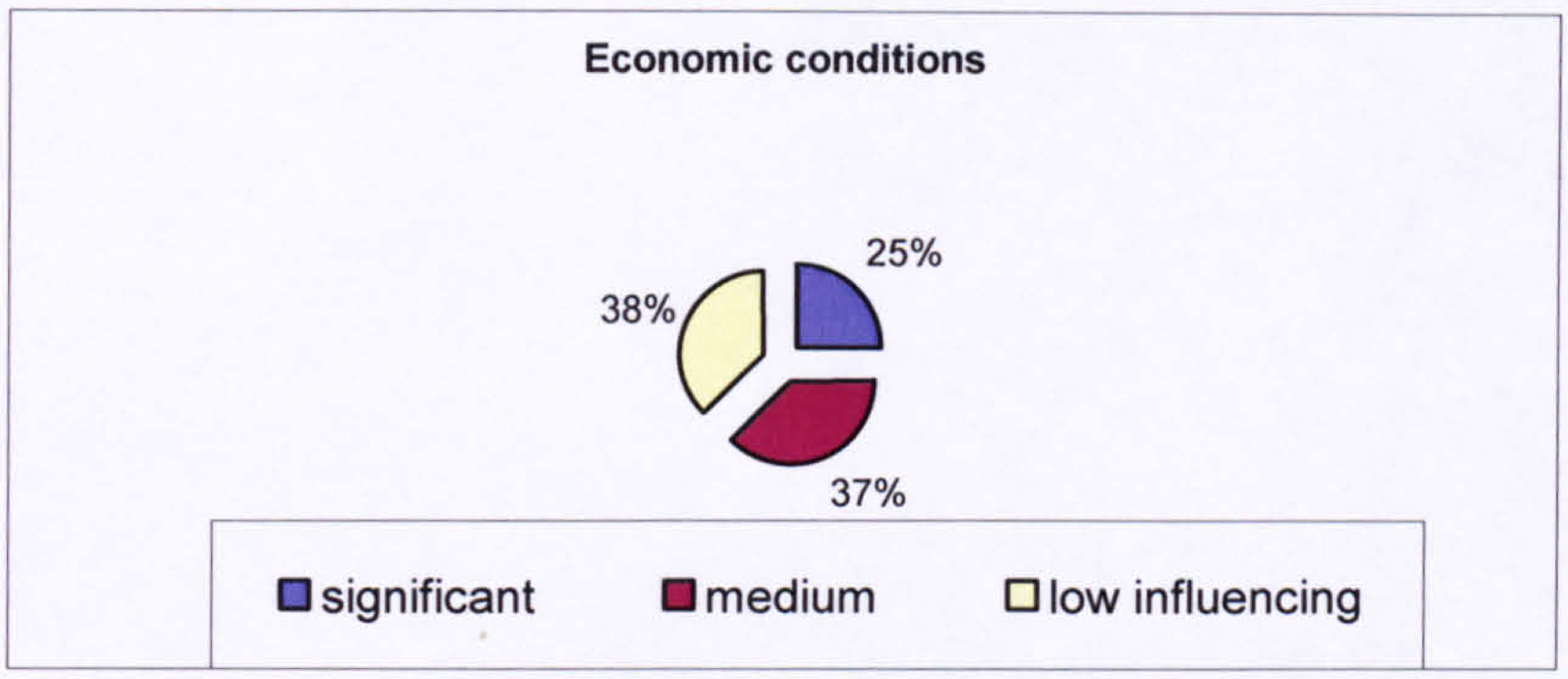

Fig. 6. 50 Economic conditions

Figure 6.50 shows that 38% of the respondents see economic condition as a low influence on the pricing system, 37% of the respondents score its influence as medium, and 25% consider that the economic condition is a significant factor in the pricing system. The mean score of the survey result is 2.88. Hence, as a result of the survey, it is clear that economic conditions are not an influence factor in the pricing system.

Tender documents

Construction projects require a set of documents for any project; the documents for any project include a signed contract form, approved specification, planning, time scheduling, concept design or full details design, site investigation, services availability for connection to the project such as sewage line, communications connection points, water supply, etc.

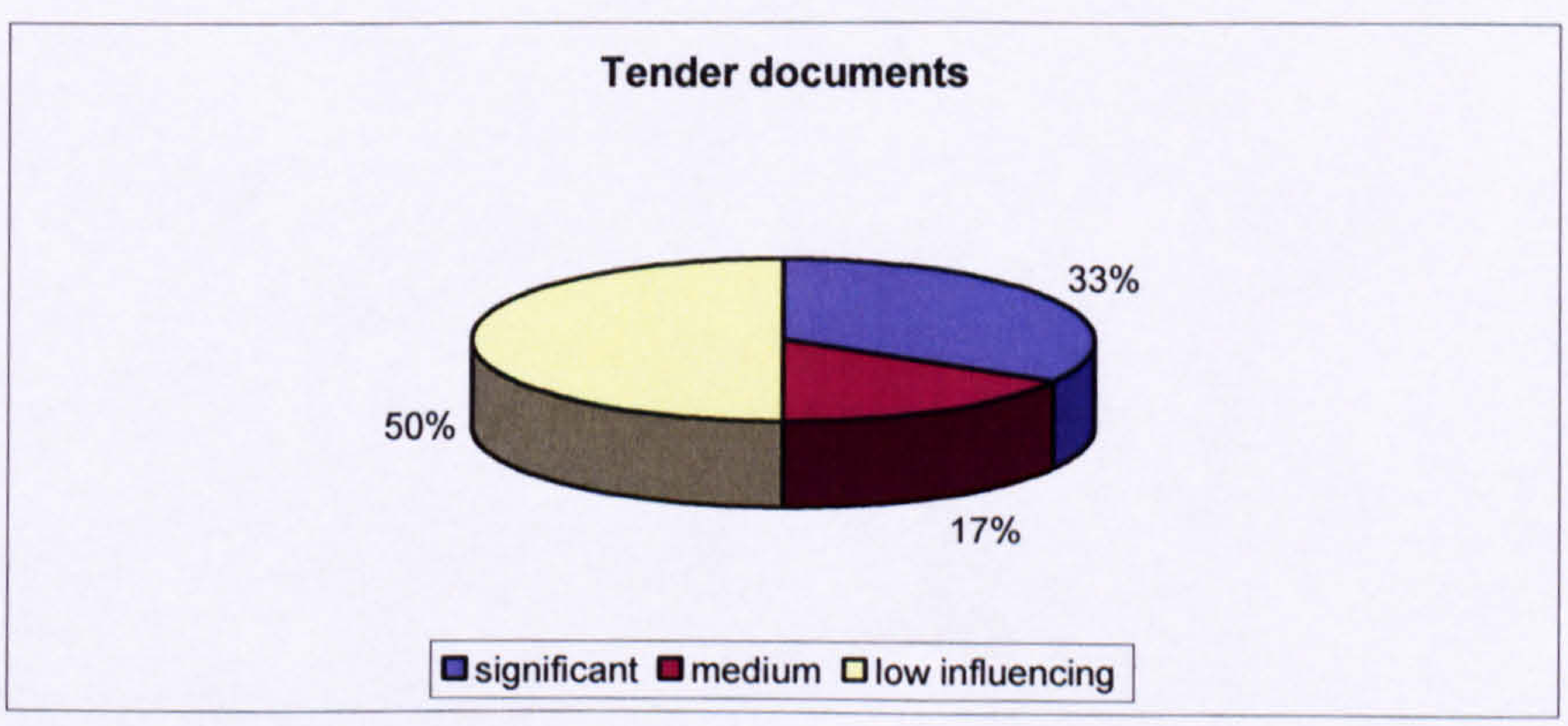

Fig. 6. 51 Tender documents

Figure 6.51 shows that 50% of the respondents see the tendering documents availability as a low influence on the pricing system, 17% of the respondents believe that the tender documents are a medium level influence factor in the pricing system, and 33% consider that tender documents availability is a significant factor in the pricing system. Hence, as a result of the survey, it is clear that the issue of tender documents availability is not an influence factor in the pricing system.

Speed (during design and construction)

Both parties of the construction project seek to have a reasonable speed for design production and construction. In the case of design and build contracts, this speed is the responsibility of the contractor who should manage the time required for the design and construct the task sequences.

Figure 6.52 shows that 44% of the respondents see speed during design and construction as a low influence on the pricing system, 36% of the respondents score its influence as medium, and 20% consider that project speed is a significant factor in the pricing system. The mean score of survey result is 3.00. Hence, as a result of the survey, it can be concluded that project speed is not an influence factor in the pricing system.

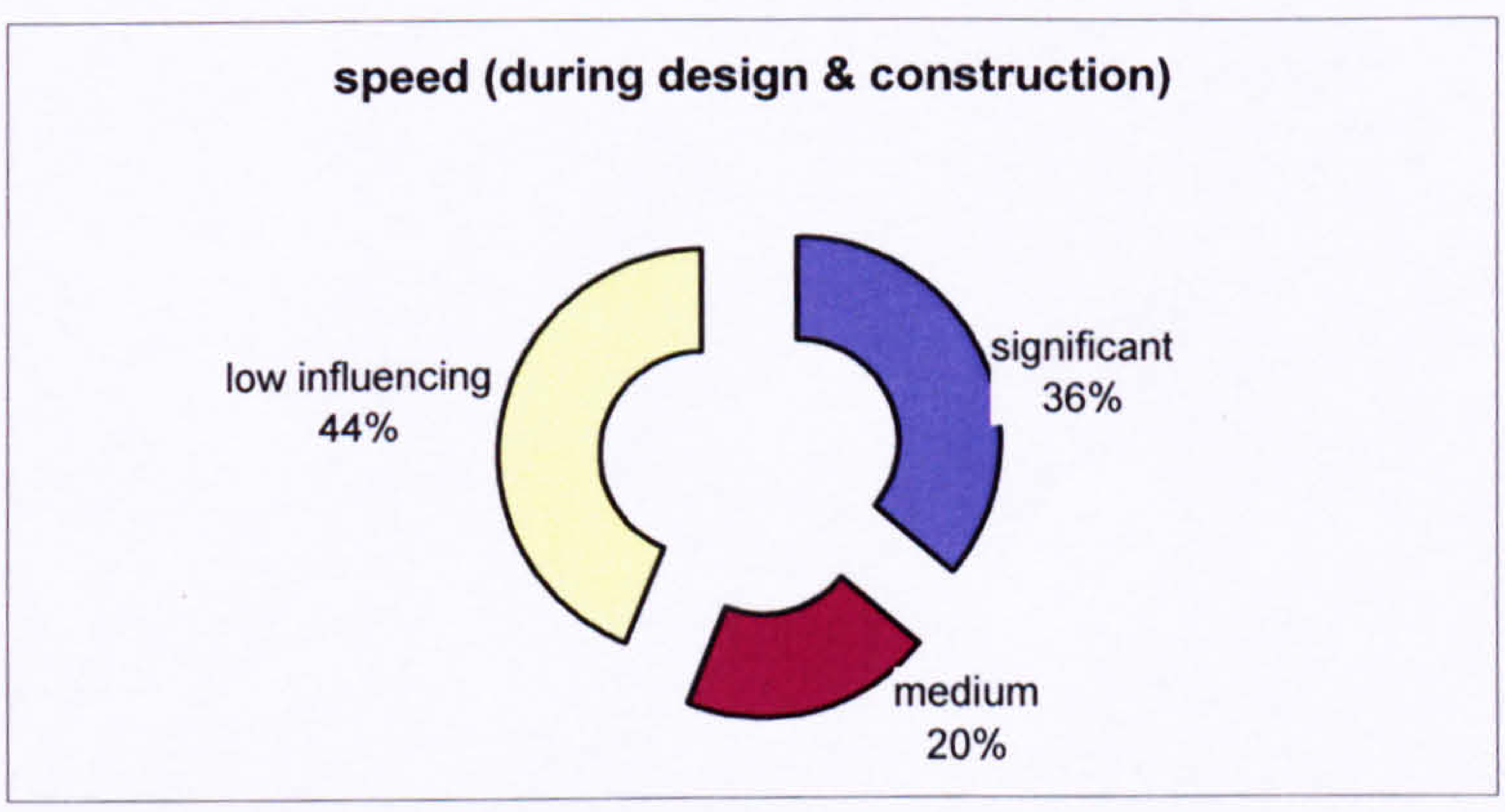

Fig. 6. 52 Speed during design and construction

Disputes Likelihood

Figure 6.53 shows that the disputes likelihood factor is significant in the pricing system. As a result of the survey, it is clear that 67% of the respondents see that disputes likelihood is significant to the pricing system, 25% of the respondents think that its influence level is medium and only 8% of the survey results see the issue of disputes likelihood as a low influence factor in the pricing system; hence this factor may be considered as a significant influence factor in the pricing system.

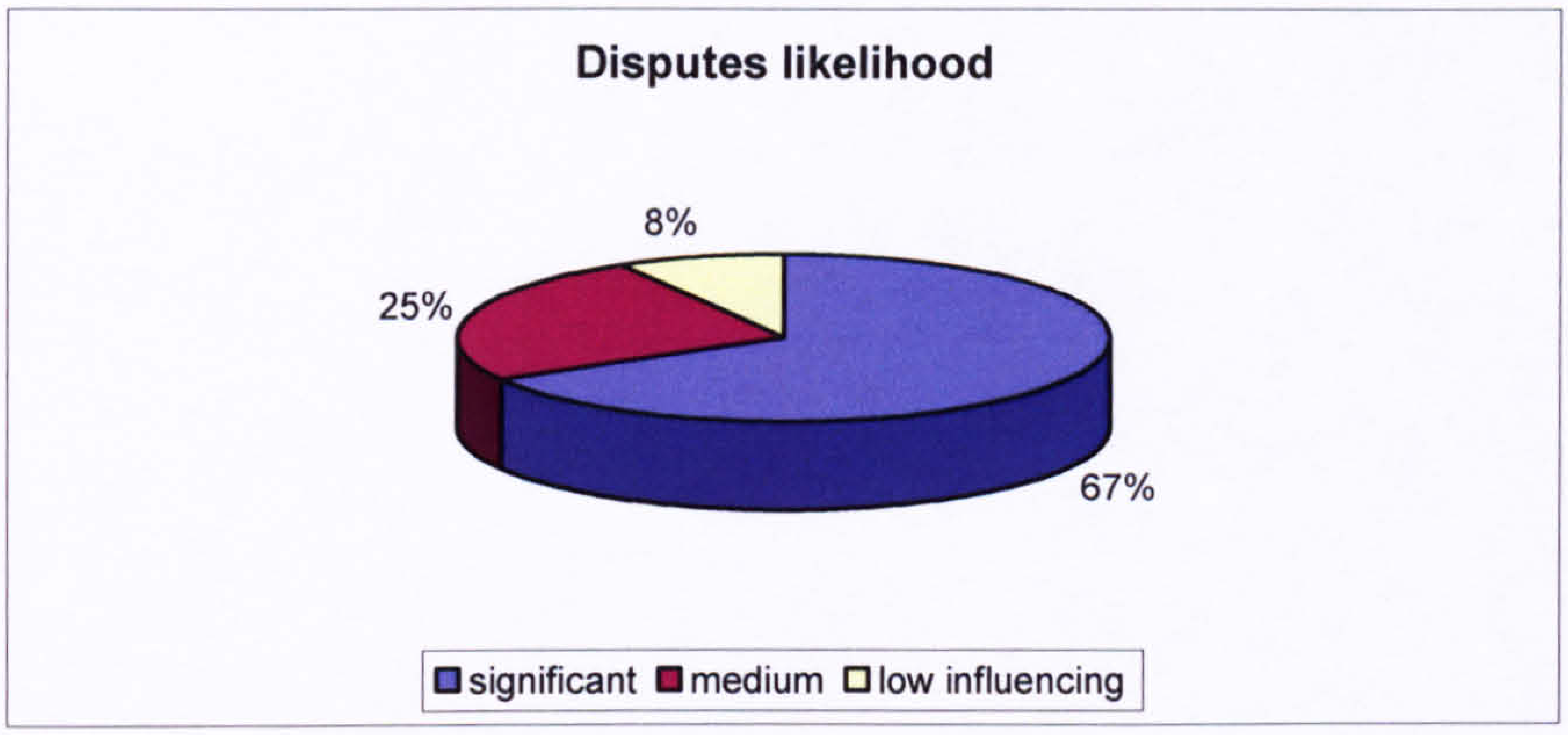

Fig. 6. 53 Disputes likelihood

Tender Methods

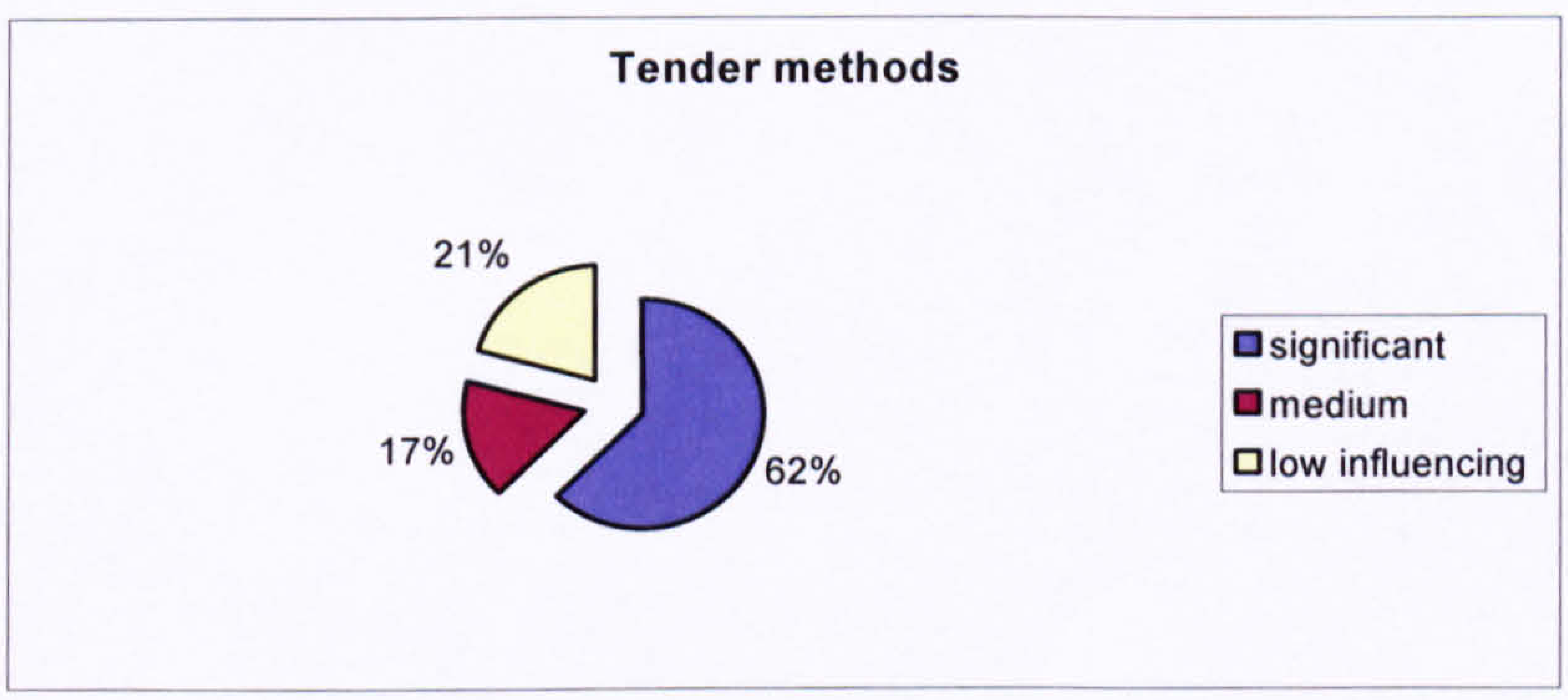

Fig. 6. 54 Tender methods

Figure 6.54 shows that the tender methods selection factor is significant in the pricing system. As a result of the survey, it is clear that 62% of the respondents see that the tender method is significant to the pricing system, 17% of the respondents think that its influence level is medium, and 21% of the survey results see the tender method as a low influence factor in the pricing system; hence this factor may be considered as a significant influence factor in the pricing system.

Extent of competition

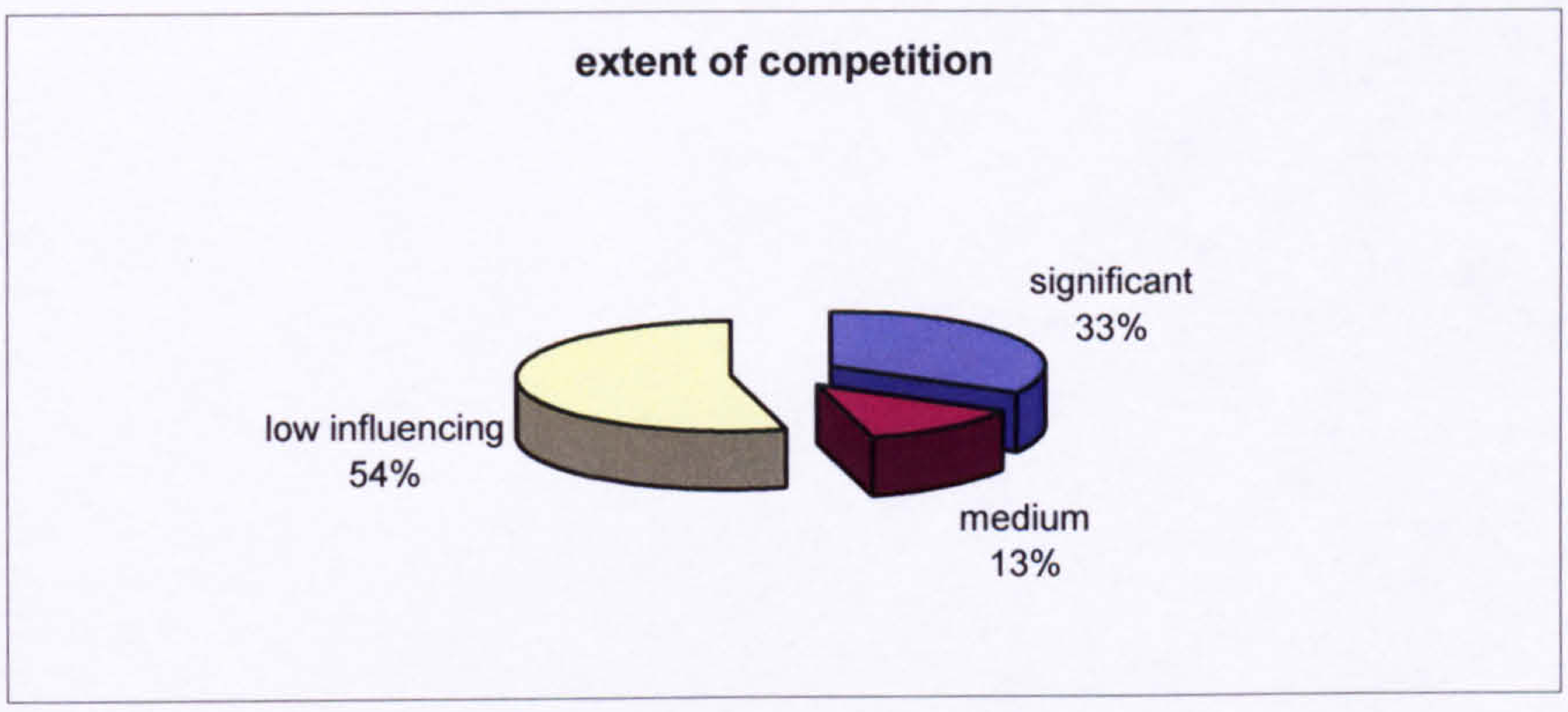

Fig. 6. 55 Extent of competition

Figure 6.55 shows that 54% of the respondents see extent of competition as a low influence on the pricing system, 13% of the respondents score its influence level as medium, and 33% consider that extent of competition a significant factor in the pricing system. Hence, as a result of the survey, it is clear that the extent of competition is not an influence factor in the pricing system.

Contractor Qualification

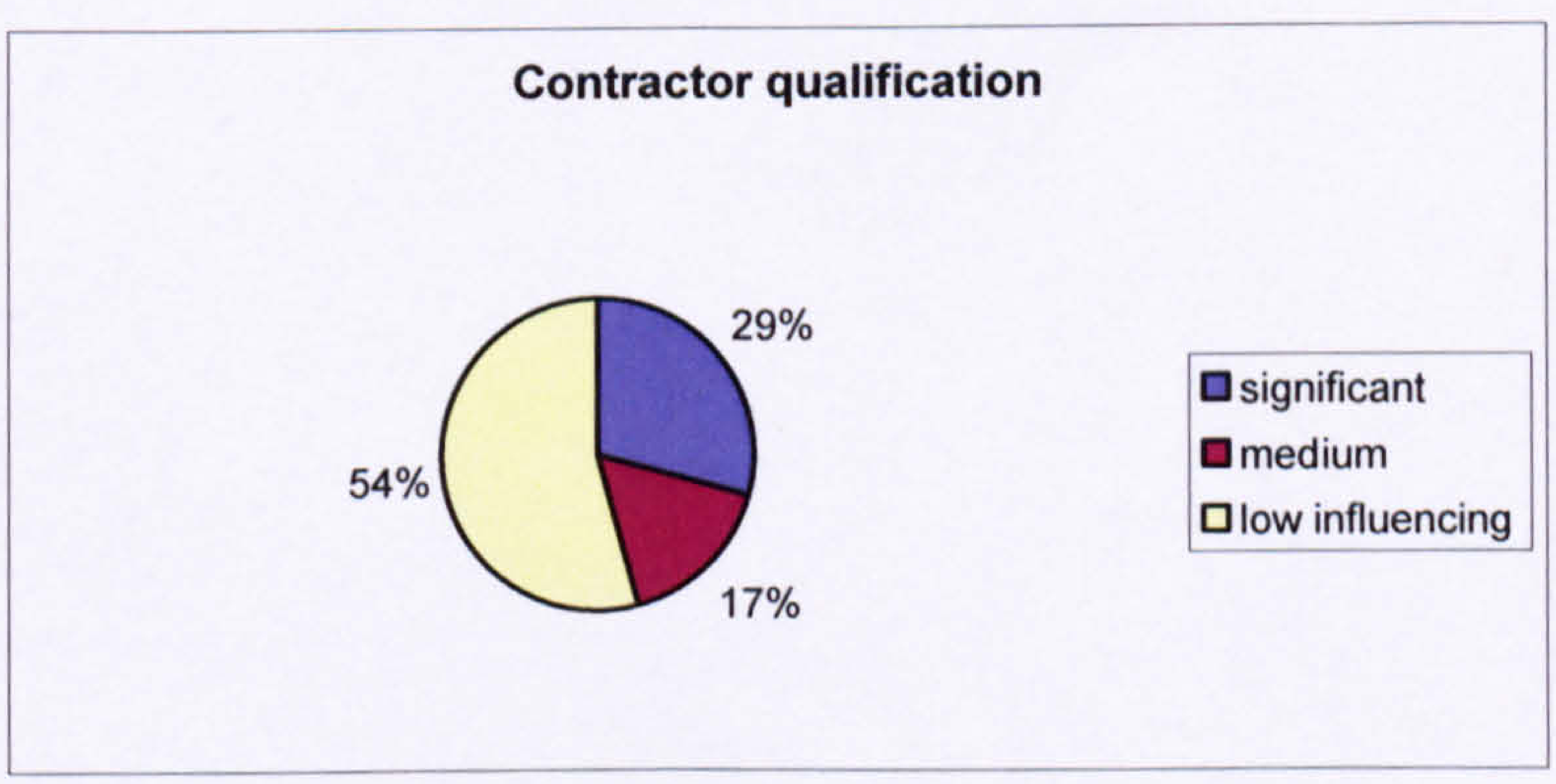

Fig. 6. 56 Contractor qualification

Figure 6.56 above shows that 54% of the respondents see the contractor qualification as a low influence factor in the pricing system, 17% of the respondents consider its effect as of medium level influence, and 29% consider that the contractor qualification is a significant factor in the pricing system. Hence, as a result of the survey, it is clear that the contractor qualification is not an influence factor in the pricing system.

Value for money

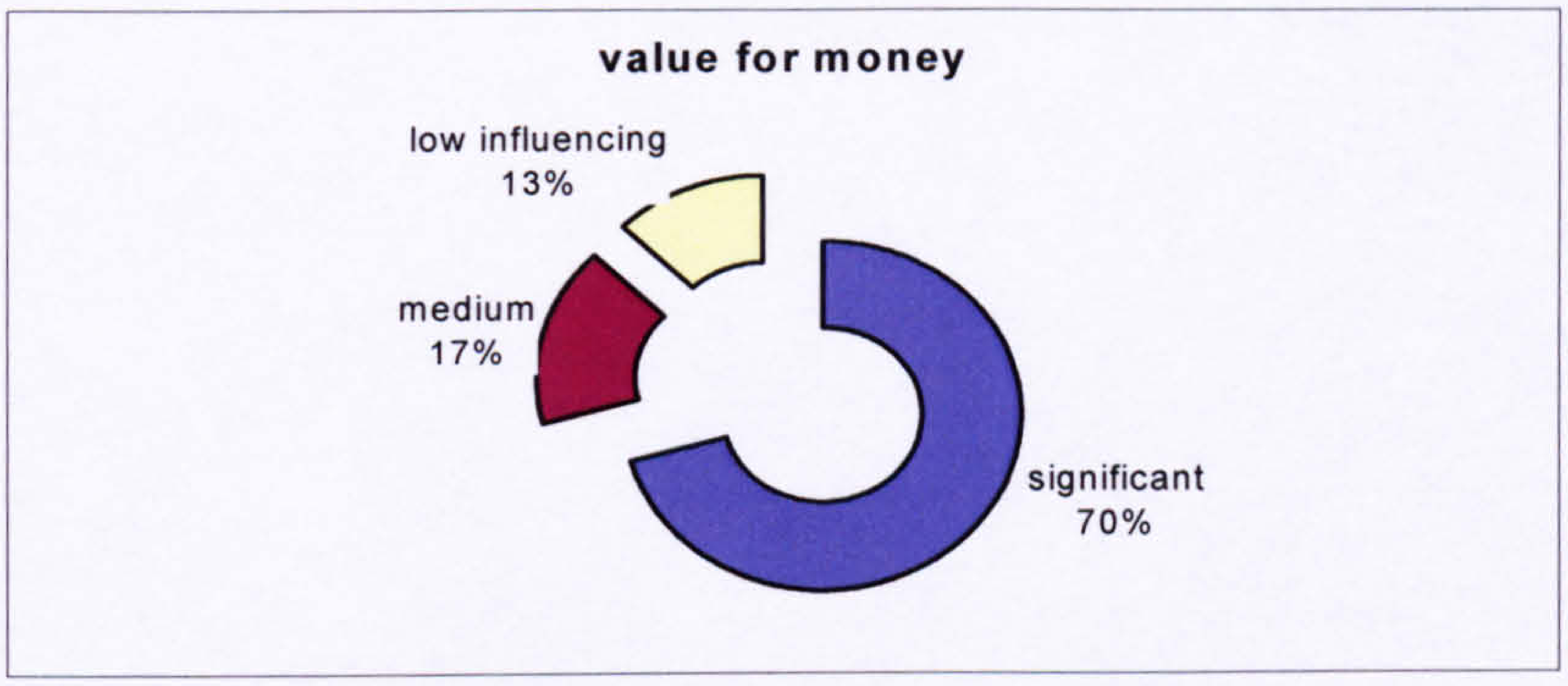

Fig. 6. 57 Value for money

Figure 6.57 above (pie chart) shows that the Value for Money factor is significant to the pricing system. As a result of the survey it is clear that 70% of the respondents see that the value for money is significant to the pricing system, 17% of the respondents consider its effect as a medium influence factor, and 13% of the survey results see the value for money issue as a low influence factor in the pricing system; hence this factor may be considered as a significant influential factor in the pricing system.

Site Conditions

The site conditions depend on the results of the soil investigation report which will describe the type of the top soil, ground water level, topography, soil components, contamination level and other factors. These elements will directly affect the type of foundation, type of materials used for foundations, works required such as the dewatering system during the time of constructing the foundations. Accordingly the building prices will change.

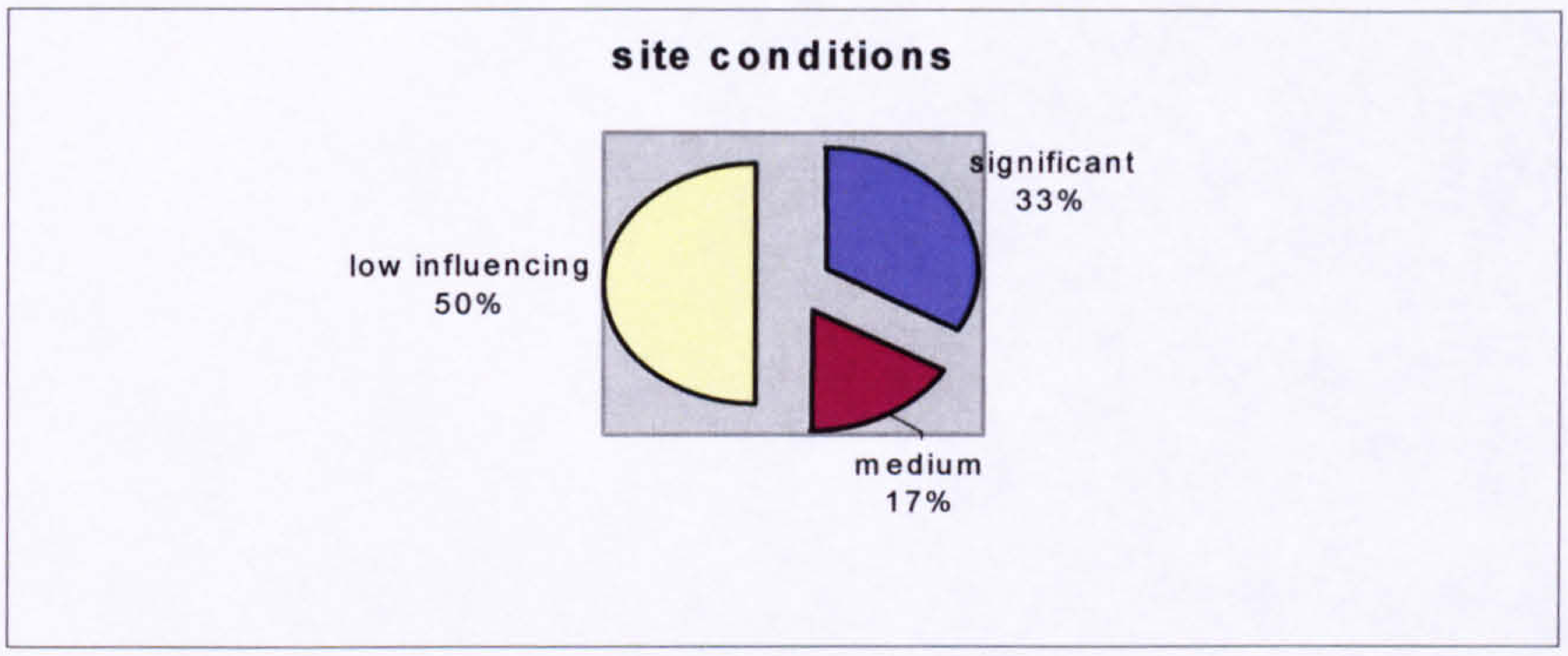

Fig. 6. 58 Site conditions

Figure 6.58 shows that 50% of the respondents see the site conditions as a low influence on the pricing system, 17% of the respondents score its influence level as medium, and 33% consider site conditions to be a significant factor in the pricing system. Hence, as a result of the survey, it is clear that site conditions are not an influence factor in the pricing system.

Site Location

The location of the project site has a significant effect on the project cost. If the site is located in or close to the cities this will be helpful for the transportation costs for all materials and labour, equipment, and also it will be cheaper to connect the services to the site. On the other hand, if the projects are located out of the cities this will require more mobilization and labour accommodation, and it will be expensive to connect services to the site.

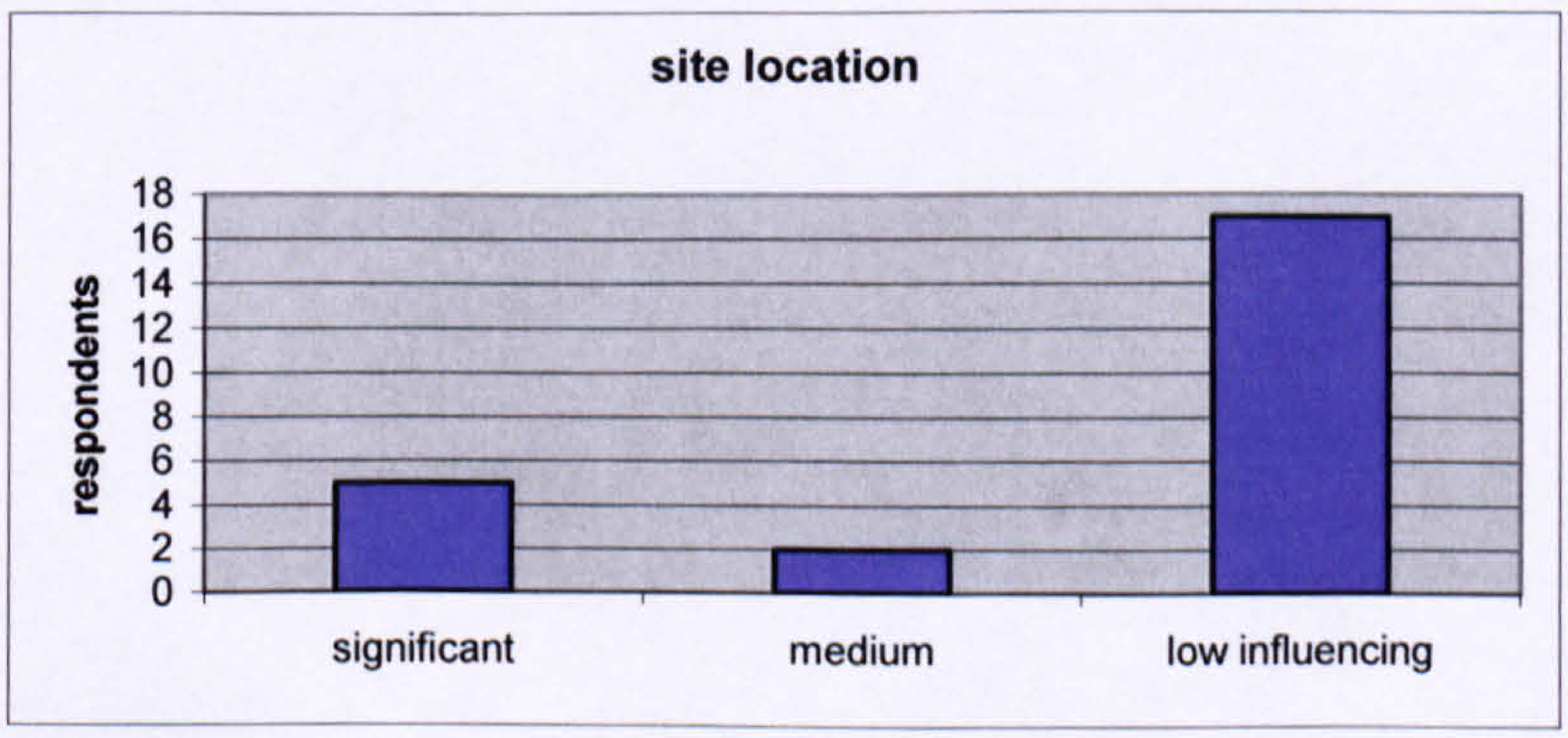

Fig. 6. 59 Site location

Figure 6.59 above (clustered column chart) shows that the site location factor has a low influence on the pricing system. As a result of the survey, it is clear that 71% of the respondents see that site location is of low influence on the pricing system, 8% of the respondents think that its influence is medium, and 21% of the survey results see that site location is a significant influential factor in the pricing system; hence the site location is considered to be a low influencing factor in the pricing system.

Project security level

Different projects require different levels of security. The level of security depends on the project type and location of the project.

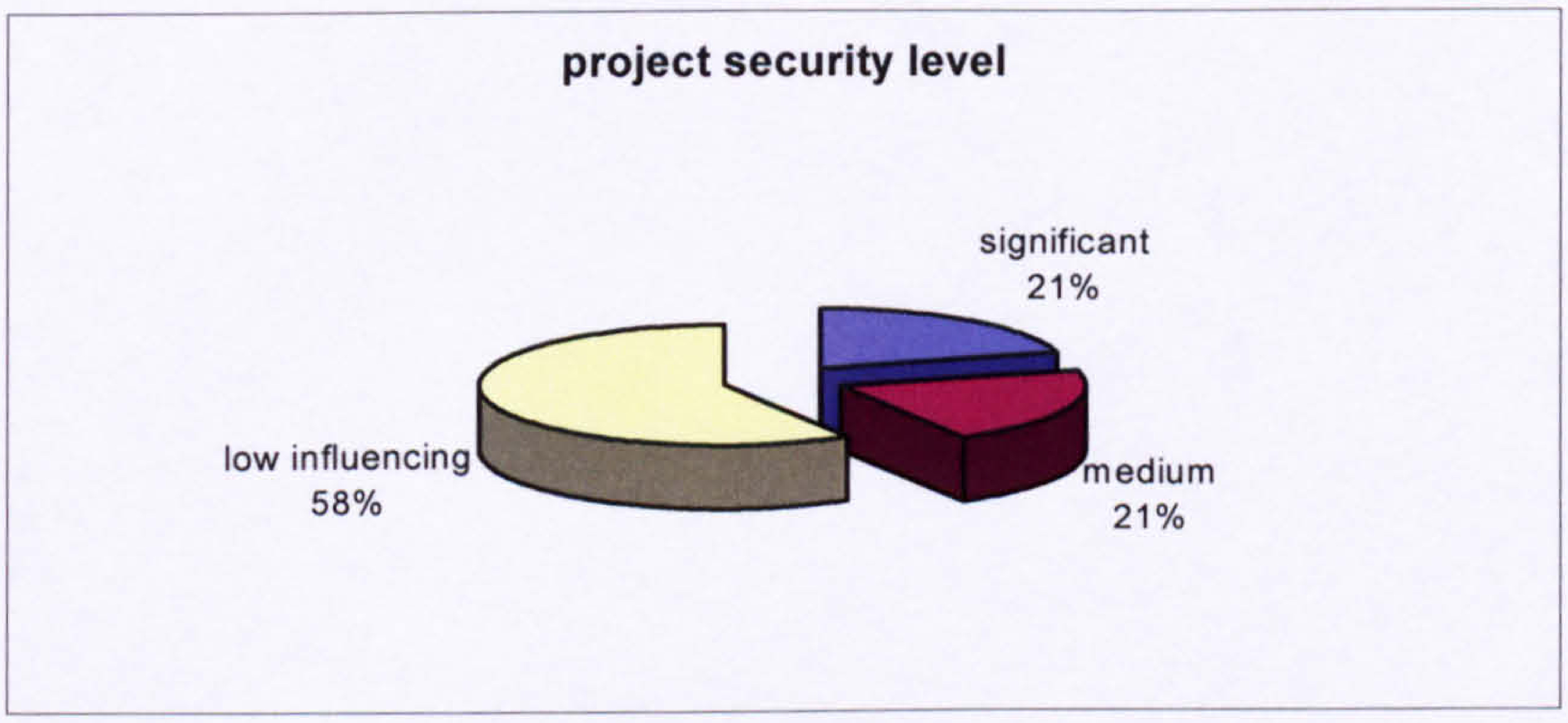

Fig. 6. 60 Project security level

Figure 6.60 above shows that the project security level factor has a low influence on the pricing system. As a result of the survey, it is clear that 58% of the respondents see that the effect of project security level is of low influence on the pricing system, 21% of the respondents score its influence level as medium, and 21% of the survey results see that project security level is a significant influence factor in the pricing system; hence the project security level is considered as a low influence factor in the pricing system.

Flexibility in working time

Time flexibility can be achieved by the use of flexible hours. The most familiar method is flexi time in which employees can vary their daily hours of work on either side of the core-time when they have to be present, providing the longer term required hours are completed. Time flexibility can be achieved in companies according to the fluctuations in labour requirements and project operations requirements.

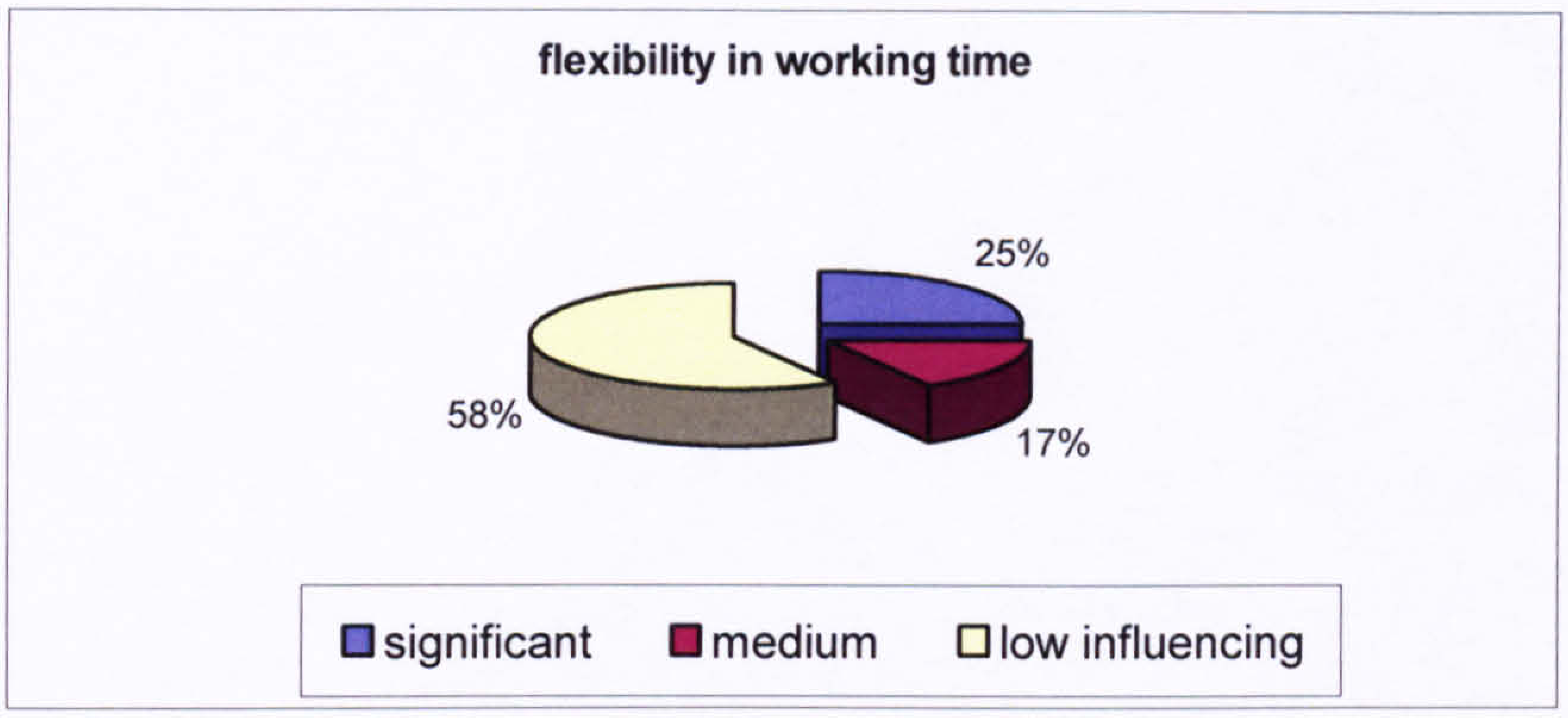

Fig. 6. 61 Flexibility in working time

Figure 6.61 above shows that 58% of the respondents see flexibility in working time as a low influence factor in the pricing system, 17% of the respondents consider its effect as of medium level influence, and 25% consider that flexibility in working time is a significant factor in the pricing system. Hence, as a result of the survey, it is clear that flexibility in working time is not an influence factor in the pricing system.

Peer relationships

Relationships can exist between an owner, the professional consultants that are engaged to work on the project in order to formulate, design, supervise and manage the creation of the facility, and the contractors, suppliers who may be engaged to supply and/or construct the project.

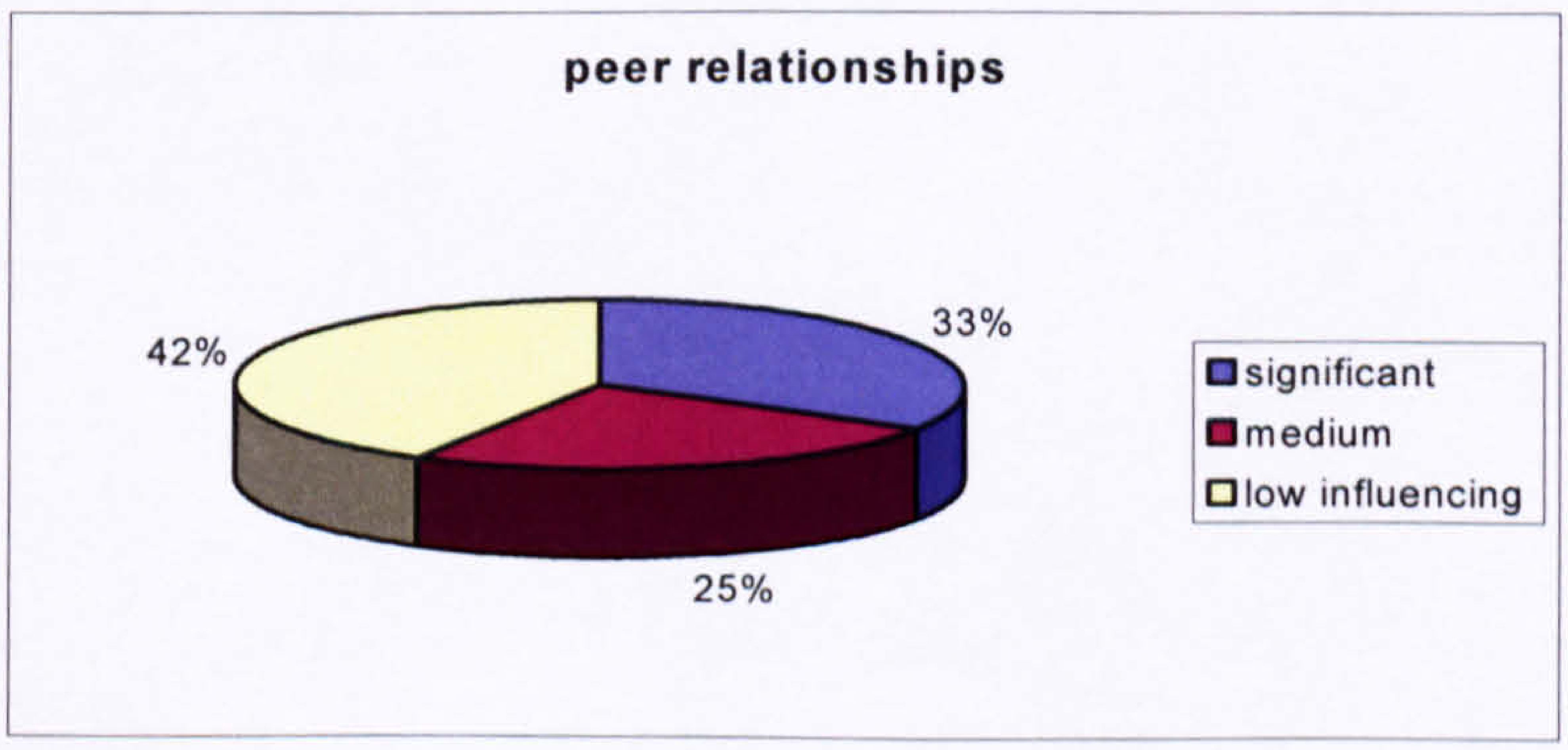

Fig. 6. 62 Peer relationships

Figure 6.62 shows that 44% of the respondents see peer relationships as a low influence on the pricing system, 36% of the respondents score its influence as medium, and 20%

consider that peer relationships are a significant factor in the pricing system. Hence, as a result of the survey, it can be concluded that peer relationships are not an influence factor in the pricing system.

Allocation of responsibilities

Daoud and Hamdani (1988) consider that the lack of a clear understanding of the rights and responsibilities of each party in a project is a major source of problems in construction. To remove confusion of responsibilities, written procedures are suggested: for example, concentrating responsibility for design in the hands of one architect or engineer and so for other activities to allocate clear responsibility to each one within the organization.

