Financial Model for Private Finance Initiative Projects Applied to School Buildings

By

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Private Finance Initiative (PFI) has become a major procurement method in the UK and worldwide. The number of signed PFI deals is growing, but competition is restricted to those companies that are able to afford the initial investment. The bidding cost of PFI projects are high, and bidding companies are not compensated if the client does not award them the project. This is the reason behind several recent high-profile tender withdrawals, and is considered a major barrier for private companies wanting to take part in the bidding process.

There is an obvious need for a tool to enable construction organizations to participate in PFI projects; one that can support these organizations in a decision-making process that is compatible with their project selection strategies, and will allow them to bid for PFI projects with clearer goals and reduced costs. A computer-based financial model was developed to predict the cost and cash flow of PFI projects, enabling project teams to assess investment decisions at the tendering stage. The proposed model consists of four modules to identify the required building area, predict the construction cost, distribute the occupancy cost, and predict the cash flow of the project. The output of the model provides the project investment results, such as the Net Present Value (NPV), Internal Rate of Return (IRR), Debt Service Coverage Ratio (DSCR), payback period and investment growth ratio. The model can predict the unitary payment but also allows the user to define the unitary payment. The reports of the model contain the cash flow and investment ratio for both types of unitary payment.

The model attempts to provide the information required to assess the feasibility and affordability of the project. It gives the private sector the chance to assess the project before they spend unrecoupable funds on the project. It allows the public sector to determine the project cost, cash flow, unitary charge, and provide the information to be used for the Public Sector Comparator. The data required for the development of the model was collected from different sources. The model was initially developed on spreadsheet software; the final version was transformed into a web-based model using the Hypertext Preprocessor (PHP) and Javascript programming languages. The completed model was then sent to many practitioners for validation and assessment of both the concept and numerical application. The responses received show the valuable role the model could play in PFI projects.

To

My family

In particular, to my wife, Shaikah, for her support, encouragement and patience, and for our children; Abdullah, Sarah, Thamer and Mohammad.

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Al-Sharif, Faisal and Kaka, Ammar (2003) Potential of PFI/PPP as a financing source for public services projects in Saudi Arabia. *In:* Greenwood, D (Ed.), *19th Annual ARCOM conference*, University of Brighton. Association of Researchers in Construction Management, Vol. 1, 71-80.

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Mustaffa, Nur Emma, **Al-Sharif, Faisal**, Kaka, Ammar and Bowles, Graeme (2005) Dispute Management in Private Finance Initiative (PFI) projects: UK experience. *In:* Yaowu, W and Qiping, S (Eds.), *International conference on construction & real estate management*, Penang, Malaysia, Vol. 1, 14-19.

Salama, M, Al-**Sharif, F**, Kaka, A P and Leishman, C (2006) Cost modelling for standardised design projects. *In:* Boyd, D (Ed.), *22nd Annual ARCOM Conference*, 4-6 September 2006 Birmingham, UK. Association of Researchers in Construction Management, Vol. 2, 621-631.

Cahpter One

Introduction

1.0 Introduction

1.1 Introduction

This research aims to develop a computer-based model to help in the financial management of PFI projects. This chapter provides an overview of the thesis; it also highlights the research rationale, aim and objectives, findings, and outlines the structure of the thesis.

1.2 Background

Private Finance Initiative (PFI) is the name given to the policies announced by the Chancellor of the Exchequer in his autumn statement of 1992 (RICS, 1995). It is a type of Public Private Partnership (PPP) where project financing rests mainly with the private sector (Akintoye *et al.*, 2001). It has become a major procurement method in the UK and worldwide. Since its launch in 1992, the UK government has supported PFI and encouraged local authorities to use PFI where it is applicable and can provide Value for Money (VfM). Since then, many projects have been provided through PFI. The total amount of investment of UK government signed deals in PFI projects had risen to £42,699 million by 2004 (Table 2.8).

Globally, the movement towards PFI procurement methods was driven by two major reasons: the need to fund these projects and/or the need for private sector innovation in the design and management of public sector facilities and infrastructure projects. In developing countries, the high demand for infrastructure development, coupled with the pressures on national budgets, is making the government move towards encouraging the private sector to invest in infrastructure projects.

1.3 Rationale

PFI is considered to be a new procurement system; its share of the total construction industry outcome is growing. The movement towards research in PFI/PPP is not comparative with its importance and the level of activities associated. The number of PhD research studies into PFI/PPP undertaken in the UK was only seven by August 2004 (Payne, 2004). Al-Sharif and Kaka (2004) reported that the average coverage of subjects related to PFI/PPP was only 2.61% of the total papers (1314 papers) published in four of the top journals of the construction sector. Although the study is limited to only four journals over a six-year period (1998-2003), it calls to involve academic researchers in this field in order to find solutions and overcome problems which may attract construction firms to bid for PFI/PPP projects and will further ground PFI/PPP research while enhancing its quality.

According to NAO (2001), the number of firms in the construction sector in 1999 was 163,236, of which 95% have 1-13 employees, 4% have 14-79 employees, and only 1% have over 80 employees. This means that 99% of the construction firms in the UK are small and medium size contractors, based on employee number classification. The PFI market is limited to large size contractors; Bing *et al.* (2005) found that only 15% of construction cost and 13.20% of the operation Net Present Value (NPV) cost of the fifty-three PFI projects they surveyed are less than £10 million. Small and medium contractors are not capable of dealing with the complexity and size of PFI projects. Financial and managerial requirements, in addition to the arrangements needed to complete a competitive PFI bid, are not found in small and some medium contractors. The complexity of relationships, negotiation, arrangements, agreements, and long-term engagement are barriers for small construction organisations.

The bidding cost is considered to be high in PFI projects. Both the public and private sectors are required to hire technical, legal, and financial consultancies to ensure the project's affordability and VfM for the public sector, profitability, bidding quality etc. Ahadzi and Bowles (2004) stated that the bidding and advisory costs to both the private and public sectors were found to be equally high, ranging from £0.1-2.0 million, depending on project type. The reason for bidding costs often being highlighted in the context of PFI is that bidding usually takes place at risk. In other words, if the client awards the project contract to a competitor or does not award it at all, the contractor will not be compensated for their bidding costs (Rintala, 2004).

Public sector authorities are required to ensure that procurement by departments should be based on value for money — defined as the optimum combination of whole life costs and quality to meet the customer's requirements — rather than initial purchase price (NAO, 1999). The Value for Money (VfM) assessment requires a Public Sector Comparator (PSC) in which the authority should compare other options against the PFI procurement method. The data on traditional procurement methods is mostly accessible, because authorities have completed many projects in this way already. Consultants provide the data and results of PFI options in this case This means that the authorities will have to spend a reasonable amount of money before they know if they are going to go with the PFI option or not. This will raise the project cost, whatever the selected option may be.

Consequently, an integrated cost and cash flow model for PFI projects may help in overcoming some of these problems. The need is for a tool to model the project cost, cash flow, and to assess the affordability and viability of the project investment. If the model provides the ability to change inputs and check outputs, this may allow for the assessment of alternatives, which is important for the visibility studies and value for money in PFI projects.

1.4 Motivations

The importance of PFI projects in the construction sector is highlighted above (Section 1.2). The rationale behind selecting the topic is also highlighted above (Section 1.3). These are the main motivation factors on which this research is based. There are many motivation factors in addition to the above. These factors are as follows:

- The need of private sector participation in providing public services and infrastructure projects in developing countries, where lack of funds and lack of management skills are chronic problems and barriers to providing the necessary projects. The aspiration to capture the knowledge that could help in solving such problems was one of the motivations in selecting the research area.
- The personal interest in PFI and financial management in the construction industry provided the stimulation to proceed in exploring the area of financial management in PFI projects.
- The construction industry needs research to make entry into PFI projects clearer and simpler. The cost of financial models for PFI projects is beyond the capability of medium and small construction organisations. This limits participation in the PFI field to the larger construction organisations.
- This research could be one of is the first academic researches in modelling PFI financial management processes. It is intended as the first step from which other researchers can develop further research.

1.5 Aim and Objectives

This research aims to develop a computer-based model for the financial management of PFI projects. The model attempts to forecast school project's cost and cash flow to enable project teams to assess the investment decision at the tendering stage. The objectives undertaken to achieve this aim were:

- To explore PFI procurement systems and how they works. This was conducted by reviewing research publications, textbooks, reports and guidelines which discuss PFI and its associated issues.
- To explore the project's costing, cash flow, and financial management. This was undertaken by methods similar to those mentioned in the previous objective.

- To explore and report on the current practices of PFI financial modelling by conducting a series of semi-structured interviews with experienced practitioners.
- To develop an integrated computer-based model to model the cost and cash flow of PFI school projects. This model comprises four modules:
  - Space planning module to calculate the building area.
  - Construction cost module to predict the cost of construction.
  - Occupancy cost module to normalize and distribute the Life Cycle Cost (LCC) and Facilities Management (FM) costs.
  - Cash flow module to model the behavior of proposed cash flow, and calculate the investment ratios and project financial management.
- To evaluate the model concepts and its workability and intelligibility.

1.6 Research Design and Methodology

The research methodology adopted to meet the research objectives was mainly that of a quantitative approach. A numerical modelling system was developed to model the PFI project's cost and cash flow, and to produce the results needed for decision making in the early stages of the project. There are objectives to support achieving the aim, such as exploring the current state of PFI research, and surveying the current practices in PFI financial modelling. The survey was conducted through a series of semi-structured interviews to support the main research methodology.

The research design, as shown in Fig. 1.1, started with gathering knowledge about the subject as a base to justify the research problem, and to select the most suitable approach for conducting the research. The literature review and the survey of PFI current modelling practices identified the gaps which needed to be clarified and filled. The recommendations concluded from the survey, with the data collected to develop the individual modules, all formed the modelling process.

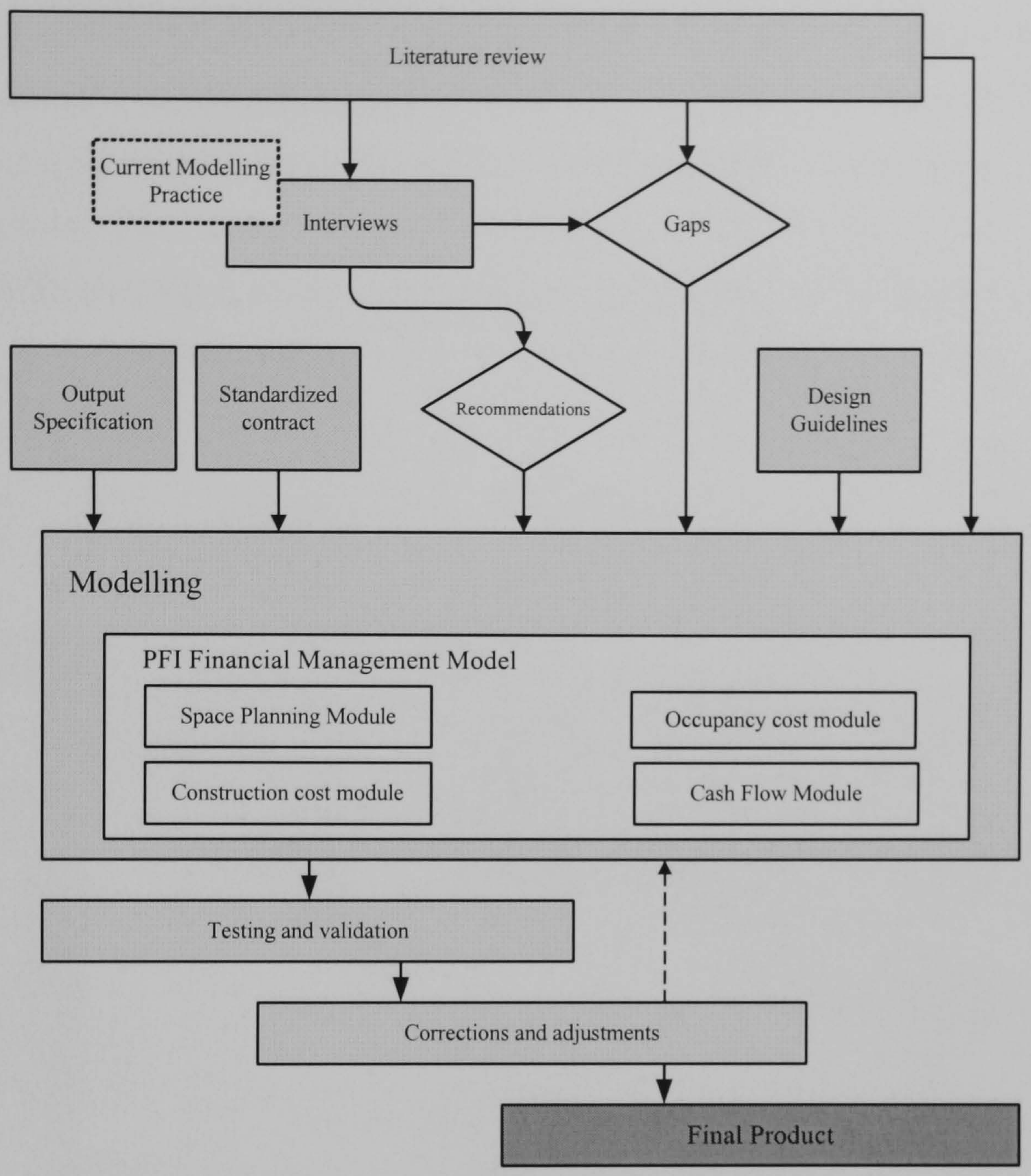


Figure 1.1: Research design

1.7 Research Findings

Based on the conclusion of the literature review and the survey conducted to explore the current practice of PFI financial modelling, an integrated computer-based model (concept of which is shown in Fig. 1.2) was designed to support decision making in the early stages of PFI projects. The model structure comprises four integrated modules. The first is to calculate the school building's area; the second is to predict the construction cost; the third module is to distribute the occupancy cost along the project duration, and the fourth module is to predict the cash flow and calculate the results of the project investments.

The data required for the development of the model was collected from different sources. The model was initially developed on spreadsheet software. However, the final version was transformed into a web-based model using Hypertext Preprocessor (PHP) and Javascripts. The completed model was then sent to many practitioners for validation and assessment of both the concept and numerical application. The responses received show the valuable role the model could play in PFI projects.

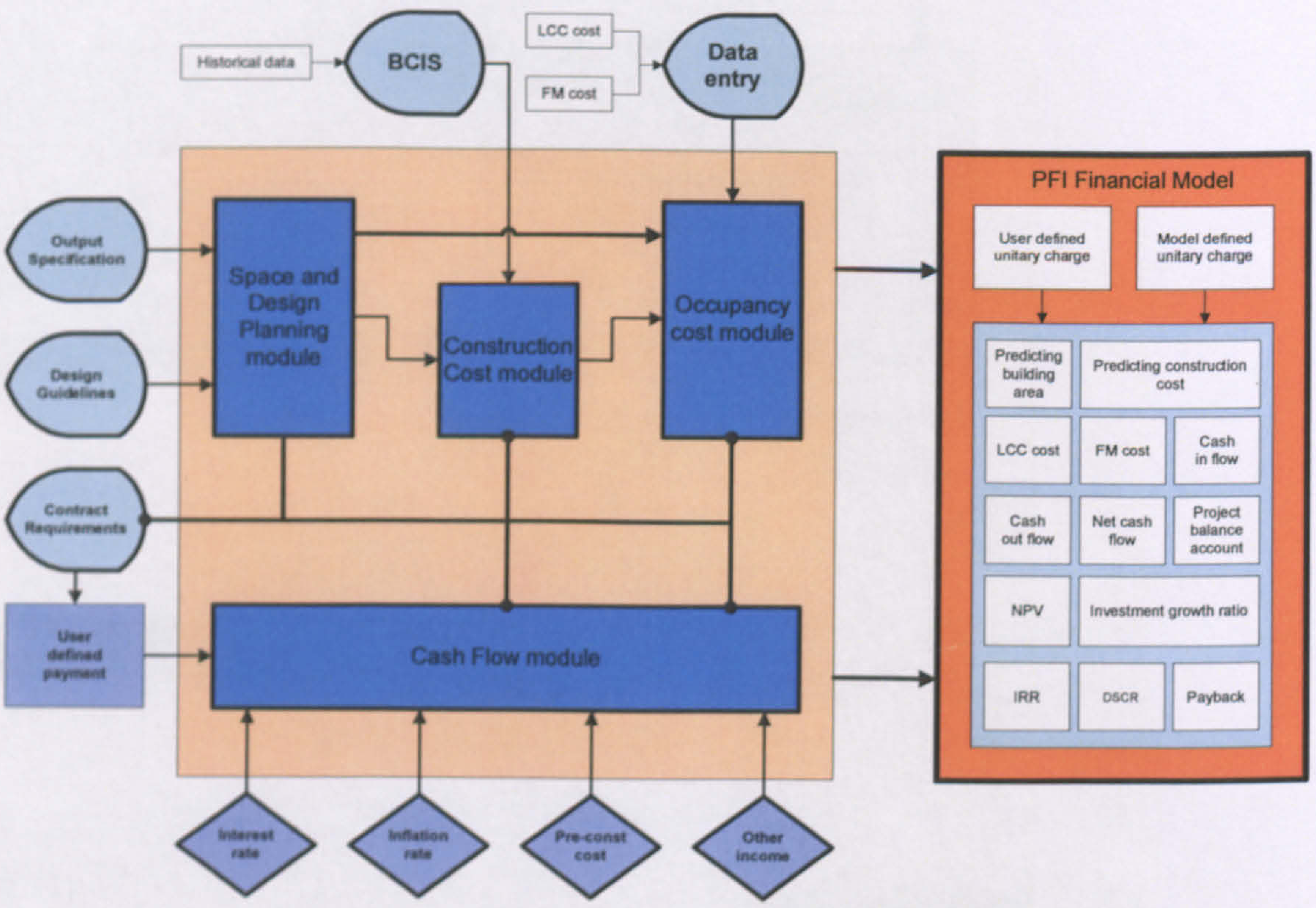


Figure 1.2: PFI Financial Management Model structure.

1.8 Structure of the thesis

The thesis is comprised of eleven chapters; it starts with the diagnosis by introducing the research, reviewing the literature and exploring current practices. The research structure then highlights the research methodology, and the description of the research undertaken to achieve the targeted aim and objectives. The research output and conclusion are reported in the later chapters of the thesis. The outline of the research is graphically represented in Figure 1.3 below, and the chapter's overview is as follows:

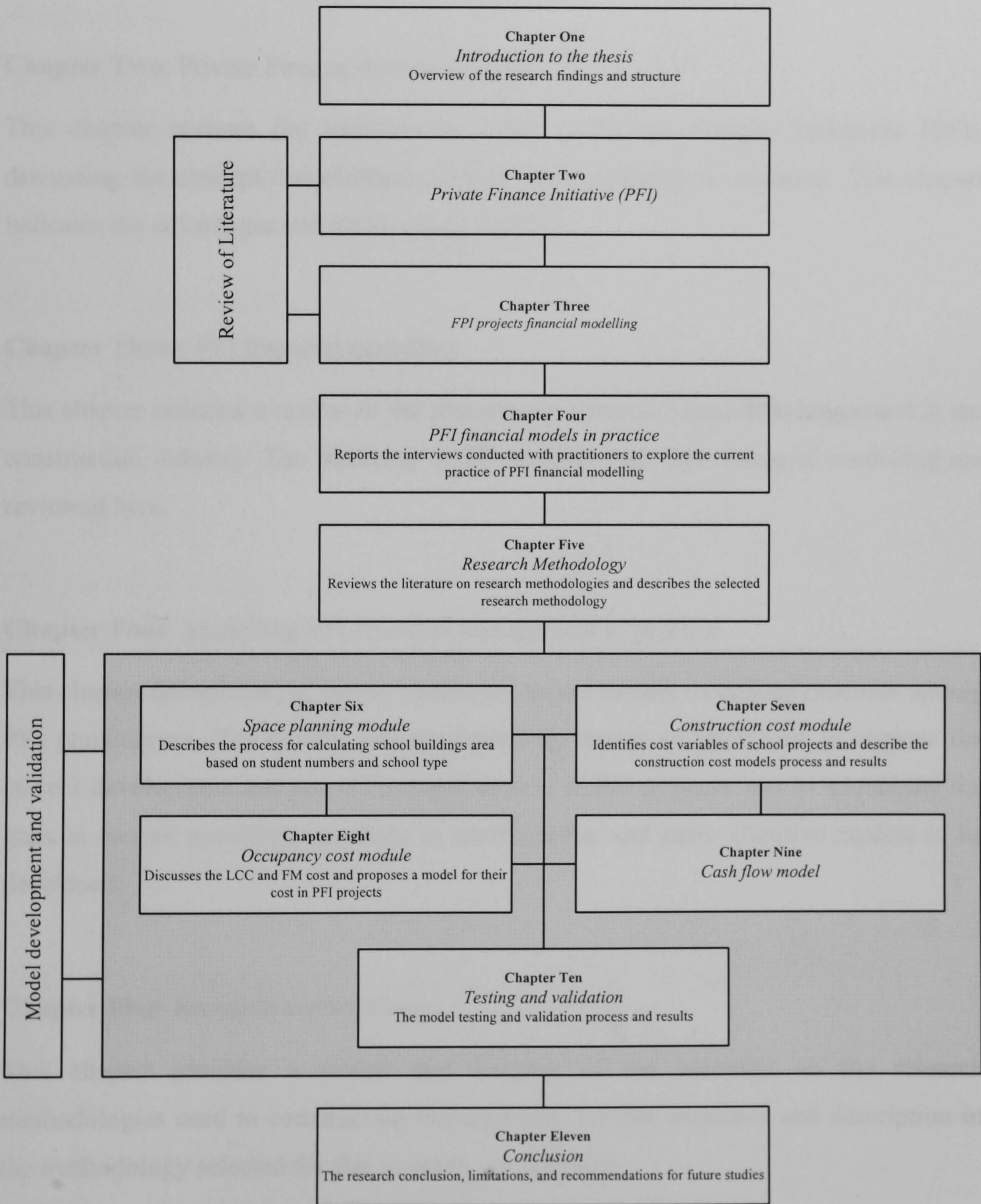


Figure 1.3: Research outline.

Chapter One: Introduction to the thesis

This chapter provides the introduction to the thesis and gives an overview to the research rationale, aim and objectives, methodology, findings, and structure of the thesis.

Chapter Two: Private Finance Initiative (PFI)

This chapter reviews the literature in terms of Private Finance Initiatives (PFI), discussing the concept, reviewing its history, and exploring its contracts. This chapter indicates the advantages and disadvantages of PFI.

Chapter Three: PFI financial modelling

This chapter contains a review of the literature in terms of financial management in the construction industry. The financing of PFI projects and their financial modelling are reviewed here.

Chapter Four: Modelling PFI financial management in practice

This chapter documents the survey conducted on the current modelling practices among PFI practitioners. The survey was conducted by means of interviews to explore the current development and use of financial models in PFI projects, and to investigate the gaps in current modelling practices to enable better and more effective models to be developed.

Chapter Five: Research methodology

This chapter provides a review and analysis of the literature on the research methodologies used in construction management. Further emphasis and description of the methodology selected for this research are provided.

Chapter Six: Space planning module

The basis of school building space-planning is explored, and a model is developed to calculate the school building area based on the number of students and school type.

Chapter Seven: Construction cost module

This chapter defines the variables of cost based on Building Cost Information Service (BCIS) indices; it discusses the data limitations, and develops a construction cost-prediction model for school buildings.

Chapter Eight: Occupancy cost module

Chapter eight explores the occupancy cost definition and components, and provides a module that will normalise and distribute the Life Cycle Cost (LCC) and Facilities Management (FM) cost through the project life.

Chapter Nine: Cash flow module

This final module reports on the development process of the cash flow modules. It also describes the project investments assessment ratios. The model inputs and outputs are also reported in detail.

Chapter Ten: Model validation

The model test and validation process and result are reported in this chapter. The model was validated in different ways to check its usefulness and accuracy.

Chapter Eleven: Conclusion

This chapter reports the thesis conclusions and finding. It also highlights the research limitations, contribution to knowledge, and recommendations for future studies.

Cahpter Two

Private Finance Initiative (PFI)

2 Private Finance Initiative (PFI)

2.1 Introduction

Private Finance Initiative (PFI) was launched in the UK in 1992 to use private sector capital investments to fund public service projects. The government depends on these new initiatives to upgrade and modernise public services, and therefore, many deals were signed to build new facilities and refurbish old ones using this type of procurement. This chapter will highlight PFI, its characteristics, and the benefits that such a procurement system offers for public services projects, the construction industry, and the public and private sectors.

The topic of private sector financed projects is a wide one; it could be viewed from different angles. This chapter presents the important issues in brief as an introduction for this thesis. It will be followed by specific chapters focusing more on the PFI financial process and modelling.

2.2 Searching for a definition

It is very important to define PFI before discussing its advantages and disadvantages. Most of the literature does not give a clear definition for PFI; it is implied through a description of its characteristics. The definition of PFI could be understood within the context of a Public-Private Partnership (PPP) for providing projects for the infrastructure and services. PPP can mean just about any collaboration between the public and private sector (Davies and Fairbrother, 2003). Li and Akintoye (2003) stated that 'Carrol and Steane (2000) defined PPPs in broad terms to encompass a very wide diversity of partnerships and the circumstances in which they arise as agreed co-operative ventures that involve at least one public and one private-sector institution as partner'. PPP and other initiatives can collectively be placed under the heading of privatisation, which was introduced by the Conservative Government and then applied with increasing frequency in the 1980s and 1990s (Gallimore *et al.*, 1997). The concept of PPP covers PFI, but it also embraces traditional procurement in which a public body engages a private company for a specific purpose (Davies and Fairbrother, 2003). Therefore, The Stationery Office (2000) published a report on the government approach to PPP and stated that Public Private Partnerships bring public and private sectors together in long term partnerships for mutual benefit. It also stated that the PPP label covers a wide range of partnership, including:

- The introduction of private sector ownership into state-owned businesses, using the full range of possible structures (whether by flotation or the introduction of the strategic partner), with sales of either a majority or minority stake.
- The Private Finance Initiative (PFI) and other arrangements where the public sector contracts to purchase quality services on a long-term basis so as to take advantage of private management skills.
- Selling Government services into wider markets and other partnership arrangements where private sector expertise and finance are used to exploit the commercial potential of Government assets.

Based on what has been mentioned above, PFI is a type of PPP where project financing rests mainly with the private sector (Akintoye *et al.*, 2001b). It is also a means of using private finance and skills to deliver capital investment projects traditionally provided by the public sector (S.P., 1999).

In principle, Private Finance Initiative (PFI) is the name given to the policies announced by the Chancellor of the Exchequer in the autumn statement of 1992 (RICS, 1995). The UK government was said to be considering this method of procurement as a corner-stone in modernising its public services (HM Treasury, 2000). In their review of the literature, Wildridge et al. (2004) found that PFI/PPP is now the dominant method for procuring public services involving capital spending in the NHS. PFI as a procurement system was introduced to benefit from the efficient management of the private sector when dealing with assets. Therefore, efficiency of facilities and value for money are the foundation of this policy, from programming for the design to the end of the contract. All the characteristics of PFI (such as innovation in design and operation, application of life cycle cost (LCC), sustainability, quality of performance and risk transfer) taken as a whole make PFI not only a procurement system, but also a tool for developing the construction industry through innovation and perfecting process (Al-Sharif and Kaka, 2003). In PFI procurement, the public sector defines what the services will be and the private sector determines how those services will be provided (Eaton *et al.*, 2005).

PFI is essentially the same thing as Design-Build-Finance-Operate (DBFO) projects (Palmer, 2000); it covers the same objectives from design to the operation of the facility. Akbiyikli and Eaton (2005a) and HM Treasury (1995) listed some abbreviations frequently used in connection with PFI schemes; these are: DBFO (Design, Build, Finance, Operate), DCMF (Design, Construct, Manage, and Finance), BOO (Build, Own and Operate), BOT (Build, Operate and Transfer), and BOOT (Build, Own, Operate and Transfer). The report stated that 'all these abbreviations, confusingly, have the same meaning'. The confusion between PFI and PPP in particular is always present. PFI is a public service delivery type of PPP where responsibility for providing public services is transferred from the public to the private sector for a considerable period of time. PFI is therefore a generic classifier for all types of 'construction' PPP (Eaton and Akbiyikli, 2005).

2.3 PFI history

The participation of the private sector with the public sector in delivering and providing projects is not new. The first known concession arrangement is the water distribution network which was given to the Perier brothers in Paris in 1782 (Hanke and Walter, 1987, Walker and Smith, 1995). The Suez Canal, which opened for international navigation on 17 November 1869, was a 99-year concession project (Walker and Smith, 1995). The Saudi Arabian government has a history of being very innovative in its approach to private participation in providing public projects. As early as May 1933 the

Saudi Government was already contracting out its oil operations to the Standard Oil Company via the formation of ARAMCO (Al-Sarhan and Presley, 2001). Walker and Smith (1995) reported that the Hong Kong cross-harbour tunnel project, which opened in 1972, was arguably the world's first true BOT project.

PFI as a strategy arose in the context of the stagnation of the economy since the 1960s and the expanding deficit that concerned the incoming Thatcher government, starting from 1979. The primary aim of Thatcher's government was to roll back the frontiers of the state and allow more direct private sector involvement in the provision of public services (Eaton and Akbiyikli, 2005). By the beginning of the 1980s, interest in the use of private finance to fund investments by public sector bodies, particularly nationalized industries, was sufficiently strong to prompt a re-examination of Government policy. The Treasury set up a committee under Sir William Ryrie; their report conclusions, known as 'Ryrie Rules', restricted the use of private sector funds to test against public fund alternatives which should result with more cost effective. The other Ryrie Rule is that unless Ministers decide otherwise in particular cases, the privately funded projects should not be additional to public expenditure provision (i.e., provision for public expenditure would be reduced by the amount of private funding obtained). These rules continued to apply until 1989. They were regularly criticised for being too restrictive and giving public bodies no incentive to seek privately funded solutions (HM Treasury, 1995). Nevertheless, there were privately funded projects over that period of time, as shown in table 2.8.

In May 1989, John Major, then the Chief Secretary to the Treasury, formally retired the Ryrie Rules on the grounds that they had outlived their usefulness; they were seen as incomprehensible, and set impossible hurdles. This move was intended to further encourage the private sector to bring forward schemes for privately financed projects (Eaton and Akbiyikli, 2005). The rise of PFI as a government initiative to enable public sector works to be carried out using input from the private sector has been marked by evolution as well as growth since its formal inception by the then Chancellor, Norman Lamont, in November 1992 (CIC, 1998).

In May 1997, the Labour Party won the general election and took over in government. The Labour Government redefined the PFI terminology; the three types of projects that had been previously known as PFI projects were renamed Public Private Partnerships (PPP). However, the Labour Government retained the term PFI in use for asset-based private provision of public services (Rintala, 2004).

2.4 PFI concept

In PFI structures, the private sector develops, finances and maintains an asset used in the delivery of public services. In return, the public sector pays a monthly charge that covers both the repayment of the capital investment and the ongoing service costs (BDO, 2003). This transforms government departments from being owners and operators of assets into the purchasers of services from the private sector (Ahadzi, 1999). PFI is one of a range of government policies designed to increase the involvement of the private sector in the provision of public services, or services that were once publicly provided. Other polices with similar aim are privatisation and contracting out. PFI differs from privatisation in that the public sector retains a substantial role in PFI, either as a main purchaser of the services provided or as an essential enabler of the project; it differs from contracting out in that the private sector is involved as a provider of the capital asset as well as the provider of services (HM Treasury, 1995). Figure 2.7 shows the PPP models and private sector involvement level in the public projects, and the ranges of this involvement. The key concepts of PFI according to Eaton et al. (2005) are:

- Purchase services not assets;
- value for money;
- risk management;
- incorporate private sector know-how and expertise; and
- whole life-cycle costing.

The whole concept of PFI is a government policy to tackle financial problems in facility provision and to integrate private management skills to increase efficiency, effectiveness and quality (Eaton and Akbiyikli, 2005). It is believed that, for PFI to achieve the project objectives, the outputs that the service is intended to deliver (as a result of the facility/development) must be clearly defined at the initial stages by the client (CIOB, 2002). As shown in figure 2.1 below, the role of the public sector (the procurer) is to specify the requirements for the facility and services they need; this is called the output specifications. The private sector (the provider) then will design, finance, and operate the facilities, which meet and provide for the procurer's needs. The procurer in return will pay the provider according to availability and performance of services and facilities.

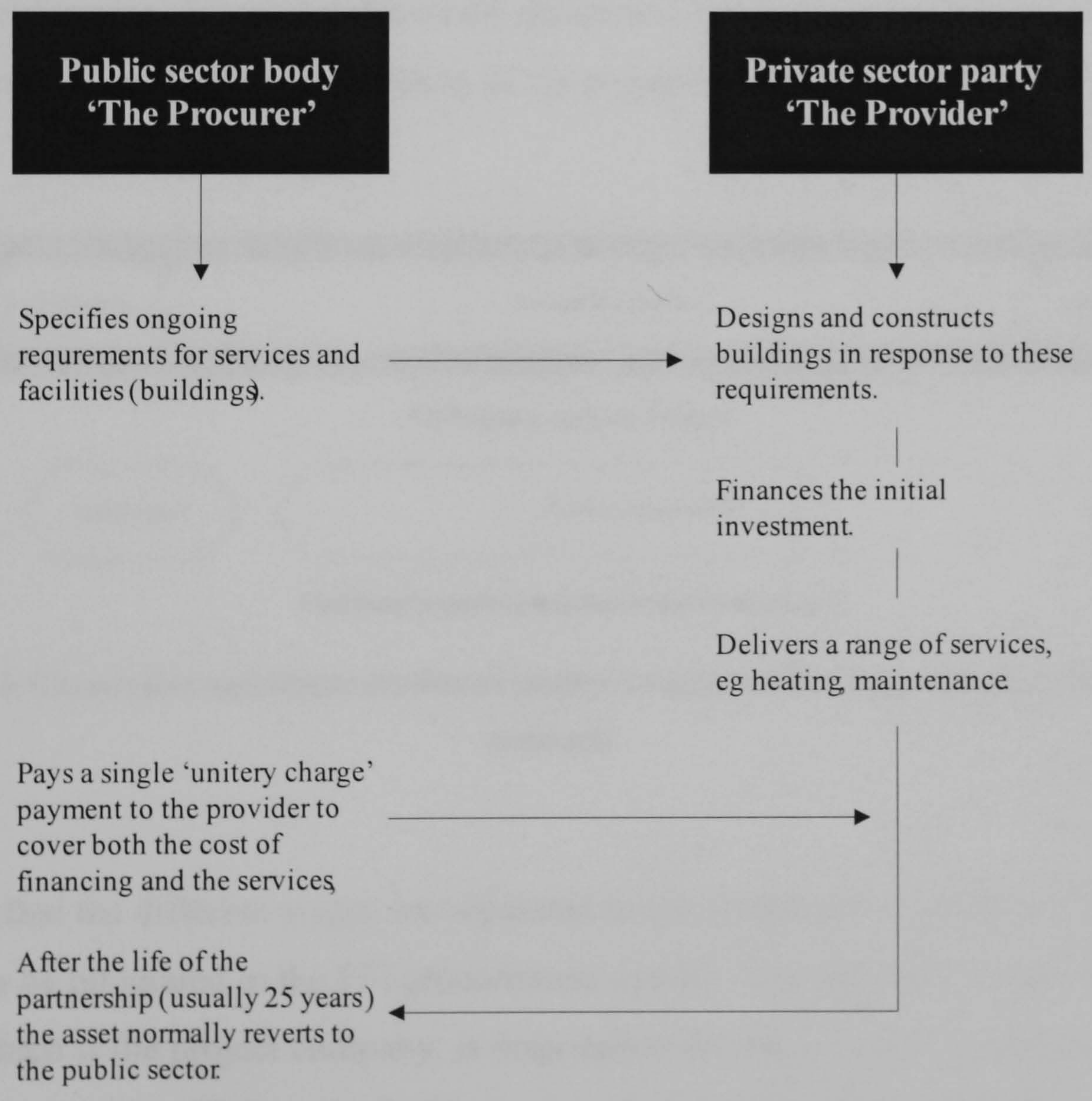


Figure 2.1: Key features of PFI projects (source: BDO, 2003)

2.5 PFI characteristics

The construction industry has been criticized for its fragmented process (Arayici and Aouad, 2004, Azam *et al.*, 1998, Cooper *et al.*, 2005, Dulaimi *et al.*, 2002, Gidado, 2004, Green *et al.*, 2005, Winch *et al.*, 1998). Egan (1998) described the fragmented nature of construction project processes as a fundamental malaise infecting the industry. Separation in responsibilities and work teams between design, finance, construction and operation of the building and the running of the facilities assets was one of the main reasons for failure or lack of performance in many projects. Franks (1990) stated that 'the separation of the design and construction processes tends to foster a 'them and us' attitude between the designers and contractors. This reduces the team spirit that experience has shown to be vital for the satisfactory conclusion of a building project. The same could be said for the separation between design, construction, and facilities management stages. Figure 2.2 shows the difference between traditional procurement systems and PFI in terms of correlation of the project processes.

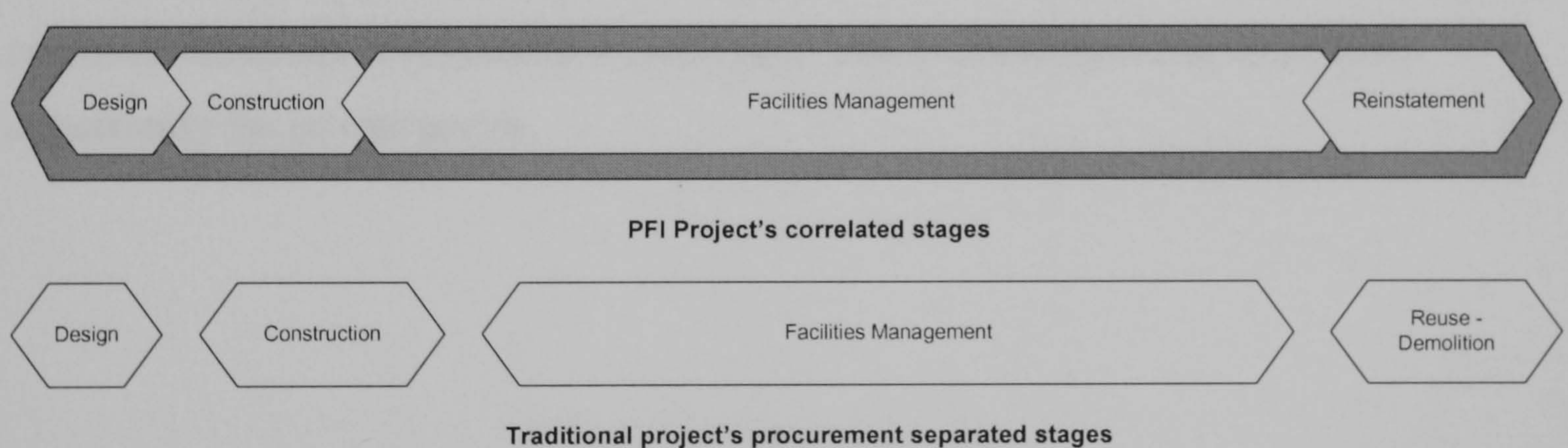


Figure 2.2: Correlation and fragmentation of project's stages in PFI and traditional procurement contracts

It is clear that the different stages are separated in the traditional systems, while it appears to be integrated in the PFI procurement system. The Special Purpose Vehicle (SPV), which is the project company, is responsible for the project from the start to the end of the contract, which normally spans more than twenty years. Design and construction become fully integrated up-front, with operations and asset management to follow (NSWG, 2001), while in traditional systems, different providers for each stage of the project have no direct relation with each other. There are some other differences highlighted in figure 2.1 for the different categories. According to Dixon et al. (2005), PFI projects typically comprise three main parties, as follows:

- The awarding authority: the public sector client responsible for procuring the project. It may be a central government department, local authority, or government agency.
- The special purpose vehicle (SPV): A limited company that is set up for the sole purpose of delivering the PFI project. It acts as the management and operating company for the project, and is the legal owner of the concession that is granted by the public sector (Akbiyikli and Eaton, 2004).
- Third-party funders: such as equity, bank loans, or bonds.

Table 2.1 shows the differences between PFI and other conventional procurement systems. The obvious differences are the risk allocation and transfer, contract duration, responsibilities and involvement of each party and improvement and innovation opportunity for private sector.

Table 2.1: Differences of PFI and traditional procurement (Ahadzi and Bowles, 2001)

Area of consideration	Characteristics of traditional public sector procurement (generalized)	Characteristics of the Private Finance Initiative (generalized)
Duration of private sector involvement in the project	Until construction of the facility is complete (plus the defects liability period)	Normally for at least 25 years for construction-related PFI projects
Specific company involvement	Appointed by the public sector client on an individual basis for the supply of specific skills	Involved as part of a concessionaire consortium with all the skills necessary or taking a key supply contracting role, being appointed by the bidding firm or concessionaire
Private sector risks	Specific to the area of involvement and limited to defect liabilities	Wide ranging and long term
Remuneration	Lump sum or percentage fee	Annualized payment
Opportunity for private sector to suggest improvements	Limited	Considerable
Key financial consideration for private sector company	Maintaining a positive cash flow and margins	Having an adequate asset base and debt facility
Attitude required of the private sector from the public sector	Maintaining a positive cash flow and margins	Maintaining a positive cash flow and margins
Responsibility for design, build, finance and operate	Lies with the public sector procurer	Lies with the private sector concessionaire
Accountability for the resulting services	Public sector procurer is accountable to itself/Parliament	The private sector concessionaire is accountable to the public sector procurer who in turn remains accountable to parliament for the services provided

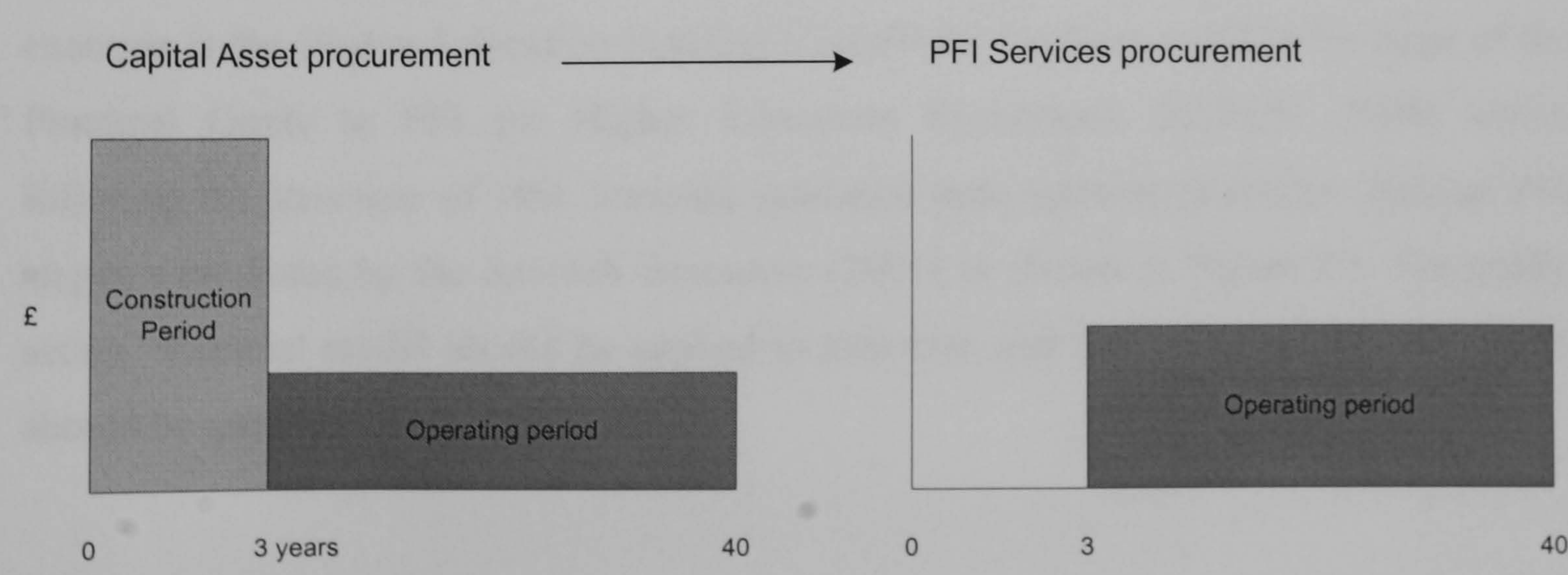


Figure 2.3: Comparison of Conventional and PFI procurement

A distinguishing feature of the PFI procurement is the timing of responsibility and payments. As demonstrated in figure 2.3, the public sector procurer no longer pays capital over the construction period, but rather pays for the service during the operational period; the private sector pays the capital cost, which it recoups through the service payments. The public sector no longer takes responsibility for the design of specification but rather it specifies its services by way of an output specification. The public sector operator no longer operates the asset but rather monitors service delivery and performance (Ahadzi, 1999).

2.6 PFI Process

HM Treasury Taskforce (TTF, 1998) issued a guidance note called 'Step by step guide to the PFI procurement process' to provide a short overview of the process of procuring service under PFI. This guidance note outlines the PFI process from the public sector point of view; therefore the first five steps deal with the decision making within the authority. This involvement of the private sector starts with expressions of interest as a response to the public sector invitation published in the Official Journal of the European Community (OJEC), as in stage six of the processes shown in figure 2.4.

The PFI procurement stages, as listed in the HM Treasury guidance, consist of fourteen steps; government authorities should follow these steps if they intend to use PFI. An example is the Higher Education Funding Council for England's (HEFCE) issue of the Practical Guide to PFI for Higher Education Institutions (HEFCE, 2004) which followed the structure of HM Treasury guidance note mentioned earlier. Similar PFI stages were listed by the Scottish Executive (2001) as shown in Figure 2.4. For public sector, financial model should be applied in step two, and for private sector, the model should be used after step seven.

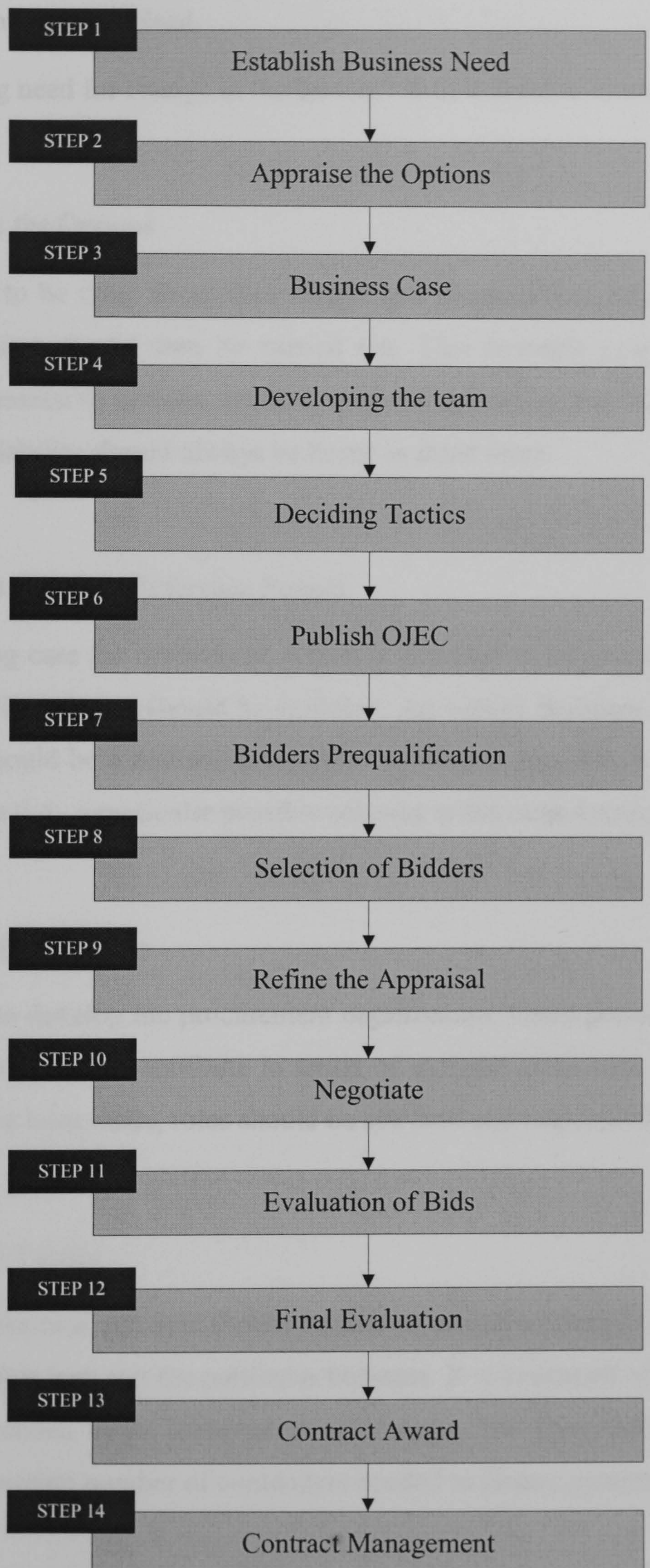


Figure 2.4: PFI procurement steps (Source: TTF, 1998)

Stage 1: Establish Business Need

Is there a pressing need for change in the service? Will it involve investment?

Stage 2: Appraise the Options

The client needs to be clear about their output specification (i.e., what do they want?) An option appraisal should then be carried out. This strategic examination involves identifying and assessing options, realistic ways of achieving the change that appears necessary. Affordability should always be borne in mind there.

Stage 3: Business Case and Reference Project

If there is a strong case for investment, which is expected to be cost-effective, then the possibility of a PFI solution should be explored. An outline Business Case needs to be prepared. This should be a realistic assessment of what is possible. It should include a Reference Project (i.e., a particular possible solution to the output requirement).

Stage 4: Developing the team

The first step is to develop the procurement organisation. Good project management is essential. Advisers should contribute in terms of external skills and experience. Once appointments have been made, roles should be clarified and responsibilities allocated.

Stage 5: Deciding Tactics

The client's professional advisers should be able to advise on the procedure and tactics for procurement that best suit the particular business. It is important to have a clear plan as to what is intended to be achieved at each stage. The final tender list should be limited to the minimum number of contenders needed to ensure genuine competition.

Stage 6: Invite Expressions of Interest

The formal procurement begins with publication of a contract notice in the Official Journal of the European Community (OJEC).

Stage 7: Prequalification of Bidders

The list of respondents to the OJEC notice, who have notified their interest on receipt of the Information Memorandum and have provided the requested information, should be evaluated against minimum standards set for technical capacity, financial and economic standing, and ability (where the procurement is for services but not works). The purpose of this stage is to assess the general level of competencies of the individual bidders.

Stage 8: Selection of Bidders (Short-listing)

Whereas prequalification is a test of general competencies, selection for the final short-list must be on the grounds of specific project competencies. To select the tenderers, it is legitimate to request, in some technical detail, the approach bidders would take to the project, including their appetite for risk, financing and also an indicative price for the project. Confidentiality of bidders' proposals is paramount.

Stage 9: Refine the Appraisal

Before the detailed bids are formally requested through the Invitation to Negotiate (ITN) stage, the original appraisal of the project needs to be re-visited. Drawing on knowledge gained during the procurement process to date, it is likely that some refinement of the output specification, business case and reference project (Public Sector Comparator, or PSC) will be needed.

Stage 10: The Invitation to Negotiate (ITN)

The ITN should be specific as to:

The services required, in output terms;

the constraints on the scope of the project;

proposed contractual terms (length, payment method);

the evaluation criteria for bids; and

the scope for variant bids.

This stage may be quite long for complex projects — perhaps three to four months. There is a lot of information for bidders to absorb and respond to in a formal bid.

Stage 11: Receipt and Evaluation of bids

The project team will need to evaluate the bids received in accordance with the principles and criteria set out in the invitation documents. At the end, the client may seek a best and final offer (BAFO) on the basis of the clarified bids. A well-scoped project at the ITN stage should remove any uncertainty in the project specification and should avoid the need for a BAFO.

Stage 12: Selection of Preferred Bidder and the Final Evaluation

When the preferred bidder is selected the PFI proposition should be re-tested against the key value for money and affordability criteria listed below:

- It must be affordable, or within a likely negotiating distance of affordability.
- If a Public Sector Comparator is to be used, the accounting officer will want to compare it with the cost of the preferred bid.

Stage 13: Contract Award and Financial Close

This is where the contract is signed and a contract award notice placed in the OJEC.

Stage 14: Contract Management

The management of the contract is a distinct process, which follows on from the process of procurement. While some degree of continuity is important, new processes will be needed. The structure of the contract will have defined the basis for the new, long-term operational and managerial relationship between public sector client and PFI service provider.

2.7 Contractual relationships

The emphasis of PFI is to establish long-term relationships between the public and private sectors, with the public sector becoming long-term purchaser of services (RICS, 1998). Contractual agreements put in place between the parties in the transaction are central to all PFI transactions; these agreements define each party's roles and clarify the expected requirements and liabilities (Akbiyikli and Eaton, 2005b). PFI contracts are generally of a long-term nature; the service requirement which is set out in the contract should take into account not only the authority's current requirement, but also its future ones (NAO, 2001b). Concessionary contracting falls neatly into PFI arrangement, whereby the private sector is encouraged to construct public projects, then charge a levy on this provision for a fixed period of time specified in the contract (Ashworth, 2006).

In PFI structures, the private sector develops, finances and maintains an asset used in the delivery of public services. In return, the public sector pays a monthly charge that covers both the repayment of the capital investment and the ongoing service costs (BDO, 2003). Figure 2.5 shows the typical principle structure of a PFI contract.

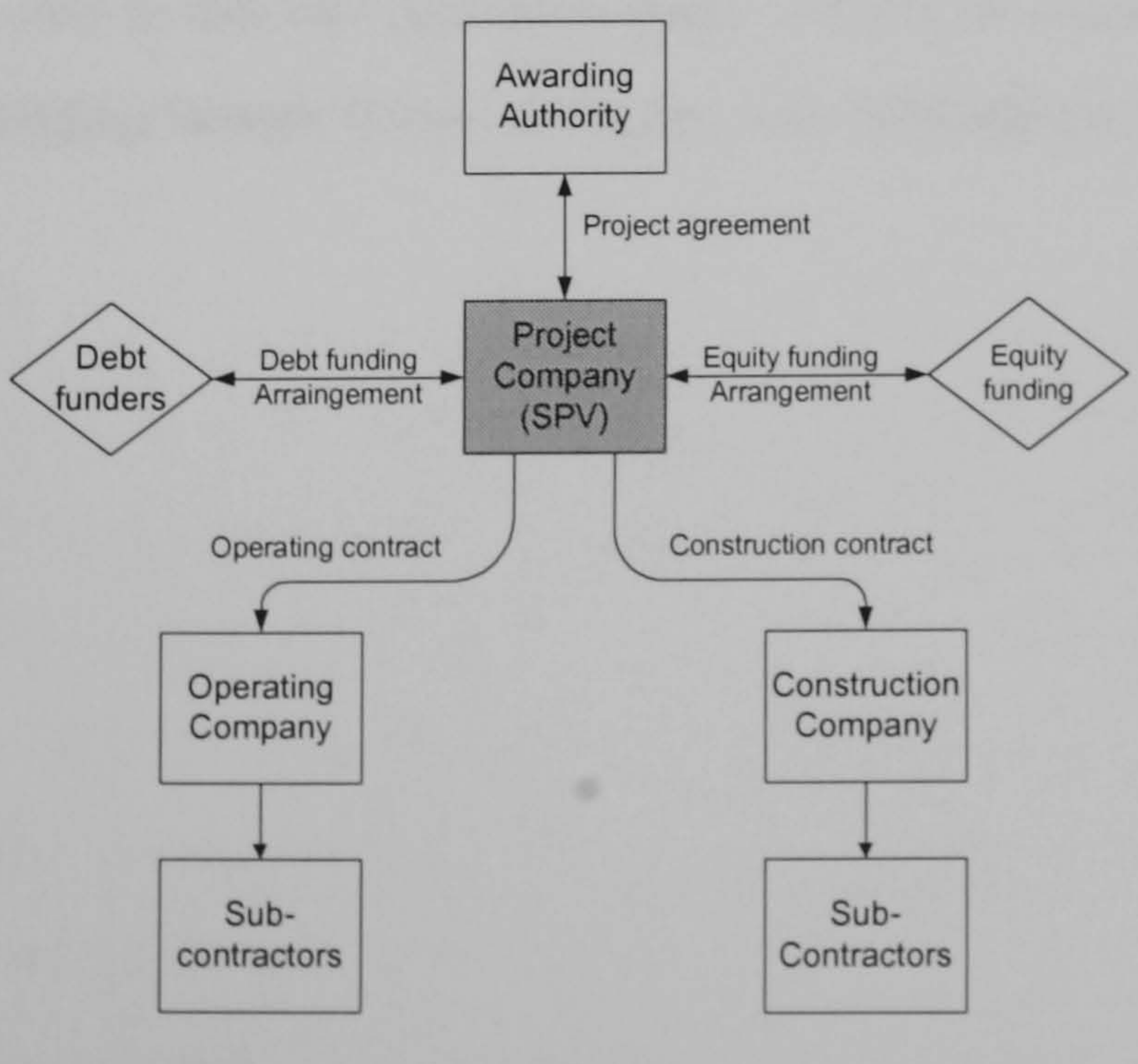


Figure 2.5: PFI contract structure (Developed from: Fox and Tott, 1999)

Many parties are participating in PFI contracts; clients are shifting the risk to the private sector, and to manage all contractual relationships with client and users or with subcontractors and financing sources. Figure 2.6 shows some of the parties involved in a PFI contract and their relationship to each other. The successful delivery of a PFI project depends on a number of factors. These include clarity at contract stage and effective long-term relationship between the parties. Open communication plays a key part of the development of good performance monitoring practices. At the beginning of a contract, it is important for the client and the service company to establish acceptable standards of services and working relationships (McDowall, 2003).

Contracts are very important in any project, whatever the procurement strategy. In PFI projects, it is the most important document that regulates the parties' relationship and dealings throughout the project's life cycle. The contractual relationship in PFI is not simply one which being enters to deliver an asset, but also to provide an on-going service (Broadbent and Laughlin, 2005). In practice, the PFI contractual relationships are very complex and the discipline of the contract is more subtly applied in the context of building an on-going relationship between the parties (Broadbent *et al.*, 2003). Due to the multi-disciplinary nature of the PFI contract, all participating parties commonly rely on the advice given by external consultants (Asenova *et al.*, 2002). This in turn will expand the circle of participants in the preparation and negotiation of project inputs. The process of negotiation undertaken to reach the contract agreed by all parties is adversarial in nature, due to the fact that each party will try to secure its position in case the contractual relationship breaks down along the way (Broadbent *et al.*, 2003).

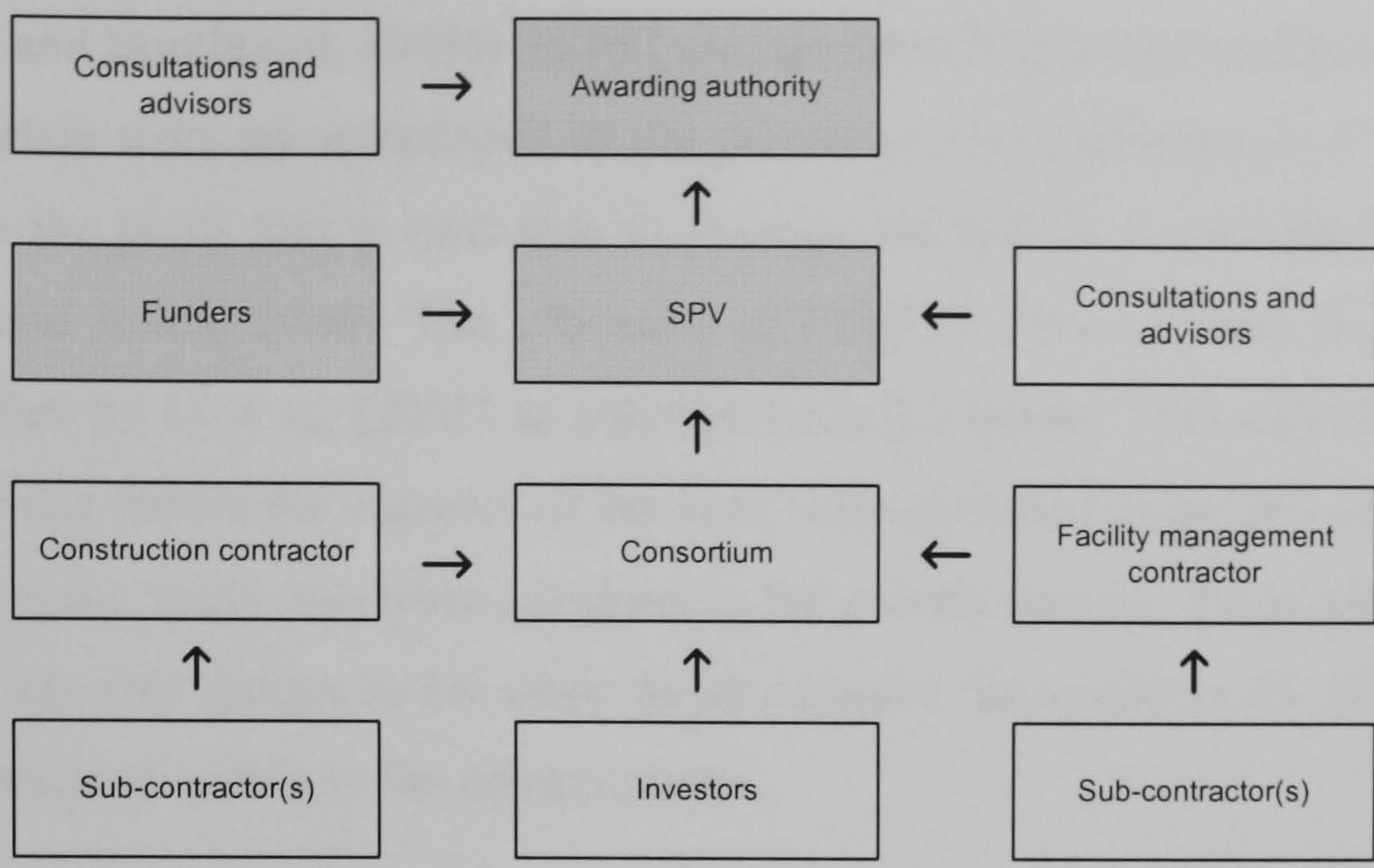


Figure 2.6: PFI project structure and main parties (Source: Dixon *et al.*, 2005)

The centre of any PFI project is a concession contract within which the public sector specifies the outputs it requires from a public service facility, and the basis for payment for those outputs (HM Treasury, 2003). In 1999, the first edition of Standardization of PFI Contract (SoPC) was published with the aim of providing guidance on the key issues that arise in PFI projects in order to promote the achievement of commercially balanced contracts, and to enable the public sector procurers to meet their requirements and deliver best value for money (HM Treasury, 2004b). Version 3 of the PFI standardization contract was published in April 2004, and its use became obligatory with effect from 14 May 2004 (HM Treasury, 2004c).

2.8 Risk and PFI

Construction is a process governed by complicated contracts and involving complex relationships across several tiers, and there are many risks involved in construction projects (Abdou, 1996). There are many definitions of risk, one of which was cited by Edwards and Bowen (2003): that risk is the probability that a particular adverse event occurs during a stated period of time. In addition, a risk is seen as the uncertain possibility of something happening in the future. It concerns potential problems (i.e., the possibility of something going wrong that can result in increased cost or cause delay

(Hardcastel and Boothroyd, 2003)). In PFI procurement, it is a fundamental requirement that appropriate risks are transferred to the private sector (Akintoye *et al.*, 2001b), or allocated to the party that is best able to manage the risk in a cost-effective manner (Akbiyikli and Eaton, 2004). The allocation of PFI/PPP risks between the sectors has been classified by Li *et al.* (2001) as listed in table 2.2 below. This allocation is based on a survey that shows the majority of the risks were allocated to the private sector (out of forty-six risks, thirty-two were assigned to the private sector). These thirty-two risk factors fall into two groups in the table: those assigned 'primarily to the private sector' and those assigned 'solely to the private sector'.

Table 2.2: Risk Allocation in PPP/PFI projects (Source: Li *et al.*, 2001)

Type of risk	Public	Private	Shared	Preferred risk allocation
Nationalisation/expropriation	79.40%	8.80%	11.80%	Public Sector
Poor political decision-making process	69.00%	6.90%	24.10%	
Political opposition	62.50%	21.90%	15.60%	
Site availability	60.60%	12.10%	16.70%	
Government stability	58.30%	25.00%	16.70%	
Level of public support	45.80%	41.70%	12.50%	Strongly Depending
Project approval and permit	35.10%	32.40%	32.40%	
Contract variation	33.30%	25.60%	41.00%	
Lack of experience in PPP arrangement	13.30%	43.30%	43.30%	
Lack of commitment from public/private partner	24.10%	10.30%	65.50%	Shared
Force majeure	18.40%	13.20%	68.40%	
Legislation change	17.10%	22.00%	61.00%	
Responsibilities and risk distribution	0.00%	22.60%	77.40%	
Authority distribution between partnerships	4.00%	28.00%	68.00%	
Tax regulation change	17.90%	51.30%	30.80%	Primarily to Private Sectore
Late design changes	26.30%	52.60%	21.10%	
Residual risk	22.60%	54.80%	22.60%	
Inflation	7.30%	56.10%	36.60%	
Tradition of private provision of public service	27.30%	59.10%	13.60%	
Staff crisis	6.70%	60.00%	33.30%	
Third party tort liability	3.30%	60.00%	36.70%	
Influential economic events	8.30%	69.40%	22.20%	
Financial attraction of project	3.00%	69.70%	27.30%	
Level of demanding project	7.70%	73.10%	19.20%	
Different working methods	0.00%	73.30%	26.70%	
Industrial regulatory change	0.00%	75.00%	25.00%	Solely to Private Sector
High financing cost	3.00%	75.80%	21.20%	
Interest rate	2.40%	78.00%	19.50%	
Organisation and coordination risk	0.00%	80.60%	19.40%	
Weather	0.00%	82.10%	17.90%	
Environment	0.00%	84.20%	15.80%	
Availability of finance	0.00%	85.30%	14.70%	
Ground condition	5.10%	87.20%	7.70%	
Operational revenue below par	2.70%	89.20%	8.10%	
Financial market	0.00%	89.50%	10.50%	
Quality of workmanship	2.50%	92.50%	5.00%	
Construction cost overrun	0.00%	92.50%	7.50%	
Frequency of maintenance	0.00%	92.50%	7.50%	
Availability of labour/material	0.00%	94.40%	5.60%	
Insolvency of subcontractors/suppliers	0.00%	94.70%	5.30%	
Low operation productivity	0.00%	94.90%	5.10%	
Design deficiency	0.00%	95.00%	5.00%	
Unproven engineering techniques	0.00%	97.00%	3.00%	
Operation cost overrun	0.00%	97.50%	2.50%	
Higher maintenece cost	0.00%	97.50%	2.50%	
Construction time delay	0.00%	97.60%	2.40%	

Morledge and Owen (1998) reported that there are two fundamental characteristics of PFI: (1) there must be a genuine transfer of risk to the private sector — this supports the overriding principle that: (2) a project must provide value-for-money to the tax payer. This shows the importance of risk management in PFI projects, and explains what Al-Sharif and Kaka (2004) have found in a survey conducted on PFI/PPP topic coverage in construction journals. They found that most of the research published (44%) was about the risk and risk management within PFI. In fact, many researchers have focused on the classification and definition of potential risks in PFI projects (Akintoye *et al.*, 2000; 2001a, Akintoye *et al.*, 2001b, Bing *et al.*, 2005, Birnie, 1998, Eaton and Akiyikli, 2005, Kalidindi *et al.*, 2005, Lewis and Greenwood, 2002, Li *et al.*, 2004, Mcdowall, 2003). However, some of the risk factors identified were similar, while others differed in their types and categories.

Table 2.3: Type of risks in PFI projects (Source: TTF, 1999)

Availability risk	The risk that the quantum of the service provided is less than required under the contract.
Construction risk	The risk that the construction of the physical asset is not completed on time, to budget and to specification.
Decant risk	The risk arising in accommodation projects relating to the need to decant staff/clients from one site to another.
Demand risk	The risk that demand for the service does not match the levels planned, projected or assumed. As the demand for a service may be (partially) controllable by the government, the risk to the public sector may be less than that perceived by the private sector.
Design risk	The risk that the design cannot deliver the services at the required performance or quality standards.
Inflation risk	The risk that actual inflation differs from assumed inflation rates.
Legislative risk	The risk that change in legislation increases costs. This can be sub-divided into general risks such as changes in corporate tax rates and specific ones, which may discriminate against PFI projects.
Maintenance risk	The risk that the costs of keeping the asset in good condition vary from budget.
Occupancy risk	The risk that a property will remain untenanted – a form of demand risk.
Operational risk	The risk that operating costs vary from budget, that the performance standards slip or the service cannot be provided.
Planning risk	The risk that the implementation of a project fails to achieve the terms of planning permission, or that detailed planning permission cannot be obtained, or, if obtained, can only be implemented at costs greater than in the original budget.
Policy risk	The risk of changes in policy direction not involving legislation.
Residual value risk	The risk relating to the uncertainty of the value of physical asset at the end of the contract period.
Technology risk	The risk that changes in technology result in services being provided using non-optimal technology.
Usage risk	The risk that actual usage of the service varies from the level forecast.

Hardcastle and Boothroyd (2003) listed and discussed the key risks encountered by contemporary PFI participants under twenty-six items: Availability, commissioning, construction, credit, cost, demand, demographic changes, design, environment, finance, land, legislative changes, legal, market, operation, performance, planning permission, political, residual value, social issues, specification, sponsor, technical, technological obsolescence, time, and volume, while Li *et al.* (2001) listed the type of risk as shown in table 2.2 above. At the same time, Treasury Taskforce (TTF, 1999) defined risk types in PFI projects as shown in table 2.3. This has resulted in confusion as to whether the literature has agreed on how to assess and treat risk in PFI projects. It is outwith the scope of this study to discuss this confusion in detail.

2.9 Value for Money

The central proposition should always be that PFI should only be pursued where it delivers value for money (VfM), where VfM is the optimum combination of whole life cost and quality (or fitness for purpose) to meet the user's requirement (HM Treasury, 2004a). PFI projects must show VfM benefit in order to be successful. The base line for this judgement is comparison with how the service is now being supplied (or could be improved by internal efficiencies), and how it could be provided if public sector funds were available (RICS, 1998). According to TTF (1999), the key object of public sector procurement is to ensure that taxpayers get value for money. This requires that public service clients should ensure that:

- projects are awarded in a competitive environment;
- economic appraisal techniques, including a proper appreciation of risk, are applied rigorously;
- risk is allocated between the public and private sector so that the expected VfM of the services provided to the public is maximised; and
- comparisons made between publicly and privately financed options are fair, realistic and comprehensive.

There are many ways in which contractors of PFI projects could offer the public sector improved value for money; as mentioned in HM Treasury (1995), they include:

- ensuring that assets are fully fit for purpose but no more;
- closely integrating design with operational needs so that the asset can be operated and maintained with maximum efficiency;
- increasing the efficiency of both construction and operation by applying existing expertise;
- making use of new technology and/or new, more effective business processes.
- achieving economies of scale by enlarging the asset and sharing its use between the public sector and other customers, or between two or more public sector customers;
- designing the asset to provide scope for other services to be sold to third party users;
- designing the asset to improve its resale value or its capacity to be transferred to new uses after the end of the contract; and
- facilitating the introduction of user charges where appropriate as a means of improving the match between supply and demand.

The New South Wales Government's guidelines for Privately Financed Projects (NSWG, 2001) listed the major value-for-money drivers as:

- improved risk management — more rigorous risk evaluation and transfer to the private sector of those risks it is best able to manage;
- ownership and whole-of-life costing efficiency is improved because design and construction become fully integrated up-front with operations and asset management. Ongoing service delivery, operational, maintenance and

refurbishment costs become a single party's responsibility for the length of the concession period;

- innovation — wider opportunities and incentives for innovative solutions to deliver services requirements; and
- asset utilisation — reducing cost to government, as a sole user, through more efficient design to meet performance specifications and by creating complementary opportunities to generate revenue from use of the asset by others.

The evidence of achieving VfM by using PFI in project delivery is reported by many researchers: Arthur Anderson and Enterprise (TTF, 2000) reported that the average saving was closer to 17% on the 29 PFI projects they studied compared with the Public Sector Comparator. NAO has published a report called PFI: construction performance (NAO, 2003a) which shows that most public sector project managers surveyed were satisfied with the design and construction of their PFI buildings. They were also mostly satisfied with the performance of the building. Table 2.4 shows that cost and time overrun is less with PFI projects.

Table 2.4: Project cost and time overrun (Source: NAO, 2003a)

	Previous experience (1999 Government survey)	PFI experience (2002 NAO census)
Construction projects where cost to the public sector exceeds price agreed at contract	73%	22% (1)
Construction projects delivered late to public sector	70%	24% (2)

NOTES
1 None of the increases in PFI price after contract award were due to changes led by the consortium alone. For example, in some cases the department changed some of the specifications from those for which the consortium had bid, so the price increased to reflect the changes. Some of these specification changes arose due to new factors affecting the department's needs after contract award. These changes would also have led to price increases under traditional procurement.

(2) In only eight per cent of PFI projects surveyed was the delay more than two months. No comparative data for this statistic are available for traditionally procured projects. Previous studies of traditional projects had referred to the percentage of time overruns rather than the number of months.2

2.10 Types of PPP/PFI

According to HM Treasury (2000), PPP label covers a wide range of different types of partnership, including:

- the introduction of private sector ownership into state-owned businesses, using the full range of possible structures (whether by flotation or the introduction of the strategic partner), with sales of either a majority or minority stake;
- the Private Finance Initiative (PFI) and other arrangements where the public sector contracts to purchase quality services on a long-term basis so as to take advantage of private management skills incentives by having private finance take on the risk; and
- selling government services into wider markets and other partnership arrangements where private sector expertise and finance are used to exploit the commercial potential of Government assets.

These three types were mentioned in the HM Treasury (1993) as: *financially free-standing projects*, where the private sector undertakes the project on the basis that costs will be recovered entirely through charges for services to the final user; *services sold to the public sector*, where the cost of the project is met wholly or mainly by charges from the private sector service provider to the public sector body that let the contractor; and *joint ventures*, where the cost of the project is met partly from public funds and partly from other sources of income, with overall control of the project resting with the private sector. According to Li *et al.* (2005b), the UK government has identified eight types of PPPs as follows:

1) Asset sales: this relates to the sale of surplus public sector assets.

2) Wider market: this introduces the skills and finance of the private sector to help with better use of public sector assets.

3) Sales of business: this relates to the sales of shares in the state owned businesses by flotation or trade sale.

4) Partnership companies: this includes introducing private sector ownership into state-owned businesses, while still preserving public interest through legislation, regulations, etc.

5) Private Finance Initiative.

6) Joint ventures, in which public and private partners pool their assets and resources together under joint management.

7) Partnership investment, in which the public sector contributes to the funding of investment by private sector parties, to ensure that the public sector shares in the return generated.

8) Policy partnerships, in which the private sector individuals, or parties, are involved in the development, or implementation, of the public sector policy.

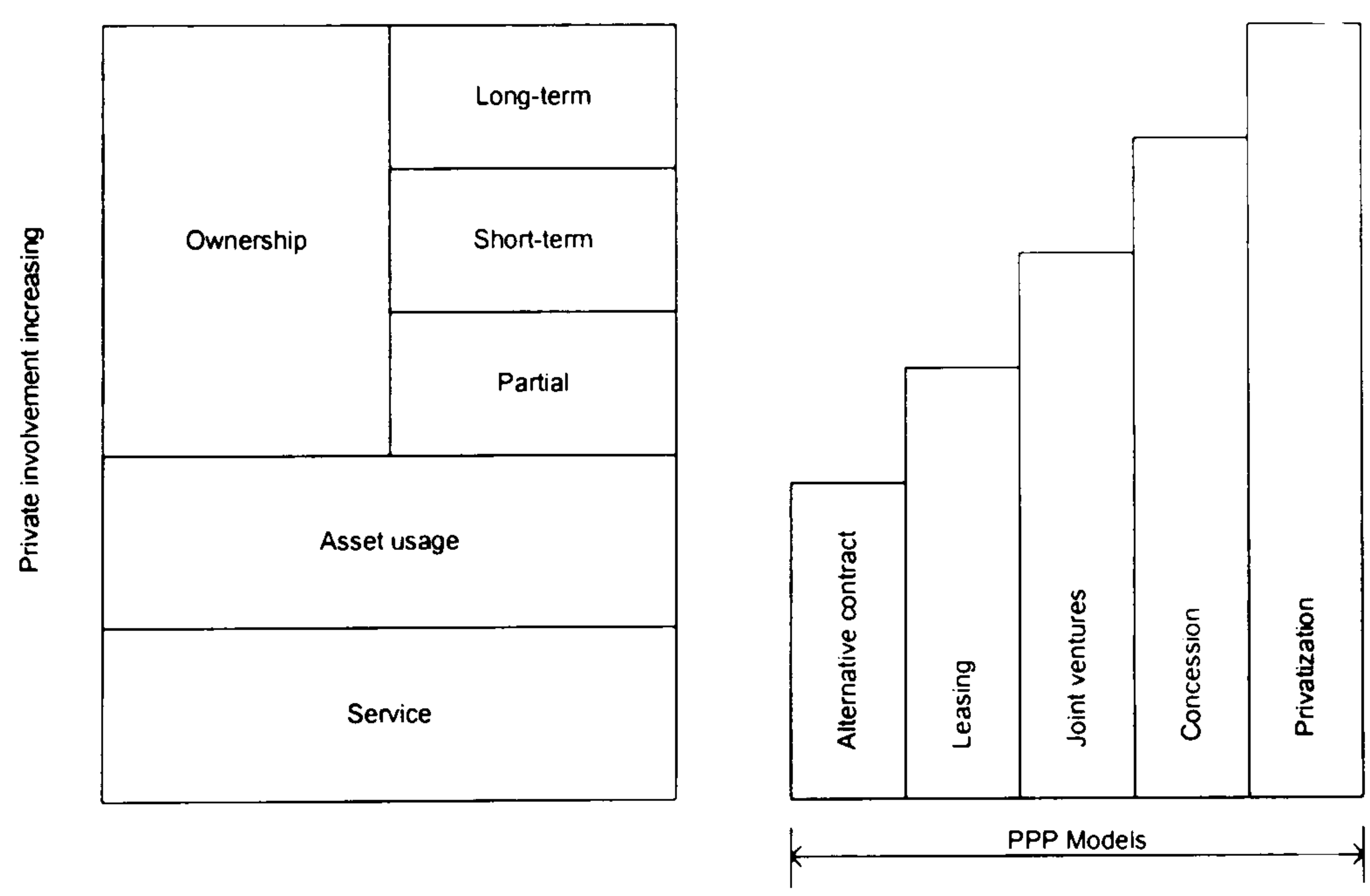


Figure 2.7: PPP models and private sector involvement level (Source: Li and Akintoye, 2003)

2.11 Dispute management in PFI projects

Disputes in the construction industry usually arise out of a number of factors and the seeds of possible future disputes are often sown in the beginning of a project, hence it is pivotal for the parties to establish their objectives from the beginning. Unlike construction projects, where there is a beginning and an end, the same cannot be said of how and when a dispute will be settled (Cree, 1992). Therefore, it is important that the appropriate procurement path is chosen for the project (Turner and Turner, 1999), and that the method of dispute management has been agreed from the beginning of the project.

The main cause of disputes in the construction industry may be attributed to the number of parties involved in each building project (Ndekugri and Jenkins, 1994). Generally, disputes may be caused by factors such as interpretation of contract, payment matters, time, determination of the agreement, site and execution of work, negligence, nuisance, issuance of final certificate or payment (Watts and Scrivener, 1992). Sykes (1996) identified the nature of construction contract and the unpredictability of future events as two major sources of disputes.

Although PFI and its close working relationships is suggested as one of the solutions for dispute avoidance (Ahadzi and Bowles, 2001, Cox and Thompson, 1998). According to Ahadzi and Bowles (2001), one objective of the PFI/PFI is to minimize claims by transferring responsibility to the private sector in order to achieve value for money. Disputes could still arise in PFI projects; between client/user and the project company (SPV), and between the SPV and its subcontractors and financing organization, as shown in Figure 2.8. There are two potential phases in which disputes may arise in PFI projects — the period of the construction stage and the long duration of service period. Research conducted on PFI suggested that due to the length of the contract, disputes may arise from a number of factors, such as interpretation of the contract, poor performance, poor quality of service or output, failure to agree on new additional prices, delay or late delivery/ missed deadlines, changes in requirement, disagreement over responsibilities and poor communication (NAO, 2001b).

Guidelines on how to handle disputes in PFI were prepared by the Centre for Effective Dispute Resolution (CEDR, 2004) in light of the government's encouragement for more alternative dispute resolution methods in the construction industry. The HM Treasury Standardization of PFI contract is the form of contract that is commonly used by local authorities undertaking PFI schemes. In this form, guidelines are also laid down on how to handle disputes that may arise in PFI projects.

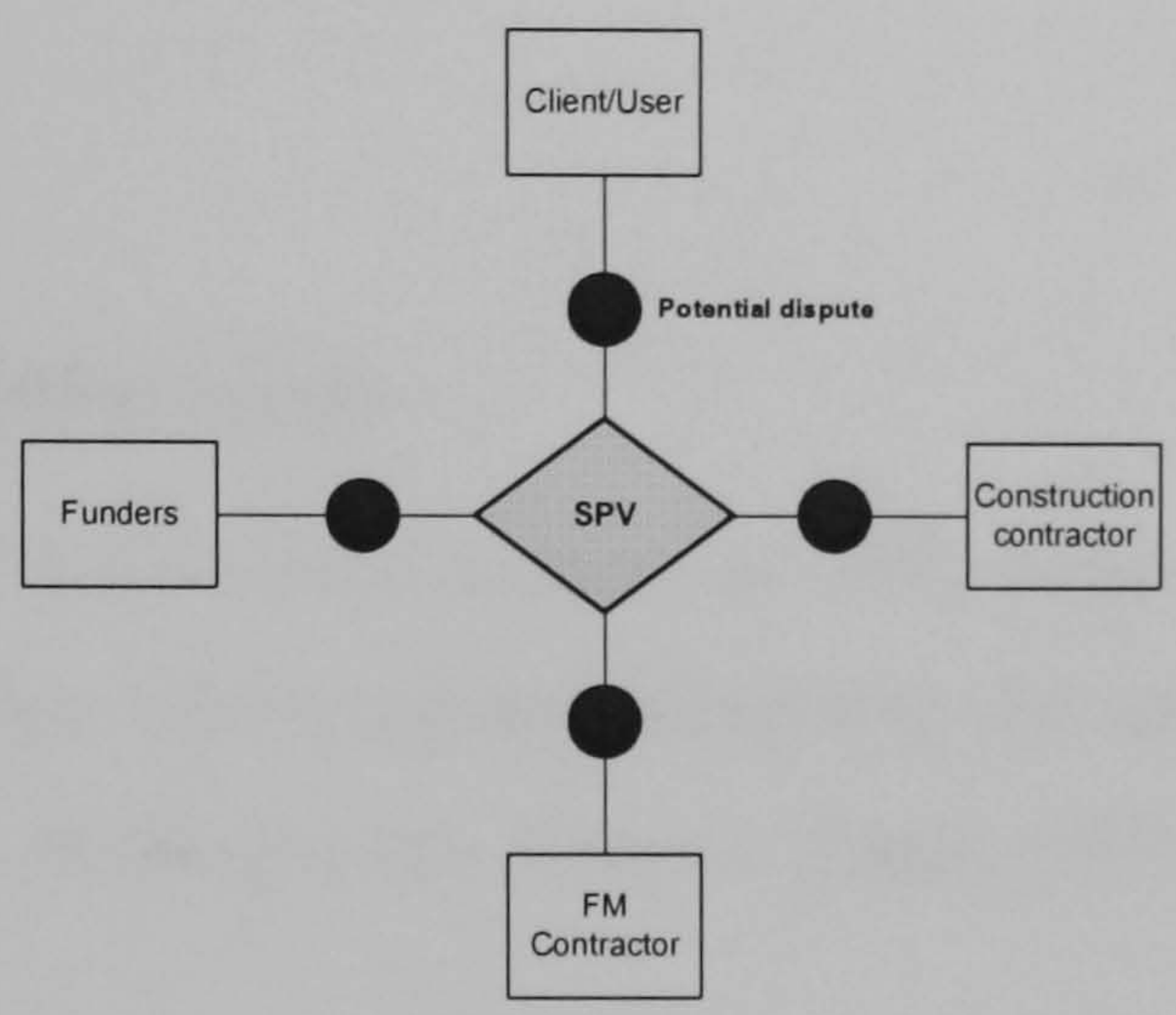


Figure 2.8: Potential dispute nodes

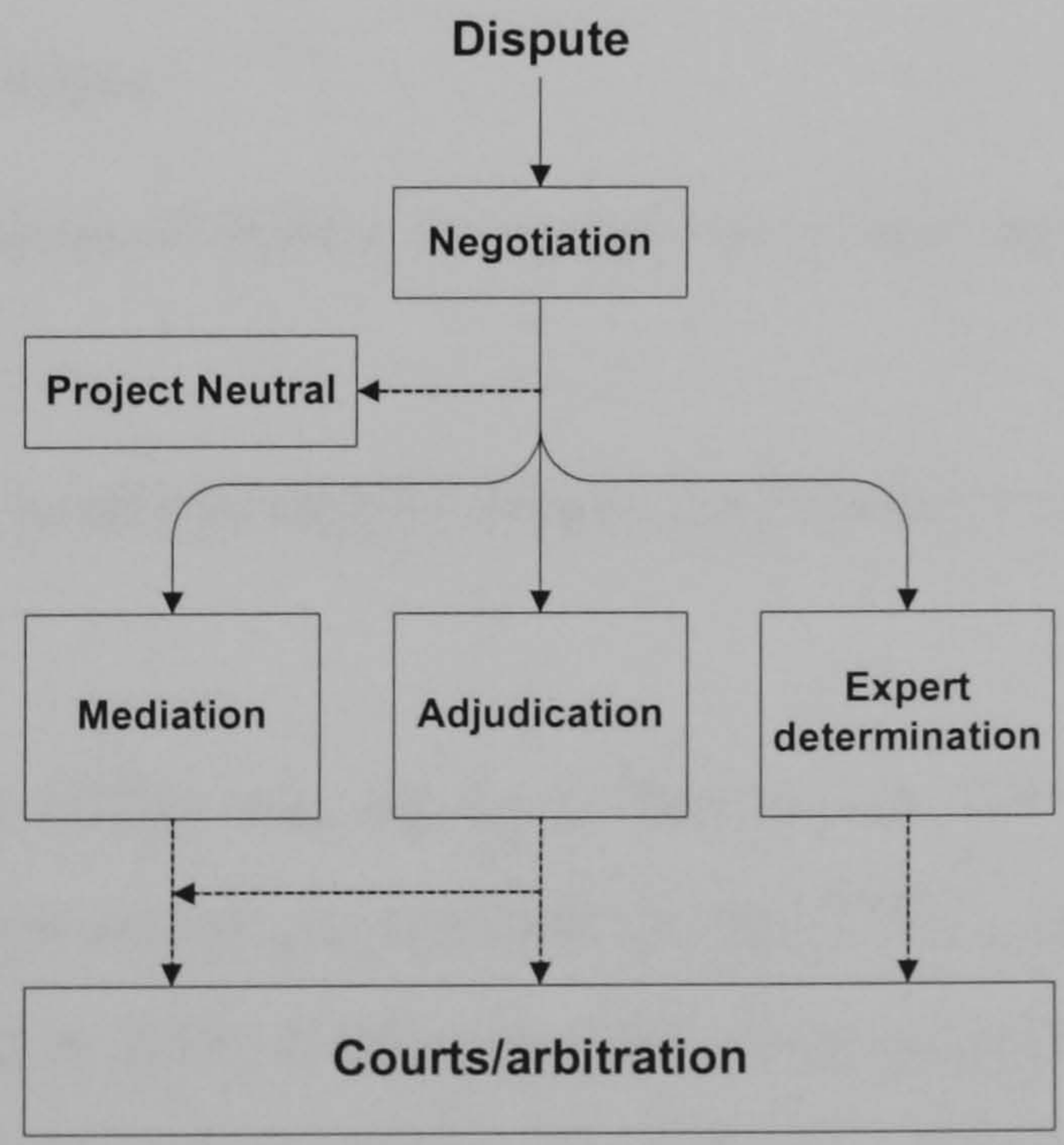


Figure 2.9: Dispute resolution flow in PFI arrangement (Source: CEDR, 2004).

The clause (or schedule) in PFI agreements normally set the procedures for the dispute to be handled. It promotes discussion or negotiation between the parties as the starting point for the disputes to be resolved. Inability of the parties to resolve disputes through negotiation will require a referral to an independent expert or adjudicator in order for a swift decision to be made. Dissatisfaction with the decision of the expert or the adjudicator will give the opportunity for the parties to refer it to an arbitrator or court as a final tribunal (CEDR, 2004). Figure 2.9 shows the dispute resolution flow in PFI arrangements.

2.12 PFI application and projects

The announcement of PFI by Norman Lamont in 1992 required the creation of certain bodies, to be responsible for improving and enhancing the implementation of PFI. This started with the creation of the Private Finance Panel (PFP) whose role was (Allen, 2001):

- to encourage greater participation in the initiative by both public and private sectors;
- to stimulate new ideas;
- to identify new areas of public sector activity where the private sector could get involved; and
- to seek solutions to any problems that might impede progress.

The Treasury Taskforce (TTF) was set up in September 1997 to be the central focal point for all PFI activities across government (Allen, 2001). Subsequently, Partnership UK (PUK) was launched in 2000 to take over the advisory role of the TTF (Akintoye *et al.*, 2001a), and to support and accelerate the delivery of infrastructure renewal, high quality public services and the efficient use of public assets through better and stronger partnerships between the public and private sectors (Partnership UK, 2006). The Office of Government Commerce (OGC) was established in April 2000 to replace the policy arm of the TTF (Allen, 2001), with a mission to work with the public sector as a catalyst to achieve efficiency, value for money in commercial activities and improved success in the delivery of programmes and projects (OGC, 2006).

The Public Private Partnerships Programme Ltd (4Ps) is another organisation that has been tasked with enhancing the implementation of PFI. It is a local-government-owned agency established in April 1996 to help local authorities increase investment in local services through PFI and other forms of PPP (Akintoye *et al.*, 2001b). In addition, there are a lot of organisations that deal with PFI/PPP in the UK, such as the National Audit Office (NOA).

The UK has been the location for a series of innovations in public sector management, and the latest of these is the Private Finance Initiative (PFI) (Froud, 2003). The investment of the UK government in PFI projects has risen from two projects with a total value of £10.5 million in 1994 to seventy projects with a total value of £7,733 million in 2002 (HM Treasury, 2004d). The PPP/PFI was seen as an attractive policy in terms of the potential benefits it might bring to local economic development (Broadbent and Laughlin, 2005, Li *et al.*, 2005a).

The importance of PFI in the UK construction project market can be seen from the number, type and capital value of projects provided with this type of procurement. Table 2.5 show the PFI signed deals by department: education and health are dominant in terms of number of projects. Table 2.6 highlights the growing share of PFI in the construction outputs from 1998 to 2003. It is clear that the value of projects provided by PFI is growing. The growth reached 19.19% in 2003 for projects with a total capital value of £14,854 million. Tables 2.7 and 2.8 show the distribution of signed PFI deals by region and year.

Table 2.5: PFI singed deals, breakdown by department (Source: HM, 2005)

Cabinet Office	Number of Signed deals	Capital value (£m)
Cabinet Office	2	347.70
HM Customs & Excise	2	170.30
Constitutional Affairs	13	306.40
Culture, Media & Sport	7	68.60
Environment, Food and Rural Affairs	13	632.70
Transport	45	21,432.10
Education & Skills	121	2,922.80
Health	136	4,901.20
Trade & Pensions	8	180.80
Work & Pensions	11	1,341.00
Foreign & Commonwealth Office	2	91.00
HM Treasury	2	189.00
Home Office	37	1,095.80
Inland Revenue	8	453.80
Defence	52	4,254.80
Northern Ireland	39	528.80
Office of the Deputy Prime Minister	61	972.10
Office of Government Commerce	1	10.00
Scotland	84	2,249.30
Wales	33	551.30

Table 2.6: PFI value and construction output (Sources: (1: HM, 2004) and (2: DTI, 2004))

Year	PFI projects capital value (£ million)	UK construction industry output (£ million)	%
	1	2	
1998	2,758	68,411	4.03%
1999	2,580	69,294	3.72%
2000	3,934	69,676	5.65%
2001	2,211	71,087	3.11%
2002	7,732	74,090	10.44%
2003	14,854	77,394	19.19%

Table 2.7: PFI signed deals, breakdown by region (Source: HM, 2005)

Region	Number of signed deals	Capital value (£m)
East Midlands	36	865.80
East of England	28	1,357.20
London	99	22,007.60
North East	30	878.40
North West	49	1,257.90
Northern Ireland	39	528.80
Scotland	91	2,538.50
South East	67	2,061.30
South West	50	1,926.60
Wales	38	672.70
West Midlands	36	2,053.00
Yorkshire & The Humber	49	1,688.50
National / More than one region	64	4,862.60
N/A	1	3.80
Total	677	42,702.70

Table 2.8: PFI signed deals by year (Source: HM, 2005)

Region	Number of signed deals	Capital value (£m)
1987	1	180.00
1988	0	-
1989	0	-
1990	2	336.00
1991	2	6.00
1992	5	518.50
1993	1	1.60
1994	2	10.50
1995	11	667.50
1996	38	1,560.10
1997	60	2,474.90
1998	86	2,758.00
1999	99	2,580.40
2000	108	3,934.20
2001	85	2,210.80
2002	70	7,732.50
2003	52	14,854.10
2004	45	2,809.80
N/A	10	64.60
Total	677	42,699.50

2.13 Global PFI

The Public Private Partnership has established itself worldwide as a significant means for delivering public infrastructure development (Akintoye *et al.*, 2005). In Asia, most promoters and lenders of BOT projects are in no doubt of the role of the private sector in funding infrastructure projects (Yeo and Tiong, 2000). A number of high profile projects have successfully been privately financed in markets such China, India, Thailand, the Philippines, Pakistan and Indonesia (Tiong and Anderson, 2003). Hong Kong is well known for having developed high calibre transportation infrastructure using new procurement systems. Its government was not short of capital for infrastructure for the major part of 1980s and 1990s, and it opted to channel funds to alternative uses, while mobilising private sector resources, including finance and expertise, through the BOT vehicle (Kumaraswamy and Zhang, 2003).

The merits for improving the infrastructure of developing countries through private sector participation was reported by (Jnr, 1996). Within these countries, the high demand for infrastructure development, coupled with the pressures on national budgets, is making governments move towards encouraging private sector investment in infrastructure projects in the form of BOT and other private-finance initiatives (Ahadzi and Bowles, 2002, Kalidindi and Thomas, 2003). The major attraction in using private financing is that developing economies can meet their infrastructure needs without having to pay for the projects (Pipattanapiwong *et al.*, 2003).

The use of private sector capital and skills is not limited to developing countries where the need for project financing is significant. Smith (2003) reported that the United States is an active participant in the worldwide trend toward use of public-private partnership to improve the quality and cost-effectiveness of government service provision. Eaton and Akbiyikli (2005) discussed the intention of governments and local authorities across Europe and elsewhere to investigate how the concepts of PFI/PPP might work in their markets. Table 2.9 shows a selection of different European countries and the current situation of PFI/PPP projects respectively. Table 2.10 shows the current situation of PFI/PPP in some other countries.