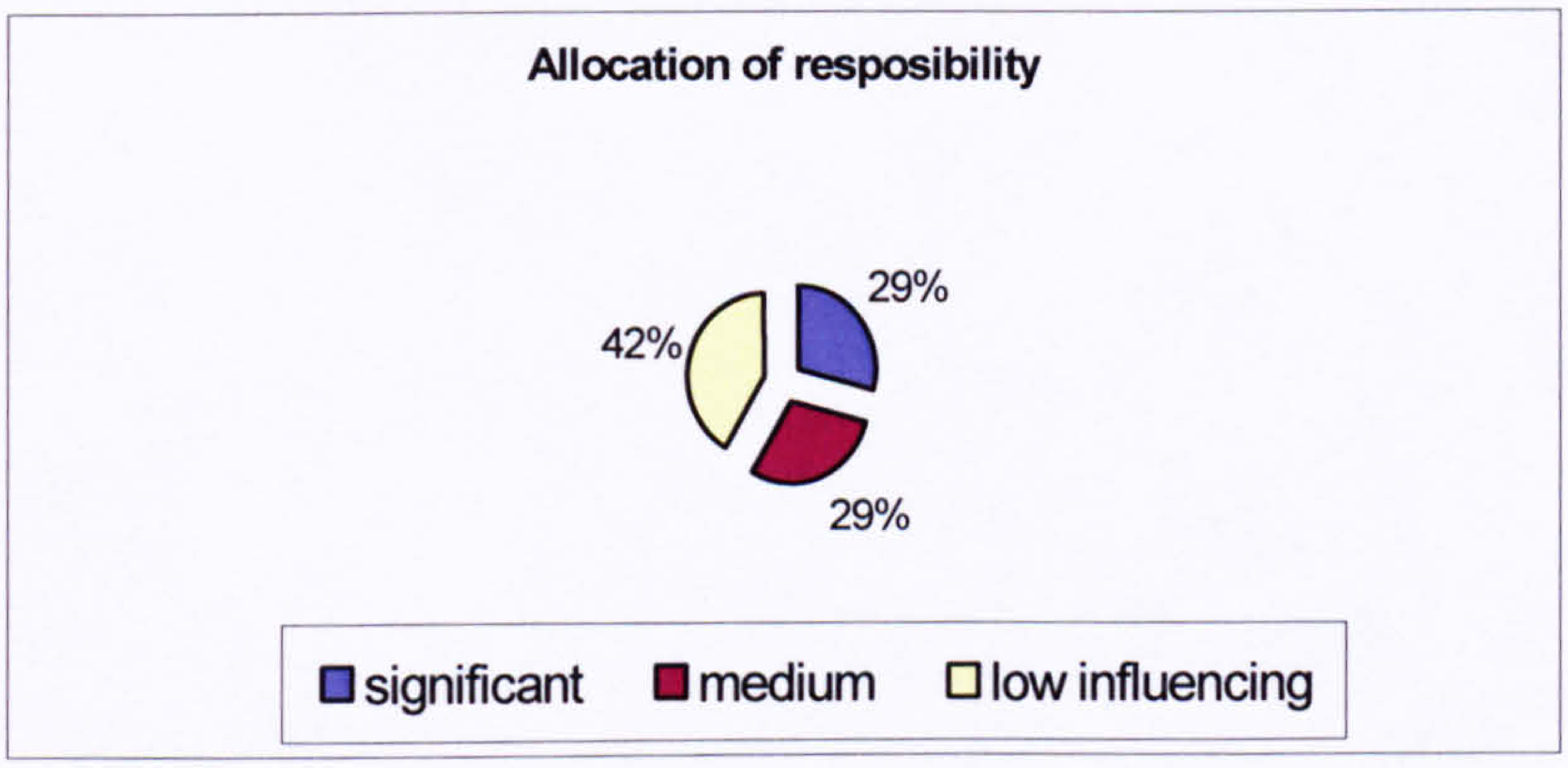

Fig. 6. 63 Allocation of responsibility

Figure 6.63 shows that 42% of the respondents see the allocation of responsibility as a low influence on the pricing system, 29% of the respondents score its influence level as medium, and 29% consider that allocation of responsibility is a significant factor in the pricing system. Hence, as a result of the survey, it is clear that allocation of responsibility is not an influence factor in the pricing system.

Client Reputation

Client reputation depends on many criteria, such as the organization management level, the personnel experience in the construction project, past experience, projects successfully completed and executed in the past. Client budget availability of the planning projects, and satisfaction of the other project parties, are among the most important criteria for the client's reputation.

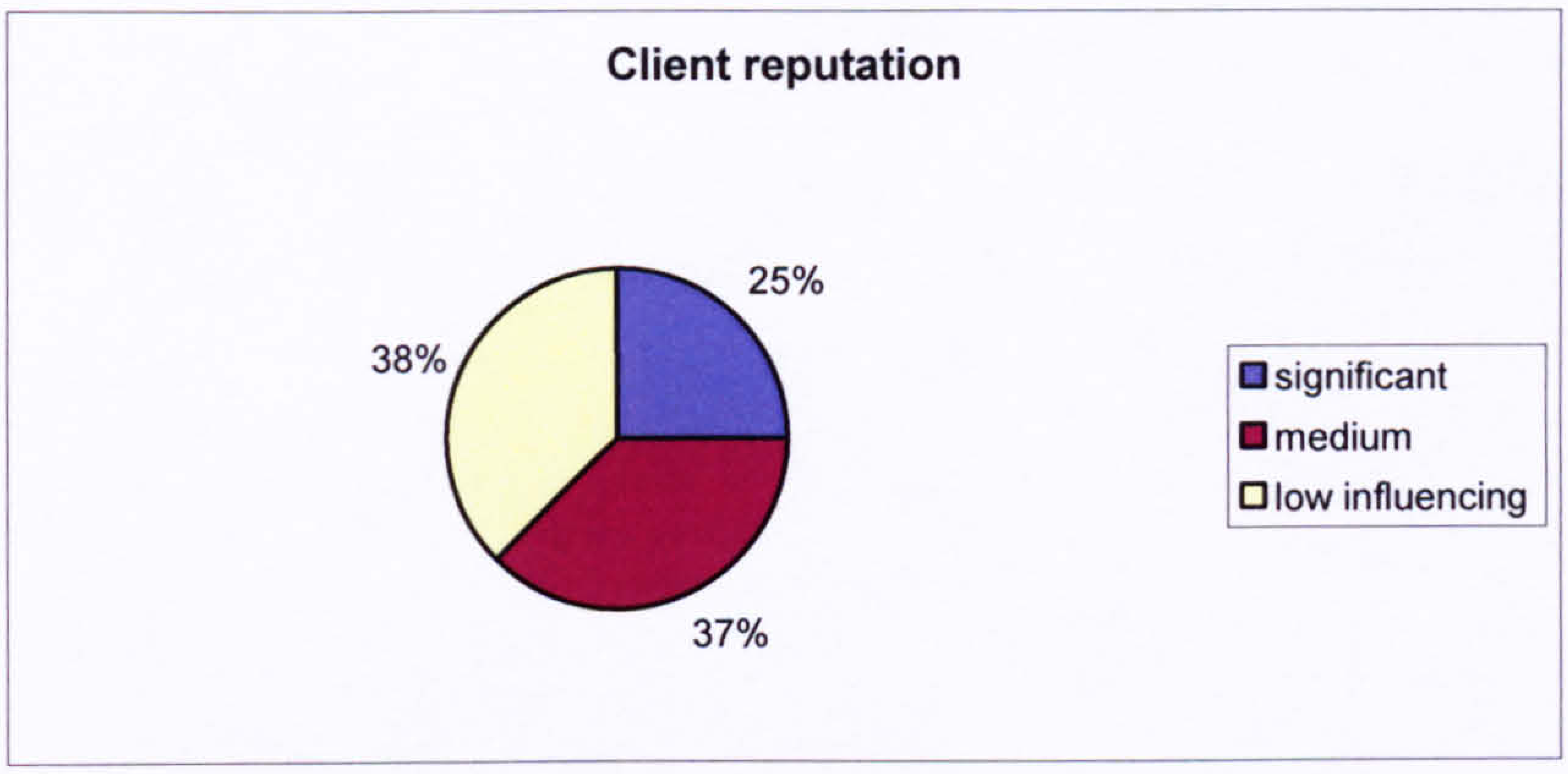

Fig. 6. 64 Client reputation

Figure 6.64 shows that 38% of the respondents see client reputation as a low influence on the pricing system, 37% of the respondents score its influence level as medium, and 25% consider that client reputation is a significant factor in the pricing system. Hence, as a result of the survey, it is clear that client reputation is not an influence factor in the pricing system.

Project budget availability

The budget of a project represents the scheduled expenditure and scheduled revenue as a function of time. The simplest approach to budgeting is to estimate the expected costs, an income associated with each activity, task and milestone. Based on the project schedule, these costs are assigned specific dates and a budget is generated; however it may be only a partial budget because some of the indirect costs are not usually included at the preliminary stage. The development of detailed project budgets is based on schedule and resources considerations.

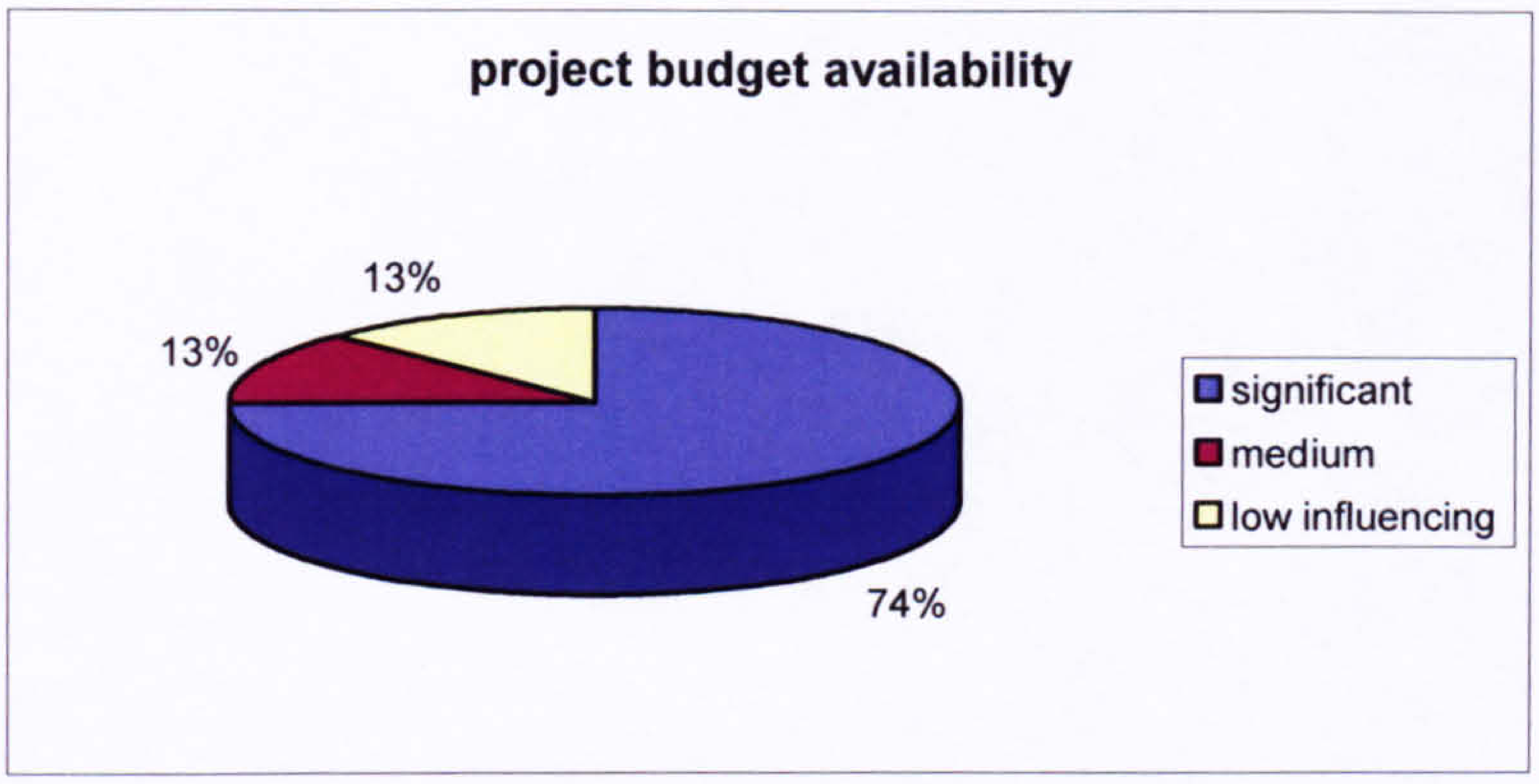

Fig. 6. 65 Project budget availability

Figure 6.65 above shows that project budget availability factor is significant to the pricing system. As a result of the survey, it is clear that 74% of the respondents see that project budget availability is significant to the pricing system, 13% of the respondents think that its effect is medium, and 13% of the survey results see project budget availability as a low influence factor in the pricing system; hence this factor may be considered as a significant influence factor in the pricing system.

Integrated project team

Team working becomes more significant when the technology or operating processes require cellular working or considerable interaction between people carrying out different functions but with a common purpose. Effective team working is more important during periods of rapid change. Waterman (1988) has noted that teamwork is a tricky business; it requires people to pull together toward a set of shared goals or values. Richard Walton (1985) has commented that in the new commitment based organization it will often be teams rather than individuals who will be organizational units accountable for performance. Construction project teams in particular require a multi-functional, inter-disciplinary representation, engaging a cross-section of industry professionals responsible for carrying out duties particular to their area of expertise (Tennant *et al.*, 2005).

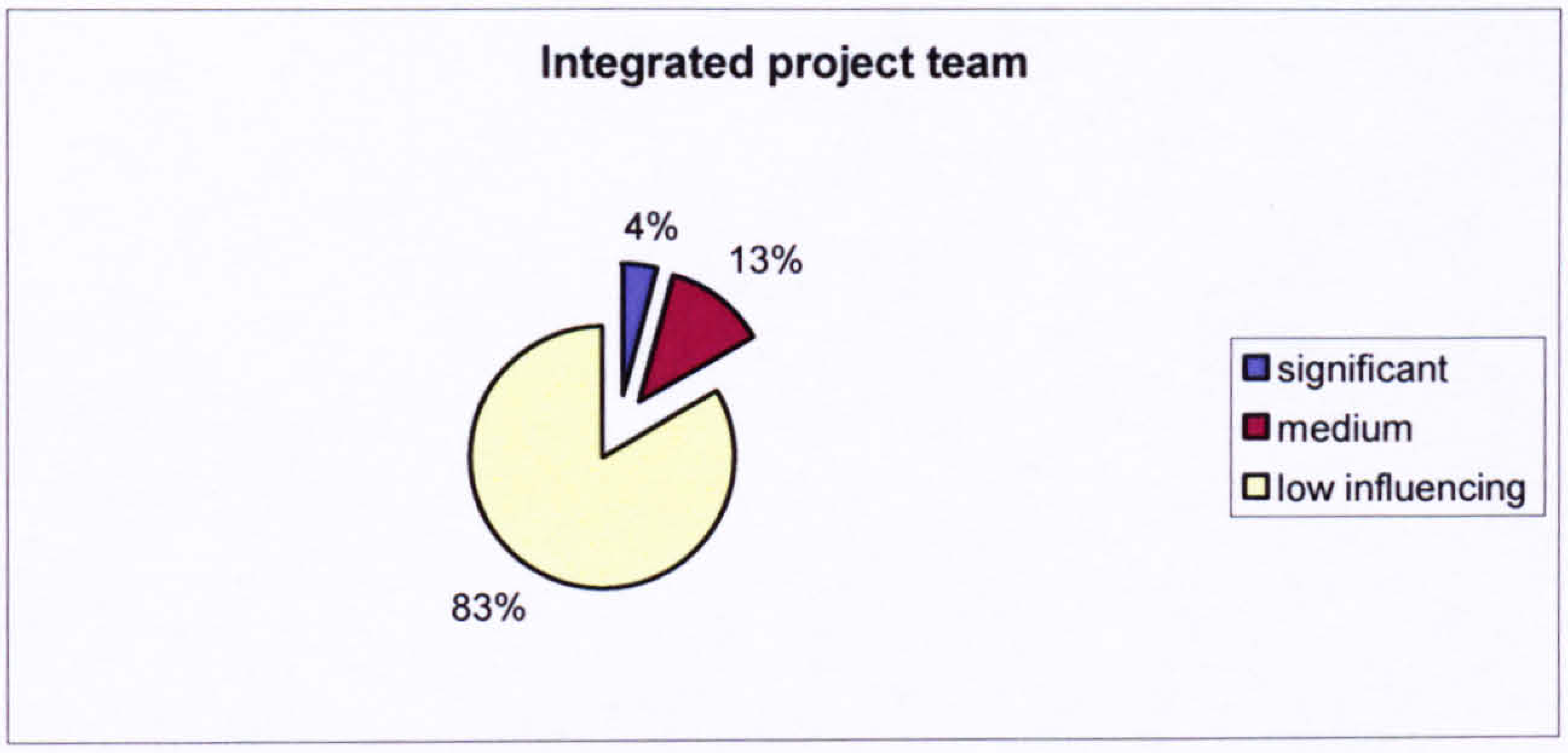

Fig. 6. 66 Integrated project team

Figure 6.66 shows that the integrated project team factor has a low influence on the pricing system. As a result of the survey, it is clear that 83% of the respondents see that integrated project team is a low influence factor in the pricing system, 13% of the respondents think that its effect is medium, and only 4% of the survey results see that the integrated project team is a significant influence factor in the pricing system; hence the issue of the integrated project team is considered as a low influence factor in the pricing system.

Investment briefing

Accepting the fact that cost control is most effective in the early stages of the project development, it has to be recognized that controlling the scope of project, which is determined initially by the process design, controls costs in the first place.
Figure 6.67 (pie chart) shows that investment in the briefing stage has a low influence on the pricing system. As a result of the survey, it is clear that 41% of the respondents see that the effect of investment in the briefing stage is of low influence on the pricing system, 38% of the respondents consider its effect as medium, and 21% of the survey results see investment in briefing as a significant influence factor in the pricing system; hence the issue of the investment in the briefing stage is considered as a low influence factor in the pricing system.

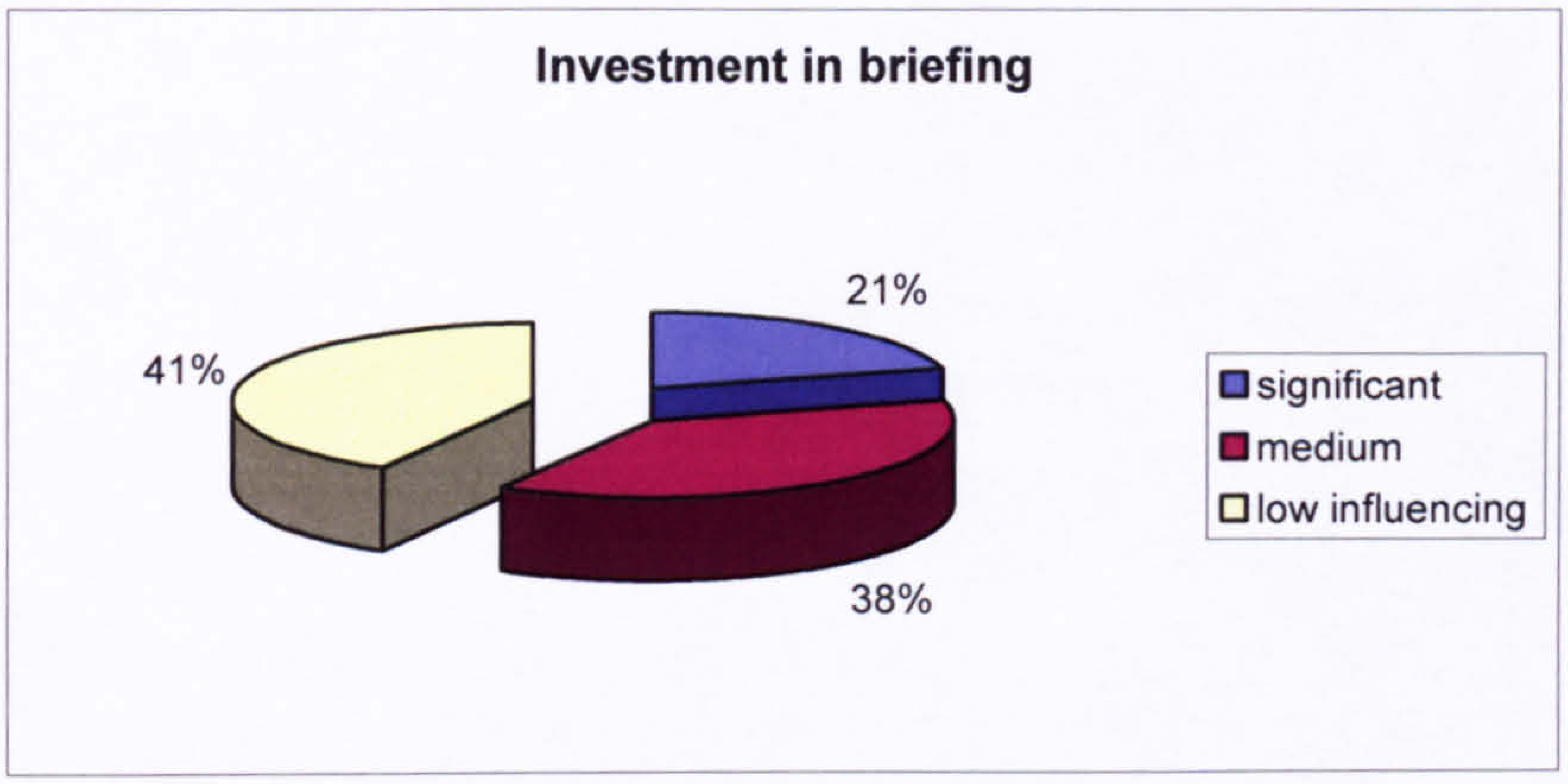

Fig. 6. 67 Investment in briefing

No blame culture

Blame effects might distort the response by leading to an overemphasis on individually based factors at the expense of managerial and external factors. Assigning responsibility to individuals absolves the supervisor and company from direct blame and typically leads to recommendations for behaviour change, often through disciplinary approaches (Whittington *et al.*, 1992).

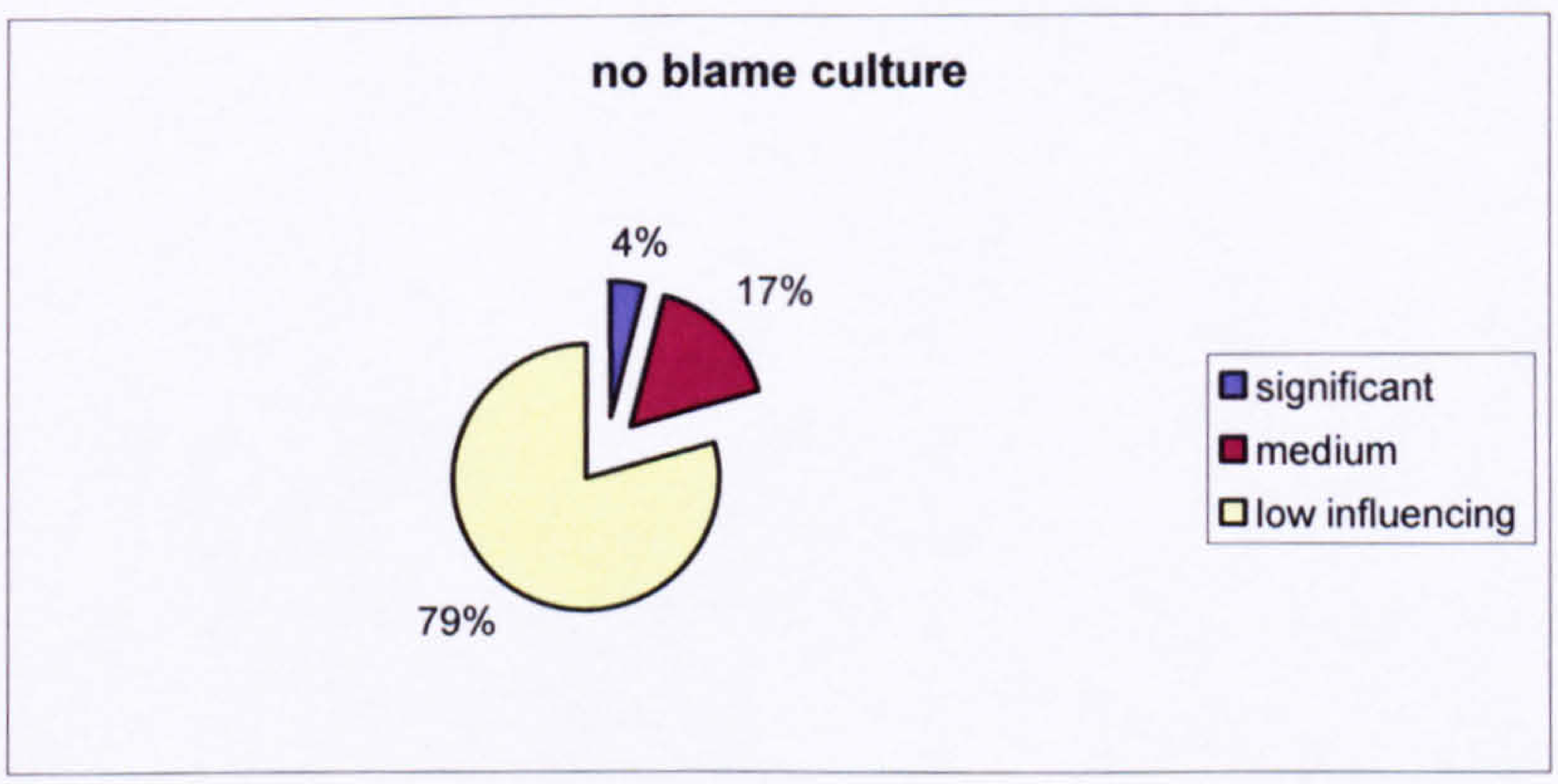

Fig. 6. 68 No blame culture

Figure 6.68 (pie chart) shows that no blame culture factor has a low influence on the pricing system. As a result of the survey, it is clear that 79% of the respondents see that the effect of no blame culture factor is of low influence in the pricing system, 17% of the respondents consider its influence level as medium, and only 4% of the survey results see the no blame culture as a significant influence factor in the pricing system; hence the effect of the no blame culture is considered as a low influence factor in the pricing system.

Client experience

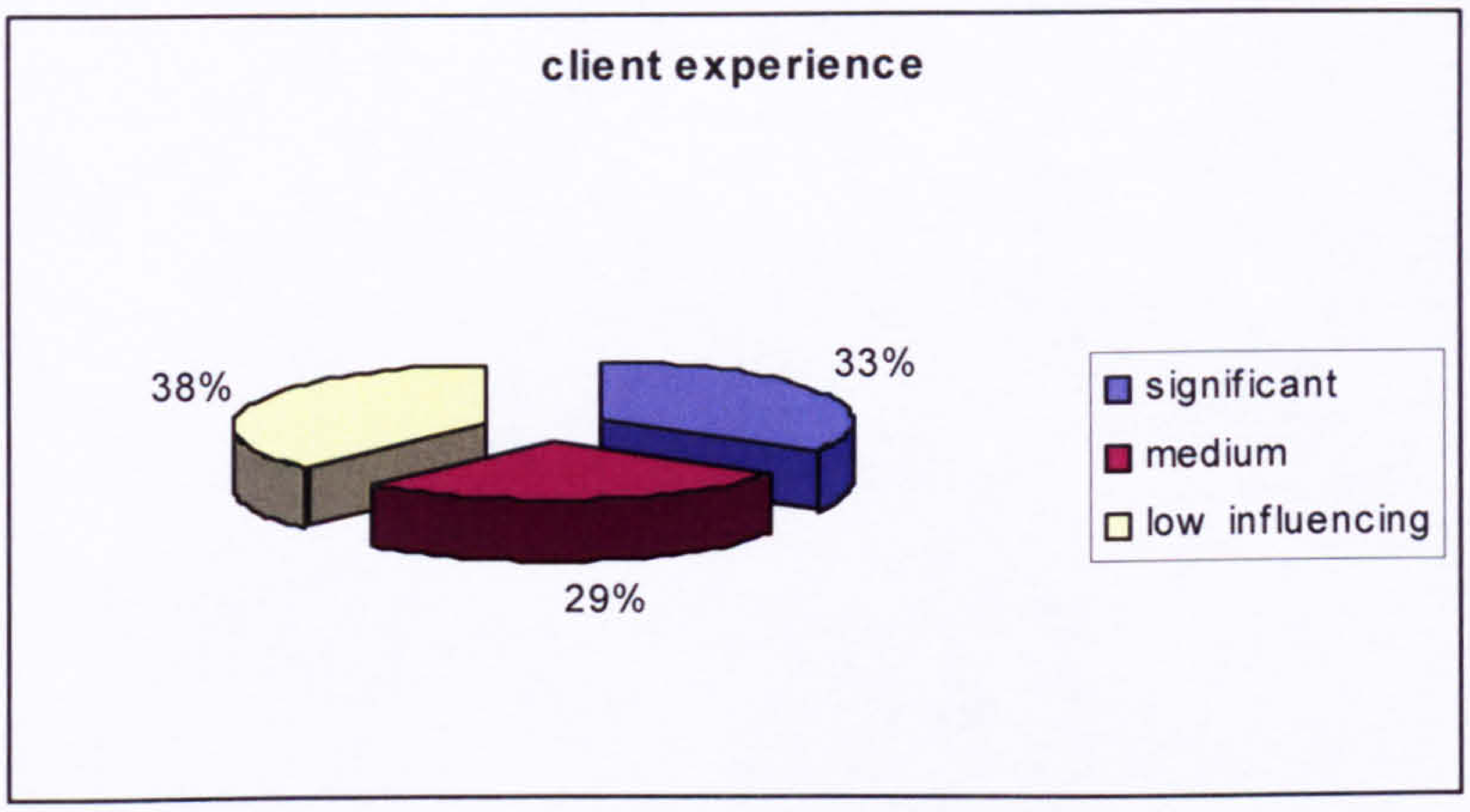

Fig. 6. 69 Client experience

Figure 6.69 shows that client experience has low influence on the pricing system. Figure 6.67 above (pie chart) shows client experience has a low influence on the pricing system. As a result of the survey, it is clear that 38% of the respondents see that the effect of investment in the briefing stage is of low influence on the pricing system, 29% of the respondents consider its effect as medium, and 33% of the survey results see client experience as a significant influence factor in the pricing system; hence the issue of the investment in the briefing stage is considered as a low influence factor in the pricing system.

Authority of project manager

The planning stage is critical. It must include the planning and establishment of the authority relationships for the entire duration of the project. The amount of authority granted to the project manager varies according to project size, management philosophy, and management interpretation of potential conflicts with functional managers. His/her authority should be sufficient to permit him to engage all necessary managerial and technical actions required to complete the project successfully. He/she should have appropriate authority in design and in making technical decisions in development, control funds, schedule and quality of the products.

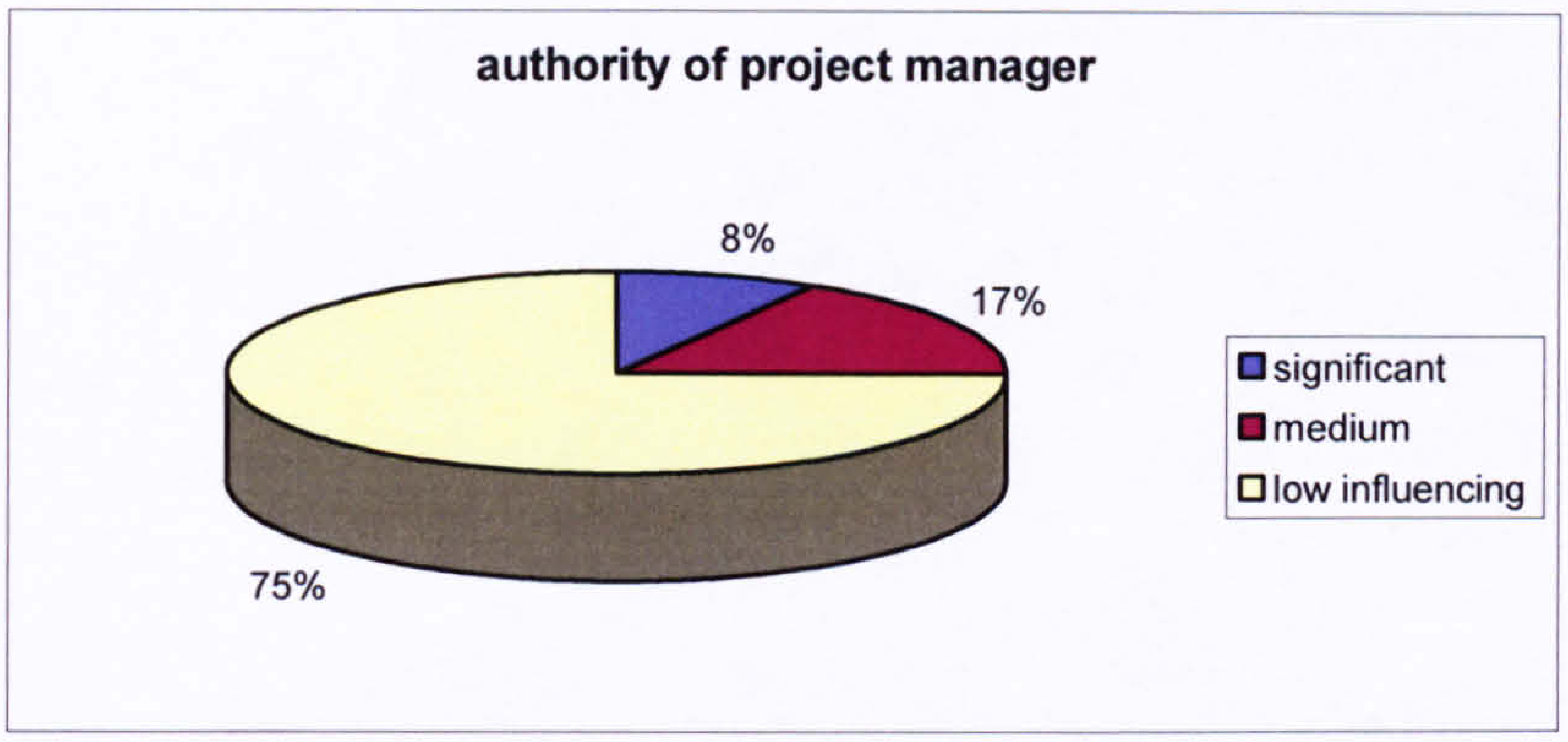

Fig. 6. 70 Authority of project manager

Figure 6.70 above shows that the project manager authority factor has a low influence in the pricing system. As a result of the survey, it is clear that 75% of the respondents see that the effect of project manager authority is of low influence on the pricing system, 17% of the respondents score its influence level as medium, and 8% of the survey results see that project manager authority is a significant influence factor in the pricing system; hence the issue of project manager authority is considered as a low influence factor in the pricing system.

6.4 DISCUSSION OF RESULTS

The differences in the answers between the respondents reflect their attitude and the experience. Attitudes are affected by the current projects being handled, ongoing or not long completed, while the experience depends on accumulating the company history, and the types of projects executed. Results from the questionnaire show that thirteen factors can be considered to be of significant influence on the choice of either the payment method or pricing system. The list of 13 factors were developed using a simple criterion: that is any factor with an overall score (in each of payment or pricing categories) of less than 3.5 was excluded. The strategy behind this was to include as many variables as possible, but to keep the selection aid tool (see next chapter) simple and attractive to practitioners. The following section discusses the results for these factors of significant influence.

Cost certainty

The result of the survey showed cost certainty to have a significant influence on both payment methods and pricing system; this is because cost certainty is directly affected by the payment method and/or pricing system being used. As indicated before, lump sum prices are more suitable for projects where cost certainty is of high priority.

Time certainty

It is clear from the survey analysis that whilst time certainty has a significant effect on the choice of payment method, its effect on pricing systems is less significant. This was not unexpected given the scope of the research: that is, not to include incentive pricing systems.

Contractor cash flow

Most of the respondents saw cash flow to be a significant factor influencing the choice of payment methods and pricing system. This is because the payment method being selected has a significant effect on the project cash. For example, when the interim payment (monthly) is being applied, the resulting cash flow will be more favourable to the contractor than in the case with the milestone or stage payment systems which largely depend on the dates to be defined for each payment. Similarly, in the case of pricing systems, the selection of the cost plus system provides the contractor and its lenders with more certainty about the project outcome, hence the ability to obtain the funding for the work becomes easier.

Form of contract

For the project parties it is very important to choose an appropriate form of contract according to the project objectives' characteristics. The survey shows the form of contract to be a significant factor for the payment system. Although each of the main forms of contracts offers several payment and pricing options, the survey results suggest that some payment systems are more suitable for particular contracts.

Speed during design and construction

The speed of the design and the construction progress is very important to the client and other project parties in order to save time and the cost of the project. Results showed that respondents consider the speed issue to be significant to the payment method selection. For example, defined milestones encourage the contractor to speed up the work progress on the site. Also, for early completion, the target incentive contract provides incentives, while the traditional contract provides bonus payments. On the other hand, the results showed that the client's desire for a speedy completion has a low influence on the pricing system.

Disputes likelihood

Certainty and the selection of an appropriate form of contract often lead to greater avoidance of disputes. From the survey results it is clear that most of the respondents consider that the likelihood of disputes is a significant factor in the choice of both payment and pricing methods. Payment systems may be associated with different levels of disputes. For example, milestones may lead to more disputes if they are not very clearly defined, whereas interim payments create conflicts if the quantity surveyor does not agree with the client's representative of the works being performed. The cost plus pricing system is more helpful in reducing conflicts than in the case of bill of quantities, particularly in such cases where there are changes in the specifications of any item.

Risk allocation

As in the case for disputes, projects with high levels of risks apply a particular payment system and not others. Payment systems play a key role in defining how risks are allocated. For example, a lump sum contract enables the client to transfer all risks to the contractor, whilst cost plus contracts tend to help the contractor to avoid the majority of risks.

Project size

The total cost of the construction project gives an indication of the project size.
As a result of the survey, the respondents consider the project size as a significant factor in the pricing system. Small projects are often priced on a lump sum basis, while the larger ones require deeper understanding of the relationship between pricing system and project objectives. The survey results, however, considered size to be of low influence on the choice of payment methods. This was unexpected given that less complex systems such as stage payment or milestones were perceived to be more applicable to small projects.

Procurement system

The appropriate selection of the procurement system is a very important decision to be taken for the successful completion of the construction project. The survey results show that the procurement selection is a significant factor in the pricing system. This result was expected given that in certain procurement systems (e.g. design and build) the cost plus system is more suitable given the uncertainty of the design specification at the tendering stage. On the other hand most respondents consider procurement system to be of low influence on the choice of payment methods.

Value for money

Value for money in construction is about more than delivering a project to time and cost. It is clear from the survey results that the issue of the value for money is considered to be significant to the pricing system. Results coincided with the author's earlier argument that pricing systems such as cost plus may add value to the project (more than lump sum prices, for example), given that cost plus pricing systems will provide better flexibility for changes and innovations. In terms of payment methods, results showed a relationship with value for money.

Tender methods

The construction industry offers several methods for project tendering, so that an appropriate one may be selected for a project tendering. The survey results showed that the tendering method selection is a significant factor in the choice of project pricing system. For example, negotiated tenders allow clients and contractors a degree of flexibility in terms of what pricing system to use; however, most of the respondents considered this issue to be of low influence on the payment methods.

Budget availability

The project budget availability is a very important factor to the project's success. The survey found that the project budget availability is significant to the pricing system selection. As indicated before, cost plus pricing systems provide contractors with more certainty and hence ability to raise loans and other external funding; lump sum and fixed prices, on the other hand, provide the client with more certainty. Respondents, however, consider this issue to be of low influence on the payment methods

Project duration

The length of time needed to complete the project has a significant influence on the project cash flow forecasting. As a result of the survey carried out, project duration has a high effect on the project cash flow, because project cash flow is associated with the project duration. As a result of the project duration increasing, the cash flow will decrease, and vice versa. On the other hand, most of the respondents see the effect of project duration as of low influence on the payment methods and pricing system selections.

Table 6.1 below summarises the influence of the above-mentioned factors on both payment methods and pricing systems according to the survey results.

Table 6.1 List of the above factors overall ranked in terms of their influence:

No	Factor	Payment methods	Pricing system
1	Cost certainty	Significant	Significant
2	Contractor cash flow	Significant	Significant
3	Contract form	Significant	Significant
4	Disputes likelihood	Significant	Significant
5	Risk allocation	Significant	Significant
6	Time certainty	Significant	Low
7	Speed (during D&B)	Significant	Low
8	Project size	Low	Significant
9	Procurement system	Low	Significant
10	Flexibility (accommodate design changes)	Low	Significant
11	Value for money	Low	Significant
12	Tender methods	Low	Significant
13	Budget availability	Low	Significant

6.5 RESULTS VALIDATION

The validity here is concerned with the degree to which the variables influence the payment and pricing systems, and also measured effect, which is the result of the identified causal relationship. Generally, as validity is increased, so confidence in the accuracy of the results is increased.

Validity concerns how well a measure determines the concept it is supposed to measure. Concurrent validity measures the variables on which people differ, and determines whether the measures of the variables are consistent, including according to theory and literature (Fellow and Liu, 2003). It is important to be sure of the validity of the work.

To achieve good internal validity, care is needed in the research design such that alternative explanations are examined and appropriate methods selected by which the causality can be investigated (Fellows and Liu, 2003).

The emphasis of this study has been the identification and analysis of factors influencing the payment system. The influencing factors identified have been analysed by the use of mean score and then tested by ranking the mean score and analysis of variance to examine the significant difference of the mean score between the various groupings identified (payment methods and pricing system).

The results of the analysis of the influencing factors and their impact on the payment system elements were discussed within the limitation of the data collected.

6.6 RESULTS TESTING

For testing the results throughout, the following tests tools were applied:

6.6.1 Rank sum test

Nonparametric statistical tests are available to treat data that are inherently in ranks as well as data whose seemingly numerical scores have the strength of ranks (Siegel, 1956).

The Spearman rank correlation coefficient is often used as a test statistic to test for independence between two random variables (Conover, 1980).

The derived indexes were then ranked according to their level of significance, using the Microsoft Excel function RANK. This methodology has been extensively used in project management and construction related research, by, for example, Wong *et al.* (2002), and

Okpals and Aniekwu (1988). Accordingly, the ranking of the influencing factors were listed in tables 6.2 and 6.3, as shown below:

Table 6.2 Payment methods ranking of the influence factors

	Payment methods			
	Factors	mean score	Idex	Ranking
1	Time Certainty	4.0833	0.8166667	2
2	Disputes Likelihood	4.0833	0.8166667	2
3	Cost certainty	4.0000	0.8	4
4	Risk allocation	4.0000	0.8	4
5	Contractor cash Flow	3.9583	0.7916667	5
6	Contract Form	3.8333	0.7666667	6
7	Speed	3.1236	0.62472	7
8	Investment in briefing	3.1053	0.6210526	8
9	Quality	2.9583	0.5916667	10
10	Extent of competition	2.9583	0.5916667	10
11	Value for money	2.9167	0.5833333	11
12	Project budget availability	2.9130	0.5826087	12
13	Tender Methods	2.8750	0.575	14
14	Tender documents	2.8750	0.575	14
15	No blame culture	2.8421	0.5684211	15
16	Contractor Exper.	2.8333	0.5666667	16
17	Flexibility	2.8261	0.5652174	18
18	Allocation of responsibility	2.8261	0.5652174	18
19	Procurement system	2.7917	0.5583333	20
20	Project Type	2.7917	0.5583333	20
21	Project size	2.7500	0.55	21
22	Peer relationship	2.7391	0.5478261	22
23	Authority of project	2.6842	0.5368421	23
24	Client reputation	2.6522	0.5304348	24
25	Economic Condition	2.6250	0.525	26
26	Project complexity	2.6250	0.525	26
27	Flexibility in work time	2.5000	0.5	28
28	Client Experience	2.5000	0.5	28
29	Contractor Qalification	2.4583	0.4916667	30
30	Tendering Time	2.4583	0.4916667	30
31	Project Security level	2.3750	0.475	32
32	Project duration	2.3750	0.475	32
33	Site condition	2.3333	0.4666667	33
34	Integrated Project team	2.3158	0.4631579	34
35	Site Location	2.2083	0.4416667	35

Table 6. 3 Pricing systems ranking of the influence factors

pricing system

	Factors	mean score	Idex	Ranking
1	Cost certainty	4.1666667	0.8333333	1
2	Contractor cash Flow	4	0.8	4
3	Procurement system	4	0.8	4
4	Disputes Likelhood	4	0.8	4
5	Value for money	4	0.8	4
6	Project budget availability	4	0.8	4
7	Contract Form	3.9583333	0.7916667	7
8	Project size	3.9166667	0.7833333	8
9	Risk allocation	3.875	0.775	9
10	Tender Methods	3.75	0.75	10
11	Investment in briefing	3.0625	0.6125	11
12	Speed	3	0.6	13
13	Authority of project	3	0.6	13
14	No blame culture	2.9375	0.5875	14
15	Quality	2.9166667	0.5833333	16
16	Flexibility	2.9166667	0.5833333	16
17	Contractor Exper.	2.875	0.575	18
18	Economic Condition	2.875	0.575	18
19	Flexibility	2.8333333	0.5666667	20
20	Project Type	2.8333333	0.5666667	20
21	Time Certainty	2.7916667	0.5583333	23
22	Tendering Time	2.7916667	0.5583333	23
23	Tender documents	2.7916667	0.5583333	23
24	Peer relationship	2.7916667	0.5583333	23
25	Project duration	2.75	0.55	27
26	Client Experience	2.75	0.55	27
27	Extent of competetion	2.75	0.55	27
28	Client reputation	2.75	0.55	27
29	Integrated Project team	2.75	0.55	27
30	Project compexity	2.7083333	0.5416667	30
31	Site condition	2.5833333	0.5166667	31
32	Flexibility in work time	2.5	0.5	32
33	Contractor Qalification	2.4583333	0.4916667	33
34	Project Security level	2.3333333	0.4666667	34
35	Site Location	2.2083333	0.4416667	35

The author wishes to be able to reach a decision regarding the existence of an association between variables that will lead to computing a measure that in some sense expresses the degree or strength of the relationship between these variables. Daniel (1990) stated that such measures computed from sample data usually serve four purposes, as follows:

1- They measure the strength of the relationship among the sample observations.

2- They provide a point estimate of the measure of the strength of the relationship between the variables in the survey carried out.

3- They provide the basis for constructing a confidence interval for the measure of the strength of the relationship between variables in the survey carried out.

4- They allow the investigator to reach a conclusion about the presence of a relationship in population from which the sample was drawn.

According to the above, the sample correlation coefficient measure of the strength of the relationship among the survey was needed to provide a valid statistical technique for use with the data collected. The statistical technique selected was the Spearman rank correlation, which is widely used in such cases. A nonparametric (distribution-free) rank statistic was proposed by Spearman in 1904 as a measure of the strength of the associations between two variables (Lehmann and D'Abrera, 1998). The most significant inputs to the analysis can be determined using the Spearman rank correlation coefficient (Kottegoda and Rosso, 1997).

In preparation for computing the Spearman rank correlation coefficient, data should be subjected to the following procedures:
Data designate the n pairs of observations ($X_1, Y_1), (X_2, Y_2), \ldots\ldots (X_n, Y_n)$
Each X & Y are ranked relative to all observed values of X &Y from largest to smallest values in order of magnitude of the mean scores.
The test statistic is

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \quad \text{where:} \quad \sum d_i^2 = \sum_{i=1}^{n} [R(X_i) - R(Y_i)]^2$$

where n=total number of data points (i.e. variables); d_i=difference between ranks (i.e., rank of total value of alternative n for data point in each group, as the author split the data into three groups named A ,B and C, where group A is a list of all the respondents, group B is a list of the first half of the respondents, and group C is a list of the second half of the respondents.
The correlation coefficient is calculated between each input parameter and the total value of each alternative using the data obtained from the reliability analysis. The input values and total alternative values are ranked within each data set, with the highest value obtaining a ranking of one.

The intermediate calculations necessary for computing r_s are given in table 8.3 for the variables influencing the payment methods, and table 6.4 for the variables influencing the pricing systems.

Table 6. 4 Payment methods d^2 calculation

The Factors	Groups A&B		Groups A&C		Groups B&C	
	d_i	d_i^2	d_i	d_i^2	d_i	d_i^2
Time Certainty	-1.0	1	-2.5	6.25	-1.5	2.25
Cost certainty	-2.0	4	1.5	2.25	3.5	12.25
Flexibility	-2.0	4	4.0	16	6.0	36
Project size	2.5	6.25	-3.0	9	-5.5	30.25
Project complexity	-2.5	6.25	2.5	6.25	5.0	25
Project Type	-3.5	12.25	3.5	12.25	7.0	49
Project duration	1.0	1	0.5	0.25	-0.5	0.25
Contractor cash Flow	2.5	6.25	-1.5	2.25	-4.0	16
Contractor Experience.	1.0	1	-5.5	30.25	-6.5	42.25
Client Experience	0.5	0.25	-2.0	4	-2.5	6.25
Contract Form	1.0	1	0.0	0	-1.0	1
Tendering Time	2.5	6.25	-1.5	2.25	-4.0	16
Quality	-0.5	0.25	-5.5	30.25	-5.0	25
Economic Condition	5.0	25	-4.5	20.25	-9.5	90.25
Tender documents	0.5	0.25	0.5	0.25	0.0	0
Speed (D&B)	4.0	16	3.0	9	-1.0	1
Procurement system	-6.0	36	7.0	49	13.0	169
Disputes Likelihood	5.0	25	2.5	6.25	-2.5	6.25
Tender Methods	5.5	30.25	-1.5	2.25	-7.0	49
Extent of competition	2.5	6.25	3.0	9	0.5	0.25
Contractor Qualification	7.5	56.25	-3.5	12.25	-11.0	121
Risk allocation	0.5	0.25	6.0	36	5.5	30.25
Value for money	8.0	64	6.0	36	-2.0	4
Site condition	4.5	20.25	6.5	42.25	2.0	4
Site Location	5.0	25	6.0	36	1.0	1
Project Security level	6.0	36	6.0	36	0.0	0
Flexibility in work time	8.5	72.25	4.0	16	-4.5	20.25
Peer relationship	5.0	25	6.0	36	1.0	1
Allocation of responsibility	11.0	121	3.0	9	-8.0	64
Client reputation	5.5	30.25	8.0	64	2.5	6.25
Project budget availability	6.0	36	7.5	56.25	1.5	2.25
Integrated Project team	10.5	110.25	6.5	42.25	-4.0	16
Investment in briefing	7.0	49	10.0	100	3.0	9
No blame culture	7.5	56.25	11.5	132.25	4.0	16
Authority of project manger	8.0	64	11.0	121	3.0	9
Sum	______	**954.25**	______	**992.5**	______	**881.25**

Table 6.5 Pricing system d^2 calculation

The Factors	Groups A&B		Groups A&C		Groups B&C	
	d_i	d_i^2	d_i	d_i^2	d_i	d_i^2
Time Certainty	-10.5	110.25	7.5	56.25	18.0	324
Cost certainty	-1.0	1	-1.5	2.25	-0.5	0.25
Flexibility	0.0	0	-1.0	1	-1.0	1
Project size	1.0	1	0.5	0.25	-0.5	0.25
Project complexity	3.0	9	5.5	30.25	2.5	6.25
Project Type	0.0	0	-1.0	1	-1.0	1
Project duration	-2.5	6.25	6.0	36	8.5	72.25
Contractor cash Flow	-4.5	20.25	2.5	6.25	7.0	49
Contractor Experience.	-11.5	132.25	4.0	16	15.5	240.25
Client Experience	-3.5	12.25	6.0	36	9.5	90.25
Contract Form	-0.5	0.25	1.5	2.25	2.0	4
Tendering Time	0.5	0.25	2.0	4	1.5	2.25
Quality	-3.5	12.25	-1.0	1	2.5	6.25
Economic Condition	-3.5	12.25	0.5	0.25	4.0	16
Tender documents	-5.5	30.25	2.5	6.25	8.0	64
Speed	-5.5	30.25	0.0	0	5.5	30.25
Procurement system	-3.0	9	2.0	4	5.0	25
Disputes Likelihood	-1.5	2.25	0.5	0.25	2.0	4
Tender Methods	1.5	2.25	0.0	0	-1.5	2.25
Extent of competition	0.0	0	2.0	4	2.0	4
Contractor Qualification	0.0	0	-4.0	16	-4.0	16
Risk allocation	2.0	4	-3.5	12.25	-5.5	30.25
Value for money	2.0	4	0.0	0	-2.0	4
Site condition	1.0	1	0.0	0	-1.0	1
Site Location	0.0	0	2.0	4	2.0	4
Project Security level	0.0	0	-4.0	16	-4.0	16
Flexibility in work time	0.5	0.25	-3.0	9	-3.5	12.25
Peer relationship	0.0	0	1.0	1	1.0	1
Allocation of responsibility	1.0	1	-2.5	6.25	-3.5	12.25
Client reputation	0.0	0	-0.5	0.25	-0.5	0.25
Project budget availability	0.0	0	0.0	0	0.0	0
Integrated Project team	0.0	0	0.0	0	0.0	0
Investment in briefing	0.0	0	0.5	0.25	0.5	0.25
No blame culture	-0.5	0.25	-1.0	1	-0.5	0.25
Authority of project	0.0	0	1.0	1	1.0	1
Sum		**401.75**		**274.25**		**1041**

The calculations were based on: number of variables n=35, Probability $\sigma_{(1)}$ =0.005

The critical value of r_s = 0.433 (Daniel 1990).