Table 2.9: PPP/PFI in some European countries (Developed from: Eaton & Akbiyikli, 2005)

Country	Current PPP/PFI situation
Croatia	No single government authority.
	Government strategy is positively oriented to use BOT schemes for motorway construction
	Transportation, energy and water have priority.
	A new law is being prepared to facilities concessions.
Czech Republic	In 2000 a task force was estabilished to study PPP/PFI proposals.
	The task force will act as the nucleus of the joint venture of the public institutions and the private sector.
France	No formal governmental PPP/PFI unit.
	There is a long-established tradition of public-private co-operation using a concession structure.
	The French PPP model goes back more than a hundred years.
	PPP/PFI is not an instrument permitted in the social infrastructure area.
Germany	No formal central government unit or programme.
	A BOT law exists.
	Principally developing PPP/PFI in the transport (tunnels), defence and education sectors.
Greece	Government has formally launched a PPP/PFI programme in November 2000.
	There is a central PPP/PFI unit.
	Road concessions (rwal toll), 2004 Olympic Games infrastructure, light rail projects.
Hungary	No governmental authority specially assigned to deal with PPP/PFI.
	Seriously considering the PPP/PFI model for water, waste disposal and transport sector.
	The government has serious intentions to expand public-private partnership (Szechenyi Plan).
Ireland	The government has a strong public commitment to a formal PPP/PFI programme.
	The Irish administrative structure is based on the interaction of four different elements: 1- Central PPP/PFI unit in the Department of Finance. 2- The interdepartmental Working Group on PPP/PFI (IDG). 3- The Public/Private Informa Advisory Group on PPPs/PFI (IAG). 4- The Cabinet sub-Committee on infrastructure.
	Many projects covering road, rail, education, water and waste sectors.
Italy	There is a special PPP/PFI Taskforce - UFP
	Legislative reform of the Public Works Framework Law (Merloni Low) in 1998 set the framework for using private sector contractors and incorporated provisions on project finance.
	Hospital, transport and waste management projects are in progress.
	The government expected to finance through private funds 9 billion Euros of new infrastructure between 2001-2004.
Poland	PPP/PFI is a new concept in Poland, and some pilot projects have been identified.
	The Polish law provides for direct financing by government (up to 15%) of the total costs of the development of motorways.
	The same law allows government to share the risk of investment up to 50%.
Netherlands	A strong framework is in place for PPP/PFI including a dedicated PPP/PFI Unit.
	Kennis-centrum PPPs was set up in 1999 within the Ministry of Finance.
	Current projects includs road, railway, harbours, water, health, education and government buildings projects.
Portugal	Portugal was early exponent of PPP/PFI in Europe, although, there is no central PPP/PFI government unit.
	Many large road PPP/PFI projects have been pushed ahead successfully in Portugal, for example the Tagus Bridge in Lisbon.
	Ministry of Public Works has develpoed the SCUT programme to build the country's road Infrastructure.
Spain	No established formal PPP/PFI Unit.
	Government has road programme using the shadow toll structure.
	PPP/PFI projects are planned for roads, rail lines, health and waste management sector.

Table 2.10: PPP/PFI in some other countries (Developed from: Eaton & Akbiyikli, 2005)

Country	Current PPP/PFI situation
Australia	The first DBFO privatisations occurred in the 1990s.
	Victoria, New South Wales and Queensland have now developed PPP/PFI policies and plans for future investment.
	There is a certain amount of debate surrounding the VFM afforded by PPP/PFI.
Brazil	The Brazilian federal government has formed a strategic PPP commission which has identified several pilot projects.
	The government required approximately $200 billion for infrastructure investement and PPP has been identified as potential solution.
Canda	The government of British Colombia established Partnerships British Colombia (PBC) in 2002. Partnerships British Colombia provides advice, support and assistance to public sector client agencies on non-traditional funding relating to capital assets.
	Partnerships British Colombia maintains an independent profile within government and with the Private sector. It is not an approval organization but a facilitator of successful projects implementation.
	PBC expect 7 financial closes by April 2005 representing approximately $3.5 billion worth of capital assets, including hospitals, water treatment plant, bridges, roads and rail rapid transit line.
	Other provinces, such as Ontario and Quebec, are also looking at PPP.
Mexico	PPP is used as a solution to the $20 billion project schedule. Individual states are being encouraged to come up with pilot projects.
Japan	A private finance law was enacted in 2000 (PFI Law) and the first PFI commenced later that year. PFI has progresses more slowly than expected. Seven deals have reached financial close. Various pathfinder projects are considered in offices, accommodation, waste, energy, transport and healthcare.
	In Japan there is no central government agency coordinating PFI policy or projects.
	Within government a PFI Cabinet Office for the Government of Japan has been established. Within the Cabinet Office the PFI Promotion Committee is beginning to develop guidelines and systems for the country.
South Africa	Has looked closely at PPP for some time and set up a Governmental PPP task Force in 1997 and a PPP Unit in 2000. South Africa manages public private partnerships through the National Treasury ministry.
	The Public Finance Management Act passed in 2000 governs the implementation of PPPs. In South Africa the PPP agency is mandatory and it is both a facilitator and an approval mechanism.
	The PPP Unit has published a list of potential PPP projects but few deals have been completed to date.

2.14 The other side of the picture

The public sector reports glorify the progress of PFI in delivering and improving public services and infrastructure projects (Hm_Treasury, 1995, Nao, 2001a; 2002; 2003a; b). It is clear from what has been stated earlier that PFI contributes to the improvement of public services and infrastructure projects; however, like other procurement systems, PFI has not been a total success. There are no comparisons in the statistics to show the percentage of project failure and the effects of some of the disadvantages associated with PFI on public projects or the end users. Akintoye *et al.* (2001b) cited some problems reported with PFI procurements, such as:

- high costs are used to tender PFI projects;
- agreements are brought about through complex negotiations;
- innovation inputs, in both design and construction, could be inhibited, as contractors become wary of overruns;
- the information of project consortia (SPVs) can be difficult as constituent members have differing objectives;
- there are disparity problems between the private and public sector, in terms of differing modes of operations, decision making and accountability;
- the attitude of government, supportive or otherwise, can ease or complicate the problems;
- the cost of finance is quite high, given that governments can borrow money more cheaply than private firms.

There are some other disadvantages pointed out in the literature; one of them is the high transaction cost associated with PFI projects (Edwards, 2005). Others cast some doubt on the savings and value for money which PFI is believed to provide to the public sector (Gaffney *et al.*, 1999, Mccabe *et al.*, 2001). UNISON, which is the trade union for people delivering public services, has argued against PFI. They have published several reports against PFI, arguing the threat to public services and their members (Unison, 2000). In another report (Pollock *et al.*, 2005), UNISON criticised the data used in the HM Treasury reports which claimed that the public sector was benefiting from PFI. The report, entitled 'The Private Finance Initiative: A policy built on sand' examined the Treasury's evidence for cost and time overrun data in value for money policy and appraisal. In a press release about this report (Unison, 2005), Dave Prentis, The General Secretary of UNISON said:

> "UNISON has always argued that PFI is a waste of taxpayers money. This report knocks out another of the Government's chief arguments for its continued use, namely that it generates value for money by improving the efficiency of construction procurement. This report shows that the evidence used to justify this claim was not only selective but fatally flawed."

In a study conducted on PFI in the National Health Service (NHS), Gaffney *et al.* (1999) concluded that high cost is ascribed to risk transfer but little risk is actually transferred. The government's claim that the Private Finance Initiative represents better value than public procurement was not supported, and clinicians should not allow spurious economic arguments to deflect them from criticising the clinical impact of PFI development. This was supported by UNISONs latest report (Aldred, 2006), which examined the NHS Local Improvement Finance Trust (LIFT) model, and identified six key disadvantages: bureaucracy, profit, inflexibility, conflicts of interest, value for money and staff.

2.15 Summary

The introduction of the private sector to provide public services project has resulted positively in the development, availability and performance of the public facilities. Although the PFI procurement system is relatively new, the number of deals signed using this type of procurement is increasing in the UK and worldwide. The nature of PFI makes the commitment long; thus, no complete PFI project is investigated yet. As a result of PFI project performance reviews, the UK government is more confident in applying PFI in its public services modernisation plan, particularly in health and educational facilities. The expenditure on school buildings consists of more than 23% of the Scottish PFI projects expenditure (Accounts Commission, 2002). Despite voices against PFI, there are many benefits in private sector participation in providing public services and infrastructure, expertise management, innovation, performance, and value for money; in particular, when public funds are limited. Reviews conducted on PFI projects provide clear evidence that PFI offers not only VfM and risk transfer, but could be a perfect strategy for construction industry in treatment of processes fragmentation and for ever well performing facilities.

Chapter Three

PFI Financial Management

3 PFI Financial Management

3.1 Introduction

Financial modelling for construction projects is a sophisticated tool for project planning and control. It helps all parties in making the correct decisions, and models the actual shape and impacts of the financial process and transactions. This chapter is part of the literature review of the subjects related to the main topic of the research: PFI financial management. It concentrates on reviewing what has been published in the area of construction financial management and financial modelling techniques and their impact on project management.

3.2 Financial Management

Financial management, which is sometimes referred to as corporate finance or business finance, is concerned primarily with financial decision-making within a business entity. Financial management decisions include maintaining cash balances, extending credit, acquiring other firms, borrowing from banks, and issuing stocks and bonds (Fabozzi and Peterson, 2003). Financial plans represent the planned position throughout a project and as such would be concerned with expenditure or liability, income or earning, and cash flow or surplus — net cash flow (Mawdesly *et al.*, 1997). Financial resources consist of the firm's borrowing capability, credit lines, credit rating, ability to generate cash, and relationship with investment bankers (Kerzner, 2001a). Financial planning is central to the survival of any company: it is essential, as lack of funds has been identified as the most common cause of business failure (Kaka, 1990). The critical activity of the financial management process is that of financial decision-making, specifically decisions aimed at creating maximum value for the owners of the business (McMenamin, 1999).

Inadequate attention to cash flow forecasting is an aspect of poor financial management that could lead to bankruptcy (Boussabaine and Kaka, 1998, McCaffer et al. 2001). Kaka (1994) stated that budgeting in construction companies is very difficult, and with current fluctuations in the economy, forecasting contractors' performance and cash flow is no easier than forecasting the weather. A further difficulty is that contractors rarely prepare a comprehensive construction plan at the tendering stage, as they usually wait until winning the contract (Kaka and Fortune, 2002). The tendering stage, which comprises bidding, proposing, and contracting processes, was considered by Ritz (1994) as the lifeblood of the engineering–construction industry.

3.3 PFI Financial Management

The concept of PFI is believed to counter problems in public project delivery, such as over-design, poor project management, time and cost overruns, over-degradation of assets, higher maintenance and operational costs and lower asset residual value (Forshaw, 1999). PPPs often offer the means for an alternative financing of projects. It is looked upon as a way of using private sector finance to initiate projects that the public sector, at a given time, cannot find the funds to initiate itself (Leiringer, 2001). The number of signed PFI deals is growing, and the increasing number of events, seminars and workshops organised by major bodies is not only a reflection of the growing importance of PFI, but a recognition of the need for further improvement (Carrillo *et al.*, 2006). In developing a proposal for such projects, large capital commitments are required not only during the construction stage, but also during the pre-investment studies (Tiong and Alum, 1997a).

Financial companies play an important role in PFI transactions, where they perform different functions including debt arrangement, debt and equity provision and financial consultation. In addition to this, they ensure that the whole multi-company operation runs smoothly according to the financial plans (Akintoye *et al.*, 2001). Al-Sharif and Kaka (2005) have called for more involvement of the construction industry, either in the development or the application of PFI strategies and processes. They stated that the bidding process, cost and time span are constraints to construction organisations in bidding for PFI/PPP projects.

According to Yescombe (2002), an adequate financial model is an essential tool for financial evaluation of the project. It serves several purposes:

- Initial evaluation and re-evaluation of the project's financial aspects and returns for the sponsors during the development phase.
- Formulating the financial provisions of the project contract.
- Structuring the finance and reviewing the benefits of different financial terms to the sponsors.
- As part of the lenders' due-diligence process.
- Quantifying critical issues in the finance negotiations.
- Providing the base case.

3.4 Cost Models

Unlike the economists' world of mass production, where repetitive production costs and price levels are assumed to be accurately known, the construction–contracting situation demands that estimates be made of the price level and future production costs for a product, and in an environment only loosely resembling previous products and environments. This means that the situation must be viewed as a non-deterministic one in which events need to be considered in terms of their probability of occurrence (Skitmore, 1989).

Cost estimates could be described as the technical process or function undertaken to assess and predict the total cost of executing an item of work in a given time using all available project information and resources (Kwakey, 1996). The purpose of the cost estimating activities in the inception and feasibility phases is to determine the cost range with indications of quality or advice on the owner's cost limits. Cost planning in this phase refers to the process in which it is decided whether or not construction of the project is suitable under the prevailing physical and legal conditions (Tas and Yaman, 2005). In order to control the cost within an acceptable level, it is necessary to have an appropriate and accurate measurement of various project-related determinants and the understanding of the magnitude of their effects (Chan and Park, 2005).

A construction project is unique, wide in scope and high in cost; creating a prototype is not only uneconomical but also impractical. Therefore, it is crucially important to produce a forecast of the probable total building cost (Tas and Yaman, 2005). Cost is one of the measures of function and performance of a building and should therefore be capable of being 'modelled' in order that a design can be evaluated (Ferry *et al.*, 1999). Construction cost and cost model are among the subjects most often dealt with in construction management research studies. Some studies have aimed to survey the cost model in application; these studies were summarised by Fortune (1999) when he listed the models identified as available for use, as in Table 3.1.

Table 3.1: Models identified as available for use (Source: Fortune, 1999).

No	Model type	Manual/Computer	No	Model type	Manual/Computer
1	Conference	Manual	17	Regression Analysis	Computer
2	Comparison	Manual	18	Monte-Carlo	Computer
3	Graphical	Manual	19	Judgment	Manual
4	Unit	Manual	20	Financial	Manual
5	Superficial	Manual	21	Life Cycle Costs	Computer
6	Superficial Perimeter	Manual	22	Value	Computer
7	Cube	Manual	23	Expert System	Computer
8	Story-Enclosure	Manual	24	Detailed Quants	Manual
9	Functional	Manual	25	Significant Items	Manual
10	Exponent	Manual	26	Principal Items	Manual
11	Interpolation	Manual	27	Time Series	Computer
12	Resource	Computer	28	Casual Costs	Computer
13	Factor	Manual	29	Risk Analysis	Computer
14	Approximate Quants	Manual	30	Con Cost Simulator	Computer
15	Elemental Analysis	Manual	31	Dynamic Programme	Computer
16	Process	Computer	32	Linear Programmes	Computer

Ashworth (2004) classified cost models based on their purpose, and stated that while there is overlap between them, their chrematistics will be different. The cost model purposes he classified are as shown in Table 3.2 below. Ferry *et al.*(1999) classified the traditional cost models based on the design stage, as shown in Figure 3.1 below.

Table 3.2: Purpose of Cost Models (Ashworth, 2004).

Model	Purpose
Design optinisation models	Concened with securing value-for-money aspects in buillding design. Frequently used as part if the overall design economics and cost planning process.
Tender prdiction models	Forcasts the likely tender sum that will be expected by a client from a contractor.
Cash flow models	Indicate amounts and when the funds are likely to be required.
Whole-life costing models	Concerned with the whole life of a project and are thus not restricted to design and construction alone but also to use and occupation by the cllient.
Resource-based models	Assist contractors in their own estimating and forcasting process.

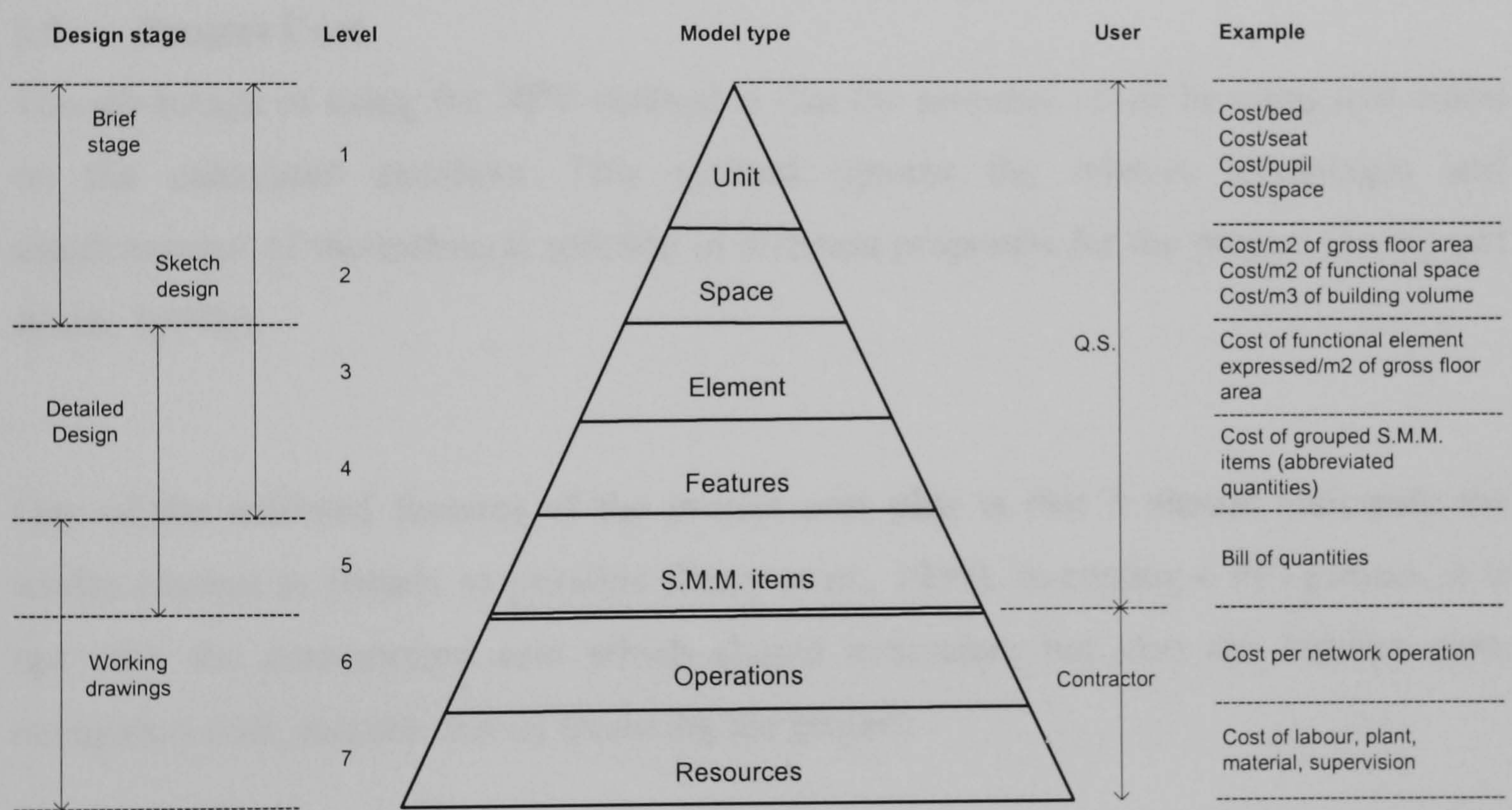


Figure 3.1: Traditional cost modelling (Adapted from Ferry et al., 1999)

Cost modelling may be defined as the symbolic representation of a system, expressing the content of that system in terms of the factors which influence its cost (Ferry *et al.*, 1999). Akintoye (2000) identified seven main factors that influence the contractor's cost estimate. The seven factors are: project complexity, technological requirements, information, team requirements, contract requirements, duration, and market requirements.

In cost estimation, construction companies generally produce the cost data after the completion of contractors' work and settlement of final accounts. Historical cost data derived from similar projects provides feedback to assist with future designs. This means larger construction companies have larger cost databases (Tas and Yaman, 2005). In a study conducted by Boussabaine and Elhag (1999), the contribution and the degree of influence of cost attributes on the tender price of office buildings were examined. They found that (with the exception of floor area and duration) there is little inter-dependency between office projects tendering cost and cost attributes.

3.5 Project Cost

The advantage of using the NPV method is that the proposal could be compared based on the calculated numbers. This method ignores the relative advantages and disadvantages of the technical solution in different proposals for the project (Tiong and Alum, 1997b).

One of the essential features of the project cost plan is that it should anticipate the tender amount as closely as possible (Ferry *et al.*, 1999). In costing a PFI project, it is not only the construction cost which should estimated, but also the bidding cost, occupancy cost, and the cost of financing the project.

3.5.1 Bidding Cost

The bidding cost of PFI projects is high and uncertain. In a survey on Scottish PFI contractors, Dick and Akintoye (1996) found that 87% of the respondents believe that bidding costs reduced the numbers of PFI contracts pursued by their firms; it was clearly the most cited barrier to PFI. Ahadzi and Bowles (2004) stated that the bidding and advisory costs to both the private and the public sectors were found to be equally high, ranging from £0.1 to £2.0 million, depending on project type. Businesses not engaged in PFI cite bidding costs as the main negative factor (BDO, 2003). Owen and

Merna (1999) reported that the high bidding cost of PFI projects was the reason behind the withdrawal of several high profile tenders, with the result that some preferred bidders were selected by default as other competitors withdrew. Cartlidge (2006) stated that high bid costs have the effect of restricting the competition to those companies that are able to afford the initial investment. This was also emphasised by Bult-Spiering and Dewulf (2006) as a barrier to taking part in the bidding process for private companies.

Ahadzi (2004) found that the average cost of bidding for thirteen PFI school projects is £1.12 million, as shown in Table 3.2. With the exception of only one project, all projects exhibited excess bidding costs over and above their original estimates, with one of them recording an excess bidding cost as high as 133% for the private sector participant. In October 2005, the Major Construction Group published the results of a survey of thirteen of its members on the bid costs of PFI projects. The survey covered 57 projects and showed that on school projects bid costs had fallen by 23% (from £3.1 million to £2.4 million) compared with the year 2003. By contrast, the average bid cost of hospital schemes rose by almost half, from £7.7 million to £11.5 million (Cartlidge, 2006).

Table 3.3: Bidding cost for Educational/School projects (Source: Ahadzi, 2004)

	Capital Value	Pre-contract/Bidding cost			
		Expected (3m)	Actual (£m)	Variation (£m)	Variation (%)
1	40.00	1.00	2.20	1.20	120.00%
2	70.00	0.20	0.40	0.20	100.00%
3	75.00	0.50	1.00	0.50	100.00%
4	37.00	1.85	3.70	1.85	100.00%
5	n/a	0.13	0.28	0.15	115.38%
6	24.00	0.80	1.20	0.40	50.00%
7	25.00	0.35	0.55	0.20	57.14%
8	52.00	0.60	1.40	0.80	133.33%
9	91.00	0.75	1.00	0.25	33.33%
10	35.00	0.40	0.70	0.30	75.00%
11	12.00	0.40	0.40	0.00	0.00%
12	40.00	1.19	1.20	0.01	0.84%
13	20.00	0.40	0.50	0.10	25.00%
	Average	0.66	1.12	0.46	70.00%

3.5.2 Construction Cost

The construction cost estimate usually gives the first specific indication of the total project cost. The estimate of total project cost gives vital information to the owner, the project designer, and the construction contractor. The owner uses the latest total project cost projection to verify the project's economic viability and cash flow (Ritz, 1994). According to Kaka and Cheetham (1997), contractors rarely prepare a comprehensive construction plan at the tendering stage but wait until they have won the contract. The detailed engineering and design work provides the basis for estimating the construction costs for the project. Construction cost estimates should include the cost of all facilities necessary for the project's operation as a free-standing entity (Finnerty, 1996).

The final agreed-upon cost for the construction work sets the financial baseline for the construction cost. Usually the price starts as an estimated cost that is agreed by the owner and contractor. The estimate used to reach the contract price is then converted to the project control budget for controlling project costs (Ritz, 1994). The estimation is usually used by pricing the bill of quantity where there are a large number of items. The rule of 80/20 was introduced when many researchers found that 80% of the total cost is contributed to by 20% of the measured items (Munns and Al-Haimus, 2000, Seeley, 1981). In UK construction, estimating expertise and costing routines appear largely keyed to the exploitation of commercial situations, rather than building up accurate cost estimation (Nicolini *et al.*, 2000). However, conceptual estimates are critical inputs for decision making in the early planning stages of a construction project, where planning decisions are based on cost figures that are estimated under a high level of uncertainty about the project's future (Serpell, 2004, Trost and Oberlender, 2003). Boussabaine and Elhag (1997) mention that an important requirement for the successful completion of projects within the predicted budget is the effective evaluation of the factors influencing the cost of projects, followed by sound management. The construction cost is discussed in Chapter Seven.

3.5.3 Occupancy Cost

The occupancy stage is critical in the PFI contract due to its length and potential for different types of risk. Occupancy costs are the cost of performing the function for which the building is intended. They are distinguished from operation costs, as they relate to the costs attributable to a specific process undertaken by the client, which may change within the life of the building (RICS, 2006). According to Kahn (1999), the narrowest definition of occupancy costs is that they constitute all direct rental and operating expenses for a real estate obligation. Boussabaine and Kirkham (2004) stated that the total occupancy costs projection is a quantification and presentation of the monetary resources required for running an occupied facility efficiently and effectively. The issues related to occupancy cost are discussed in more detail in Chapter Eight.

3.5.4 Cost of Finance

Cost of capital is concerned with how much will it cost the contractor to borrow money for new project (or product) development, or on an interim basis to account for cash flow deficits (Kerzner, 2001a). It is the return that must be provided for the use of an investor's funds. If the funds are borrowed, the cost is related to the interest that must be paid on the loan. If the funds are equity, the cost is the return that investors expect; from the investor's point of view, the cost of capital is the same as the required rate of return (Fabozzi and Peterson, 2003).

Because of their greater complexity, project financing involves higher transaction costs than comparable conventional financings. These higher transaction costs reflect the legal expense involved in designing the project structure, researching and dealing with project-related tax and legal issues, and preparing the necessary project ownership, loan documentation, and other contracts (Finnerty, 1996). As reported by CIC (1998), the cost of finance of the first two PFI prison contracts represented 40% of the operating costs. The UK government borrows more cheaply than private borrowers. Nevertheless, the case for recourse to private finance hinges not only upon the existence of efficiency gains but also upon their magnitude being sufficient to offset the higher financing cost (Heald, 1997).

3.6 Project Income

PFI project income consists of two sources. The first is the payment for the service provided, which is in arrears and is directly related to the service. The second is the additional revenue from third party sources. For example, a PFI school may have included enhanced sports facilities which are used out of school hours by fee-paying clubs or members of the public (CIC, 1998).

3.7 Payment Mechanism

By their nature, PFI projects require little or no expenditure in the early years of the agreement. However, each agreement will represent a commitment to the payment at a later stage of significant annual charges to the private sector provider (CIPFA, 1999). The contract document contains the conditions precedent for release authorisations, acceptance processes and the commencement of payments in addition to the details of payment mechanisms (TTF, 1999). The payment of PFI projects is called the Unitary Charge. According to the PFI Standardisation Contract (HM Treasury, 2004), the unitary charge is the payment calculated in accordance with the payment mechanism. The key features of a payment mechanism must be as follows:

- no payments should be made until the service is available;
- there should be a single unitary charge for the service which is not made up of separate independent elements relating to availability or performance;
- the single unitary charge should be paid only to extent that the service is available (e.g. proportionate to the number of available places or units); and
- the payment mechanism should seek to make deductions for substandard performance, so that the contractor is worse off than if the required service had

been delivered; but deductions should reflect the severity of failure — no service should lead to no payment, but a minor failure should cause at most only a minor deduction, except in the case of persistent failure where ratchet mechanisms may increase the level of deduction.

The client pays for the service, not for the facilities. The service provider does not receive a payment until the facilities are available for use. This contrasts with the payment profile of conventionally procured projects (BDO, 2003).

According to Cartlidge (2006), the general objective of payment mechanisms in PFI projects should be to:

- Provide realistic, challenging but achievable availability and performance standards for the service provider to meet.
- Provide incentives to meet standards by including penalties for under-performance.
- Match payment to outcomes.
- Provide incentives for the service provider to rectify problems quickly by linking delay to increased penalty level.

The Public Private Partnership Programme (4Ps, 2001) has developed some initial proposals for local performance indicators, which local authorities may wish to consider as part of developing their PFI projects, in particular the output specification and payment mechanism. These potential local performance indicators are shown in Figure 3.4.

Table 3.4: Potential local performance indicators (4Ps, 2001).

Local Performance Indicator	Commentary
Number of availability and/or performance deductions	Indicator of the service provider's performance against the output specification. Aim could be to show continuous improvement.
% of pupils taking school meals	Indicator of pupil satisfaction with the quality and price of school meals delivered by the service provider.
Indicator of vandalism	Indicator of the behavior of the pupils and the ability of staff and in particular the service provider to manage them through the design of facilities and security monitoring.
Stakeholder satisfaction	Indicator of staff, pupils and parents satisfaction with the school and the school environment.
% usage of ICT	Indicator of the usage of ICT by staff and pupils.
% of pupils taking part in extra-curricular activities	Indicator of the range, quality and pupil satisfaction with extra-curricular activities where the service provider is responsible of providing (some of) these activities.
Number of bookings/users from community groups and other third parties	Indicator of the range, quality and promotion of services available for use by community groups and other third parties

3.8 Financing PFI Projects

Project finance is the raising of funds to finance an economically separable capital investment project in which the providers of the funds look primarily to the cash flow from the project as the source of funds to service their loans and provide the return of and a return on the equity they have invested in the project (Finnerty, 1996). Finance is a discipline concerned with determining value and making decisions. The finance function allocates resources, which includes acquiring, investing, and managing resources. What distinguishes project finance from other forms of lending is that the project's creditors do not have resources against assets; instead the lenders must be paid through the output and/or the cash flow that the project generates (Valence, 2002). In PFI projects, financing is based on the shareholders' equity and the third party's fund, as shown in Figure 3.3. The equity will cover the bidding expenditure while the third party funds will cover the rest of the capital cost.

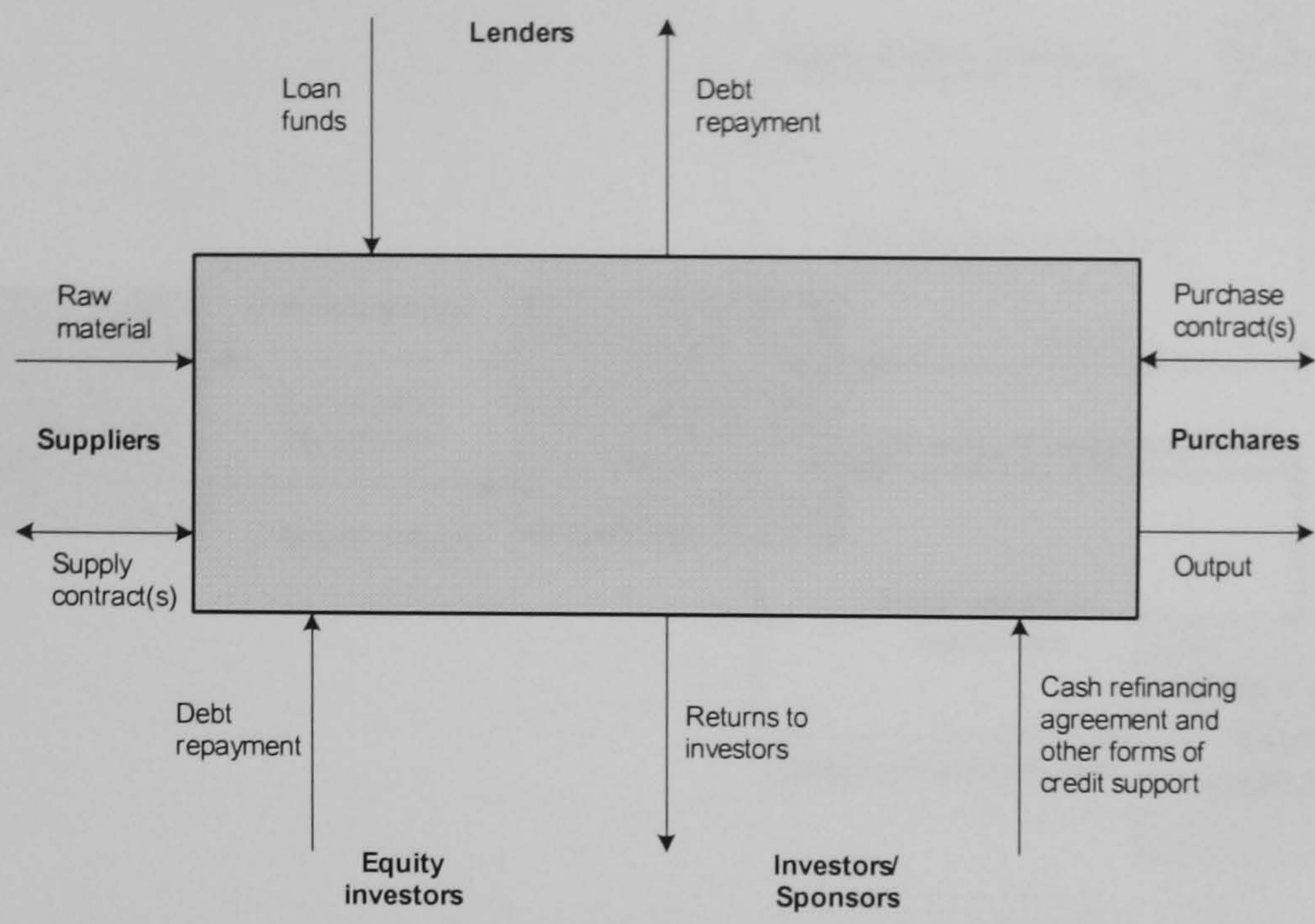


Figure 3.2: The basic elements of project financing (Finnerty, 1996)

Large PFI projects can be financed through a different mixture of financing options (e.g., by bank debt and bonds (fixed rate or linked)). The choice of financing method for a particular project depends on its specific requirements, the project risks, the amount of equity available and the perceived quality of the consortia. It has been argued that no single financing option is ideal for all projects (Akintoye *et al.*, 2001). The highest PFI project expenses occur during the construction phase. In most cases, the senior debt providers start supplying a loan after the SPV members have made their shareholders' contribution. Following this cash input from the senior debt provider, future payments become dependent on the completion of certain construction phases or milestones. During the entire construction stage, parts of the project's overall loan are continuously drawn, so that the interest and the actual amount of debt increase until it is eventually repaid a couple of years before the end of the concessional period (Asenova and Beck, 2003).

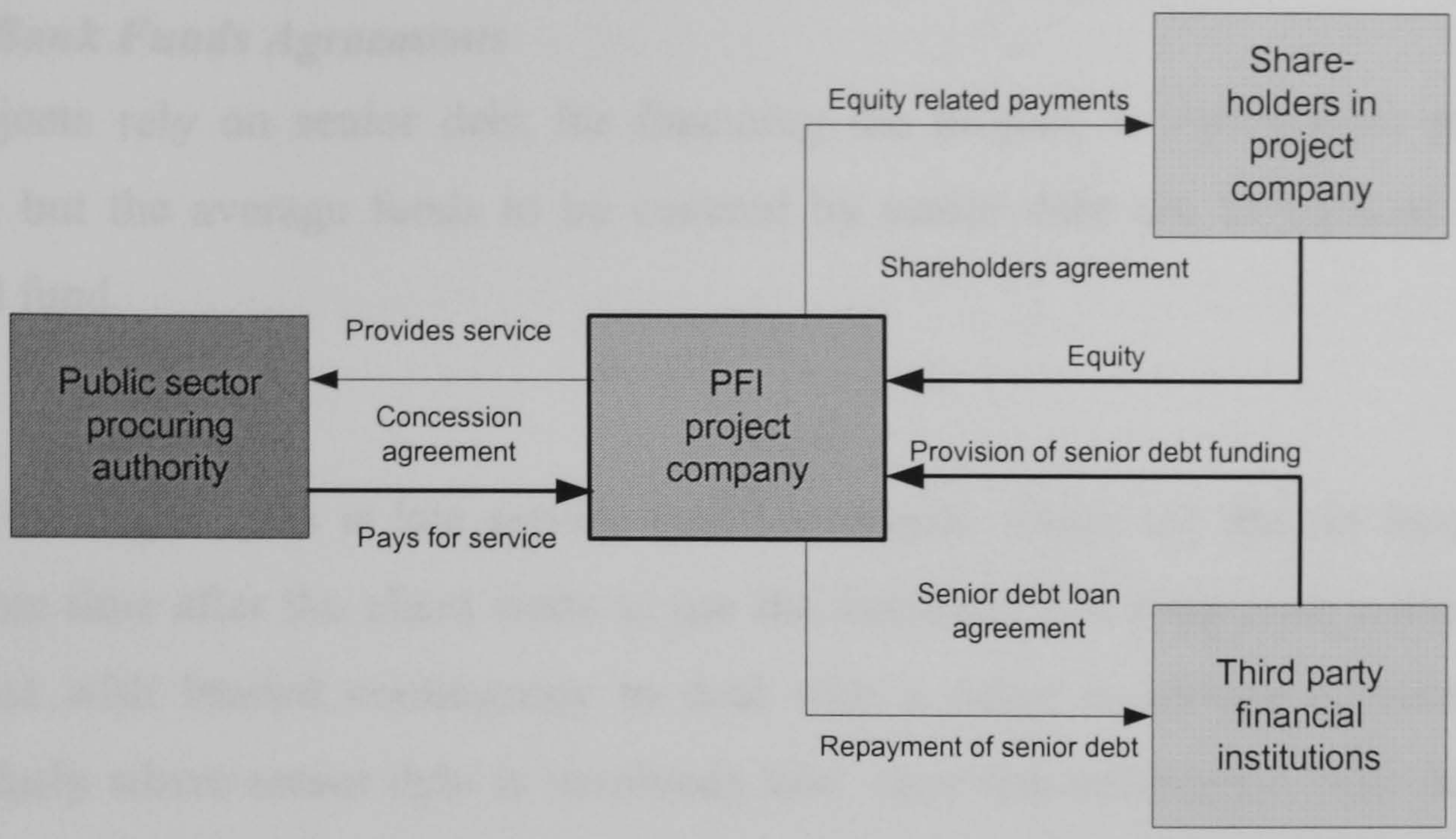


Figure 3.3: PFI financing framework (Source: Cartlidge, 2006)

3.8.1 Equity Financing

Equity is the portion of the project's capital costs contributed by the investors, which may be provided as share or capital subordinated debt (2002). In PFI projects, private companies come together to form the consortia or the SPV; they have to demonstrate their commitment to the project by providing a small amount of capital. This capital is by no means sufficient to finance the construction phase (Akintoye *et al.*, 2001). The equity returns reflect all the uncertainty of the prior commitments of the firm (Booth, 1998). Equity capital of a company is the owners' interest in it, and this comprises the capital 'permanently' invested by them (excluding loans) and any trained profit (Puxty and Dodds, 1991).

Equity finance comprises the amount originally contributed by the owners together with the profits from the previous year's trading which have not been distributed as part of a dividend (Ashworth, 1996). In the context of SPV, equity is another word for the shares held in the company (Cartlidge, 2006). The equity proportions may be as low as 1-2% of the capital cost (BDO, 2003).

3.8.2 *Bank Funds Agreements*

PFI projects rely on senior debt for financing the project; it varies from project to another, but the average funds to be covered by senior debt are 85-95% of the total required fund.

One of the major risks is late service commencement, where the project income will start some time after the client starts to use the facilities. The contractor's financing is structured with limited contingency to deal with a delay in service commencement (particularly where senior debt is involved), and they risk suffering a cash flow drain because senior debt obligations are not being met by payments of the unitary charge by the Authority. For every day the contractor is late in commencing service delivery, not only does it lose revenue, but its revenue-earning period is also reduced. The longer the construction phase is, relative to the service period, the greater the concern for the contractor (HM Treasury, 2004).

3.8.3 *Subordinate Finance*

Subordinate debt is the debt whose debt service comes after amounts due to senior lenders, but before distribution of dividends to investors (Yescombe, 2002). This debt, which is also called a mezzanine debt, is relied upon in cases where there is a gap between senior debt and sponsor equity. This situation typically arises when senior debt providers are not prepared to increase the level of debt and the sponsors cannot invest more equity (Asenova and Beck, 2003). It is usually provided at a fixed rate of interest higher than the cost of senior debt (Yescombe, 2002).

3.8.4 *Refinancing*

Refinancing is the ability of private sector consortia to re-negotiate their debt during the currency of the contract (Cartlidge, 2006). It involves changing the conditions on which a loan was initially provided. Refinancing of PFI projects has become possible recently, as a result of the increased confidence in the financial market towards PFIs. The refinancing option was suitable for some earlier projects, where the construction had been completed and successful operation has been demonstrated (Akintoye *et al.*, 2001). Yescombe (2002) argued that this is a common phenomenon in project finance, reflecting the reduction in risk as the project progresses, and benefits the investors in the project company.

During the life of the project, the contractor may wish to replace, augment or change the structure, nature or terms of the financing solution that it put in place at financial close for the purposes of financing the project. Where such restructurings or changes will have the effect of increasing or accelerating distributions to investors or of reducing their commitments to the project, these effects are individually and collectively referred to as refinancing gains (HM Treasury, 2004). According to Yescombe (2002), refinancing can take various forms, such as:

- Increasing the debt amount (so allowing an immediate repayment of part of the equity)
- Extending the debt repayment term
- Reducing the interest costs
- Improving loan terms (e.g., by reducing reserve account requirements)

3.9 Cash Flow Models

It is often said that cash is king, and in construction contracting cash is contractors' (and subcontractors') number one concern (Kaka, 2001). Cash flow forecasts are of great importance to construction contractors as well as to the client, to help prevent the unsavoury consequences of liquidation and bankruptcy. However, an accurate forecast of construction cash flow has been a difficult issue, owing to the risks and uncertainties inherent in construction projects (Odeyinka *et al.*, 2002). These risks and uncertainties are unquestionably greater in PFI projects. Cash flow is the increase or decrease in the cash of a business over a particular period of time (Rasmussen *et al.*, 2002). Cash flow forecasting at the tendering stage needs to be simple and fast, considering the short time available and the associated cost (Kaka and Cheetham, 1997). The net cash flow is the difference between the cumulative project cost and the income received from valuations at any point in the project duration (Cooke and Jepson, 1986). According to Kaka and Cheetham (1997), the amount of working capital required to run a contracting firm is low and may be negative. This is achieved by exercising tight cash flow control, where contractors try their best to precipitate payments from the client and delay those to subcontractors and suppliers.

Cash flow projection assists management in ensuring that there will be adequate funds available to pursue the construction programme, while at the same time not tying up the full cost of the project for the entire construction duration (Ward and Litchfield, 1980). Kaka and Khosrowshahi (1996) claimed that cash flow forecasting and control are essential for the survival of any contractor. In construction projects, companies must maintain a proper balance between equity and the credit market when raising funds. A firm with strong continuous cash flow may be able to fund growth projects out of cash flow rather than through borrowing. This is a usual financial-growth strategy for small firms (Kerzner, 2001b).

Accurate cash flow forecasting is an essential activity during the bidding stage for all successful construction contracting organisations. It provides contractors with information, such as the amount of capital required to perform a contract; the amount of interest needed to be paid to support any overdraft required; and the evaluation of different tendering strategies (Kaka and Fortune, 2002).

Kenley (2003) classified the model as follows:

- A deterministic approach is that which allows a deterministic model (usually from an average of past projects) to be held as a fixed model for future projects, from which forecast cash flows can be calculated.

- A stochastic approach is that which allows for the probability of variation in the forecast (sometimes, for convenience, from an average of past projects) by calculating future cash flows as an assembly of a trend and probabilistic variation about that trend.

Deterministic models use the deterministic values of the variables, and no randomness is incorporated. Probabilistic models use multiple estimates, and have at least one operating characteristic given by a probability density function. Most corporate financial models in use are deterministic in nature (Kaka, 2002).

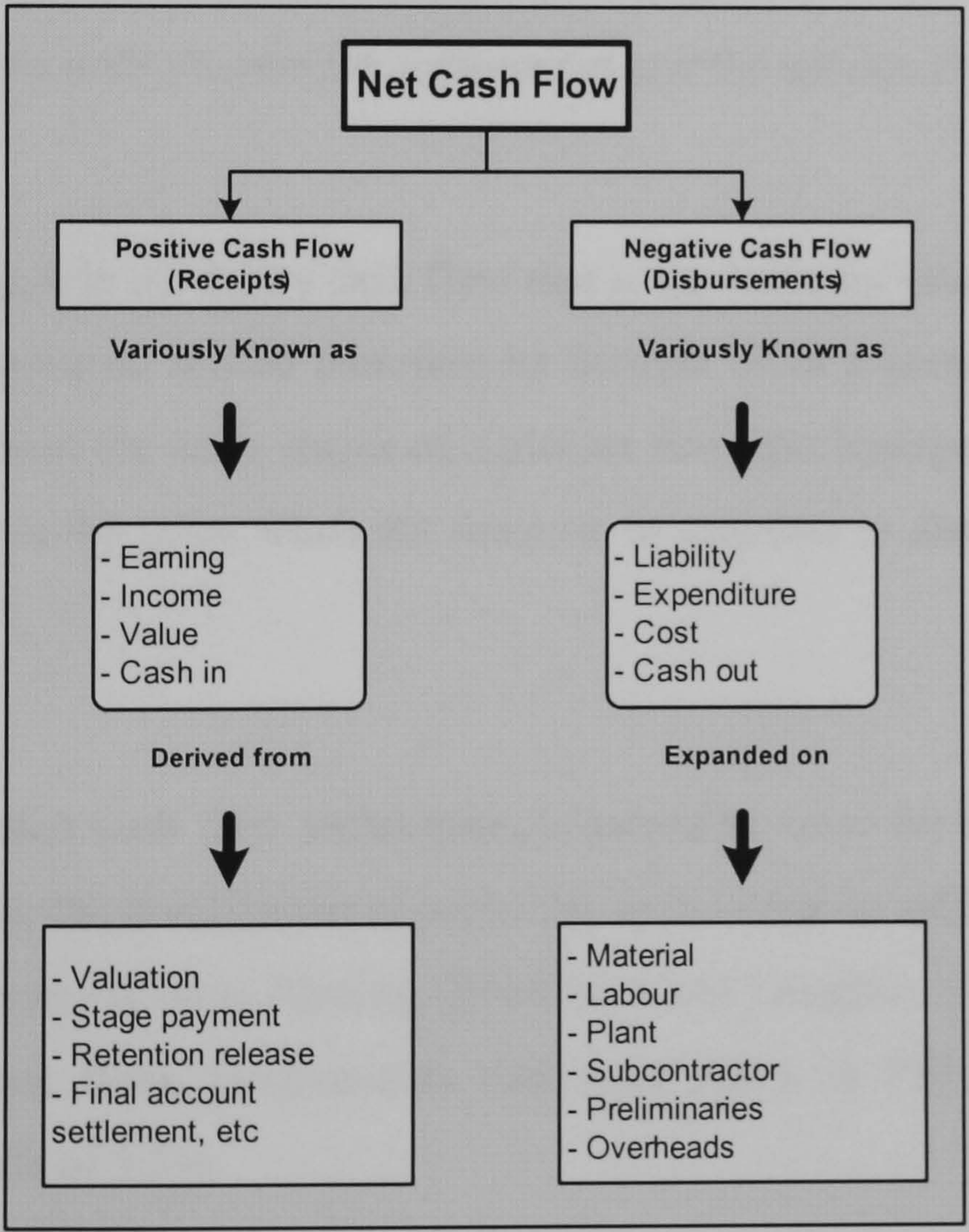


Figure 3.4: Construction cash flow concept (Odeyinka and Lowe, 2001).