The test statistic is the measure of the degree of correspondence between the ranks of the sample observations rather than between the observations themselves. It is thought of as a measure of the strength of the relationship between the sample X and Y values and as an estimate of the strength of the relationship between X and Y in the survey.

Testing against independent data is called validation and the scores need to be correlated sufficiently strongly with the scores obtained. In order to assess data quality, there is the need to check for representative ness in the data, weighting the evidence and checking for researcher's effect. Checking for representative ness refers to the procedure necessary to confirm that the findings could be generalised. Project management and construction related research rely extensively on the use of descriptive statistics to explain the outcome of the findings.

A nonparametric (distribution-free) rank statistic was proposed by Spearman in 1904 as a measure of the strength of the associations between two variables (Lehmann and D'Abrera, 1998).

Table 6 6 Correlation coefficient calculation

Payment methods		Pricing system	
Groups	Correlation	Groups	Correlation
r_s group A and B	0.793138	r_s group A and B	0.814577
r_s group A and C	0.68332	r_s group A and C	0.824201
r_s group B and C	0.713435	r_s group B and C	0.493999
Average correlation	0.729964	Average correlation	0.710926
Probability	.05%	Probability	.05%
Number of variables	35	Number of variables	35

From the statistic table:

It can be seen that the critical value of r (correlation coefficient)= 0.433.

Since the average correlation coefficient for both the payment methods and pricing system is higher than the critical value of r at .05% probability, there is clear agreement between the three groups. This makes the results acceptable.

From the above results, it can be seen that the correlation coefficient is very close to one; this means that there is high correlation between the three groups tested.

6.6 SUMMARY

The main concern of this chapter has been the analysis of the influence factors in the payment system. The results of the analysis showed the 13 influence factors considered in the study. These factors could be grouped into three categories: first, factors having significant influence on the choice of both payment and pricing systems: (cost certainty, contractor cash flow, form of contract, disputes likelihood and risk allocation); second, factors having a significant influence on the choice of payment methods alone: (time certainty, and speed during design and construction); third, factors having a significant influence on the selection of pricing systems: (project size, procurement system, flexibility to accommodate design changes, value for money, tender methods, and budget availability). Finally, statistical calculations using the rank test and correlation coefficient at 0.05% probability were carried out to confirm the validity of the first survey results.

Chapter 7

Development of the aid selection tool and the validation of the survey results

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INTRODUCTION

The approach used in this research was consistent in that each phase consisted of data collection using measurement scales, data processing and results validation. Chapter 6 described the first survey results and the validation of these results. This chapter deals with the important issues of the second questionnaire design for data collection, and develops the selection aid tool for a payment system by identifying the utility factors for the variables identified in the first survey results. The multi-attribute utility theory (MAUT) has been used to develop the tool that will help project teams to select the most appropriate payment and pricing systems.

7.1 DEVELOPMENT OF THE SELECTION TOOL

One of the most widely used techniques for deciding alternatives with multiple objectives is Multi-Attribute Utility Theory (MAUT) (for details see chapter 4).
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, 1984).

In this study the Multi Attribute Decision-Making (MADM) is used to integrate both priority rating and the utilities derived from the respective payment system criteria. It focuses on the development of a MADM based selection model that will help project teams to select a construction project payment system. The model consists of a set of selection criteria, utilities factors and a categorisation of various payment methods or pricing system used in construction projects. The development of the selection tool was undertaken into two steps: first design the questionnaire, and second, calculate the mean of utility factor for each variable against the proposed payment system.

a) Design of the questionnaire

A structured questionnaire was designed as a follow-up to the first survey. The first questionnaire was designed and posted to construction contractors and other practitioners in the UK to select the significant factors influencing the payments system. As a result of this, a list of influencing factors was selected. These factors were identified as having a significant influence on the choice of the payment and pricing mechanisms.
A second questionnaire was designed and posted to determine the suitability of each payment or pricing system to each of these influencing factors. Two tables were produced, listing the influencing factors (column1 vs. the alternative payment or pricing systems (row1) considered in this research. Contractors were asked to score the payment and the pricing systems against the influencing factors, using a scale 10-110 where 10 represents low suitability and 110 represents significant suitability. Appendix (b) presents a copy of the questionnaire. Copies of the questionnaire were sent to eighty contractors, requesting them to respond within one month. Twenty four contractors responded making a response role of 30%. This is not an uncommon ratio of response, as shown in previous research in the area of construction management.

b) Mean utility coefficient calculation

The mean utility coefficient produced reflects the overall views of the respondents. It is calculated by averaging the scores (10-110) assigned by the users for each payment system vs each factor.

The selection of the suitable payment and pricing system is based on multiple factors influencing their selection. These factors (identified in questionnaire 1) are project specific and tend to represent project characteristics and client objectives. Therefore, it is necessary to derive a set of priority ratings representing their relative importance. These priority rating are inserted by the user of the developed decision aid tool, using a score of 1 to 20. Using the above results, a spreadsheet-based model was designed to assist the project manager to define the suitable payment or pricing system for the project. The user inserts the rate of significance (a score of 1 to 20) of each factor to this particular project and the model calculates the priority rating for each payment system by multiplying the factors ratings by established mean utility coefficients. Summing up the weighted priority variables of each payment method or pricing mechanism will yield the one with highest score (i.e. suitability).

7.2 PAYMENT METHODS

As indicated above, the questionnaire was structured in two parts, the first part being focused on the payment methods.

In this part, three payment methods were considered.

(a) Interim payment, which is well known by most construction contractors and widely used by them; it is based on monthly measurement of work, as explained in chapter 2, section 2.6.1.

(b) Stages payment: stages defined will be based on the characteristics of the project and contractors are paid on completion of each stage. (See chapter 2, section 2.6.2).

(c) Milestones payments: the Milestones dates describe significant stages of the construction process. Milestones provide the data to support control procedures and form the basis for budgeting and scheduling (see chapter 2, section 2.6.3).

7.3 PRICING SYSTEM

Three pricing systems were considered in the questionnaire. These three systems are likewise widely used in the construction industry:

(a) Cost plus fees: Cost-plus fee contracts provide that the owner will compensate the contractor for all construction costs and pay a fee for his services (see chapter 2, section 2.5.1).

(b) Lump sum price (fixed price), A fixed price contract provides for a price that is not subject to any adjustment, and is based on the contractor's cost experience in performing the contract (see chapter 2, section 2.5.2).

(c) Unit price contract: in this system, the items are those that are paid for on the basis of a contractor's predetermined estimate of the cost of doing each unit of work (see chapter 2, section 2.5.3).

7.4 ANALYSIS OF QUESTIONNAIRE

Using a spreadsheet, results of the questionnaires were analysed to determine the mean utility coefficient for each factor. The feedback of all the respondents was entered on the spreadsheet to calculate the mean average for the utility coefficient for each factor against each payment method and also for each pricing system. The respondents scored the factors on a scale of 10-110 where 10 has a low influence and 110 has significant influence for either payment method or pricing system. To validate the results of the utility coefficient, the standard deviation was calculated for the feedback data. The overall average of the standard deviation was calculated and comparison was made between this average and the standard deviation for each factor. It can be concluded that the feedback generally was accepted, but differences were found between the average of the standard deviation and the standard deviation for some factors; for example, in the pricing system the average standard deviation was 23.22 and the standard deviation for project flexibility was 8.34. This was because most of the respondents considered that the cost plus fee is most suitable for project flexibility to accommodate the design changes because it very much helps the project team to price new items. Also, it was found that the suitability of interim payment for the JCT (BoQ) form of contract was consistent, as indicated by the standard deviation which was only 6.54. This means that most respondents strongly agreed in the case of this factor (the average standard deviation for payment methods was 22.32). It is therefore clear that the JCT form of contract is mostly associated with the interim payment method.

Calculations are presented with more details in tables 7.1 and 7.2, as shown below.

Table 7.1 average coefficients of the utility factors (payment methods)

Payment Methods

Factors	Payment method	Utility coefficient U.F	Averge.STDEV.20.32 stad. Deviation
Time certainty	Intrim	49	19.22
	Lump sum	76	21.64
	Milestone / stage	75	21.44
Cost Certainty	Intrim	58	22.38
	Lump sum	75	24.30
	Milestone / stage	74	18.82
Contractor cash flow	Intrim	89	21.10
	Lump sum	53	23.37
	Milestone / stage	73	19.05
Form of Contract Interim payment	JCT(BQ)	104	6.54
	JCT(d&b)	75	23.37
	NEC	75	23.03
	Fidic	71	20.10
	G.C	71	20.83
Form of Contract Lump sum payment	JCT(BQ)	30	23.09
	JCT(d&b)	54	22.83
	NEC	30	14.72
	FIDIC	24	18.42
	G.C	31	20.78
Form of Contract milestone payment	JCT(BQ)	48	19.24
	JCT(d&b)	92	16.00
	NEC	55	21.47
	FIDIC	55	20.43
	G.C	61	21.33
Speed (during D&C)	Intrim	52	19.14
	Lump sum	79	22.70
	Milestone / stage	71	20.34
Disputes Likelihood	Intrim	83	17.32
	Lump sum	73	18.57
	Milestone / stage	69	20.00
Risk Allocation	Intrim	42	21.46
	Lump sum	69	24.31
	mileston payment	66	23.1

Table 7.2 Average coefficients of the utility factors (pricing systems)

Factors	Pricing system	U.coefficient	STDVE (Averag 23.01)
Cost certainty	Cost + fees	21	11.91
	Standard rates	49	19.45
	Lump sum	104	7.76
Project Size Cost + fees	Small	70	25.28
	Medium	54	20.60
	Large	40	22 55
Project Size Standard rates	Small	66	23.47
	Medium	61	22.70
	Large	66	24.58
Project Size Lump sum	Small	98	14.14
	Medium	94	18.61
	Large	85	22.84
project complexity	Cost + fees	63	23.40
	Standard rates	46	24.46
	Lump sum	57	23.40
Contract Cash flow	Cost + fees	86	19.80
	Standard rates	76	19.14
	Lump sum	58	29.00
Form of Contract Cost + fees	JCT(BQ)	45	25.17
	JCT(d&b)	48	22.78
	NEC	78	28.43
	FIDIC	54	25.41
	G C	49	26.75
Form of Contract Standard rates	JCT(BQ)	71	26.59
	JCT(d&b)	73	23.90
	NEC	74	24.83
	FIDIC	65	26.21
	G C	73	26.25
Form of Contract Lump sum	JCT(BQ)	54	29.48
	JCT(d&b)	78	27.97
	NEC	83	22.59
	FIDIC	76	24.83
	G.C	79	27.17
Flexibility	Cost + fees	102	8.34
	Standard rates	76	21.69
	Lump sum	28	18.41
Risk Allocation	Cost + fees	38	28.24
	Standard rates	49	24.47
	Lump sum	78	26.32
Disputes Likelihood	Cost + fees	102	9.55
	Standard rates	58	23.34
	Lump sum	44	25 08
Procurement System Cost + fees	D&B	43	22.93
	Trad.	44	23.56
	CM	74	26.97
	PPP	36	26.84
	Turnkey	36	24.87
Standard rates	D&B	36	28.46
	Trad.	58	25.49
	CM	49	25.60
	PPP	46	28.71
	Turnkey	51	30 56
Lump sum	D&B	54	29.38
	Trad.	46	27.05
	CM	39	28.11
	PPP	56	28.58
	Turnkey	68	29.65

The next step was to design a spreadsheet model to determine the suitability of the payment methods or the pricing mechanism. The model involved the following steps: the project manager assesses the relative importance of each factor (e.g. cost certainty, time certainty, complexity,) on a scale of 1-20 (column 2 priority rating). Rational priority ratings are then calculated by dividing each priority rating by the sum of all the ratings. The sum of rational ratings is therefore equal to one. Then, each rational priority rating is multiplied by a utility coefficient connecting each factor to each payment method or pricing mechanism. The rational priority ratings (utility coefficient products) are added for each payment method or pricing mechanism and the resulting total is then ranked in descending order. The most appropriate payment or pricing method is taken to be the one with the highest total. All the above calculations were modelled on a spreadsheet in order to give the results once the priority ratings for each criterion are assigned.

7.4.1 Payment system selection tool

The table below 7.3 shows the decision aid selection tool for the payment method. The first column lists the influencing factors identified as a result of the first survey. The second column is the factor rating, which is to be inserted by the user on a scale of 1-20 and to represent the importance of each factor to this particular construction project. The third column is calculated by the spreadsheet model as a ratio of the rating of the factor to the total rating. Column four lists the mean utility coefficient for each factor against the interim payment, as obtained from the second survey. The next column is the result of multiplying the priority rating column values by the utility coefficient. The same applies for columns six and seven for lump sum payment and column eight and nine for milestone payment. The last raw (rank order) generates the order of suitability of the most appropriate payment method to be selected for the project.

Table 7.3 The multi-attribute utility applied in selection of payment methods.

Factors		Rating	Priority rating	Interim payment		Lump-sum (one payment)		Milestone payment	
				U.C	Result	U.C	Result	U.C	Result
Time certainty		Insert the rating 1-20		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									

7.4.2 Pricing system selection tool

Table 7.4 below shows the decision aid selection tool for the pricing system. The first column lists the influencing factors identified as a result of the first survey. The second column is the factor rating which is to be inserted by the user on scale 1-20 and to represent the importance of each factor to this particular construction project. The third column is calculated by the spreadsheet model as a ratio of the rating of the factor to the total rating. Column four lists the mean utility coefficient for each factor against the cost plus fees as obtained from the second survey. The next column is the result of multiplying the priority rating column values by the utility coefficient. The same applies for columns six and seven for standard rates prices and column eight and nine for lump sum prices. The last raw (rank order) generates the order of suitability of the most appropriate pricing system to be selected for the project.

Table 7.4 The multi-attribute utility applied in selection of pricing system

Factors		Rating	Priority rating	Cost plus fees		Standard rates		Lump sum price	
				U.C	Result	U.C	Result	U.C	Result
Cost certainty				21		49		104	
Project size	Small			70		66		98	
	Medium	Insert the rating 1-20		54		61		94	
	Large			40		66		85	
Project complexity				63		46		57	
Contractor cash flow				86		76		58	
Contract forms	JCT(BQ)			45		71		54	
	JCT(DB)			48		73		78	
	NEC			78		74		83	
	FIDIC			54		65		76	
	G.C			49		73		79	
Flexibility				102		76		28	
Risk allocation				38		49		78	
Disputes likelihood				102		58		44	
Procurement system	D&B			43		36		54	
	Traditional			44		58		46	
	CM			74		49		39	
	PPP			36		46		56	
	Turnkey			36		51		68	
Tendering time				98		42		39	
Tender Methods	Open			74		63		61	
	Negotiation			88		89		91	
	Selected			68		71		78	
Value for money				58		66		78	
Project budget availability				44		62		75	
Total									
Rank order									

7.5 SURVEY TRIANGULATION

The questionnaire was intended to obtain the views or attitudes of the construction industry. The mean utility coefficients produced reflect the overall views of the respondents. The findings of the questionnaires and analyses were discussed with an expert practitioner in an interview (qualitative methodology) who explained the logic of the results and by doing this confirmed the finding of the survey (triangulation). The previous section 7.4 therefore discusses the variables for the survey results:

7.5.1 Payment methods:

Time_certainty: the practitioner agreed with the results that showed that the utility coefficient for the milestone system is higher than that of the other systems. Milestones provide the project with specific interim targets that will ensure tight control on progress. The second most suitable payment method was also agreed to be the lump sum method. The practitioner also agreed that lump sum payments are most suitable when the client's prime objective is cost certainty. The survey shows strong bias to lump sum systems in this case. In terms of contractors' cash flow, the survey confirms the practitioner's remark that the interim payment method is preferred because it gives better cash flow for the contractors and also it is widely adopted in the majority of construction projects.
In terms of forms of contracts, the practitioner indicated that in JCT forms most projects use interim payments; furthermore, the result of the survey confirms this fact. JCT is often seen as a very traditional form of contract and hence more traditional payment systems are applied. The suitable payment method for the design and build forms of contracts is the milestone. The practitioner attributed this to the fact that it is important (but also practical) to set progress targets between design and construction.
The new engineering form of contract includes different payment mechanisms for each of the main six options, as mentioned in sections 2.6. The schedules of cost components in NEC are defined as the resources which are used to provide the works under labour, plant and materials. The contractors and sub contractors are paid on the basis of the schedule of cost components less certain disallowed costs. The practitioner claimed that this makes interim payments a more suitable method.

The FIDIC forms of contract have become the baseline for a fair international construction contract. Most users adopt of this form of contract on the basis of the traditional method of payment with a re-measurable price. Given this, the practitioner agreed with the questionnaire results, that interim payments are preferred.

The General Contract (G.C.): - is claimed to be very similar to the JCT form of contract. Therefore, the most preferred payment method is the interim payment.

The practitioner claimed that it is becoming common in the construction industry to shorten the duration of design and construction combined, these overlapping the two phases. The milestone payment method is the most preferred method in the case of speeding up the project. Again as for the time certainty, the second preferred choice is the lump sum payment.

In terms of disputes likelihood, the practitioner strongly agreed with the questionnaire which showed that interim payments are the most suitable option, because it allows for flexibility and fairness. The milestone system was perceived to create potential disputes during the construction of the project caused by the delay of payments or by defining the time target accurately.

7.5.2 Pricing system

Cost certainty: the practitioner agreed with the results that showed that the utility coefficient for the lump sum price is higher than that for the others. Lump sum prices are most suitable when the client's prime objective is cost certainty. The practitioner also agreed that the most suitable pricing system for the small project size is the lump sum price, and the second preferred system is the cost plus fees; for the large project size the survey showed that the most suitable pricing system is the lump sum price, and the second preferred is the standard rate. In terms of project complexity, the practitioner agreed with the results, which showed that the utility coefficient for the cost plus fees is higher than that for the others. Cost plus fees is the most suitable pricing system when the project has a high degree of complexity. In terms of contractors' cash flow, the survey confirms the practitioner's remark that cost plus fees is preferred because it gives better cash flow for the contractors, and also it is widely adopted in the majority of construction projects.

In terms of forms of contracts, the practitioner indicated that in JCT forms most projects use standard rates (BoQ); again, the result of the survey confirms this fact. JCT is often seen as a very traditional form of contract and hence more Bill of Quantity rates are applied. The suitable pricing system for the design and build forms of contracts is the lump sum price, and the second preferred system is the standard rate, which is mostly used. The new engineering form of contract includes the schedules of cost components, defined as the resources which are used to provide the works under labour, plant and materials. The contractors and sub contractors are paid on the basis of the schedule of cost components less certain disallowed costs. The practitioner claimed that this makes lump sum price or standard rates the preferred , as being more suitable.

The FIDIC forms of contract have become the baseline for a fair international construction contract. Most users adopt of this form of contract on the basis of the re-measurable price. Given this, the practitioner agreed with the questionnaire results, that lump sum prices are preferred because the standard rates create potential disputes during the preparation of the bills.

The General Contract (G.C.) is claimed to be very similar to the JCT form of contract. Thus, the most preferred pricing system to be used is the lump sum price.
With reference to disputes likelihood, the practitioner strongly agreed with the questionnaire, which showed that cost plus fees are the most suitable option, because it allows for flexibility and fairness. The standard rates system was perceived to create potential disputes during the construction of the project, caused by defining the unit price accurately owing to changes in the material specification.

Concerning value for money, the practitioner noted that the lump sum price contract added value to the project if there are no changes and most of the risks are transferred to the contractors. Furthermore, the practitioner claimed that the shortening of time for the tendering of any project will increase the contractor's risk, which in turn will increase the costs of the projects. Given this, the practitioner agreed with the questionnaire results, that cost plus price systems are preferred. In terms of project budget availability, the practitioner strongly agreed with the survey result, that the lump sum gives more certainty to the budget availability.

7.6 DISCUSSION AND SUMMARY

The research identified the factors influencing the payment mechanism, which was divided into four layers (payment methods, pricing system, payment chain and cash flow). The total number of these factors was 35 for each layer, and the selections of the influencing factors for each layer were based on the average mean score of each factor being greater than 3.5. In total, thirteen factors were found to influence the selection process.

The primary concern of the following step of the research study was to investigate the extent to which pre-defined factors of clients' requirements and project characteristics affected the choice of the payment and pricing mechanism. The research 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 methods will help project teams to take into account the interest of the wider supply chain and hence reduce the likelihood of disputes and conflict. Such action will ensure the alignment of interest between project team members, leading to a win-win situation. The proposed decision aid model requires each project team to assess and prioritise these influencing factors objectively, 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 derive utility coefficient values. This technology has been successfully applied in previous construction management research and in particular to the selection of the aid procurement system. The results of the survey together with the developed model were validated by an experienced practitioner.

Chapter 8

Cash Flow Model

Table of contents

INTRODUCTION

This chapter initially discusses the concept of the flexible cash flow forecasting model developed in this research. It then explains the drivers for developing the model, and the features which had to be considered when designing the model.
The chapter then provides a complete description of the model's specifications, and concludes by outlining the limitations associated.

8.1 THE CONCEPT OF THE CASH FLOW MODEL

Previous chapters discussed the importance of selecting an appropriate payment system for a particular project. The framework being proposed in this research is for project teams to use a combination of project characteristics and client preferences in arriving at the most appropriate payment and pricing systems. As indicated in chapters 4and 7, a multi-attribute decision tool has been proposed to process these characteristics and preferences into an outcome. Once a decision is taken on what payment system to use, project teams need to assess the impact of this decision on the cash flow of clients, contractors and subcontractors. A negative impact may require project teams to manipulate cash flow variables (e.g. retention, payment delays etc.) or reconsider their decision concerning the payment system altogether.

In order to assess the impact of the choice of payment system on cash flow, a flexible cash flow model that is capable of simulating alternative payment systems has been developed. The main concept of the model is that certain payment systems (e.g. stage payments) are based on the project plan and hence the cash flow model should be based on the project schedule rather than the traditional S-curve. Once the project schedule is produced, contract parties assign the method of payment which will be used in the project and also the contractual condition such as project start date, the advance payment %, retention money %, materials advance purchases payment and materials on site, as shown in fig.8.1. According to the above data, the model will provide the contractor with cash in as shown in Fig.8.2 and cash out as shown in fig 8.3.

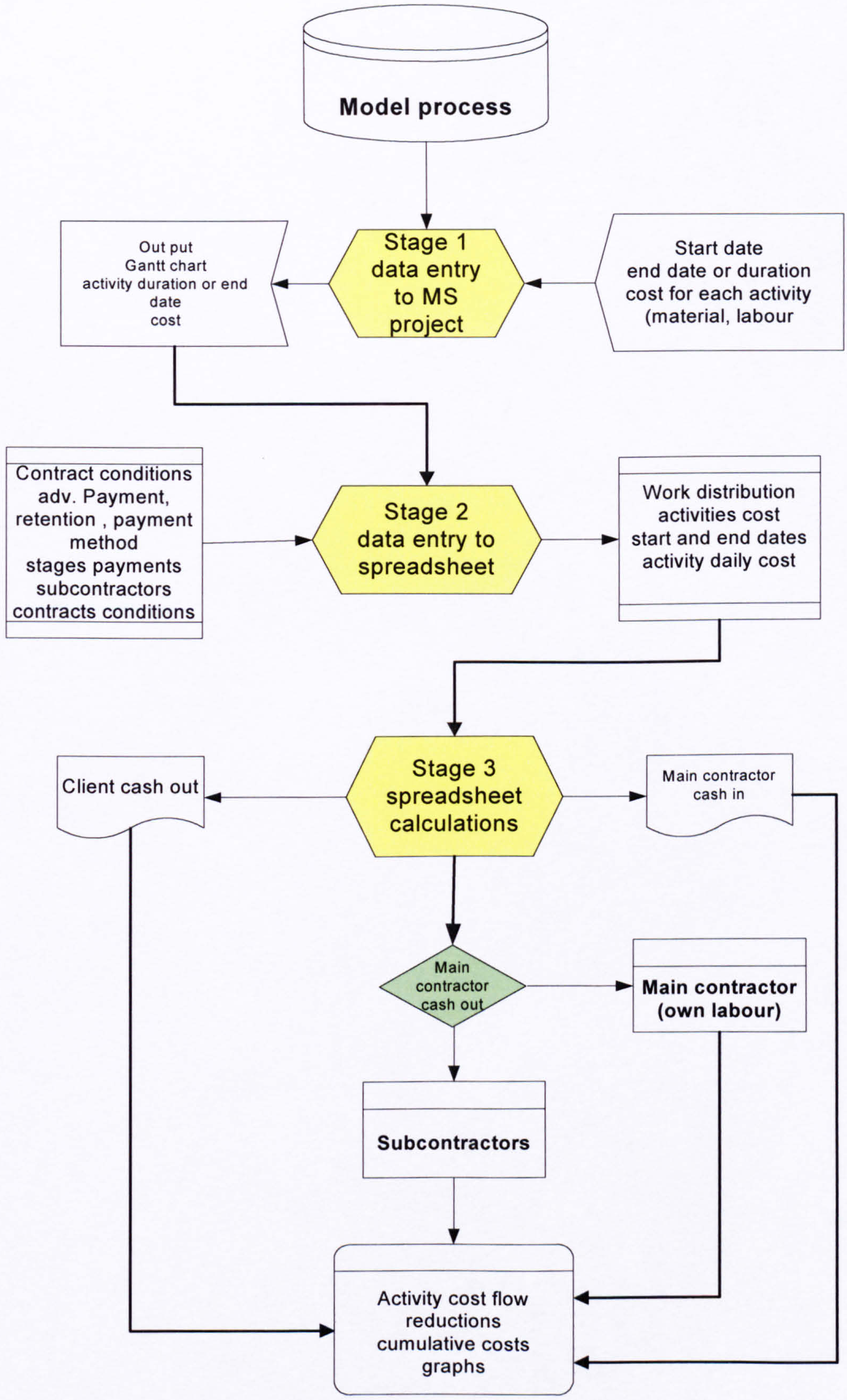


Fig. 8.1 Model process

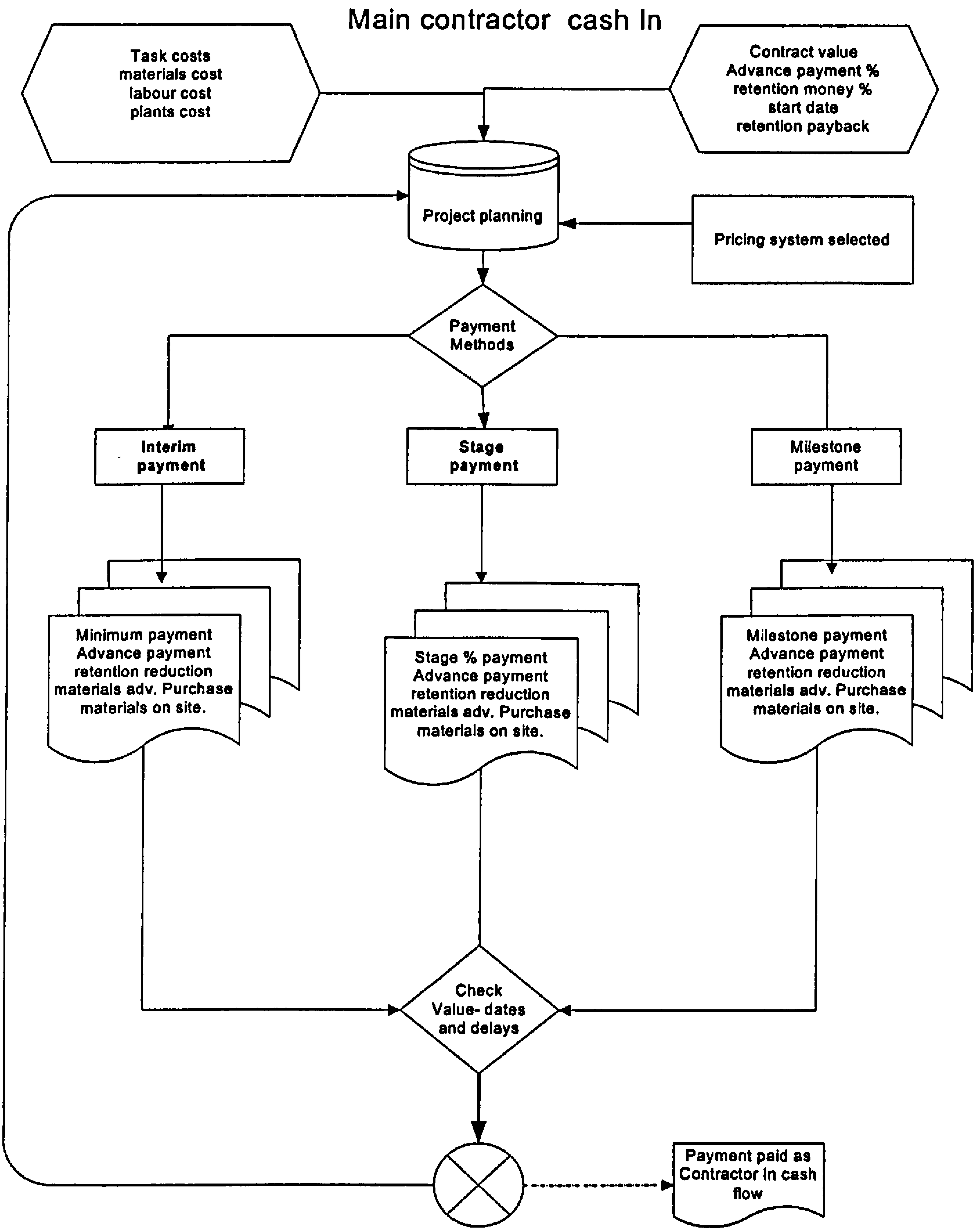


Fig. 8.2 Main contractor cash in

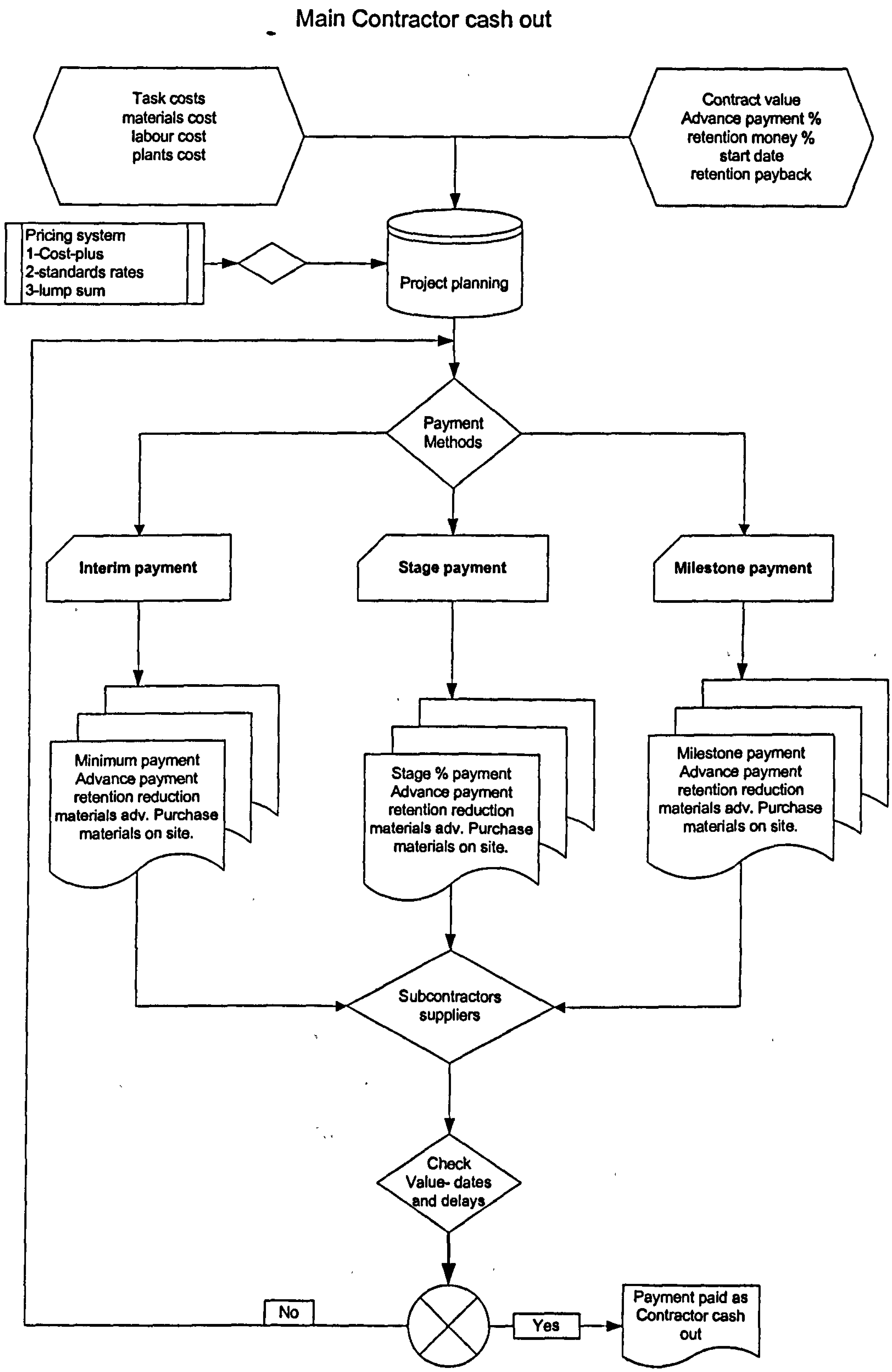


Fig. 8.3 Main-contractor cash out.

8.2 NEED FOR A NEW MODEL

The need for cash flow forecasting is given as providing a good warning system to predict possible insolvency, which enables preventive measures to be considered and taken at the right time. The industry has expressed a need to predict construction project cash flows, and will continue to do so, despite any arguments that present methods are valid. A cash flow model enables a straightforward approach to performance measurement and management (Eldridge *et al.*, 2002). Upson (1987) concluded that cash flow forecasting is an essential tool for the financial management of a contraction company.

Past research has focused on the development of computer based cash flow models. The applicability of these models to this study, however, is not high. The following points discuss why a new cash flow model needs to be developed:

- Previous cash flow forecasting models, for example that of Nazem (1968), Peer (1982), Bromilow's model (1978) and Kaka's (1990) corporate financial model, are based on the traditional payment system and standard forms of contract only.
- The approach to cash flow forecasting was established with emphasis on how the cumulative value vs. time curves and cumulative cost vs. time curves are derived using fast and simple approaches. Simple approaches are based on standard cost (or value curves) for the contractors without detailed identification of the schedule of work. This makes the model incapable of relating payments to completion of particular activities (stage payment). Models based on an S-curve are also incapable of simulating supply chain payments beyond contractors (subcontractors, suppliers). Given that subcontractors undertake a significant proportion of the construction, it is very important that their cash flow is taken into account when selecting and defining the payment system. Previous models also need to be further developed to simulate contractors' and subcontractors' cash flow for alternative payment systems, and the output must be included in a comprehensive financial report representing the mechanism of the strategic decisions and the factors associated with the input data for a particular project.

8.3 FEATURES CONSIDERED IN THE DESIGNING OF THE MODEL

The following features were considered when designing the model: -

1- The model has to operate with the limited information available to the project team at the time of selecting the payment system.

2- At the same time, the system should be capable of taking into account more detailed data, such as activities cost and project schedule. This is because some payment systems need this level of details.

3- The main objective of the model is to enable clients, contractors and subcontractors to simulate alternative payment and pricing systems. Hence multi approaches are needed for calculating payments from clients to all constructors.

4- The model is also to enable the user to simulate and manipulate detailed cash flow variables, such as the advance payment, retention money, materials advance purchases, and labour payments delay. These are considered part of the process of defining or fine tuning the payment system.

5- The model has to be accurate and simple to inform the client, the contractor and subcontractors of their financial positions during the project period.

8.4 THE PROPOSED CASH FLOW MODEL

Today most models are built with the aid of computers, which can be made to simulate, optimise or forecast in a probabilistic and/or a deterministic manner. The strength of modelling on a computer lies in its ability to be flexible and permit adjustment and amendment. The developed model took into consideration the contract parties' options to select the payment methods and the pricing system in addition to several other cash flow variables, such as advance materials purchase etc. The prime concern is the application of modelling to financial decision-making. The developed framework defines the payment system in terms of the four layers: namely 'the supply chain', 'the pricing system, 'the payment method 'and' 'cash flow factors'. 'Supply chain' defines the project stakeholders, the products and the services they will be providing and the contractual link (or cash flow link if different) between them. 'Pricing method' defines the way in which each product or service is to be priced. 'Payment method' defines how these products and services will be paid, and 'cash flow factors' incorporate relevant contract conditions. In order to understand the elements of the model and their interrelationships, the following sections will include a description of the four proposed payment system layers, namely payment methods, pricing system, cash flow variables, and who pays what to whom (payment chain).

1- Payment methods

The model takes into consideration three methods of payments: monthly payments (interim payments), stages payments (based on a defined profile of percentage performed for example each 10% in the first month, 30% in the fourth month, etc.) and milestones payments (based on defined milestones agreed between the contract parties such as finishing of the earth works, foundation, roofing the ground floor etc).

2- Pricing system

The pricing systems included in the model are:

- Cost-plus fees
- Lump sum price
- Standard rates

It is often the case that the contractors have different approaches to contract pricing. A single firm may have different objectives and approaches in different contracting situations. For example, the cost-based pricing approach involves an analysis of a firm's cost to produce a product, and the addition of a reasonable profit to determine the selling price. The definition of a reasonable profit will depend on many factors, including:

- Competition;
- Objectives of the firm;
- Necessary investment; and
- Risk involved.

The contracting manager should use every means available to ascertain whether a fair and reasonable price can be determined before requesting cost or pricing data. He must not require unnecessarily the submission of pricing data, because it leads to increased proposal preparation costs, generally extends acquisition lead time, and consumes additional contractor resources.

3- Construction projects cash flow variables

When cash flows are considered in some real life projects it can be seen that the majority of the activities are subcontracted, and the costs associated with these activities are paid to the subcontractors when the activities are completed.

The process of allocating bill items to activities is required to determine the timing of each item, and thus all of the costs and revenues associated with each bill item will be fixed into a time slot within the project plan. To produce cash flow forecasts, additional variables need to be included. The main objective of the contractor is to complete construction projects at maximum efficiency in terms of time and costs by optimising the use of four resources: plant, materials, manpower and management. The construction planner assesses the level of the resources at both the corporate and project levels and hence the allocation and relocation of resources between projects could be controlled. The ability to manage these resources has an impact on the profit potential of any construction company. A contract cash flow can be obtained from the contract programme in conjunction with the resources, and the contract programme should preferably be in the form of a linked bar chart provided by, for example, an MS Project. With the logic and sequence of construction, a cumulative cost for the works can be derived and converted into a cost commitment curve which represents the basis for calculating the contract cash flow. The calculation of cash flow for a contract is a well tried procedure of simple calculations following a very complex pattern, because of the large number of resources, time intervals, payment periods, delays in payment and amount of retention involved (Kaka, 1990). As a result, the cash flow of the project will depend on the activities' duration and the payment method and pricing system to be selected.

The detailed cash flow forecasting methodology at the pre-tendering stage has not found its way into contractor's practical application. Contractors can't afford to invest too much time and money into cash flow forecasting and planning of a construction project before they have been awarded the contract. The proposed cash flow forecasting model is designed for use at the tendering stage with the ability to assess the impact of alternative payment systems. It is based on the detailed approach (project plan) and hence it is important that the added value of the proposed model is demonstrated so that project teams do make an effort in using such a tool.

4- **Payment chain (who pays what to whom)**

The payment proposals chains-are as in the following:

- Client pays main contractor.
- Client pays suppliers.
- Client pays subcontractors.
- Main contractor pays subcontractors.
- Main contractor pays suppliers.

Traditional cash flow forecasting models have focused only on the payment chain where the client pays the contractors and the contractors pay the subcontractors and suppliers. This very much ignores the situation where the client either nominates subcontractors/ suppliers or indeed opts for direct payments in cases where contractors are found to have delayed payments.

8.5 AIM OF THE MODEL

The main aim of this model is to forecast the cash flow of a single contract, taking into account the payment method, pricing system and the contractual conditions to be applied on the project. The basic concept of the model is that whilst cash flow is influenced by the choice of payment or pricing system, other cash low variables (contract conditions) can be manipulated to arrive at a favourable and fair cash flow for the different members of the project team. Cash in is derived from the value curve of the activities carried out during a specific time, and the net cash flow is the result of subtracting cash out from the cash in curves. Within these processes there are many other variables that add to the flexibility of the model and hence a different output could be provided for the alternative strategies project teams may wish to examine. The basic structure of the model is illustrated in figure 8.1.

8.6 THE PROCESS WITHIN THE MODEL

The users of the cash flow model provide the data entry needed to generate the monthly expenditure (materials cost, labour, plants, indirect costs, overheads, etc.), profit margins and time delays in order to derive the value curve which in turn is used to generate the cash in profile for the contractor. The expenditure profile is also used to calculate the cash out curve, and the difference between cash in and cash out is used to calculate the cash flow.

The model is divided conceptually into two main parts (modules):

1- Schedule planning and works distribution (Microsoft Project).

Data entry:

The data entries required to generate the output for this module are:

- Starting and finishing dates of each activity.
- Activities cost including labour cost, materials, equipments, profit, and overheads.
- Works distribution between the main contractor's own labour, and subcontractor's works.

Output:

- Planning diagram CPM.
- Gantt chart.
- Duration for each activity or the finishing date if the user enters the activities' durations.

2- Cash flow spreadsheet module (Excel2000).

Data entry:

The data entry for this module includes the output generated by the schedule planning module together with the following:

- Advance payment percentage.
- Retention money.
- Materials advance purchase period in months.
- Selection of payment method to be used.
- Selection of pricing system to be used.

Output:

- Activities cost commitment each month.
- Cumulative cost calculation and curve.
- Monthly retention reduction.
- Monthly advance payment reduction.
- Payments due each month.
- Milestone payment amount and time due.
- Stages payments amount and time due.
- Main contractor net cash flow values and graph plots.

- Subcontractor's cash in values and graph plots.
- Client's cash out, values and graph plots.

The model aims to forecast the cash flow of the project taking into account all of the above effective variables. Some of these variables add to the flexibility of the model and allow the project team to manipulate the project cash flow and address any concerns individual contractors may have at the planning stage.
The basic concept of the model is that the cost commitment curve can be developed from the individual activities listed in the project plan. The cost commitment curve is then used to generate the cash out curves, and the value curve is the result of adding profit to cost curves. Cash in is developed from the value of the activities carried out during a specific time period, and the net cash flow is the result of subtracting cash out from the cash in curves. The following discusses the detailed calculations that the model adopts in arriving at the cash flow.

8.7 MODELLING TOOLS

(a) Microsoft Project software

Microsoft Project is used to provide the combination of a project plan and the activities cost. Microsoft Project helps the module developer to provide the following:

- Task durations or the finishing date for each activity.
- The Gantt chart including task schedules, plus any links between the tasks to form a summary task or a project stage.
- Arrangements of the items costs.
- Work distribution for the project parties.
- CPM for the project.
- The link with the spreadsheet model to enable the automatic transfer or changes of data.

(b) Spread sheet

Spreadsheets are based on a large matrix structure in which the cells of the matrix may be thought of as the computer equivalent of a large multi-column analysis sheet. Traditionally, a spreadsheet model contains a number of work sheets and each worksheet accounts for numerous rows and columns. Excel's spreadsheet function is a powerful application for handling data, mostly numerical data. A spreadsheet is rather like an electronic ledger, which provides a method by which data can be analysed and used in complex calculations (Beck and others 1994).

Excel has a range of powerful, easy-to-use template packages for preparing comprehensive financial projections for a business plan, budgets etc. It can also be used as a tool for strategic and corporate planning, raising finance, business restructuring and financial appraisals within almost any size and type of business (Beck and others 1994). As Excel-plan incorporates extensive formulae (up to 33,000) and pre-programmed menus and buttons (over 200 items) the module developer needs only a very basic knowledge of Excel to prepare highly professional and presentable projections. In the case of an advanced Excel user, the module developer can utilize his or her own expertise to enhance and expand Excel-plan to meet particular needs. Excel-plan incorporates comprehensive facilities and features. It is suitable for managers and business people with minimal previous experience of financial or business planning, as well as for experienced planners, accountants, consultants and model-builders.

8.8 MODEL APPLICATION

The proposed model forecasts the project cash flow using a combination of tools, namely Microsoft Project and Excel. In principle, to compile the cost flow curve of a project the costs of each activity have to be distributed over its duration. The durations of activities are taken from the schedule (Gantt chart in Microsoft Project). An account is taken of the payment method, which will lead to the calculation of the client's outflow of money which, in some cases, is equal to the main contractor's cash in unless the client makes some of the payments directly to suppliers or subcontractors.

The model follows these steps when calculating the cash flow:

First stage: Data entry to MS project

The data for the model are usually prepared first and then entered into the computer. The data required to produce the Gantt chart in Microsoft project include the following:

- Start date and duration for each activity.
- Cost of the individual activities which may be broken down into labour, materials, plant, and overheads.

- All of the works carried out by main contractors' own employees.
- All of the works carried out by subcontractors.
- Definition for any links between individual and summary activities.

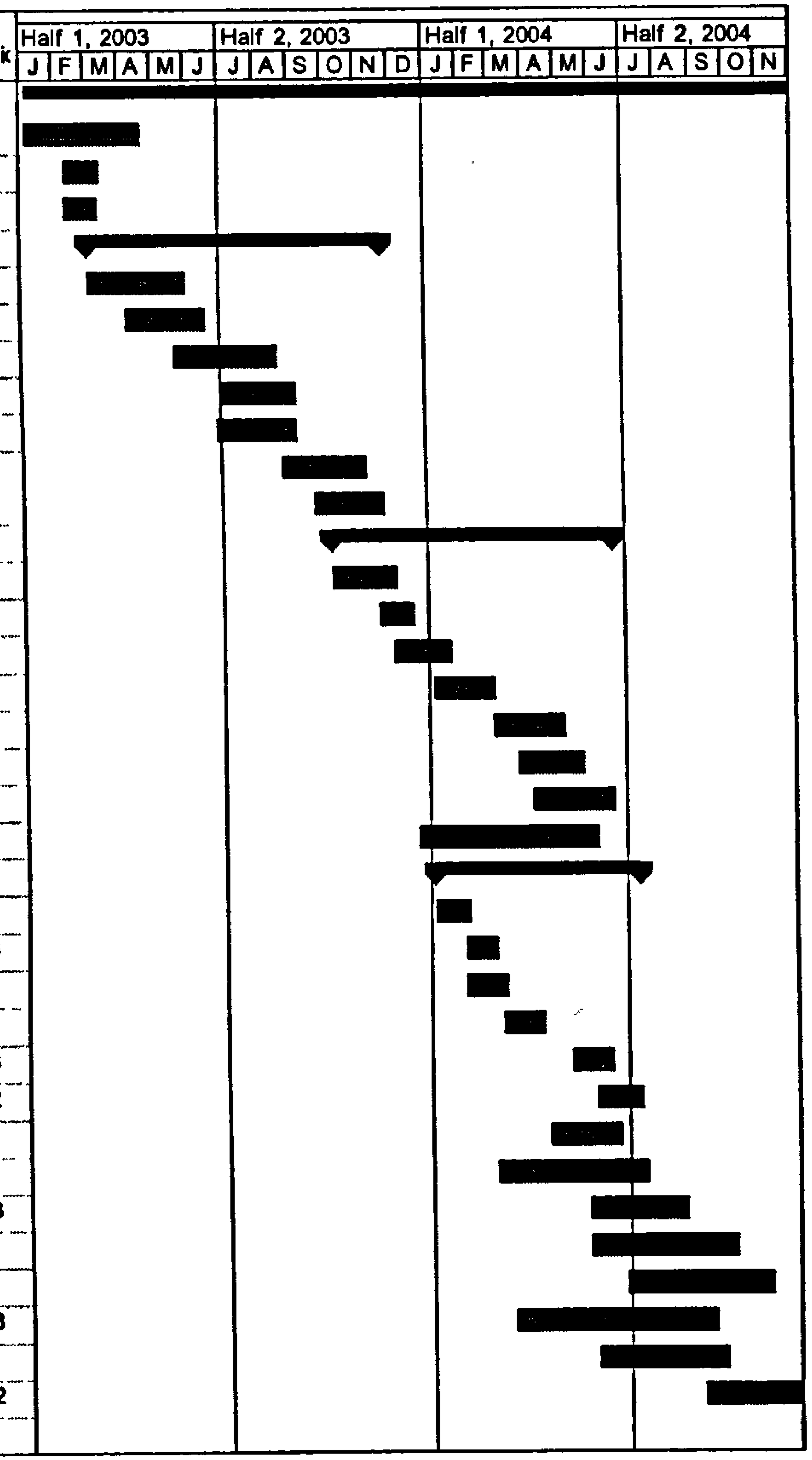
First stage outputs

This stage provides the Gantt chart using Microsoft project including all project activities and the resources used and their costs. The report produced by this stage specifically assigns the works executed by subcontractors versus the main contractor's own labour. The activities costs may be broken down into labour costs, materials costs, and plants costs, as shown in fig.8.4.

The first column lists the activities to be carried out, the second column represents the start date for each activity and the following column represents the finish date for each activity (start date plus duration in terms of working days). The fourth column represents the materials cost for each activity and the following two columns represent the labour and the plants costs respectively. Finally, the last column represents the work distribution where number 1 refers to the works carried out by the main contractor, and 2.1,2.2, 2.3 refer to works carried by the subcontractors 1, 2 and 3.

Fig. 8.4 Microsoft project Gantt chart

ID	Task Name	Start	Finish	materials	manpower	equipment	work stributk
1	**Construction Phases**	**Mon 06/01/03**	**Sat 18/12/04**	**£0.00**	**£0.00**	**£0.00**	
2	Foundations	Mon 06/01/03	Mon 21/04/03	£24,500.00	£26,540.00	£8,900.00	1
3	Draing and water	Mon 10/02/03	Fri 14/03/03	£6,450.00	£7,600.00	£7,850.00	2.1
4	Ground floor leveling and	Mon 10/02/03	Tue 11/03/03	£23,560.00	£27,560.00	£14,500.00	1
5	**External Walls**	**Mon 03/03/03**	**Fri 21/11/03**	**£0.00**	**£0.00**	**£0.00**	
6	External walls Grounc	Mon 03/03/03	Fri 30/05/03	£17,500.00	£25,950.00	£9,800.00	1
7	External walls 1st	Mon 07/04/03	Tue 17/06/03	£8,750.00	£9,750.00	£8,500.00	1
8	External walls 2nd	Mon 19/05/03	Tue 19/08/03	£12,450.00	£8,950.00	£7,500.00	2.3
9	External walls 3rd	Mon 30/06/03	Fri 05/09/03	£11,250.00	£9,850.00	£5,600.00	2.3
10	External walls 4th	Thu 26/06/03	Fri 05/09/03	£14,520.00	£12,660.00	£9,850.00	2.2
11	External walls 5th	Mon 25/08/03	Thu 06/11/03	£11,680.00	£12,580.00	£7,200.00	2.1
12	External walls 6th	Mon 22/09/03	Fri 21/11/03	£16,850.00	£14,550.00	£6,500.00	1
13	**Internal Walls**	**Mon 06/10/03**	**Fri 18/06/04**	**£0.00**	**£0.00**	**£0.00**	
14	internal walls ground	Mon 06/10/03	Thu 04/12/03	£25,750.00	£19,850.00	£16,580.00	1
15	Internal Walls 1st	Mon 17/11/03	Fri 19/12/03	£25,700.00	£22,350.00	£21,400.00	2.1
16	Internal Walls2nd	Mon 01/12/03	Wed 21/01/04	£24,800.00	£21,250.00	£23,750.00	2.3
17	Internal Walls 3rd	Mon 05/01/04	Mon 01/03/04	£25,600.00	£23,450.00	£21,350.00	1
18	Internal Walls 4th	Mon 01/03/04	Wed 05/05/04	£19,800.00	£20,500.00	£22,550.00	2.1
19	Internal Walls 5th	Mon 22/03/04	Fri 21/05/04	£19,800.00	£21,200.00	£26,800.00	2.1
20	Internal Walls 6th	Mon 05/04/04	Fri 18/06/04	£20,850.00	£20,450.00	£21,350.00	1
21	Internal doors	Mon 22/12/03	Fri 04/06/04	£42,750.00	£54,850.00	£29,850.00	1
22	**Lift /Stairs**	**Mon 05/01/04**	**Mon 12/07/04**	**£0.00**	**£0.00**	**£0.00**	
23	1st floor	Mon 05/01/04	Thu 05/02/04	£7,560.00	£5,800.00	£2,850.00	2.1
24	2nd floor	Mon 02/02/04	Tue 02/03/04	£5,400.00	£6,250.00	£2,900.00	2.3
25	3rd floor	Mon 02/02/04	Wed 10/03/04	£4,950.00	£5,800.00	£2,750.00	1
26	4th floor	Mon 08/03/04	Wed 14/04/04	£4,860.00	£5,150.00	£3,200.00	1
27	5th floor	Mon 10/05/04	Tue 15/06/04	£3,950.00	£4,520.00	£2,250.00	2.3
28	6th floor	Tue 01/06/04	Mon 12/07/04	£3,860.00	£4,250.00	£1,850.00	2.2
29	Roof	Mon 19/04/04	Wed 23/06/04	£59,400.00	£45,800.00	£35,800.00	1
30	Plumbing & Sanitary-ware	Mon 01/03/04	Fri 16/07/04	£75,800.00	£87,950.00	£48,500.00	1
31	Mechanical Services	Mon 24/05/04	Fri 20/08/04	£165,500.00	£221,500.00	£185,700.00	2.3
32	Floor Finishes	Mon 24/05/04	Mon 04/10/04	£75,450.00	£62,850.00	£65,800.00	1
33	Ceiling Finishes	Mon 28/06/04	Fri 05/11/04	£89,500.00	£105,600.00	£95,800.00	1
34	Wall finishes	Mon 15/03/04	Wed 15/09/04	£121,500.00	£154,600.00	£145,600.00	2.3
35	Fixtures & fitting	Mon 31/05/04	Fri 24/09/04	£74,560.00	£68,500.00	£58,700.00	1
36	External works	Mon 06/09/04	Mon 06/12/04	£215,900.00	£198,500.00	£168,500.00	2.2
37	Handover & clean	Mon 29/11/04	Sat 18/12/04	£4,600.00	£8,500.00	£2,550.00	1



Second stage

The data entry to the spreadsheet includes the output from MS project which is exported from Microsoft project into the spreadsheet model. The Gantt chart in Microsoft project is electronically linked to the spreadsheet model in such a way that any changes to the source file will be reflected in the spreadsheet model.

Additionally, the other required entry data are as follows:

- Contract start date.
- Advance payment percentage.
- Retention money percentage.
- Payment method (to be selected).
- Pricing system (to be selected).
- Advance materials purchase (time in months).
- Payment delays from client to contractor.
- Payment delays from contractor to subcontractors, labour, plants, materials, suppliers and overheads.
- Payment delay from subcontractor to suppliers.
- Profits percentage.
- Any data associated with payment or pricing system.

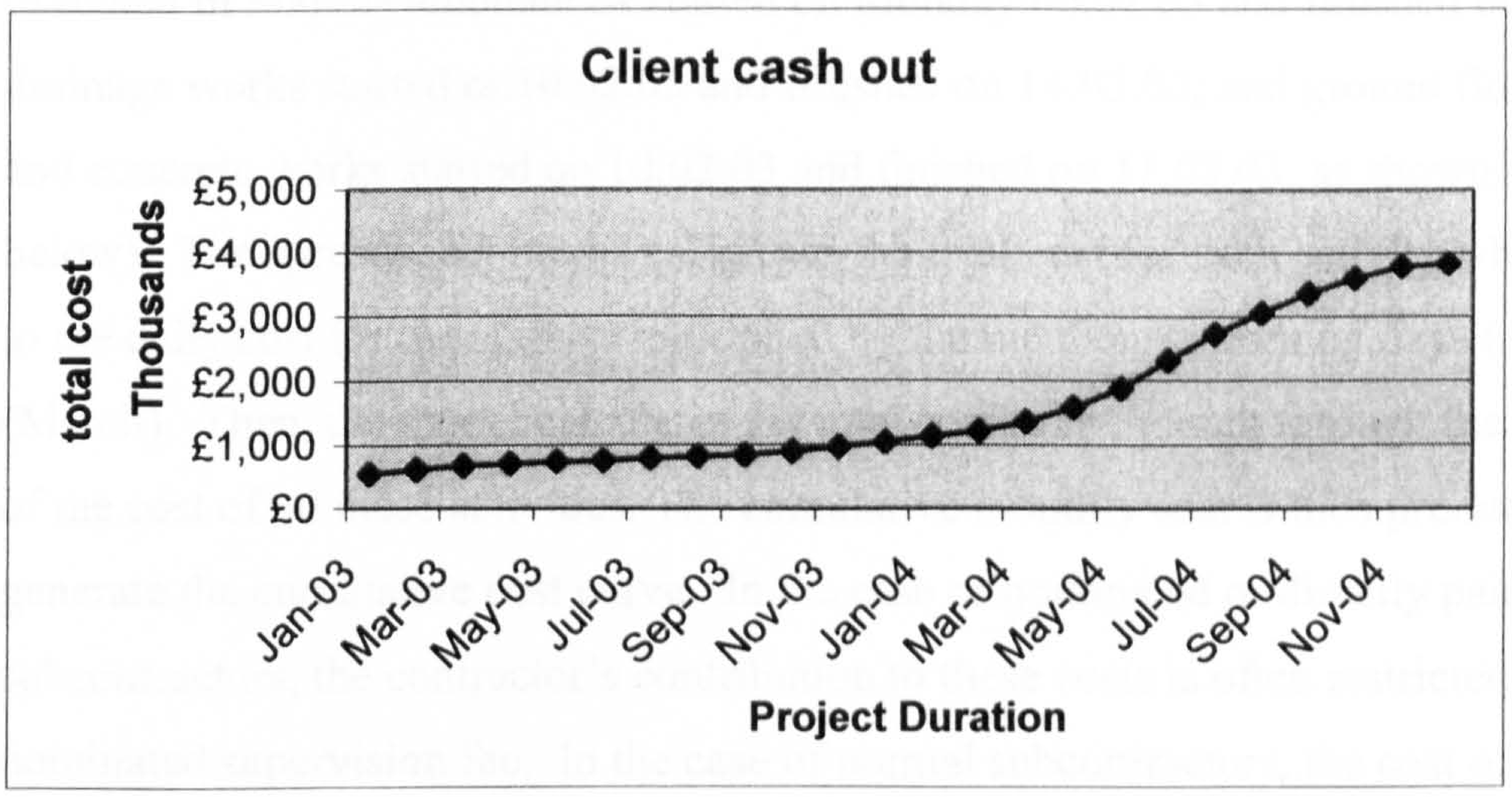
The user may initially predict and therefore enter into the model for a particular project that the client is expected to pay an advance payment which is represented in terms of a percentage (%) of the total contract value. Similarly, the retention to be held by client in each interim valuation is expressed in terms of a percentage of the monthly valuations. The user then selects the pricing system that will be applied (e.g. the unit rate or the cost plus fees). These variables will have direct effects on the cumulative value and cost curves and cash flow.

Third stage

(a) Calculating value curve and cash out for the client

At this stage the model will provide the calculation for the value curve and hence the cash out curve for the client, which often represents the cash in curve for the main contractor. The calculations are based on the data entry in the second stage together with performance bound reduction, and percentage fees in the case of the cost plus pricing system. The calculations are presented in the form of tables, as shown in table 8.1. The spreadsheet takes into account the activities' table value and durations; then, using the project schedule, it calculates the activities' monthly values. The spreadsheet then calculates the total value for all activities for each month which is then used to calculate the project cumulative value curve. Applying client's payment delay, the cumulative value curve is then transferred into the client's cash out curve, as shown in fig 8.5.

Fig 8.5 Cumulative cost curve (client cash out)



Here the payment and pricing systems being selected influence the calculations significantly. In the case of stage or milestone methods of payments, the model triggers payments only when stages are reached. This is different from the traditional model where only interim payments are considered. In such cases, the monthly value curve is used directly to generate the payments.

In terms of pricing, the model relies on " pure" costing to generate the cost or value curves. These are the actual costs of resources that the contractor or subcontractors incur. In order to convert these costs into value, the model takes into account the pricing method being adopted (e.g. fixed percentage, profit margins, supervision fees, etc.).

(b) Calculating the cash in curve for contractor

The cash out curve of the client is usually equal to the cash in curve for the contractor. However, in the case of nominated subcontractors and suppliers, clients often pay these directly. This model allows for direct payment to subcontractors and hence for the calculation of contractors' cash in curves these payments are subtracted.

(c) Calculation of cost curves for the main contractor and subcontractors

Using the data entry listed in the first stage, the model generates the calculations for the contractor's and subcontractors' cost curves as follows: -

First: The main contractor cost curve

This includes the calculation for all the works carried out by the main contractor, his or her own employees and also those of the subcontractors. For example, to calculate the total cost of the works carried in March 2003, the spreadsheet recognises the activities executed in March (foundations started on Monday 06.01.03 and finished on 21.04.03, drainage works started on10.02.03 and finished on 14.03.03; and ground floor levelling and concrete works started on 10.02.03 and finished on 11.03.03, as shown in table 8.2 below). The spreadsheet model calculates the total cost for each activity which is equal to the daily cost for the activity multiplied by the number of working days in that month (March). Then, the model calculates the total cost of the month through the summation of the cost of all these activities. The cumulative monthly cost is then produced to generate the cumulative cost curve. In the case of nominated or directly paid subcontractors, the contractor's contribution to these costs is often restricted to a nominated supervision fee. In the case of normal subcontractors, the cost of the work for these is entered by the user to represent their own individual costs. The model adds contractors' contributions (supervision cost) to arrive at contractors' cost for such work.

The pricing system being selected does not influence the calculations here.

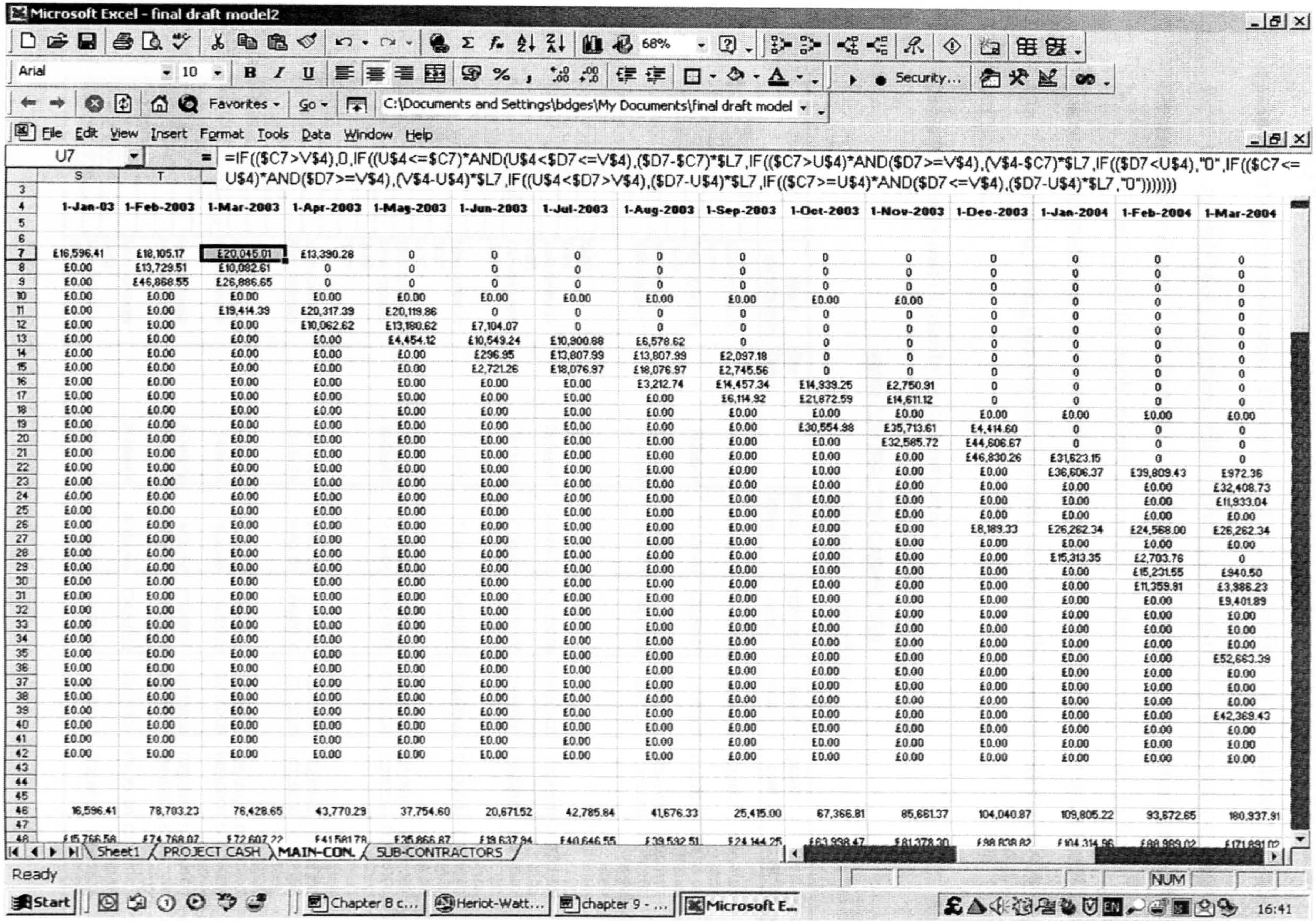
Table 8.2 Activities start and finish dates and cost calculations

A		B	C	D	T	U	V
Raw no	Activity no	Activity	start dates	finish dates	1-Feb-03	1-Mar-03	1-Apr-03
		Construction Phases	6-Jan-03	18-Dec-04			
7	1	Foundations	6-Jan-03	21-Apr-03	£18,105.17	£20,045.01	£13,390.28
8	2	Drainage and water	10-Feb-03	14-Mar-03	£13,729.51	£10,082.61	0
9	3	G.F. concrete& leveling	10-Feb-03	11-Mar-03	£46,868.55	£26,886.65	0
10	4	External Walls	3-Mar-03	21-Nov-03	£0.00	£0.00	£0.00
		External walls Ground	3-Mar-03	30-May-03	£0.00	£19,414.39	£20,317.39
		External walls 1st	7-Apr-03	17-Jun-03	£0.00	£0.00	£10,062.62

For calculation the cost in cell U7 the formula applied is (cost in cell U7) =IF(($C7>V$4),0,IF((U$4<=$C7)*AND(U$4<$D7<=V$4),($D7-$C7)*$L7,IF(($C7>U$4)*AND($D7>=V$4),(V$4-$C7)*$L7,IF(($D7<U$4),"0",IF(($C7<=U$4)*AND($D7>=V$4),(V$4-U$4)*$L7,IF((U$4<$D7>V$4),($D7-U$4)*$L7,IF(($C7>=U$4)*AND($D7<=V$4),($D7-U$4)*$L7,"0")))))))

For more details see fig. (8.6) below:

Fig. 8.6 Main contractors' cost curve



	1-Jan-03	1-Feb-2003	1-Mar-2003	1-Apr-2003	1-May-2003	1-Jun-2003	1-Jul-2003	1-Aug-2003	1-Sep-2003	1-Oct-2003	1-Nov-2003	1-Dec-2003	1-Jan-2004	1-Feb-2004	1-Mar-2004
7	£16,596.41	£18,105.17	£20,045.01	£13,390.28	0	0	0	0	0	0	0	0	0	0	0
8	£0.00	£13,729.51	£10,082.61	0	0	0	0	0	0	0	0	0	0	0	0
9	£0.00	£46,868.55	£26,886.65	0	0	0	0	0	0	0	0	0	0	0	0
10	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	0	0	0	0
11	£0.00	£0.00	£19,414.39	£20,317.39	£20,119.86	0	0	0	0	0	0	0	0	0	0
12	£0.00	£0.00	£0.00	£10,062.62	£13,180.62	£7,104.07	0	0	0	0	0	0	0	0	0
13	£0.00	£0.00	£0.00	£0.00	£4,454.12	£10,549.24	£10,900.88	£6,578.62	0	0	0	0	0	0	0
14	£0.00	£0.00	£0.00	£0.00	£0.00	£296.95	£13,807.99	£13,807.99	£2,097.18	0	0	0	0	0	0
15	£0.00	£0.00	£0.00	£0.00	£0.00	£2,721.26	£18,076.97	£18,076.97	£2,745.56	0	0	0	0	0	0
16	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3,212.74	£14,457.34	£14,939.25	£2,750.91	0	0	0	0
17	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£6,114.92	£21,872.59	£14,611.12	0	0	0	0
18	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
19	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£30,554.98	£35,713.61	£4,414.60	0	0	0
20	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£32,585.72	£44,606.67	0	0	0
21	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£46,830.26	£31,623.15	0	0
22	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£36,606.37	£39,809.43	£972.36
23	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£32,408.73
24	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,933.04
25	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
26	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£8,189.33	£26,262.34	£24,568.00	£26,262.34
27	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
28	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£15,313.35	£2,703.76	0
29	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£15,231.55	£940.50
30	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,359.81	£3,986.23
31	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£9,401.89
32	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
33	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
34	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
35	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£52,663.39
36	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
37	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
38	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
39	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£42,369.43
40	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
41	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
42	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
46	16,596.41	78,703.23	76,428.65	43,770.29	37,754.60	20,671.52	42,785.84	41,676.33	25,415.00	67,366.81	85,661.37	104,040.87	109,805.22	93,672.65	180,937.91

Secondly, main contractor cash out

Table 8.3 below presents the calculation of the works carried out by the main contractor's own resources. These costs are calculated by a spreadsheet as follows:

First, the spreadsheet recognises the activities carried out by the main contractor using the assigned symbol (1) in column 7 of fig.8.4. Using this, the spreadsheet calculates these activities' costs for each month according to their contribution in that month. Then, the spreadsheet calculates the total costs for all activities for each month which is again calculated, using the cumulative cost curve for the works undertaken by the contractors.

Table 8.3 Works cost carried by main contractors

MAIN CONTRACTOR CASHFLOWS

Works excuted by main contractors

Activity	Work distribution	Start Dates	Finish Dates	materials cost	labour cost	plants cost	Cost	Activity Cost+over H
Construction Phases								
Foundations	Main contractor	6-Jan-03	21-Apr-03	£24,500.00	£26,540.00	£8,900.00	£59,940.00	£61,738.20
Draing and water	Sub1						£0.00	£0.00
Ground floor	Main contractor	10-Feb-03	11-Mar-03	£23,560.00	£27,560.00	£14,500.00	£65,620.00	£67,588.60
External Walls	Sub3						£0.00	£0.00
External walls Ground	Main contractor	3-Mar-03	30-May-03	£17,500.00	£25,950.00	£9,800.00	£53,250.00	£54,847.50
External walls 1st	Main contractor	7-Apr-03	17-Jun-03	£8,750.00	£9,750.00	£8,500.00	£27,000.00	£27,810.00
External walls 2nd							£0.00	£0.00
External walls 3rd							£0.00	£0.00
External walls 4th	Sub2						£0.00	£0.00
External walls 5th	Sub1						£0.00	£0.00
External walls 6th	Main contractor	22-Sep-03	21-Nov-03	£16,850.00	£14,550.00	£6,500.00	£37,900.00	£39,037.00
Internal Walls	Sub3						£0.00	£0.00
internal walls ground F.	Main contractor	6-Oct-03	4-Dec-03	£25,750.00	£19,850.00	£16,580.00	£62,180.00	£64,045.40
Internal Walls 1st	Sub1						£0.00	£0.00
Internal Walls2nd							£0.00	£0.00
Internal Walls 3rd	Main contractor	5-Jan-04	1-Mar-04	£25,600.00	£23,450.00	£21,350.00	£70,400.00	£72,512.00
Internal Walls 4th	Sub1						£0.00	£0.00
Internal Walls 5th	Sub1						£0.00	£0.00
Internal Walls 6th	Main contractor	5-Apr-04	18-Jun-04	£20,850.00	£20,450.00	£21,350.00	£62,650.00	£64,529.50
Internal doors	Main contractor	22-Dec-03	4-Jun-04	£42,750.00	£54,850.00	£29,850.00	£127,450.00	£131,273.50
Lift /Stairs	Sub3						£0.00	£0.00
1st floor	Sub1						£0.00	£0.00
2nd floor							£0.00	£0.00
3rd floor	Main contractor	2-Feb-04	10-Mar-04	£4,950.00	£5,800.00	£2,750.00	£13,500.00	£13,905.00
4th floor	Main contractor	8-Mar-04	14-Apr-04	£4,860.00	£5,150.00	£3,200.00	£13,210.00	£13,606.30
5th floor							£0.00	£0.00
6th floor	Sub2						£0.00	£0.00
Roof	Main contractor	19-Apr-04	23-Jun-04	£59,400.00	£45,800.00	£35,800.00	£141,000.00	£145,230.00
Plumbing & Sanitary-ware	Main contractor	1-Mar-04	16-Jul-04	£75,800.00	£87,950.00	£48,500.00	£212,250.00	£218,617.50
Mechanical Services							£0.00	£0.00
Floor Finishes	Main contractor	24-May-04	4-Oct-04	£75,450.00	£62,850.00	£65,800.00	£204,100.00	£210,223.00
Ceiling Finishes	Main contractor	28-Jun-04	5-Nov-04	£89,500.00	£105,600.00	£95,800.00	£290,900.00	£299,627.00
Wall finishes							£0.00	£0.00
Fixtures & fitting	Main contractor	31-May-04	24-Sep-04	£74,560.00	£68,500.00	£58,700.00	£201,760.00	£207,812.80
External works	Sub2						£0.00	£0.00
Handover & clean	Main contractor	29-Nov-04	18-Dec-04	£4,600.00	£8,500.00	£2,550.00	£15,650.00	£16,119.50
#N/A	Sub3						£0.00	£0.00

This is subtracted from the total cost curve of the contractor to arrive at the cost curve for all of the subcontractors. In terms of the contractor's cash out curve, the model applies the payment delays specified by the users for materials, own labour, plant and overheads to the contractor's own labour cost curve. Separately, the cost curve generated for subcontractors is delayed using the assent payment delay, and, by deducting retentions (retention contractor hold against subcontractors), the cash out curve for the contractor is calculated.

The model makes a novel contribution in that held retention is partially paid at completion of the subcontractors' work. This is possible only through the consideration of individual subcontractors' work and cash flow.

Thirdly: -The works carried by subcontractors

In this case the calculations are provided for each subcontractor in separate tables, as shown in the following details. Once an individual subcontractor's cost curve is produced, both the cash out and in curves are generated in the same way as in the main contractor.

Subcontractor 1

Table 8.4 shows an example of the output report generated for subcontractor 1. The first column lists the activities to be carried out by this subcontractor. The following columns shows the start dates and finish dates for each activity together with their costs (total and for the different types of resources), and the final column lists the percentage fees to be charged by the main contractor for supervising the work executed by the subcontractor. The output shown in table 8.4 is based on an advance payment percentage of 15%, retention money of 7% (5% payback at primary handover and 2% after the maintenance period has elapsed). The pricing system selected is cost plus fixed fees, which is equal to7%.

Table 8.4 Cost of the resources subcontractor (1)

Sub-contractor 1 RESOURCE

No	Avtivity	start dates	finish dates	E activity cost	F materials cost	G labour cost	H plants cost	I DAY/COST	J over H. FEES%	Fixed Fees
	Construction Phases			£0.00	£0.00	£0.00	£0.00			
1	Foundations			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
2	Draing and water	10-Feb-03	14-Mar-03	£21,900.00	£6,450.00	£7,600.00	£7,850.00	£676.45	3.00%	7.00%
3	Ground floor			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
4	External Walls			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
	External walls Ground			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
5	External walls 1st			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
6	External walls 2nd			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
7	External walls 3rd			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
8	External walls 4th			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
9	External walls 5th	25-Aug-03	06-Nov-03	£31,460.00	£11,680.00	£12,580.00	£7,200.00	£428.76	3.00%	7.00%
10	External walls 6th			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
11	Internal Walls			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
	internal walls ground F.			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
12	Internal Walls 1st	17-Nov-03	19-Dec-03	£69,450.00	£25,700.00	£22,350.00	£21,400.00	£2,145.17	3.00%	7.00%
13	Internal Walls2nd			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
14	Internal Walls 3rd			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
15	Internal Walls 4th	01-Mar-04	05-May-04	£62,850.00	£19,800.00	£20,500.00	£22,550.00	£961.38	3.00%	7.00%
16	Internal Walls 5th	22-Mar-04	21-May-04	£67,800.00	£19,800.00	£21,200.00	£26,800.00	£1,122.98	3.00%	7.00%
17	Internal Walls 6th			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
18	Internal doors			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
19	Lift /Stairs			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
	1st floor	05-Jan-04	05-Feb-04	£16,210.00	£7,560.00	£5,800.00	£2,850.00	£516.65	3.00%	7.00%
20	2nd floor			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
21	3rd floor			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
22	4th floor			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
23	5th floor			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
24	6th floor			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
25	Roof			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
26	Plumbing & Sanitary-ware			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
27	Mechanical Services			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
28	Floor Finishes			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
29	Ceiling Finishes			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
30	Wall finishes			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
31	Fixtures & fitting			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
32	External works			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
33	Handover & clean			£0.00	£0.00	£0.00	£0.00	£0.00	3.00%	7.00%
0	0.00									
	Total works cost (sub-contractor 2)			£269,670.00	£90,990.00	£90,030.00	£88,650.00			

Subcontractor 2

Table 8.5 shows an example of the output report generated for subcontractor 2. The first column lists the activities to be carried out by this subcontractor. The following columns show the start dates and finish dates for each activity, together with their costs (total and for the different types of resources), and the final column lists the percentage fees to be charged by the main contractor for supervising the work executed by the subcontractor. The output shown in table 8.5 is based on an advance payment percentage of 15%, retention money of7% (5% payback at primary handover and 2% after the maintenance period has elapsed). However, the pricing system is applied based on labour and materials cost plus 5% . All works carried by subcontractor 2 are shown in table.8.5.

Table 8.5 Cost of the resources subcontractor (2)

Sub-contractor 2 RESOURCE

No	Avtivity	start dates	finish dates	activity cost	materials cost	labour cost	plants cost	DAY/COST	FEES%
	Construction Phases								
1	Foundations			£0 00	£0.00	£0.00	£0.00	£0.00	5.00%
2	Draing and water			£0.00	£0.00	£0.00	£0.00	£0.00	6.00%
3	Ground floor			£0.00	£0.00	£0 00	£0.00	£0.00	5.00%
4	External Walls			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	External walls Ground			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
5	External walls 1st			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
6	External walls 2nd			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
7	External walls 3rd			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
8	External walls 4th	26-Jun-03	05-Sep-03	£37,030.00	£14,520.00	£12,660.00	£9,850.00	£399.85	5.00%
9	External walls 5th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
10	External walls 6th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
11	Internal Walls			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	internal walls ground F.			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
12	Internal Walls 1st			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
13	Internal Walls2nd			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
14	Internal Walls 3rd			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
15	Internal Walls 4th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
16	Internal Walls 5th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
17	Internal Walls 6th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
18	Internal doors			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
19	Lift /Stairs			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	1st floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
20	2nd floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
21	3rd floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
22	4th floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
23	5th floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
24	6th floor	01-Jun-04	12-Jul-04	£9,960.00	£3,860.00	£4,250.00	£1,850.00	£205.81	5.00%
25	Roof			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
26	Plumbing & Sanitary-ware			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
27	Mechanical Services			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
28	Floor Finishes			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
29	Ceiling Finishes			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
30	Wall finishes			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
31	Fixtures & fitting			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
32	External works	06-Sep-04	06-Dec-04	£582,900.00	£215,900.00	£198,500.00	£168,500.00	£4,761.92	5.00%
33	Handover & clean			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
0	0			£0 00	£0 00	£0.00	£0.00		5.00%
	Total works Cost (sub-contract 2)			£629,890.00	£234,280.00	£215,410.00	£180,200.00		

Subcontractor 3

Table 8.6 shows an example of the output report generated for subcontractor 3. The first column lists the activities to be carried out by this subcontractor. The following columns show the start dates and finish dates for each activity together with their costs (total and for the different types of resources), and the final column lists the percentage fees to be changed by the main contractor for supervising the work executed by the subcontractor. The output shown in table 8.6 is based on an advance payment percentage of 15% and retention money of 7%. The pricing system applied is cost plus fixed fees, which is equal to5%.

This contract is based on these conditions: no advance payment, retention money 9% (5% payback at primary handover and 4% after the maintenance year).

Table 8.6 Cost of the resources subcontractor (3)

Sub-contractor 3 RESOURCE

				E	F	G	H		J
No	Avtivity	start dates	finish dates	activity cost	materials cost	labour cost	plants cost	DAY/COST	FEES%
	Construction Phases			£0.00		£0.00	£0.00		
1	Foundations			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
2	Draing and water			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
3	Ground floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
4	External Walls			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	External walls Ground			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
5	External walls 1st			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
6	External walls 2nd	19-May-03	19-Aug-03	£28,900.00	£12,450.00	£8,950.00	£7,500.00	£141.52	5.00%
7	External walls 3rd	30-Jun-03	05-Sep-03	£26,700.00	£11,250.00	£9,850.00	£5,600.00	£175.32	5.00%
8	External walls 4th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
9	External walls 5th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
10	External walls 6th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
11	Internal Walls			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	internal walls ground F.			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
12	Internal Walls 1st			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
13	Internal Walls2nd	01-Dec-03	21-Jan-04	£69,800.00	£24,800.00	£21,250.00	£23,750.00	£506.86	5.00%
14	Internal Walls 3rd			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
15	Internal Walls 4th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
16	Internal Walls 5th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
17	Internal Walls 6th			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
18	Internal doors			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
19	Lift /Stairs			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	1st floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
20	2nd floor	02-Feb-04	02-Mar-04	£14,550.00	£5,400.00	£6,250.00	£2,900.00	£193.02	5.00%
21	3rd floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
22	4th floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
23	5th floor	10-May-04	15-Jun-04	£10,720.00	£3,950.00	£4,520.00	£2,250.00	£114.02	5.00%
24	6th floor			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
25	Roof			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
26	Plumbing & Sanitary-ware			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
27	Mechanical Services	24-May-04	20-Aug-04	£572,700.00	£165,500.00	£221,500.00	£185,700.00	£1,966.34	5.00%
28	Floor Finishes			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
29	Ceiling Finishes			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
30	Wall finishes	15-Mar-04	15-Sep-04	£421,700.00	£121,500.00	£154,600.00	£145,600.00	£691.93	5.00%
31	Fixtures & fitting			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
32	External works			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
33	Handover & clean			£0.00	£0.00	£0.00	£0.00	£0.00	5.00%
	0.00								5.00%
	Total works Cost (sub-contract 3)			£1,145,070.00	£344,850.00	£426,920.00	£373,300.00		

8.9 MODEL REPORT OUTPUT

The model provides three types of results:

1- Client's cash flow.

2- Contractor's cash flow.

3- Subcontractors' cash flow.

Client's cash out, which is often equal to main contractor cash in, is provided in the form of a table and a graph as mentioned above in table 8.1 and figure 8.5.

In terms of the main contractor's cash flow the model provides the cash out curve for the main contractor, which includes the main contractor's own labour work together with the subcontractor's packages. Contractors' cash in curves is also reported but depends very much on the payment system applied, as shown in figures 8.7 and 8.8 below.

Fig. 8.7 Contractor cash in using interim payment and advance payment

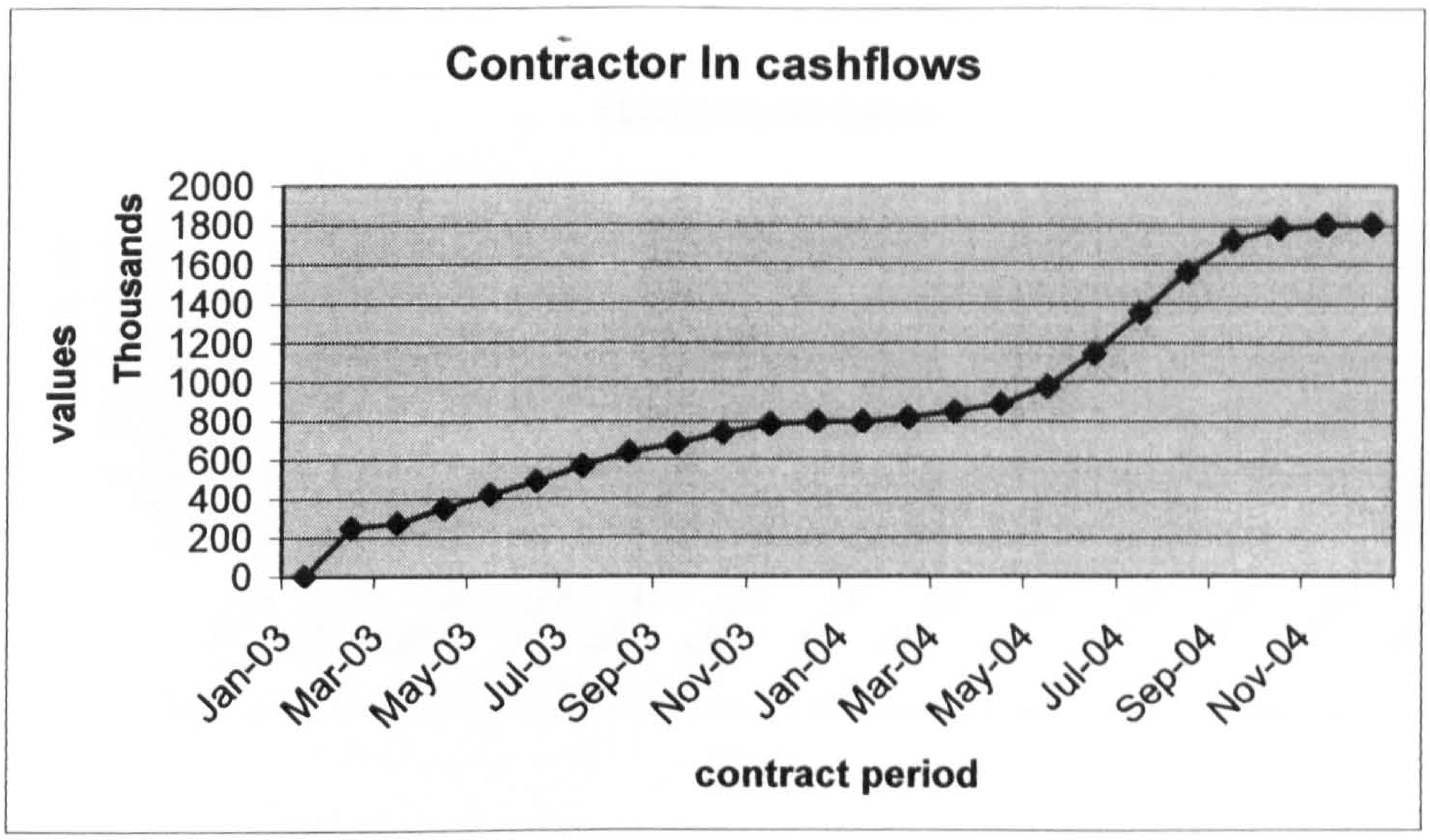


Fig. 8.8 Contractor cash in using stage payment system

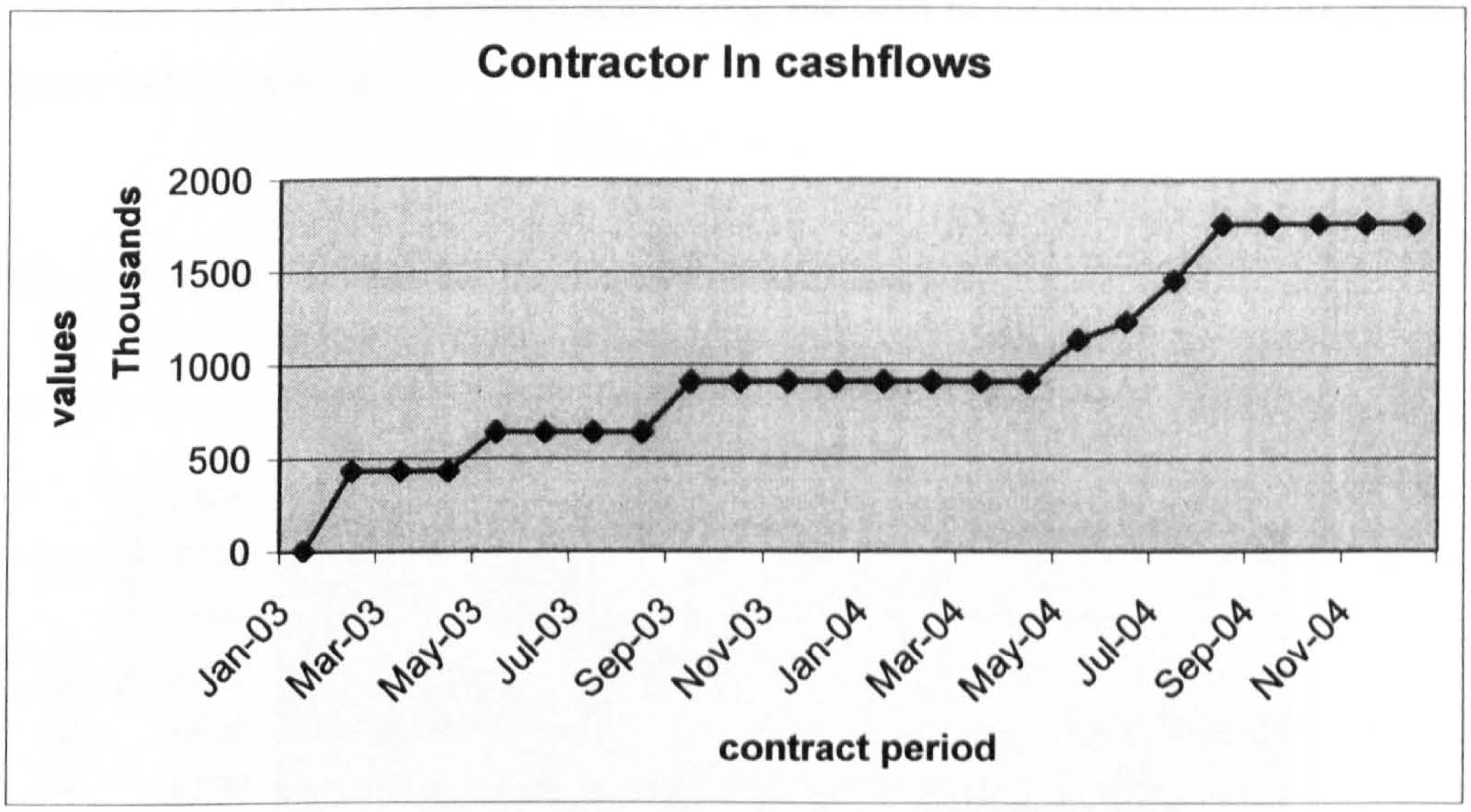
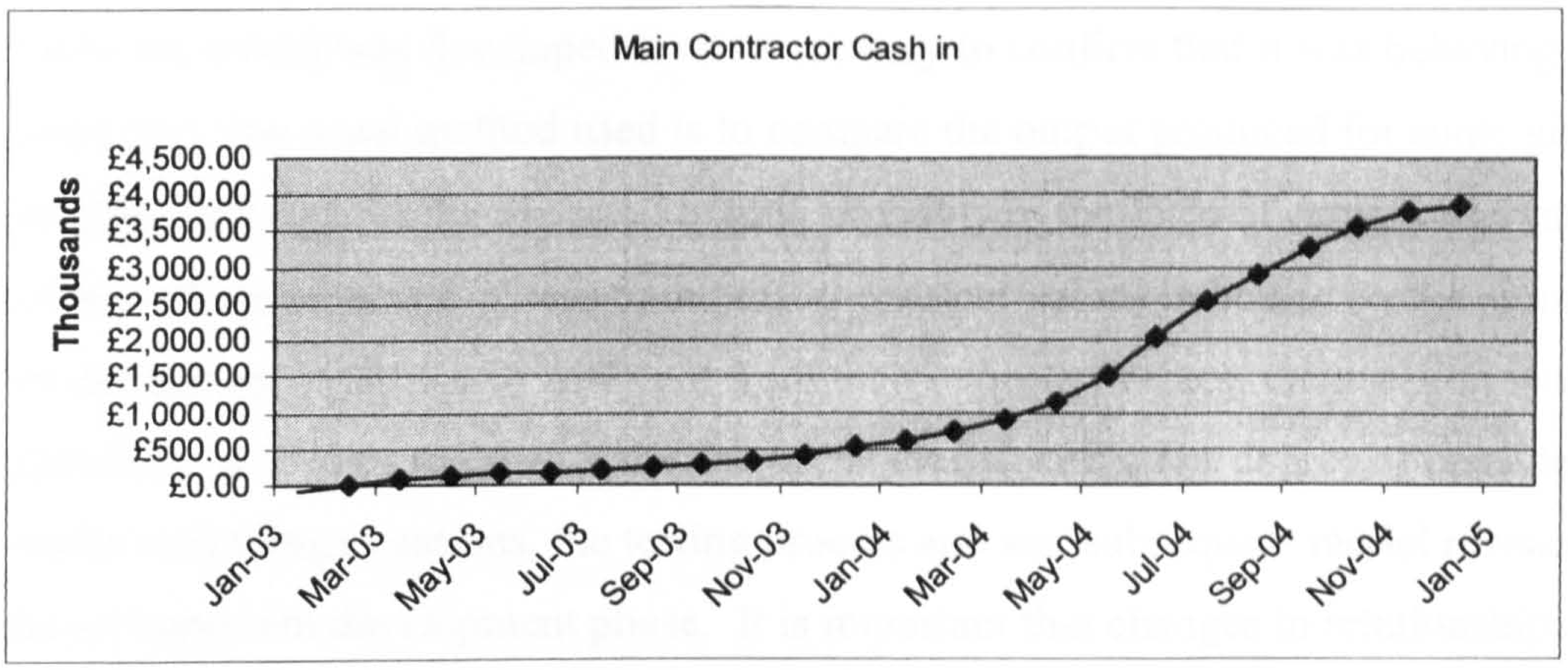


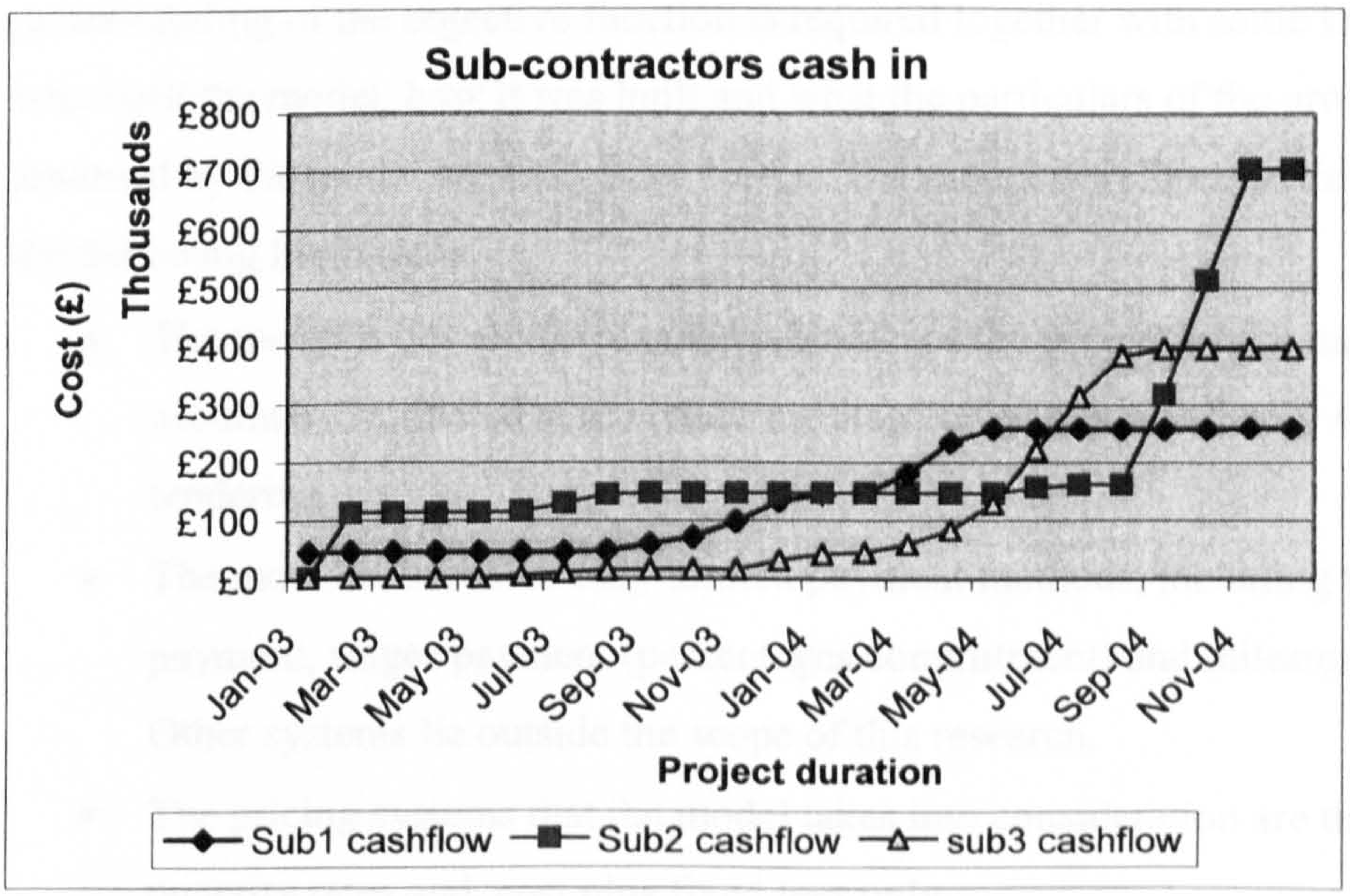
Fig. 8.9 Contractor cash flow without advance payment



Cash in for subcontractors will also be provided in the form of a table and a graph. This output will show the subcontractors' cost curves for the alternative pricing systems and payment methods being considered.

The model's output for subcontractors (e.g. the cash in for subcontractors1, 2, and 3) are shown below in fig 8.10.

Fig. 8.10 The in cash flows for the subcontractors (1,2,and 3).



8.10 TESTING THE MODEL

Once the model was developed it was necessary to confirm that it was behaving correctly. The usual method used is to compare the output produced for some given set of input data against the expected output, probably in the form of actual observations from a previous period. If it is found that the output values indicated by the simulation model are not significantly different from their expected values, the decision maker should be able to proceed with the use of the model with a fair degree of confidence. In many modelling situations, the testing process and any subsequent model revisions will be an important development phase. It is important that changes in relationships are reflected in the model immediately. Otherwise, serious mistakes could be made as a result of taking decisions on the basis of information from a mis-specified model. Hence the testing process should be regarded by the modeller as a regular exercise in all except the most stable systems. Chapter 9 explained in detail the case studies that were used to test and evaluate the model.

8.11 LIMITATION OF THE MODEL

There are limitations in any financial model. The decision maker should be aware that computer-based models are only an abstraction of what goes on in real life. Some understanding of the objective function is required together with some knowledge of who built the model, how it was built and what the particulars of the problem definition assumed by the model were (Raftery 1998). The model developed in this research has the following limitations:

- The model relies on the planned schedule of the project which may not be accurately estimated at the tendering stage or even immediately following tendering.
- The model is based on only limited payment methods, including the interim payment, stages payment (percentages commitment) and milestones payments. Other systems lie outside the scope of this research.
- The pricing systems that the model takes into consideration are the Bill of quantity rates and, cost plus fixed fees only.
- The model assumes that item costs are uniformly distributed along its duration. In real life this may not be the case given the variations in productivity and the work associated with each activity.

8.12 SUMMARY

This chapter described the need for a new cash flow model that can be applied to help construction teams to select the most appropriate payment system for a particular project. The proposed model provides the client, the contractor and subcontractor with their individual cash flow profiles resulting from the payment and pricing systems being considered and the other influencing contract conditions. The chapter describes the mechanism developed to process the data entry into the output report. This consists mainly of three stages: the first stage where the project work plan is defined and processed into a cost curve (using MS. Project) and the second stage where output of the first stage and other data such as the payment method and contract conditions to be used as entry data to the model are described. The third stage is where the detailed cash flow calculation is undertaken to convert the individual cost curves (for client, contractor and subcontractors) into the cash out and cash in for each party. The chapter then concludes by outlining the main assumptions that the model had to make and the limitations that the author declares as falling outside the scope of the research.

Chapter 9

Cash flow model testing

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INTRODUCTION

It is erroneous to assume that the developed cash flow model will produce 100 percent accurate results, or even to aim at this when designing the model. It is the objective of the research to develop a sufficiently precise model which can be used reliably for the abovementioned purposes. The model was logically designed to satisfy this goal. The evaluation process included three stages:

1- verification and debugging:

2- validation: and

3- evaluation:

9.1 VERIFICATION AND DEBUGGING OF THE CASH FLOW MODEL

In order to evaluate the reliability of the model it is essential first to ensure that the model is working as designed. During the development of any computer model it is inevitable that errors occur. The process of debugging the model (checking and removing errors) was performed in two stages. The first stage was conducted simultaneously with the coding of the model. This involved checking the typed formulae, testing the logic of results, performing calculations, etc. The second stage involved the following steps:

- The model was designed so that cash flow forecasting calculations, such as payments to contractors and subcontractors, were based on the type of payment system being adopted. Each input variable was varied in turn to examine the effects on the overall output. The detailed output report was used to show variation in input. For example, the change of payment method found that the interim payment is more helpful than the milestone for the contractor's cash flow.

- The output of the model was checked to see if it was reasonable. For example, advance payments improved the contractor's cash flow position, and the balance between value curve and cash in becomes very close. This results in the fact that most of the time the contractor's cash flow is positive.

9.2 CASH FLOW MODEL VALIDATION

Once the model has been debugged, tests were performed to ensure that the model does simulate the contracting activities adequately. This process is commonly known as model validation, which could be undertaken by any of three approaches:

1- The model may be run with historic data to see if the model produces actual past results with sufficient accuracy.

2- The model may be run with variations in input data, and the results can be checked to see if the model responds in the way expected.

3- Particular relationships may be discussed with informed managers and industry experts.

Because no single person can guarantee the validity of the model, the first two methods were considered. The model did not posses any statistical relationship model and here the third method was ignored. The model was then run with variations in input data in order to validate the behaviour of the output to those variations. This process goes further than the debugging stage where the model was checked for directions in movements (for example, a decrease in clients' payments delays should reduce the working capital requirement). In the validation process, the data entry was varied within practical limits. Variations in entry data and output results were measured and discussed with an expert practitioner.
Owing to the flexible nature of the model (in simulating alternative payment system), each test was repeated for each of the payment systems considered. For example, the milestone payment system was tested for the frequency of the payments generated by the defined milestones projects, with fewer milestones resulting in less frequent payment and hence worst cash flow for the contractor.

9.3 VALIDATION THROUGH CASE STUDIES

One of the approaches to model testing is running the model with historical data to see whether it is producing actual past results with sufficient accuracy (case study). Having confirmed that the model is operating as designed, case studies were used to evaluate the accuracy of the model. The model was used to simulate the cash flow by using past entry project data. By analysing two past projects the model accuracy was confirmed. This was done by comparing model output with the actual data provided from two actual construction projects. Using spreadsheets allows the user to apply tools with which they are familiar for developing and testing the models.

(a) Harawa Houses project

The Harawa housing project involved constructing houses in an area of 40 k.m. east of Sirte city, as shown in fig.9.1. Following the completion of the Great Man-made River project in Libya, a 30 x 40-km area of land was selected for a new agricultural settlement. In 1990, Enka (Turkish Contractor) signed a form of contract for the turnkey construction of 240 farmhouses, including social and technical buildings, water reservoirs, pipelines, roads and infrastructure, with a total plot area of 50,000 sq. km. The housing type had been selected and located in six areas (40 houses in each area and a grouping of four semi-detached houses located at the corner of each farm). Under this comprehensive contract, the project's goal was to turn the arid desert into cultivatable land, and a habitable settlement materialized in several stages between 1990 and 1992. The contract value was 14,500,000 LYD (approximately £19,333,000.) to construct 240 farmhouses, a primary school, health centre, mosque, shopping centre, and accommodation for the health centre and school employees.