3.10 Cash Flow in PFI Projects

Cash flow planning is partially a state of mind and should be included in all decision-making processes (Schleifer, 1990). According to Kenley (2003), net cash flow is the balance between inward cash flow and outward cash flow, and relates to individual projects. Projects usually commence with negative cash flow and then move to positive cash flow. The negative start of the net cash flow is obvious in PFI projects, where the inward cash flow starts when the operation of the facility is commenced. Information on cash flow can be communicated quickly and easily by use of a line diagram called a cash flow diagram, a type of graph used extensively because of its simplicity and ease of construction. It consists of two basic parts: the horizontal time line, and the vertical cash flow lines. The horizontal time line is subdivided into a number of compounding periods, with each compounding period representing whatever unit of time duration is specified for the problem under consideration. The vertical lines represent cash flow and are placed along the time lines at points corresponding to the timing of the cash flow (Collier *et al.*, 2002). Fig. 3.5 shows the cash flow diagram of a typical PFI project. The cash flows negatively until the service commences and the service charge is received.

In project financing, it is the future cash flow that is the basis for raising private finance. Project financial appraisal should therefore be thought of as a continuous process that takes place throughout the early stages of a project from the emergence of the need for the project and up to the point when the decision to sanction or abandon the project is made (EC, 2003).

The use of discounted cash flow techniques to ascertain value for money has been an important element in the justification of particular approaches to infrastructure provision and the release of permission to funding (Broadbent and Laughlin, 2005). HM Treasury (2003) in the Green Book recommends that cash flows in PFI projects are to be discounted at the rate of 3.5%.

According to Noel and Brzeski (2005), impediments to private participation in infrastructure may be grouped in four main categories:

- Inadequate cash flow (level, variability);

- Inadequate contractual framework (transparency, enforcement, and dispute resolution);
- Lack of policy risk mitigation instruments;
- Limited exit possibilities for first-round investors.

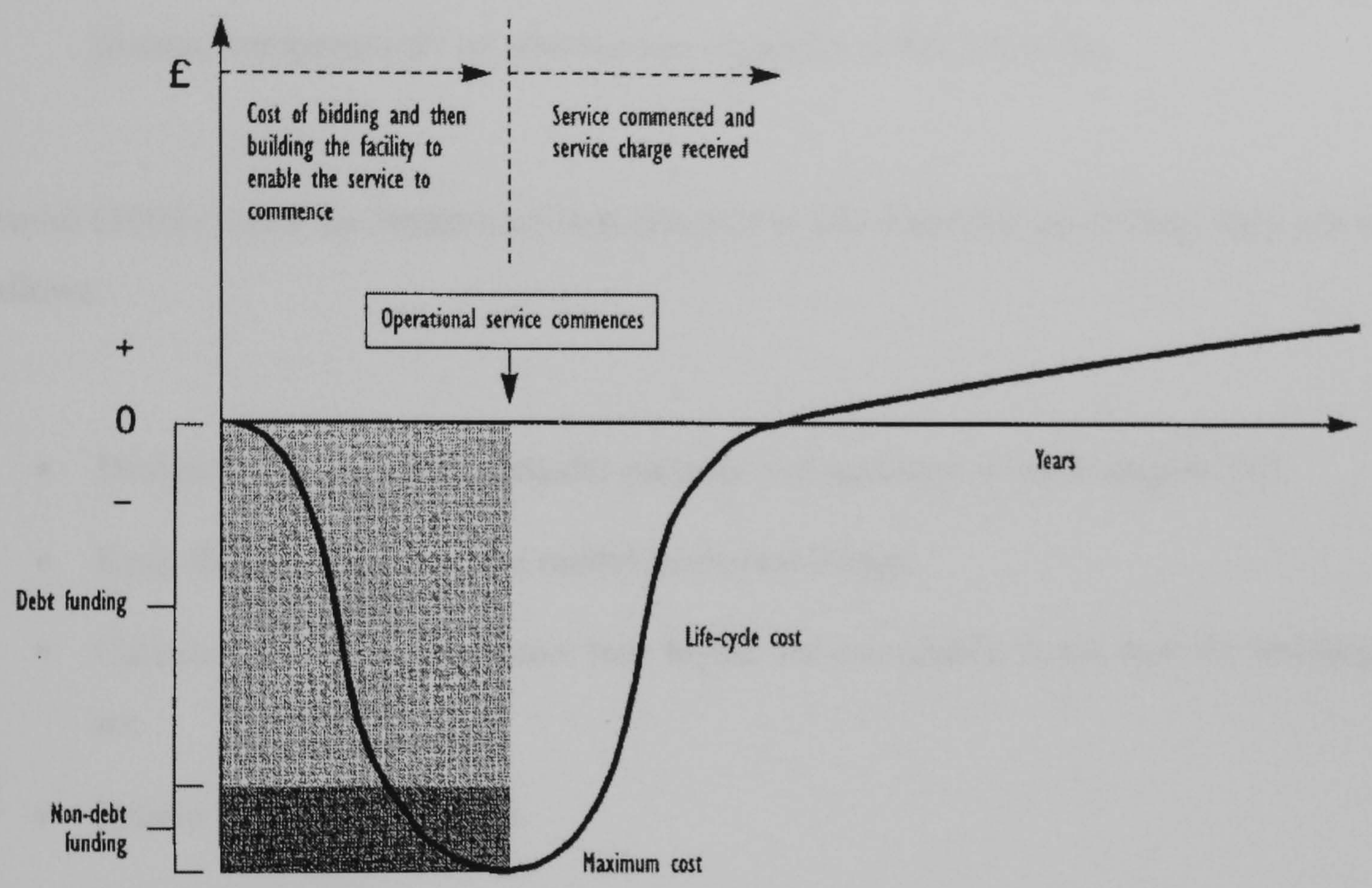


Figure 3.5: Cash flow profile of PFI project (Source: CIC, 1998)

The construction business operating without some type of cash flow planning is out of control for the simple reason that one never knows when one is going to run out of money (Schleifer, 1990). Cash flow occurs whenever cash or its equivalent "flows" or changes hands from one party to another (Collier *et al.*, 2002). Inadequate cash flow is the first concern among investors in infrastructure PPPs. Cash flow level and stability may be influenced, directly or indirectly, by a broad range of foreign exchange risk allocation, legal, regulatory, institutional and financial instruments (Noel and Brzeski, 2005).

Handley (2002) classified PFI financial models as follows:

- Pre financial close: evaluation tool — is the deal worth entering into (i.e., one knows how much the procuring authority can afford to pay. Will this amount cover the anticipated costs and provide a return to investors?).
- Post financial close: A monitoring and control tool for build and operational phases, compensation on termination, changes, and refinancing.

Daniel (2002) listed the features of best practice in PFI financial modelling; they are as follows:

- Design the output first: consider purpose and audience at each stage of bid.
- Keep things simple: do not model irrelevant things.
- Calculate things in one place: best layout for calculation is not best for printing, so:
- Ensure logic easy to check.
- Speed recalculation.
- Maintain a 'house' structure and methodology: repeatable, improvable, and transferable, because modelling is central to the bid.

MacMillan (2002) stated that PFI models currently conform to funders rather than inform the client. According to Fox (2002), funders require that models should provide the following:

- Demonstration that project is compatible with basic commercial terms: maturity, cover ratio, margins, equity IRR.

- Demonstration that project is robust enough to cope with economic and performance sensitivities (e.g., inflation, operating and life cycle cost, payment deduction).
- A robust forecasting and monitoring tool for the next 30 or more years.
- A product that consumers other than the modellers can understand.

3.11 Financial Risk

The cost of finance depends on investors' perceptions of risk. In the case of public sector financing, many of the implicit risks associated with investments are never exposed. The taxpayer provides the finance, but the risks of a particular investment project are not isolated and priced by the financial market. When private finance is used, risks are exposed. However, some of the risks associated with providing finance are likely to relate to the nature of the contract with government, and the reputation of the government as a contractual counter-party (Jenkinson, 2003). PFI enables a government to update its infrastructure without having to borrow to fund the investment, although a similar long-term commitment is still present (Grout and Stevens, 2003).

3.12 Use of Computers in Construction Management

Construction management dependence on computers has grown since the mid 1980s, when the reduction in hardware and software costs, plus a shortage of labour to undertake routine work, encouraged many firms to re-evaluate the use of computers (Ferry *et al.*, 1999). Alshawi and Ingirige (2003) stated that the high-speed developments in information and communication technology (ICT) have helped project management practices to take a new turn, taking advantage of newly developed management tools and the latest technology. McMenamin (1999) claimed that the efficiency and effectiveness of the financial planning process will be greatly aided by the application of computerised financial modelling. Proprietary software packages (e.g., Excel and Lotus) can be used to create a range of possible financial scenarios and to evaluate the financial effects of any changes in plans or targets.

Computer techniques now enable the economic modelling of proposed building designs (Ferry *et al.*, 1999). The use of computers has helped in process integration, and collaborative working in construction was found in many literature sources (Alshawi and Underwood, 1996a, Alshawi and Underwood, 1996b, Alshawi and Ingirige, 2003, Faraj *et al.*, 2000, Winch, 2002). The application of information technology to the estimating process has allowed much of the repetition and routine processes to be removed. It has also allowed many of the previously discrete processes to be linked together (Ashworth, 1996). It is argued that such a system would improve communication between the parties and permit a far higher quality of costing and cost feedback (Ferry *et al.*, 1999).

3.13 Summary

A PFI project is an investment project; understanding investment and its related issues is important for PFI projects. Because of the complicated nature of this type of project, construction contractors rely on external advisors to conduct the required analysis and modelling of cost and cash flow. Cost estimates could be described as the technical process or function undertaken to assess and predict the total cost of executing the project. In the early stages of the project, cost estimates could be conducted in different models. Cash flow is the balance between inward cash flow and outward cash flow.

The costs of PFI projects consist of the cost of the bidding stage, construction cost, occupancy cost, and the cost of financing the project. Financing a PFI project could be provided from different sources, mainly the equity and senior debt financing. The equity represents a tiny portion of the financing compared to the debt money, which could be provided either from the senior debt (bank borrowing agreement) or subordinate (mezzanine) finance that is provided by bank agreement or by equity. PFI financial models should provide a demonstration that a project is compatible with basic commercial terms such as cover ratio, IRR and NPV. They should provide realistic, challenging but achievable availability and performance standards for the service provider to meet.

Chapter Four

PFI Financial Modelling in Practice

4 PFI Financial Modelling in Practice

4.1 Introduction

Exploring what has been done in practice is one of the important early steps in any research project. This exploration could be undertaken through a review of the literature, or by a survey of the industry to gain the knowledge of how financial modelling is being (or could be) done in practice, particularly in the early stages of projects, which is the focus of this research. This chapter highlights the outcome of interviews conducted with different members of the industry, examining the practice of financial modelling in the early stages of a PFI project.

4.2 Aim and methodology

The aim is to investigate and explore those PFI organisations that have experience in PFI projects in order to document the current development and use of financial models in such projects, and to investigate the gaps in current modelling practices to enable better and more effective models to be developed. The objectives of this survey are:

- To explore the models used in practice for the cost estimation and cash flow predictions at the early stage of the project.
- To identify the most important factors affecting the cost and cash flow of a PFI project at the tendering stage.
- To explore the input and output of the current financial models.
- To explore the role of each party of the project in terms of model development and the data needed to feed into the model.

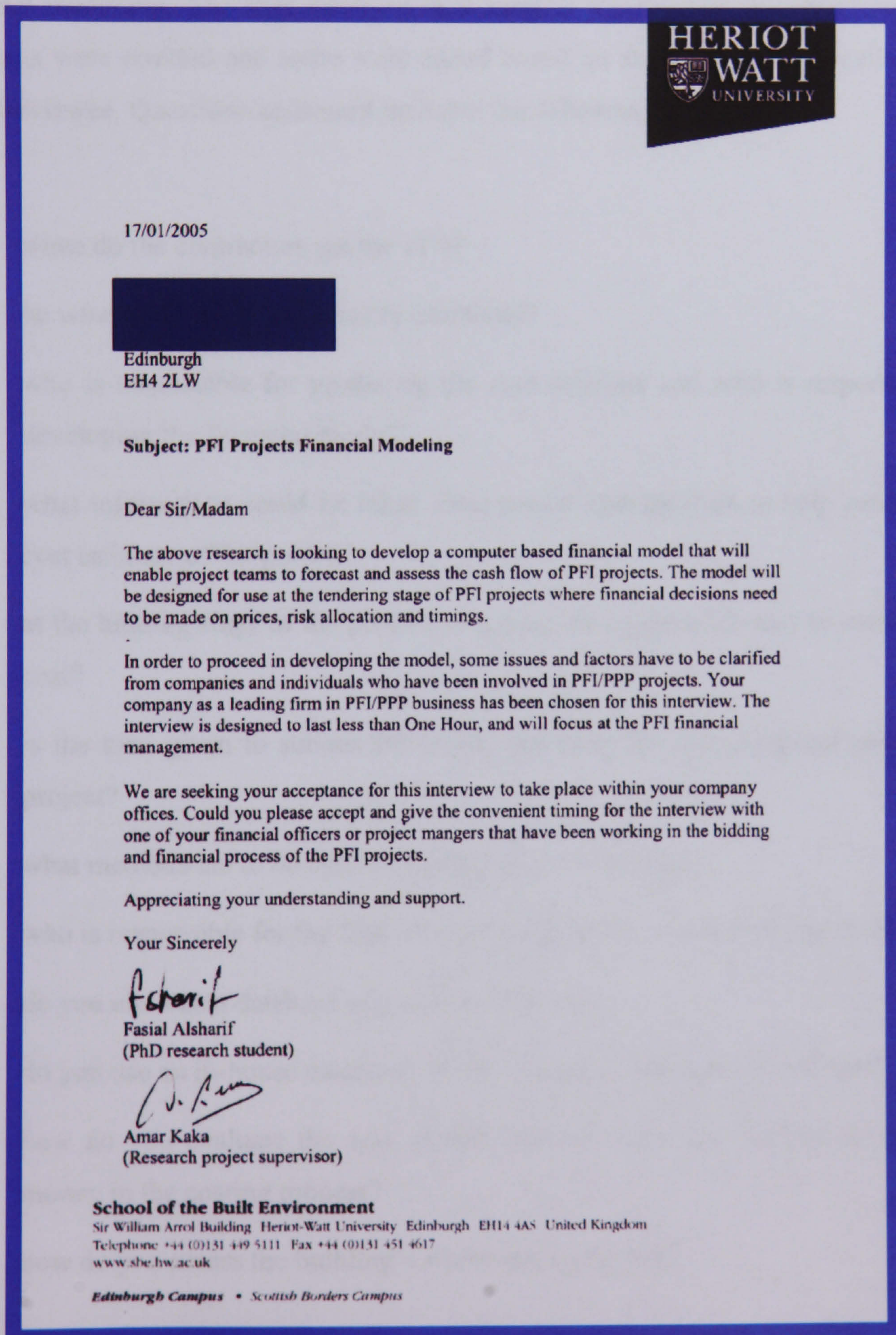
In order to achieve these objectives, a postal questionnaire survey or face-to-face interviews could be adopted as a means for collecting the data. Interviewing experts who have worked on PFI contracts was selected as the method of data collection for this research, for a number of reasons. These include the following: 1) The nature of the information required which focused on the practice of modelling financial activities related to PFI projects. 2) The need to contact organizations directly to obtain information about what they use, how it works and what they think about it. 3) The desire of the researcher to see an actual financial model used in planning and controlling PFI projects. The potential for obtaining this kind of information is greater through interviews than by using a questionnaire survey.

An invitation was sent to sixteen organizations that deal with PFI contracts, informing them about the aim and objectives of the research, and requesting their participation in the project through an interview, hence they would explain their practices in the areas of financial management and financial modelling of PFI projects (Figure 4.1). Three practitioners accepted the invitation; one invitation letter was returned because the addressee had moved job, and one responded by indicating the nature of the information required was commercially sensitive and therefore the request could not be granted. The exploratory interviews could involve limited number of participants; sometimes more interviewees add nothing to knowledge, especially if they use the same techniques and follow similar policies. Further interviewees were however sought by direct contacts or through friends and acquaintances. This resulted in four additional acceptances. Table 4.1 shows the total number and type of practitioners interviewed.

Table 4.1: Number of interviews

Category	Invited	Respond	Acceptance	Personal contacts	Total Interviews
Contractors	6	4	1	1	2
Clients	2	1	1	1	2
Architect / Engineers	2				
Quantity surveyer	2			1	1
Legal advisor	2	1	1		1
Financial adviser	2			1	1
Total	16	6	3	4	7

The results of these interviews were very important to the research, showing the current practice of financial models, clarifying how models work and highlighting the gaps that needed to be taken into consideration for the development of a new model in this area.



HERIOT WATT UNIVERSITY

17/01/2005

[redacted]
Edinburgh
EH4 2LW

Subject: PFI Projects Financial Modeling

Dear Sir/Madam

The above research is looking to develop a computer based financial model that will enable project teams to forecast and assess the cash flow of PFI projects. The model will be designed for use at the tendering stage of PFI projects where financial decisions need to be made on prices, risk allocation and timings.

In order to proceed in developing the model, some issues and factors have to be clarified from companies and individuals who have been involved in PFI/PPP projects. Your company as a leading firm in PFI/PPP business has been chosen for this interview. The interview is designed to last less than One Hour, and will focus at the PFI financial management.

We are seeking your acceptance for this interview to take place within your company offices. Could you please accept and give the convenient timing for the interview with one of your financial officers or project mangers that have been working in the bidding and financial process of the PFI projects.

Appreciating your understanding and support.

Your Sincerely

Fasial Alsharif
(PhD research student)

Amar Kaka
(Research project supervisor)

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Figure 4.1: Interview invitation letter.

4.3 The Interviewing Process

The questionnaires were presented in the interviewees' offices and a digital recorder was used to record the discussions. The questions were designed to cover the points that needed to be clarified, and to explore the actual practice of the industry regarding PFI financial modelling. The first interview was used as a test; after this interview, some questions were omitted and some were added based on the information received from the interviewee. Questions addressed included the following:

- when do the contractors get the ITN?
- on what basis is the cost usually estimated?
- who is responsible for producing the cost estimate and who is responsible for developing the financial model?
- what information could be taken from output specification to help produce the cost estimate of the project?
- at the bidding stage of the project, is a detailed design necessary to estimate the cost?
- is the time given to submit the tender sufficient for designing and pricing the project?
- what methods are to be used to produce the cost estimate?
- who is responsible for the final cost estimate of the project (bidding price)?
- do you use a cost database of previous projects?
- do you use an in-house database? If not, what cost database do you use?
- how do you evaluate the cost of risk, and how do you incorporate value for money in the costing process?
- how do you assess the building's whole life cycle cost?

During the interviewing process, follow-up questions were generated from interviewee's answers. Questions were designed to be open-ended to allow further useful points and amplification of interesting areas. It is to trigger discussion that aims not only to identify current practices but also to seek practitioners' views and suggestions. Most of the interviewees referred to specific projects they have experienced in order to substantiate their claims. The names of the practitioners and the projects they were referring to were kept confidential to keep the interviewees anonymous. Some of the questions generated from the answers go back to the principles and processes of PFI projects, particularly in terms of contractual relationships between project parties and their involvement in the financial planning activities and tasks.

4.4 Survey Findings

One of the findings of the survey is that contractors and client organisations are unable to prepare the financial models in-house. They rely on independent consultants and financial modellers for analysing the financial activities of PFI projects. They only estimate the project costing and the financial modeller will do the rest. The main findings of the survey are detailed below:

4.4.1 Financial Models

All interviewees raised the importance of computer-based financial models in developing the application of private sector participation in public projects. They identified the concerns associated with the modelling process, as many PFI bidders and their subcontractors are able to design the project and define the FM processes, and work out the cost input. However, what they struggle with at times is gathering together all of the financial information in a model package. This can be an expensive exercise, and only a few companies can provide this service. One interviewee intimated that effective participation of the private sector in public project investment took off when computer-based financial models became available. This was critical to the analysis of the impact of various scenarios and outputs on cash flow. Computer-based financial models are more sophisticated in terms of their ability to analyse uncertainty and 'what if...' questions.

The long duration of a PFI contract makes the financial model the cornerstone of decision-making and negotiation between all parties. It also enables the contractors to make the ultimate decision; whether to bid for the project or not. The models used in modelling the financial aspects of PFI projects by either the public or private sector are mainly based on spreadsheets. No available commercial software packages were known to any of the interviewees. In most cases, the financial advisor is the producer of the model, and each financial advisor has his own developed model that may differ significantly from what the others use, but targets the same output. The models available are designed as bidding models to support the decision during the early stages of the project for both the public and private sector. In practice, these models are designed to get everything in place for the 'financial close'. They are much more complicated than the models used to control the financial process of PFI projects during the operational stages. These are mostly traditional accounting and cash-flow software that are widely applied on other non-PFI projects.

The significant bidding cost is often seen as one of the main barriers to PFI projects. Contractors face a great deal of expenses before they are awarded the project, which is only valuable if they win. Otherwise, it is a considerable waste of money. This high bidding cost was reported in several literature sources, and also stressed by the interviewees who claimed that this is why the number of competitors for PFI projects was, on average, declining from 6-8 companies to 2-3. Even with the increase in PFI projects, the average number of competitors for each project in Scotland was 1.7 during the last 2 years, although this number is currently rising again to 3 contractors per project today. One of the interviewees claimed that some PFI projects have only attracted one bidder. The Highland school project is an example of this. This project involved the building of 11 new schools on 10 sites in the Highlands, under a 31-year PFI concession. The project is currently being negotiated with one bidder, and the anticipated cost is about £140 million. Bidding cost can amount to significant sums of money — one of the interviewees was party to a project where the bidding cost amounted to about £4 million before the contract was even signed. This entailed the SPV paying the bank advisors, lawyers, financial advisors, and contractors their costs for their time and efforts in putting the bid together.

Financial models are usually checked by the legal advisor to make sure that the inputs and assumptions match all of the contract documents, and the risk allocation fully agreed in the contract. Lawyers are not concerned with the mechanics or the output of the model; these are the concerns of the clients and their financial advisors. Nevertheless, the model should be simple enough to be read and understood by all parties in order for them to give the right advice or contribution.

4.4.2 Project Costing

Contractors depend on the superficial area of the project (in square metres) to build up their initial project cost. This information comes from client requirements detailed in the output specification. They start their arrangements for the project using these preliminary numbers to predict the project value and requirements. Simultaneously, they start the design, either by using in-house engineers or often by employing a design consultant. The client gives Invitation to Negotiation (ITN) and normally allows 12-14 weeks for proposal submission. This period is short for complete design documentations, which are normally used as the basis for an accurate cost estimate. The Facilities Management contractor provides the facilities management cost at this stage, on a square metres basis for each element of the services. This is done using their historical data and data available from indices such as the Chartered Institution of Building Service Engineers (CIBSE) Guide for energy efficiency in buildings. The average FM rate is then generated from the total FM cost in relation to the building area. The life cycle cost is provided by the cost consultant again as a cost-per-metre-square, which encompasses the cost of changing building elements or conducting building refurbishment work during the life of the building.

In estimating the project cost, the main cost items to be included are the cost of bidding, construction, and facilities management. The debt arrangement roll-up and diligence cost will then be added, together with the Special Purpose Vehicle's (SPV) management and insurance costs. The total of these costs will then form the basis for the unitary charge for the project. In terms of costing, estimating the cost of the construction project, and simply adding further factors or items to the running and maintenance cost for a PFI project is not particularly difficult, if one can develop a format that is compatible with the classification of categories founded in practical cost indices. The difficulty arises when attempting to develop a standard format that suits all. This could be done from historic data with some recognition of the risks and assumptions associated. The FM contractor does the same thing: "he can look at the screen and say there is a school of 4,000 m^2,' and consider how much roughly per m^2 that will cost him".

Many factors affect the total cost of a PFI project. These include, amongst others the type of project, interest rate, taxation, inflation, and risk assessment. These factors should all be assessed and incorporated into the model. The cost of financial models and other costs of consultancy services during bidding stage are high. This is why the abortive cost is very high. For these reasons a few contractors and major players have pulled out of bids altogether.

In order to produce a cost estimate for a project before a complete design has been prepared, project teams rely on the use of historic cost models. The area of the facility will usually drive up cost figures, based on the knowledge of past school projects and what this would cost per metre square. This is used to calculate a lump sum figure per school, using the given information on how many pupils per school, and the internal floor area per person.

Another way for costing the project and deciding to bid or not to bid is to acquire very general information from the client before even buying the project documents. In the case of a school project, the contractor searches for some information about the project, such as how many schools to be built, and how many pupils are involved, where all are used to calculate the area from such information.

In terms of facilities ownership, shortly after the Labour Party came to power in 1997, it has been made a condition that assets would be owned by the public sector and would continue to be owned throughout the project life cycle. Until recently, the practice was that there was a lease to the private sector and a lease back to management. This has given the perception that the private sector owns the assets, but now the approach used is what is called contract debtor accounting, which is a right to occupy. This is not an exclusive right, but a right to occupy or attend to the services and provide the services. That is particularly the case in dual businesses like schools, but when it comes to other projects, such as electrical generation projects, it would be much less important for the public sector to own those assets, because the interest here is on the pure output (i.e, electricity). The policies seem to be moving towards assets being placed within the public sector, but the interviewee suspects that the dynamics are still not clear. It does not make much sense for local authorities to end up with huge waste disposal units in 25 years' time, when the PFI contract ends.

4.4.3 How do the financial models work?

A financial advisor will be appointed by the SPV, and will be responsible for the provision and running of the financial model, which forms the basis for submitting the tender. As shown in Figure 4.2, the financial advisor relies on other parties to provide the financial data needed for the model. The project company SPV will provide the initial cost of the project and its management cost. The construction contractor will provide the construction cost and also the Life Cycle Cost on a monthly basis. The facilities management company will provide operation and maintenance costs (FM cost) on a six-monthly basis, and the banks will provide the financial information related to the project financing. The financial advisor will collect all the cost estimate of the project, and feed them into the model together with adjustments to the number of occupants and variable rates to suit the service provider target.

These models are commercially very sensitive. They can make a significant difference to the final bidding offer and the chances of winning the project. By optimising the model, the contractor can make 5-10% difference to the bids of other competitors, in relation to the capital that the contractor has available to spend on the project. This gives a huge commercial advantage. For a school project, it was claimed that, using the financial model can make a large saving (5-10%) to the client organisation, and/or a substantial profit margin to the SPV.

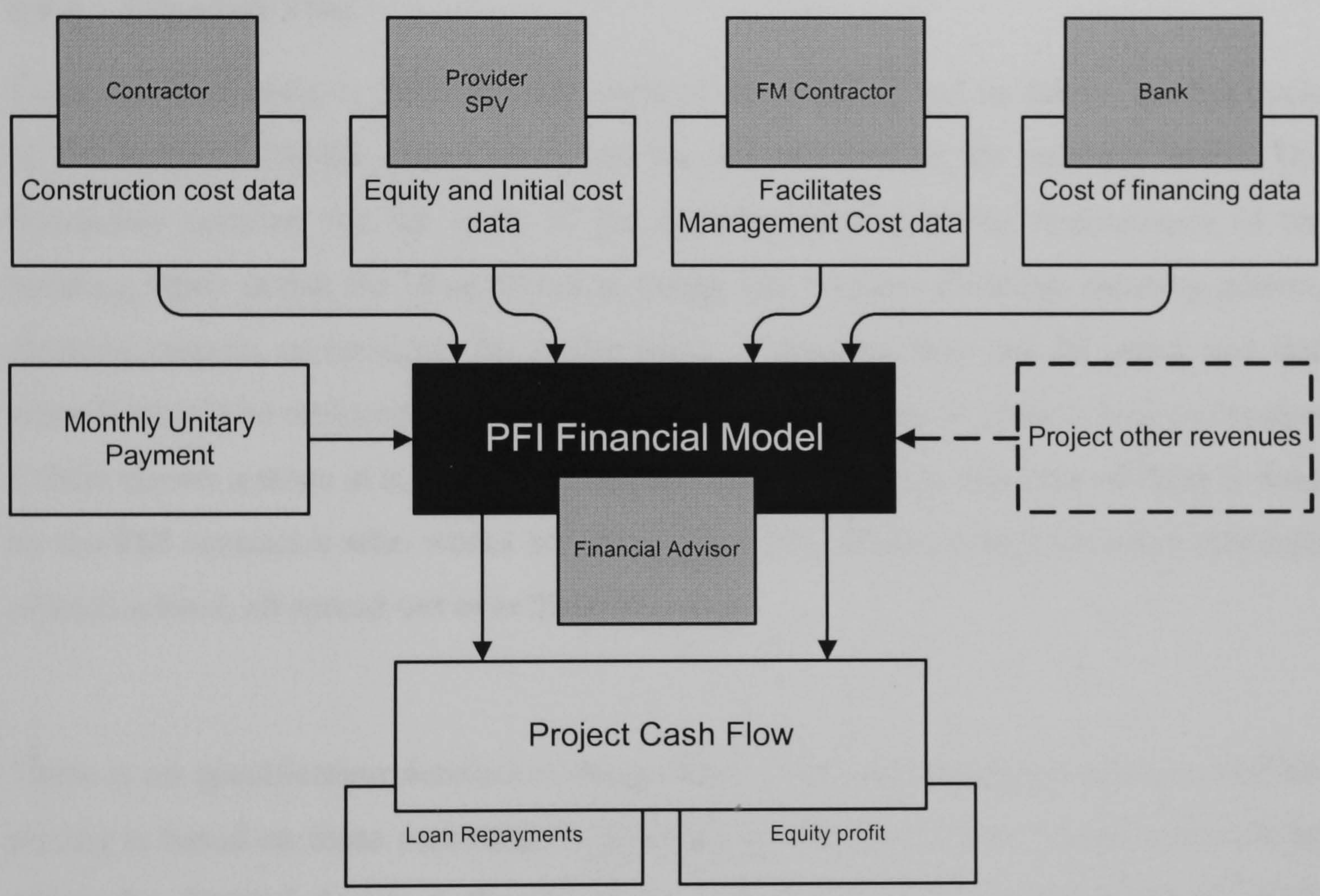


Figure 4.2: Current use of financial models in PFI projects

The client will provide data on the budget available to the public sector for the project. Normally the public sector will provide:

- the first year's unitary charge, and
- the overall Net Present Value (NPV) of the project.

The financial advisor will then be able to use the indexation provided in the contract to schedule how much money will be available each year. The financial advisor compares these, with the minimum unitary charge that could be accepted by the equity provider, and these inputs are adjusted in coordination and negotiation with those subcontractors and other parties who provide the figures.

4.4.4 Life Cycle Cost

There are three parts to LCC: the life cycle of the building and its fabric, the life cycle of the furniture (tables, chairs etc.), and the maintenance of the building fabric. The distinction between the life cycle of the building fabric and the maintenance of the building fabric is that the latter relates to things like window cleaning, cleaning gutters, cleaning carpets, or servicing the boiler plant. A window may last 20 years, and that when it should be replaced. In the intervening years, if a pane of glass is broken because a child throws a stone at it, or it has to be painted every 5years, that type of thing is done by the FM contractor who works for the builder. The same pertains for other elements of each school, all spread out over 20 to 25 years.

There is no specification detailed in the pricing. There are many assumptions, and the pricing is based on these assumptions. Contract conditions are set to have a process by which the detailed design is developed to confirm the assumptions; much of which depends on established working relationships, based on past experiences. These people involved in negotiating the contract include the facilities manager and the contractors; in the majority of the cases they belong to the same group of companies. The agreed pricing will indicate the extent to which the life cycle costing has been taken effectively into account, and the level of profit margins expected. In terms of the level of profit margins, one interviewee indicated that he does not think anyone will know for another few years yet if the project will result in tight margins; not until there is a significant number of PFI projects with 10-15 years' maturity will anyone know how the life cycle models are actually working out. The assumption is that the estimate does include a degree of some profit margin, and therefore it is far to say that the project is being priced on intuition. What usually happens is that some technical advisors will produce an estimated schedule of when each building item will need to be replaced. This schedule will be used to calculate the life cycle cost.

4.4.5 Risk assessment

The models currently being used have no specific and separate provision for costing risks within a bid. Construction costs normally include a margin to cover for related risks and uncertainty, and same applies for the FM costs where input of the risk is hidden in the operation and maintenance costs. The only time the financial advisor puts a particular risk premium within the construction cost would be when an item of a section of the building has been identified in the contingency section of the contract.

In cases where uncertainty is high, the impact of the risk on the project cost is separately assumed and taken up by the client. For example, in Stirling, because of the historical nature of the city, archaeological risks are often taken up by the Council. In addition to the risk associated with cost of uncertainty, the schedule of works will also need to be examined and assumed so that to ensure completion of the construction work by the agreed time scale provided in the contract.

Risk assessment in PFI projects is rather less scientific than might be imagined. The client identifies it in three parts: the risk associated with construction cost, resources cost and delivery risks. In terms of the cost of construction; the risk associated is the same as any other construction project. In order to build a school, hospital or office block, one looks at the design, the schedule programme that is required to build the school, resources availability, ground and site conditions, surrounds, and the overall time scale in which the project is going to be executed. The contractor assesses these factors when producing the cost plan.

There is one further risk in life cycle costs, and that is employment cost. In most contracts the soft service element (i.e., cleaning etc.) is market-tested for 5 or 7 years, so the labour-cost risk is effectively shortened. However, in the case of replacement which requires labour to carry out the works required any time in the future (where the cost is not market-tested and therefore there is a labour cost risk extending to 25-30 years). The risk associated is considered to be moderated by the assumption that the actual replacement cost of the materials is the significant element. However, predicting labour cost over 25-30 years period is still difficult and risky.

The standard Scottish schools contract at the moment recognises the risk of vandalism and the change of law risk, and hence provides for it to be shared between the client and the project company (regarding change of law risk: if there is a change of law which actually requires changes in the configuration of the building, then that is capital cost which is passed onto the client). Nevertheless, such laws are reasonably manageable and foreseeable; there is a 4-5 year gestation period before proposed legislation becomes law.

4.4.6 Taxation

SPVs are entities working in the UK where taxation rules should be applied. Models are normally designed to the best available tax information, and should be subjected to any taxation change for the project period. Tax change is a risk that needs to be identified and agreed upon. Normally, if the changes within the general taxation regime within the UK affect everyone, then it is the SPV's risk and they have to deal with it. If the change is considered as a discriminatory change in the tax laws, which affects only SPVs, or even more specifically SPVs who are running school projects, for example, that could be classified as a council change, and there will be compensation for the SPV.

4.4.7 Inflation

Inflation is contract specific. Typically, the client would agree to pay a unitary charge indexed at a factor that follows the Retail Price Index (RPI), which is the standard regime of inflation in the UK. This means that the unitary charge will be increased annually; but the client will have to choose here whether they are prepared to take the full indexation risk, in which case the rate goes up according to RPI, or they can choose to share the inflation increase with the SPV. Some contractors work on two-thirds inflation of Imported Price Indices (IPI), which is a series of economic indicators that measure change in prices of goods and raw material imported into the UK. It is only a small proportion of the unitary charge that is affected by inflation. Inflation affects mostly the FM costs; even though the facilities management company in obtaining that amount of money usually takes this into account to recover the differences between RPI and wage cost. Usually, FM companies allocated on inflation role that will lie between 1% and 5%.

In most PFI contracts, the inflation rate is fixed for the project duration. This means that most of the risk is weighted towards one party, depending on increased or decreased value. The client may choose also to pay part of the inflation, for example two-thirds of inflation as RPI to the end of project duration, and this distributes the inflation risk to both parties. This is one aspect of the financial risk the FM contractor would face. What they mostly do is set a fixed inflation rate for the project's duration; they make it higher than the current inflation rate (e.g., if the inflation rate is 2.5%, the FM contractor can make his inflation price 3.5% for the contract period, which means that the FM contractor will get 1% higher than his price if inflation remains at this limit. If inflation increases, to 4.3%, for example, the contactor will lose 0.8%).

4.4.8 Payment mechanism

School project payments used to be based on the number of pupils, but this has been changed. The standard version 3 of the Scottish School Contract is made up of Gross

Service Units (GSU) for the whole of the project — over the number of desks. Basically, what happens is that the contractor is not paid on the basis of how many pupils there are; he is paid a utility charge depending on whether there are 100 pupils or 1000 pupils. The pupil numbers are simply used to break the utility charge down and to figure how much a particular classroom is worth. However, the construction companies and consortiums do not take volume risk, which means they get paid 100% in terms of the number of pupils, and the deductions are based on availability targets set in the performance specifications, so the demand risk is always taken by the public sector.

4.4.9 Payment deductions

The level of deductions usually appears to be low in relation to the overall contract, but much higher relative to the FM contracts, which is where the risk will lie. In general, the contractor will take certain design risks in relation to that, but principally the FM contractor will take the majority of the risk. They however have rights against the contractor if there is a design failure that causes a loss, which is not an ideal solution for the FM contractors. There is rather a misconception in terms of how much damage that particular risk can cause. It should be assessed in relation to the value in reductions in relation to the FM contract, rather than the value of the deductions relevant to the overall contract. It is believed that there are many early projects, where the payment mechanism was not negotiated in this way, which proved not to be very effective. The key is to make sure that performance measurement is related to the important points and that there is a good mechanism for measuring these. In principle, the level of deduction is always greater than the cost of ignoring it, so it would be undesirable for someone to say 'Actually, it is cheaper to ignore this and take the reduction'. That requires some testing by the authority in advance of the procurement, to make sure that the repair mechanism is properly calibrated. As nearly all projects will suffer reductions, they will always appear to be relatively low compared with the value of the overall contract.

4.4.10 Legal aspects

There are some legal aspects associated with the financial models. The financial models are part of the contract: they are contractual documents, and they are the soft part,with all the formulae used to calculate changes. Therefore, in principle, if changes are instructed the public sector will ask for a proposal and costs of the change in the service provision. Those changes are entered into the financial model, and the financial model is rerun with the aim of keeping the repayment schedules and debt the same. The payment of dividends and IRR are the same, and that produces the new price that is required to be paid, so the models are legal documents and it is important therefore that they do what they designed to do. There is a question concerning who is responsible for developing the financial model, and there have been various projects in which the interviewee has been involved where errors are discovered later in the process, impacting on the overall costs of the project. If that happens late in the project, then that is a problem. If it happens after the financial close, then that is an even bigger problem — especially if there is any audit, as always happens before financial close. This is a cost borne by contractors, because it usually costs £50,000 to get a model audited, so trying to get accountancy firms to say that the model is correct is a difficult risk to offset. However, the equity and the funders will look for that; it will be part of the contract, and will therefore be a live contract for the life of the project.

Although PFI is a dispute avoidance concept, it has been reported that disputes exist in PFI projects, and the adjudication procedure is used quite widely within these types of projects. It is a difficult process because there are normally three parties involved in a dispute: Authority, Project Company and Public Sector. The project company and one or more of the sub-contractors will normally take the view that the matter is between the two entities, and in fact the public sector will say it wants to make a deal, but in reality three parties are involved, and it can result in a messy dispute resolution process. It is believed that there are more disputes to come over time, and most contracts will have disputes in the early phases. The dispute process is a fairly sophisticated process in these contracts, and they are relatively quick to resolve in theory. In practice it is rather difficult because of the tri-partite nature of these disputes, and it is quite difficult to resolve them. The courts are not used, as the use of the courts would extend the process a lot more.

4.4.11 Other issues

If the private sector makes a provision for community services, for example gymnasiums or swimming pools, and there is income from these facilities, the question arises: does this income go directly to the private sector, or what happens to it? The standard school contract makes a provision for a share to be bid or negotiated, and that is done on a case by case basis. Usually, there will be some sharing of the profits, because it is only in very rare cases that the property financiers will allow that to be assessed as definite income. Therefore, for it to be assessed as part of the company's income, it does not reduce the price, so there has to be some sharing mechanism if any profit is made. It is however not exclusively the case. There have been some situations where such income has contributed to a reduction in the price, in which case all of the income goes to the private sector. This is quite rare, but certainly happens within school and hospital PPP/PFI projects.

In the school projects the councils (because they will determine the location of the schools on an educational basis and hence provide the land) also have to go through long consultation processes, which add to the efforts required in the preparation for delivering the school on a new site. Some of the earlier PPP/PFI projects involved a facility being built on a piece of land to be provided by the contractor. This proved to be problematic for contractors. Usually, there is an obvious, preferred location, and councils do not want 2 or 3 bidders competing for the land, with the possibility of one party getting it while another is in a much more position to win the bid.

One interviewee thinks that there is also a misconception concerning how important the risk of project siting is, because if the public sector builds that school conventionally, it is taking that risk, and the risk is there for the projected life of that building. If it transpires half way through that building is not needed, then it is still the case that the council has borne that risk, the risk has materialised, and money is lost as a result. However, because it is paid for in the totality 15 years before, it is not perceived as being a risk. Whereas with PFI, because the payments are spread across the life of the project, these payments need to be made in the period after which the facility would have been closed half way through its life. It is believed that the risk is there from the moment the decision is taken to build that asset, and that the position is not any different between PFI and non-PFI projects. The questions for any council are always: where are the schools sited, and where is the lowest-risk place that this can be built in terms of future projections of the community needs? Councils are always faced with these rational decision-making factors. However, there are always other factors involved: availability of sites, key issue in terms of the location, and often practical matters. Politics are also an issue, in which local politicians have the most say, and the administration can determine where schools are to be located. It is not necessarily the case that they will always be located in the appropriate places. Nevertheless, it is very hard to predict in 15 years' time where the population is going to be — but it is a public sector risk, and without privatising school provision, the author believes there is little that can be done about that.

The service availability is another element that features in the PFI financial model. Although it has nothing to do with the number of students, there were some early projects in the health sector, and also one of the early projects in the college sector, where there was an element of risk associated with patient or with student numbers. However, the interviewees did not think they proved particularly good value for money, because the private sector could not influence that; if the private sector cannot influence or manage a risk, then it is not one in which it is going to be able to price effectively.

If student numbers go down, the clients pay the same amount: it is based on pupil places, so there will be a projected number of students and that will be pupil places bought — the fee is based on the number of pupil places. Furthermore, if the number increases, it could be argued that the private sector is taking a risk, because there is a great risk of damage. Generally it is taken that the risk of extra costs being incurred is relatively low, because there may be only a few more people. It is not as if it has a risk of impacting heavily on the cost, and the policy is unlikely to move to a position where overcrowding or devaluation of quality would be allowed. The NHS was interested in certain facilities in which the costs could be related to the cost of patients using that facility. It is generally taken that if they wanted to change the class of patient in the hospital, then that hospital would require a new configuration, and any costs related to the change in class would therefore be classified as change, and that is the general view taken.

4.5 Summary

This survey aims basically to widen and strengthening the knowledge base about the current practices of PFI-project financial modelling. The number of interviews was quite adequate to support this aim (apart from some difficulties regarding cooperation between industry and academic researchers). Information gathered from these interviews point to the fact that the current financial modelling for PFI projects seems to be costs collected from different parties and manipulated with project income and economic factors. The contractors and subcontractors prepare the costs using different criteria, and the financial modeller (consultant) will compile all of this data in one model, known as the PFI financial model. The survey reveals many points that will be taken into consideration in the new model being developed through this research. The model will encompass costing for the project, risk assessment, whole life cycle costing, calculation of interest rate and many other useful points.

Chapter Five

Research Methodology

5 Research Methodology

5.1 Introduction

The literature reviewed in Chapters Two and Three reveal the importance of PFI projects not only for the construction organisations and clients, but also for service quality and performance. Financial management is a centre of concern in such projects due to their complexity and length of engagement. This chapter discusses the problems and design of the research model; it also explores the quantitative and qualitative research methods that were considered for the collection and analysis of data, and later on the development of the financial model. The selected research methods are also discussed in details in this chapter.

5.2 Research Strategies in Construction Management

Research is important for the development of the field of construction management. Its development followed the advent of studies on socio-economic development in the late 1950s (Ofori, 1993). Different research approaches were identified and/or applied by many researchers. A literature review about research strategies and approaches reveals many terms relating either to research strategy and approach, theories and paradigms, or even to the description of data collection and analysis. Terms such as interpretivism, positivism, inductive, deductive, structuralism, constructivism and others mix the research strategy with research theory and style. Naoum (1998) stated that one of the problems of reading about research methods and techniques is the terminology, adding that writers use terms that may be incomprehensible to other people.

Construction management can broadly be described as the application of the principles of economics and management systems to the business and production processes of organisations that operate in the construction industry (McCaughey and Edum-Fotwe, 1999). The application of the Latham Report (Latham 1994), according to Seymour and Rooke (1995), has turned attention to the institutions of the construction industry and to the culture that has developed within them. However, over the past four decades the construction industry has experienced significant transformation in the way its projects are managed and its business activities undertaken, driven largely by changes in industry competition but also with a contribution from research efforts (McCaughey and Edum-Fotwe, 1999).

According to Runeson (1997), construction management is a set of functions where different techniques are employed. Some of the functions are based on, or can be explained by, various scientific theories; some of the techniques have a theoretical background. Runeson commented on the note by Seymour *et al.* (1997), suggesting that it would be better to concentrate on the interpretative method that researchers and managers use to make sense of the world. They were in favour of interpretative (qualitative) methods and against rationalistic (quantitative) research methods in construction management research, in another word, they were against a positivist epistemology and for a nominalist ontology (Runeson, 1997). The problem that is seen with the rationalist paradigm is that it does not require researchers to question their own position. Instead, rationalists put their faith in the use of particular methodological routines to guarantee their impartiality (Seymour and Rooke, 1995).

Because of the confrontational nature of the construction industry, Loosemore (1998) summarized the methodological challenges that are likely to be faced by researchers operating within a confrontational environment, as listed in Table 5.1. He stated that these challenges are likely to be exacerbated by qualitative methods and real-time data collection. Furthermore, he presented a methodology that was designed to overcome the problems of sensitivity, tension, stress, pressure and uncertainty found within a confrontational construction industry. Table 5.2 provides a summary of the proposed solutions, with the intention that the solutions identified would be useful to researchers who face similar challenges in their research.

Table 5.1: The methodological challenges of a confrontational environment (Source: Loosemore, 1998)

Environment	Methodological challenge
General	*Pressure*: Under pressure, people are likely to be anxious, emotional, stressed, irrational, impulsive and insecure. There may be a limited period of biased data.
	Sensitivity: Sensitive data may be closely guarded and difficult to access.
	Ethic: Ethical questions can arise about the timing of data collection, what data should be collected and whether it is right to collect data.
	Uncertainty: There is unlikely to be a collective definition of a phenomenon, meaning that conflicting accounts of it will be received. These will have to be reconciled to produce a coherent account of reality.
Construction specific	*Leanness of the industry*: Low margins and extra work-loads will make minimizing respondent inconvenience a priority.
	Logistics: The interdependent nature of people contributing to construction projects means that the management of respondents is an important issue.
	Uncertainty: The complexity of interdependency in construction projects, means that respondents are unpredictable in the timing and nature of their contribution to problem resolution. This necessitates a flexible rather than a pre-planned approach.

Table 5.2: Methodological responses to challenges (Source: Loosemore, 1998).

Uncertainty	Sensitivty	Pressure, stress and emotion
Clearly define and limit respondent boundaries.	Collect data retrospectively. If the study is longitudinal, it must be unobtrusive.	Combine quantitative and qualitative methods. Reduce reliance upon in-depth techniques.
Closely monitor data collection.	Provide security. Hand over control of data collection to respondents.	Timing is important. Retrospective studies are preferable; avoid longitudinal studies unless these are unobtrusive.
Use a two-stage methodology incorporating a period of reflection and adjustment at its centre.	Build trust over time via prominence, continuity, familiarity, independence and professionalism.	Collect varied perceptions. Avoid single data sources.
Build in flexibility, responsiveness, semi-structure distance, natural sampling and self-management of data collection; see all respondents as potential source of data.	Avoid sensitive issues.	Pilot study experience is essential.
Ensure respondent autonomy. Hand over control of data collection to respondents.	Formally assure confidentiality in writing.	Provide emotional outlets and flexibility via a semi-structured format.
Have patience and do not interfere with respondents.	Minimize respondent uncertainty early on. Provide clear explanations of data required, research aims and modes of dissemination.	Be sensitive to people's feelings and know the limits of data collection.
		Minimize inconvenience by simplification and spreading responsibility for data supply over many respondents.