The contract was based on a cost plus fees for the materials imported but local materials were to be paid direct by the client. The contractor was to pay for materials delivery and storage. The contractor prepared the cost breakdown for each item, such as design cost, materials cost, labour cost, equipment, overheads and profit. The contract conditions are summarised in table 9.1.

Fig.9.1 Harawa project location

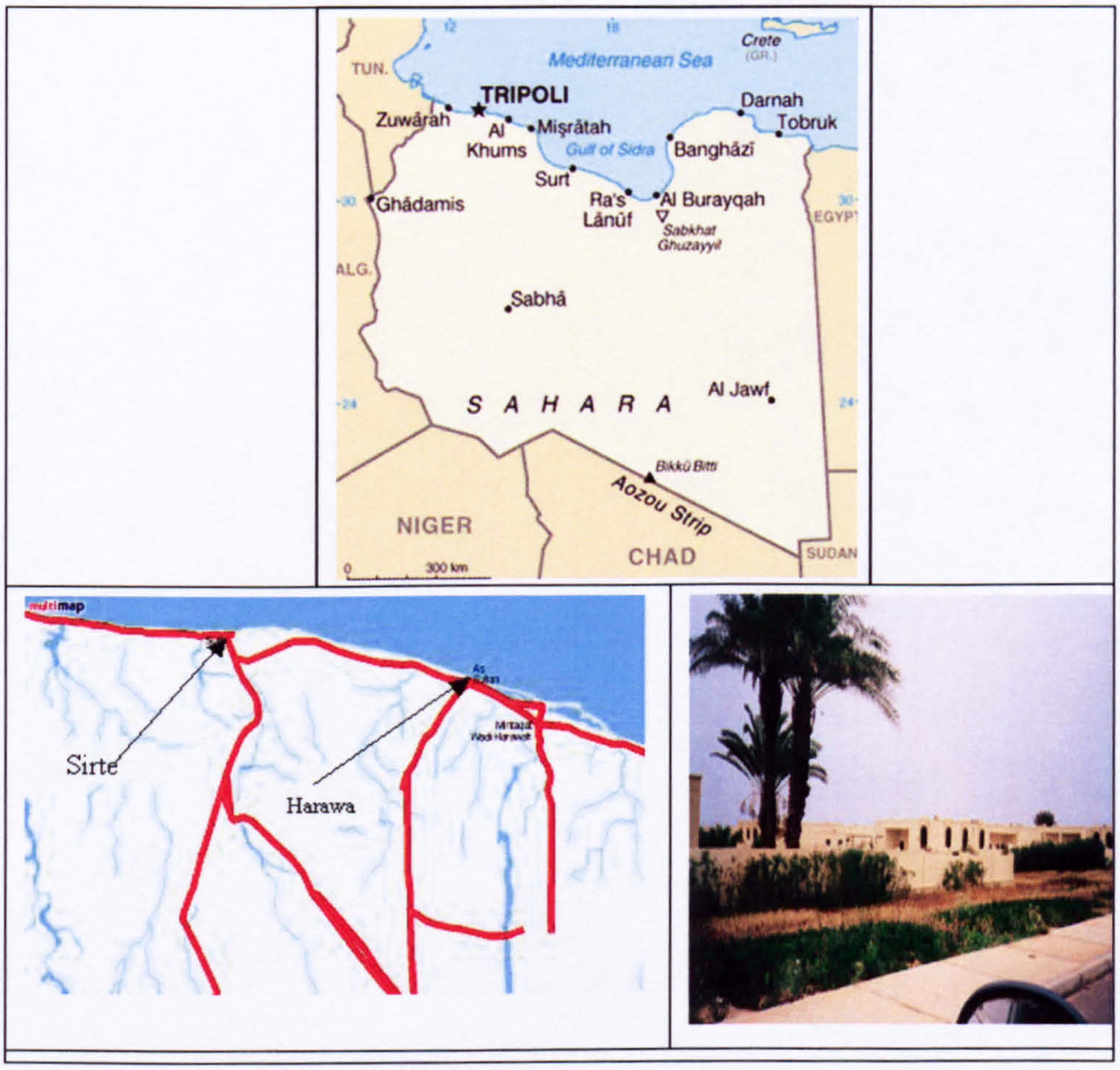


Figure 9.2 represents the project planned schedule which was produced at the start of the project. The contractor divided the project into work packages, based on groups of activities to be carried out at the same time with approximately the same output because all of the houses were of the same type.

Fig. (9. 2) farmhouses Gantt chart (planning)

ID	Task Name	Start	Finish
1	**Construction Phas**	**Wed 08/**	**Tue 24/1**
2	Final Design	Thu 14/	Wed 22/
3	earth works and l	Wed 08/	Tue 18/
4	moblisation camp	Mon 12/	Fri 08/C
5	**house buildings**	**Mon 19/(**	**Tue 24/1**
6	foundation gro	Thu 03/(	Wed 23/
7	walls works gr	Mon 09/	Thu 30/(
8	concrete colur	Mon 21/	Thu 22/
9	concrete slabs	Mon 02/	Fri 16/1
10	Internal walls p	Tue 26/(	Fri 16/1
11	Electrical wires	Mon 27/	Wed 23/
12	plumping wrok	Mon 24/	Fri 25/C
13	water supply	Mon 23/	Fri 23/1
14	walls clading ((	Mon 19/	Fri 23/1
15	Floor tiles	Mon 24/	Fri 26/C
16	Internal walls p	Tue 23/	Mon 21/
17	water ground t	Fri 23/1	Mon 24/
18	septic tanks	Wed 23/	Fri 07/C
19	land scaping	Wed 23/	Tue 24/
20	**houses Grouf**	**Mon 19/(**	**Tue 24/1**
21	foundation (	Thu 03/(	Wed 23/
22	walls works	Mon 09/	Thu 30/(
23	concrete cc	Mon 21/	Thu 22/
24	concrete sla	Mon 02/	Fri 16/1
25	Internal wall	Tue 26/(	Fri 16/1
26	Electrical wi	Mon 27/	Wed 23/
27	plumping wi	Mon 24/	Fri 25/C
28	water suppl	Thu 17/(	Tue 25/(
29	walls cladin	Mon 19/	Fri 23/1
30	Floor tiles	Mon 24/	Fri 26/C
31	Internal wall	Tue 23/	Mon 21/
32	water groun	Fri 23/1	Mon 24/
33	septic tanks	Wed 23/	Fri 07/C
34	land scapin	Wed 23/	Tue 24/
35	**Houses grouf**	**Mon 19/(**	**Tue 24/1**
36	foundation (	Thu 03/(	Wed 23/
37	walls works	Mon 09/	Thu 30/(
38	concrete cc	Mon 21/	Tue 21/(
39	concrete sla	Mon 02/	Fri 07/C
40	Internal wall	Tue 26/(	Wed 05/
41	Electrical wi	Mon 27/	Thu 08/
42	plumping wi	Mon 24/	Fri 23/1
43	water suppl	Thu 17/(	Tue 25/(
44	walls cladin	Mon 19/	Fri 23/1
45	Floor tiles	Mon 24/	Fri 26/C
46	Internal wall	Tue 23/	Mon 21/
47	water groun	Fri 23/1	Mon 24/
48	septic tanks	Wed 23/	Fri 07/C
49	land scapin	Wed 23/	Tue 24/

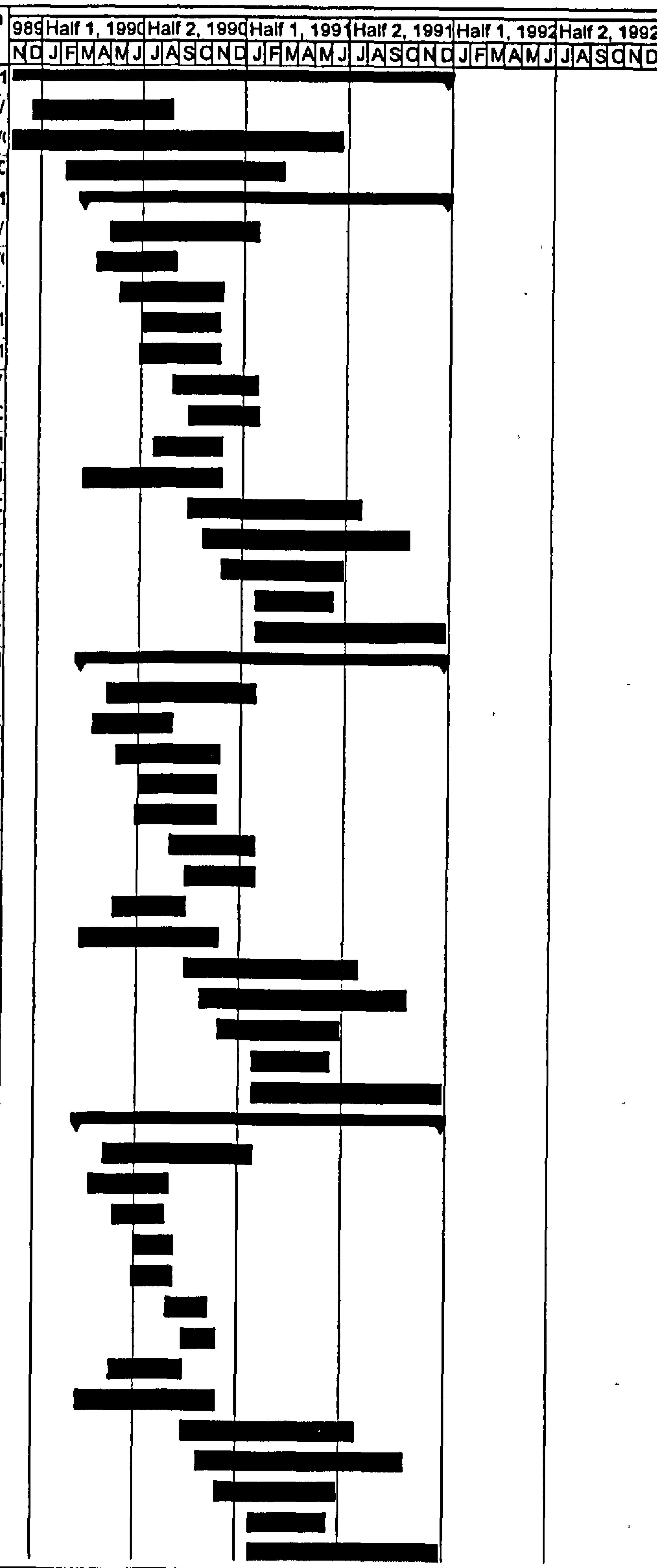


Figure 9.3 represents the actual programme for the project. The contractor divided and planned the projects into the work packages to be performed simultaneously with approximately same rate of progress, but in actual terms did not meet the planning programme.

Fig.(9.3) farmhouses Gantt chart (actual programme)

ID	Task Name	Duratio	Start	Finish	materials	manpowe	equipme
6							
7	**Houses groups 1&2**	**502 day**	**Mon 08/01**	**Tue 10/12**	**£0.0**	**£0.0**	**£0.0**
8	foundation group 5&6	273 da	Mon 08/0	Wed 23/0	£35,600	£54,800	£18,700
9	walls works group 5&6	100 da	Mon 08/0	Fri 25/05	£17,400	£19,500	£17,200
10	concrete columns G5&	80 da	Mon 04/0	Fri 21/09	£24,600	£17,600	£15,700
11	concrete slabs G5&6	67 da	Mon 30/0	Tue 30/1	£24,550	£16,750	£11,200
12	Internal walls plaster	40 da	Mon 09/0	Fri 31/08	£27,550	£24,350	£18,750
13	Electrical wires and cab	65 da	Mon 09/0	Fri 06/07	£11,350	£24,300	£15,250
14	plumping wroks	90 da	Mon 06/0	Fri 07/12	£28,800	£31,600	£13,200
15	water supply	102 da	Thu 17/05	Fri 05/10	£75,900	£87,500	£65,700
16	walls clading (ceramic)	180 day	Mon 19/03	Fri 23/11	£70,500	£120,50	£65,800
17	Floor tiles	220 day	Mon 24/0	Fri 26/07	£156,75	£129,50	£85,600
18	Internal walls paint	251 day	Mon 05/1	Mon 21/1	£175,40	£105,40	£78,500
19	water ground tanks	152 day	Fri 23/11	Mon 24/0	£45,700	£35,400	£28,500
20	septic tanks	90 day	Mon 04/0	Fri 07/06	£65,700	£45,500	£35,650
21	land scaping	210 da	Wed 23/0	Tue 12/1	£145,70	£96,500	£115,40
22	**Houses groups 3&4**	**432 day**	**Mon 16/04**	**Tue 10/12**	**£0.0**	**£0.0**	**£0.0**
23	foundation group 3&	190 da	Thu 03/05	Wed 23/0	£35,600	£54,800	£18,700
24	walls works group 3	95 da	Mon 11/0	Fri 19/10	£17,400	£19,500	£17,200
25	concrete columns G	75 da	Mon 11/0	Fri 21/09	£24,600	£17,600	£15,700
26	concrete slabs G3&	60 da	Mon 13/0	Fri 02/11	£24,550	£16,750	£11,200
27	Internal walls plaste	45 da	Mon 16/0	Fri 14/09	£27,550	£24,350	£18,750
28	Electrical wires and	35 da	Mon 08/1	Fri 23/11	£11,350	£24,300	£15,250
29	plumping wroks	75 day	Mon 24/0	Fri 04/01	£28,800	£31,600	£13,200
30	water supply	82 day	Mon 04/0	Tue 25/09	£75,900	£87,500	£65,700
31	walls clading (ceram	175 da	Mon 16/0	Fri 14/12	£70,500	£120,50	£65,800
32	Floor tiles	210 da	Mon 15/1	Fri 02/08	£156,75	£129,50	£85,600
33	Internal walls paint	240 da	Mon 29/1	Fri 27/09	£175,40	£105,40	£78,500
34	water ground tanks	152 day	Fri 23/11	Mon 24/0	£45,700	£35,400	£28,500
35	septic tanks	85 da	Mon 04/0	Fri 28/06	£65,700	£45,500	£35,650
36	land scaping	230 da	Wed 23/0	Tue 10/12	£145,70	£96,500	£115,40
37	**Houses groups 5 8**	**391 day**	**Mon 04/06**	**Mon 02/12**	**£0.0**	**£0.0**	**£0.0**
38	foundation group	168 da	Mon 04/0	Wed 23/0	£35,600	£54,800	£18,700
39	walls works gro	90 da	Mon 09/0	Fri 09/11	£17,400	£19,500	£17,200
40	concrete colum	70 da	Mon 09/0	Fri 12/10	£24,600	£17,600	£15,700
41	concrete slabs G	50 day	Mon 10/0	Fri 16/11	£24,550	£16,750	£11,200
42	Internal walls pla	50 da	Mon 06/0	Fri 12/10	£27,550	£24,350	£18,750
43	Electrical wires	34 day	Mon 24/0	Thu 08/1	£11,350	£24,300	£15,250
44	plumping wroks	65 da	Mon 08/1	Fri 04/01	£28,800	£31,600	£13,200
45	water supply	90 da	Mon 18/0	Fri 21/06	£75,900	£87,500	£65,700
46	walls clading (ce	220 da	Mon 05/1	Fri 06/09	£70,500	£120,50	£65,800
47	Floor tiles	200 da	Mon 24/0	Fri 28/06	£156,75	£129,50	£85,600
48	Internal walls pa	251 day	Mon 05/1	Mon 21/1	£175,40	£105,40	£78,500
49	water ground tan	141 day	Mon 10/1	Mon 24/0	£45,700	£35,400	£28,500
50	septic tanks	90 day	Mon 04/0	Fri 07/06	£65,700	£45,500	£35,650
51	land scaping	224 da	Wed 23/0	Mon 02/1	£145,70	£96,500	£115,40

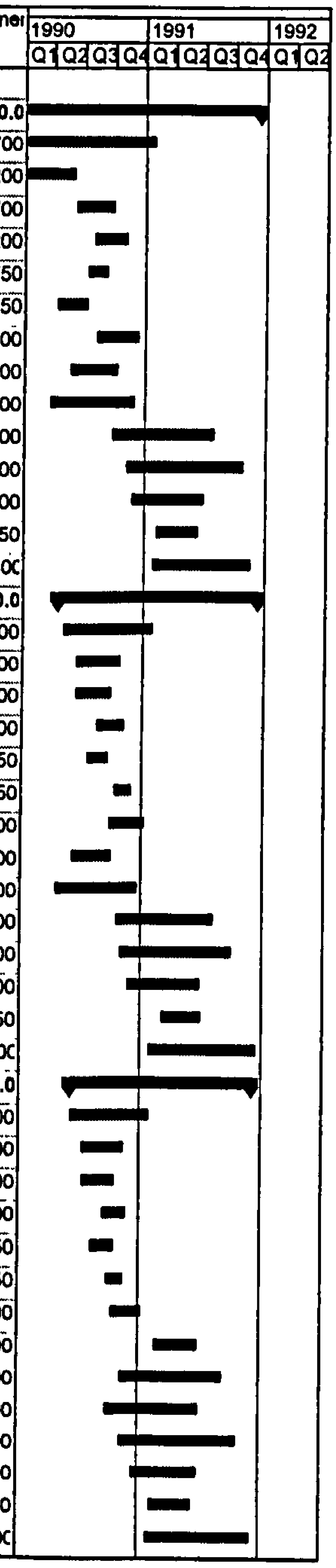


Table (9.1) Farmhouses contract conditions

Contract conditions	
Contract Duration.	18 months
Retention money	5%
Advance payment	0.0
Contract type	Cost plus fees
Procurement system	Design and build
Payment method	Monthly
Materials on site payment	0.0

Table 9.2 shows a comparison between the model's forecast cash flow, (based in terms of both the planned and actual schedule) and the actual cash flow. The first column represents the project dates in months, the second column represents the planning payments and the next column is the cumulative planning payment. The fourth column represents the monthly payment due to the contractor, which is converted into cumulative values in the following column. The next two columns represent the actual progress of the works, the actual payment received by the contractor and their cumulative values. The three payment profiles are shown below in fig. 9.4.

Fig.9.4 The cumulative cash in curves based on planned, actual progress vs actual payments received:

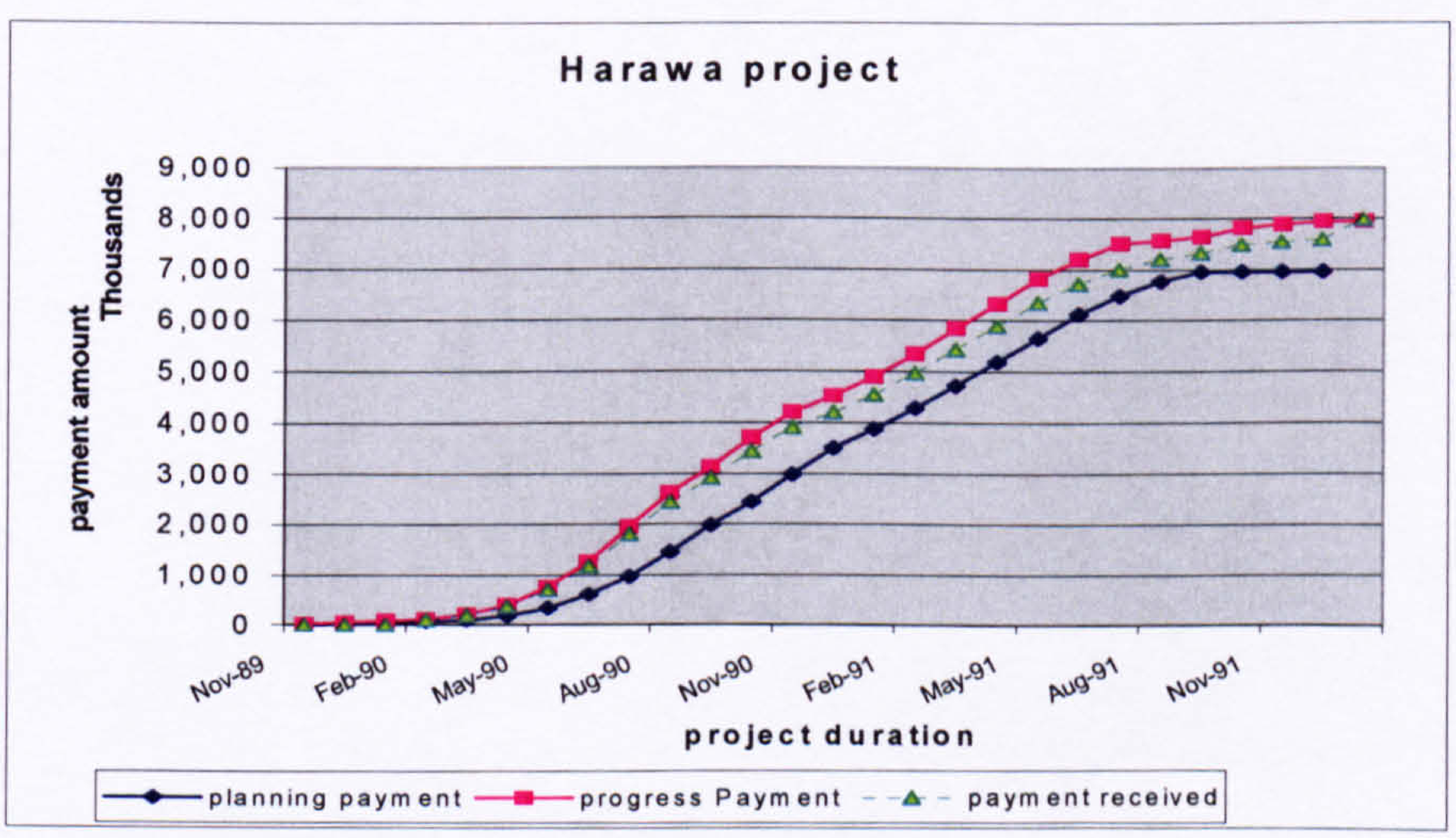


Table 9. 2 Forecast costs (planning, actual programme) and the actual payment received

Harawa Farmhouse project

Month	Forecasting cash flow				Actual payment (£1.0 = 0.75 Libyan Dinar)	
	Planning programme		Actual programme			
	Planned payment	Cumulative	Actual progress	Cumulative	Payment received	Cumulative
1	0	0	0	0	0	0
2	13,121	13,121	31,916	31,916	0	0
3	17,944	31,065	31,916	63,832	25,000	25,000
4	33,178	64,243	28,827	92,659	70,000	95,000
5	36,866	101,109	100,934	193,593	92,750	187,750
6	82,988	184,096	192,398	385,990	182,550	370,300
7	159,648	343,744	359,668	745,658	334,491	704,791
8	274,576	618,320	502,446	1,248,104	467,275	1,172,066
9	357,476	975,796	685,661	1,933,766	635,440	1,807,506
10	482,988	1,458,784	676,471	2,610,237	629,118	2,436,624
11	525,023	1,983,807	511,908	3,122,145	480,440	2,917,064
12	467,151	2,450,958	570,922	3,693,067	530,957	3,448,022
13	546,997	2,997,954	491,603	4,184,669	455,190	3,903,212
14	514,670	3,512,624	321,306	4,505,975	198,814	4,102,026
15	374,775	3,887,399	371,167	4,877,142	445,185	4,547,211
16	407,318	4,294,716	449,599	5,326,741	422,760	4,969,971
17	432,170	4,726,886	497,770	5,824,510	462,926	5,432,896
18	472,829	5,199,716	481,713	6,306,223	450,350	5,883,246
19	455,769	5,655,485	497,770	6,803,993	462,960	6,346,206
20	470,961	6,126,446	382,093	7,186,086	365,770	6,711,976
21	363,161	6,489,607	315,429	7,501,515	293,340	7,005,316
22	285,034	6,774,641	209,619	7,711,134	199,850	7,205,166
23	191,120	6,965,761	202,857	7,913,991	0	7,205,166
24	0	6,965,761	176,241	8,090,232	265,400	7,470,566
25	0	6,965,761	69,414	8,159,646	225,350	7,695,916
26	0	6,965,761	54,856	8,214,502	107,860	7,803,776
27	0		0	8,214,502	410,725	8,214,502

It is clear from the above results that there are some differences between the three sets of outcomes and particularly between the profile based on the planned progress and the rest. The reasons for the differences are explained below: -

- The client did not make a payment to the contractor for the first couple of months because it was agreed that, owing to shortage of contractor's cash, the client paid the relevant supplier of the camp facilities directly.

- In terms of the difference between the planned and actual progress, some activities suffered delays because of problems in materials supply. There was a lack of supply of cement to the site, because the nearest cement factory was under maintenance. The contractor was asked to bring the cement from another factory, which is about 600 km from the project site. Despite this, the factory could not fully supply the required quantities for the project (month 14).
- The contractor was asked to transfer his labour and equipment to another project following the client's request for the contractor's resources to be diverted temporarily into another project (month 23). The model could not simulate this disruption of work as the model assumes a uniform rate of progress in each activity.

(b) Administrative centres project

The Libyan government decided to locate the administrative centres out of the capital of Libya (Tripoli). They identified the middle part of Libya as the best connection point between the east and west of the country. Sirte city was therefore selected as the preferred place for the project. The project was located in the central area of the city, but the site conditions where it was planned was a marsh land (sebkh and damp land because its level is lower than the sea level).

The project included an administrative office building. It consisted of 8 two-storey buildings, giving a total area of 60,000sq.m, 6 buildings of three storeys (10,500 sq. m each), two building of four storeys (area 11,200sq.m and 12,800sq.m.) and a congress complex building containing a hall with 3,500 seats, two halls with 700 seats each, a press hall with 150 seats, a coffee shop with 550 seats and other facilities and service areas.

The contract was divided into several stages. The first stage was commissioned to an Italian contractor (Enterprise spa.). The contract covered an area costing 212.5 LYD/sq. m, plus additional extra cost for specification changes.

Fig. 9. 5 Administrative buildings site plan as design

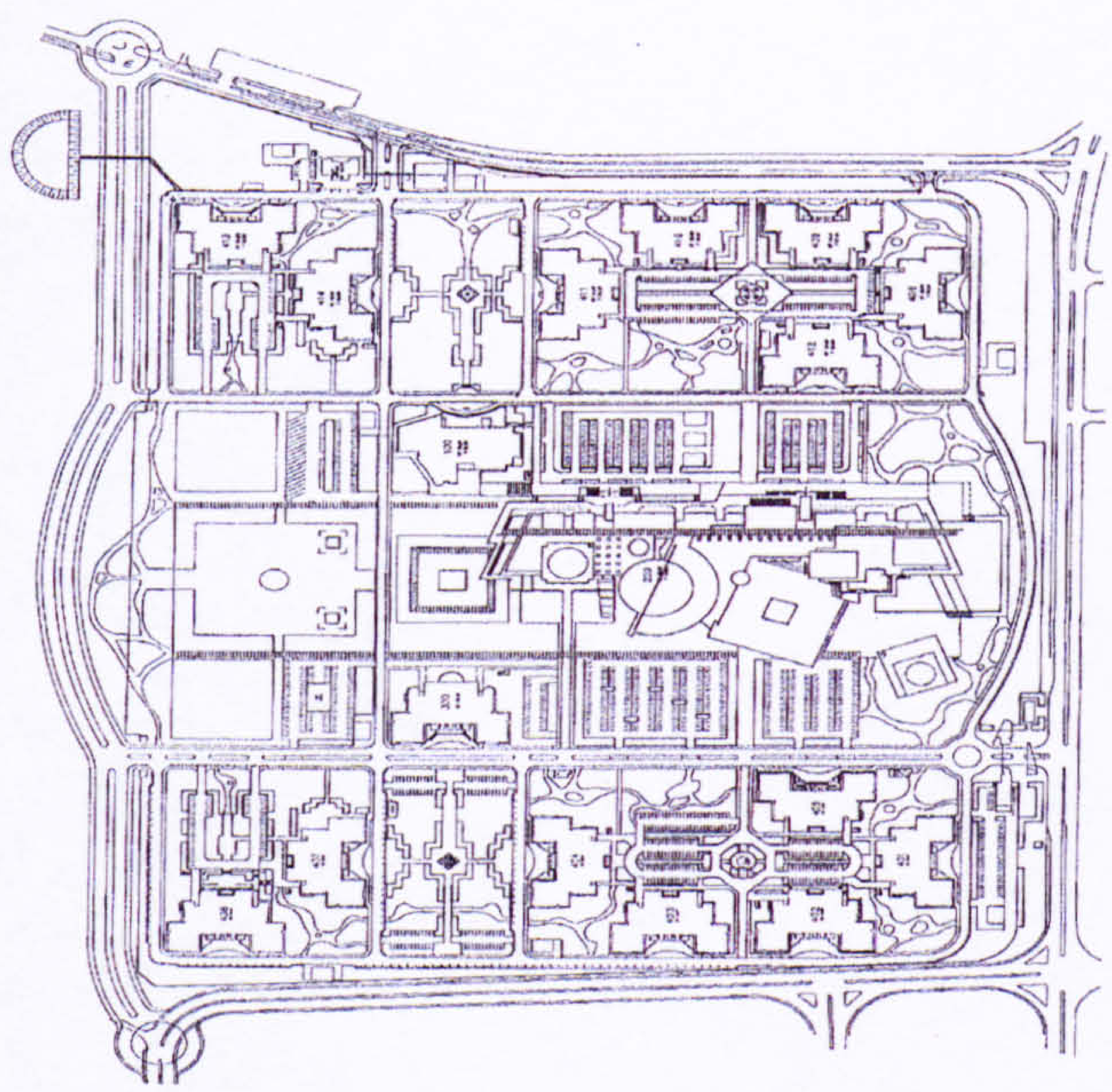


Fig.9.6 administrative building project as shown by Google earth 2006

The cost was distributed between the two-storey building, as shown in the table below.

Administrative Building Type (D) Total Area 7500sq.m

LYD 212.50/sq.m

Building cost = 212.5*7500= 1,593,750 LYD

Table (9. 3) project cost breakdown

Items Description	Item %	Item cost
Design	**1.44%**	**LYD 22,950.00**
Final design Architectural	15%	LYD 3,442.50
Final design structural	15%	LYD 3,442.50
Final design services	15%	LYD 3,442.50
Execution drawing Architecture.	15%	LYD 3,442.50
Execution drawing structural	15%	LYD 3,442.50
Execution drawing services	15%	LYD 3,442.50
As built drawings	10%	LYD 2,295.00
Earth Works	**2.10%**	**LYD 33,468.75**
Excavation	60%	LYD 20,081.25
Filling & compaction	40%	LYD 13,387.50
Concrete works	**30.26%**	**LYD 482,268.75**
Lean concrete	1%	LYD 4,822.69
Foundation	15%	LYD 72,340.31
Ground floor concrete	4%	LYD 19,290.75
Column ground floor	4%	LYD 19,290.75
Column first floor	4%	LYD 19,290.75
Concrete walls ground floor	7%	LYD 33,758.81
Concrete walls first floor	8%	LYD 38,581.50
Concrete slab, beams G.F.	20%	LYD 96,453.75
Concrete slab, beams F.F.	20%	LYD 96,453.75
Stairs	7%	LYD 33,758.81
Parapets and lintels	10%	LYD 48,226.88
Walls	**5%**	**LYD 79,687.50**
Masonry walls G.F.	50%	LYD 39,843.75
Masonry walls F.F.	50%	LYD 39,843.75
Plastering, rendering	**5%**	**LYD 79,687.50**
Internal Ground floor	30%	LYD 23,906.25
Internal First floor	30%	LYD 23,906.25
External	40%	LYD 31,875.00
Roof Finishing	**5%**	**LYD 79,687.50**
Slope concrete	25%	LYD 19,921.88
Insulation layer	25%	LYD 19,921.88
Water proofing	25%	LYD 19,921.88
Paving	25%	LYD 19,921.88
Floor & wall finishing	**10%**	**LYD 159,375.00**
Floor covering work G.F.	30%	LYD 47,812.50
Floor covering work F.F.	25%	LYD 39,843.75

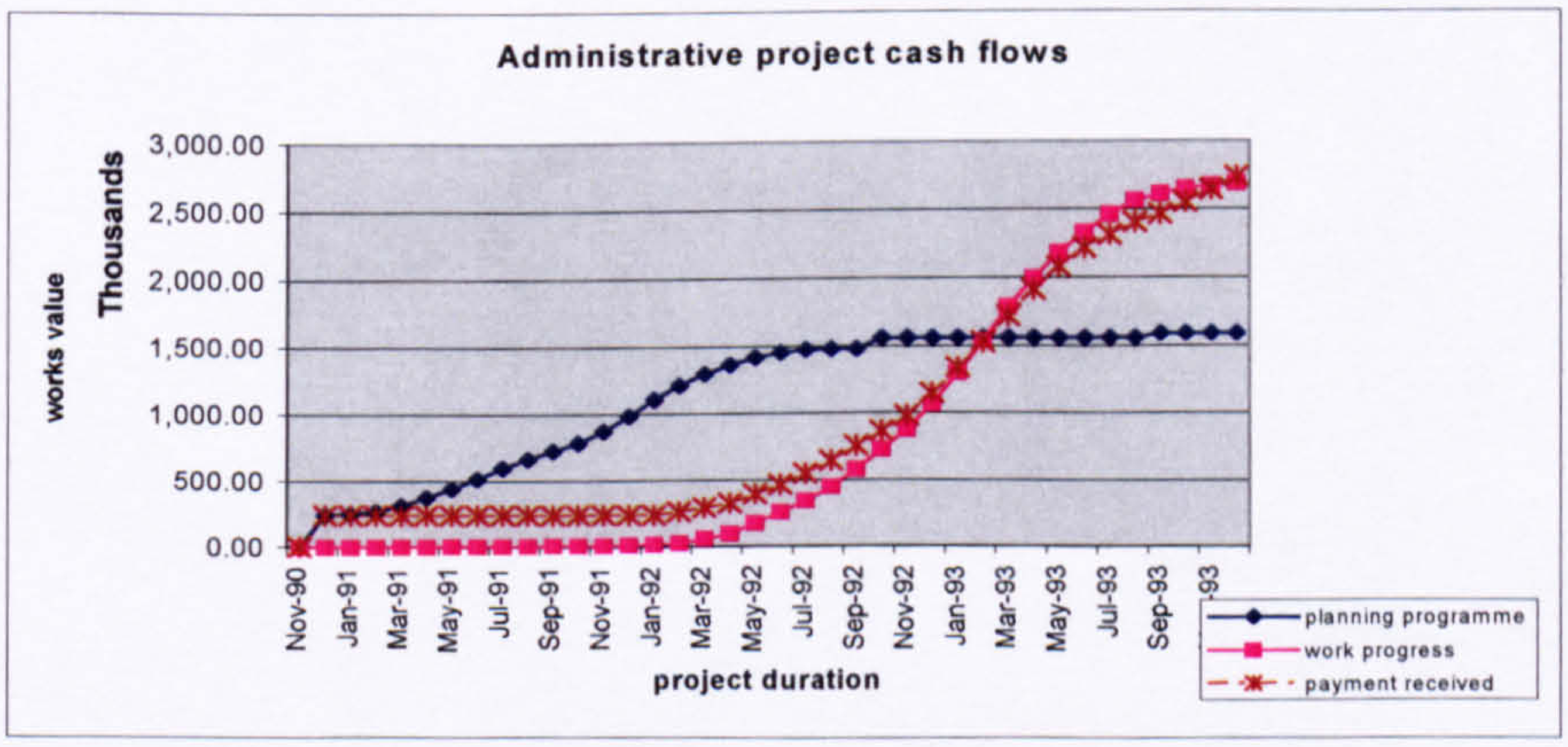
Finishing stairs marble	15%	LYD 23,906.25
Finishing handrail	5%	LYD 7,968.75
Finishing skirting	10%	LYD 15,937.50
Finish bathroom & kitchen floor water Prf.	5%	LYD 7,968.75
Wall cladding bathroom & kitchen	10%	LYD 15,937.50
Painting	**4.50%**	**LYD 71,718.75**
Internal	70%	LYD 50,203.13
External	30%	LYD 21,515.63
Doors& Windows	**10.70%**	**LYD 170,531.25**
Doors Ground floor	20%	LYD 34,106.25
Doors first floor	20%	LYD 34,106.25
Windows Ground floor	30%	LYD 51,159.38
Windows first floor	30%	LYD 51,159.38
Sanitary work	**7%**	**LYD 111,562.50**
Water supply network	20%	LYD 22,312.50
Sewage& rainwater goods	20%	LYD 22,312.50
Sanitary goods G.F.	25%	LYD 27,890.63
Sanitary goods F.F.	20%	LYD 22,312.50
Accessories & siphons	15%	LYD 16,734.38
Electrical works	**7%**	**LYD 111,562.50**
Conducts	15%	LYD 16,734.38
Cabling	15%	LYD 16,734.38
Internal lighting unit	20%	LYD 22,312.50
External lighting unit	15%	LYD 16,734.38
Switches & sockets	10%	LYD 11,156.25
Distribution board &cables	25%	LYD 27,890.63
Air conditioning	**10%**	**LYD 159,375.00**
Completion and testing	**2%**	**LYD 31,875.00**
Extra cost works	**70%**	**LYD 1,115,625.00**
Curtains wall	15%	LYD 167,343.75
Air-condition central	10%	LYD 111,562.50
Domes mosaic cladding	10%	LYD 111,562.50
Lights fixtures	5%	LYD 55,781.25
Office Furniture	10%	LYD 111,562.50
Granite flooring	5%	LYD 55,781.25
V.I.P. Bathrooms applicants	5%	LYD 55,781.25
Falls ceiling	10%	LYD 111,562.50

Table 9. 4 Administrative B. Contract conditions

Contract conditions	
Contract duration	36 months
Contract value	LYD 1,593,521
Advance payment 15%	LYD 239,000
Extra cost (change specifications)	LYD 1,115,625
Total contract value	LYD 2,706,146
Retention money	5%
Advance payment	15%
Contract type	BoQ (Area cost)
Procurement system	Traditional
Payment method	Monthly
Materials on site payment	75%

Table 9.5 below shows the calculations of the cost of the project. These costs are as follows: the first column represents the project duration from start date to the project finish date; the second column represents the planned cumulative cost flow which was based on the project actual plan multiplied by the cost breakdown of the different items of costs; the third column represents the cost flow based on the actual executed project programme multiplied by the cost breakdown of the items costs, and the last column represents the actual payment made to the contractor. Results are shown in figure 9.7.

Fig. 9.7 Project forecast planning, works progress and payment received curves



It is clear from the results that the difference between the payment profiles, based on the planned progress and the other two, is significant. This is as a result of the delay in the start of the project, notwithstanding that the client did make an advance payment at the date of contract start. In addition, the project underwent considerable changes in the specifications of air conditioning, curtains, walls, light fixtures and furniture. These resulted in significant increases in the project value. However, the difference between the actual payment profile and that based on actual progress is very small, the model output calculations are shown in appendix (c). This confirms the reliability of the model.

Table (9.5) planning cost, adjustable planning cost and payment received

Forecasting cash flow (libyan dinar)						
Month	Planning programme		Progress programme		Actual payment	
	planning programme	Cumulative	progress payment	cumulative	payment received	Cumulative
1	142.81	142.81	0.00	0.00	0.00	0.00
2	239,386.44	239,529.25	0.00	0.00	239,062.50	239,062.50
3	8,741.90	248,271.15	0.00	0.00	0.00	239,062.50
4	19,357.91	267,629.07	110.15	110.15	0.00	239,062.50
5	45,678.00	313,307.07	320.11	430.26	0.00	239,062.50
6	60,915.29	374,222.36	677.38	1,107.64	0.00	239,062.50
7	66,975.97	441,198.34	1,113.81	2,221.45	0.00	239,062.50
8	75,490.57	516,688.91	1,077.88	3,299.32	0.00	239,062.50
9	82,463.30	599,152.21	1,113.81	4,413.13	0.00	239,062.50
10	69,283.25	668,435.45	1,345.13	5,758.27	0.00	239,062.50
11	60,078.21	728,513.66	1,304.17	7,062.44	0.00	239,062.50
12	61,098.72	789,612.37	1,614.66	8,677.10	0.00	239,062.50
13	84,990.25	874,602.62	1,191.73	9,868.83	0.00	239,062.50
14	114,606.27	989,208.89	1,097.94	10,966.76	0.00	239,062.50
15	118,281.44	1,107,490.33	4,520.36	15,487.12	0.00	239,062.50
16	104,804.88	1,212,295.20	11,046.33	26,533.45	25,400.00	264,462.50
17	87,580.49	1,299,875.70	31,243.25	57,776.70	30,100.00	294,562.50
18	66,855.52	1,366,731.22	37,928.15	95,704.85	32,000.00	326,562.50
19	55,368.49	1,422,099.71	78,608.76	174,313.61	70,500.00	397,062.50
20	37,426.41	1,459,526.12	82,598.65	256,912.26	70,500.00	467,562.50
21	17,617.99	1,477,144.10	90,665.76	347,578.02	85,000.00	552,562.50
22	4,680.67	1,481,824.78	103,651.30	451,229.31	95,850.00	648,412.50
23	258.99	1,482,083.77	131,552.06	582,781.37	110,500.00	758,912.50
24	79,687.50	1,561,771.27	149,141.29	731,922.66	110,500.00	869,412.50
25		1,561,771.27	147,759.26	879,681.92	110,500.00	979,912.50
26		1,561,771.27	186,725.92	1,066,407.84	170,500.00	1,150,412.50
27		1,561,771.27	237,498.47	1,303,906.31	190,800.00	1,341,212.50
28		1,561,771.27	234,261.81	1,538,168.12	190,800.00	1,532,012.50
29		1,561,771.27	250,990.47	1,789,158.59	190,800.00	1,722,812.50
30		1,561,771.27	204,997.30	1,994,155.89	190,800.00	1,913,612.50
31		1,561,771.27	189,355.76	2,183,511.65	170,500.00	2,084,112.50
32		1,561,771.27	146,684.39	2,330,196.04	135,700.00	2,219,812.50
33		1,561,771.27	132,433.19	2,462,629.23	92,800.00	2,312,612.50
34		1,561,771.27	99,720.17	2,562,349.40	92,800.00	2,405,412.50
35	31,870.41	1,593,641.68	49,987.49	2,612,336.89	95,470.00	2,466,212.50
36		1,593,641.68	39,664.67	2,652,001.56	85,650.00	2,551,862.50
37		1,593,641.68	20,211.53	2,672,213.09	91,900.00	2,643,762.50
			16,142.11	2,688,355.20	60,800.00	2,739,232.50

Fig. 9.8 Administrative buildings Gantt chart (planning)

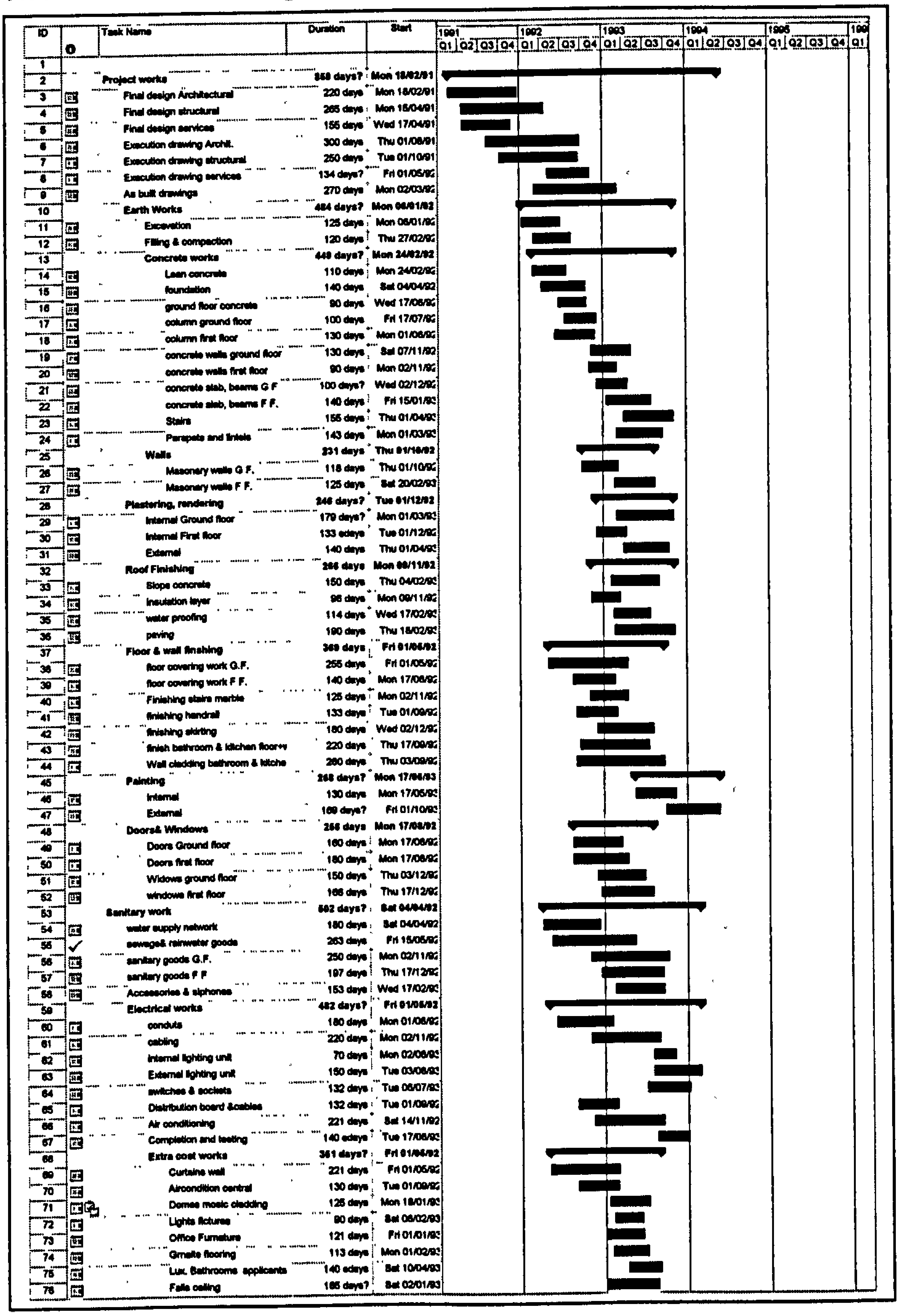
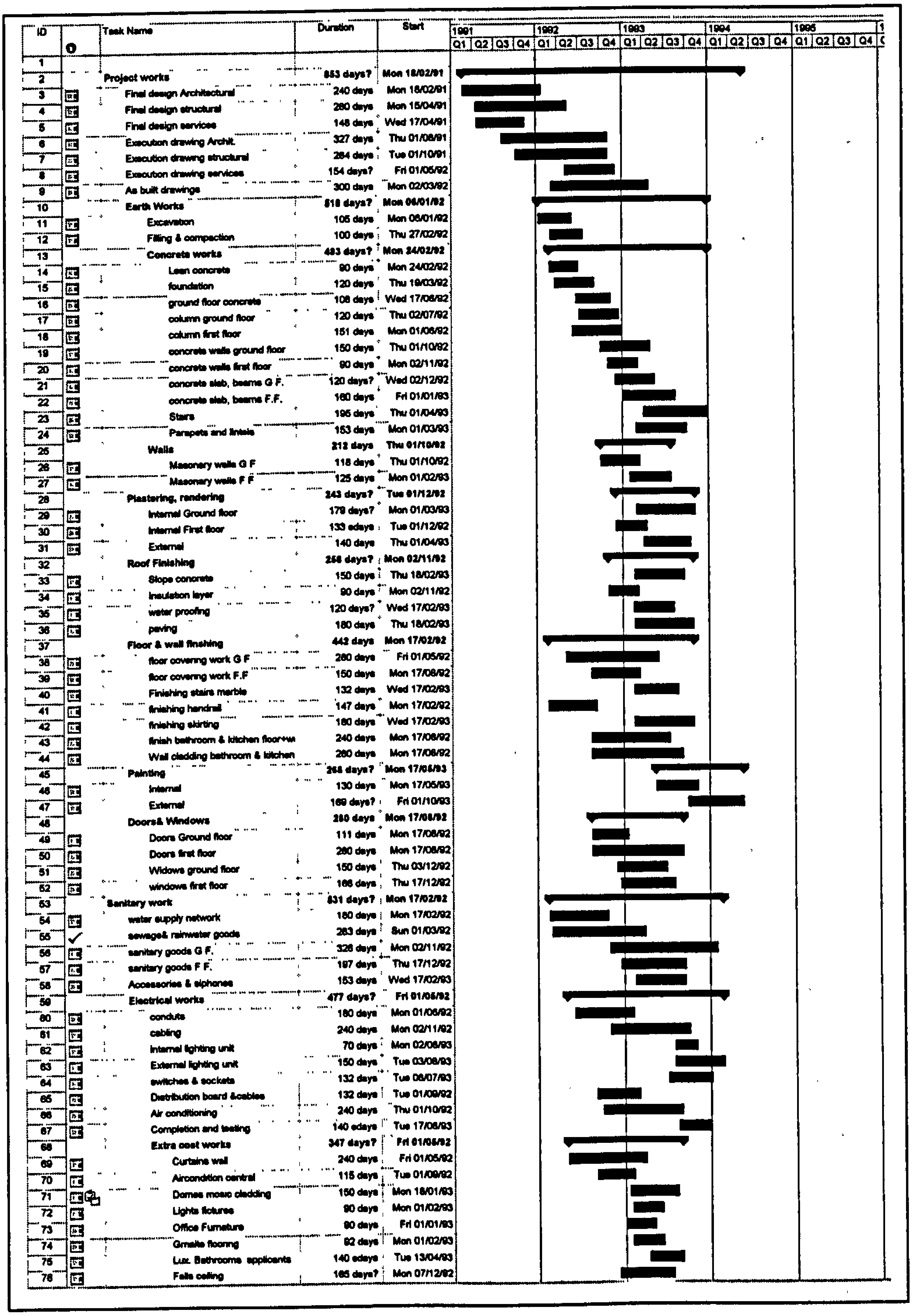


Fig. 9.9Administrative buildings Gantt chart (actual programme)



9.4 MODEL EVALUATION

After the validation of the reliability of the model, it is necessary to evaluate the effectiveness of the model in producing the cash flow forecasting.
First, the difference between results obtained using the model and the past projects actual payment profiles were analysed.
Second: the model was evaluated by an expert who commented on the design and on the model behaviour, and the results obtained.

9.5.1 Comparison of the model output and past projects

In validating a model, the model's output resulting from known inputs is compared with realisations of the reality, such as an ex-post forecast (Fellows and Liu, 2003). The model was used to simulate the cash flow by using past entry date to assess the extent to which the model output represented the actual project outcome, as shown in figures 9.4 and 9.7.

The cash flow model helps in assessing the size of the greatest negative and positive cash flows associated with a plan, and provides the basis for accurate decision regarding the financing of the project. When it is set up on a spreadsheet, a good cash flow forecasting model functions as an extremely effective tool, allowing the effect of variance in assumptions to be examined. A comparison was carried out between the actual progress of the work and the actual payment received by the contractor. It can be confirmed that the model produced excellent results in terms of accuracy and ease of use. Figure 9.7 above shows the comparison between the model's output and actual payment received for the administrative buildings project. From the figure it can be seen that the model's output (based on actual progress) is close to the actual payment profile. Although each of the three payment curves has an approximately S-shaped profile, the curve based on the planned progress is by no means close to the rest. In fact, a quick visual inspection of the curves suggests that there are significant differences, not only between the absolute curves, but also between the shapes themselves. However, in order for a meaningful examination to be conducted, the results have to be looked at from modelling and forecasting perspectives. A standard S-curve is usually expressed in terms of percentages of total cost and duration, and is only converted to absolute values when applied to a particular project. Also, the shape of a standard S-curve is usually expressed in terms of a mathematical model; that is, they are fitted to a mathematical expression whose parameters can be adjusted to suit particular projects. Most of the previous S-curve models have been developed using polynomial regression for the curve fitting and for representing the standard curves themselves. An alternative to the use of polynomial regression analysis for curve fitting is "logit transformation". This was initially proposed and used by Kenley and Wilson (1986) and later adopted by Kaka and Price (1993). The fitted curve that results from this transformation can be uniquely described by two- shape parameters- alpha and beta (α and β). It was decided to apply the same methodology in this research for the following reasons: the accuracy of the individual fits produced in the past value models demonstrated its efficiency; it is reliable, easy to understand and flexible; accuracy of fits in previous work was available for comparison. Therefore, in order to assess the effect of the three "different" programmes on the shape of the S-curve profiles, the total durations and costs of the projects were normalised. In order to do this all cost and time values were converted to percentages of their corresponding totals. The following step was to fit curves to these profiles using the logit transformation. The process of fitting these curves is as follows:

1- The linear equation is found by a logit transformation of both the independent and the dependent variables (in this case, time and cost respectively):

$$Logit = Ln \frac{Z}{1-Z}$$

where Z is the variable to be transformed and Logit is the transformation.

2- Once the two variables are transformed, a linear equation can be fitted into the transformed data and thus α and β can be found. This linear equation is expressed as follows:

$$Y = \alpha + \beta X$$

Where: $Y = Ln \dfrac{c}{100 - c}$ and $X = Ln \dfrac{t}{100 - t}$

3- The S-curve is then generated using the following equation;

$$C = \frac{100\ xF}{1 + F} \quad \text{where} \quad F = e^{\alpha} \left(\frac{t}{100 - t}\right)^{\beta}$$

Figures 9.12 and 9.13 show these fits were generated for planned, progress and actual payments curves.

4- the SDY is calculated using the following equation

$$SDY = \sqrt{(\Sigma(Y - YE)^2 / N}$$

where Y is the actual payment received

YE is the work progress payment

N is the number of observation (accounting periods).

9.5.2 Analysis of results

A common way of analysing the variability between curves is through the use of the standard deviation of the Y estimate (SDY measure). SDY is the standard deviation of the difference in Y-axis value (i.e. in this case percentage of total cost) between two curves at corresponding points (i.e. points of equal percentage of total time). This measure has been applied successfully to measure accuracy of fit of S-curve models as well as variability between S-curves (Kenley and Wilson, 1986; Kaka and Price, 1993). It was decided to adopt the SDY measure in this study.

The SDY value between individual fitted S-curves were hence calculated.

Figure 9.10 shows the group of fitted S-curves after the logit transformation has been applied. Visual examination of the curves yields the following:

Curves 2 and 3 are very similar, denoting that the payment profile generated from actual progress is very close to the actual payment profile.

The test was conducted to determine the variability between the shapes of the three fitted payment curves. SDY values were calculated for pairs of curves, and these values, presented as percentages of cost, are illustrated in table 9.7.

Any fitted process will result in some degree of error between the fitted curve represented by a mathematical expression and the original curve from which it was derived (i.e. there is rarely a perfect fit). Therefore a test was conducted to measure

SDY values between individual fits and their original curves derived directly from the model output. The aim of the test was to determine whether the error in fitting curves was higher or lower than the variability between individual payment curves. SDY values are presented in table 9.8. The range of SDY value obtained by comparing the original curves with fitted curves was within the range obtained by other researchers; for example, Kaka and Price (1993) quote the value between 4.9% and 38.8% for a group of projects. These show that the fitting technique applies to be accurate and that SDY values obtained were within the acceptable range specified by Kaka and Price (1993) and Kenley and Wilson (1986).

Fig. 9.10 Group of fitted payment curves.

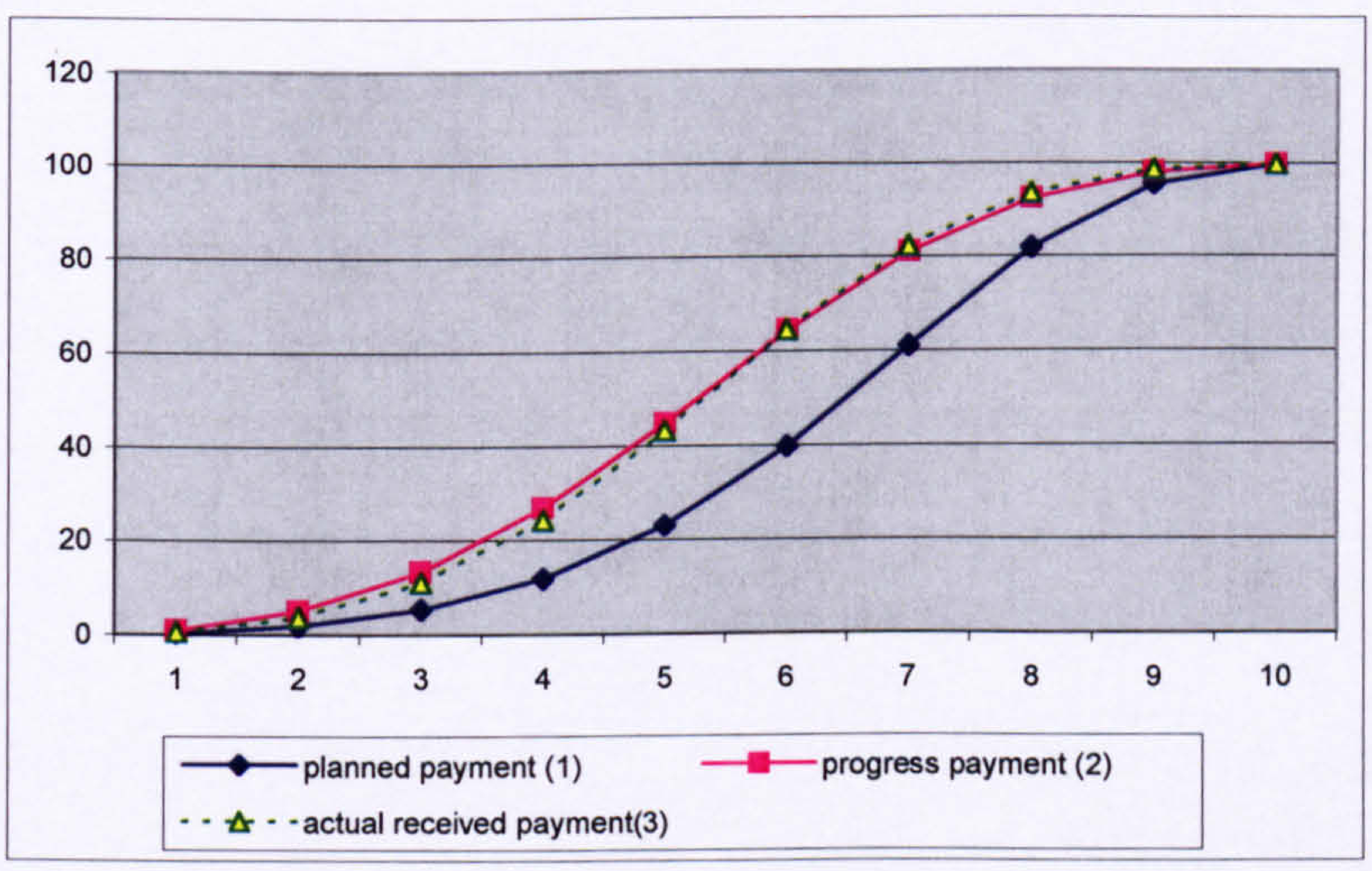


Table 9.6 α and β values

Curve	α	β
Planned payment	-0.077254	2.538176
Progress payment	-0.162253	0.9362941
Actual payment	-1.20315	1.9571252

Table 9.7 SDY values measuring the difference between the fitted S-curve

	Planned payment	Progress payment	Actual payment
Planned payment (1)	0.0		
Progress payment (2)	14.1683	0.0	
Actual received payment (3)	14.5837	1.5125	0.0

Fig. 9.11 progress and payment received

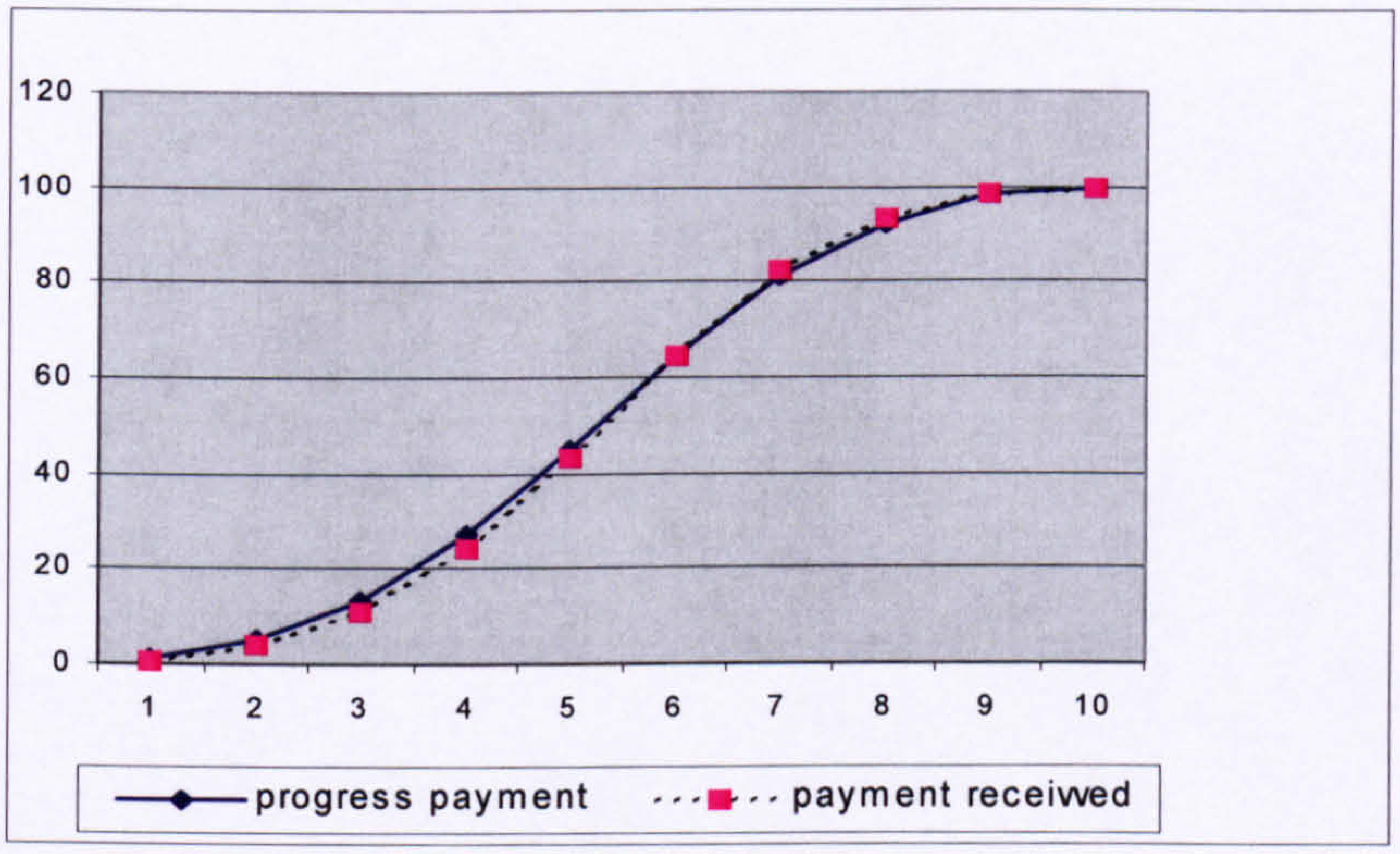


Fig. 9.12. Progress payment curve vs fitted curve

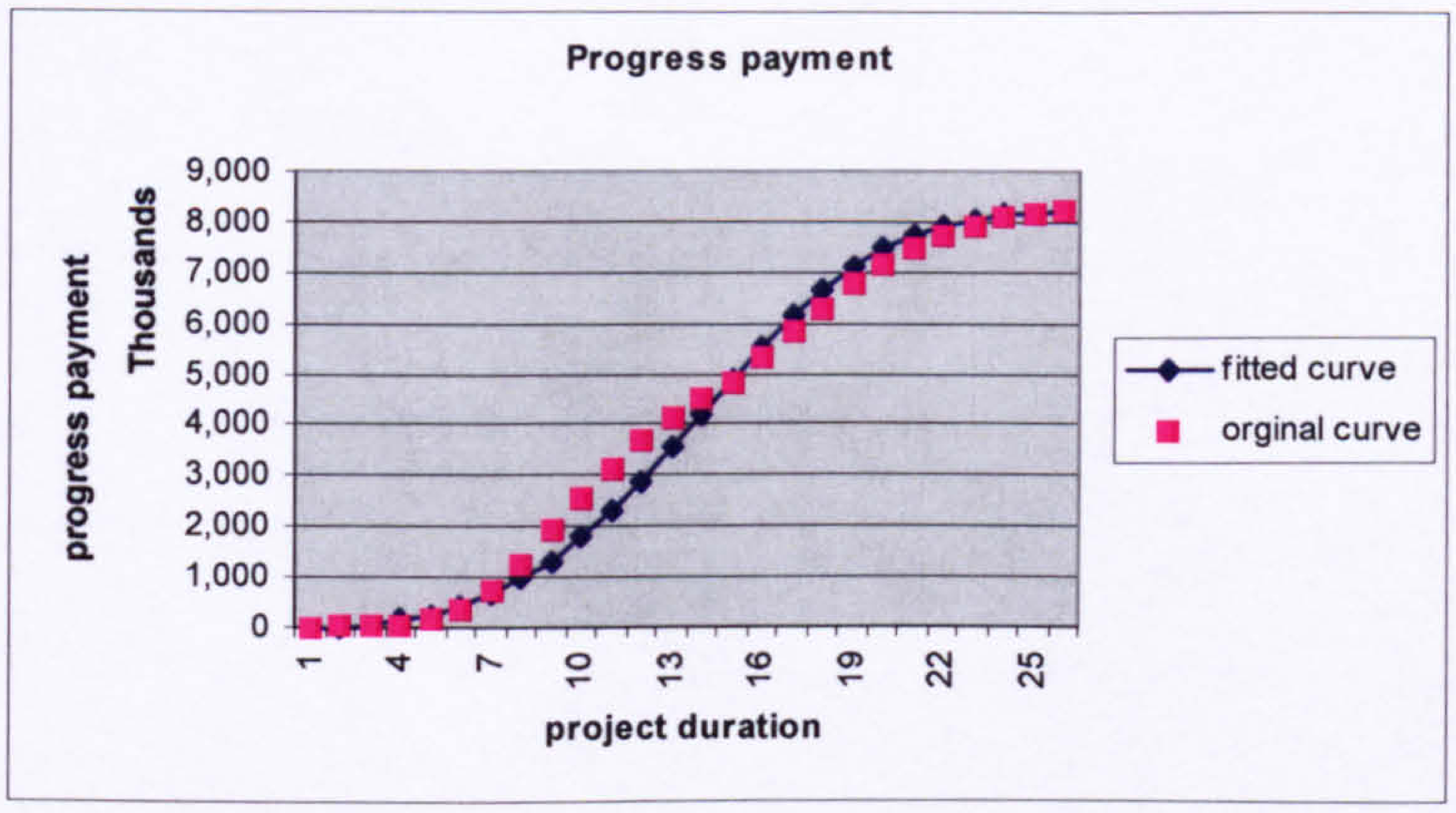


Fig. 9.13 Planned payment curve vs fitted curve

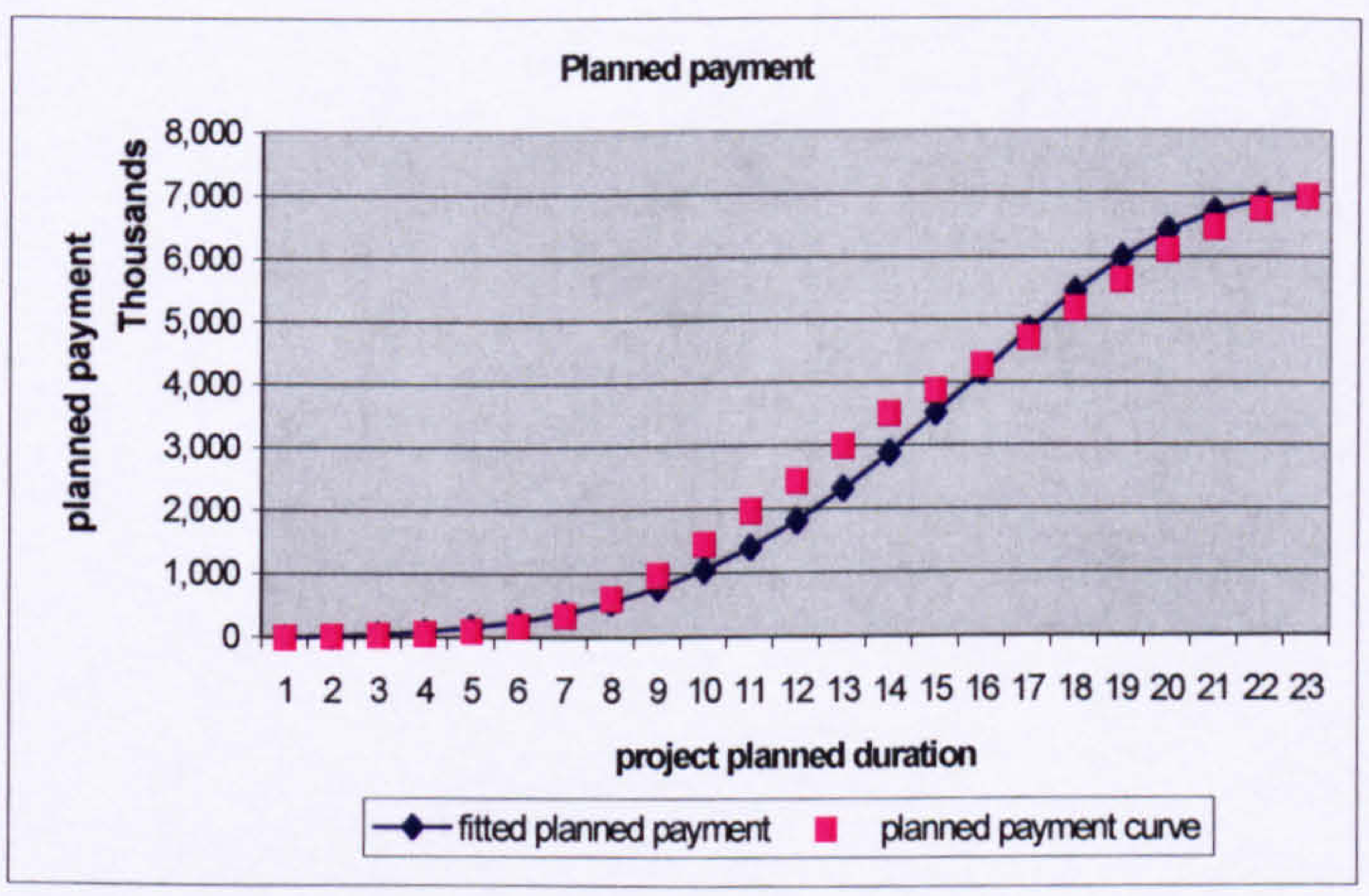


Fig. 9.14 Actual payment curve vs fitted curve

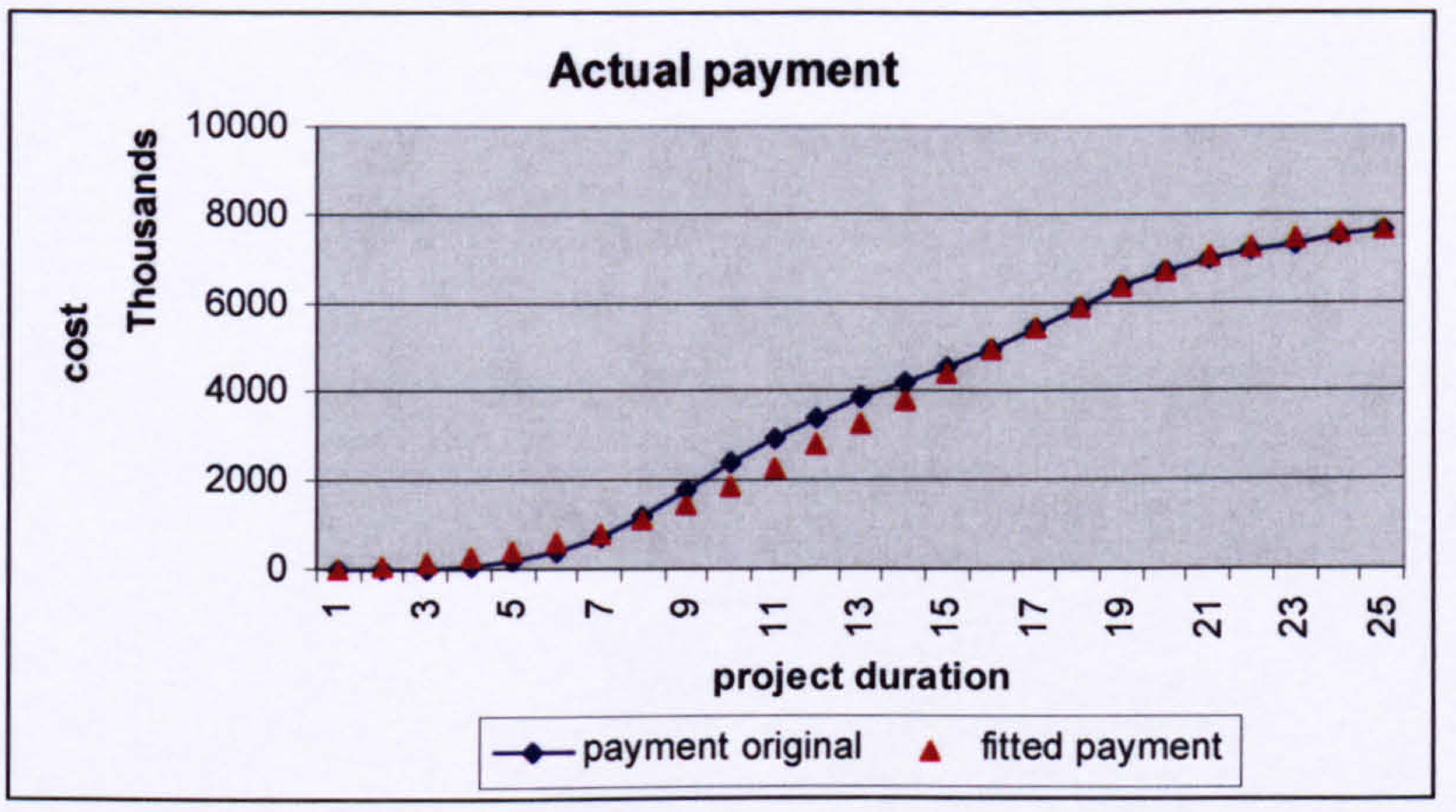


Table 9.8 SDY values for the individual curves and their fits curve

Planned payment	Progress payment	Actual payment
1.22844E-08	-0.00031	-0.00011
1.46713E-07	-0.001	-0.00031
6.33845E-07	-0.0019	-0.00054
1.81021E-06	-0.00285	-0.00075
4.11658E-06	-0.00365	-0.00091
8.08214E-06	-0.00406	-0.00098
1.42699E-05	-0.00372	-0.00087
2.31427E-05	-0.00213	-0.00052
3.47812E-05	0.001451	0.000205
4.83432E-05	0.008081	0.001474
6.11375E-05	0.01935	0.003529
6.73414E-05	0.037655	0.006729
5.74242E-05	0.066686	0.011606
2.42026E-05	0.112248	0.018973
3.07907E-06	0.183722	0.030105
0.000273271	0.296767	0.047061
0.002343611	0.478555	0.0733
0.014209757	0.778567	0.114914
0.083760953	1.292491	0.183259
0.585172558	2.220203	0.301148
6.427994972	4.024087	0.519103
242.8486603	7.93636	0.965209
	18.0088	2.036109
	53.16439	5.444564
10.86794626	3.408068	9.752292
SDY = 3.29665683	SDY = 7.291391	SDY= 2.333359

The model evaluation by an expert

Cash flow testing has become an increasingly important aspect of actuarial work in the construction industry. Cash flow forecasts are important tools for investigating whether a project or business is viable. They allow project teams to experiment with changing factors, to see the impact that this will have.

The model was presented to an expert who has long experience in managing construction projects. The aim was to make sure that the model's behaviour and functions are performing as designed. It was also to obtain the feedback on the model functionality. There was long discussion about the model, and the comments given by the expert were very constructive. Some of the comments and justifications are listed below.

The expert commented that the model's expectation that users should start the data entry through an MS project was appropriate, given that this may encourage the team to prepare the schedule programme for the project activities. This was so because most contractors before bidding should prepare the schedule programme for the project activities, in order to manage the resources availability within the activity duration, and address issues to do with overlapping activities.

One of the comments was about allocation of duties amongst the contractors. The expert raised the issue of how the model would perform if the contractor changes the work distribution after the contract is awarded. If the contractor wishes to change the work distribution after the works progress on site, then the model provides this flexibility to transfer the work package from one to another automatically by changing the symbol of the work distribution in the project, and then through the link provided between the MS project and Excel. The works will be reallocated according to the changes done.

The expert commended the model particularly for its flexibility in dealing with alternative payment methods. The model was developed to be flexible, and changes in the payment methods for the project are automatically processed. The model provides the contractors with a cash flow forecast based on the payment method to be selected. For example, when the contractor selects interim payments the model will provide a monthly payment profile for the works to be performed after subtracting the retentions and advance payment percentages. When selecting the stages payments method, the model will provide the cash flow forecast based on the stages assigned to the model and the payment profile will be based on the work progress achieved by the contractor.

To guarantee that the required materials are available when they are needed, the contractor may store materials on site several days in advance. This practice requires a material delivery before it is urgently needed. The model provides for advance materials purchase payment up to three months in advance to allow for contracts that do encourage the contractor to supply the materials to the site in advance. The model does this by adding (either partially or fully) the cumulative cost of materials for the following one to three months to the client payment forecast in that month. The expert practitioner recognised that this would be of significant sole to contractors, who are encouraged by clients to adopt lean strategies.

The practitioner also commented on the value of the model in allowing users to assess the impact of changes in the pricing system. The model provides flexibility in assessing changes in the pricing methods for the contractor and subcontractors, including unit rates and cost plus.

Finally, the practitioner considered the results of the research to be helpful, and it also contributed to the construction industry in the payment system selection which was previously unexplored.

9.5 SUMMARY

This chapter describes the process that was followed in order to validate and evaluate the model. Three stages were pursued: verification and debugging, validation, and evaluation.

The first stage was conducted simultaneously with the changing of variables of the payment system and contract conditions. The model was run with variations in input data and the researcher, together with an expert from the industry, confirmed that the model was behaving as expected.

Two cases studies were used to generate financial results. The model was used to simulate the cash flow by using a past entry date to assess the extent to which the model output represented the actual project outcome. The model was used to simulate the payment profile by using past entry project data. By analysing two past projects the model accuracy was confirmed. This was done by comparing model output for client's payment to contractors with the actual data provided from two actual construction projects.

In addition, the evaluation of the model was made with respect to its value and benefits to the construction industry. An expert practitioner confirmed that the proposed model would enable a project team to understand more the impact of an alternative payment system to their performance and financial positions.

Chapter 10

Conclusions and Recommendations

Contents

10.1 INTRODUCTION

This chapter sets out the main conclusions that have been drawn in connection with the aims and objectives that were established for the study in chapter (1).
In addition, the limitations of the study have been identified and a series of recommendations for further work in this topic area have been advanced.

The research problem addresses complex issues relating to the factor affecting the selection of building payment methods and pricing systems. It develops an understanding of how appropriate selection of building project payment system could take place. The methodology of the research evaluated the process that should be adopted when selecting an appropriate payment system based on project requirements. This study started with a survey to find out the factors influencing the selection of the payment system, then a decision aid tool was developed to help project teams select a suitable payment method and pricing system based on the project managers weightings for these factors. The last part of this research was the development of the cash flow model to enable the project team to assess the impact of the selected payment system on their individual cash flows.

10.2 GENERAL CONCLUSIONS

Identify the factors that affect the selection of building project payment system and developing decision aid tool for helping the user to select the suitable system was one of the main aims of this study. Lack of understanding is the major reason why construction projects participants often use the traditional payment system without thinking of evaluating alternative options of payments that match project characteristics. Many researchers on the other hand, have provided tools to select a suitable procurement system e.g. NEDO (1985), Skitmore and Marsden (1988), Luu T. D. et al.(2003), (Love et al.1998), (Love 2002). This study was concerned with the development of an understanding of how payment system selection is affected by the project characteristics, and users' attitudes and their consciousness of priority ratings of the relevant influencing factors.

This research initially mapped out the various building procurement system available and found that the traditional payment system does not cater for the many drivers for the more innovative procurement processes. The study also examines some of the widely applied forms of contracts. It was clear from the literature review that forms of contracts do allow for alternative payment or pricing systems to be adopted. Nevertheless, it was evident that the traditional payment system (unit price plus interim payments) was overwhelmingly applied. This was mainly due to lack of understanding of other payment systems, and perhaps more importantly, the inability to relate project characteristics to an appropriate payment method.

Two questionnaires were design and used to elicit views and opinions from the construction Industry. The first questionnaire was prepared to identify the significant factors that have an impact on the selection of payment systems. A Likert scale (1-5) was applied to determine the importance of each factor. Chapter (6) presents the analysis of the first survey which led to the second survey.

The second questionnaire consisted mainly of the significant factors for each element of the payment system. Respondents were asked to score the utility coefficient for each factor on scale of 10 to 110. A decision aid tool was developed to help project teams to determine the suitable payment method and, pricing system for a given project. The user provides the priority rating (in terms of weightings) for each factor and the tool finds out the suitable payment system for the project. Results showed that the mailed questionnaire to be a very useful and appropriate tool for the collection of such information. Construction contractors suffer from many financial problems, which often lead them to bankruptcy. These problems are due the unsuitability of the selection of the procurement system and/or payment system.

Through cash flow forecasting the decision maker of a contraction company can identify any likely cash flow problems well in advance and arrangements for acquiring funds from outside can be made to avoid financial problems from accruing in the company. The decision maker provided with such information, can always choose not to accept the work even in the case of high potentials for profit. These problems can be addressed by providing a cash flow model to help the contractors to assess the cash flow.

The following part of the research was the development of the cash flow forecasting model that will not only enable project teams to assess the impact of payment systems on cash flow, but also to aid in the definition and fine tuning of the payment system. The model takes in to account the several alternative payment systems currently being applied in the construction industry. This model produced accurate results and when demonstrated to a practitioner it was commended for its ease of use. Also the model provided a comprehensive cash flow forecasts including the cash flow for the client contractors and subcontractors.

Microsoft suit of packages was selected for the model development in order to facilitate a link between a spreadsheet model and project planning model. Microsoft Project provides a project planning in the form of Gantt chart that automatically linked into an Excel sheet. Excel is one of the most suitable tools for providing financial based calculation and results easily generated in the form of graphs and tables. The cash flow model was developed using Excel 2000 which has proved to be an efficient tool for modelling and simulating complicated contracting financial transactions.

10.3 RESEARCH OBJECTIVES

The research was driven by four main objectives as following:

- identifying the different construction projects' payment systems currently being adopted in industry;
- identifying the factors influencing the selection of a suitable payment system;
- developing a decision aid tool for selecting payment and pricing methods;
- developing a cash flow model that will enable project teams to forecast their individual cash flow based on different types of payment systems.

The following lists some of the main conclusion of the study:

- As a result of this study it can be concluded that there were several payment systems currently being adopted in construction industry but a few of them were widely used. This is due to the fact that projects participants and particularly clients lack the understanding of how to relate project characteristics to the different payment systems.

- Influencing factors, which were identified throughout the nationwide survey, effected payment systems selection to a different degree. Results of the analysis of the influencing factors and their impact on the payment and pricing systems were discussed and it was found that affected the selection process the most.
- 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 derive utility coefficient values. This technology has been successfully applied in previous construction management research and in particular to aid procurement system selection. The results of the survey together with the developed model were validated by an experienced practitioner. The main findings here where that the cost plus system was more appropriate and suitable for large and complex projects which have high degree for changes in specifications and design. Milestones were found to be more suitable for medium and completed design project and also where there is no expectation for changes in design and specifications.
- The need for cash flow forecasting is given as providing a good warning system to predict possible insolvency, which enables preventive measures to be considered and taken at right time. The main objective of the model is to enable clients, contractors and subcontractors to simulate alternative payment and pricing systems. The proposed cash flow forecasting model is designed for use at the tendering stage with the ability to assess the input of alternative payment systems. It is based on the detailed approach (project plan) and hence it is important that the added value of the proposed model is demonstrated so that project teams do put the effort in using such a tool. The proposed model also provides the client, the contractor and subcontractor with their individual cash flow profiles resulting from the payment and pricing systems being considered and the other influencing contract conditions. The user accordingly assesses the results for the most appropriate payment system he/she may consider modifying some of the contract conditions to achieve a fair and favorable cash flow for all.

- The model was used to simulate the cash flow by using past entry project data. By analysing two completed projects the model accuracy was confirmed. This was done by
  comparing model output with the actual data provided from two actual construction projects. The model was presented to an expert who has long experience in managing construction projects.

10.4 CONTRIBUTION AND APPLICATIONS OF THE RESEARCH

The main contribution of the research is the development of decision aid tool to help project teams select a suitable payment method and pricing system. Furthermore, the research developed a cash flow forecasting model to enable the project team to assess the impact of the selected payment system on their individual cash flows. The contribution of the research with respect to these models is outlined with some recommendations.

10.4.1 The decision aid tool model

One of the most widely used techniques for deciding alternatives with multiple objectives is Multi-Attribute Utility Theory (MAUT). The multi-attribute utility theory (MAUT) has been used to develop the aid decision tool to help project teams to select the most appropriate payment and pricing systems. The tool consists of a set of selection criteria, utilities coefficients and a categorisation of various payment method or pricing system currently being applied in the construction industry. A spreadsheet based model was designed to assist the project manager to do the calculations. The user insert the rate of significance (a score 1 to 20) of each factor for a particular construction project and the model calculates the priority rating for each payment system and provides in rank order, the most suitable systems. In total thirteen factors and three payments and pricing system options were considered in the decision aid tool. Industry feedback suggested that this is practically feasible and does not require project team significant amount of time to complete.

10.4.2 Cash flow model

The research has clearly established the need for a new cash flow model that can be applied to help construction teams in selecting the most appropriate payment system for a particular project. The developed model provides the client, contractor and subcontractors with their individual cash flow profiles resulting from the payment and pricing systems being considered and the other influencing contract conditions. The model also enables the user to simulate and manipulate detailed cash flow variables such as the advance payment, retention money, materials purchase, and labour payment delay. These are considered part of the process of defining or fine-tuning the payment system. The model developed in this research offers a simple and accurate approach providing project teams with their financial positions during the project period. There are many variables that add to the flexibility of the model and hence different output could be provided for the alternative strategies project teams may wish to examine. In the validation process, the data entry was varied within practical limits. Variations in entry data and output results were measured and discussed with an expert practitioner. The model was used to simulate the cash flow by using past entry date to assess the extent to which the model output represented the actual project outcome. The model was tested on two case studies and was shown to produce accurate results. A comparison was carried out between the actual progress wok and the actual payment paid to contractor curves to measure the accuracy of the model.

10.5 LIMITATION OF THE STUDY

The following lists the limitations of the study: -

1- The questionnaires survey were undertaken in the UK and only 24 responses were obtained. The low rate of response (27%) reflects the lack of experience of applying alternative payment systems. Whilst there is an evidence to suggest that practitioners in different countries would convey different opinion and judgement, the results of this research cannot be confidently be applied internationally.
2- The literature review highlighted several payment and pricing systems available to the industry. This research has only considered interim, lump sum (one payment) and milestone (stages payment) for payment and cost plus, lump sum and unit rate for pricing.

3- The concept of the cash flow forecasting model was based on the fact that project teams should consider individual cash flow positions for all core members of the supply chain and not just client vs. contractor. This research have made a novel contribution of including subcontractors cash flow. However designers and suppliers were left outside to scope of the study.

10.6 RECOMMENDATIONS FOR FURTHER WORK

The following recommendations for further works have been advanced following considerations to this study and its acknowledged limitations, and they include:

- The nationwide survey could be expanded to include practitioners in different countries.
- The determination of the relationship between payments systems and project characteristics and objectives provides a benchmark for further studies on a global scale, to establish a wider perspective on payment system selection, and the usefulness of alternative types of selection tools.

- The cash flow forecasting model currently is restricted to the construction phase and hence it needs to be developed further to apply for the long- term projects such as PFI, and PPP given the increased use of these procurement system..

- The cash flow model is based on only limited payment methods and pricing system other systems lies outside the scope of this research. In addition, the model assumes that the cost activities are uniformly distributed along their durations. In real life this may not be the case given the variation in productivity and the work associated with each activity. It is recommended therefore that an investigation of the impact of other payment systems on the cash flow profiles is undertaken with the possibility of further model development. Furthermore, mathematical expression to allow for variations of activities rates of progress may be included in the model to enable the user to reflect these possible variations the link between the variations in productivity and activities duration.

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Appendix (a)
Questionnaire (1)

Dear Sir/madam

An assessment of alternative innovative payment & pricing mechanism in construction contracts

I am currently carrying out research work as a postgraduate student in Heriot-Watt university. Leading to the award of the degree of doctor of philosophy (PhD) under the supervision Prof. A.P. Kaka.

The research is aimed at developing a decision-aid model that will assist project managers to select an appropriate payment system for a particular project. The system will be based on the needs of the construction project and its participants.
We have defined payment systems in terms of three layers: pricing mechanism, payment methods and cash flow factors. The following list are some of the alternative pricing mechanisms and payment methods.

1- pricing Mechanism e.g.	2- payment methods e.g.	3-cash flow factors
lump sum price	advance payment	retention money
re-measurement contract (BoQ)	interim payment	valuation claims
cost-plus fees	incentives payments	payment delay
cost-plus incentives	milestone payments	payment materials on
fixed/standard rates	Lump sum	site.
(schedule rates)	(one payment)	
Others	others	others

I enclose a draft list of the factors which we believe to have an influence on the selection of appropriate payment system. I would very much appreciate if you could indicate your own assessment of the effect of these factors on each of the three layers, where -1- has the negligible effect & -5- has significant effect. Pleas feel free to add other influencing factors.

I would like to take the opportunity to thank you in anticipation of your valued co-operation.

Yours faithfully

E.Sherif

Please return back your answers by the attached envelope.

No	Factors influencing selection	Payment methods					Pricing mechanism					Cash flow				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1-	**Time certainty** Completion by certain time is estimated	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
2-	**Cost certainty** Completion by certain cost is estimated	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
3-	**Project size (value)**	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
4-	**Project complexity** Advanced technologically	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
5-	**Project type** (Commercial, industrial ...etc.)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
6-	Project duration	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
7-	Contractor(s) cash flow	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
8-	**Contractor(s) experience** In payment system	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
9-	**Client experience** In payment system	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
10-	**Contracts form** (JCT, NEC, FIDIC, ...etc	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
11-	**Tendering time** availability	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
12-	**Quality** standards, prestige	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
13-	**Economic conditions** (Inflation, strikes, etc)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
14-	**Tender documents** Completing , ...	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
15-	**Speed** (during design & construction)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
16-	Procurement system Traditional, D&B, etc	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
17-	Disputes likelihood	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

No	Factors influencing selection	Payment methods					Pricing mechanism					Cash flow				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
18-	**Tender Methods** (open, selected, negotiation)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
19-	Extent of competition	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
20-	**Flexibility** to accommodate design changes	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
21-	Contractor qualification	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
22-	Risk allocation	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
23-	Value for money	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
24-	Site condition	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
25-	Site location	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
26-	Project security level	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
27-	Flexibility in Working time	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
28-	Peer relationship (partnership, previous jobs	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
29-	Allocation of Responsibility	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
30-	Client reputation	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
31-	project budget availability	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
32-	Integrated Project Team	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
33-	Investment in Briefing	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
34-	No blame culture															
35-	Authority of the Project Manager.	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

	The Factors	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	mean score
1	TimeCertainty	4	4	5	4	4	5	5	5	3	4	3	3	4	5	4	4	5	3	4	5	4	1	4	3	3.96
2	Costcertainty	4	4	3	4	5	5	4	5	4	3	2	2	5	5	4	4	3	5	5	5	4	4	4	3	4.00
3	Flexibilityto accom. Cha	3	1	3	4	2	3	1	4	2	1	5	2	3	3	3	1	3	4	3	3	3	4	2	2	2.83
4	Projectsize	4	1	1	2	3	4	3	4	3	1	5	3	2	1	5	3	2	1	3	4	3	2	5	1	2.75
5	Projectcomplexity	3	5	1	3	2	4	1	2	3	2	1	3	2	4	1	3	4	2	1	4	3	2	4	3	2.63
6	ProjectType	3	1	2	4	3	3	3	1	4	1	5	2	2	1	2	3	5	2	4	3	3	3	3	4	2.79
7	Projectduration	2	1	3	1	3	4	1	2	4	2	3	2	1	2	3	1	2	4	3	1	3	2	4	3	2.38
8	ContractocashFlow	4	5	3	4	4	3	5	5	4	4	5	4	4	1	2	3	4	3	4	5	5	4	5	5	3.96
9	ContractorExper.	4	2	1	3	4	3	4	4	3	1	5	2	4	2	3	4	1	2	3	2	3	3	3	2	2.83
10	ClientExperience	4	1	3	3	1	2	3	4	1	4	2	2	4	1	2	3	3	2	2	1	3	2	3	4	2.50
11	ContractForm	4	5	2	4	3	3	4	2	4	4	5	5	3	3	4	3	5	3	5	4	4	4	5	4	3.83
12	TenderingTime	2	2	1	2	3	2	5	1	2	3	5	2	4	1	2	3	4	1	3	2	3	2	2	2	2.46
13	Quality of project	3	2	2	5	3	3	4	2	3	3	5	2	3	1	4	3	3	4	3	2	3	2	4	2	2.96
14	EconomicCondition	3	2	4	4	1	2	3	2	3	3	5	2	1	3	2	3	1	5	2	4	1	1	4	2	2.63
15	Tenderdocuments	3	4	2	5	2	2	4	1	2	3	5	1	2	4	4	2	3	3	5	2	3	3	2	2	2.88
16	Speed (D&C)	3	4	1	5	3	3	5	4	3	4	5	2	4	4	5	4	4	5	3	4	5	4	3	5	3.83
17	Procurementsystem	1	3	2	4	1	3	2	4	3	1	2	2	4	2	3	4	3	4	2	4	3	3	4	3	2.79
18	DisputesLikelihood	4	5	5	4	4	4	4	5	3	4	5	2	5	4	4	5	3	5	4	5	4	4	3	3	4.08
19	TenderMethods	4	3	1	5	3	4	4	2	3	1	5	2	2	2	5	3	2	1	3	2	4	2	2	4	2.88
20	Extentofcompetition	3	3	2	4	3	4	4	2	2	1	5	2	4	2	1	4	3	5	3	4	3	2	3	2	2.96
21	ContractorQalification	4	2	1	1	2	4	3	1	1	1	5	2	4	1	4	2	2	4	3	2	3	2	3	2	2.46
22	Riskallocation	5	4	2	5	3	4	4	5	3	4	5	3	4	4	5	5	4	2	5	3	4	4	5	4	4.00
23	Valueformoney	3	2	2	1	3	5	4	2	3	2	5	1	3	4	5	3	3	2	2	3	3	4	3	2	2.92
24	Sitecondition	4	1	1	1	4	3	1	4	2	1	5	1	1	2	3	2	3	4	3	2	2	2	1	3	2.33
25	SiteLocation	1	2	2	3	1	4	3	2	2	1	5	1	2	1	3	1	2	2	3	2	3	2	3	2	2.21
26	ProjectSecuritylevel	3	1	1	5	3	4	3	2	2	2	5	1	1	1	3	2	3	2	1	4	1	2	2	3	2.38
27	Flexibilityinworktime	3	4	1	4	2	3	2	1	2	2	3	2	4	1	1	3	4	2	3	3	2	2	3	3	2.50
28	Peerrelationship	3	3	3	4	4	3	3	2	4	1	5	2	1	2	2	1	2	3	2	3	1	3	4	2	2.74
29	Allocationofresponsibilit	2	1	2	4	2	4	1	4	2	2	5	2	2	3	1	4	3	2	4	4	1	4	2	4	2.83
30	Clientreputation	2	4	1	2	4	3	1	4	2	3	1	2	3	2	3	4	1	3	3	2	2	4	3	2	2.65
31	Projectbudgetavailability	3	2	3	1	4	4	4	2	4	2	5	2	2	4	1	3	2	4	3	2	1	4	2	3	2.91
32	IntegratedProjectteam	0	0	0	0	3	1	2	1	2	1	5	2	1	1	2	3	1	4	2	3	1	4	2	3	2.32
33	Investmentinbriefing	1	2	1	2	1	1	2	5	2	3	5	1	3	1	3	1	1	2	1	3	3	1	2	2	2.58
34	Noblameculture	0	0	0	0	3	3	1	3	2	2	5	1	1	4	3	2	4	2	4	2	5	2	3	2	2.84
35	Authorityofproject	0	0	0	0	3	1	2	1	2	3	5	2	1	2	3	2	4	3	2	3	4	2	3	3	2.68

	The Factors	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	mean score
1	Time Certainty	2	1	3	4	2	4	1	3	2	4	3	4	2	3	2	3	1	4	3	2	3	4	3	4	2.79
2	Cost certainty	5	4	5	4	3	5	5	4	4	5	5	2	5	2	5	4	3	4	5	5	4	3	5	4	4.17
3	Flexibility design change	5	1	3	2	4	1	4	5	3	5	2	3	3	1	3	2	3	5	3	2	3	2	2	1	2.83
4	Project size	2	5	4	5	4	4	3	4	5	4	5	3	2	4	3	4	5	4	5	3	4	5	4	3	3.92
5	Project compexity	2	4	1	5	2	4	1	3	4	2	5	3	2	1	3	1	4	3	4	1	3	2	4	1	2.71
6	Project Type	2	4	2	4	4	3	3	3	4	2	5	2	2	1	3	4	2	3	2	3	4	3	2	1	2.83
7	Project duration	2	3	1	3	4	2	4	2	4	2	5	2	2	4	2	3	3	1	4	2	3	4	3	1	2.75
8	Contractor cash Flow	4	5	5	3	4	3	4	3	4	4	5	2	5	4	4	3	5	3	5	4	5	5	4	3	4.00
9	Contractor Exper.	4	2	3	3	4	3	2	1	3	1	5	2	4	1	3	4	2	5	3	3	1	3	4	3	2.88
10	Client Experience	4	2	1	3	4	3	1	4	3	4	3	2	4	1	4	3	4	1	4	2	3	2	3	1	2.75
11	Contract Form	4	5	5	4	4	3	3	2	4	4	5	5	3	3	5	3	5	4	5	3	5	4	2	5	3.96
12	Tendering Time	5	2	1	5	2	4	2	5	4	1	5	2	4	1	2	1	3	1	3	2	4	3	2	3	2.79
13	project Quality	5	2	4	5	2	3	2	4	3	2	5	1	3	2	3	1	3	4	1	3	2	5	2	3	2.92
14	Economic Condition	5	2	3	4	3	4	3	4	2	3	3	1	2	3	2	3	1	3	5	1	2	2	3	5	2.88
15	Tender documents	3	4	2	1	2	2	4	5	2	3	1	5	2	3	2	4	1	5	2	3	4	1	4	2	2.79
16	Speed	5	1	2	5	3	2	5	1	2	4	2	5	1	3	4	3	2	4	2	3	1	5	3	4	3.00
17	Procurement system	4	5	3	5	3	4	1	4	4	5	5	4	5	5	4	3	4	5	4	3	5	4	4	3	4.00
18	Disputes Likelhood	4	4	3	5	3	4	5	5	3	4	5	4	5	3	2	5	2	5	4	3	5	3	5	5	4.00
19	Tender Methods	5	4	4	5	3	5	5	4	4	1	5	5	2	5	3	2	3	4	2	5	3	5	4	2	3.75
20	Extent of competetion	3	2	2	5	3	4	4	4	4	1	5	2	4	2	4	2	1	2	1	2	3	2	2	2	2.75
21	Contractor Qalification	4	1	5	4	3	4	4	4	1	1	5	1	3	1	1	2	1	3	2	3	2	1	2	1	2.46
22	Risk allocation	5	5	3	5	2	5	4	5	4	5	5	4	4	3	5	3	4	3	4	2	4	2	5	2	3.88
23	Value for money	4	5	5	4	3	5	3	4	4	5	5	3	4	2	5	3	5	4	5	4	2	5	5	2	4.00
24	Site condition	4	1	2	1	4	3	2	4	2	1	5	1	2	1	3	2	1	2	4	1	2	1	2	1	2.17
25	Site Location	1	2	4	1	4	4	3	2	4	2	5	1	2	1	3	2	2	1	2	1	2	2	1	1	2.21
26	Project Security level	3	1	1	5	3	4	4	2	4	1	5	1	1	1	3	2	3	2	1	1	1	2	2	3	2.33
27	Flexibility in work time	4	2	1	4	3	4	2	1	4	2	5	2	4	1	3	2	2	1	1	2	2	3	2	3	2.50
28	Peer relationship	3	4	4	4	4	4	3	5	4	1	5	3	1	1	2	3	2	3	2	2	1	1	2	3	2.79
29	Allocation of responsibil	3	4	2	5	3	4	4	4	4	1	5	3	2	2	2	2	3	3	2	2	2	1	3	3	2.88
30	Client reputation	3	2	3	5	4	3	3	4	4	2	5	1	3	1	3	4	3	1	3	1	1	2	2	3	2.75
31	Project budget availabili	3	5	5	3	4	4	4	5	2	4	5	4	2	5	5	4	3	4	5	2	5	4	5	4	4.00
32	Integrated Project team	1	1	2	1	1	2	2	2	3	2	3	2	1	2	3	2	2	4	2	1	1	2	1	1	2.75
33	Investment in briefing	3	2	3	2	4	1	3	5	2	3	5	1	3	1	3	1	4	2	1	3	3	1	4	3	3.94
34	No blame culture	2	1	2	1	2	1	1	3	2	1	5	2	1	2	2	2	1	3	1	2	3	2	3	2	2.94
35	Authority of project man	1	2	2	4	1	2	2	1	3	2	5	1	1	2	3	2	3	1	3	1	2	1	2	1	3.00

	Payment methods			
	Factors	mean scor	Idex	Ranking
1	Time Certainty	4.0833	0.816667	2
2	Disputes Likelihood	4.0833	0.816667	2
3	Cost certainty	4.0000	0.8	4
4	Risk allocation	4.0000	0.8	4
5	Contractor cash Flow	3.9583	0.791667	5
6	Contract Form	3.8333	0.766667	6
7	Speed	3.1236	0.62472	7
8	Investment in briefing	3.1053	0.621053	8
9	Quality	2.9583	0.591667	10
10	Extent of competition	2.9583	0.591667	10
11	Value for money	2.9167	0.583333	11
12	Project budget availability	2.9130	0.582609	12
13	Tender Methods	2.8750	0.575	14
14	Tender documents	2.8750	0.575	14
15	No blame culture	2.8421	0.568421	15
16	Contractor Exper.	2.8333	0.566667	16
17	Flexibility	2.8261	0.565217	18
18	Allocation of responsibility	2.8261	0.565217	18
19	Procurement system	2.7917	0.558333	20
20	Project Type	2.7917	0.558333	20
21	Project size	2.7500	0.55	21
22	Peer relationship	2.7391	0.547826	22
23	Authority of project	2.6842	0.536842	23
24	Client reputation	2.6522	0.530435	24
25	Economic Condition	2.6250	0.525	26
26	Project complexity	2.6250	0.525	26
27	Flexibility in work time	2.5000	0.5	28
28	Client Experience	2.5000	0.5	28
29	Contractor Qalification	2.4583	0.491667	30
30	Tendering Time	2.4583	0.491667	30
31	Project Security level	2.3750	0.475	32
32	Project duration	2.3750	0.475	32
33	Site condition	2.3333	0.466667	33
34	Integrated Project team	2.3158	0.463158	34
35	Site Location	2.2083	0.441667	35

pricing system

Factors	mean scor	Idex	Ranking
Cost certainty	4.166667	0.833333	1
Contractor cash Flow	4	0.8	4
Procurement system	4	0.8	4
Disputes Likelhood	4	0.8	4
Value for money	4	0.8	4
Project budget availability	4	0.8	4
Contract Form	3.958333	0.791667	7
Project size	3.916667	0.783333	8
Risk allocation	3.875	0.775	9
Tender Methods	3.75	0.75	10
Investment in briefing	3.0625	0.6125	11
Speed	3	0.6	13
Authority of project	3	0.6	13
No blame culture	2.9375	0.5875	14
Quality	2.916667	0.583333	16
Flexibility	2.916667	0.583333	16
Contractor Exper.	2.875	0.575	18
Economic Condition	2.875	0.575	18
Flexibility	2.833333	0.566667	20
Project Type	2.833333	0.566667	20
Time Certainty	2.791667	0.558333	23
Tendering Time	2.791667	0.558333	23
Tender documents	2.791667	0.558333	23
Peer relationship	2.791667	0.558333	23
Project duration	2.75	0.55	27
Client Experience	2.75	0.55	27
Extent of competetion	2.75	0.55	27
Client reputation	2.75	0.55	27
Integrated Project team	2.75	0.55	27
Project compexity	2.708333	0.541667	30
Site condition	2.583333	0.516667	31
Flexibility in work time	2.5	0.5	32
Contractor Qalification	2.458333	0.491667	33
Project Security level	2.333333	0.466667	34
Site Location	2.208333	0.441667	35