5.3 Research Classification

In an attempt to classify different types of research, Fellows and Liu (2003) classified them into three categories:

- Pure and applied research, where pure research studies focus on the discovery of theories, laws of nature, etc., and applied research is directed towards the end user and practical applications.
- Quantitative and qualitative research; this is the most widely used classification of research and will be discussed in detail in this chapter.
- Other categories of research; where further categorisation of research studies accords with the purpose of research as follows:
  - Instrumental — to construct/calibrate research instruments, whether physical measurement equipment or a test/data collection.
  - Descriptive — to identify and record systematically all the elements of a phenomenon, process or system. Such identification and recording is done from a particular perspective and often for a specified purpose.
  - Exploratory — to test, or explore aspects of theory.
  - Explanatory — to answer a particular question or explain a specific issue/phenomenon.
  - Interpretive — to fit findings/experience to a theoretical framework or model.

5.4 Quantitative and Qualitative Approaches

Most of the research undertaken in construction management and economics uses either qualitative or quantitative methods, with a preferences for quantitative approaches (Carter and Fortune, 2004; Dainty *et al.*, 2000; Loosemore *et al.*, 1996). Carter and Fortune (2004) found that most of the papers published in the Association of Researchers in Construction Management (ARCOM) annual conferences held in 2000 and 2001 applied quantitative methodologies. This supports the findings of Loosemore *et al.* (1996), when they reviewed the papers published by Construction Management and Economics journal between 1983 and 1993 and found that 57% of the papers were conducted using quantitative methodology, 8% using qualitative methodology, 13% were conducted using mixed methodology, and 22% of the papers were discussion papers. The construction management community is gradually witnessing a polarisation of research orientation from interpretive schools of thoughts into rational or positivist strategies. However, it has to be emphasised that within construction management, there is room for both perspectives to co-exist, and in fact complement each other (Edum-Fotwe *et al.*, 1997).

Qualitative data is collected across a range of social sciences disciplines, often with varying techniques or emphasis, but typically aiming to capture live experiences of the social world where the people concerned share their experiences from their own perspectives (Corti and Thompson, 2004). This means that qualitative methods might concentrate on exploring in much greater depth the nature and origins of people's views (i.e., the reasons for, and consequences of) on the issues being studied (Easterby-Smith *et al.*, 2002).

According to Fellows and Liu (2003), quantitative approaches seek to gather factual data and to study relationships between facts and how such facts and relationships accord with the theories and findings of any research executed previously. Quantitative research is based on the collection of considerable data from a representative sample of a large population for a few variables (Black, 1999). Quantitative research, according to Naoum (1998), is selected under the following circumstances:

1- When you want to find facts about a concept, a question or an attribute.

2- When you want to collect factual evidence and study the relationship between these facts in order to test a particular theory or hypothesis.

Both qualitative and quantitative approaches may adopt common research styles — it is the nature and objectives of the work together with the (consequent) nature of the data collected which determine whether the study may be classified as qualitative or quantitative (Fellows and Liu, 2003). Mixing both approaches in conducting a research study are often referred to as triangulation and multi-paradigmatic approaches, which clearly, according to Raftery *et al.* (1997), demonstrates a positive way forward towards an 'existentialist' approach concerning the choice of paradigm and methodology. Triangulation employs plural methods; bridges involves linking two or more analytic formats (research methods) to make them more mutually informative, whilst maintaining the distinct contributions and integrity of each independent approach/discipline (Fellows and Liu, 2003). PhD researchers in construction management use mostly mixed methodologies (more than one research method). This was highlighted by Hughes (2003) when he found that 63% of the seventy PhD students who responded used two or more research methods.

5.5 Modelling in Construction Research

A basic definition of a model is a procedure developed to reflect, by means of a derived process, adequately acceptable output for an established series of input data (Seeley, 1996). Jaggar *et al.* (2002) summarised the purpose of models as helping to provide the following information about the construction project system they represent:

- The communication of facts about the system. For example, one might use a model that will predict the likely future cost of a primary school to be built in 2002 in Loughborough.

- The communication of ideas about the system. For example, the model of the proposed space use within the building may give rise to a design review of what space to provide and its juxtaposition to other spaces.

- The prediction of how the system will behave in certain circumstances. For instance, the total cost of a project may change as a result of different procurement methods.

- The provision of insight into why the system behaves as it does. For example, in observing the cost behaviour of the project model in this study, one might be able to assess how costs vary as the height of the building increases.

Models must be capable of manipulation so as to predict the optimal values of the chosen variables, must be simpler than the reality they represent, must be easier to manipulate and control, and as a result must be cheaper because failure of the real thing can be expensive (Pilcher, 1992). Models may be used to investigate and/or to predict; for managers, predictive models are more valuable, whilst auditing requires investigative models (Fellows and Liu, 2003). The reason models are of such benefit is that they can assist in predicting the behaviour of a real-life situation. The prediction may have varying degrees of confidence, so they can inform the decision makers as to the effects of making a particular decision (Jaggar *et al.*, 2002).

Models may be solved by experimentation or by mathematical analysis. Using experimentation means the process of substituting a series of values for the variables in the model, viewing the results and deciding when an optimal solution has been obtained. Mathematical analysis means solving a mathematical equation or a series of equations to obtain precise and optimal results (Pilcher, 1992). The common forms of model, according to Fellows and Liu (2003), are:

- Iconic: Visual or pictorial representation of certain aspects of a real system, such as computer screen icons to denote programmes, and /or detailed drawings of parts of a building (Churchman *et al.*, 1957).

- Replications: displaying significant physical similarity to the reality, such as a doll (Sayre and Crosson, 1963).

- Analogue: employs one set of properties to represent some other set of properties which the system possesses, (e.g., electrical circuit to mimic heat flow through a cavity wall) (Churchman *et al.*, 1957).

- Symbolic: requires logical or mathematical operations (e.g., 'S curve' equation of project cash flow) (Churchman *et al.*, 1957).

Analogue and symbolic are common forms for research purposes, whilst in construction industry, iconic models and replications are usual (Fellows and Liu, 2003). For the sake of expediency and cost, it is necessary, according to Ferry *et al.* (1999), to construct models that represent the real situation in another form or to a smaller scale, so that a realistic appraisal of performance can be made. These models can be:

- physical (as in a three-dimensional architect's balsa model);

- three-dimensional computer graphic 'walk-through' and 'fly-bys';

- mathematical (as in a heat loss equation);

- statistical (where some collected information indicates a certain trend).

Modelling is a research method: it can be qualitatively or quantitatively based, depending on the model's objective and nature. Models help in making decisions by interpreting the outcome, which should represent the case intended. Raftery (1999) thinks that the model may be viewed as part of a chain, which leads from raw data through some kind of model and output and on to a decision maker, as illustrated in Fig. 5.1 below.

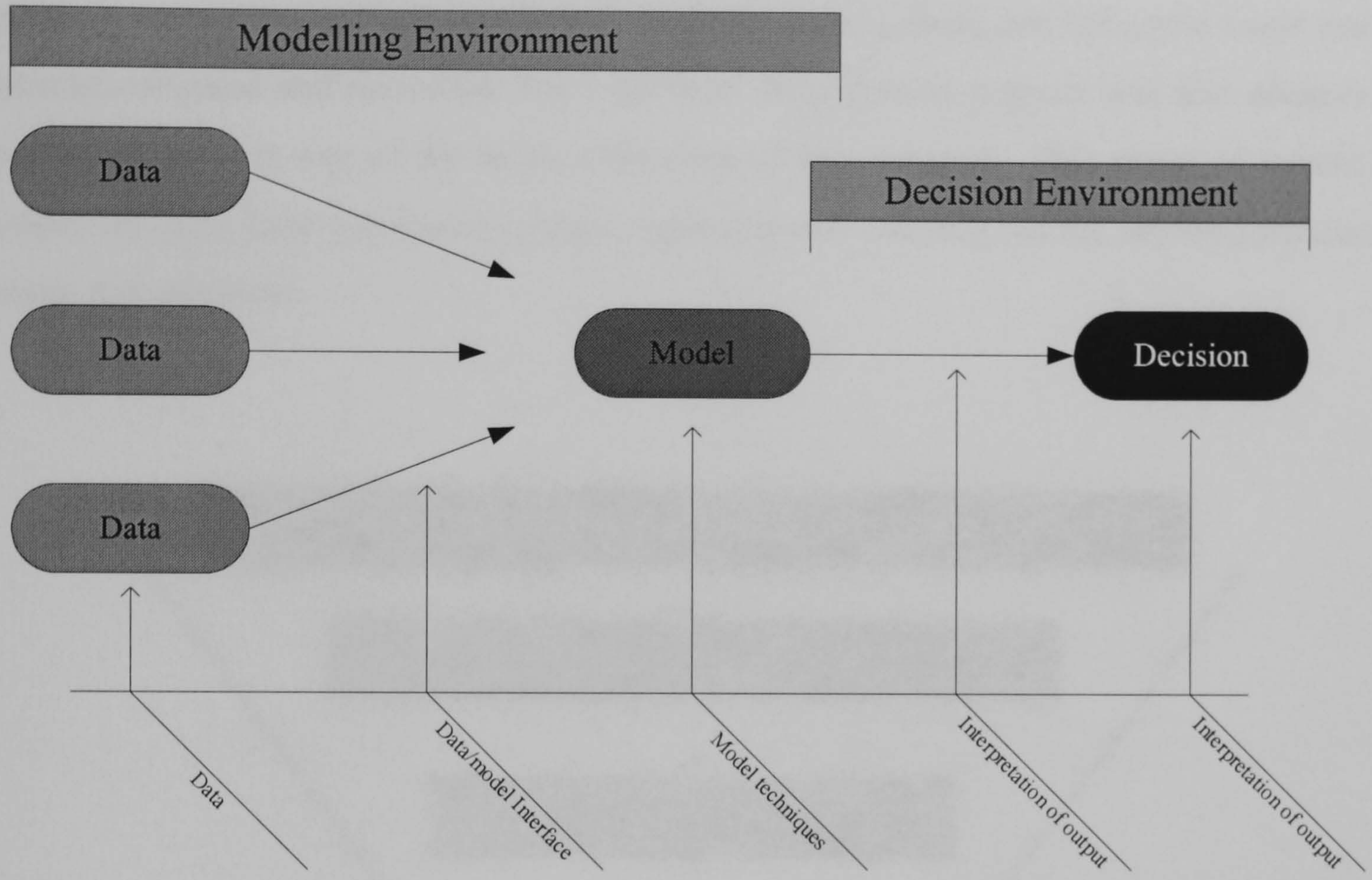


Figure 5.1: The decision and modelling environment (Source: Raftery, 1999).

5.6 Research Area

The research area was refined from the construction management and economics as the broad subject towards the construction projects' financial management, this being one of the most important factors in the success of the construction projects. Then PFI projects were selected to be investigated because of their recent necessity and complexity. This was narrowed down to developing a computer-based model for cost prediction and cash flow for school projects. The flow of narrowing the research area to the final research outcome is illustrated in Fig. 5.2.

The process junctures to reach the final result constitute many areas of exploration within the construction management discipline. PFI as a new and major procurement method was explored and studied, and cost management of construction projects was an important area that has been reviewed. Cost prediction models in the early stage of the projects were surveyed and conducted; facilities management and life cycle costs were also investigated and reviewed. The cash flow in long-term projects was also observed and tried, as it is one of the main objectives of this research. This piece of research could not have been conducted without exploring and carrying out the above-mentioned areas and methods.

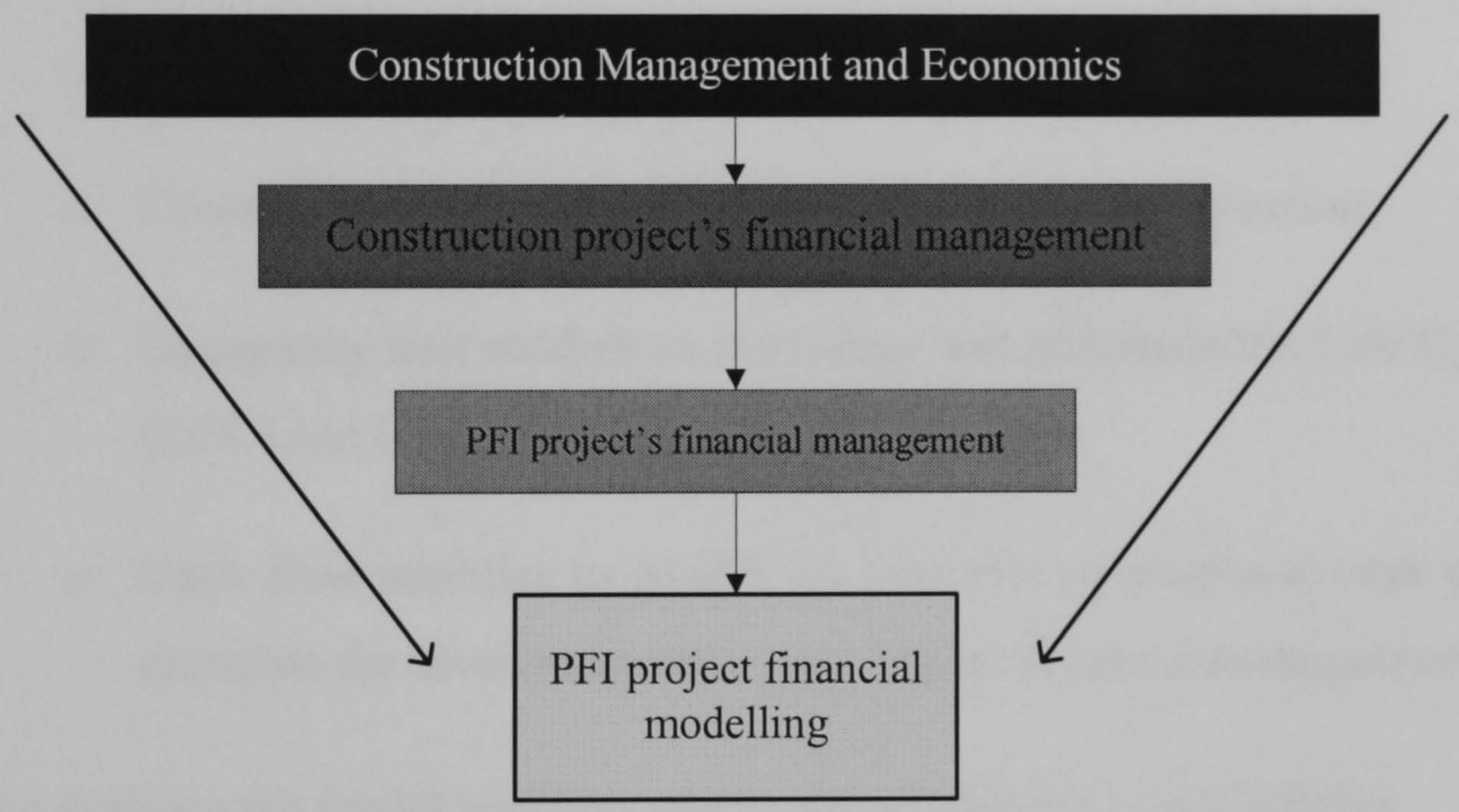


Figure 5.2: Narrowing down research area

5.7 Research aim and objectives

This research aims to develop a computer-based model for the financial management of PFI projects. The model attempts to forecast school project's cost and cash flow to enable project teams to assess the investment decision at the tendering stage. The objectives undertaken to achieve this aim were:

- To explore PFI procurement systems and how they works. This was conducted by reviewing research publications, textbooks, reports and guidelines which discuss PFI and its associated issues.

- To explore the project's costing, cash flow, and financial management. This was undertaken by methods similar to those mentioned in the previous objective.

- To explore and report on the current practices of PFI financial modelling by conducting a series of semi-structured interviews with experienced practitioners.

- To develop an integrated computer-based model to model the cost and cash flow of PFI school projects. This model comprises four modules:

    - Space planning module to calculate the building area.

    - Construction cost module to predict the cost of construction.

    - Occupancy cost module to normalize and distribute the Life Cycle Cost (LCC) and Facilities Management (FM) costs.

    - Cash flow modules to model the behavior of proposed cash flow, and calculate the investment ratios and project financial management.

- To evaluate the model concepts and its workability and intelligibility.

5.8 Research process

The research process in construction management was suggested by the Science Engineering Research Council as shown in Fig. 5.3 (Fellows and Liu, 2003). These processes are general and can be applied in almost every research project, particularly in the construction management disciplines. The process of the research could be transformed to a plan for conducting the research within a time frame. The research design will depend on the process selected to suit the research objectives, as each research has different goals, types and sources of data, and research methods. Reaching the targeted results is not always possible in research and may be considered by some as a negative result; however, reaching a negative outcome is often a result in its own right. Knowledge is a cumulative process, and the research community could benefit from such negative results, which may lead to the attainment of positive results through the use of different methodologies.

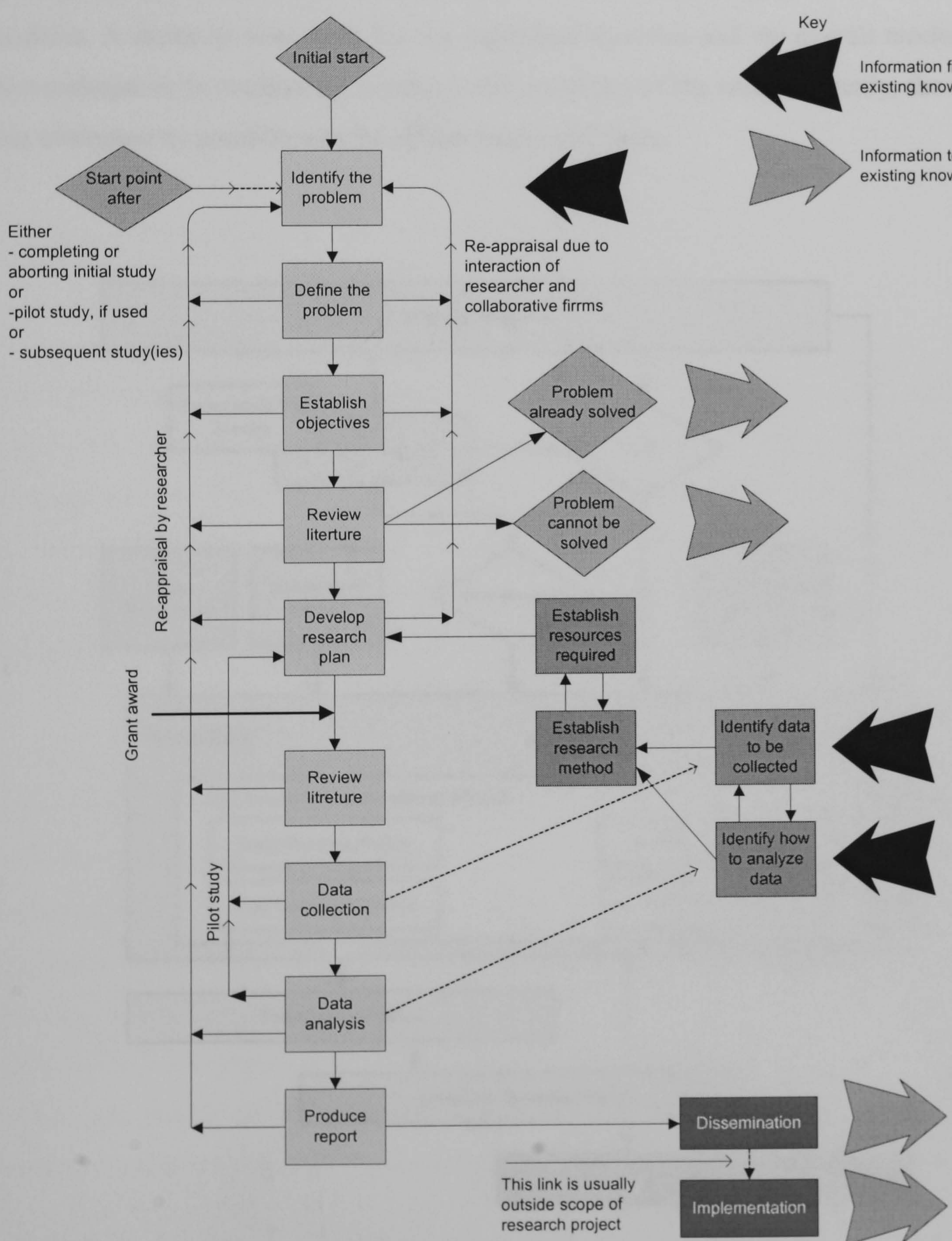


Figure 5.3: Suggested construction management research process (Source: Fellows and Liu, 2003)

5.9 Research Design

In order to achieve the above-mentioned aim and objectives, a framework of research process should be followed in a realistic time span. Fig. 5.4 shows the steps of the research designed to fulfil the requirements needed and produce the thesis. These phases start with an extensive literature review, followed by an investigation of the industry's PFI financial models. The actual modelling process was then conducted to develop the space-planning, construction cost prediction, then occupancy cost and cash flow modules. A series of tests, both for the individual modules and the overall model were then undertaken to confirm the accuracy and reliability of the results. Finally, the model was evaluated by practitioners for effectiveness and value.

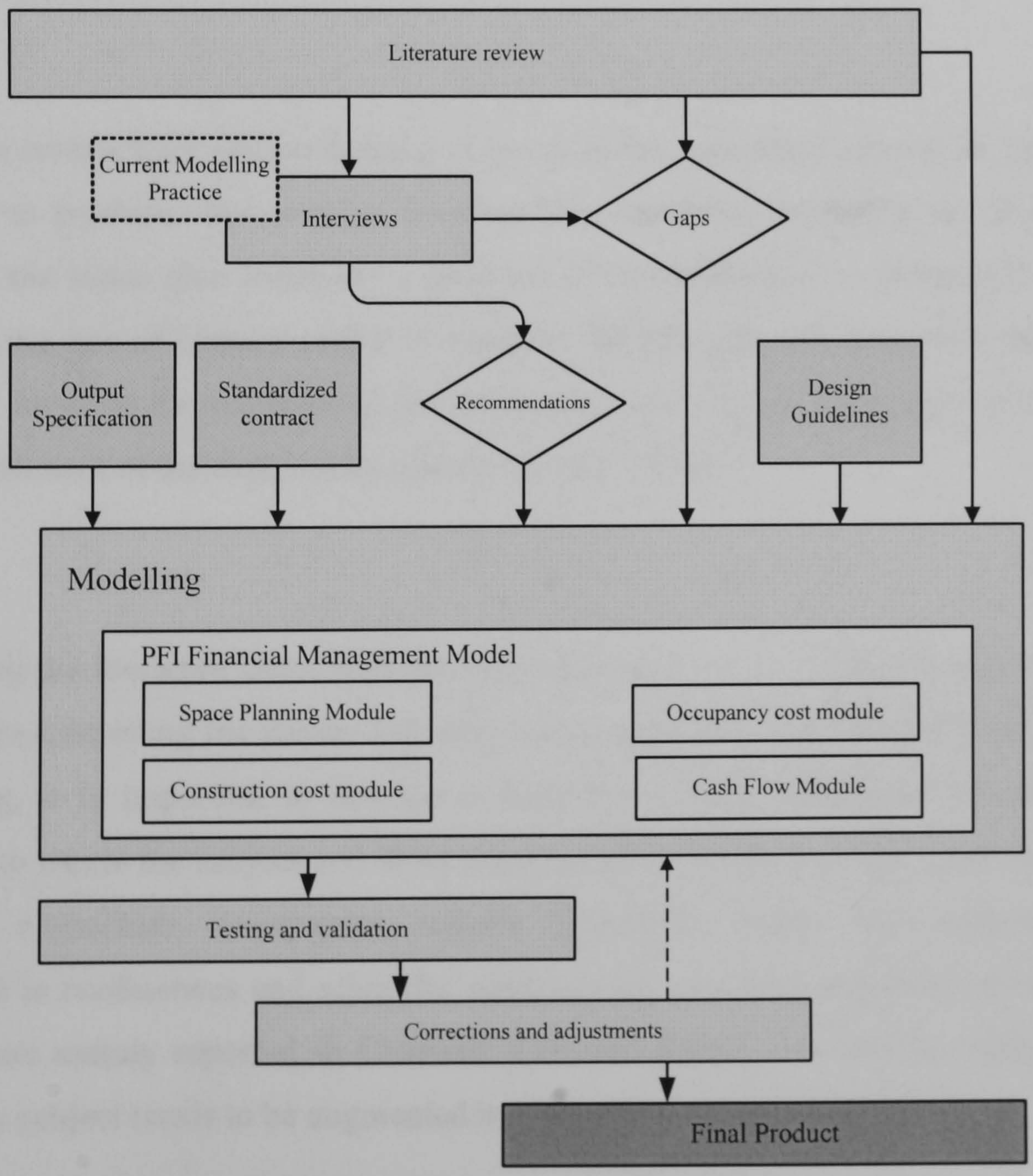


Figure 5.4: Research design

5.9.1 Literature review

The literature review demonstrates that the researcher has a professional command of the background theory (Phillips and Pugh, 2000). The literature review should demonstrate that the researcher has a comprehensive grasp of existing knowledge in order to be able to make an original contribution to knowledge in his research area (Naoum, 1998). The literature review forms an important chapter in the thesis, where its purpose is to provide the background to and justification for the research undertaken (Bruce, 1994). It is aimed at obtaining a detailed knowledge of the topic being studied by locating, reading and evaluating reports of research as well as reports of casual observation and opinion that are related to the topic (Borg and Gall, 1989). In other words, the literature review demonstrates that the researcher has a professional command of the background theory (Phillips and Pugh, 2000).

Literature review may also be defined in terms of the associated process or 'product' it attempts to produce. The process involves the researcher exploring the literature to establish the status quo, formulate a problem or research enquiry, defend the value of pursuing the line of enquiry and/or to compare the findings and ideas with others. The 'product' involves the synthesis of the work of others in a form which demonstrates the accomplishment of the exploratory process (Bruce, 1994).

Reviewing the literature starts with the commencement of the PhD project and finishes just before submitting the thesis. The only varying aspect is the time spent on it. At the beginning, it is important to develop a solid background and build the knowledge required to tackle the subject and drive the research to the next stage. Many textbooks, journals, magazines, newspapers, reports, guidelines, theses and referred papers published in conferences and scientific meetings are reviewed and documented. These reviews are mainly reported in Chapters Two and Three, and also in other chapters where the subject needs to be augmented by previous research and studies.

Some of the extensive literature review was documented in a research paper published and presented in ARCOM 20th annual conference (Al-Sharif and Kaka, 2004). Four major construction-management related journals were reviewed for a period of six years to search for the PFI topic's coverage in the construction research community. The total number of papers published in the four journals was 1314. Among them, 34 papers addressed PFI subjects, as shown in Fig. 5.5.

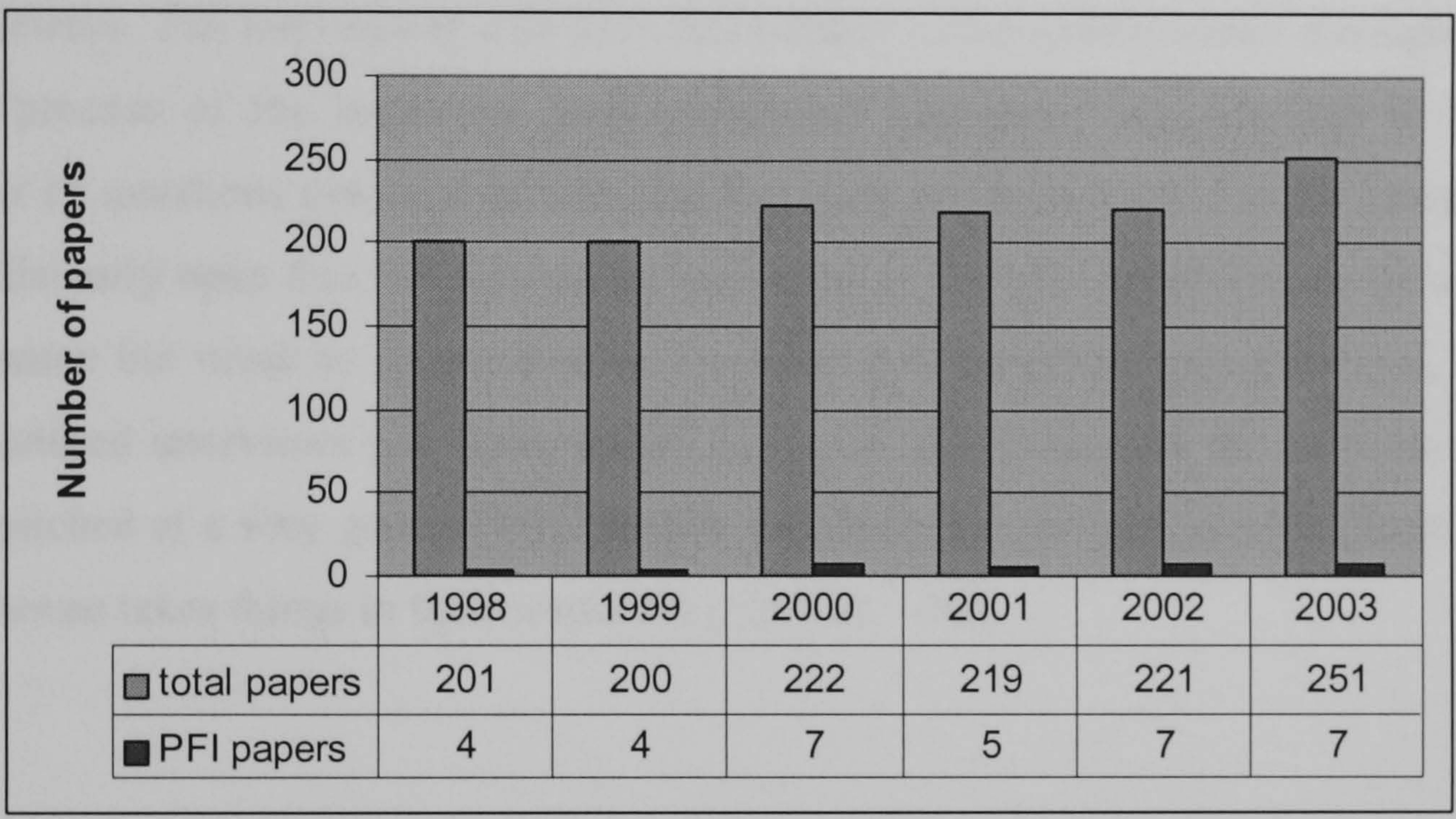


Figure 5.5: PFI topics in construction management journals

5.9.2 Industry survey

The literature review provides the background to the targeted subject. Practice reports as part of the literature are minimal and show mostly broad information. In order to investigate current methods being practised by the industry, the opinion and experience of the practitioners should be obtained. This could be done by conducting a questionnaire or in the form of face-to-face interviews. The postal questionnaire is probably the most widely used data collection technique for conducting surveys. It is most suited to surveys where the purpose is clear enough to be explained in a few paragraphs of print, in which the scheme of questions is not over-elaborated (Naoum, 1998). Interviews are conversations that have a structure and a purpose. They go beyond the natural exchange of views as in everyday conversation, and become a careful questioning and listening approach with the purpose of obtaining thoroughly tested knowledge (Kvale, 1996).

According to Fellows and Liu (2003), interviews vary in their nature; they can be structured, semi-structured and unstructured. Naoum (1998) stated that in the structured interview, questions are presented in the same order and with the same wording to all interviewees. The interviewer will have full control of the questionnaire throughout the entire process of the interview. Semi-structured interviews are designed to have a number of questions prepared in advance, but such prepared questions are designed to be sufficiently open that the subsequent questions of the interviewer cannot be planned in advance but must be improvised in a careful and theorized way (Wengraf, 2001). Unstructured interviews use 'open-ended' or 'open' questions, and the questionnaire is often pitched at a very general level so that the researcher can see in what direction the interviewee takes things in their responses (Naoum, 1998).

Qualitative data is collected with varying techniques or emphasis, but typically aimed at capturing lived experiences of the social world and the meanings people give to these experiences from their own perspectives (Corti and Thompson, 2004). Interviews could be the best way for acquiring data from industrial practices (Dawood and Dalakliedis, 2002). In these types of studies, samples are most often small (Corti and Thompson, 2004); this was also recognised by Kaka and Price (1994) in their survey of contractors' corporate planning and financial budgeting. Silverman (2001) suggested that half a dozen interviews would be needed to generate sufficiently reliable data.

With the aim of exploring current PFI financial modelling techniques and practice, a series of semi-structured interviews was conducted with experts involved in PFI projects. The outcome of these interviews is reported in details in Chapter Four. These interviews provided a good experience for the researcher to acquire a vast range of opinions and data from people who work in the field, taking financial decisions, and observing models and their outcome.

5.9.3 Modelling PFI Financial Management

The construction industry needs to be more involved either in development or in applications of PFI strategies and processes. The number of PFI projects is growing in the UK and worldwide. The bidding process, the associated costs, and time span are often seen as constraints by construction organizations when bidding for PFI/PPP projects. Therefore, developing an automated or semi-automated financial model for use at the early stages of a PFI project could form a tool for decision-making before any major cost is committed to the project.

As mentioned earlier, the aim of this research is to develop a computer-based model to enable project teams to forecast and assess the cash flow of PFI projects at the tendering stage. This will also give the private sector the ability to predict the project's profitability and assist in negotiation with their subcontractors as well as the project client. On the other hand, the model will help the public sector to establish the potential scope and to develop the reference project.

The model structure as shown in Fig. 5.6 contains four modules linked to each other. The plan is to enter the required data at the beginning and each module will calculate the outcome and pass it to the targeted module. The cash flow module will get the (Cash out) items from the construction cost module, the FM cost module, and from other data entries for other cost items such as initial cost (to be provided by the project company), and the cost of financing (to be provided by the bank through the SPV). Other data entries, such as interest rate and inflation rate, are entered by the user individually. In the other part of the equation, income data entries are provided by the user based on the client budget or assumptions to be evaluated. The final results should lead to the calculation of the project profit and the project cash flow following any repayments of the loans the project company commit to.

The model applies to school projects, where the school net area is calculated according to the type of school and number of students. The proposed model provides the flexibility to adjust or amend the calculated areas according to the project's specific needs, and to compare it with the recommended school building area. The school area will be based on Building Bulletins: Area Guidelines for Schools, which is published to assist clients in developing design briefs to the necessary detail and ensuring that the priorities of the school are clearly expressed and can be carried through the design (DfES, 2004; DfES, 2004).

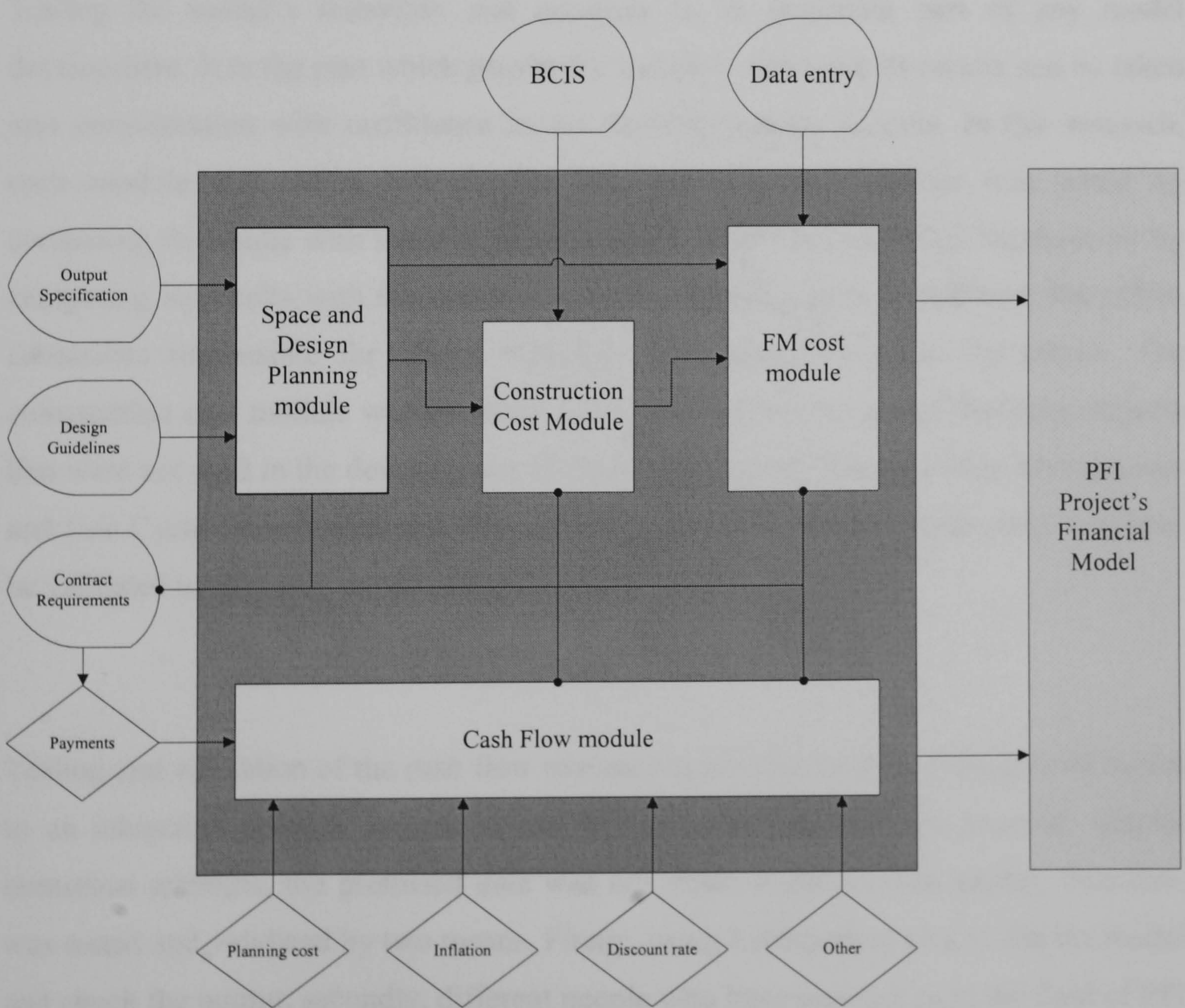


Figure 5.6: PFI Project's Financial Model structure

The construction cost module is used to calculate construction cost depending on the output of the space planning module, and by using data selected from the Building Cost Information Service (BCIS) on past schools projects. The Facilities Management (FM) cost is based on the output of the space module and cost data entered by the user in according to the Building Maintenance Index (BMI) cost categories. This calculated cost is adjusted for inflation using indices published by BCIS for indexing construction cost in the UK. These costs are exported to the cash flow module to calculate the project cash flow. The four modules are discussed in detail in Chapters Six, Seven, Eight and Nine.

5.10 Testing and Validation

Testing the model's reliability and accuracy is an important part of any model development. It is the part which proves the model is valid and its results can be taken into consideration with confidence in the decision-making process. In this research, each module was tested individually. The space-planning module was tested by comparing its results with those of other schools taken from the BCIS database, or by comparing its results with the exemplar school's building area. In addition, the public authorities responsible for school buildings were asked to assess the output. The construction cost module was tested by using data for twenty school building projects that were not used in the development of the original model. The Facilities Management and Life Cycle Costs are entered directly by the user of the model. Such costs could not be validated as they rely on the judgement of the user.

Testing and validation of the cash flow module entailed the testing of the overall model in an integrated manner. Access to real PFI projects data was not possible; despite numerous attempts, the promised data was not made available. The model, therefore, was tested and validated by two means. Firstly, using hypothetical data to test the model and check the output; secondly, different people who have experience in the field of PFI projects reviewed the value and effectiveness of the model. The results of these tests are discussed in Chapter Ten.

5.11 Summary

The study of construction management and economics is now recognised as an independent research discipline, although it overlaps with many other disciplines. The research methodologies within construction management and economics were discussed in this chapter with more emphasis on the quantitative and qualitative approaches and modelling techniques. The methodology applied in this research is a mixture of qualitative and quantitative approaches. The qualitative approach was applied to survey current practices and use of the cash flow models in PFI projects. This survey is reported in Chapter Four. The modelling process, which benefited from the industrial survey and literature review, included modelling the space requirement of school buildings, and their associated construction and occupancy costs. This mainly involved quantitative approaches, where cost data were collected and statistically modelled. The cash flow module uses the output from all of the individual modules to assess the financial outcome of the project. These modules are explained and their mechanism and output are explained in the following chapters.

Chapter Six

Space Planning Module

6 Space planning module

6.1 Introduction

In PFI projects, it is the responsibility of the private sector to design, finance, build and operate the facilities. The client will define their requirements on the output specification that will be given to the competitors. The preferred bidder will be selected upon their design quality and project price. The process of reaching the final price is known as the 'bidding stage', which is not only lengthy in PFI but also very costly. Ahadzi and Bowles (2004) found that the bidding and advisory costs to both the private and the public sectors to be equally high, ranging from £0.1 to 2.0 million, depending on the project type. The overruns were equally substantial on the advisory and bidding costs, ranging from 25 to 200%, given the continued retention of advisors by both sides during the protracted negotiations. This increases the need for a tool to help with the forming of decisions before committing to any significant cost on the project. Without it, the chances or capability of winning the competition could be diminished, with the project cost exceeding the available budget.

This chapter describes the space planning module and provides information about the superficial area that is required for cost planning in the early stages of the project. The space planning module was designed to calculate the school building area, based on the school type and number on the roll (NOR). The module, which depends on the official publication of the school area guidelines, was tested and gave accurate and acceptable results.

6.2 Space planning module

The aim of the space planning module, as shown in Figure 6.1, is to calculate the required area of school facilities, based on the published guidance for public school buildings (Building Bulletins 98: Briefing framework for secondary school projects DfES (2004a), and Building Bulletins 99: Briefing framework for secondary primary school projects DfES (2004b)). These documents were published by the Department for Education and Skills to assist school staff and governors, together with the help of Local Education Authorities (LEAs), to calculate the required area. These documents supersede Building Bulletin 82: Area Guidelines for Schools, (DfES, 1996), and any associated revisions. They give the minimum areas for all types of space in primary and secondary schools in the UK.

The space planning module is based on the space formulas provided by the BB98/BB99 guidelines. It relies on the type of school and number of pupils to give the area required for each type of space. The total of these spaces is the school building net area which will be added to other non-net areas, including circulation, toilets, internal wall area, plants and school kitchen, to come up with gross building area as shown in figure 6.2.

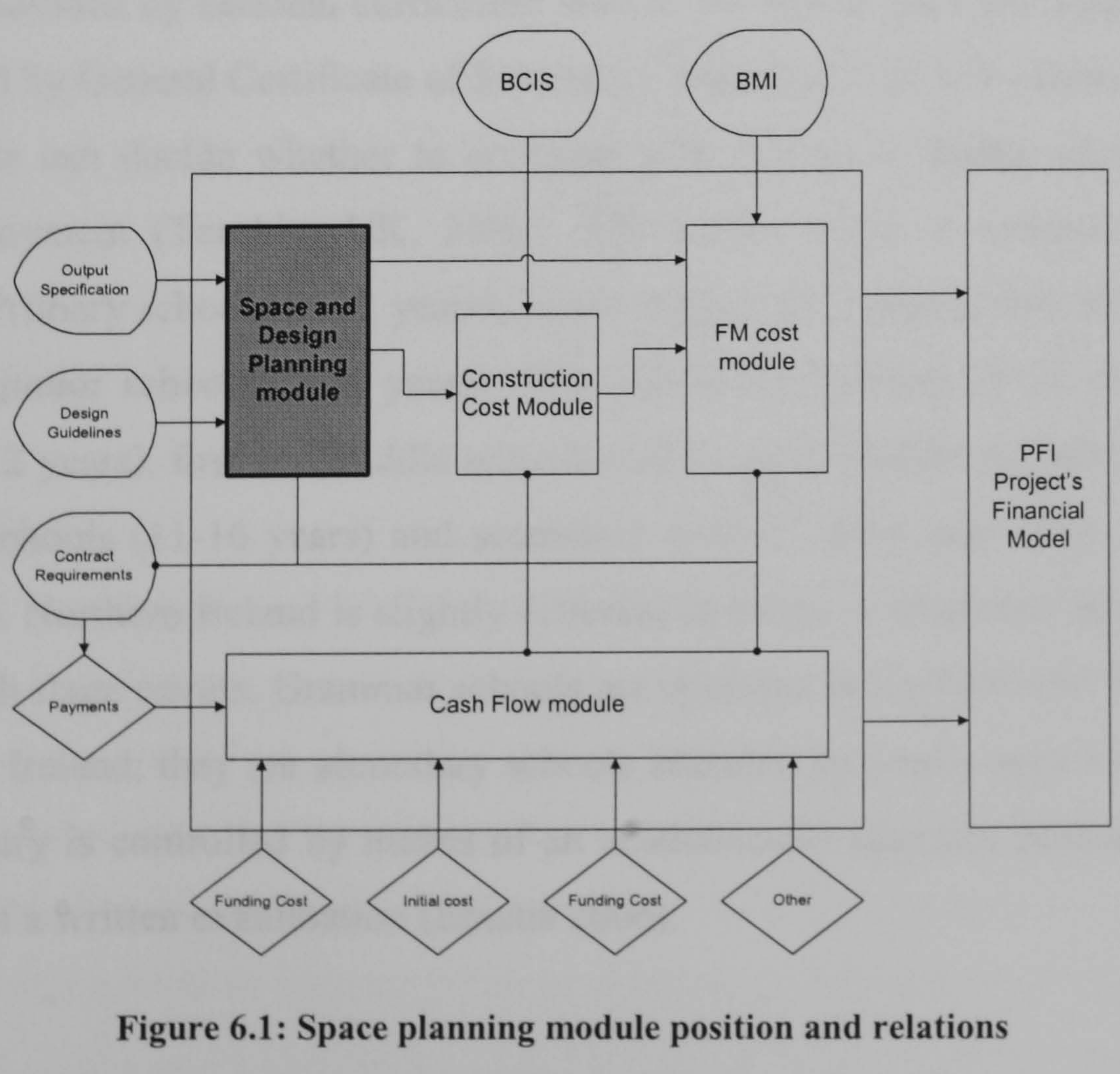


Figure 6.1: Space planning module position and relations

6.3 School types

School types vary in the UK. The pre-university public education system includes different type of schools from the primary and secondary schools, such as first schools, grammar schools, middle schools and others. In Scotland, there are two types of schools: primary schools (7 stages from age 5-11/12) and secondary schools (a maximum of 6 stages from age 12-17/18) (Summers 2006). The case is different in England and Wales. Where there are four key stages to education under the national curriculum:

Key stage 1	5 to 7-year-olds
Key stage 2	7 to 11-year-olds
Key stage 3	11 to 14-year-olds
Key stage 4	14 to 16-year-olds

Pupils are assessed by national curriculum tests at the end of each key stage. Key stage 4 is assessed by General Certificate of Secondary Education (GCSE) examinations, after which pupils can decide whether to continue with further or higher education, or to begin employment (Teaching-UK, 2006). The school types in England and Wales consist of: Primary schools (5-11 years), Infant schools (5-7 years), first schools (5-8 or 5-9 years), junior schools (7-11 years), first and middle schools (5-12 years), middle schools (8-12 years), first and middle schools (5-13 years), middle schools (9-13 years), secondary schools (11-16 years) and secondary with 6th form (age from 11-18 years) (Dale 2005). Northern Ireland is slightly different in terms of education and the number of years each stage covers. Grammar schools are operated in England and Wales as well as Northern Ireland; they are secondary schools attended by pupils aged 11 to 18 years, to which entry is controlled by means of an academically selective process, sometime consisting of a written examination (Emetis 2006).

According to Dale (2005), some local authorities still operate a '3-tier' system of education with first, middle (or first and middle combined) and secondary (or upper) schools. However, the number has diminished over recent years and continues to do so. Currently there are only around 350 middle schools in England, so although it is important that guidance is available for these schools, they are a very small minority in the UK. The same applies to grammar schools. There are approximately 160 grammar schools in the UK, and these remain highly controversial, despite educating only 4 per cent of the secondary school population, their selective ethos makes grammar schools repugnant to educational egalitarians, who believe that equality of opportunity requires all children to have the same standard of education (Politics 2006).