The Factors	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	mean score
SiteLocation	1	2	2	3	1	4	3	2	2	1	5	1	2	1	3	1	2	2	3	2	3	2	3	2	2.21
IntegratedProjectteam	0	0	0	0	3	1	2	1	2	1	5	2	1	1	2	3	1	4	2	3	1	4	2	3	2.32
Sitecondition	4	1	1	1	4	3	1	4	2	1	5	1	1	2	3	2	3	4	3	2	2	2	1	3	2.33
Projectduration	2	1	3	1	3	4	1	2	4	2	3	2	1	2	3	1	2	4	3	1	3	2	4	3	2.38
ProjectSecuritylevel	3	1	1	5	3	4	3	2	2	2	5	1	1	1	3	2	3	2	1	4	1	2	2	3	2.38
TenderingTime	2	2	1	2	3	2	5	1	2	3	5	2	4	1	2	3	4	1	3	2	3	2	2	2	2.46
ContractorQalification	4	2	1	1	2	4	3	1	1	1	5	2	4	1	4	2	2	4	3	2	3	2	3	2	2.46
ClientExperience	4	1	3	3	1	2	3	4	1	4	2	2	4	1	2	3	3	2	2	1	3	2	3	4	2.50
Flexibilityinworktime	3	4	1	4	2	3	2	1	2	2	3	2	4	1	1	3	4	2	3	3	2	2	3	3	2.5000
Investmentinbriefing	1	2	1	2	1	1	2	5	2	3	5	1	3	1	3	1	1	2	1	3	3	1	2	2	2.5789
Projectcomplexity	3	5	1	3	2	4	1	2	3	2	1	3	2	4	1	3	4	2	1	4	3	2	4	3	2.6250
EconomicCondition	3	2	4	4	1	2	3	2	3	3	5	2	1	3	2	3	1	5	2	4	1	1	4	2	2.6250
Clientreputation	2	4	1	2	4	3	1	4	2	3	1	2	3	2	3	4	1	3	3	2	2	4	3	2	2.6522
Authorityofproject	0	0	0	0	3	1	2	1	2	3	5	2	1	2	3	2	4	3	2	3	4	2	3	3	2.6500
Peerrelationship	3	3	3	4	4	3	3	2	4	1	5	2	1	2	2	1	2	3	2	3	1	3	4	2	2.7391
Projectsize	0	1	1	2	3	4	3	4	3	1	5	3	2	1	5	3	2	1	3	4	3	2	5	1	2.5833
ProjectType	3	1	2	4	3	3	3	1	4	1	5	2	2	1	2	3	5	2	4	3	3	3	3	4	2.7917
Procurementsystem	1	3	2	4	1	3	2	4	3	1	2	2	4	2	3	4	3	4	2	4	3	3	4	3	2.7917
Flexibilityto accom. Changes	3	1	3	4	2	3	1	4	2	1	5	2	3	3	3	1	3	4	3	3	3	4	2	2	2.8261
Allocationofresponsibility	2	1	2	4	2	4	1	4	2	2	5	2	2	3	1	4	3	2	4	4	1	4	2	4	2.8261
ContractorExper.	4	2	1	3	4	3	4	4	3	1	5	2	4	2	3	4	1	2	3	2	3	3	3	2	2.8333
Noblameculture	0	0	0	0	3	3	1	3	2	2	5	1	1	4	3	2	4	2	4	2	5	2	3	2	2.8421
Tenderdocuments	3	4	2	5	2	2	4	1	2	3	5	1	2	4	4	2	3	3	5	2	3	3	2	2	2.8750
TenderMethods	4	3	1	5	3	4	4	2	3	1	5	2	2	2	5	3	2	1	3	2	4	2	2	4	2.8750
Projectbudgetavailability	3	2	3	1	4	4	4	2	4	2	5	2	2	4	1	3	2	4	3	2	1	4	2	3	2.9130
Valueformoney	3	2	2	1	3	5	4	2	3	2	5	1	3	4	5	3	3	2	2	3	3	4	3	2	2.9167
Quality of project	3	2	2	5	3	3	4	2	3	3	5	2	3	1	4	3	3	4	3	2	3	2	4	2	2.9583
Extentofcompetition	3	3	2	4	3	4	4	2	2	1	5	2	4	2	1	4	3	5	3	4	3	2	3	2	2.9583
ContractForm	4	5	2	4	3	3	4	2	4	4	5	5	3	3	4	3	5	3	5	4	4	4	5	4	3.8333
Speed (D&C)	3	4	1	5	3	3	5	4	3	4	5	2	4	4	5	4	4	5	3	4	5	4	3	5	3.8333
TimeCertainty	4	4	5	4	4	5	5	5	3	4	3	3	4	5	4	4	5	3	4	5	4	1	4	3	3.9583
ContractocashFlow	4	5	3	4	4	3	5	5	4	4	5	4	4	1	2	3	4	3	4	5	5	4	5	5	3.9583
Costcertainty	4	4	3	4	5	5	4	5	4	3	2	2	5	5	4	4	3	5	5	5	4	4	4	3	4.0000
Riskallocation	5	4	2	5	3	4	4	5	3	4	5	3	4	4	5	5	4	2	5	3	4	4	5	4	4.0000
DisputesLikelihood	4	5	5	4	4	4	4	5	3	4	5	2	5	4	4	5	3	5	4	5	4	4	3	3	4.0833

The Factors	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	mean score
Site condition	4	1	2	1	4	3	2	4	2	1	5	1	2	1	3	2	1	2	4	1	2	1	2	1	2.17
Site Location	1	2	4	1	4	4	3	2	4	2	5	1	2	1	3	2	2	1	2	1	2	2	1	1	2.21
Project Security level	3	1	1	5	3	4	4	2	4	1	5	1	1	1	3	2	3	2	1	1	1	2	2	3	2.33
Contractor Qalification	4	1	5	4	3	4	4	4	1	1	5	1	3	1	1	2	1	3	2	3	2	1	2	1	2.45
Flexibility in work time	4	2	1	4	3	4	2	1	4	2	5	2	4	1	3	2	2	1	1	2	2	3	2	3	2.50
Investment in briefing	3	2	3	2	4	1	3	5	2	3	5	1	3	1	3	1	4	2	1	3	3	1	4	3	2.63
Project compexity	2	4	1	5	2	4	1	3	4	2	5	3	2	1	3	1	4	3	4	1	3	2	4	1	2.71
Project duration	2	3	1	3	4	2	4	2	4	2	5	2	2	4	2	3	3	1	4	2	3	4	3	1	2.75
Client Experience	4	2	1	3	4	3	1	4	3	4	3	2	4	1	4	3	4	1	4	2	3	2	3	1	2.75
Extent of compotetion	3	2	2	5	3	4	4	4	4	1	5	2	4	2	4	2	1	2	1	2	3	2	2	2	2.75
Client reputation	3	2	3	5	4	3	3	4	4	2	5	1	3	1	3	4	3	1	3	1	1	2	2	3	2.75
Integrated Project team	1	1	2	1	1	2	2	2	3	2	3	2	1	2	3	2	2	4	2	1	1	2	1	1	2.75
Time Certainty	2	1	3	4	2	4	1	3	2	4	3	4	2	3	2	3	1	4	3	2	3	4	3	4	2.79
Tendering Time	5	2	1	5	2	4	2	5	4	1	5	2	4	1	2	1	3	1	3	2	4	3	2	3	2.79
Tender documents	3	4	2	1	2	2	4	5	2	3	1	5	2	3	2	4	1	5	2	3	4	1	4	2	2.79
Peer relationship	3	4	4	4	4	4	3	5	4	1	5	3	1	1	2	3	2	3	2	2	1	1	2	3	2.79
Project Type	2	4	2	4	4	3	3	3	4	2	5	2	2	1	3	4	2	3	2	3	4	3	2	1	2.83
Contractor Exper.	4	2	3	3	4	3	2	1	3	1	5	2	4	1	3	4	2	5	3	3	1	3	4	3	2.88
Economic Condition	5	2	3	4	3	4	3	4	2	3	3	1	2	3	2	3	1	3	5	1	2	2	3	5	2.88
Allocation of responsibility	3	4	2	5	3	4	4	4	4	1	5	3	2	2	2	2	3	3	2	2	2	1	3	3	2.88
project Quality	5	2	4	5	2	3	2	4	3	2	5	1	3	2	3	1	3	4	1	3	2	5	2	3	2.92
No blame culture	2	1	2	1	2	1	1	3	2	1	5	2	1	2	2	2	1	3	1	2	3	2	3	2	2.94
Speed	5	1	2	5	3	2	5	1	2	4	2	5	1	3	4	3	2	4	2	3	1	5	3	4	3.00
Authority of project manage	1	2	2	4	1	2	2	1	3	2	5	1	1	2	3	2	3	1	3	1	2	1	2	1	3.00
Flexibility design change	5	2	3	2	5	2	5	5	3	5	2	3	3	2	3	2	3	5	3	2	3	2	2	2	3.08
Tendor Methods	5	4	4	5	3	5	5	4	4	1	5	5	2	5	3	2	3	4	2	5	3	5	4	2	3.75
Risk allocation	5	5	3	5	2	5	4	5	4	5	5	4	4	3	5	3	4	3	4	2	4	2	5	2	3.88
Project size	2	5	4	5	4	4	3	4	5	4	5	3	2	4	3	4	5	4	5	3	4	5	4	3	3.92
Contract Form	4	5	5	4	4	3	3	2	4	4	5	5	3	3	5	3	5	4	5	3	5	4	2	5	3.96
Contractor cash Flow	4	5	5	3	4	3	4	3	4	4	5	2	5	4	4	3	5	3	5	4	5	5	4	3	4.00
Procurement system	4	5	3	5	3	4	1	4	4	5	5	4	5	5	4	3	4	5	4	3	5	4	4	3	4.00
Disputes Likelhood	4	4	3	5	3	4	5	5	3	4	5	4	5	3	2	5	2	5	4	3	5	3	5	5	4.00
Value for money	4	5	5	4	3	5	3	4	4	5	5	3	4	2	5	3	5	4	5	4	2	5	5	2	4.00
Project budget availability	3	5	5	3	4	4	4	5	2	4	5	4	2	5	5	4	3	4	5	2	5	4	5	4	4.00
Cost certainty	5	4	5	4	3	5	5	4	4	5	5	2	5	2	5	4	3	4	5	5	4	3	5	4	4.17

2.77
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3.95
3.91
3.86
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3.96
4.00
4.14

FACTORS INFLUENCING THE SELECTION OF PAYMENT SYSTEMS IN CONSTRUCTION PROJECTS

Elhadi Sherif[1] and Ammar Kaka

School of the Built Environment. Heriot-Watt University, Edinburgh EH14 4AS, UK

Construction contracts are fundamental to any project, and the selection of an appropriate payment system is vital given that the ultimate success of any construction project depends on the suitability of the selected payment system to the project's characteristics and client's requirements. In this paper we have defined the payment system in terms of four layers as Payment mechanism, Pricing mechanism, Payment chain (who pays who), and Other Cash-flow factors. In order to develop a tool that will help the project team to select an appropriate payment system, a list of factors that influence the selection process was created. The most influential factors were identified using a U.K based nation-wide postal survey. In this questionnaire the opinions of different types of organizations- consultants, contractors and clients were collected and assessed. The results showed that different factors were perceived to influence the selection of each layer linking the payment system. According to the results a total of seventeen factors were found to influence the selection process. This paper presents the work, which is part of an ongoing PhD study.

Keywords: cash flow, payment mechanism, pricing system.

INTRODUCTION

In the construction industry it is often said that 'cash is king' and in construction contracting cash is the contractors' (and the subcontractors') number one concern. Over the years, contractors have come up with many innovative ways of enhancing cash flow. Some of these ways have been found through implementing more efficient management processes and information systems, thereby allowing contractors to minimize the outstanding balances owed by clients. Others have been found through adapting pricing policies (e.g. unbalancing and front-end loading) or somewhat unfair procedures such as over-measurement and the delaying of payments to subcontractors and suppliers. In the UK, the normal practice in the construction industry is for the contractor to price the products and services provided based on unit rates and quantities. The contractor is then paid monthly and the value of these payments is determined by agreement between the respective quantity surveyors of the employer and the contractor. Payment systems based on measurement are approaches that neither require detailed and time-consuming management and neither reward achievement nor distinguish between the inefficient and the efficient contractor. Crucially, this is a system that does not help to deliver value for money. Indeed, from a wider supply chain perspective, the conventional payment mechanism places a considerable and unfair strain on particular parties and thus on the overall spirit of team working, partnering and supply chain management called for by Egan and others. The current payment system has not been designed to cater for the 'newer'

Appendix (b)
Questionnaire (2)

HERIOT WATT UNIVERSITY

Dear Sir or Madam:

Develop Decision support tool for the selection of appropriate payment &pricing mechanism in construction projects.

I am currently carrying out research work as a postgraduate student in Heriot-Watt University. Leading to the award of the degree of doctor of philosophy (PhD).

The research is aimed at developing a decision-aid model that will assist project managers to select an appropriate payment system for a particular project. The system will be based on the needs of the construction project and its participants.
We have defined payment systems in terms of three layers: pricing mechanisms, payment methods and cash flow factors. The following lists some of the alternative pricing mechanisms and payment methods.

1- **Pricing mechanism** e.g.

* Lump sum price
* Re-measurement contracts (B&Q)
* Cost-plus fees
* Cost-plus incentives
* Fixed / standard rates (schedule rates)
* Others

2- **Payment methods e.g.**

* Interim +advance payment
* Interim payment
* Milestone payments (stage)
* Lump sum (one) payments

others

I enclose a list of the factors, which were identified in the first questionnaire to have an influence on the selection of appropriate payment systems. I would very much appreciate it if you could indicate your own assessment by scoring the payments system against the listed factors, where -10- represents low suitability and, 110 represents significant suitability. Please feel free to add your remarks and comments.

I would like to take the opportunity to thank you in anticipation of your valued co-operation[1].

Yours faithfully

E. Sherif

Payment Methods

Could you please Score the payment methods against the factors pe have an Impact on the selection of a payment method using a scale where 10 represents " low suitability and 110 represents " significant

No	Factors	Payment Methods		
		Intrim (m Payment	Lump su payment	Milestone Payment
1	**Time Certainty** Time certainty is crucial to client satisfaction and project success.			
2	**Cost certainty** Cost certainty is cruial to client satisfaction and project success.			
3	**Contractor cash flow** How important is the selection of payment methods help the contractor cash flow.			
4	**Contract Form** The suitability of payment methods to each of the following forms of contracts.			
	a- G.C (general works contract)			
	b- others ( ) Pls specify			
5	**Speed (during D & C)** Project needs to be completed quickly.			
6	**Disputes Likelihood** To which exten these payment methods help to avoid or limit disputes.			
7	**Risk Allocation** To what extent these payments methods help the client to avoid or transfer the risk to contractors.			

Could you please Score the pricing Mechanisms against the factors perceived to I an impact on the selection of a pricing systems using a scale of 10-110 where 10 represents " low suitability and 110 represents " significant suitability"?

No	Factors	Pricing Mechanism			
		cost plus fees	Unit rates	Lump sump price	
1	**Cost certainty** Cost certainty is cruial to client satisfaction and project success.				
2	**Project size** The suitability of different price Mechanisms to the different projects size				
	i- Small projects (less than 0.5 M)				
	ii- Medium size (from 0.5- 2.5 M)				
	iii- Large size (over 2.5M)				
3	**Project Complexity** Building with high specifications and Technologically demanding				
4	**Contractor cash flow** How Important is the selection of pricing Mechanism in helping contractors cash flow.				
5	**forms of Contracts** The suitability of pricing Mechanisms to each of the following contract forms.				
	a- G.C (General works contract).				
	b- Others ( )				
6	**Flexibility** Flexibility in accomodating design changes is crucial to the success of the project.				
7	**Risk allocation** To what extent these pricing mechanism help the client to avoid or transfer the risk to contractors				

No	Factors	Pricing Mechanism			
		cost plus fees	Fixed Price	Lump sum price	
8	**Disputes Limits** To which extent pricing mechanism will help to avoid or limit disputes.				
9-	**Procurement Systems** The suitability of pricing mechanisms to each the following procurement system				
	a- D & B (design &Build)				
	b- Traditional (B.&Q.)				
	e- Turnkey				
	f- Others ( ) pls. specify				
10-	**Tendering time** Limited time is avaliable to contractors to tender for the project.				
11-	**Tendering Methods** The suitability of pricing mechanisms to each of the following tendering methods.				
	a- open method				
	b- Negotiate tender				
	c- Selected tender.				
12-	**Value for Money** The suitability of pricing mechanisms in helping to obtain value for money.				
13-	**Project Budget availablity** There is uncertainty in terms of budget availability. (client cash flow needed to suport project)				

B & Q : Bill of Quantities
D & B : Design and build
G.C: General Works Contract

Reference no	/Q2
Prepared by	
company	
date	/03

Appendix (b)

HERIOT WATT UNIVERSITY

Mrs. Mc Geechie

216 west george street

Glasgow

G2 2PQ

30.09.03

Questionnaire

Reference to telephone conversation held on Monday 29th September 03 regarding the above subject, I would like to thank you in advance for sparing the time to fill-up the attached questionnaire.
Note: the information will use as academic purpose only

Sincerely yours,

E.sherif

School of the Built Environment
Heriot-Watt University.
Edinburgh

Mr. Stewert Sobb

1 Pinkhill, Corstorphine

Edinburgh

EH12 7BA

30.09.03

Questionnaire

Reference to telephone conversation held on Monday 29th September 03 regarding the above subject, I would like to thank you in advance for sparing the time to fill-up the attached questionnaire.
Note: the information will use as academic purpose only

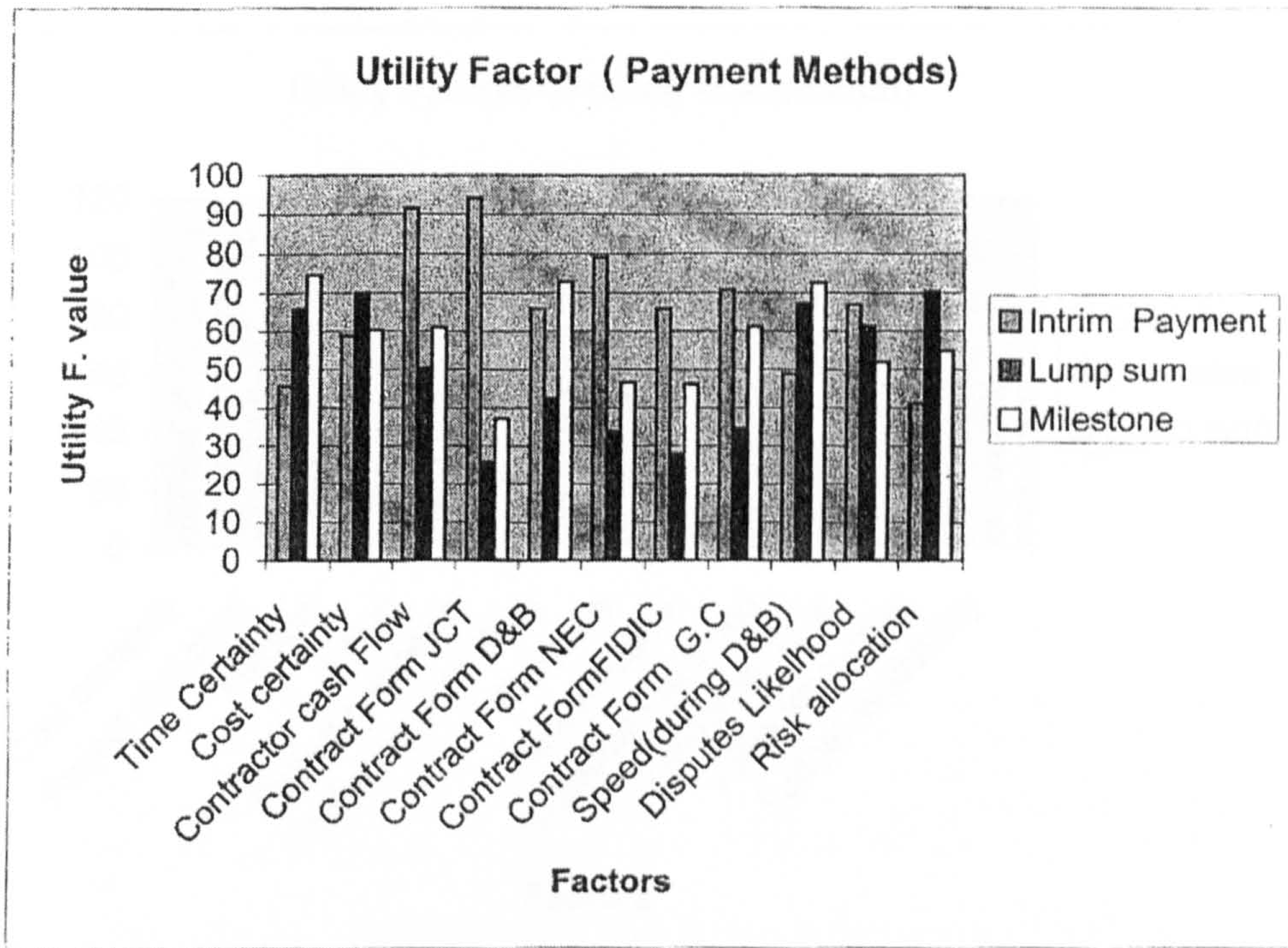
Sincerely yours,

E.sherif

School of the Built Environment
Heriot-Watt University.
Edinburgh

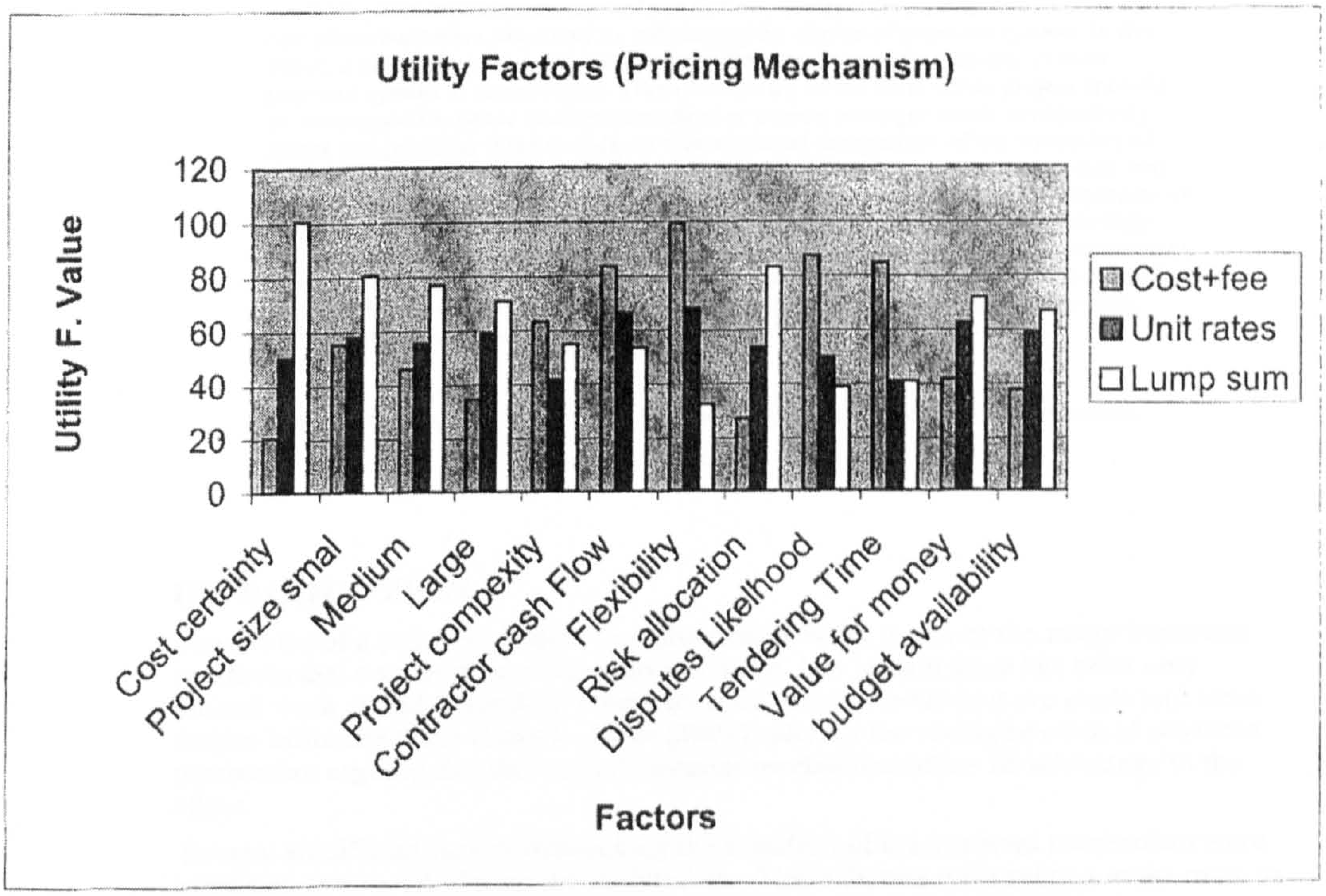
Utility Factors (Payment Methods)

Factors	Intrim Payment	Lump sum	Milestone
Time Certainty	45.77	65.77	74.62
Cost certainty	58.85	70.00	60.38
Contractor cash Flow	91.54	50.38	61.15
Contract Form JCT	94.17	25.83	37.08
Contract Form D&B	65.83	42.50	72.92
Contract Form NEC	79.17	33.75	46.67
Contract FormFIDIC	65.83	27.92	46.25
Contract Form G.C	70.83	34.58	61.25
Speed(during D&B)	48.85	67.31	72.69
Disputes Likelhood	66.92	61.54	51.92
Risk allocation	41.15	70.38	55.00



Utility Factors (Pricing Mechanism)

Factors	Cost+fee	Unit rates	Lump sum
Cost certai	21	50	101
Project siz	55	58	81
Medium	46	56	77
Large	35	59	71
Project cor	63	42	55
Contractor	83	67	53
Flexibility	100	68	33
Risk alloca	27	53	83
Disputes L	87	50	39
Tendering	85	41	41
Value for n	42	63	72
budget ava	38	59	67



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

El-hadi Sherif[1] and Ammar Kaka

School of the Built Environment. Heriot-Watt University. Edinburgh EH14 4AS, UK

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.

[1] E.sherif@hw.ac.uk

Sherif, E-h and Kaka, A (2004) A multi criteria mode for the selection of the payments systems in construction projects. *In:* Khosrowshahi, F (Ed.), *20th Annual ARCOM Conference*, 1-3 September 2004, Heriot Watt University. Association of Researchers in Construction Management, Vol. 1, 163-72.

Appendix (c)

Administrative buildings project
Cash flow calculations

£0.00	£0.00	£0.00	£110.15	£320.11	£309.79	£320.11	£309.79	£320.11
£0.00	£0.00	£0.00	£0.00	£0.00	£138.51	£274.07	£265.23	£274.07
£0.00	£0.00	£0.00	£0.00	£0.00	£229.08	£519.62	£502.86	£519.62
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
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£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00

actual programme cash flow
Administrative buildings project

£320.11	£309.79	£320.11	£309.70	£320.11	£172.53 0	0	0	
£274.07	£265.23	£274.07	£265.23	£274.07	£274.07	£256.30	£274.07	£265.23
£519.62	£502.86	£519.62	£129.21 0	0	0	0	0	
£231.32	£220.29	£233.84	£226.29	£233.84	£233.84	£218.75	£233.84	£220.20
£0.00	£0.00	£207.01	£261.21	£269.91	£269.91	£252.50	£269.91	£261.21
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£148.81	£148.46
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£3,570.00	£4,033.64	£4,311.82	£4,172.73
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£260.14	£2,977.67	£2,881.61
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£221.51	£1,211.78	£1,172.69
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£5,474.60	£12,960.15
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£2,276.79	£5,572.13	£5,392.39
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1,903.39	£5,057.58	£4,894.43
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
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£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£493.88	£1,208.72	£1,109.72
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1,133.33	£2,773.68	£2,684.21
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1,730.64	£1,693.01
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00

actual programme cash flow
Adminstrative buildings project

0	0	0	0	0	0	0	0	0	
	£85.15 0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	
	£233.64	£226.20	£233.64	£233.64	£226.29	£224.09 0	0	0	
	£269.91	£261.21	£269.91	£269.91	£261.21	£258.67 0	0	0	
	£490.17	£479.51	£495.50	£495.50	£479.51	£495 50	£479.51	£27.31 0	
	£153.41	£148.46	£153.41	£153 41	£148.46	£153.41	£148.46	£153.41	£153.41
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£3,993.07 0	0	0	0	0	0	0	0	
	£2,977.67	£2,881.61	£1,412.79 0	0	0	0	0	0	
	£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0 00
	£1,211.78	£1,004.93 0	0	0	0	0	0	0	
	£13,398.36	£12,966.15	£13,398.36	£13,398.36	£738.35 0	0	0	0	
	£0.00	£1,704.06	£4,003.44	£4,003.44	£3,874.29	£4,003.44	£1,641.19 0	0	
	£0.00	£0.00	£3,419.22	£3,572.89	£3,457.64	£3,572.89	£3,457.64	£1,810.46 0	
	£0.00	£0.00	£1,344.89	£2,842.61	£2,750.91	£2,842.61	£2,750.91	£2,842.61	£2,842.61
	£0.00	£0.00	£0.00	£0.00	£4,783.34	£4,898.32	£4,837.06	£4,898.32	£4,898 32
	£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£8,964.56	£9,894.24	£9,894.24
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£17,098.11	£17,804.47
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£13,241.93
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£6,747.32	£7,560.25	£7,560.25	£7,316.37	£7,560.25	£3,000.30 0	0	
	£0.00	£0.00	£2,606.70	£7,165.52	£6,934.37	£7,165.52	£6,934.37	£7,165.52	£1,781.75
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£2,028.11	£2,959.94	£2,864.45	£2,959.94	£2,864.45	£2,959.94	£2,959.94
	£5,572.13	£5,092.81 0	0	0	0	0	0	0	
	£5,057.58	£4,894.43	£5,057.58	£5,010.00 0	0	0	0	0	
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£3,746.41	£3,664.98	£3,787.13	£3,787.13	£3,664.96	£3,787.13	£3,664.96	£3,787.13	£3,787.13
	£0.00	£0.00	£0.00	£2,817.96	£5,764.01	£5,956.15	£5,764.01	£5,956.15	£5,956 15
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£1,208.72	£1,169.72	£1,208.72	£1,208.72	£300.55 0	0	0	0	
	£0.00	£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£350.55	£717.10	£741.00	£717.10	£741.00	£741.00
	£0.00	£0.00	£0.00	£600.32	£1,227.93	£1,208.86	£1,227.93	£1,268.86	£1,268.86
	£0.00	£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00	£0.00
	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0 00	£0 00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£3,240.32	£6,627.94	£6,848.87	£6,627.94	£6,848.87	£3,012.32
	£0.00	£0.00	£0.00	£1,284.89	£2,627.77	£2,715.36	£2,627.77	£2,715.36	£2,715 36
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£7,004.61	£7,574.64
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3,242.95	£6,854.42
	£0.00	£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00	£0.00
	£2,773.68	£2,684.21	£2,773.68	£2,773.68	£2,684.21	£2,031.80 0	0	0	
	£1,749.45	£1,693 01	£1,749.45	£1,749.45	£1,693.01	£1,749.45	£1,693.01	£1,749.45	£1,749.45
	£0.00	£0.00	£0.00	£0.00	£0 00	£0.00	£1,755.76	£1,898.68	£1,898.68
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1,192.71	£2,520.96
	£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£1,900.79	£2,080.26	£2,080.26	£2,013.16	£2,080.26	£2,013.16	£2,080.26	£2,080.26
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1,438.08	£1,556.10	£1,556.10
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£4,612.18	£4,714.98	£4,562.88	£4,714.98	£4,714.98
	£0.00	£0.00	£0.00	£0.00	£0.00	£14,573.24	£14,256.43	£14,731.64	£14,731.64
	£0.00	£0.00	£0.00	£0 00	£0.00	£0 00	£0.00	£0.00	£0.03
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£35,704.44	£34,928.25	£36,092.53	£36,092.53	£34,928 25	£36,092 53	£34,928.25	£36,092.53	£36,092 53
	£0.00	£0.00	£0.00	£0.00	£30,055.77	£32,347.04	£31,303.59	£32,347.04	£32,347.04
	£0.00	£0.00	£0 00	£0.00	£0 00	£0 00	£0.00	£0.00	£11,028.48
	£0 00	£0.00	£0.00	£0 00	£0 00	£0.00	£0.00	£0.00	£0 00
	£0.00	£0.00	£0 00	£0 00	£0.00	£0.00	£0 00	£0.00	£27,268.14
	£0.00	£0.00	£0 00	£0 00	£0.00	£0.00	£0 00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£12,049.81	£15,143.68

actual programme cash flow
Adminstrative buildings project

0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
£138.57	£153.41	£112.38 0	0	0	0	
£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	
0	0	0	0	0	0	
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
£1,073.62 0	0	0	0	0	0	
£4,514.61	£4,628.82 0	0	0	0	0	
£8,758.09	£1,472.38 0	0	0	0	0	
£16,135.65	£17,804.47	£17,288.20	£10,204.84 0	0	0	
£12,090.45	£13,385.86	£12,954.06	£13,385.86	£12,054.06	£13,385.86	£5,056.68
£3,181.19	£3,842.21	£3,718.27	£3,842.21	£3,718.27	£3,842.21	£3,842.21
£0.00	£6,963.90	£6,812 51	£7,039.59	£6,812.51	£7,039.58	£7,039.59
0	0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
£0.00	£0.00 0	0	0	0	0	
£2,873.49	£736.01 0	0	0	0	0	
0	0	0	0	0	0	
0	0	0	0	0	0	
£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00
£1,014.93	£2,949.63	£2,864.48	£2,949.63	£2,834.48	£2,949.63	£2,949.63
£1,853.81	£4,925.85	£4,768.95	£4,925.85	£3,449.42 0	0	
£1,358.63	£3,689.79	£3,570.78	£3,689.79	£3,570.76	£3,689.79	£322.38
£845.35	£2,456.80	£2,377.55	£2,456.80	£2,377.55	£2,456.80	£2,460.80
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0 00
£3,420.63	£3,787.13	£3,664.98 -	£3,262.84 0	0	0	
£5,379.75	£2,249.57 0	0	0	0	0	
£1,520.96	£4,041.41	£3,911.04	£4,041.41	£3,911 04	£4,041.41	£2,438.97
0	0	0	0	0	0	
£730.68	£1,965.44	£1,902.04	£1,965.44	£1,902.04	£1,965.44	£1,965.44
£669.29	£741.00	£717.10	£741.00	£717.10	£376.48 0	
£1,148.07	£1,268.88	£1,227.93	£1,268.88	£1,227.93	£1,268.88	£1,268.88
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£4,104 88	£8,396.34	£8,676.22	£8,676.22
£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00
0	0	0	0	0	0	
£2,452.68	£2,715.36	£2,627.77	£2,715.36	£2,627.77	£2,715.38	£2,715.36
£6,841.61	£7,574.64	£7,330.30	£7,574.64	£7,259.03 0	0	
£6,191.09	£6,854.42	£6,633.31	£6,854.42	£6,833.31	£6,854.42	£1,041.06
£0.00	£0 00	£0.00	£0.00	£0 00	£0.00	£0.00
0	0	0	0	0	0	
£1,580.15	£1,732.99 0	0	0	0	0	
£1,714.93	£1,898.68	£1,837.43	£1,898.68	£1,837.43	£1,898.68	£1,898.68
£2,276.99	£2,520.98	£2,439.64	£2,520.98	£2,439.64	£2,520.98	£2,520.98
£919.29	£2,442.69	£2,363 89	£2,442.69	£2,363.89	£2,442 69	£2,442.69
£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00
£315.95 0	0	0	0	0	0	
£1,405.51	£1,556.10	£1,505.91	£1,556.10	£1,505.91	£1,556.10	£1,556.10
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£6,940 37
£0.00	£0.00	£0.00	£0.00	£0 00	£0.00	£2,291.18
£0.00	£0.00	£0.00	£0.00	£0.00	£1,561.62	£1,885.99
£4,258.69	£411.93 0	0	0	0	0	
£13,306 00	£14,731.64	£14,258.43	£14,731.64	£14,258.43	£14,731.64	£14,731.64
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3,339.29
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£32,599.70	£36,092.53	£824 69 0	0	0	0	
£8,043.28 0	0	0	0	0	0	
£22,594.94	£25,015.82	£24,208.86	£25,015.82	£24,208 86	£25,015.82	£10,255 14
£12,508.87	£14,015.98	£13,563.83	£14,015.98	£1,076.84 0	0	
£24,915.25	£27,584.75	£20,694.92	£6,079.45 0	0	0	
£12,118 05	£13,575.81	£13,137.68	£13,575.81	£3,375.71 0	0	
£0.00	£0.00	£7,039.08	£12,351.56	£11,953.13	£12,351.56	£12,005.94
£13,678 16	£15,143 68	£14,055.17	£15,143 68	£14,655 17	£11,093.15 0	

0	0	0		£0.00
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£0.00	£0.00	£0.00 0		£0.00
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0	0	0		£0.00
£0.00	£0.00	£0.00 0		£0.00
0	0	0		£0.00
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0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
£3,718.27	£3,842.21	£211.73 0		£0.00
£6,519.19 0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
£0.00	£0.00 0	0		£0.00
£1,399.49 0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
£2,377.65	£2,116.68 0	0		£0.00
£0.00	£0.00 0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
£1,902.04	£1,629.94 0	0		£0.00
0	0	0		£0.00
£307.37 0	0	0		£0.00
£0.00	£0.00	£0.00	£0.00	£0.00
£8,306.34	£8,676.22	£3,276.91 0		£0.00
£0.00	£2,791.36	£2,730.70	£2,821.72	£0.00
£0.00 0	0	0		£0.00
0	0	0		£0.00
£850.38 0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00
£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0		£0.00
0	0	0		£0.00
£1,837.43	£1,898.68	£1,837.43	£1,898.68	£0.00
£1,358.74 0	0	0		£0.00
£1,316.56 0	0	0		£0.00
£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0		£0.00
£1,505.91	£35.56 0	0		£0.00
£7,018.35	£7,252.29	£1,101.40 0		£0.00
£2,397.76	£2,477.69	£2,397.76	£2,477.69	£0.00
£1,825.15	£1,885.99	£1,825.15	£1,885.99	£0.00
0	0	0		£0.00
£336.61 0	0	0		£0.00
£6,830.30	£7,058.04	£6,830.36	£7,058.04	£0.00
0	0	0		£0.00
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0	0	0		£0.00
0	0	0		£0.00
0	0	0		£0.00

Avtivity	start dates	finish dates	Labour cost	materials cost	plants cost	wor distrib
Design	17-Nov-90	19-Sep-92	LYD 0	LYD 0	LYD 0	
Final design Architectural	17-Nov-90	19-Sep-91	LYD 1,721	LYD 1,033	LYD 689	2.1
Final design structural	16-Feb-91	20-Aug-91	LYD 1,721	LYD 1,033	LYD 689	2.1
Final design services	8-May-91	6-Dec-91	LYD 1,721	LYD 1,033	LYD 689	2.1
Execution drawing Archit	7-Oct-91	24-Apr-92	LYD 1,721	LYD 1,033	LYD 689	2.1
Execution drawing structural	1-Oct-91	11-Aug-92	LYD 1,721	LYD 1,033	LYD 689	2.1
Execution drawing services	1-Mar-92	1-Sep-92	LYD 1,721	LYD 1,033	LYD 689	2.1
As built drawings	4-Jul-92	11-Sep-92	LYD 918	LYD 689	LYD 459	2.1
Earth Works	24-Feb-92	LYD 34,270	LYD 0	LYD 0	0	
Excivation	2-Mar-91	20-Aug-91	LYD 6,024	LYD 4,016	LYD 10,041	2.2
Filling & compaction	1-Jun-91	12-Nov-91	LYD 4,016	LYD 2,678	LYD 6,694	2.2
Concrete works	24-Feb-91	2-Sep-92	LYD 0	LYD 0	LYD 0	
Lean concrete	24-Feb-91	23-Jul-91	LYD 1,447	LYD 1,447	LYD 1,929	1
foundation	4-Apr-91	15-Oct-91	LYD 21,702	LYD 21,702	LYD 28,936	1
ground floor concrete	17-Jun-91	20-Oct-91	LYD 5,787	LYD 5,787	LYD 7,716	1
column ground floor	17-Jul-91	1-Dec-91	LYD 5,787	LYD 5,787	LYD 7,716	1
column first floor	1-Jun-91	25-Nov-91	LYD 5,787	LYD 5,787	LYD 7,716	1
concrete walls ground floor	7-Nov-91	30-Apr-92	LYD 10,128	LYD 10,128	LYD 13,504	1
concrete walls first floor	2-Nov-91	26-Feb-92	LYD 11,574	LYD 11,574	LYD 15,433	1
concrete slab, beams G.F.	2-Dec-91	16-Jul-92	LYD 28,936	LYD 28,936	LYD 38,582	1
concrete slab, beams F.F.	15-Jan-91	26-Jul-91	LYD 28,936	LYD 28,936	LYD 38,582	1
Stairs	1-Apr-91	2-Sep-91	LYD 13,504	LYD 10,128	LYD 10,128	1
Parapets and lintels	1-Mar-91	14-Sep-91	LYD 19,291	LYD 14,468	LYD 14,468	1
Walls	1-Oct-91	11-Aug-92	LYD 0	LYD 0	LYD 0	1
Masonary walls G.F	1-Oct-91	8-Mar-92	LYD 19,922	LYD 11,953	LYD 7,969	1
Masonary walls F.F.	20-Feb-91	11-Aug-91	LYD 19,922	LYD 11,953	LYD 7,969	1
Plastering, rendering	1-Dec-91	3-Nov-91	LYD 0	LYD 0	LYD 0	1
Internal Ground floor	1-Mar-91	3-Sep-91	LYD 14,344	LYD 5,977	LYD 3,586	1
Internal First floor	1-Dec-91	13-Apr-92	LYD 14,344	LYD 5,977	LYD 3,586	1
External	1-Apr-91	12-Feb-92	LYD 19,125	LYD 7,969	LYD 4,781	1
Roof Finishing	9-Nov-91	8-Feb-92	LYD 0	LYD 0	LYD 0	1
Slope concrete	4-Feb-91	27-Aug-91	LYD 9,961	LYD 5,977	LYD 3,984	1
Insulation layer	9-Nov-91	18-Mar-92	LYD 11,953	LYD 3,984	LYD 3,984	1
water proofing	17-Feb-91	22-Jul-91	LYD 11,953	LYD 3,984	LYD 3,984	1
paving	18-Feb-91	8-Aug-91	LYD 9,961	LYD 5,977	LYD 3,984	1
Floor & wall finshing	1-Jul-91	19-Nov-91	LYD 0	LYD 0	LYD 0	1
floor coveing work G.F.	1-Jul-91	14-Jun-92	LYD 28,688	LYD 11,953	LYD 7,172	2.
floor covering work F.F.	17-Aug-91	20-Feb-92	LYD 23,906	LYD 9,961	LYD 5,977	2.
Finishing stairs marble	2-Nov-91	18-Apr-92	LYD 14,344	LYD 5,977	LYD 3,586	2
finishing handrail	1-Apr-91	1-Mar-92	LYD 4,781	LYD 1,992	LYD 1,195	2.
finishing skirting	1-Mar-91	4-Sep-91	LYD 9,563	LYD 3,984	LYD 2,391	2.
finish bathroom & kitchen floor+water Prf	2-Jan-91	1-Aug-91	LYD 4,781	LYD 2,391	LYD 797	2
Wall cladding bathroom & kitchen	3-Nov-91	19-Mar-92	LYD 9,563	LYD 3,188	LYD 3,188	2.
Painting	17-May-91	25-May-92	LYD 0	LYD 0	LYD 0	2
Internal	17-May-91	12-Aug-92	LYD 30,122	LYD 12,651	LYD 7,630	2.
External	1-Oct-91	25-May-92	LYD 12,909	LYD 5,379	LYD 3,227	2
Doors& Windows	17-Aug-91	30-Jul-92	LYD 0	LYD 0	LYD 0	2.
Doors Ground floor	17-Aug-91	19-Mar-92	LYD 10,232	LYD 13,643	LYD 10,232	2
Doors first floor	17-Aug-91	18-Apr-92	LYD 10,232	LYD 13,643	LYD 10,232	2
Widows ground floor	3-Dec-91	24-Jun-92	LYD 15,348	LYD 20,464	LYD 15,348	2.
windows first floor	17-Dec-91	30-Jul-92	LYD 15,348	LYD 20,464	LYD 15,348	2.
Sanitary work	1-Jun-91	30-May-92	LYD 0	LYD 0	LYD 0	1
water supply network	1-Sep-91	1-May-92	LYD 8,925	LYD 8,925	LYD 4,463	1
sewage& rainwater goods	2-Nov-91	27-Mar-92	LYD 8,925	LYD 8,925	LYD 4,463	1
sanitary goods G F.	4-Jan-91	14-Jul-92	LYD 11,156	LYD 11,156	LYD 5,578	1
sanitary goods F.F.	1-May-91	30-May-92	LYD 8,925	LYD 8,925	LYD 4,463	1
Accessories & siphones	17-Feb-91	15-Apr-92	LYD 8,367	LYD 5,020	LYD 3,347	1
Electrical works	1-Jun-91	28-Aug-92	LYD 0	LYD 0	LYD 0	1
conduits	1-Jun-91	2-Feb-92	LYD 8,367	LYD 5,020	LYD 3,347	1
cabling	2-Nov-91	28-Aug-92	LYD 8,367	LYD 5,020	LYD 3,347	1
internal lighting unit	2-Jun-91	8-Apr-92	LYD 11,156	LYD 6,694	LYD 4,463	1
External lighting unit	3-Mar-91	28-Jun-92	LYD 8,367	LYD 5,020	LYD 3,347	'
switches & sockets	6-Jul-91	5-Jul-92	LYD 6,694	LYD 3,347	LYD 1,116	'
Distribution board &cables	1-Sep-91	24-Feb-92	LYD 11,156	LYD 8,367	LYD 8,367	'
Air conditioning	14-Nov-91	13-Jun-92	LYD 47,813	LYD 79,688	LYD 31,875	'
Completion and testing	17-Mar-91	28-Aug-92	LYD 16,938	LYD 6,375	LYD 9,563	'
Extra cost works	9-Nov-90	18-Jul-91	LYD 0	LYD 0	LYD 0	
Curtains wall	9-Nov-90	10-Oct-91				
Aircondtion conical	9-Nov-90	8-Dec-91				
Domes mosic cladding	9-Nov-90	6-Jun-91				
Lights fictures	9-Nov-90	14-Mar-91				
Office Furnature	9-Nov-90	14-Mar-91				
Gmalis flooring	9-Nov-90	18-Jul-91				
Lux. Ballrooms applicants	9-Nov-90	7-Jul-91				
Falls ceiling	9-Nov-90	9-Aug-92				
	1-Jan-00	2-Jan-00	643,684	503,708	414,287	1,
			659,822	610,080	423,810	1.