The school types covered in this study are primary schools (5-11 years), secondary schools (12-16 years) and secondary schools with 6^{th} form (12-18 years). The reasons behind this are:

1. These school types are common in all of the UK. They form the basis of all school types, and constitute the majority.

2. There is a large degree of similarity, in terms of the formulas used to calculate the building area between primary and infant, first and junior schools (Dale 2005).

3. The information available for school building construction and occupancy costs in BCIS and BMI is limited to primary and secondary schools only.

6.4 School buildings area

Public Authorities, such as the Commission for Architecture and Built Environment (CABE), the Office of the Deputy Prime Minister (ODPM), Department for Education and Skills (DfES), Scottish Executive (SE) and others, have published many reports and guidelines for designing school buildings. These guidelines are considered and adopted after the initial stage when the decision on the viability of the project is needed. The design team should be aware of all the requirements to be fulfilled and implemented in parallel with the innovations and other considerations. These requirements will be issued by the client in the project output specification, which is, arguably, the most important document in the procurement of a project through PFI. These form the basis on which the Local Authority and its stakeholders state, in output terms, what they need to achieve from the services, and any additional facilities to be provided (4Ps, 2004).

The Department for Education and Skill (DfES), and the Schools Division of the Scottish Executive (SE) were both contacted to clarify the standards and guidelines for school building area. In England, Building Bulletin 98 (for secondary schools) and Building Bulletin 99 (for primary schools) are used to provide area guidelines for school buildings. Although they are still draft documents, both BB98 and BB99 are used to decide the school building area (Dale 2005). In Scotland, there are no equivalent space standards to BB98 and BB99. It is up to each Local Authority to determine space planning standards for their schools (Summers 2006).

6.5 Module base and factors

DfES (2004b) stipulates that the future needs for any new school building will be based on the projected capacity, which is the number of pupil places; and the recommended building and site area. Figure 6.2 shows that the model is based on these two criteria to calculate the gross area of the building. The type of school and the number of the pupils will be taken from the output specification of the client, and the areas required for such requirements will be calculated from the authority's guidelines. The main two categories are shown in figure 6.3 as Net Area and Non-Net Area. Net or usable area can be calculated from formulas shown in table 6.1 for primary schools and table 6.2 for secondary school buildings. The difference is in the final result, and in some of the additional facilities being required in some schools and not in others. For example, the dining and social areas are not required in primary schools, according to the DfES (2004b).

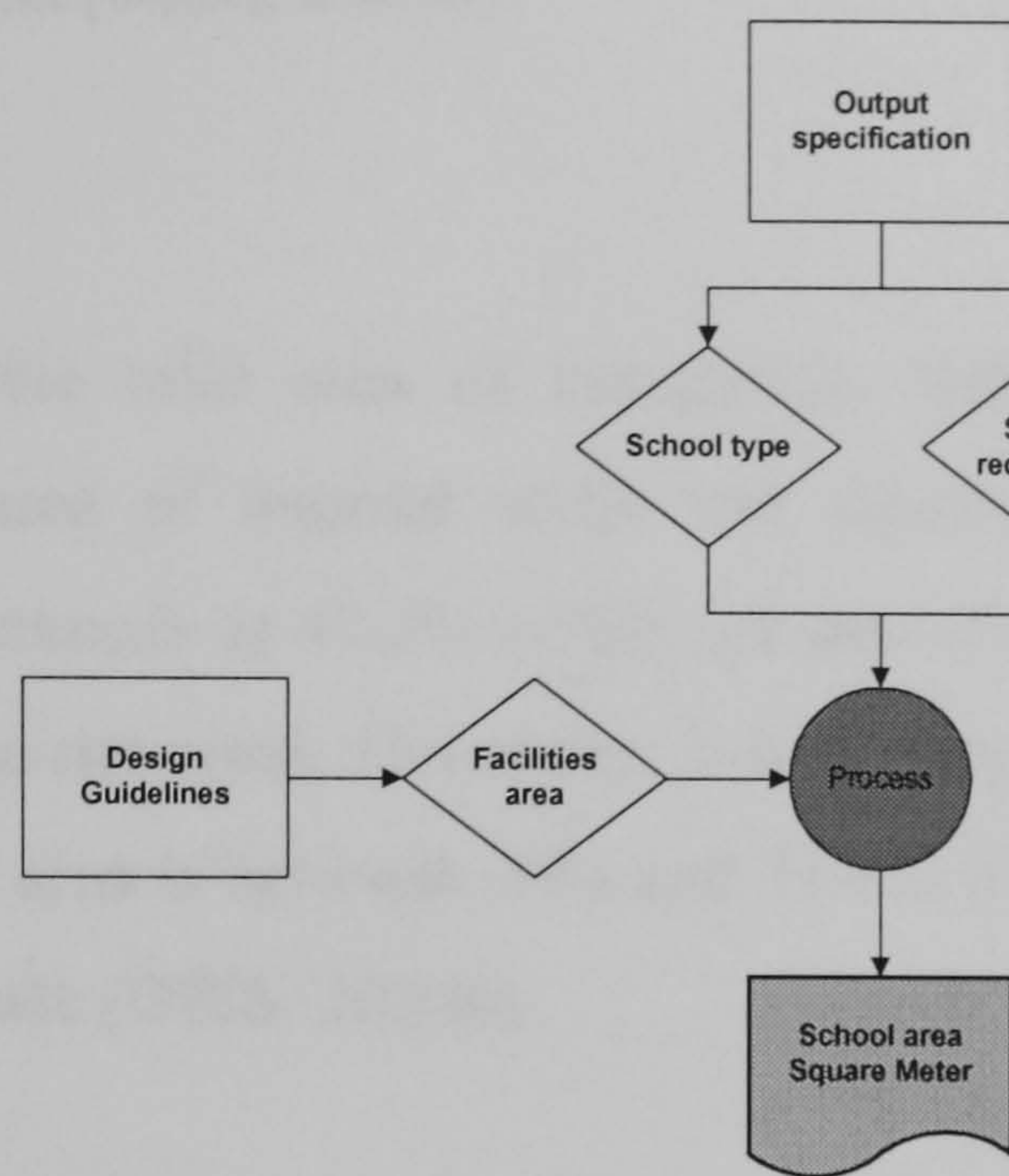


Figure 6.2: Structure of space planning module

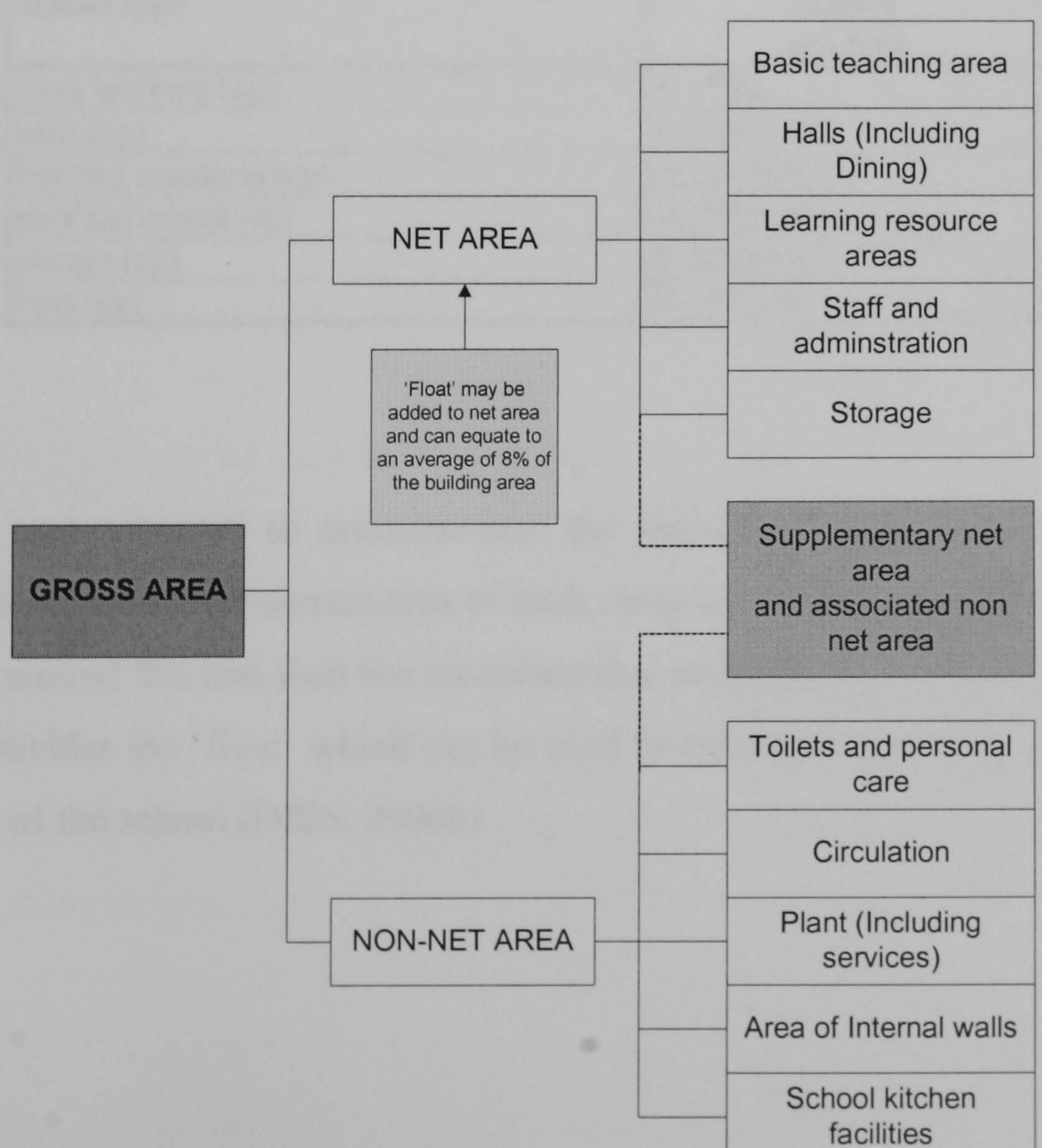


Figure 6.3: School area (Source: DfES, 2004b)

The non-net area shown in figure 6.3 will be vary more depending on the design and the configuration of existing buildings and site constraints, but will generally increase in proportion to the net area (DfES, 2004b).

The non-net area is the total area of circulation, toilets and personal care, plant (including services), area of internal walls and school kitchen facilities. This was calculated in some references as 42.5% of the net area (Dorset 2000). The gross area is the total of net and non-net areas. Generally, it may vary between 140% and 145% of the net area (or the net area is between 69% and 71.5% of the gross area) depending on the layout and type of site (DfES, 2004b).

Table 6.1: Primary school net area

N stands for number of students **School type**	**Primary School age 5-11**
basic teaching (ap)	(2.1*N)
halls (bp)	(0.3*N)+100
learning resources (cp)	(0.15*N)+15
staff and admin (dp)	(0.2*N)+30
storage (ep)	(0.25*N)+45
float (gp)	(0.1*N)+10

A 'float' is recommended to accommodate the individual priorities of each school. When the recommended minimum area of each category of space is added together, the total will be around 8% less than the recommended standard for the total net area. This difference provides the 'float' which can be used to enhance some areas, depending on the priorities of the school (DfES, 2004b)

Table 6.2: Secondary school net area

N stands for number of students **School type**	**Secondary schools age 11-16**	**Secondary with 6th form age 11-18**
Basic teaching (as)	(3*N)+50	(3.06*N)+200
halls (bs)	(0.3*N)+600	(0.3*N)+600
learning resources (cs)	(0.25*N)+75	(0.29*N)+125
staff and admin (ds)	(0.3*N)+125	(0.31*N)+125
storage (es)	(0.35*N)+175	(0.36*N)+200
dining and social (fs)	(0.2*N)+25	(0.26*N)+100
float (gs)	(0.3*N)+250	(0.32*N)+250

6.6 Module development

Based on the school type and number of pupils (school capacity or number on roll – NOR) chosen by the user, a computer-based module was developed, using MS Excel software to calculate the net area for required activities as per the equations listed in tables 6.1 and 6.2. The sum of all activities areas will give the school net area, based on BB98 and BB99, as shown in equation 6.1 for primary schools and equation 6.2 for secondary schools:

$$NA_{primary} = \sum(ap, bp, cp, dp, ep, gp)$$ Equation 6.1

$$NA_{secondary} = \sum(as, bs, cs, ds, es, fs, gs)$$ Equation 6.2

The gross area of the building will be estimated from equation 6.3, which is based on the above-mentioned guidelines.

$$GA = \frac{NA}{0.70}$$ Equation 6.3

where GA is the gross area and NA is the net area of the school building.

The module equations were developed and tested with the spreadsheet software; it was then programmed in HTML, with embedded JavaScript to enhance accessibility and reduce entry requirements in a small size file (4 kilobytes). The results were compared and found to be identical. Figures 6.4, 6.5 and 6.6 show the interface of the module separately, along with its data entry fields, drop down menu and the resulting space calculation.

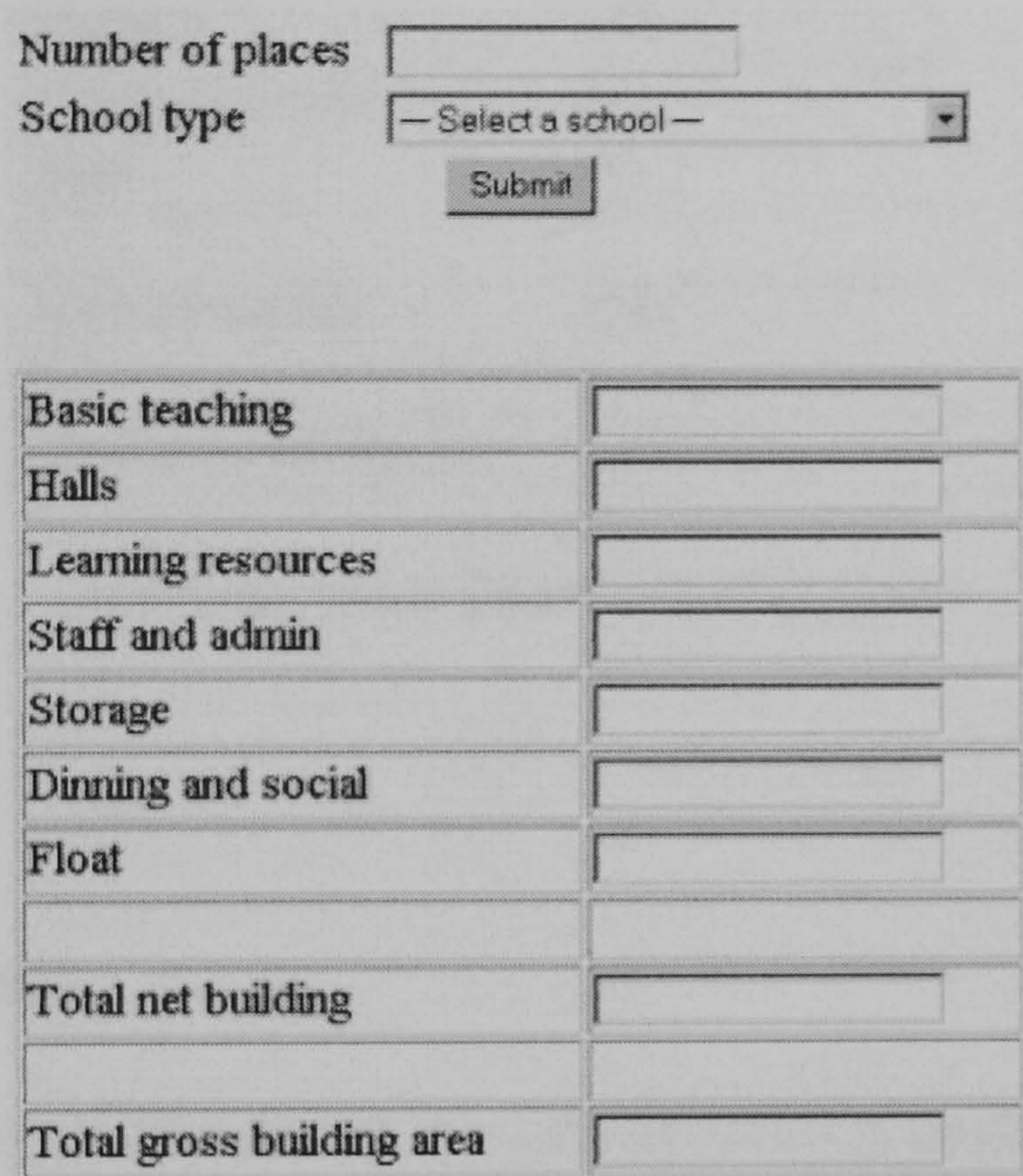


Figure 6.4: Space planning module Interface

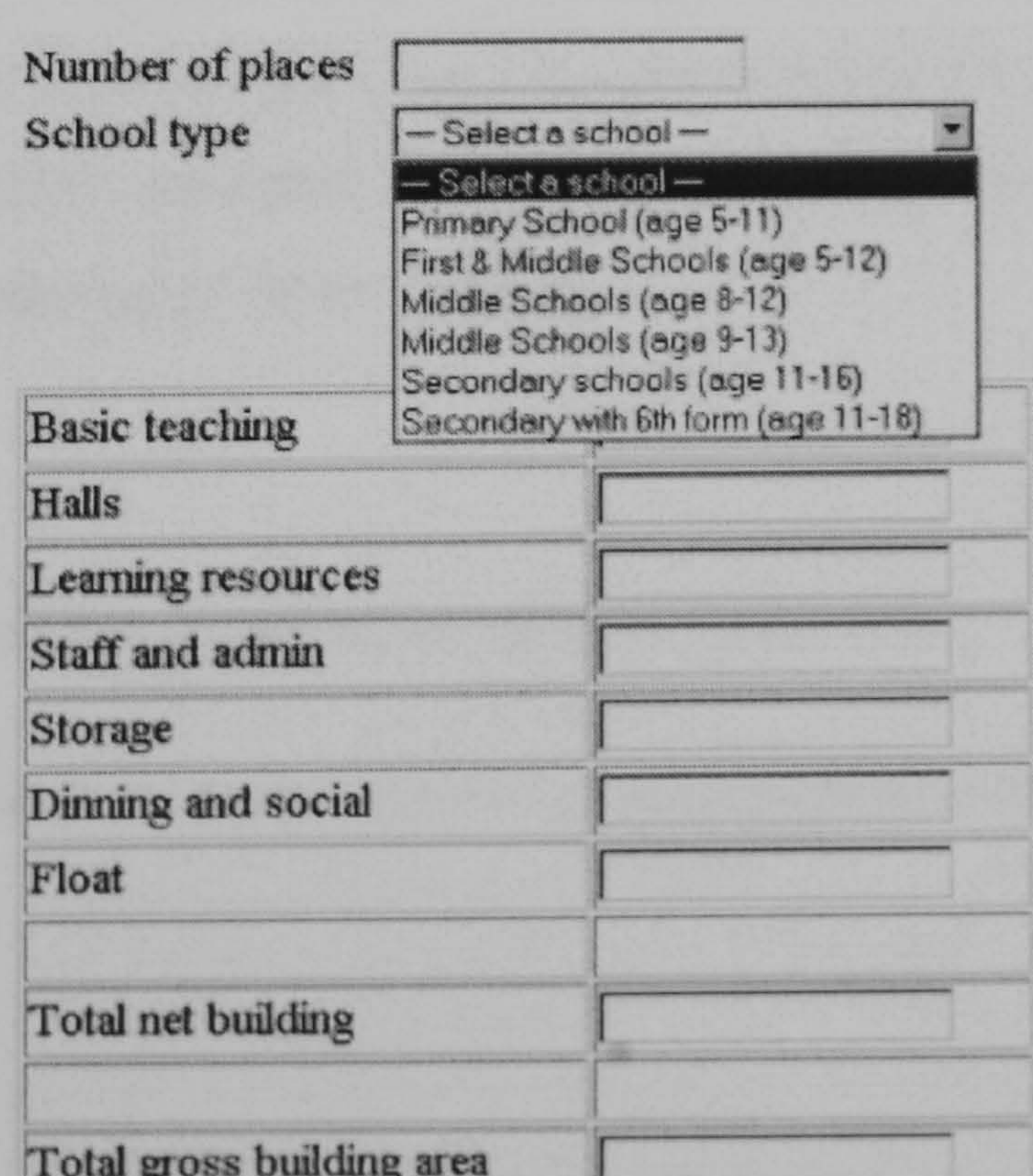


Figure 6.5: Space Planning Module data entries.

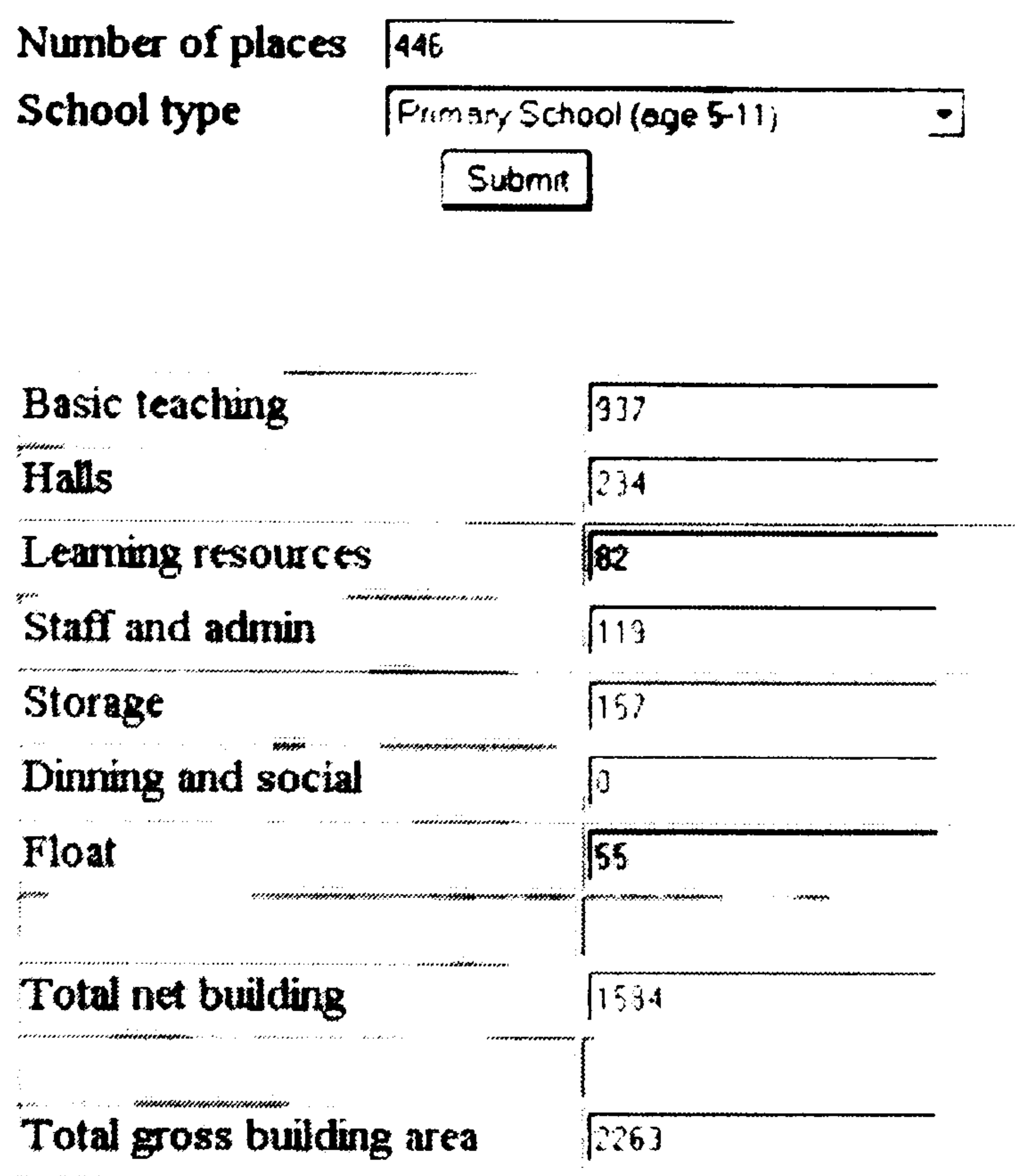


Figure 6.6: Space Planning Module results

6.7 School building

Getting the area right is only part of the task of creating facilities which support the educational aims and vision of each school (DfES, 2004b). The result of the space planning module will be used to calculate the cost using the superficial area method, and to help the design team to figure out the area required for each activity within the school. The DfES (2002) identified three checklists which draw together key points from the report into building of future schools:

Checklist 1: accommodation implications of community use;

Checklist 2: accommodation implications of greater inclusion; and

Checklist 3: security.

These factors were detailed in Building Bulletin 95 (DfES, 2002) along with many other factors which would enhance the design of the school. This, in fact, is what the Building Schools for the Future (BSF) Plan is about. The plan is to create world-class, 21st-century schools — environments which will inspire learning for decades to come and provide exceptional assets for the whole community. BSF is the biggest single government investment in improving school buildings for over 50 years. The aim is to rebuild or renew every secondary school in England over a 10-15 year period (BSF, 2006).

In June 2003, as part of Building Schools for the Future, eleven design teams were appointed to develop exemplar designs for schools fit for the twenty-first century. They examined both primary and secondary schools, including a 5-to-18 all-through school, on a range of sites. The aim is to demonstrate how high standards of school building design can be achieved within the area and cost guidelines. The designs — five primary schools, five secondary schools and one 'all-through' school — have been created by eleven leading architectural practices. The designs are intended to develop a shared vision of what 'Schools for the Future' are, create benchmarks for well designed schools and push forward the boundaries of innovation and inspiration; they will also support the delivery of Building Schools for the Future and persuade industry to develop new ways of delivering school buildings (DfES, 2006). The design criteria, (DfES, 2004b) and (DfES, 2004a) identified key considerations to ensure that design quality is achieved:

- The school's overall vision of how it will operate, deliver the curriculum, approach change and ensure excellence;
- The implications for the design of the school, for example the organization of resources or the school's preferences for furniture and equipment; and

- Key design requirements, for example, the way in which flexibility and adaptability allow for change, the provision for Special Educational Needs (SEN) and disabilities, safety and security and environmental issues.

Many reports and guidelines have been published by different organizations that could help in designing good schools; these will add more value and a functionality-focused approach to the creativity of the architect. Usually the design process starts after the decision is reached by the architect to participate in the project competition. These reports and guidelines include the Briefing Framework for Primary School Projects (DfES, 2004b), Briefing Framework for Secondary School Projects (DfES, 2004a), Achieving well designed schools through PFI: Client guide (CABE, 2002), Building schools for the future: the client design advisor (CABE, 2005), Picturing school design: a visual guide to secondary school buildings and their surroundings using the Design Quality Indicator for schools (DfES, 2005a), Being involved in school design: A guide for school communities, local authorities, funders and design and construction teams (DfES, 2004a), 21st century schools: learning environments of the future (CABE, 2004b), and, most significantly, the reports of school exemplar designs published by DfES with the aim of improving the design quality of school buildings. There is a detailed report from each design team of the eleven architectural practices about their work, and also a complete report about all of them: 'School for future: Exemplar designs concepts and ideas'.

These concepts when published are not intended to be templates, but to act as springboards for developing imaginative and sustainable school buildings, tailored to local needs and aspirations. They can serve as advanced starting points in the design process and will help to deliver excellent value for money (DfES, 2005b).

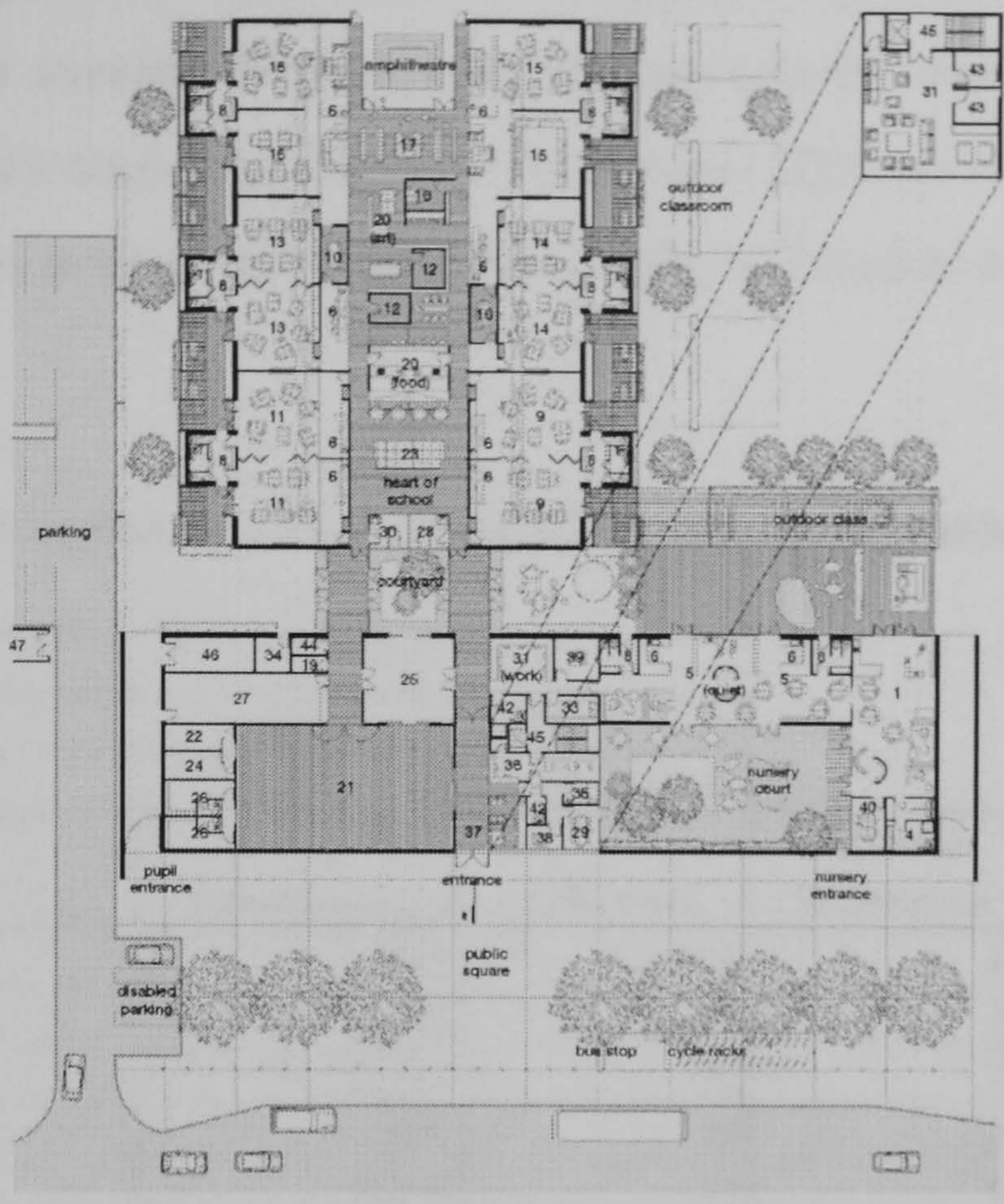


Figure 6.7: School design exemplar

6.8 Results and outcome

The module was sent to Department for Education and Skills (DfES) and the Scottish Executive (SE) for review and feedback. The reply of DfES was encouraging: they checked the module and they found that generally it worked well (Dale 2005). Their comments were constructive on the school types, and on some missing and mistyped numbers. They commented on school types, such as the operation of a '3-tier' system of education, with first, middle (or first and middle combined) and secondary (or upper) school. This system is still operated by some local authorities, but the number has diminished over recent years and continues to do so. The reply of the SE was general, and stated that there is no equivalent space planning standards to BB98 and BB99 for Scotland (Summers 2006).

The module was tested using the exemplar schools designs (five primary schools and five secondary schools). The average difference in primary school area between the actual designs and the module's output for the same NOR was 1.23%, as shown in table 6.3. For secondary schools, the average difference was 2.61%, as listed in table 6.4.

Table 6.3: Difference in module result and designed exemplar primary schools

Primary school exemplar design				
Number of students	446	students		
the module calculated area	2,263	square meters		
Design team	**School area**	**difference**	**Absolute difference**	**% difference**
Walters and Cohen Architects	2,249	-14	14	0.62%
Sarah Wigglesworth Architects	2,244	-19	19	0.84%
Building Design Partnership	2,192	-71	71	3.14%
Marks Barfield Architects	2,285	22	22	0.97%
Cottrel and Vermeulem	2,250	-13	13	0.57%
Average difference between the module and the design				1.23%

Table 6.4: Difference in module result and designed exemplar secondary schools

Secondary school exemplar design				
Number of students	1,150	student		
the module calculated area	9,580	square meters		
Design team	**School area**	**difference**	**Absolute difference**	**% difference**
Mace (RTKL Architects)	10,211	631	631	6.59%
Wilkinson Eyre Architects	9,503	-77	77	0.80%
De Rijke Marsh Morgan Architects (dRMM)	9,609	29	29	0.30%
Alsop Architects	9,711	131	131	1.37%
Penoyre and Prasad	9,960	380	380	3.97%
Average difference between the module and the design				2.61%

The following test was to apply the module on past schools built and published in the BCIS. Fifty primary schools were selected, as listed in table 6.5, and although the schools built were based on different space guidelines, such as BB82, the average difference was 7.35%.

Table 6.5: Actual built primary schools area compared with the module result

No.	NOR	Area in BCIS	Area from Module	difference	Absolute difference	% difference
1	210	1,122	1,217	95	95	7.81%
2	145	1,000	930	-70	70	7.53%
3	522	2,849	2,597	-252	252	9.70%
4	236	1,329	1,331	2	2	0.15%
5	210	1,188	1,217	29	29	2.38%
6	145	948	930	-18	18	1.94%
7	420	2,352	2,146	-206	206	9.60%
8	150	883	951	68	68	7.15%
9	585	2,882	2,879	-3	3	0.10%
10	200	1,280	1,171	-109	109	9.31%
11	450	2,510	2,280	-230	230	10.09%
12	210	1,170	1,217	47	47	3.86%
13	295	1,661	1,594	-67	67	4.20%
14	270	1,400	1,483	83	83	5.60%
15	780	3,686	3,740	54	54	1.44%
16	80	665	640	-25	25	3.91%
17	210	1,105	1,217	112	112	9.20%
18	120	761	817	56	56	6.85%
19	450	2,078	2,280	202	202	8.86%
20	210	1,298	1,217	-81	81	6.66%
21	300	1,715	1,614	-101	101	6.26%
22	210	1,297	1,217	-80	80	6.57%
23	315	1,617	1,683	66	66	3.92%
24	335	1,820	1,771	-49	49	2.77%
25	240	1,252	1,352	100	100	7.40%
26	325	1,559	1,727	168	168	9.73%
27	256	1,434	1,420	-14	14	0.99%
28	210	1,077	1,217	140	140	11.50%
29	386	1,751	1,997	246	246	12.32%
30	210	1,078	1,217	139	139	11.42%
31	180	1,056	1,083	27	27	2.49%
32	360	1,900	1,880	-20	20	1.06%
33	446	2,110	2,263	153	153	6.76%
34	236	1,156	1,331	175	175	13.15%
35	240	1,186	1,349	163	163	12.08%
36	120	811	817	6	6	0.73%
37	380	1,843	1,969	126	126	6.40%
38	210	1,044	1,217	173	173	14.22%
39	730	4,129	3,520	-609	609	17.30%
40	210	1,275	1,217	-58	58	4.77%
41	290	1,622	1,571	-51	51	3.25%
42	85	603	664	61	61	9.19%
43	420	1,893	2,146	253	253	11.79%
44	90	590	686	96	96	13.99%
45	210	1,410	1,217	-193	193	15.86%
46	360	1,828	1,880	52	52	2.77%
47	300	1,410	1,614	204	204	12.64%
48	315	1,488	1,683	195	195	11.59%
49	250	1,479	1,394	-85	85	6.10%
50	240	1,185	1,349	164	164	12.16%
	Average difference between module result and actual built schools area					7.35%

Information about another seven secondary schools was chosen from BCIS, as listed in table 6.6, and compared with the module figures for the same NOR. The average difference was 6.84%, with only one school showing a significant difference.

Table 6.6: Actual built secondary schools area compared with the module result

No.	NOR	Area in BCIS	Area from Module	difference	Absolute difference	% difference
1	600	6250	5886	-364	364	6.18%
2	1200	9553	9914	361	361	3.64%
3	1600	11898	12600	702	702	5.57%
4	1000	8469	8571	102	102	1.19%
5	240	3632	3469	-163	163	4.70%
6	1000	10805	8571	-2234	2234	26.06%
7	750	6932	6894	-38	38	0.55%
	Average difference between module result and actual built schools area					6.84%

There are two reasons that could justify these differences. The first is the difference between the guidelines on which the module was based and those on which the BCIS projects were based. These school buildings were designed according to BB82 and many other guidelines, while the module was based on BB98 and BB99, where the area has been increased to an average of 25% above the upper limit set in BB82 (1996). Second, the guidelines give only the minimum space required for the school building, while it is up to the Local Authority to decide on the final school building area. In a survey conducted by the Department for Education and Skills (DfES 2003), the area of the school sample was roughly 19% above BB82, which was the area guidance when these schools were designed and built. The survey shows that Local Education Authorities (LEAs) are generally building to higher area standards than the design guidelines.

6.9 Summary

The aim of developing a module to calculate the school area according to the basic information of school type and student numbers is to use the outcome in predicting the cost of construction and facilities management of the building, as part of the PFI financial models which is the aim of this thesis. The module was developed based on the available school space guidelines, and was reviewed by the official department responsible for building school facilities. It was found to produce accurate results. The module was also tested with the exemplar school buildings, and minor area differences of 1.23% on primary schools and 2.61% on secondary schools were found. Information on many school buildings was collected from the BCIS, and the comparison shows an average difference of 7.35% in primary schools and 6.84% in secondary schools. These differences could be the result of the base guidelines from which the data were calculated, and which differ from the new guidelines on which the module is based.

Chapter Seven

Construction Cost Module

7 Construction Cost Module

7.1 Introduction

The project finance in PFI projects is based mainly on the construction cost. Any cost occurring prior to the financial close would be paid by the SPV, and the cost of facilities management will be covered by the project income, but the construction cost will be covered by finance deals what ever the source. This indicates the importance of the construction cost to the total project cost, and to the project process as well. This chapter will describe the process of developing a module to predict the construction cost of school buildings based on the BCIS data and the result of the space planning module discussed in the previous chapter.

Regression data modelling was processed by SPSS software. The results were trained using the same data used in the model development, and tested by same group of data but not used in the development; the result seems to be satisfactory.

7.2 Construction Cost Module

The construction cost is the main core of the investment decision because the project capital is consists mainly of these costs. This shows the importance of construction cost on the decision process in the early stage of the project. In PFI projects, the construction cost is mainly the project capital, since the operation and maintenance cost (running cost) will be covered by the project income, because the project client will start paying for the service after its commencement. The importance of the construction cost for the contractor comes not only from its effect on the total project cost, but also from the source from which he will provide it. The arrangement of the project cost will centre on the construction cost of the project.

The construction cost module position within the PFI financial management model is presented in Figure 8.1. This is based on the outcome of the space planning module, and the data collected from BCIS. The historical data of eighty five school buildings was processed using regression analysis to develop a module which predicts school construction cost in the early stages of the project.

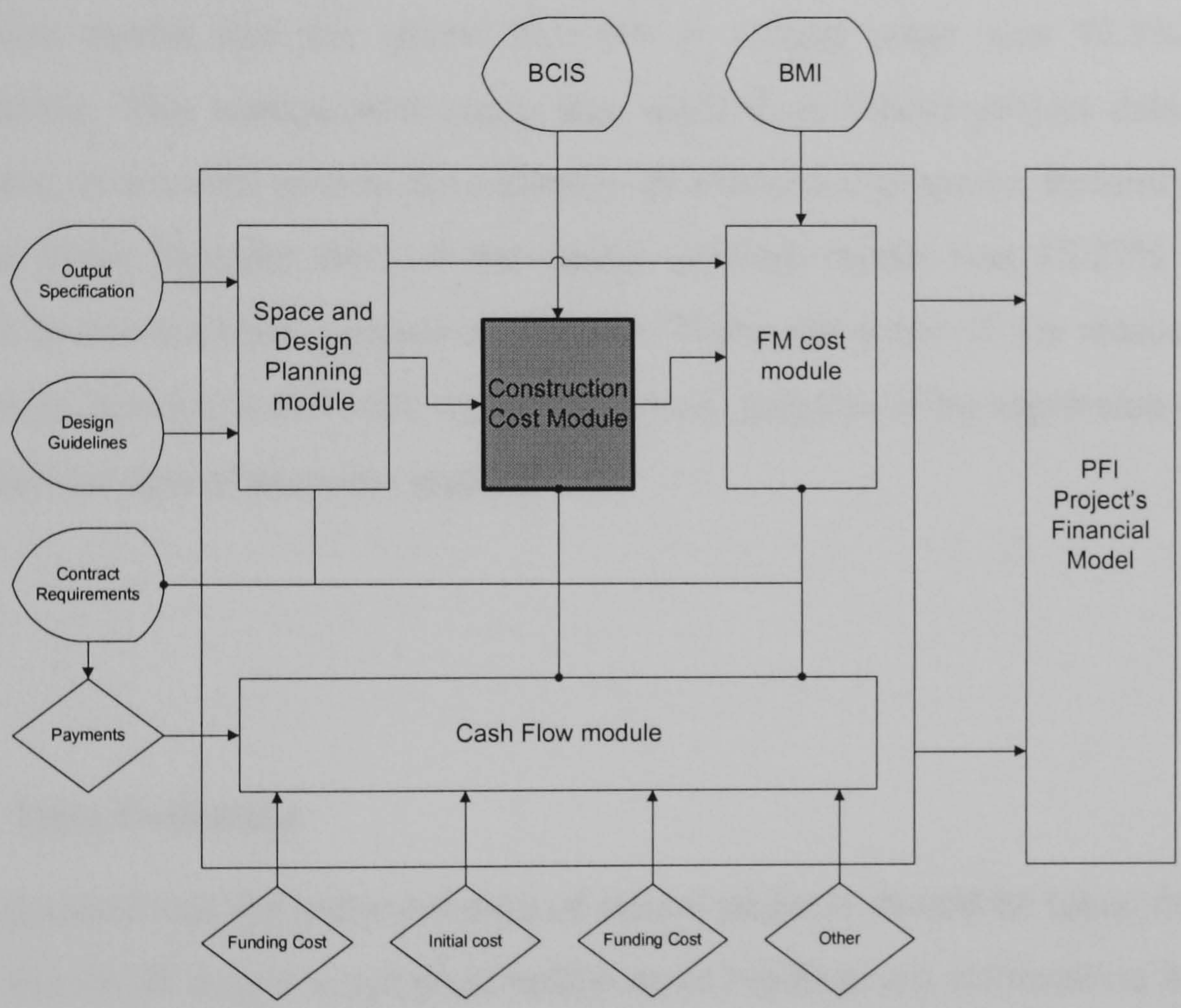


Figure 7.1: Construction Cost Module position within the PFI Financial Management Model

7.3 Need for New Model

Cost models differ from project to project depending on the technique undertaken and the stage of the project. In the early stages of the project, cost could be estimated in different ways, as discussed in Chapter 3. In this chapter, predicting the cost of a school project was required based on historical data, since there is only one cost prediction model in the early stages of school project, published by Elhag and Boussabaine (1998). This model was developed to predict the cost of school building projects in the early stages, using Artificial Neural Network (ANN) based on historical data from the BCIS database. There were two issues of concern in this model; first, the low amount of project data used in developing the model (thirty school projects), more than double the data used to develop the new model. Secondly, with regard to the modelling technique and the accuracy obtained, some research has reported that the accuracy of models developed using regression analysis is greater than models that use ANN. Elhag and Boussabaine (1999) found that the average percentage accuracy achieved by the regression model and the neural network at testing stage was 93.3% and 90.9% respectively. This comparative study was applied on school project data from BCIS. Moreover, in a model used in the valuation of residential property, Rossini (1997) found that the mean absolute error of the neural network model was 15.27% compared to 10.42% in the multiple regression analyses. These are some of the reasons behind the decision to develop a new cost model for school projects using regression analysis with the historical data of previous projects.

7.4 Data Collection

It was decided that the historical data of school projects should be taken from the BCIS index. The BCIS data is a complete reference of bidding cost information for most if not all construction projects in the UK. BCIS (Building Cost Information Service) has been providing guidance on the general level of prices in the building industry for more than 40 years. The organisation was initiated in 1962 as a mutual association under the umbrella of the Royal Institution of Chartered Surveyors (RICS) before becoming a limited company, BCIS Ltd, in the early 1990s (RICS, 1969).

From the data collected from BCIS on the bidding cost of school buildings, a complete set of historical data for eighty five schools was found to be usable. The data on seventy schools was used as training data to develop and train the regression cost model, and the data on the remaining fifteen schools was kept for testing the module. Table 8.1 shows the type and number of schools used; the data of sixty primary school and ten secondary schools (representing 85.71% and 14.29% of the sample respectively) were used in the regression cost modelling, based on the sample data.

Table 7.1: Type and number of school buildings

School type	Sample	%
Primary	60	85.71%
Secondary	10	14.29%
Total	**70**	**100.00%**

The problem with the BCIS data was the clarity of variable classification. For each set of project data, BCIS lists information about the project (Examples in appendix one), with elemental cost analysis and project specification. In some projects, plan and elevation drawings are also provided. The forms in which the project data is provided are almost similar, but the contents are not standardized for all projects; use of different specifications for the same elemental item such as the information shown in Figure 8.2 below make it difficult to know or even guess which is the most influential element.

2G	Internal walls and partitions	Loadbearing dense concrete block internal walls, including insitu conc filling to voids, PCC lintels, timber stud partitions, softwood internal screens, roller shutters, WC cubicles, brickwork restraining galvanised steel channels, louvred windows to screen. Provisionl sum £15000 for sliding screens.

Figure 7.2: Sample of BCIS project data sheet of specification

The cost analysis and specifications of elements used in projects' cost data sheets are dependant on the standard form of cost analysis developed, and were provided by RICS and used by the UK construction industry. Some elemental items were found in some project data sheets and missing from others. This data could be included in other items, but they have a significant influence on project cost. Table 8.1 shows the available and missing data in five different BCIS-listed projects.

Table 7.1: Example of missed data in the BCIS description

		BCIS project number				
	Element	**11065**	**11053**	**17083**	**16588**	**19297**
1	Substructure					
2.A	Frame	missed		missed		missed
2.B	Roof					
2.C	External walls					
3.A	Wall finishes					
3.B	Floor finishes					
4	Fittings and furnishings					
5.A	Sanitary appliances					missed
5.B	Services equipments	missed	missed	missed	missed	missed
5.C	Disposal installation		missed			
5.D	Water installation		missed	missed		missed
5.F	Space Heating					
5.E	Heat source		missed	missed	missed	missed
5.G	Ventilating services	missed		missed		missed
5.I	Gas installation	missed	missed	missed	missed	

mentioned	(blank)	missed	(hatched)

Some information, such as ground conditions, project duration, number of storeys, project site access, and others is mentioned in the BCIS project data sheet. This information is not complete in all data sheets. Figures 7.3 and 7.4 show that in some data sheets the information seems to be complete and clear, and in some other data sheets it seems to be either incomplete or not clear enough. Information on project duration, ground conditions, number of bidders, site access and type of contract is mentioned in project data sheet 1 (Figure 7.3) and not mentioned in project data sheet 2 (Figure 7.4). Such omissions reduce the sample number owing to the availability of factor data in the BCIS project data sheet; the sample should contain all data for each factor in complete sample projects.

Job Title :	Whitely Primary School
Location :	Fareham, Hampshire
District :	Fareham
Grid Reference :	SU5606
Dates :	Receipt : 3-Nov-1997 Base : 24-Oct-1997 Acceptance : 1-Dec-1997 Possession : 5-Jan-1998
Project Details :	Single storey 14 classroom primary school with shared areas. External works include macadam and brick paving, timber fences, landscaping, services and drainage.
Site Conditions :	Level green field site with moderate ground conditions. Excavation above water table. Unrestricted working space and access. Need to protect trees.
Market Conditions :	Good. Project tender price index: 143 on 1985 BCIS Index Base
Client :	Hampshire County Council
Tender Documentation :	Bill of Quantities
Selection of Contractor :	Selected competition
No of Tenders :	Issued : 6 Received : 6
Contract :	JCT LA 1980 contractors designed portion sup
Contract Period (mths) :	Stipulated : 11 Offered : 11 Agreed : 11
Cost Fluctuations :	Firm
Tender Amended :	Addendum Bill
Tender List :	£ 2,012,944 - £ 2,045,762 1.6% £ 2,071,716 2.9% £ 2,139,060 6.3% £ 2,202,570 9.4% £ 2,559,938 27.2%
	Contract Breakdown
Measured Work	£ 1,351,679
Provisional Sums	£ 86,120
Prime Cost Sums	£ 321,313
Preliminaries	£ 195,940
Contingencies	£ 80,200
Contract Sum	£ 2,035,252

Figure 7.3: Project data sheet 1

Location :	Sherborne, Dorset
District :	West Dorset
Grid Reference :	ST6316
Dates :	Receipt : 15-Jan-1997 Base : 5-Jan-1997
Project Details :	Single storey, 315 place primary school together with external works, services,

Figure 7.4: BCIS Project data sheet 2

7.5 Sample Description

The school projects data found in BCIS was explored and with all the potential variables, only the data on newly-built schools was collected. The total number of schools found in this category was 125 primary and secondary school projects. The variables were filtered to have the correct and clear described variables. Schools with two missing variables were removed, and then the remaining data was re-examined to check the missed variables. More schools were excluded because the variables were either missing or not clear enough to be included. The final filtered sample contained 85 school projects: Table 7.2 and Figure 7.5 show the number, type and percentage type of school for each year.

Table 7.2: Sample type and total by year

Year	Primary Schools	%	Secondary Schools	%	Total	%
1990	2	2.35%	0	0.00%	2	2.35%
1991	8	9.41%	1	1.18%	9	10.59%
1992	6	7.06%	1	1.18%	7	8.24%
1993	4	4.71%	0	0.00%	4	4.71%
1994	5	5.88%	2	2.35%	7	8.24%
1995	7	8.24%	0	0.00%	7	8.24%
1996	8	9.41%	2	2.35%	10	11.76%
1997	7	8.24%	1	1.18%	8	9.41%
1998	4	4.71%	2	2.35%	6	7.06%
1999	3	3.53%	0	0.00%	3	3.53%
2000	4	4.71%	0	0.00%	4	4.71%
2001	8	9.41%	2	2.35%	10	11.76%
2002	3	3.53%	1	1.18%	4	4.71%
2003	3	3.53%	0	0.00%	3	3.53%
2004	1	1.18%	0	0.00%	1	1.18%
Total	**73**	**85.88%**	**12**	**14.12%**	**85**	**100.00%**

The sample was divided for use in the model development and for training and testing purposes. The data from seventy of the school projects was used for developing the module, and fifteen projects were reserved for module testing. The portion used in the module development will be described for each variable below.

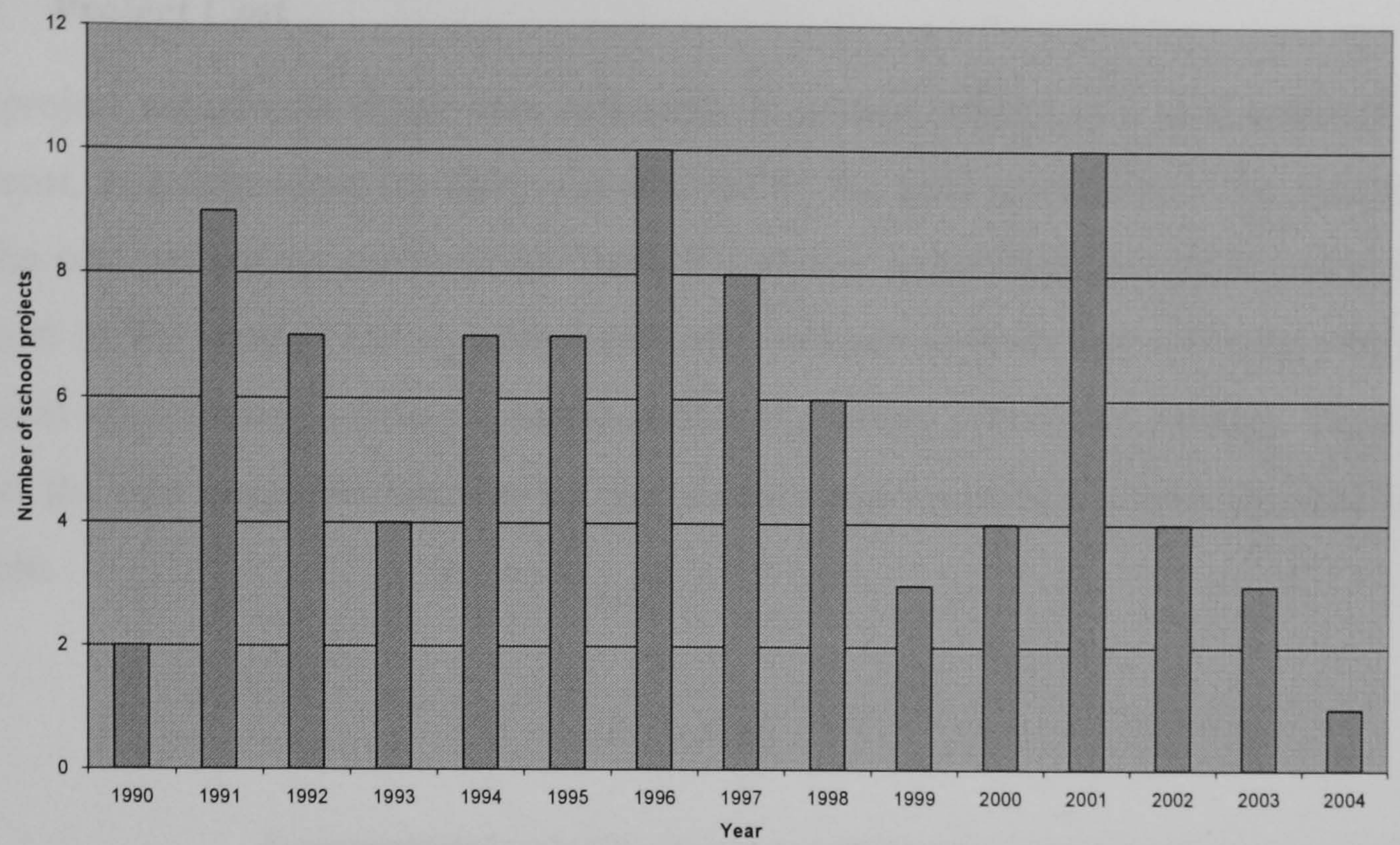


Figure 7.5: Sample distribution by year

7.6 Variables

The increase or decrease in project costs depends on the project elements, specification, location, size and other cost variables. These cost variables were drawn mostly from the data source, which should describe the requirements and specifications on which the project cost was calculated. The variables selected for the construction-cost prediction model were restricted by the BCIS data constraints mentioned earlier. Table 7.3 lists the variables and their categories.

Table 7.3: Variables type and categories

	Variable	Catigories				
1	Cost	£				
2	Area	m2				
3	Function	Primary	Secondary			
4	Ground condition	Good	Moderate	Poor		
5	Foundation type	Srtip	Pad	Raft	Strip/pad	Piles
6	Type of frame	Steel	Loadbearing	Timber	Reinforced concrete	
7	Number of floors	Single	2	3	4	
8	Preliminries	%				
9	Contigecies	%				
10	Duration	Months				

7.6.1 Project Cost

The project actual cost figure was extracted from each project as a total contract sum. The cost, as a dependent variable, was divided by the total gross area of the building to get the cost per square meter (m2). Table 7.4 shows some statistical information about the cost of the sample for all school projects, primary schools and secondary schools. The cost of secondary schools is less than that of primary schools on average. Figure 7.6 shows the cost range distribution for the primary and secondary school projects in the sample.

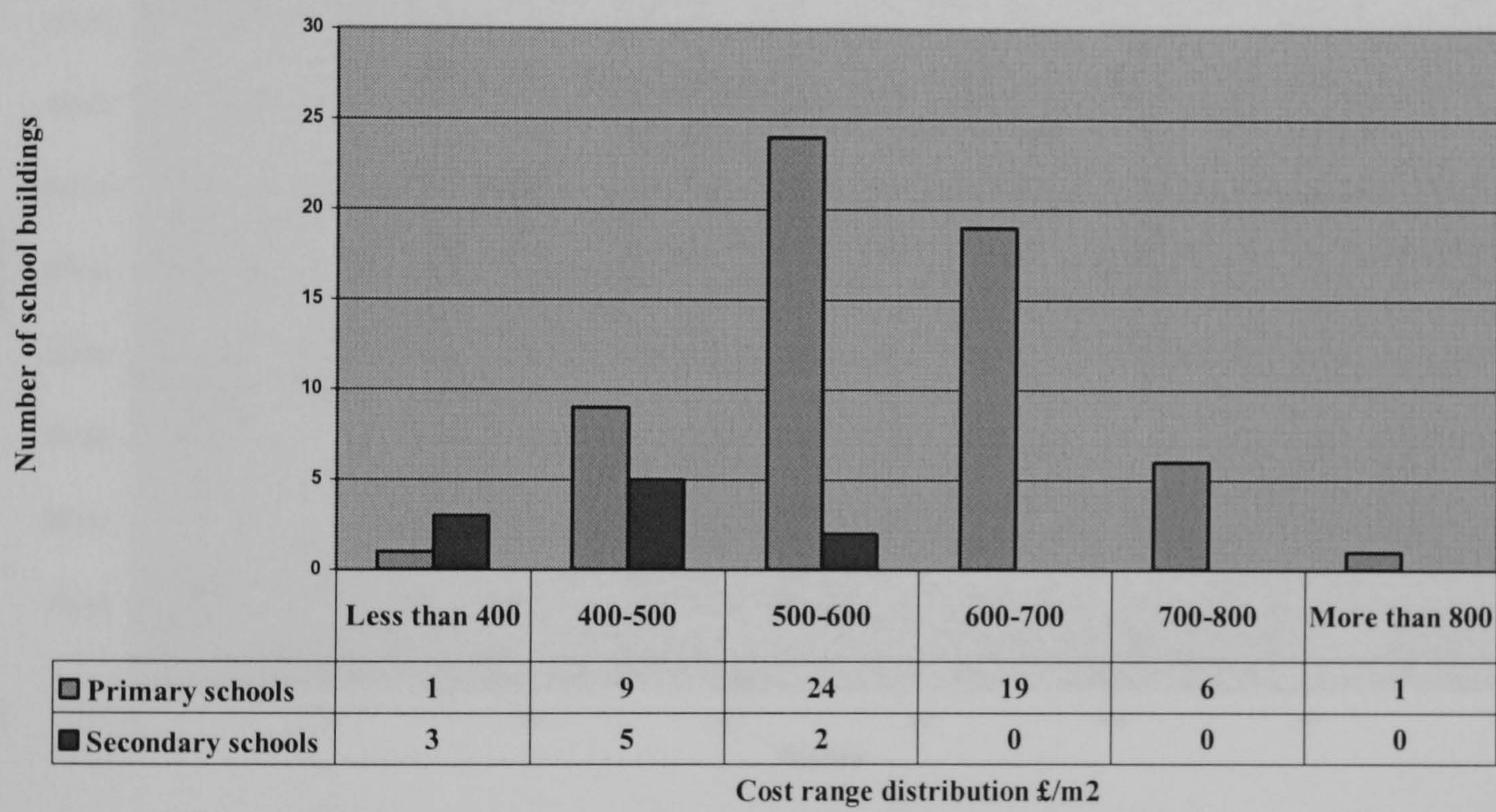


Figure 7.6: Schools buildings area

As shown in Table 7.4, the cost of a primary school ranged between £350.53 and £910.48 per square meter. The cost of secondary schools is lower than that of the primary schools. This represents an inverse relationship with the mean area of the same schools. This could be because of the average school area for each type; the average area for a secondary school is 6,159 m², for a primary school £1,369 m². This variation in area could result from the increased number of activities required for secondary schools. The influence of area on cost is obvious: the greater the area the lower the cost per square metre will be (Ashworth, 2004).

Table 7.4: Cost statistical characteristics

Category	All Schools	Only Primary	Only Secondary
Mean	571.90	592.25	449.80
Median	576.46	587.35	448.84
Standard Deviation	106.02	98.26	59.59
Minimum	910.48	910.48	551.48
Maximum	350.53	350.53	360.81
sample size	70	60	10

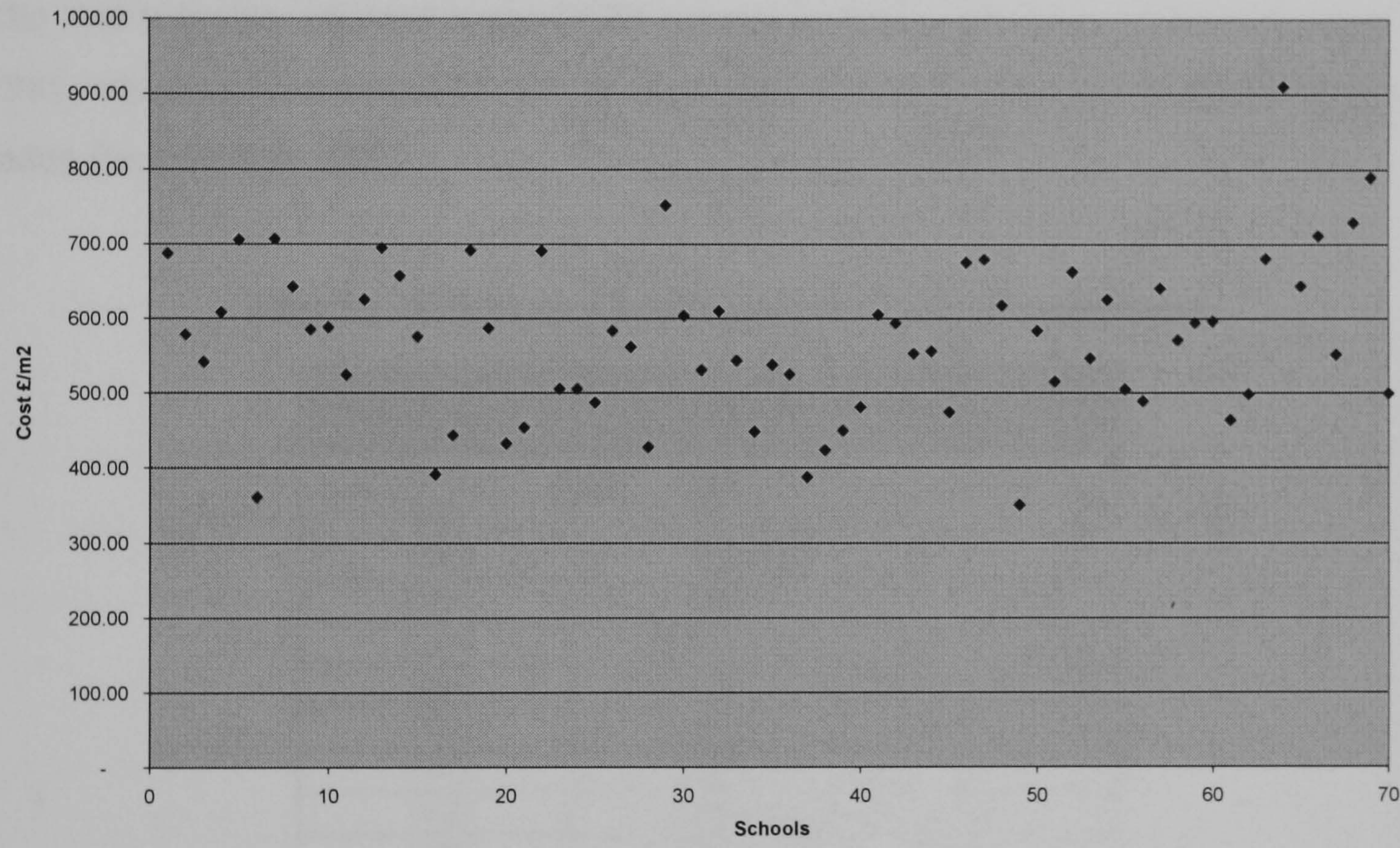


Figure 7.7: Sample indexed cost

The cost is adjusted for the base location using the mean national location factor for the UK according to BCIS Regional Trends, which give the regional indices base as 1.00 for the year of 1985. Table 7.5 lists the regional location index from 1990 to 2005.

Table 7.5: BCIS Regional trends

		Year															
	Region	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	Northern	1.03	1.01	1.04	0.97	1.02	1.03	1.02	0.95	1.01	1.02	0.97	0.97	0.97	1.00	1.01	1.04
2	Yorkshire & Humberside	1.03	0.99	0.99	0.98	1.01	0.99	1.01	0.96	0.98	0.93	0.95	0.94	0.96	0.99	1.02	1.08
3	East Midlands	0.99	1.00	1.01	1.00	1.01	1.02	1.01	1.01	1.02	1.02	1.06	1.04	1.01	0.98	1.04	1.02
4	East Anglia	0.90	0.92	0.93	0.93	0.91	0.92	0.91	0.92	0.94	0.90	0.93	0.93	1.01	0.98	0.96	0.94
5	South East (ex. London)	0.97	0.94	0.90	0.91	0.92	0.93	0.96	0.95	0.96	1.00	0.99	0.98	1.00	0.98	0.97	0.97
6	Greater London	1.00	0.91	0.91	0.90	0.95	0.94	0.93	0.94	0.99	1.00	0.96	1.05	1.01	0.97	0.94	0.93
7	South West	0.97	0.97	0.97	0.97	1.00	1.00	1.01	1.00	1.01	1.03	1.03	1.03	1.00	1.04	1.04	1.03
8	West Midlands	1.01	0.98	0.97	0.97	0.99	1.00	0.99	1.01	0.96	1.00	1.02	1.01	1.00	1.02	0.98	1.00
9	North West	1.01	1.03	0.99	1.01	0.98	1.00	1.02	1.01	0.96	0.92	0.97	0.96	0.94	0.97	0.99	0.96
10	Wales	1.01	0.97	0.97	0.98	0.96		1.03	0.96	0.96	0.91	0.98	0.94	0.97	0.99	0.96	0.95
11	Scotland	1.00	1.06	1.08	1.08	1.02	1.02	0.97	0.97	0.96	1.00	0.94	0.92	0.93	0.90	0.92	0.95
12	Northern Ireland	0.86	0.85	0.97	0.96	0.94	0.93	0.92	0.95	0.95	0.89	0.97	0.85	0.89	0.86	0.90	0.78

The cost was also adjusted to the BCIS general building cost index to the base year of 1985, which is represented by 100 in the index. Table 7.6 lists the BCIS tender price index from 1990 to 2005.

Table 7.6: BCIS General Building cost and Tender Price Indices

Year	BCIS Tender Price Index	Note
1990	129	
1991	114	
1992	108	
1993	109	
1994	121	
1995	130	
1996	130	
1997	138	
1998	146	
1999	151	
2000	161	
2001	174	
2002	187	
2003	197	
2004	213	
2005	224	
2006	230	Forecast
2007	240	Forecast
2008	253	Forecast

The cost was adjusted to cost and location indices according to equation 7.1 below, based on 1985 indices: 1.00 for the location and 100 for the cost index.

$$C_{adjusted} = C_{actual} \times \frac{GTPI_{1985}}{GTPI_{actual}} \times \frac{MLF_{1985}}{RLF_{actual}}$$ Equation 7.1

Where $C_{adjusted}$ = Adjusted project cost

C_{actual} = Actual (bidding) project cost

$GTPI_{1985}$ = Average Tender Price Index 1985 = 100

$GTPI_{actual}$ = Actual project cost at tender date for a specific project

MLF_{1985} = Mean Location Factor of the UK for 1985 = 1

RLF_{actual} = Regional Location Factor of a specific project

This equation, when applied to the sample to adjust the cost, produced the result presented in Figure 7.8. The adjusted cost was used in developing the cost module after adjustments against time and location.

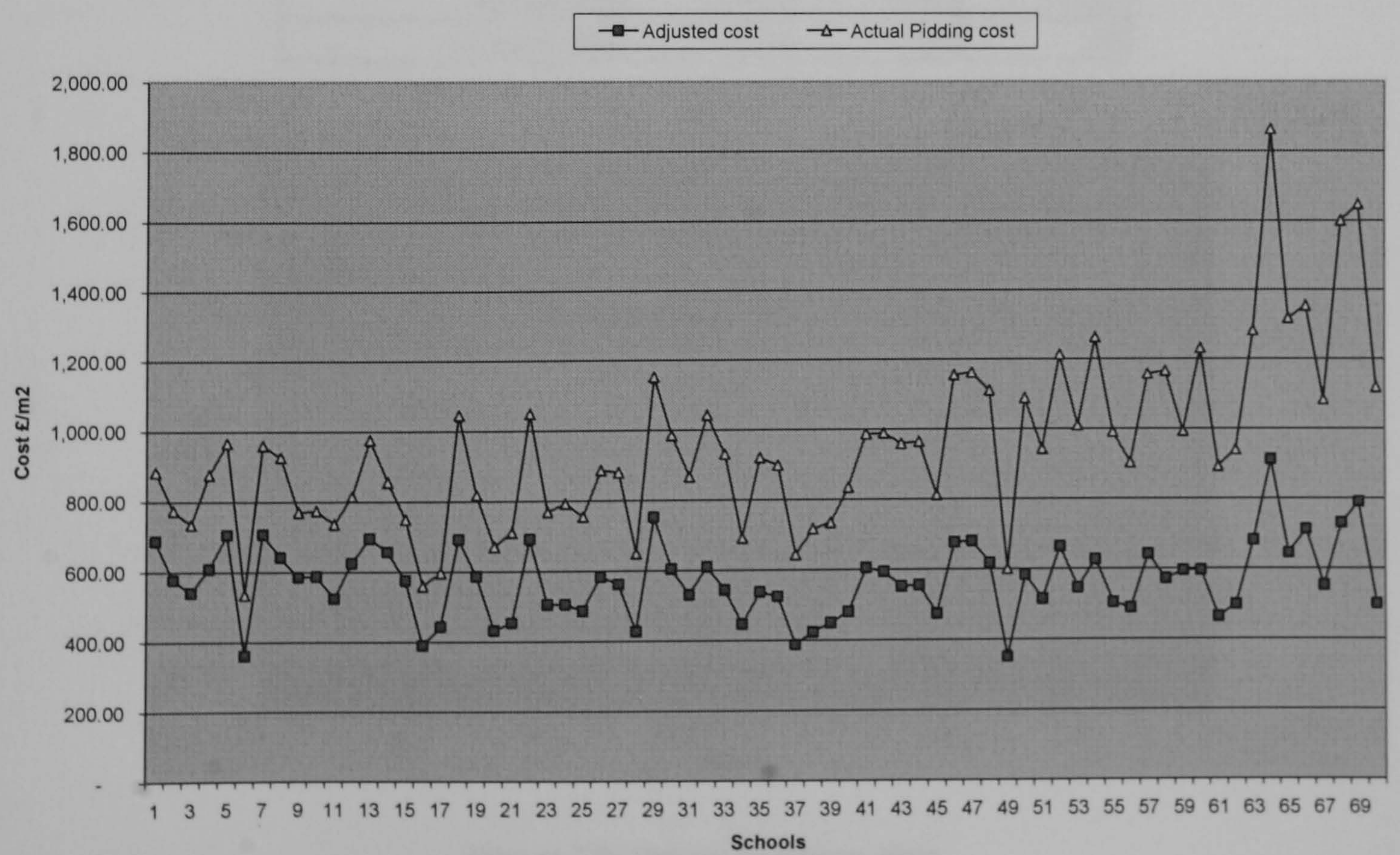


Figure 7.8: Actual and adjusted cost

7.6.2 Building Area

The area of schools is one of the most important factors that affect the cost. Boussabaine and Elhag (1999) reported that the literature and practical experience show that gross floor area plays a significant role in tender price estimation. They found that area accounted for 87.23% of tender price variations, and when project duration and gross floor area were combined together, it was found that they accounted for 89.7% of tender price variations for office projects. As shown in Table 7.7, the range of school area varies from $603m^2$ to $3686m^2$ in primary schools and from $435m^2$ to $11,898m^2$ in secondary schools. The big difference in the area of secondary schools, despite their low sample proportion, causes the mean to rise from $1369.83m^2$ for primary schools to $2054.04m^2$ for the whole sample. Figure 7.9 shows the scattered distribution of area for the whole sample.

Table 7.7: Area statistical characteristics

Category	All Schools	Only Primary	Only Secondary
Mean	2,054.04	1,369.83	6,159.30
Median	1,328.50	1,254.50	5,615.50
Standard Deviation	2,312.23	539.97	4,151.03
Minimum	435	603	435
Maximum	11898	3686	11898
sample size	70	60	10

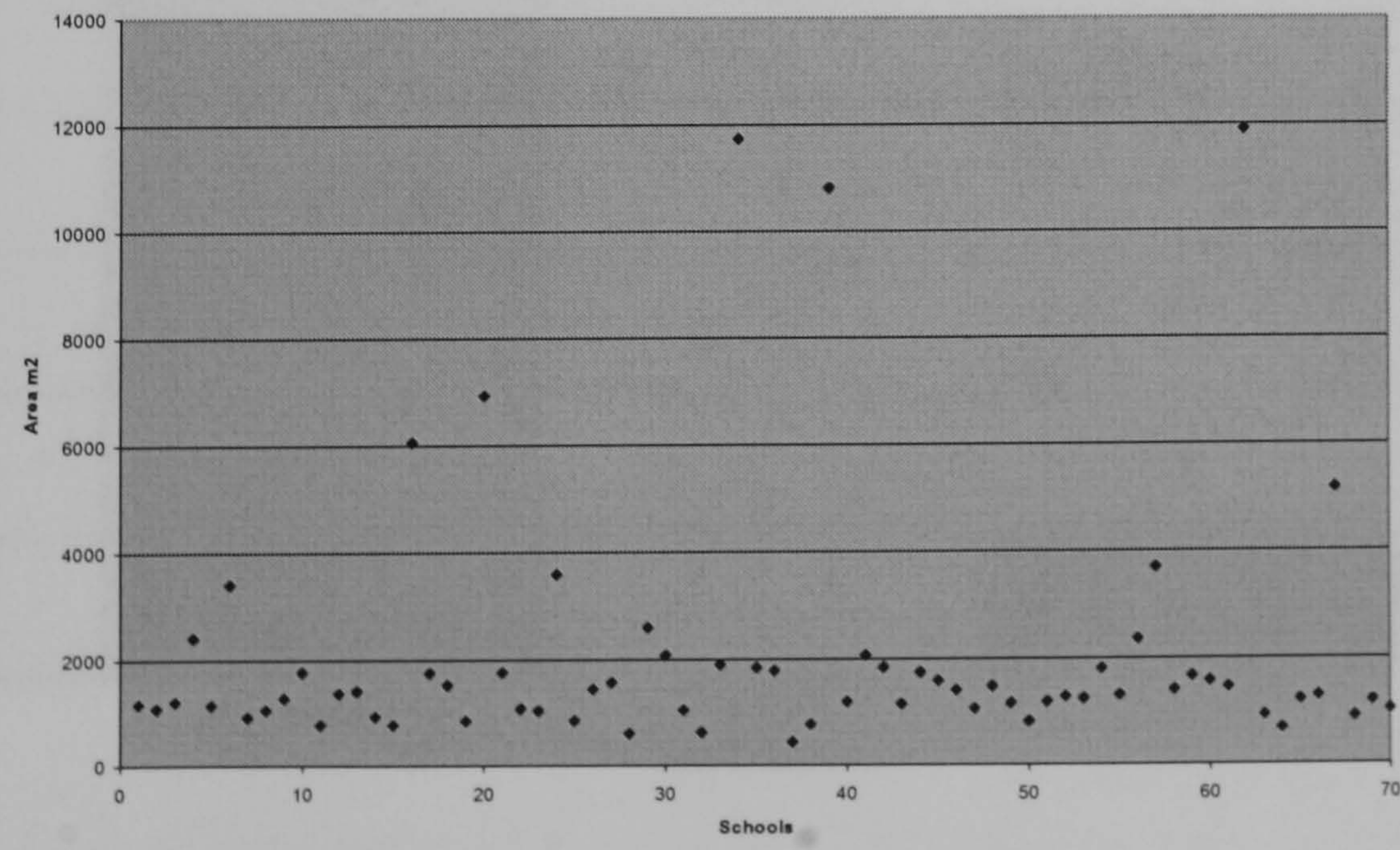


Figure 7.9: School buildings area

7.6.3 Function

The school type variable was limited to primary and secondary schools only; this was owing to data availability from the BCIS and BMI, where the schools' function was categorized into these two types. The school types and reasons behind selecting primary and secondary schools only were discussed in the previous chapter (Chapter 6: Space Planning Module). The sample used in the module consists of sixty primary schools (85.71%) and ten secondary schools (14.29%), as shown in Table 7.8 and presented in Figure 7.10. The function of the school affects the cost, as design requirements are more in secondary schools in terms of laboratories and other utilities; these requirements were also reflected in the space requirements of school design Bulletins 98 and 99.

Table 7.8 : School's function

School type	Sample	%
Primary	60	85.71%
Secondary	10	14.29%
Total	**70**	**100.00%**

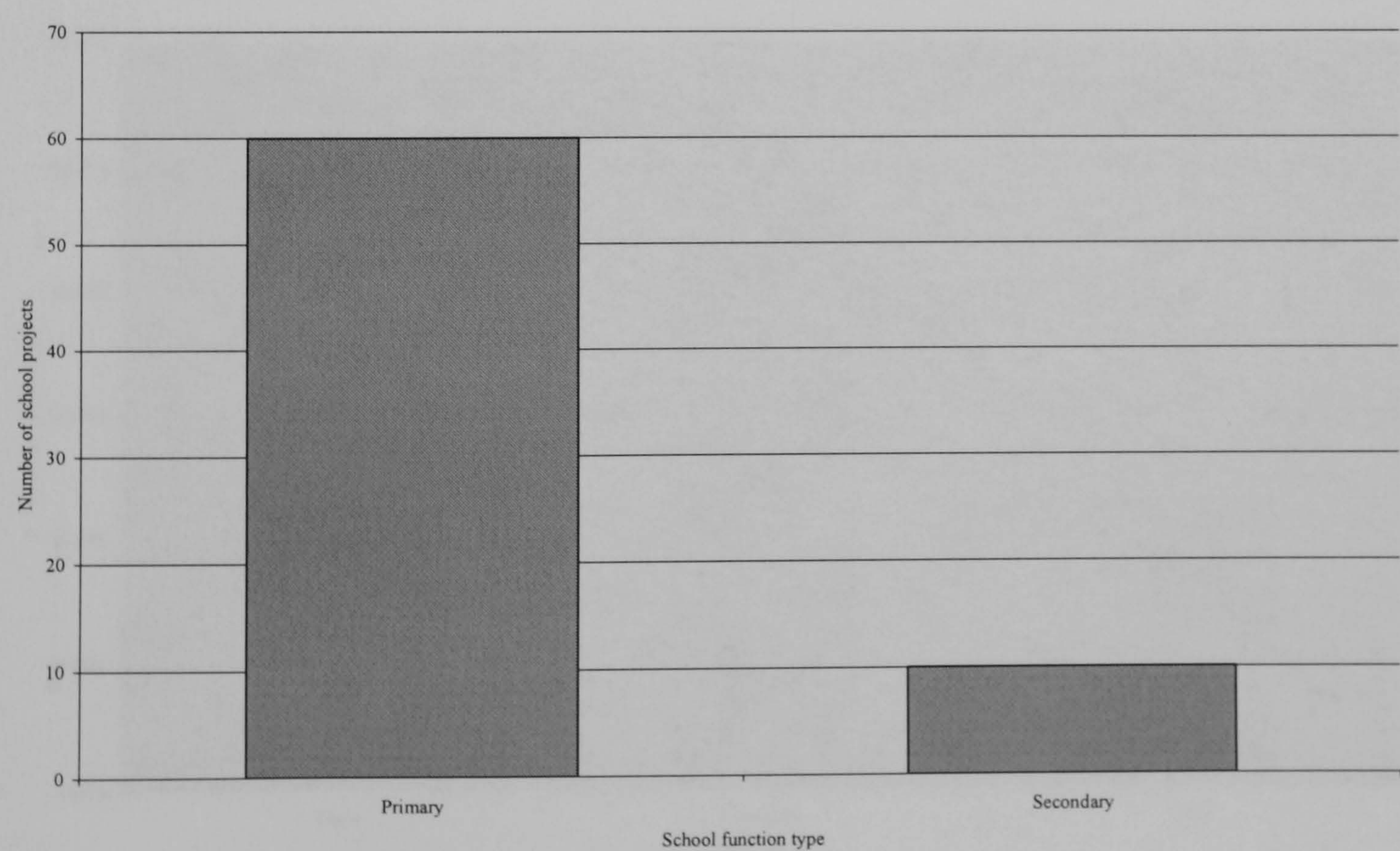


Figure 7.10: School function type.

7.6.4 Ground Condition

In a survey amongst Quantity Surveyors, Boussabaine and Elhag (1999) found that ground condition achieved an importance index of 81%, which indicates a high degree of influence on cost and duration of construction projects. Three types of ground condition were found in BCIS: good, moderate and poor. Most projects (48.57%) had moderate ground condition, as shown in Table 7.9 and Figure 7.11. Good ground condition was in the second rank for twenty school projects (28.57%) of the sample, and sixteen school projects had poor ground condition representing 22.86% of the sample.

Table 7.9: Ground condition

Ground condition	Primary Sch	Secondary Sch	Total	%
Good	17	3	20	28.57%
Moderat	30	4	34	48.57%
Poor	13	3	16	22.86%
Total	**60**	**10**	**70**	**100.00%**

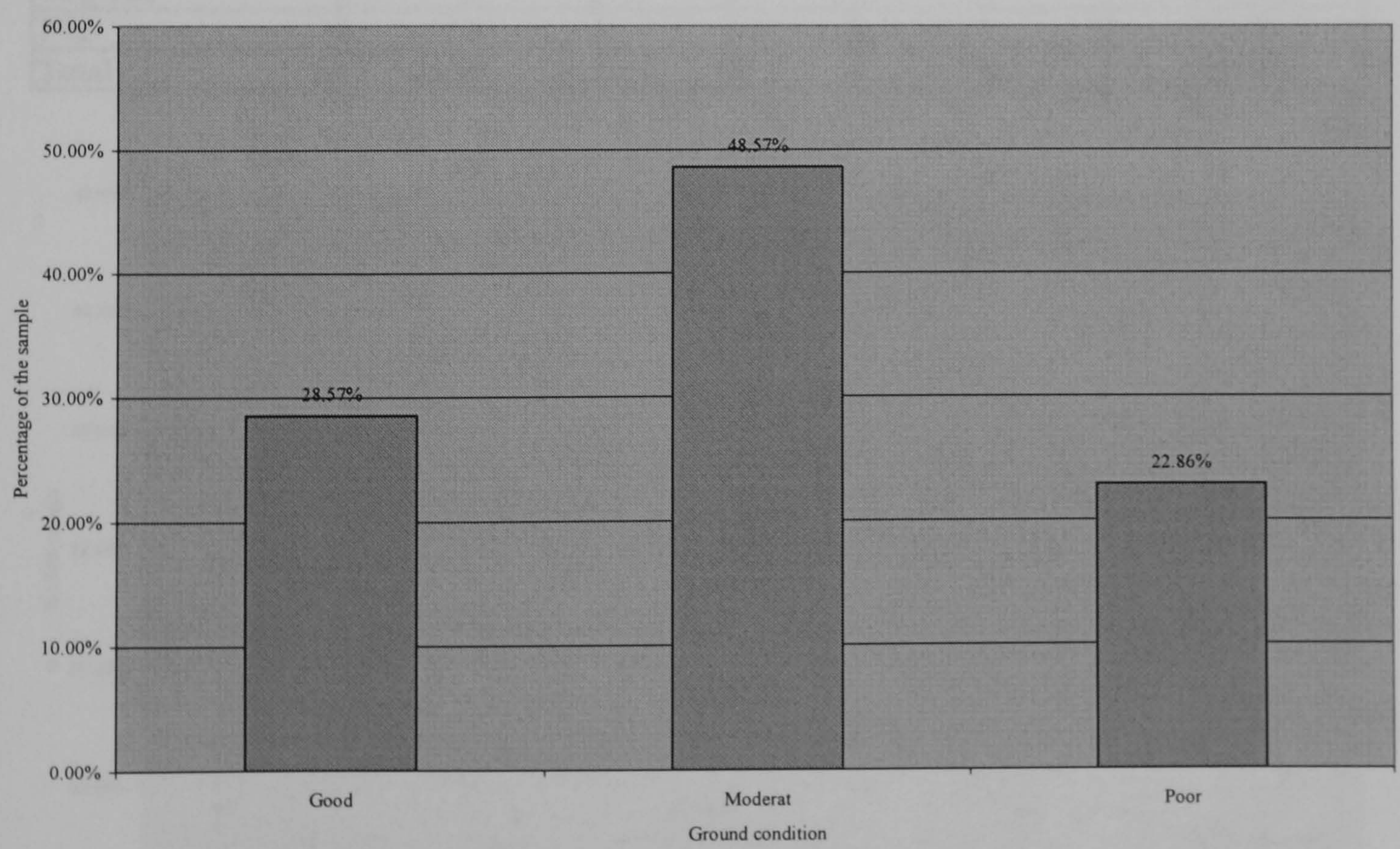


Figure 7.11: Ground condition

7.6.5 Type of Foundation

The foundation cost will vary with the shape and size of the building, and also with the number of storeys (Ashworth, 2004). Boussabaine and Elhag (1999) found in a survey of Quantity Surveyors that the type of foundation achieved an importance index of 71%, which indicates a high effect on cost and duration of construction projects. The types of foundation found in all the school projects data were defined as five types; strip, pad, raft, and piles, and in the fifth a combination of strip and pad foundations. The strip foundation type was used in more than 50% of the sample projects, while piles were used in only 5 projects, representing 7.14% of the sample. Table 7.10 and Figure 7.12 give the projects number and percentage of the type of foundation used. Strip foundation is the most commonly used type in school projects.

Table 7.10: Foundation type

Foundation type	Primary Sch	Secondary Sch	Total	%
Strip	33	4	37	52.86%
Pad	9	0	9	12.86%
Raft	6	0	6	8.57%
Strip/pad	8	5	13	18.57%
Piles	4	1	5	7.14%
Total	**60**	**10**	**70**	**100.00%**

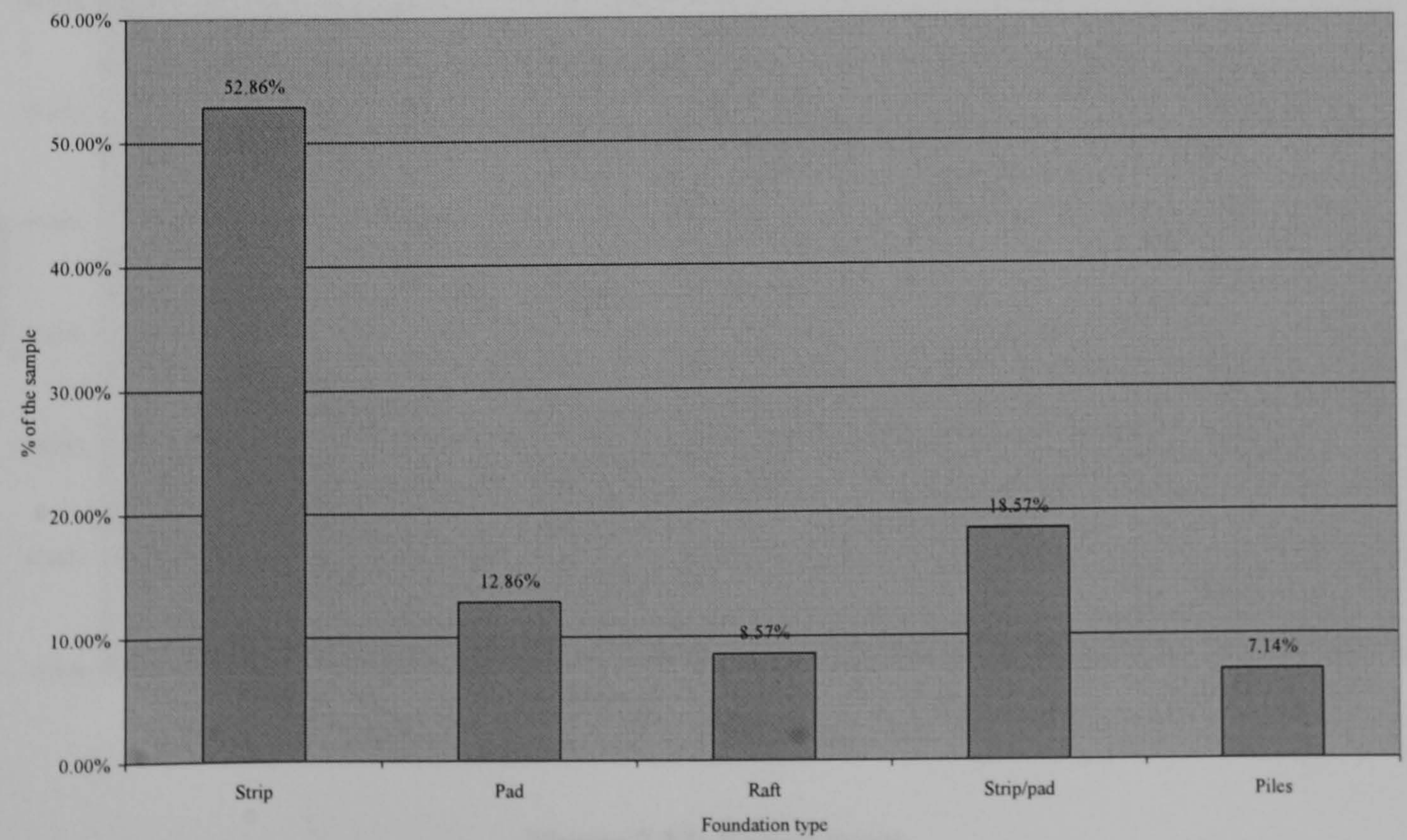


Figure 7.12: Type of foundation

7.6.6 Type of Frame

Boussabaine and Elhag (1999) reported that frame structure has gained an importance index of 68.6%, which indicates a high effect on cost and duration of construction projects. According to Ashworth (2004), the frame of a building is an important element in a cost analysis. There were four types of frame used in the sample: steel, load-bearing, timber and reinforced concrete. The steel frame was used in forty-one projects, while the reinforced concrete was used in only four projects. Table 7.11 and Figure 7.13 show the distribution of these frames between school types.

Table 7.11: Type of Frames

Frame type	Primary Sch	Secondary Sch	Total	%
Steel	34	7	41	58.57%
Load-bearing	15	1	16	22.86%
Timber	8	1	9	12.86%
Reiforced concrete	3	1	4	5.71%
Total	**60**	**10**	**70**	**100.00%**

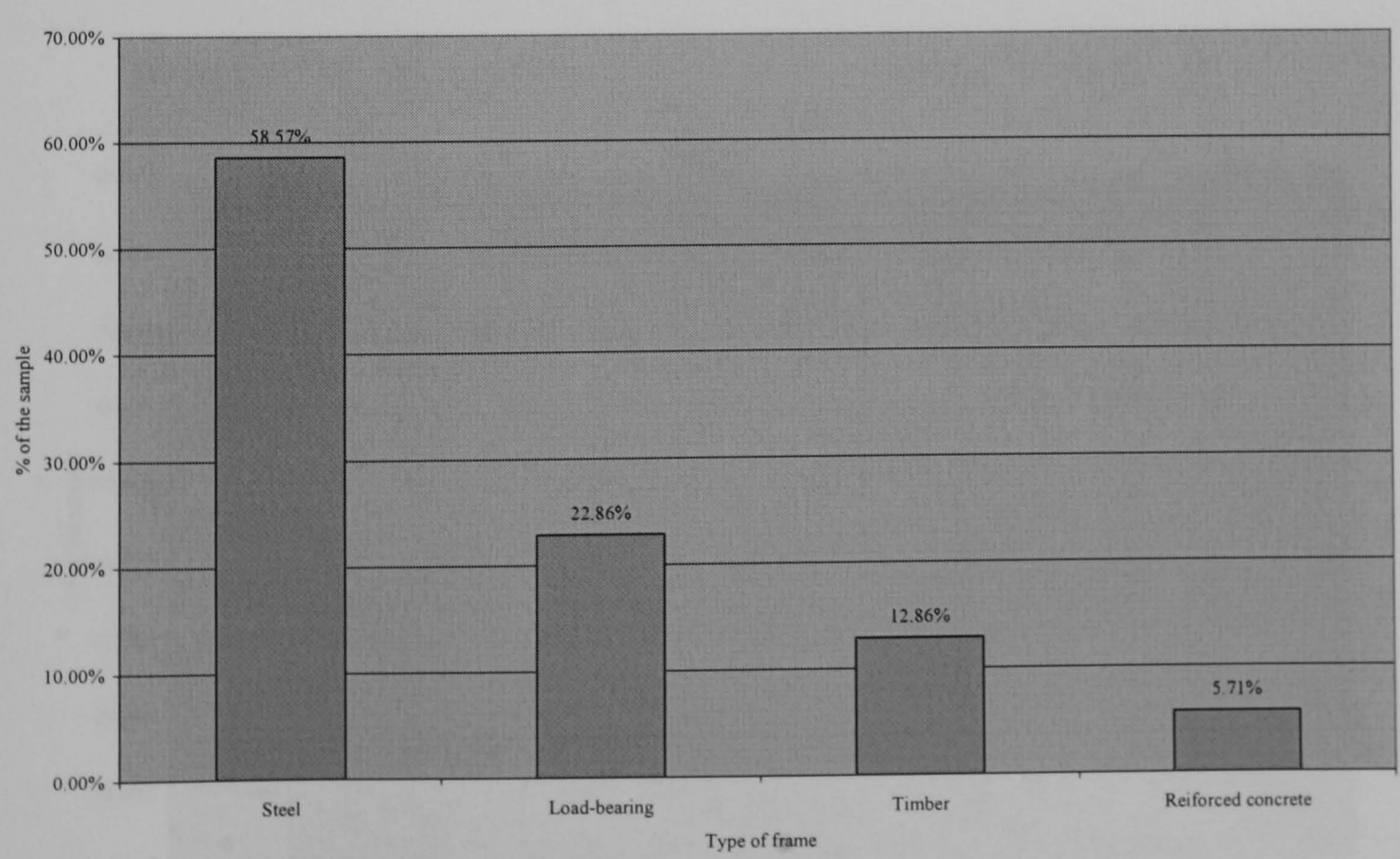


Figure 7.13: Frame types

7.6.7 Number of Floors

The number of storeys has a significant effect on the cost. A survey amongst Quantity Surveyors shows that the number of storeys factor has achieved an importance index of 92%, which indicates a high degree of influence on cost and duration of construction projects (Boussabaine and Elhag, 1999). The greater the number of storeys, the more important this element will be as far as cost-sensitivity is concerned (Ashworth, 2004). 90% of the primary schools consist of single storey buildings, whereas 70% of the secondary school buildings are two-storey buildings. Table 7.12 and Figure 7.14 show the distribution of primary and secondary school building's storeys in numbers and percentages for each school function.