Total items Cost	Cost/day	Materials %	Labour %	Plants %		1-Nov-90	1-Dec-1990	1-Jan-1991	1-Feb-1991
3,442.50	£11.24			£0.00	£3,442.50	£153.60	£348.32	£348.32	£314.61
3,442.50	£18.47			£0.00	£3,442.50	£0.00	£0.00	£0.00	£252.43
3,442.50	£15.08			£0.00	£3,442.50	£0.00	£0.00	£0.00	£0.00
3,442.50	£17.18			£0.00	£3,442.50	£0.00	£0.00	£0.00	£0.00
3,442.50	£10.92			£0.00	£3,442.50	£0.00	£0.00	£0.00	£0.00
3,442.50	£18.67			£0.00	£3,442.50	£0.00	£0.00	£0.00	£0.00
2,065.50	£29.77			£0.00	£2,065.50	£0.00	£0.00	£0.00	£0.00
0	0			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
20,081.25	£117.16			£0.00	£20,081.25	£0.00	£0.00	£0.00	£0.00
13,387.50	£81.44			£0.00	£13,387.50	£0.00	£0.00	£0.00	£0.00
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
4,822.69	£32.39			£0.00	£4,822.69	£0.00	£0.00	£0.00	£150.67
72,340.31	£372.17			£0.00	£72,340.31	£0.00	£0.00	£0.00	£0.00
19,290.75	£153.86			£0.00	£19,290.75	£0.00	£0.00	£0.00	£0.00
19,290.75	£140.42			£0.00	£19,290.75	£0.00	£0.00	£0.00	£0.00
19,290.75	£108.76			£0.00	£19,290.75	£0.00	£0.00	£0.00	£0.00
33,758.81	£192.50			£0.00	£33,758.81	£0.00	£0.00	£0.00	£0.00
38,581.50	£331.83			£0.00	£38,581.50	£0.00	£0.00	£0.00	£0.00
96,453.75	£429.08			£0.00	£96,453.75	£0.00	£0.00	£0.00	£0.00
96,453.75	£501.39			£0.00	£96,453.75	£0.00	£0.00	£8,356.40	£14,038.78
33,758.81	£218.68			£0.00	£33,758.81	£0.00	£0.00	£0.00	£0.00
48,228.68	£244.34			£0.00	£48,228.68	£0.00	£0.00	£0.00	£0.00
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
39,843.75	£260.00			£0.00	£39,843.75	£0.00	£0.00	£0.00	£0.00
39,843.75	£231.15			£0.00	£39,843.75	£0.00	£0.00	£0.00	£2,003.26
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
23,906.25	£128.27			£0.00	£23,906.25	£0.00	£0.00	£0.00	£0.00
23,906.25	£178.40			£0.00	£23,906.25	£0.00	£0.00	£0.00	£0.00
31,875.00	£100.43			£0.00	£31,875.00	£0.00	£0.00	£0.00	£0.00
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
19,921.88	£97.48			£0.00	£19,921.88	£0.00	£0.00	£0.00	£2,404.43
19,921.88	£155.19			£0.00	£19,921.88	£0.00	£0.00	£0.00	£0.00
19,921.88	£128.22			£0.00	£19,921.88	£0.00	£0.00	£0.00	£1,408.88
19,921.88	£118.25			£0.00	£19,921.88	£0.00	£0.00	£0.00	£1,230.97
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
47,812.50	£138.85			£0.00	£47,812.50	£0.00	£0.00	£0.00	£0.00
39,843.75	£212.64			£0.00	£39,843.75	£0.00	£0.00	£0.00	£0.00
23,906.25	£143.68			£0.00	£23,906.25	£0.00	£0.00	£0.00	£0.00
7,968.75	£23.78			£0.00	£7,968.75	£0.00	£0.00	£0.00	£0.00
15,937.50	£85.08			£0.00	£15,937.50	£0.00	£0.00	£0.00	£0.00
7,968.75	£37.78			£0.00	£7,968.75	£0.00	£0.00	£1,118.42	£1,055.89
15,937.50	£116.01			£0.00	£15,937.50	£0.00	£0.00	£0.00	£0.00
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
50,203.13	£110.73			£0.00	£50,203.13	£0.00	£0.00	£0.00	£0.00
21,515.63	£90.64			£0.00	£21,515.63	£0.00	£0.00	£0.00	£0.00
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
34,106.25	£158.38			£0.00	£34,106.25	£0.00	£0.00	£0.00	£0.00
34,106.25	£140.14			£0.00	£34,106.25	£0.00	£0.00	£0.00	£0.00
51,159.38	£250.32			£0.00	£51,159.38	£0.00	£0.00	£0.00	£0.00
51,159.38	£225.99			£0.00	£51,159.38	£0.00	£0.00	£0.00	£0.00
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
22,312.50	£91.66			£0.00	£22,312.50	£0.00	£0.00	£0.00	£0.00
22,312.50	£152.43			£0.00	£22,312.50	£0.00	£0.00	£0.00	£0.00
27,890.63	£50.04			£0.00	£27,890.63	£0.00	£0.00	£1,284.42	£1,401.10
22,312.50	£60.43			£0.00	£22,312.50	£0.00	£0.00	£0.00	£0.00
16,734.38	£39.53			£0.00	£16,734.38	£0.00	£0.00	£0.00	£461.14
0.00	£0.00			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
18,734.38	£67.82			£0.00	£18,734.38	£0.00	£0.00	£0.00	£0.00
18,734.38	£58.09			£0.00	£18,734.38	£0.00	£0.00	£0.00	£0.00
22,312.50	£72.36			£0.00	£22,312.50	£0.00	£0.00	£0.00	£0.00
16,734.38	£34.82			£0.00	£16,734.38	£0.00	£0.00	£0.00	£0.00
11,156.25	£30.63			£0.00	£11,156.25	£0.00	£0.00	£0.00	£0.00
27,890.63	£156.13			£0.00	£27,890.63	£0.00	£0.00	£0.00	£0.00
159,375.00	£750.44			£0.00	£159,375.00	£0.00	£0.00	£0.00	£0.00
31,875.00	£80.14			£0.00	£31,875.00	£0.00	£0.00	£0.00	£0.00
1,593,520.50	£0.00					£0.00	£0.00	£0.00	£0.00

79676.025
31870.41

1,603,521

		1-Nov-90	1-Dec-1990	1-Jan-1991	1-Feb-1991
Advance payment 15%			239062.8		
	Total cash	£142.81	£220,388.44	£8,741.90	£19,357.8
	Cumulative cash	£121.39	£239,007.83	£248,249.73	£267,607.6

1991	1-Apr-1991	1-May-1991	1-Jun-1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
46.32	£337.09	£348.32	£337 03	£348.32	£348.32	£210.21	0	0	0	0
72.60	£554 12	£572.60	£554.12	£572.60	£364.03	0	0	0	0	0
£0 00	£0.00	£412.18	£481.75	£497.81	£497.81	£481.75	£497 81	£481 78	£91.67	0
£0 00	£0.00	£0.00	£0.00	£0.00	£0 00	£0 03	£423 78	£618.41	£632 60	£632.60
£0.00	£0 03	£0 00	£0 00	£0.00	£0 00	£0.00	£334.74	£327.47	£338 38	£338 38
£0 03	£0 09	£0.03	£0 80	£0 00	£0.00	£0 08	£0 00	£0 03	£0 00	£0 00
£0.03	£0 03	£0 03	£0 00	£0.00	£0.00	£0 00	£0.90	£0 03	£0.00	£0 03
£0 03	£0 03	£0 03	£0 00	£0 00	£0.00	£0.00	£0 00	£0.00	£0 00	£0 00
176 28	£3,515.32	£3,632.49	£3,515.32	£3,632.49	£2,309 57	0	0	0	0	0
£0 03	£0 00	£0 03	£2,418.20	£2,524.79	£2,524 79	£2,443.36	£2,624.70	£953 68	0	0
£0.00	£0 00	£0 03	£0.00	£0 03	£0 00	£0 00	£0.00	£0 00	£0 00	£0.00
00.86	£968.57	£1,000 86	£968.57	£733.18	0	0	0	0	0	0
£0.00	£9,824.50	£11,537.23	£11,165.06	£11,537.23	£11,537.23	£11,165.06	£6,473.08	0	0	0
£0 00	£0 00	£0 00	£2,102 81	£4,760.80	£4,769.80	£4,619.93	£3,032.41	0	0	0
£0.00	£0 00	£0 00	£0 03	£2,059.55	£4,353.14	£4,212.72	£4,353.14	£4,212.72	£90 47	0
£0.00	£0.00	£0.00	£3,226.45	£3,371.46	£3,371.46	£3,282.71	£3,371.48	£2,687.20	0	0
£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0 00	£0.03	£4,605.72	£5,987.35	£5,987 35
£0.00	£0 03	£0 00	£0.00	£0 00	£0 00	£0 00	£0 00	£9,603 79	£10,277 35	£10,277 35
£0 03	£0 00	£0 00	£0.00	£0 00	£0.00	£0 00	£0 00	£0 00	£12,640 38	£13,208 48
342.90	£15,041.52	£15,542.90	£16,041.52	£12,889 75	0	0	0	0	0	0
£0 03	£6,487.52	£6,779.10	£6,560.42	£6,779 10	£6,779 10	£373 85	0	0	0	0
103.13	£7,330 24	£7,674.58	£7,330.24	£7,674 53	£7,674 63	£3,319.81	0	0	0	0
£0 00	£0 00	£0 00	£0.00	£0 00	£0 03	£0.00	£0 00	£0 00	£0.00	£0 00
£0.00	£0.00	£0 03	£0 00	£0.00	£0 03	£0.00	£7,900.87	£7,500.00	£7,760 00	£7,760 00
105.52	£6,934 37	£7,165.52	£6,934.37	£7,165.52	£2,475.19	0	0	0	0	0
£0.00	£0.00	£0.00	£0 00	£0.03	£0 00	£0 00	£0 00	£0.00	0	0
933 80	£3,848.09	£3,976 36	£3,848 09	£3,976.38	£3,976.36	£347.40	0	0	0	0
£0 00	£0 00	£0 00	£0 00	£0 03	£0 00	£0 00	£0 00	£0.00	£5,471.08	£5,630.65
£0 00	£2,079.62	£3,113.43	£3,013 00	£3,113 43	£3,113 43	£3,013.00	£3,113.43	£3,013 00	£3,113 43	£3,113 43
£0 00	£0.00	£0.00	£0 03	£0.00	£0.00	£0 00	£0 00	£0 00	£0.00	£0.00
321.79	£2,924 31	£3,021.70	£2,924.31	£3,021.70	£2,603.45	0	0	0	0	0
£0 00	£0 03	£0.00	£0 03	£0 00	£0.00	£0 03	£0.08	£3,302 34	£4,810 74	£4,810.74
874.76	£3,846.54	£3,974.76	£3,846.54	£2,783.40	0	0	0	0	0	0
603.67	£3,487.42	£3,603 67	£3,467.42	£3,603.67	£698.07	0	0	0	0	
£0 03	£0.00	£0 03	£0 00	£0.00	£0 00	£0 00	£0 00	£0 00	0	0
£0.03	£0 03	£0 03	£0.00	£4,198.78	£4,242.40	£4,105 85	£4,242.40	£4,105 66	£4,242 48	£4,242 48
£0 03	£0.00	£0.03	£0.00	£0 03	£3,118.75	£6,379.25	£6,591 89	£6,370.25	£6,591 89	£6,591 89
£0.00	£0.00	£0 03	£0.00	£0.03	£0 03	£0 00	£0 00	£4,119.08	£4,454 36	£4,454 36
£0 03	£704.60	£736.58	£712.82	£736 58	£736 68	£712 62	£736 63	£712.82	£736 56	£736 08
608 41	£2,551.70	£2,636.76	£2,551.70	£2,636 76	£2,636 76	£318.42	0	0	0	0
168 89	£1,130 89	£1,168 69	£1,130 99	£1,168 69	£26 70	0	0	0	0	0
£0 00	£0.00	£0 00	£0 00	£0 00	£0.00	£0 00	£0 03	£3,209 74	£3,696 45	£3,696.45
£0.00	£0 00	£0 00	£0.00	£0 00	£0.00	£0 00	£0.00	£0.00	£0 00	£0 00
£0 00	£0.00	£1,024 87	£3,321.96	£3,432 69	£3,432 60	£3,321.66	£3,432 69	£3,321.96	£3,432 69	£3,432 69
£0 00	£0 00	£0 00	£0 03	£0 00	£0 00	£0 03	£2,779 62	£2,718.19	£2,808 83	£2,809 83
£0.00	£0.00	£0 00	£0 03	£0 00	£0.00	£0 00	£0 03	£0 00	£0 00	£0 00
£0 00	£0 00	£0 00	£0 00	£0 00	£2,322 58	£4,750 73	£4,009 08	£4,750 73	£4,938.08	£4,939 08
£0 00	£0 00	£0 00	£0 03	£0.30	£2,055.37	£4,204 16	£4,344 30	£4,234.16	£4,344 30	£4,344 30
£0.00	£0.00	£0.00	£0 00	£0.00	£0 00	£0.03	£0.08	£0 03	£7,176.87	£7,759 08
£0 00	£0 00	£0.00	£0 00	£0 00	£0.00	£0.00	£0 08	£0 03	£3,314 68	£7,008 81
£0 00	£0.00	£0.00	£0 03	£0.00	£0 00	£0 00	£0 08	£0 03	£0 00	£0 03
£0 00	£0 00	£0 00	£0.08	£0.00	£0.00	£2,719 83	£2,842.08	£2,750 38	£2,842.08	£2,842.08
£0 00	£0 00	£0 00	£0 08	£0.00	£0.00	£0 00	£0 08	£4,369 77	£4,726.48	£4,725.45
551.22	£1,601.18	£1,651.22	£1,601.18	£1,651.22	£1,651 22	£1,601 18	£1,661.22	£1,601.18	£1,651 22	£1,651.22
£0 00	£0.00	£1,730 04	£1,690.01	£1,740.45	£1,740.45	£1,693.01	£1,740.46	£1,693.01	£1,749.45	£1,749 46
225 31	£1,185.78	£1,228.31	£1,185.78	£1,225 31	£1,226.31	£1,185 78	£1,225.31	£1,185 78	£1,226.31	£1,225.31
£0.00	£0.00	£0 00	£0.00	£0 00	£0 03	£0 00	£0 00	£0 00	£0 08	£0 08
£0 03	£0 00	£0.03	£2,015.03	£2,105.60	£2,105.60	£2,037 67	£2,105 80	£2,837 87	£2,105 60	£2,105 88
£0 00	£0.00	£0 00	£0.00	£0 03	£0 03	£0 00	£0.00	£1,607 77	£1,738 64	£1,738 64
£0 03	£0 00	£0 00	£2,074.18	£2,243 01	£2,243.01	£2,170 65	£2,243 01	£2,170 65	£2,243 01	£2,243 01
992.44	£1,038.60	£1,073.22	£1,038.60	£1,073 22	£1,073 22	£1,038.60	£1,073 22	£1,038 60	£1,073 22	£1,073.22
£0 00	£0.00	£0 00	£0 00	£763 79	£946.54	£918 01	£946 54	£918.01	£946.54	£946 54
£0 00	£0.00	£0.00	£0 03	£0 00	£0 00	£4,601 27	£4,932 11	£4,743 08	£4,902.11	£4,902.11
£0.00	£0 00	£0.00	£0 03	£0.00	£0.00	£0 03	£0 03	£12,607.36	£23,283.08	£23,283 08
882.88	£1,804 25	£1,864.39	£1,804 25	£1,864.39	£1,804 39	£1,804 28	£1,864 39	£1,834 28	£1,864.39	£1,864 3
£0.00	£0 00	£0 00	£0 00	£0.00	0	0	0	0	0	0
,878 80	£60,916.29	£68,075.97	£75,490.87	£82,463 30	£80,283.25	£63,078 21	£61,098 72	£84,890 26	£114,806 27	£118,281 4
,285 65	£374,200 94	£441,176 92	£516,667 49	£599,130 78	£688,414 03	£728,492 24	£789,690 95	£874,681.20	£980,187 47	£1,107,468 9

Feb-1992	1-Mar-1992	1-Apr-1992	1-May-1992	1-Jun-1992	1-Jul-1992	1-Aug-1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
£498.23	£532.59	£407.32	0	0	0	0	0	0	0	0	0
£316.55	£338.38	£327.47	£338.38	£327.47	£338.38	£116.89	0	0	0	0	0
£0.00	£572.58	£560.14	£576.81	£560.14	£576.81	£578.81	£13.23	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£823.72	£922.96	£318.62	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	
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£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
£5,502.36	£5,957.35	£5,718.71	0	0	0	0	0	0	0	0	0
£8,523.02	0	0	0	0	0	0	0	0	0	0	0
£12,356.31	£13,208.40	£12,762.39	£13,208.46	£12,782.30	£8,268.02	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	0	0	0	0	0
£7,250.00	£1,927.00	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
£6,173.74	£6,530.55	£2,200.33	0	0	0	0	0	0	0	0	0
£1,175.81	0	0	0	0	0	0	0	0	0	0	0
£0.00	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
£4,500.37	£2,437.70	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
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£3,668.69	£4,242.40	£4,105.56	£4,242.40	£1,876.01	0	0	0	0	0	0	0
£4,190.81	0	0	0	0	0	0	0	0	0	0	0
£4,168.98	£4,454.36	£2,257.11	0	0	0	0	0	0	0	0	0
£689.00	£16.83	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
£3,364.42	£2,170.44	0	0	0	0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	0	0	0	0	0	0	0	0
£3,211.23	£3,432.89	£3,321.96	£3,432.69	£3,321.96	£3,432.89	£1,208.49	0	0	0	0	0
£2,628.55	£2,009.83	£2,719.19	£7,230.68	0	0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	0	0	0	0	0	0
£4,502.37	£2,962.81	0	0	0	0	0	0	0	0	0	0
£4,064.02	£4,344.30	£2,201.35	0	0	0	0	0	0	0	0	0
£7,259.31	£7,769.95	£7,609.63	£7,759.95	£5,934.70	0	0	0	0	0	0	0
£6,553.82	£7,005.81	£6,779.82	£7,005.81	£6,779.82	£6,713.00	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	0	0	0	0	0	0	0	0
£2,658.71	£2,842.06	£2,750.39	£64.94	0	0	0	0	0	0	0	0
£4,423.50	£4,071.25	0	0	0	0	0	0	0	0	0	0
£1,451.14	£1,551.22	£1,601.18	£1,551.22	£1,501.18	£685.95	0	0	0	0	0	0
£1,636.88	£1,749.45	£1,693.01	£1,876.55	0	0	0	0	0	0	0	0
£1,148.26	£1,225.31	£581.38	0	0	0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	0	0	0	0	0
£118.03	0	0	0	0	0	0	0	0	0	0	0
£1,626.47	£1,738.64	£1,682.65	£1,733.84	£1,682.55	£1,738.64	£1,441.86	0	0	0	0	0
£2,008.30	£2,243.01	£340.67	0	0	0	0	0	0	0	0	0
£1,003.93	£1,073.22	£1,038.60	£1,073.22	£959.28	0	0	0	0	0	0	0
£885.48	£946.54	£916.01	£948.64	£916.01	£143.78	0	0	0	0	0	0
£3,749.06	0	0	0	0	0	0	0	0	0	0	0
£21,762.83	£23,263.68	£22,513.24	£23,203.68	£9,538.88	0	0	0	0	0	0	0
£1,744.10	£1,864.39	£1,804.25	£1,864.38	£1,804.25	£1,864.39	£1,643.87	0	0	0	0	0
	0	0	0	0	0	0	0	0			
£104,804.88	£87,583.49	£66,855.62	£56,366.49	£37,426.41	£17,617.69	£4,880.67	£268.99	£0.00	£0.00	£0.00	
.212,273.76	£1,299,654.28	£1,360,709.90	£1,432,078.29	£1,459,504.69	£1,477,122.68	£1,481,803.36	£1,482,062.35	£1,482,062.35	£1,482,062.35	##########	

	1-Feb-1993	1-Mar-1993	1-Apr-1993	1-May-1993
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	£0.00	£0.00	£0.00	£0.00
	£1,482,062.35	£1,482,062.35	£1,482,062.35	£1,482,062.35

Appendix (d)

Harawa project
Cash flow calculations

No	Avtivity	start dates	finish dates	materials cost	labour cost	plants cost	work distributior
	Final Design	6-Jan-90	14-Sep-90	£94,500.00	£85,800.00	£22,500.00	1
	earth works and leveling	8-Nov-90	18-Jun-91	£168,500.00	£145,700.00	£230,600.00	1
	mobilisation camp	12-Feb-90	8-Mar-91	£56,800.00	£56,300.00	£32,500.00	1
	house buildings groups 1&2	19-Mar-90	24-Dec-91	£0.00	£0.00	£0.00	
	foundation group 1&2	3-May-90	23-Jan-91	£35,600.00	£54,800.00	£18,700.00	1
	walls works group 1$2	9-Apr-90	30-Aug-90	£17,400.00	£19,500.00	£17,200.00	1
	concrete columns G1&2	21-May-90	22-Nov-90	£24,600.00	£17,600.00	£15,700.00	1
	concrete slabs G1&2	2-Jul-90	16-Nov-90	£24,550.00	£16,750.00	£11,200.00	1
	Internal walls plaster	26-Jun-90	16-Nov-90	£27,550.00	£24,350.00	£18,750.00	1
	Electrical wires and cables	27-Aug-90	23-Jan-91	£11,350.00	£24,300.00	£15,250.00	1
	plumping wroks	24-Sep-90	25-Jan-91	£28,800.00	£31,600.00	£13,200.00	1
	water supply	23-Jul-90	23-Nov-90	£75,900.00	£87,500.00	£65,700.00	1
	walls clading (ceramic)	19-Mar-90	23-Nov-90	£70,500.00	£120,500.00	£65,800.00	1
	Floor tiles	24-Sep-90	26-Jul-91	£156,750.00	£129,500.00	£85,600.00	1
	Internal walls paint	23-Oct-90	21-Oct-91	£175,400.00	£105,400.00	£78,500.00	1
	water ground tanks	23-Nov-90	24-Jun-91	£45,700.00	£35,400.00	£28,500.00	1
	septic tanks	23-Jan-91	7-Jun-91	£65,700.00	£45,500.00	£35,650.00	1
	land scaping	23-Jan-91	24-Dec-91	£145,700.00	£96,500.00	£115,400.00	1
	houses Groups 3&4	19-Mar-90	24-Dec-91	£0.00	£0.00	£0.00	
	foundation group 3&4	3-May-90	23-Jan-91	£35,600.00	£54,800.00	£18,700.00	1
	walls works group 3&4	9-Apr-90	30-Aug-90	£17,400.00	£19,500.00	£17,200.00	1
	concrete columns G3&4	21-May-90	22-Nov-90	£24,600.00	£17,600.00	£15,700.00	1
	concrete slabs G3&4	2-Jul-90	16-Nov-90	£24,550.00	£16,750.00	£11,200.00	1
	Internal walls plaster	26-Jun-90	16-Nov-90	£27,550.00	£24,350.00	£18,750.00	1
	Electrical wires and cables	27-Aug-90	23-Jan-91	£11,350.00	£24,300.00	£15,250.00	1
	plumping wroks	24-Sep-90	25-Jan-91	£28,800.00	£31,600.00	£13,200.00	1
	water supply	17-May-90	25-Sep-90	£75,900.00	£87,500.00	£65,700.00	1
	walls clading (ceramic)	19-Mar-90	23-Nov-90	£70,500.00	£120,500.00	£65,800.00	1
	Floor tiles	24-Sep-90	26-Jul-91	£156,750.00	£129,500.00	£85,600.00	1
	Internal walls paint	23-Oct-90	21-Oct-91	£175,400.00	£105,400.00	£78,500.00	1
	water ground tanks	23-Nov-90	24-Jun-91	£45,700.00	£35,400.00	£28,500.00	1
	septic tanks	23-Jan-91	7-Jun-91	£65,700.00	£45,500.00	£35,650.00	1
	land scaping	23-Jan-91	24-Dec-91	£145,700.00	£96,500.00	£115,400.00	1
	Houses groups 5&6	19-Mar-90	24-Dec-91	£0.00	£0.00	£0.00	
	foundation group 5&6	3-May-90	23-Jan-91	£35,600.00	£54,800.00	£18,700.00	1
	walls works group 5&6	9-Apr-90	30-Aug-90	£17,400.00	£19,500.00	£17,200.00	1
	concrete columns G5&6	21-May-90	21-Aug-90	£24,600.00	£17,600.00	£15,700.00	1
	concrete slabs G5&6	2-Jul-90	7-Sep-90	£24,550.00	£16,750.00	£11,200.00	1
	Internal walls plaster	26-Jun-90	5-Sep-90	£27,550.00	£24,350.00	£18,750.00	1
	Electrical wires and cables	27-Aug-90	8-Nov-90	£11,350.00	£24,300.00	£15,250.00	1
	plumping wroks	24-Sep-90	23-Nov-90	£28,800.00	£31,600.00	£13,200.00	1
	water supply	17-May-90	25-Sep-90	£75,900.00	£87,500.00	£65,700.00	1
	walls clading (ceramic)	19-Mar-90	23-Nov-90	£70,500.00	£120,500.00	£65,800.00	1
	Floor tiles	24-Sep-90	26-Jul-91	£156,750.00	£129,500.00	£85,600.00	1
	Internal walls paint	23-Oct-90	21-Oct-91	£175,400.00	£105,400.00	£78,500.00	1
	water ground tanks	23-Nov-90	24-Jun-91	£45,700.00	£35,400.00	£28,500.00	1
	septic tanks	23-Jan-91	7-Jun-91	£65,700.00	£45,500.00	£35,650.00	1
	land scaping	23-Jan-91	24-Dec-91	£145,700.00	£96,500.00	£115,400.00	1

overheads% n	Profits%	Total items Cost	Cost/day	Materials %	Labour %	Plants %
8.0%	12.0%	£243,360.0	968.1	38.83%	35.26%	9.25%
10.0%	10.0%	£653,760.0	2,939.9	25.77%	22.29%	35.27%
11.0%	12.0%	£179,088.0	459.9	31.72%	31.44%	18.15%
0.0%		£0.0	0.0	0.00%	0.00%	0.00%
12.0%	10.0%	£133,102.0	501.6	26.75%	41.17%	14.05%
10.0%	11.0%	£65,461.0	456.6	26.58%	29.79%	26.28%
10.0%	10.0%	£69,480.0	374.8	35.41%	25.33%	22.60%
11.0%	12.0%	£64,575.0	470.1	38.02%	25.94%	17.34%
10.0%	10.0%	£84,780.0	591.3	32.50%	28.72%	22.12%
12.0%	11.0%	£62,607.0	419.1	18.13%	38.81%	24.36%
10.0%	11.0%	£89,056.0	721.8	32.34%	35.48%	14.82%
10.0%	12.0%	£279,502.0	2,265.5	27.16%	31.31%	23.51%
11.0%	10.0%	£310,728.0	1,246.0	22.69%	38.78%	21.18%
12.0%	10.0%	£453,657.0	1,485.6	34.55%	28.55%	18.87%
12.0%	12.0%	£445,532.0	1,228.1	39.37%	23.66%	17.62%
12.0%	10.0%	£133,712.0	626.7	34.18%	26.47%	21.31%
10.0%	12.0%	£179,157.0	1,323.4	36.67%	25.40%	19.90%
10.0%	10.0%	£429,120.0	1,279.5	33.95%	22.49%	26.89%
		£0.0	0.0	0.00%	0.00%	0.00%
12.0%	10.0%	£133,102.0	501.6	26.75%	41.17%	14.05%
10.0%	11.0%	£65,461.0	456.6	26.58%	29.79%	26.28%
10.0%	10.0%	£69,480.0	374.8	35.41%	25.33%	22.60%
11.0%	12.0%	£64,575.0	470.1	38.02%	25.94%	17.34%
10.0%	10.0%	£84,780.0	591.3	32.50%	28.72%	22.12%
12.0%	11.0%	£62,607.0	419.1	18.13%	38.81%	24.36%
10.0%	11.0%	£89,056.0	721.8	32.34%	35.48%	14.82%
10.0%	12.0%	£279,502.0	2,127.5	27.16%	31.31%	23.51%
11.0%	10.0%	£310,728.0	1,246.0	22.69%	38.78%	21.18%
12.0%	10.0%	£453,657.0	1,485.6	34.55%	28.55%	18.87%
12.0%	12.0%	£445,532.0	1,226.1	39.37%	23.66%	17.62%
12.0%	10.0%	£133,712.0	626.7	34.18%	26.47%	21.31%
10.0%	12.0%	£179,157.0	1,323.4	36.67%	25.40%	19.90%
10.0%	10.0%	£429,120.0	1,279.5	33.95%	22.49%	26.89%
		£0.0	0.0	0.00%	0.00%	0.00%
12.0%	10.0%	£133,102.0	501.6	26.75%	41.17%	14.05%
10.0%	11.0%	£65,461.0	456.6	26.58%	29.79%	26.28%
10.0%	10.0%	£69,480.0	752.2	35.41%	25.33%	22.60%
11.0%	12.0%	£64,575.0	958.4	38.02%	25.94%	17.34%
10.0%	10.0%	£84,780.0	1,187.8	32.50%	28.72%	22.12%
12.0%	11.0%	£62,607.0	853.2	18.13%	38.81%	24.36%
10.0%	11.0%	£89,056.0	1,475.0	32.34%	35.48%	14.82%
10.0%	12.0%	£279,502.0	2,127.5	27.16%	31.31%	23.51%
11.0%	10.0%	£310,728.0	1,246.0	22.69%	38.78%	21.18%
12.0%	10.0%	£453,657.0	1,485.6	34.55%	28.55%	18.87%
12.0%	12.0%	£445,532.0	1,226.1	39.37%	23.66%	17.62%
12.0%	10.0%	£133,712.0	626.7	34.18%	26.47%	21.31%
10.0%	12.0%	£179,157.0	1,323.4	36.67%	25.40%	19.90%
10.0%	10.0%	£429,120.0	1,279.5	33.95%	22.49%	26.89%

1-Jan-90	1-Feb-1990	1-Mar-1990	1-Apr-1990	1-May-1990	1-Jun-19
:4,848.29	£27,107.23	£30,011.58	£29,043.46	£30,011.58	£29,043.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£7,665.62	£14,258.05	£13,798.11	£14,258.05	£13,798.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£14,378.11	£15,046.
£0.00	£0.00	£0.00	£9,892.39	£14,153.73	£13,697.
£0.00	£0.00	£0.00	£0.00	£3,997.95	£11,244.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£2,759.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£15,783.01	£37,380.81	£38,626.84	£37,380.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£14,378.11	£15,046.
£0.00	£0.00	£0.00	£9,892.39	£14,153.73	£13,697.
£0.00	£0.00	£0.00	£0.00	£3,997.95	£11,244.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£2,759.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£31,203.52	£63,825
£0.00	£0.00	£15,783.01	£37,380.81	£38,626.84	£37,380
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£14,378.11	£15,046
£0.00	£0.00	£0.00	£9,892.39	£14,153.73	£13,697
£0.00	£0.00	£0.00	£0.00	£8,022.95	£22,564
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£5,543.
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
£0.00	£0.00	£0.00	£0.00	£31,203.52	£63,825
£0.00	£0.00	£15,783.01	£37,380.81	£38,626.84	£37,380
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
£0.00	£0.00	£0.00	£0.00	£0.00	£0.0C
:24,848.29	£34,772.85	£91,618.65	£184,661.18	£324,171.55	£424.9
:24.848.29	£59,621.1	£151,239.8	£335,901.0	£660,072.5	£1,085.

Harawa project
planning cash flow

1-Jul-1990	1-Aug-1990	1-Sep-1990	1-Oct-1990	1-Nov-1990	1-Dec-1990	1-Jan-1991
£30,011.58	£30,011.58	£13,271.25	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£68,637.71	£91,136.86	£91,136.86
£14,258.05	£14,258.05	£13,798.11	£14,258.05	£13,798.11	£14,258.05	£14,258.05
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£15,548.42	£15,548.42	£15,046.86	£15,548.42	£15,046.86	£15,548.42	£11,389.64
£14,153.73	£13,563.99	0	0	0	0	0
£11,619.04	£11,619.04	£11,244.23	£11,619.04	£8,136.45	0	0
£13,945.22	£14,571.97	£14,101.91	£14,571.97	£7,383.92	0	0
£18,330.81	£18,330.81	£17,739.49	£18,330.81	£9,288.60	0	0
£0.00	£1,955.92	£12,573.79	£12,992.92	£12,573.79	£12,992.92	£9,517.66
£0.00	£0.00	£4,812.21	£22,376.79	£21,654.95	£22,376.79	£17,835.26
£19,634.05	£70,229.48	£67,964.01	£70,229.48	£51,444.98	0	0
£38,626.84	£38,626.84	£37,380.81	£38,626.84	£28,295.20	0	0
£0.00	£0.00	£9,903.82	£46,052.78	£44,567.20	£46,052.78	£46,052.78
£0.00	£0.00	£0.00	£10,626.15	£36,782.83	£38,008.92	£38,008.92
£0.00	£0.00	£0.00	£0.00	£4,804.34	£19,426.23	£19,426.23
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,469.58
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,089.20
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£15,548.42	£15,548.42	£15,046.86	£15,548.42	£15,046.86	£15,548.42	£11,389.64
£14,153.73	£13,563.99	0	0	0	0	0
£11,619.04	£11,619.04	£11,244.23	£11,619.04	£8,136.45	0	0
£13,945.22	£14,571.97	£14,101.91	£14,571.97	£7,383.92	0	0
£18,330.81	£18,330.81	£17,739.49	£18,330.81	£9,288.60	0	0
£0.00	£1,955.92	£12,573.79	£12,992.92	£12,573.79	£12,992.92	£9,517.66
£0.00	£0.00	£4,812.21	£22,376.79	£21,654.95	£22,376.79	£17,835.26
£65,952.90	£65,952.90	£52,567.30	0	0	0	0
£38,626.84	£38,626.84	£37,380.81	£38,626.84	£28,295.20	0	0
£0.00	£0.00	£9,903.82	£46,052.78	£44,567.20	£46,052.78	£46,052.78
£0.00	£0.00	£0.00	£10,626.15	£36,782.83	£38,008.92	£38,008.92
£0.00	£0.00	£0.00	£0.00	£4,804.34	£19,426.23	£19,426.23
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,469.58
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,089.20
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£15,548.42	£15,548.42	£15,046.86	£15,548.42	£15,046.86	£15,548.42	£11,389.64
£14,153.73	£13,563.99	0	0	0	0	0
£23,316.70	£15,575.81	0	0	0	0	0
£28,433.77	£29,711.69	£6,429.55	0	0	0	0
£36,822.14	£36,822.14	£5,592.61	0	0	0	0
£0.00	£3,981.82	£25,597.41	£26,450.66	£6,577.11	0	0
£0.00	£0.00	£9,833.65	£45,726.48	£33,495.87	0	0
£65,952.90	£65,952.90	£52,567.30	0	0	0	0
£38,626.84	£38,626.84	£37,380.81	£38,626.84	£28,295.20	0	0
£0.00	£0.00	£9,903.82	£46,052.78	£44,567.20	£46,052.78	£46,052.78
£0.00	£0.00	£0.00	£10,626.15	£36,782.83	£38,008.92	£38,008.92
£0.00	£0.00	£0.00	£0.00	£4,804.34	£19,426.23	£19,426.23
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,469.58
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£11,089.20
£577,150.10	£628,660.80	£555,558.95	£649,010.29	£678,518.48	£533,243.37	£572,409.78

Harawa project
planning cash flow

1-Feb-1991	1-Mar-1991	1-Apr-1991	1-May-1991	1-Jun-1991	1-Jul-1991	1-Aug-1991
0	0	0	0	0	0	0
£82,317.17	£91,136.86	£88,196.96	£91,136.86	£52,060.71	0	0
£12,878.24	£3,545.35	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
£41,596.06	£46,052.78	£44,567.20	£46,052.78	£44,567.20	£38,191.62	0
£34,330.64	£38,008.92	£36,782.83	£38,008.92	£36,782.83	£38,008.92	£38,008.92
£17,546.27	£19,426.23	£18,799.58	£19,426.23	£14,856.89	0	0
£37,055.56	£41,025.80	£39,702.38	£41,025.80	£8,877.89	0	0
£35,826.64	£39,665.21	£38,385.69	£39,665.21	£38,385.69	£39,665.21	£39,665.21
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
£41,596.06	£46,052.78	£44,567.20	£46,052.78	£44,567.20	£38,191.62	0
£34,330.64	£38,008.92	£36,782.83	£38,008.92	£36,782.83	£38,008.92	£38,008.92
£17,546.27	£19,426.23	£18,799.58	£19,426.23	£14,856.89	0	0
£37,055.56	£41,025.80	£39,702.38	£41,025.80	£8,877.89	0	0
£35,826.64	£39,665.21	£38,385.69	£39,665.21	£38,385.69	£39,665.21	£39,665.21
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
£41,596.06	£46,052.78	£44,567.20	£46,052.78	£44,567.20	£38,191.62	0
£34,330.64	£38,008.92	£36,782.83	£38,008.92	£36,782.83	£38,008.92	£38,008.92
£17,546.27	£19,426.23	£18,799.58	£19,426.23	£14,856.89	0	0
£37,055.56	£41,025.80	£39,702.38	£41,025.80	£8,877.89	0	0
£35,826.64	£39,665.21	£38,385.69	£39,665.21	£38,385.69	£39,665.21	£39,665.21
£594,260.91	£647,219.02	£622,910.00	£643,673.67	£482,472.22	£347,597.25	£233,022.40
£5,873,885.0	£6,521,104.0	£7,144,014.0	£7,787,687.7	£8,270,159.9	£8,617,757.2	£8,850,779.6

Harawa project
planning cash flow

1-Sep-1991	1-Oct-1991	1-Nov-1991	1-Dec-1991	1-Jan-1992	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£0.00	£0.00	£0.00	£0.00	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£36,782.83	£25,390.37	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£38,385.69	£39,665.21	£38,385.69	£30,335.36	£0.00	
£0.00	£0.00	£0.00	£0.00	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£36,782.83	£25,390.37	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£38,385.69	£39,665.21	£38,385.69	£30,335.36	£0.00	
£0.00	£0.00	£0.00	£0.00	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£36,782.83	£25,390.37	0	0	£0.00	
0	0	0	0	£0.00	
0	0	0	0	£0.00	
£38,385.69	£39,665.21	£38,385.69	£30,335.36	£0.00	
£225,505.55	£195,166.74	£115,157.08	£91,006.07	£0.00	£0,477,615.00

No	Avtivity	start dates	finish dates	materials cost	labour cost	plants cost	work distribution	overheads%	Profits%
	Construction Phases	8-Nov-89	24-Dec-91	£0.00	£0.00	£0.00	0	0	0.00%
	Final Design	6-Mar-90	2-Nov-90	£94,500.00	£85,800.00	£22,500.00	1	3%	12%
	earth works and leveling	8-Nov-89	18-Jun-91	£188,500.00	£145,700.00	£230,600 00	2.1	3%	8%
	mobilisation camp	5-Mar-90	6-Mar-91	£56,800.00	£56,300.00	£32,600.00	1	3%	8%
	house buildings	23-Jan-90	23-Jan-91	£0.00	£0.00	£0.00	0	0	0.00%
	0	0-Jan-00	0-Jan-00	£0.00	£0.00	£0.00	0	0.0%	0.00%
	Houses groups 1&2	19-Mar-90	24-Dec-91	£0.00	£0.00	£0.00	0	0.0%	0.00%
	foundation group 5&6	3-May-90	23-Jan-91	£35,600.00	£54,800.00	£18,700.00	2	3%	11%
	walls works group 5&6	9-Apr-90	30-Aug-90	£17,400.00	£19,500.00	£17,200.00	1	3%	10%
	concrete columns G5&6	21-May-90	21-Aug-90	£24,600.00	£17,600.00	£15,700.00	2 3	3%	12%
	concrete slabs G5&6	2-Jul-90	7-Sep-90	£24,550.00	£16,750.00	£11,200.00	2 3	3%	11%
	internal walls plaster	26-Jun-90	5-Sep-90	£27,550.00	£24,350.00	£18,750.00	2 2	3%	11%
	Electrical wires and cables	27-Aug-90	8-Nov-90	£11,350.00	£24,300.00	£15,250.00	2 1	3%	11%
	plumping wroks	24-Sep-90	23-Nov-90	£28,800 00	£31,000.00	£13,200.00	1	3%	11%
	water supply	17-May-90	25-Sep-90	£75,000.00	£87,500.00	£65,700.00	1	3%	10%
	walls clading (ceramic)	19-Mar-90	23-Nov-90	£70,500.00	£120,500.00	£65,800.00	1	3%	9%
	Floor tiles	24-Sep-90	26-Jul-91	£156,750.00	£129,500.00	£85,600.00	1	3%	8%
	Internal walls paint	23-Oct-90	21-Oct-91	£175,400.00	£105,400.00	£78,500.00	1	3%	10%
	water ground tanks	23-Nov-90	24-Jun-91	£45,700.00	£35,400 00	£28,500 00	1	3%	11%
	septic tanks	23-Jan-91	7-Jun-91	£65,700.00	£45,500 00	£35,650.00	1	3%	10%
	land scaping	23-Jan-91	24-Dec-91	£145,700.00	£98,500.00	£115,400.00	1	3%	11%
	Houses groups 3&4	19-Mar-90	24-Dec-91	£0.00	£0.00	£0.00	0	0.0%	11%
	foundation group 3&4	3-May-90	23-Jan-91	£35,600.00	£54,800 00	£18,700.00	1	3%	11%
	walls works group 3&4	9-Apr-90	30-Aug-90	£17,400.00	£19,500.00	£17,200 00	1	3%	10%
	concrete columns G3&4	21-May-90	21-Aug-90	£24,600.00	£17,600 00	£15,700.00	2.3	3%	11%
	concrete slabs G3&4	2-Jul-90	7-Sep-90	£24,550.00	£16,750.00	£11,200.00	2 3	3%	11%
	Internal walls plastur	26-Jun-90	5-Sep-90	£27,550.00	£24,350.00	£18,750.00	2 2	3%	0%
	Electrical wires and cables	27-Aug-90	8-Nov-90	£11,350.00	£24,300.00	£15,250.00	2 1	3%	8%
	plumping wroks	24-Sep-90	23-Nov-90	£28,800.00	£31,600.00	£13,200.00	1	3%	11%
	water supply	17-May-90	25-Sep-00	£75,900 00	£87,500.00	£65,700.00	1	3%	10%
	walls clading (ceramic)	19-Mar-90	23-Nov-90	£70,600.00	£120,500.00	£65,800.00	1	3%	10%
	Floor tiles	24-Sep-90	26-Jul-91	£156,750.00	£129,500.00	£85,600.00	1	3%	10%
	Internal walls paint	23-Oct-90	21-Oct-91	£175,400.00	£105,400.00	£78,500.00	1	3%	0.00%
	water ground tanks	23-Nov-90	24-Jun-91	£45,700.00	£35,400.00	£28,500.00	1	3%	0.00%
	septic tanks	23-Jan-91	7-Jun-91	£65,700.00	£45,500.00	£35,650.00	1	9%	0.00%
	land scaping	23-Jan-91	24-Dec-91	£145,700.00	£98,500.00	£115,400.00	1	3%	0.00%
	Houses groups 5 &6	19-Mar-90	24-Dec-91	£0.00	£0.00	£0.00	0	0.0%	0.00%
	foundation group 5&6	3-May-90	23-Jan-91	£35,600.00	£54,800.00	£18,700.00	1	3%	11%
	walls works group 5&6	9-Apr-90	30-Aug-90	£17,400.00	£19,500.00	£17,200.00	1	3%	11%
	concrete columns G5&6	21-May-90	21-Aug-90	£24,600.00	£17,600.00	£15,700.00	2 3	3%	9%
	concrete slabs G5&6	2-Jul-90	7-Sep-90	£24,550 00	£16,750.00	£11,200 00	2.3	3%	8%
	internal walls plaster	26-Jun-90	5-Sep-90	£27,550.00	£24,350.00	£18,750 00	2.2	3%	11%
	Electrical wires and cables	27-Aug-90	8-Nov-90	£11,350 00	£24,300.00	£15,250.00	2.1	3%	10%
	plumping wroks	24-Sep-90	23-Nov-90	£28,800.00	£31,000.00	£13,200.00	1	3%	10%
	water supply	17-May-90	25-Sep-90	£75,900.00	£87,500.00	£65,700.00	1	3%	10%
	walls clading (ceramic)	19-Mar-90	23-Nov-90	£70,500.00	£120,500.00	£65,800.00	1	3%	11%
	Floor tiles	24-Sep-90	26-Jul-91	£156,750.00	£129,500 00	£85,600.00	1	3%	11%
	Internal walls paint	23-Oct-90	21-Oct-91	£175,400.00	£105,400.00	£78,500 00	1	3%	9%
	water ground tanks	23-Nov-90	24-Jun-91	£45,700.00	£35,400 00	£28,500 00	1	3%	8%
	septic tanks	23-Jan-91	7-Jun-91	£65,700.00	£45,500.00	£35,650.00	1	3%	11%
	land scaping	23-Jan-91	24-Dec-91	£145,700.00	£98,500.00	£115,400.00	1	3%	10%
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Appendix (d)

Total Items Cost	Cost/day	Materials %	Labour %	Plants %		8-Nov-99	1-Dec-99
£0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!		£0.00	£0.00
£233,220.0	968.2	40.52%	36.79%	9.65%		£0.00	£0.00
£604,728.0	1,029.5	27.86%	24.09%	38.13%		£23,338.31	£31,015.
£161,616.0	0.0	0.00%	0.00%	0.00%		£0.00	£0.00
£0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!		£0.00	£0.00
£0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		0	0
£0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!		£0.00	£0.00
£124,374.0	468.7	28.62%	44.06%	15.04%		£0.00	£0.00
£61,133.0	426.4	28.46%	31.90%	28.14%		£0.00	£0.00
£66,585.0	720.8	36.95%	28.49%	23.55%		£0.00	£0.00
£59,650.0	688.3	41.02%	27.89%	18.71%		£0.00	£0.00
£80,541.0	1,128.4	34.21%	30.23%	23.28%		£0.00	£0.00
£58,026.0	790.8	19.56%	41.88%	26.28%		£0.00	£0.00
£83,904.0	1,389.7	34.32%	37.86%	15.73%		£0.00	£0.00
£258,883.0	1,970.6	29.32%	33.80%	25.38%		£0.00	£0.00
£287,616.0	1,153.3	24.61%	41.90%	22.88%		£0.00	£0.00
£412,753.5	1,351.6	37.98%	31.37%	20.74%		£0.00	£0.00
£406,009.0	1,117.3	43.20%	25.96%	19.33%		£0.00	£0.00
£124,944.0	0.0	0.00%	0.00%	0.00%		£0.00	£0.00
£165,940.5	1,225.8	30.59%	27.42%	21.48%		£0.00	£0.00
£407,664.0	1,215.5	35.74%	23.67%	28.31%		£0.00	£0.00
£0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!		£0.00	£0.00
£124,374.0	468.7	28.62%	44.06%	15.04%		£0.00	£0.00
£61,133.0	426.4	28.46%	31.90%	28.14%		£0.00	£0.00
£66,006.0	714.5	37.27%	26.66%	23.70%		£0.00	£0.00
£59,650.0	688.3	41.02%	27.99%	18.71%		£0.00	£0.00
£79,128.0	1,108.6	34.82%	30.77%	23.70%		£0.00	£0.00
£56,499.0	770.0	20.09%	43.01%	28.90%		£0.00	£0.00
£83,904.0	1,389.7	34.32%	37.86%	15.73%		£0.00	£0.00
£258,883.0	1,970.6	29.32%	33.80%	25.38%		£0.00	£0.00
£290,184.0	1,163.6	24.29%	41.53%	22.68%		£0.00	£0.00
£420,190.5	1,376.0	37.30%	30.82%	20.37%		£0.00	£0.00
£370,079.0	1,018.4	47.40%	28.48%	21.21%		£0.00	£0.00
£112,866.0	0.0	0.00%	0.00%	0.00%		£0.00	£0.00
£151,255.5	1,117.3	43.44%	30.08%	23.57%		£0.00	£0.00
£368,328.0	1,098.3	39.55%	26.20%	31.33%		£0.00	£0.00
£0.0	0.0	#DIV/0!	#DIV/0!	#DIV/0!		£0.00	£0.00
£124,374.0	468.7	28.62%	44.06%	15.04%		£0.00	£0.00
£61,674.0	430.2	28.21%	31.62%	27.89%		£0.00	£0.00
£64,848.0	702.0	37.93%	27.14%	24.21%		£0.00	£0.00
£58,275.0	864.9	42.13%	28.74%	19.22%		£0.00	£0.00
£80,541.0	1,128.4	34.21%	30.23%	23.28%		£0.00	£0.00
£57,517.0	783.9	19.73%	42.26%	26.51%		£0.00	£0.00
£83,168.0	1,377.5	34.63%	35.00%	15.87%		£0.00	£0.00
£258,883.0	1,970.6	29.32%	33.80%	25.38%		£0.00	£0.00
£292,752.0	1,173.0	24.08%	41.16%	22.48%		£0.00	£0.00
£423,909.0	1,358.2	36.98%	30.65%	20.19%		£0.00	£0.0C
£402,416.0	1,107.4	43.59%	26.19%	19.61%		£0.00	£0.0C
£121,656.0	570.2	37.56%	29.10%	23.43%		£0.00	£0.0C
£167,409.0	1,236.6	39.25%	27.18%	21.30%		£0.00	£0.0C
£404,088.0	1,204.9	30.06%	23.86%	28.56%		£0.00	£0.0C

Jan-1990	1-Feb-1990	1-Mar-1990	1-Apr-1990	1-May-1990	1-Jun-1990	1-Jul-1990	1-Aug-1990	1-Sep-1990
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£24,799.50	£28,980.43	£29,952.65	£28,980.43	£29,952.65	£29,952.65	£28,086.43
1,915.84	£28,827.21	£31,915.84	£30,886.30	£31,915.84	£30,886.30	£31,915.84	£31,915.84	£30,886.30
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0 00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0 00	£0.00
£0.00	£0.00	£0.00	£0.00	£13,435.28	£14,060.18	£14,528.85	£14,528.85	£14,060.18
£0.00	£0.00	£0.00	£9,238.35	£13,217.95	£12,791.56	£13,217.95	£12,667.20	0
£0.00	£0.00	£0.00	£0.00	£7,686.66	£21,624.36	£22,345.17	£14,926.81	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£26,353.25	£27,537.66	£5,959.00
£0.00	£0.00	£0.00	£0.00	£0.00	£5,265.96	£34,981.03	£34,981.03	£5,312.08
£0 00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3,890 47	£23,724.43
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£9,204.76
£0.00	£0.00	£0.00	£0.00	£28,901.62	£59,116.96	£61,087.52	£61,087.52	£46,689.38
£0.00	£0.00	£14,609.07	£34,600.42	£35,753.77	£34,600.42	£35,753.77	£35,753.77	£34,600.42
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£9,010.88
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£13,435.28	£14,060.18	£14,528.85	£14,528.85	£14,060.18
£0.00	£0.00	£0.00	£9,238.35	£13,217.95	£12,791.56	£13,217.95	£12,667.20	0
£0.00	£0.00	£0.00	£0.00	£7,821.80	£21,436.32	£22,150.66	£14,797.01	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£26,353.25	£27,537.66	£5,959.09
£0.00	£0.00	£0.00	£0.00	£0.00	£5,173.58	£34,367.33	£34,307.33	£5,219.77
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3,593.35	£23,100.10
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0,204.76
£0.00	£0.00	£0.00	£0.00	£28,901.62	£59,116.96	£61,087.52	£61,087.52	£46,689.38
£0.00	£0.00	£14,730.50	£34,909.35	£36,073.00	£34,909.35	£36,073.00	£36,073.00	£34,900.35
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£9,173.21
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0 00	£0.00	£0.00	£13,435.28	£14,060.18	£14,528.85	£14,528.85	£14,060.18
£0.00	£0 00	£0.00	£9,320.10	£13,334.92	£12,904.76	£13,334.92	£12,779.30	0
£0.00	£0.00	£0.00	£0.00	£7,488.09	£21,060.24	£21,702.25	£14,537.42	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£25,650.74	£26,812.09	£5,802.27
£0.00	£0.00	£0.00	£0.00	£0.00	£5,265.96	£34,981.03	£34,681.03	£5,312.98
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3,858.09	£23,516.32
£0 00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0 00	£0,183.49
£0.00	£0.00	£0.00	£0.00	£28,901.62	£59,116.96	£61,087.52	£61,087.52	£46,689.38
£0.00	£0.00	£14,869.94	£35,218.29	£30,392.23	£35,218.20	£36,392.23	£36,392.23	£35,218.26
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£8,254.39
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0 00	£0.00	£0.00	£0.00	£0.00	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
£31,915.84	£28,827.21	£100,833.86	£192,397.59	£359,667.56	£502,440.49	£685,661.32	£676,471.15	£611,907
£87,168.0	£115,895.2	£216,920.1	£409,328.7	£768,094.2	£1,271,440.7	£1,057,102.0	£2,033,573.2	£3,145,46

1-Oct-1990	1-Nov-1990	1-Dec-1990	1-Jan-1991	1-Feb-1991	1-Mar-1991	1-Apr-1991	1-May-1991	1-Jun-1
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£20,852.65	£1,650.62	0	0	0	0	0	0	0
£31,915.84	£30,886.30	£31,915.84	£31,915.84	£28,827.21	£31,915.84	£30,886.30	£31,915.84	£18,231
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£0.00	£0.00	£0.00	£0.00	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£14,528.85	£14,060.18	£14,528.85	£10,642.77	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£24,515.24	£6,095.86	0	0	0	0	0	0	0
£43,081.14	£31,558.10	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£35,763.77	£26,190.60	0	0	0	0	0	0	0
£41,900.48	£40,548.85	£41,900.48	£41,900.48	£37,845.59	£41,900.48	£40,548.85	£41,900.48	£40,54
£9,683.51	£33,519.83	£34,637.16	£34,637.16	£31,285.18	£34,637.16	£33,519.83	£34,637.16	£33,51
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£0.00	£0.00	£0.00	£10,823.46	£34,321.05	£37,999.30	£36,773.52	£37,900.30	£8,222
£0.00	£0.00	£0.00	£10,534.74	£34,035.31	£37,681.95	£36,468.40	£37,681.95	£36,46
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£14,528.85	£14,060.18	£14,528.85	£10,642.77	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£23,870.11	£5,935.44	0	0	0	0	0	0	0
£43,081.14	£31,558.10	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£35,073.00	£26,424.44	0	0	0	0	0	0	0
£42,655.44	£41,279.40	£42,655.44	£42,655.44	£38,527.50	£42,655.44	£41,279.40	£42,655.44	£41,27
£8,826.56	£30,553.48	£31,571.93	£31,571.93	£28,516.56	£31,571.93	£30,553.48	£31,571.93	£30,55
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£0.00	£0.00	£0.00	£9,683.33	£31,284.61	£34,636.53	£33,519.22	£34,636.53	£7,405
£0.00	£0.00	£0.00	£9,518.23	£30,751.20	£34,045.97	£32,947.72	£34,045.97	£32,94
£0.00	£0.00	• £0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.0
£14,528.85	£14,060.18	£14,528.85	£10,642.77	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£24,300.20	£6,042.30	0	0	0	0	0	0	0
£42,703.24	£31,281.27	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
£36,392.23	£26,658.29	0	0	0	0	0	0	0
£43,032.92	£41,644.76	£43,032.92	£43,032.92	£38,868.45	£43,032.92	£41,644.76	£43,032.92	£41,64
£9,597.81	£33,223.20	£34,330.64	£34,330.64	£31,008.32	£34,330.64	£33,223.20	£34,330.64	£33,22
£0.00	£4,371.16	£17,674.69	£17,674.69	£15,964.23	£17,674.69	£17,104.53	£17,674.69	£13,51
£0.00	£0.00	£0.00	£10,717.47	£34,625.65	£38,335.58	£37,098.95	£38,335.58	£8,29
£0.00	£0.00	£0.00	£10,442.33	£33,736.75	£37,351.41	£36,146.52	£37,351.41	£36,14
£570,921.83	£491,602.67	£321,305.05	£371,166.99	£440,593.57	£497,769.84	£481,712.75	£407,760.84	£382,
£3,716,403.0	£4,208,005.7	£4,529,311.3	£4,900,478.3	£5,350,076.9	£5,847,846.7	£6,329,559.5	£6,827,329.3	£7,20

harawa project
actual progress

1-Jul-1991	1-Aug-1991	1-Sep-1991	1-Oct-1991	1-Nov-1991	1-Dec-1991	1-Jan-1992
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
£0.00	£0.00	£0.00	£0.00	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	0
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
£34,748.11	0	0	0	0	0	£0.00
£34,637.16	£34,637.16	£33,519.83	£23,138.00	0	0	£0.00
£0.00	£0.00	£0.00	£0.00	0	0	£0.00
0	0	0	0	0	0	£0.00
£37,681.95	£37,681.95	£36,466.40	£37,681.95	£36,466.40	£28,818.59	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
£35,374.20	0	0	0	0	0	£0.00
£31,571.93	£31,571.93	£30,553.48	£21,090.39	0	0	£0.00
£0.00	£0.00	£0.00	£0.00	0	0	£0.00
0	0	0	0	0	0	£0.00
£34,045.97	£34,045.97	£32,947.72	£34,045.97	£32,947.72	£26,037.85	£0.00
£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
£35,687.25	0	0	0	0	0	£0.00
£34,330.64	£34,330.64	£33,223.20	£22,933.24	0	0	£0.00
0	0	0	0	0	0	£0.00
0	0	0	0	0	0	£0.00
£37,351.41	£37,351.41	£36,146.52	£37,351.41	£36,146.52	£28,505.79	£0.00
£315,428.62	£209,619.06	£202,857.15	£176,240.95	£69,414.12	£54,856.44	£0.00
£7,524,851.0	£7,734,470.0	£7,937,327.2	£8,113,568.1	£8,182,982.2	£8,237,838.7	£8,237,838.7