Table 7.12: School buildings number of storeys

Number of stories	Primary Sch	Secondary Sch	Total	%
1	54	1	55	78.57%
2	6	7	13	18.57%
3	0	2	2	2.86%
4	0	0	0	0.00%
Total	**60**	**10**	**70**	**100.00%**

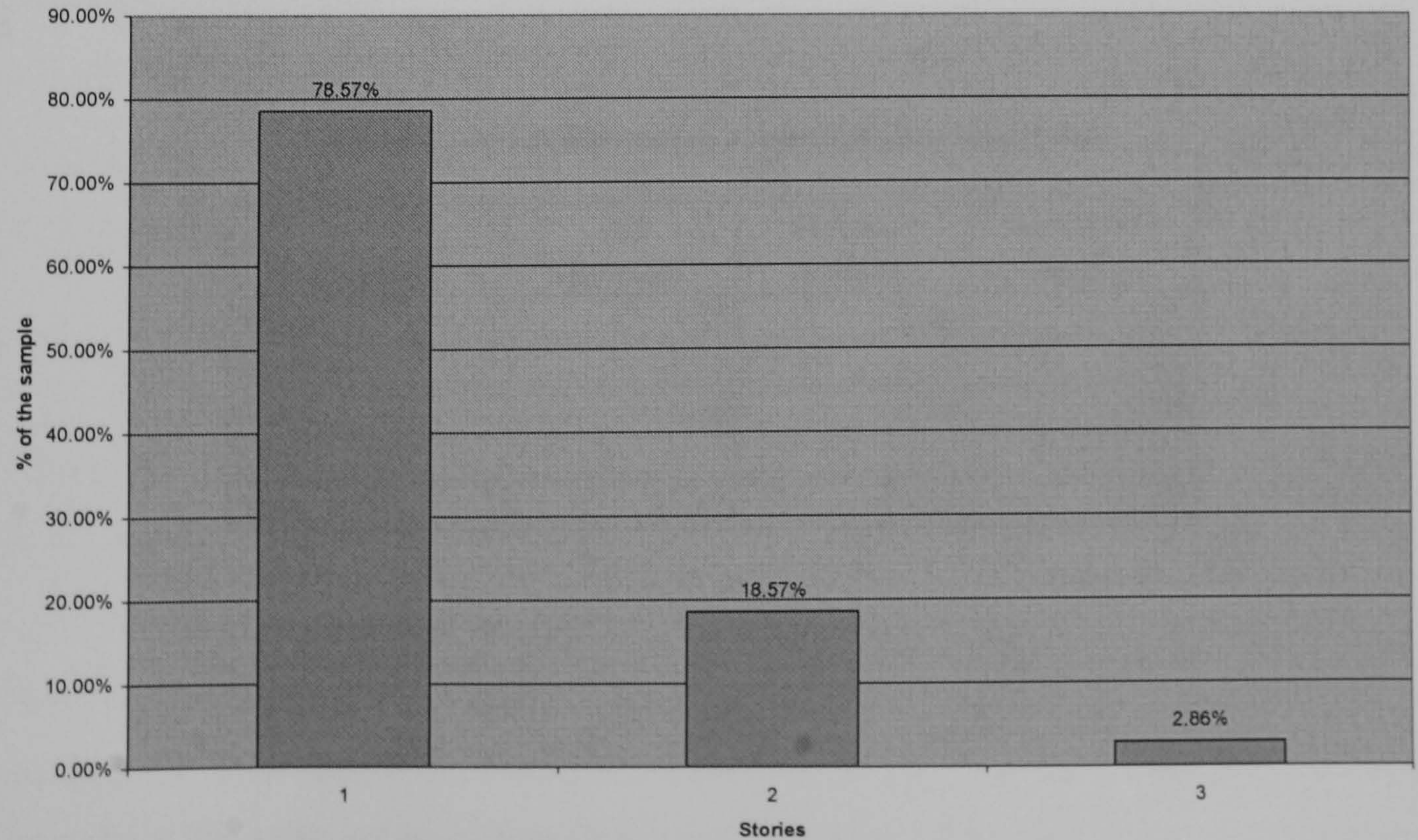


Figure 7.14: Number of storeys

7.6.8 Preliminaries

The BCIS Standard Form of Cost Analysis recommends that preliminaries should be expressed as a percentage of the reminder of the contract sum (RICS, 1969). Preliminaries include the cost of the site management team, scaffolding, site offices, toilets, canteen, first aid, insurance for works, temporary protection, plant and equipment not specific to one task, keeping roads clear of mud, removal of site debris, water and power for the works, temporary lighting, site telephones, cleaning the works, safety requirements and other general items specific to the contract conditions (Flanagan and Tate, 1997). These other general items and more were listed by Ferry *et al* (1999) to include more cost items such as: National Insurance payments, redundancy payments, anticipated increase in cost of labour or material, bonuses or other supplementary payments, ... , head office expenses (overhead) and profit.

The preliminaries cost percentage ranges from 0.18% to 21.45% with a mean of 8.99% for the whole sample. The standard deviation (S.D.) is 4.4% in primary schools, which is near to the S.D. for the sample, and 6.99% in secondary school projects. Table 7.13 shows the statistical characteristics of preliminaries cost, and Figure 7.15 shows the scattered distribution of the preliminaries for the whole sample.

Table 7.13: Preliminaries statistical characteristics

Category	All Schools	Primary Schools	Secondary Schools
Mean	8.99	8.61	11.27
Median	8.58	8.45	10.02
S.D	4.88	4.40	6.99
Min	0.18	0.18	1.81
Max	21.45	19.67	21.45

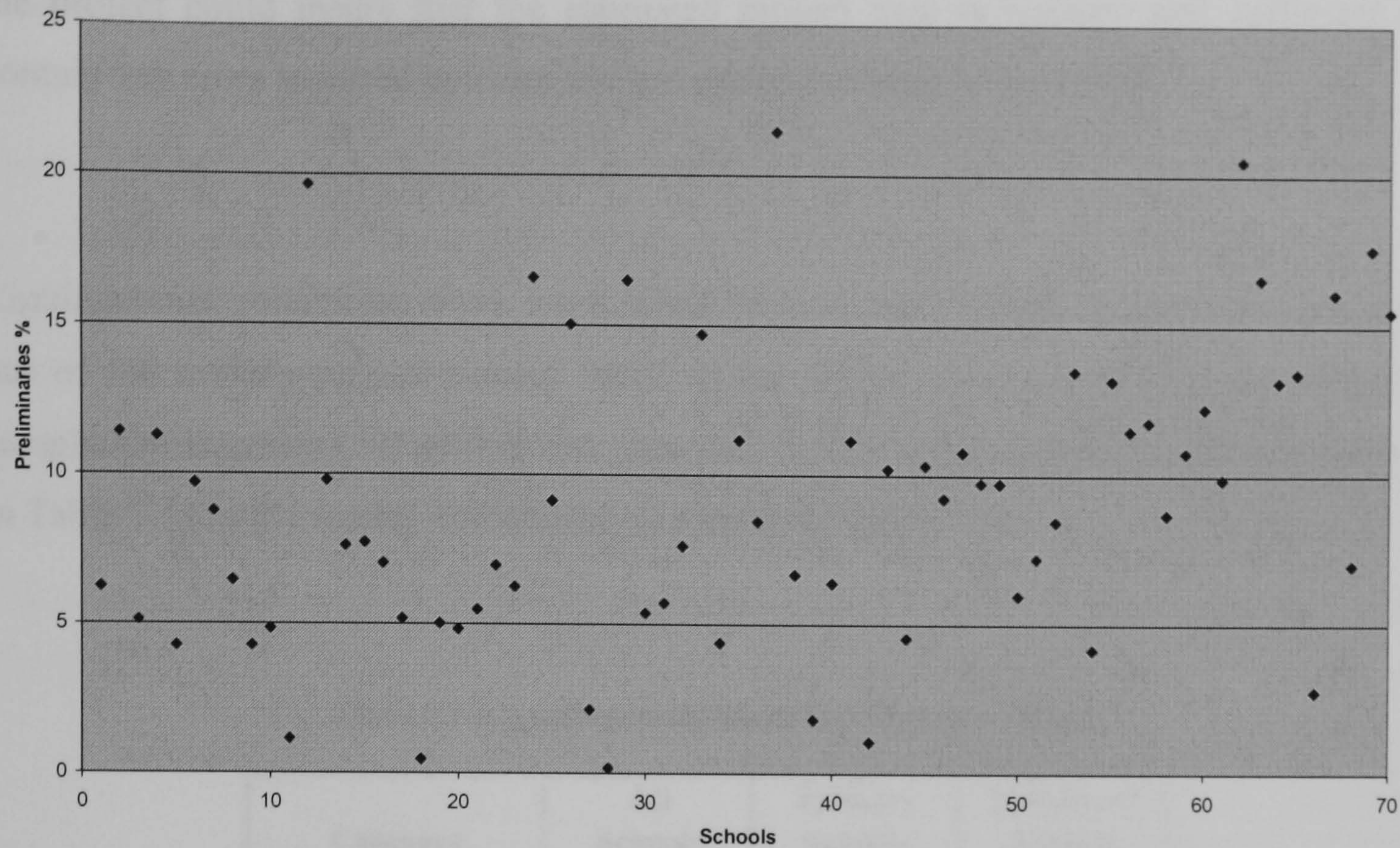


Figure 7.15: Preliminaries cost

7.6.9 Contingencies

The contingency sum is the amount of money or time needed above the estimate to reduce the risk of overruns on project objectives to a level acceptable to the organization (PMI, 2000). It is included to cover unforeseen items and eventualities which occur during the construction (Flanagan and Tate, 1997). The contingency sum is an arbitrary amount decided by the client or the design team. This means that it is not part of the contractor's tender but is the amount that contractor is instructed to add to his tender in order that there may be a cushion to absorb unforeseen extras (Ferry *et al.*, 1999).

The contingency sum is mostly calculated as a percentage addition on the project estimate, derived from intuition, past experience and historical data (Mak *et al.*, 1998). It is important for the contingencies to be taken into consideration with the most accurate measurements possible. In a case study research conducted on one organization's experiences, Baccarini (2004) found that construction contingency covered only 52.25% of the approved contract variations. The sum of contingencies either added by the contractor's estimator or instructed to be added to the total cost of the project could insure that the estimated project cost is realistic and sufficient to contain any costs incurred by risks and uncertainties (Mak *et al.*, 1998).

Contingencies percentage costs were found to have been added to sixty-nine projects out of the seventy-project sample listed in the BCIS cost analysis. For the selected sample, contingencies range between zero and 12.9%, with a mean of 3.56% as shown in Table 7.14 and a scatter distribution as shown in Figure 7.16.

Table 7.14: Contingencies Statistical Characteristics

Category	All Schools	Primary Schools	Secondary Schools
Mean	3.56	3.57	3.47
Median	3.32	3.37	3.07
S.D	1.83	1.82	1.99
Min	0	0	1.55
Max	12.9	12.9	8.12

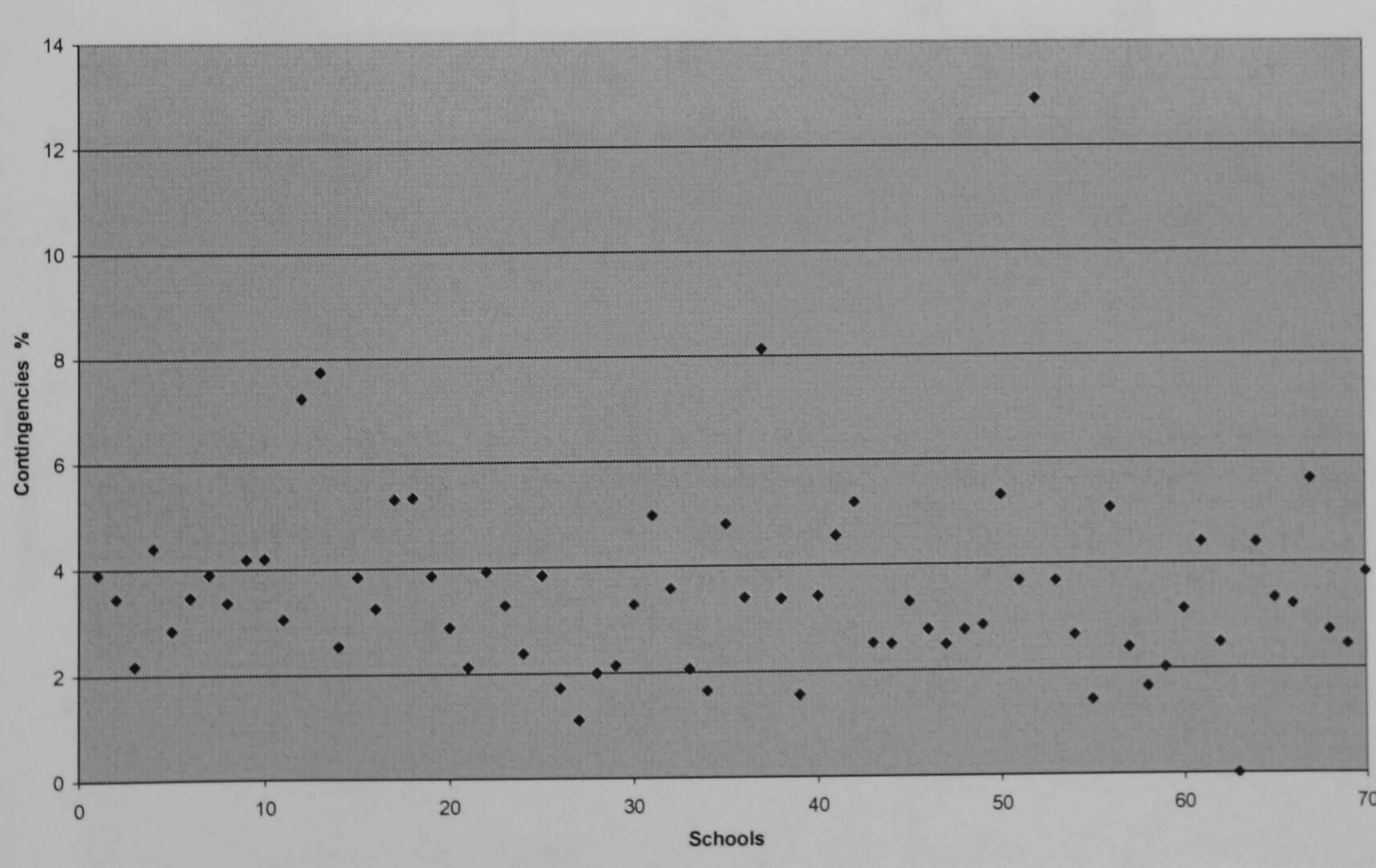


Figure 7.16: Contingencies scattered distribution

7.6.10 Project Duration

Duration of the project is believed to have a cost impact on the project; it is among the factors influencing cost estimation listed by Akintoye (2000) when he analyzed the factors influencing project cost estimation practice. Boussabaine and Elhag (1999) found that there is a strong linear relationship between project duration and tender price, and they are positively correlated. They found that project duration accounted for 70.44% of tender price variations. The sample mean of project duration is 13.07 months, while it is 11.80 months for primary schools and 20.70 months for secondary schools. Table 7.15 shows the statistical characteristics of the projects duration and Figure 7.17 shows the scattered distribution.

Table 7.15: Statistical characteristics of the project duration

Category	All Schools	Primary Schools	Secondary Schools
Mean	13.07	11.80	20.70
Median	12.00	12.00	19.00
S.D	5.61	2.61	11.03
Min	6	6	6
Max	40	18	40

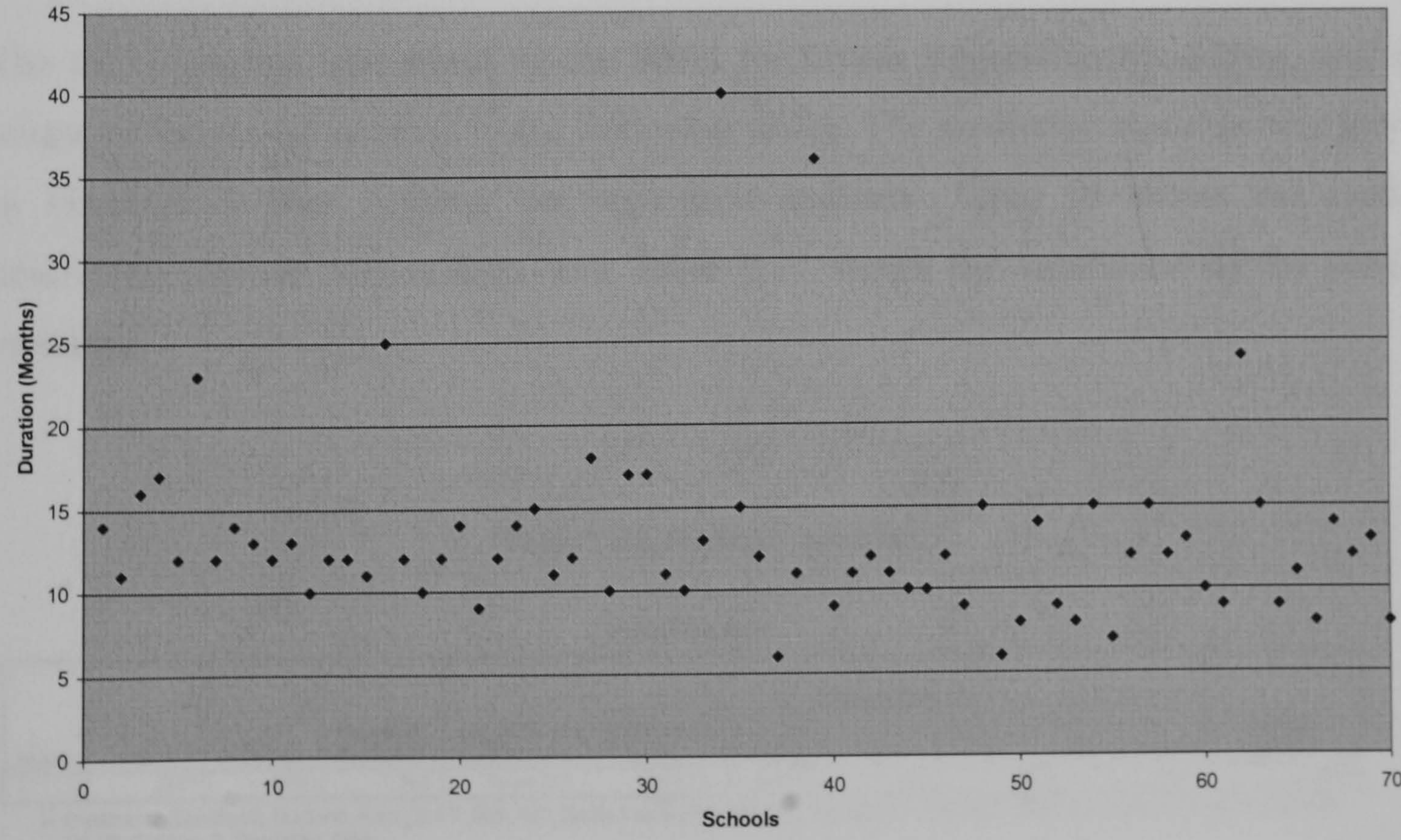


Figure 7.17: Project duration (months)

7.7 Data Regression Modelling

Regression analysis is about providing a relationship between two sets of variables (Fellows and Liu, 2003). In such an approach, past data on the relevant variables is used to develop and evaluate a prediction equation. The variable that is being predicted by this equation is the dependent variable; a variable that is used to make the prediction is an independent variable (Hildebrand and Ott, 1987). It is the fit of a predictive model to the data in this study and uses that model to predict values of the dependent variable from one or more independent variables. Simple regression seeks to predict an outcome from a single predictor whereas multiple regressions seeks to predict an outcome from several predictors (Field, 2000).

The regression analysis used in developing this model was multiple regression; cost is the dependent variable while the variables listed in Table 7.16 are the independent variables. The data collected for all variables was processed using SPSS statistical software, and the produced coefficient equation is found in Equation 5 below.

The data collected was sorted in the SPSS for Linear Regression Modelling, and an output of the model is listed in the following tables. The prediction equation was given in Equation 5 after running the regression analysis. Table 16 shows the model descriptive statistic information, and Table 7.17 shows the coefficient of the model variables.

Table 7.16: Module summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.707[a]	.500	.349	85.54502	.500	3.311	16	53	.001	1.804

a. Predictors: (Constant), Duration, Floor_3, FT_Raft, GC_Good, Frame_Tm, FT_Pad, Frame_LB, Prelimin, Frame_RC, Contin, GC_Bad, FT_Pile, FT_St_P, Floor_2, Secondry, Area

b. Dependent Variable: Cost

Table 7.17: Coefficient of variables

Variable	B
(Constant)	496.2476383
Secondry	-117.3306963
GC_Good	-1.002564783
GC_Bad	14.22229312
FT_Pad	-77.20300692
FT_Raft	-25.24725908
FT_St_P	-41.1662384
FT_Pile	-5.082136817
Frame_LB	-91.32861423
Frame_Tm	-27.90280757
Frame_RC	-88.30173927
Floor_2	16.16961541
Floor_3	-163.772614
Area	0.020716929
Prelimin	6.734274654
Contin	5.753524502
Duration	7.824401133

The overall model fit as shown in table 7.16 as the R Square represents the amount of variance in the outcome explained by the model (Field, 2000). R square is 0.50 in this model which is the best fit that is possible from the data available. More variables could have enhanced the accuracy of model fit. This was not possible given the data source used (BCIS). The literature review however, confirmed that the variables selected were all of significant importance to cost of construction projects.

The prediction equation as a result of the regression model is as follow:

$$PC_i = \beta_0 + \beta_1(school\ type)_i + \beta_2(ground\ condition)_i + \beta_3(fundation\ type)_i + \beta_4(frame\ type)_i + \beta_5(No.\ of\ stories)_i + \beta_6(building\ area)_i + \beta_7(preliminaries)_i + \beta_8(contengencies)_i + \beta_9(prject\ duration)_i \quad \text{Equation 7.2}$$

Where PC = Predicted Cost

i = 1,2,3, ... , No. of projects

This equation was used to predict the cost of the project if the variables are known; it was applied on the same sample as training to measure the prediction error based on Equation 7.3 below:

$$Pae_i = \frac{AC_i - PC_i}{AC_i} \times 100 \qquad \text{Equation 7.3}$$

Where Pae = Prediction absolute error (%)

AC = Adjusted cost

The Prediction Accuracy (PA) was also calculated for each project based on Equation 7.4 below:

$$PA_i = 100 - Pae_i \qquad \text{Equation 7.4}$$

The Mean Predication Cost accuracy absolute error (MPCae) and Average Prediction Accuracy (APA) is calculated based on equations 7.5 and 7.6:

$$MPCae = \left(\sum_{i=1}^{n} \frac{|AC_i - PC_i|}{AC_i} \times 100\%\right) \div n \qquad \text{Equation 7.5}$$

$$APA = 100\% - MPCae \qquad \text{Equation 7.6}$$

Table 7.18 shows prediction error and accuracy for the training of the seventy projects used in the module development; the Mean Prediction Cost absolute error is 9.98% and the average accuracy of the module is 90.02%. The cost module was tested on fifteen school project's historical data, which were not used in the module development. The testing mean prediction error was 8.23% and the average accuracy was 91.77%, as shown in Table 7.19.

Table 7.18 : Adjusted and predicted cost of the training projects

Project No.	Adjucted Cost (£/m2)	Predicted Cost (£/m2)	Prediction Error %	Prediction Accurecy %
1	687.45	576.33	16.16	83.84
2	578.09	629.63	8.92	91.08
3	541.44	643.67	18.88	81.12
4	608.28	680.71	11.91	88.09
5	705.03	611.74	13.23	86.77
6	360.81	382.94	6.13	93.87
7	706.68	652.63	7.65	92.35
8	642.10	554.52	13.64	86.36
9	585.13	533.14	8.89	91.11
10	588.09	610.21	3.76	96.24
11	524.15	606.28	15.67	84.33
12	625.08	708.67	13.37	86.63
13	694.44	646.21	6.95	93.05
14	656.59	607.91	7.41	92.59
15	574.82	654.63	13.88	86.12
16	390.94	438.99	12.29	87.71
17	443.35	467.04	5.34	94.66
18	690.98	499.68	27.69	72.31
19	586.60	587.43	0.14	99.86
20	432.31	424.27	1.86	98.14
21	453.84	553.24	21.90	78.10
22	690.51	637.31	7.70	92.30
23	505.75	554.10	9.56	90.44
24	505.40	522.43	3.37	96.63
25	486.70	559.02	14.86	85.14
26	583.44	579.16	0.73	99.27
27	561.45	547.25	2.53	97.47
28	427.62	532.55	24.54	75.46
29	751.42	694.03	7.64	92.36
30	603.17	544.29	9.76	90.24
31	530.93	539.63	1.64	98.36
32	609.48	632.47	3.77	96.23
33	543.64	578.27	6.37	93.63
34	447.84	461.86	3.13	96.87
35	537.50	636.36	18.39	81.61
36	524.79	596.72	13.71	86.29
37	387.22	365.09	5.72	94.28
38	423.09	553.63	30.85	69.15
39	449.84	432.86	3.77	96.23
40	480.73	527.65	9.76	90.24
41	604.48	607.81	0.55	99.45
42	593.34	579.94	2.26	97.74
43	552.48	473.28	14.34	85.66
44	555.85	572.50	3.00	97.00
45	474.10	485.10	2.32	97.68
46	675.38	562.19	16.76	83.24
47	679.52	618.03	9.05	90.95
48	617.03	664.53	7.70	92.30
49	350.53	431.65	23.14	76.86
50	583.09	587.55	0.76	99.24
51	514.83	562.01	9.16	90.84
52	662.99	685.60	3.41	96.59
53	546.19	552.92	1.23	98.77
54	625.43	619.62	0.93	99.07
55	504.49	529.73	5.00	95.00
56	488.46	570.74	16.84	83.16
57	640.65	569.48	11.11	88.89
58	570.73	629.28	10.26	89.74
59	594.37	605.54	1.88	98.12
60	596.13	656.69	10.16	89.84
61	463.59	551.15	18.89	81.11
62	498.02	488.76	1.86	98.14
63	680.40	664.97	2.27	97.73
64	910.48	665.43	26.91	73.09
65	643.72	647.98	0.66	99.34
66	711.36	569.31	19.97	80.03
67	551.48	495.66	10.12	89.88
68	728.85	607.69	16.62	83.38
69	788.80	627.50	20.45	79.55
70	499.42	585.75	17.29	82.71
		Number of projects	**70**	**70**
		Mean	**9.98**	90.02
		Standard Deveation	7.53	**7.53**

Table 7.19: Construction cost module testing result.

Project No.	Adjusted Cost	Predicted Cost	Prediction Error %	Prediction Accuracy %
1	505.90	562.91	11.27	88.73
2	583.23	661.14	13.36	86.64
3	462.78	488.56	5.57	94.43
4	655.98	586.93	10.53	89.47
5	509.48	606.66	19.07	80.93
6	597.62	552.75	7.51	92.49
7	606.82	555.00	8.54	91.46
8	490.89	511.74	4.25	95.75
9	646.68	662.57	2.46	97.54
10	482.84	559.54	15.89	84.11
11	620.97	579.24	6.72	93.28
12	553.41	538.00	2.78	97.22
13	609.71	619.78	1.65	98.35
14	608.80	572.65	5.94	94.06
15	688.68	633.92	7.95	92.05
		Mean	**8.23**	**91.77**
		Standard Deviation	**5.03**	

7.8 Model Accuracy

The accuracy of cost prediction models has been a major concern and a subject of much scrutiny over the last three decades (Trost and Oberlender, 2003). Elhag and Boussabaine (1999) developed a tender price estimation model to predict the project tendering cost based on the historical data of 36 office buildings, extracted from BCIS. They found that the average percentage accuracy is 93.3%, using the regression analysis technique, and 90.9% using the neural network modelling technique. The testing sessions were done for 9 office buildings and the accuracy ranges between 86 - 96% for the neural network and between 81 - 99% for the regression model; this result was described in the paper as a high level of accuracy percentage. Another cost model was developed by Boussabaine and Elhag (1997) to predict cost and duration of construction projects based on the actual data of 12 projects from the BCIS database using Neurofuzzy modelling techniques. Seven post projects were used to test the model and the data of only three projects were shown; the cost prediction accuracy of these 3 projects was 89.7%, 86.8% and 92.9%, giving an average of 89.8%.

In another research paper, Elhag and Boussbaine (1998) developed two models using the Artificial Neural System for cost estimate on the data of 30 school projects extracted from BCIS. Model 1 comprises four cost-influencing factors as input attributes and model 2 consists of 13 input cost variables. The average accuracy achieved was 79.3% and 82.2% respectively. In a model developed by Emsley *et al* (2002) to predict the total construction cost, the average accuracy achieved was 83.4%, which was considered in the study as favourable compared with the average accuracy values of earlier cost prediction models, which were 79.2% and 74.1%.

Williams (2003) tested his cost model on 1108 projects and found that 68% of the projects' costs were predicted with an accuracy of 90% or more, while 32% of the projects were predicted with less than 90% accuracy. However, these models were used to predict the final cost using regression models to predict completed cost, which is different from the low bid for competitively bid highway projects. Furthermore, Chan and Park (2005) found that the average percentage error was about 13% in their predictive project cost model using principal component regression. Ling and Boo (2001) found that clients may take a calculated risk and not seek more funds, if the Quantity Surveyor estimates are higher than their budget by less than 10%.

The average accuracy of the model developed was 91.7%, which could be acceptable compared with the results of the models mentioned above. Figure 7.18 shows the predicted cost compared with the actual cost of the 15 school projects tested by the model, and it shows acceptability in most of the projects.

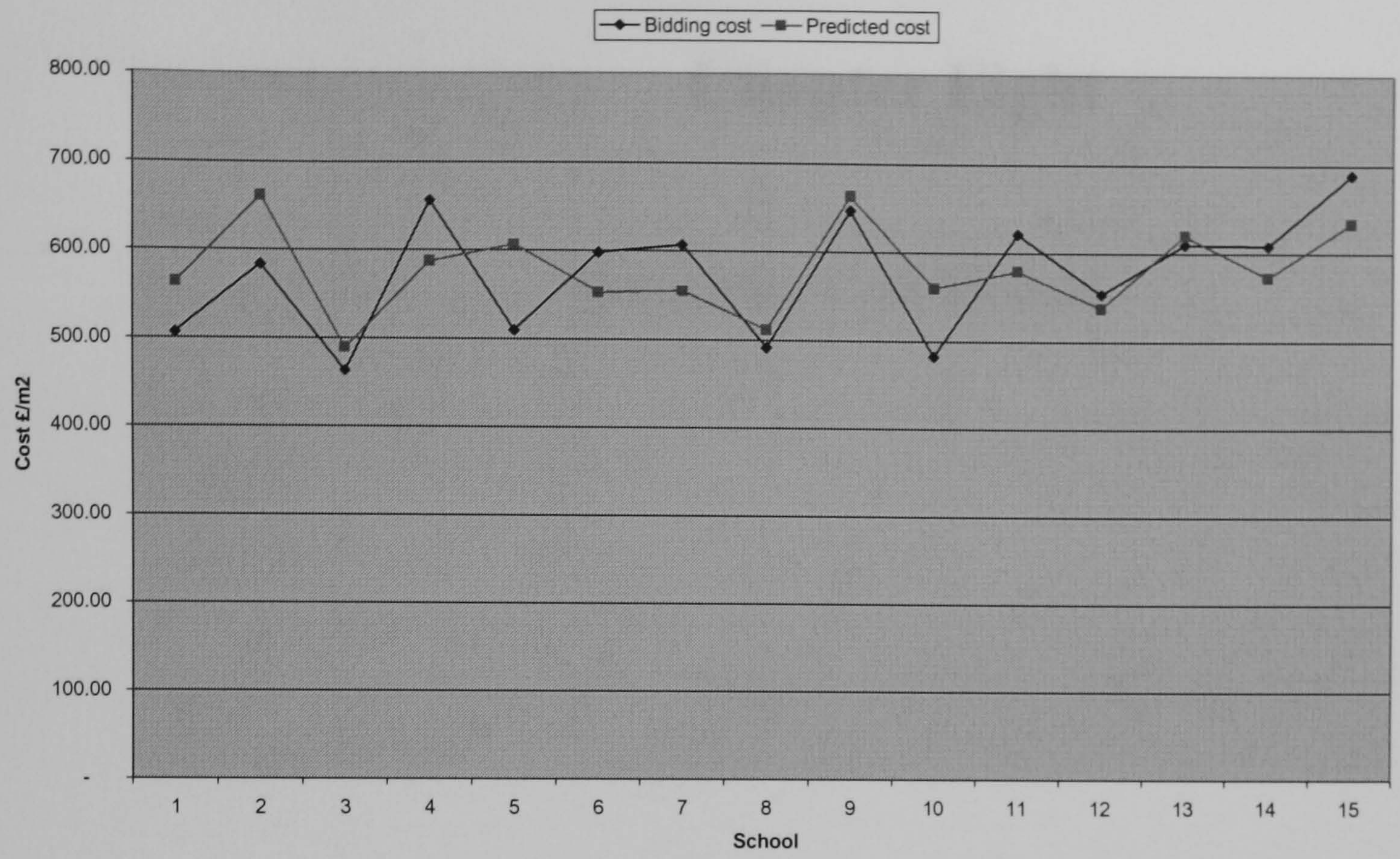


Figure 7.18: Predicted and actual cost of tested projects

7.9 Summary

The aim of this part of the research is to develop a model which could predict the cost of school projects in the early stages of the project, based on historical data collected from the BCIS database in order to integrate with other parts of the model, to giving the final product of the PFI financial model. A computer-based cost model was developed using regression analysis modelling techniques, with by the help of SPSS software and MS Excel, to predict the cost of new school buildings. The historical data of 85 school buildings was taken from the BCIS database, and processed to produce the prediction equation. The training results were 90.09% when the model was trained on the same data, and the testing result had a prediction accuracy of 91.77%. This module will be linked with the space planning and the FM cost and cash flow modules toward the final PFI financial model.

Chapter Eight

Occupancy Cost Module

8 Occupancy Cost Module

8.1 Introduction

The private sector in PFI projects is responsible for providing the committed services along the project duration. Facilities should be kept in good condition to provide these services with minimum cost and at required level of efficiency. The cost of running the facilities and keeping them healthy significantly affects the total project cost because it represents the major part of it. Whole Life Cycle Cost (WLCC) is widely used in most if not all PFI projects. In fact, these techniques, although known since the 1960s, were developed and enhanced with the PFI procurement applications. This chapter highlights the concept of WLCC and its associated definitions; it reviews the available models and their use, and describes the difficulties of obtaining data. Then it describes the proposed data entry and its practicality for this research.

8.2 Occupancy and LCC Costing

The cost of PFI should cover the total cost of the project from the inception stage to the end of the contract requirements. These costs include occupancy costs, and the cost needed to keep the building running as well as the cost of maintenance and replacement. In order to develop a financial model for PFI projects, LCC and FM costs should be taken into consideration; this represents the major part of the cost over the life cycle of the building. Figure 8.1 shows the position of the FM cost module within the proposed PFI project financial management model, and also where the data for this module is to be collected from; how it works will be demonstrated later.

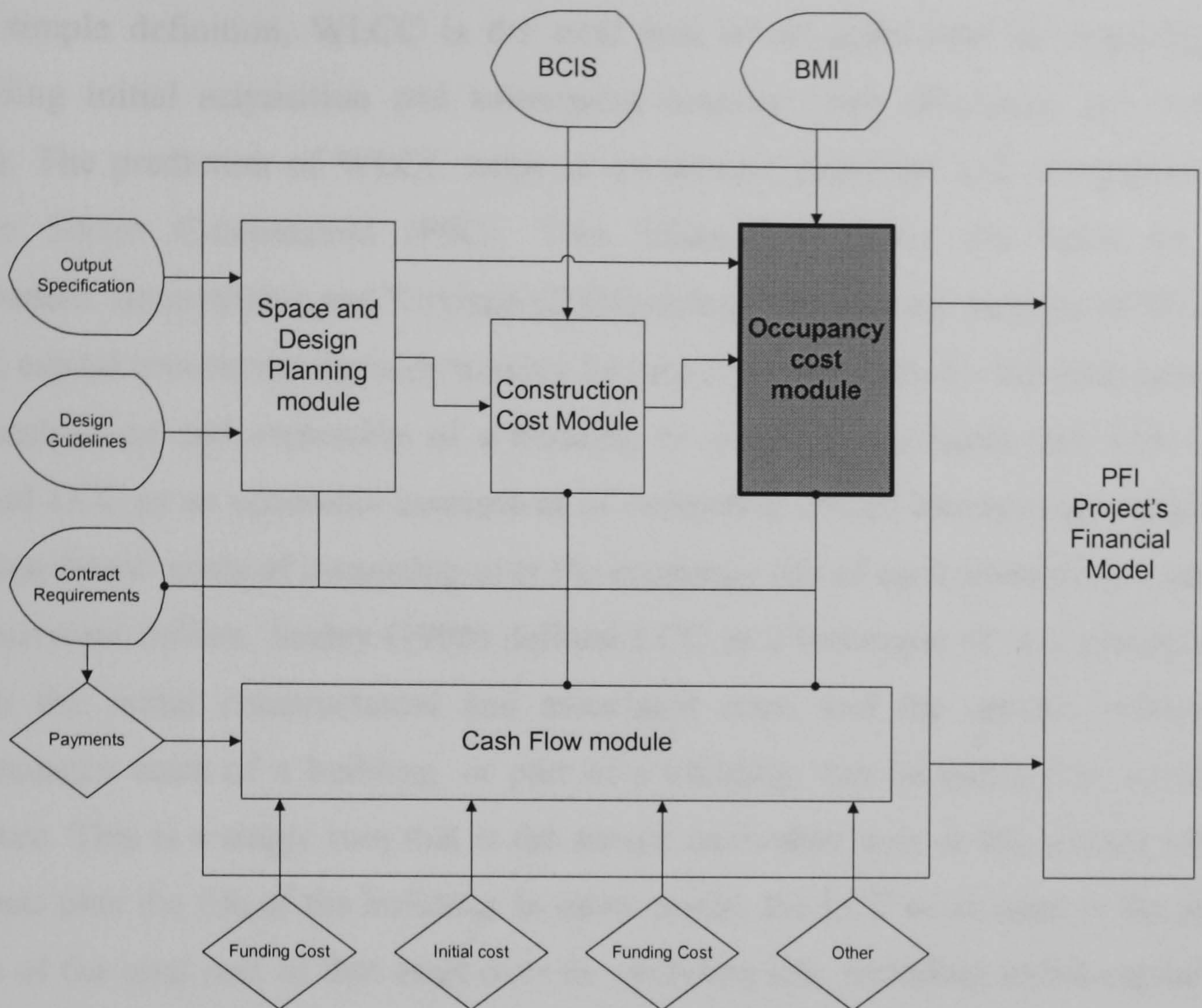


Figure 8.1: Occupancy cost module position within the PFI Financial Management Model

8.3 Searching for Definition

The building investment decision should be based on the whole life cycle cost of the building. Until the mid 1960s, many developers continued to make investment decisions purely on the basis of capital cost (Al-Hajj and Horner, 1998). Whole Life Cycle Costs (WLCC) of a facility are the costs of acquiring it (including consultancy, design and construction costs, and equipment), the costs of operating it and the cost of maintaining it over its whole life through to its disposal. These costs include internal resources and departmental overheads, where relevant; they also include risk allowances as required, flexibility (predicted alterations for known changes in business requirements, for example), refurbishment costs and the costs relating to sustainability and health and safety aspects (OGC, 2003).

In a simple definition, WLCC is the total cost of an asset over its operating life, including initial acquisition and subsequent running costs (Flanagan and Norman, 1983). The prediction of WLCC helps in investment decisions and comparison with Public Sector Comparators (PSC). This information forms the basis for VfM assessment. Boussabaine and Kirkham (2004) defined the primary purpose of WLCC as to aid capital investment decision making by providing forecasts for the long-term costs of construction and ownership of a building or structure. Dell'isola and Kirk (1983) defined LCC as an economic assessment of competing design alternatives, considering all 'significant' costs of ownership over the economic life of each alternative, expressed in equivalent dollars. Seeley (1996) defined LCC as a technique of cost prediction by which the initial constructional and associated costs and the annual running and maintenance costs of a building, or part of a building, can be reduced to a common measure. This is a single sum that is the annual equivalent cost or the present value of all costs over the life of the building. In other words, the LCC of an asset is the present value of the total cost of that asset over its operating life, including initial capital cost, occupation costs, operating costs and the cost or benefit of the eventual disposal of the asset at the end of its life (RICS, 1999).

Operating costs include estimates of rent, rates, energy costs, cleaning costs, building-related staffing costs and other costs (RICS, 2006). It is the cost associated with operating the building itself (RICS, 1986), while the maintenance costs are the cost of keeping the building in good repair and working condition; this includes painting, decorating, repairs, and renewals (Al-Hajj and Horner, 1998).

Occupancy costs are the cost of performing the function for which the building is intended. They are distinguished from operation costs, as they relate to the costs attributable to a specific process undertaken by the client, which may change within the life of the building (RICS, 2006). According to Kahn (1999), the narrowest definition of occupancy cost is that they constitute all direct rental and operating expenses for a real estate obligation. Boussabaine and Kirkham (2004) stated that the total occupancy costs projection is a quantification and presentation of the monetary resources required for running an occupied facility efficiently and effectively.

Facilities Management (FM) is a relatively new profession; it is responsible for co-ordinating all efforts related to planning, designing and managing buildings and their systems, equipment and furniture to enhance the organisation's ability to compete successfully in a rapidly changing world (Becker, 1990). The British Institute of Facilities Management (BIFM, 2006) defined FM as the integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities.

According to Flanagan and Norman's (1983) definition of LCC, running costs are any other cost included in the LCC, spaced out from initial acquisition cost. Many terminologies are used in literature to describe this cost: operating cost, maintenance cost, running cost, occupancy cost, maintenance and operation cost and facilities management cost.

In their study on developing a framework for whole-of-life costing in NHS estates, Kirkham and Boussabaine (2000) reported that there is still no real credible standard or accepted definition in place. They added that the interpretation of what would come under a WLC assessment varies between groups and individuals, and this is probably why WLC is still viewed with certain mistrust.

8.4 Cost Breakdown Structure (CBS) for LCC

The Occupancy cost and WLCC were calculated in two different studies using the same method, calculating the cost on a yearly basis for the life of the building. The two studies used the same elements of the cost but used different headings and titles. The first study is a BMI (1999) Special report about occupancy costs of school buildings. It divided the cost into eight main categories which were used in the BMI financial statement to collect data in accordance with the Standard Form of Property Occupancy Cost Analysis (RICS, 1984). The eight categories are:

- Decoration: External and Internal.
- Fabric: External walls, roofs, fittings and fixtures, internal finishes, and other structural items such as substructures, frame, upper floors, stairs, internal walls, windows and external doors, and internal doors.
- Services: Plumbing and internal drainage, heating and ventilating, lifts and escalators, electric power and lighting, and other M and E services.
- Cleaning: Windows, external surfaces, internal.
- Utilities: Gas, electricity, fuel oil, solid fuel, water rates, effluents and drainage charges.
- Administrative costs: Services attendants, laundry, porterage, security, rubbish disposal, property management.
- Overheads: Property insurance, rates.
- External works: Repairs and decoration, external services, cleaning, gardening.

The cost in the BMI study was calculated for 20 years using a table showing the cost of each item on the year required. Most of the costs were similar for the twenty years; these include utilities cost, administration cost, cleaning cost and overheads. This study was conducted on a complete design and bills of quantities for two school projects. Categories classification was found in RICS (2003), where the occupancy costs of two university teaching blocks were published. Items were listed according to the BMI cost elements of occupancy cost. There was no identification of facilities management items and life cycle items; all item were listed as occupancy cost items. Splitting the costs yearly on the items was found to be not typical in some items. This raises a question on the basis of splitting the cost of an occupancy item for the life of the project, which could last up to 60 years. Costs were shown on the report date's prices, with no changes over the future years, and the sum of the cost was the basis of comparison and analysis.

The second study, which was conducted by Exemplar Designs for DfES, calculated the occupancy costs in the reports prepared by consultants for the ten exemplar designs. The report prepared by the Buildings Design Partnership (BDP, 2003), for example, classified the whole life cost in three categories:

- Initial capital costs: construction cost including fees, abnormal including fees, and loose furniture and equipment plus fees.
- Life cycle capital costs: maintenance and repair of substructure, superstructure, internal finishes, fixtures (fixed furniture and equipment), M and E services, ICT cabling, external works, loose furniture and equipment, internal adaptations, ICT equipment.
- Facilities Management costs: building maintenance, responsive repairs, cleaning and refuse collection, catering, caretaking /security, grounds maintenance, ICT network management, energy, water, insurance, rates.

This classification of items seems to be practical since it disconnects the items of LCC and FM, given the difference between the definition of LCC or WLCC. This classification matches with the interviewee's point of view about the perception on LCC and FM. They claimed that LCC is about replacements, while FM is about managing the building. This classification is also different from the break down structure which was given by RICS (1999) for LCC. This breakdown was categorised as follows:

- Capital/initial costs: Land, fees and acquisition, construction cost, taxes, finance for land purchase and construction, loan charges.
- Operation costs: Energy, cleaning, insurance, security and health, manpower, land charges, equipment associated with occupier's occupation.
- Maintenance costs: Main structure, external decorations, internal decorations, finishes, fixtures and fittings, plumbing and sanitary services, heat source, ventilation and air treatment system, electrical instillations, gas instillations, lift and conveyor system, external works.
- Occupancy cost: Client occupancy costs.
- Residual values: Resale value, demolition and site clearance, renovation / refurbishment cost.

8.5 LCC Modelling Techniques

Several mathematical modelling techniques are available for calculating the LCC cost in building investments. Boussabaine and Kirkham (2004) and Kishk *et al.* (2003) listed many mathematical equations used to calculate the whole life cost by applying the different investment decision-making methods, such as Present Worth, Net Present Value, Discounted Payback Period, Internal Rate of Return, and others. These models employ mostly the NPV (Boussabaine and Kirkham, 2004). The WLC decision-making exercise can be done at any stage of the project. However, it is most beneficial during the early design stage (Kishk, 2005). Equation 8.1 below is an example of these mathematical models. It is the NPV of an alternative (i), which is defined as the sum of money that needs to be invested today to meet all future financial requirements as they arise throughout the life of the project (Kishk *et al.*, 2003).

$$NPV_i = C_{0i} + \sum_{t=1}^{T} {}^{d}O_{it} + \sum_{t=1}^{T} {}^{d}M_{it} - {}^{d}SAV_i$$ Equation 8.1

Where

C_{0i}	=	the initial construction of alternative i
$\sum_{t=1}^{T} {}^{d}O_{it}$	=	the sum of discounted operation costs at time t
$\sum_{t=1}^{T} {}^{d}M_{it}$	=	the sum of discounted maintenance costs at time t
${}^{d}SAV_{i}$	=	the discounted salvage value = ${}^{d}RV_{iT} - {}^{d}DC_{iT}$
${}^{d}RV_{iT}$	=	the discounted resale value at the end of analysis period
${}^{d}DC_{iT}$	=	the discounted disposal costs
T	=	the analysis period in years

The other example of a mathematical model, Equation 8.2, is given to calculate the NPV of the life cycle cost of the building if the required data listed in the model is provided. This model was developed by the American Society for Testing and Material (ASTM).

$$NPV = C + R - S + A + M + E \qquad \text{Equation 8.2}$$

Where

C	=	investment cost
R	=	replacement costs
S	=	the resale value at end of study period

A = annually recurring operating, maintenance and repair costs (except energy costs)

M = non- annually recurring operating, maintenance and repair costs (except energy costs)

E = energy costs

The LCC mathematical models are mostly simple to apply, although Kishk *et al.* (2003) stated that their accuracy lies outside the expected range. This could be because the mathematical equation relies on variables that require judgement which could be the source of inaccuracy.

There are many computer-based models listed by Kishk *et al.* (Kishk *et al.*, 2003) for the calculation of LCC and comparisons of alternative options. Two of these software packages were reviewed for this research. The first one is internet-based software which is provided by ampsol ltd. to estimate the costs over the life of the equipment, taking into consideration the purchase price, running costs, and overheads. The model requires the user to enter the capital cost of the item of plant in the set-up cost, yearly consumable cost, yearly maintenance cost, refurbishment cost and its interval, and occasional cost and its interval. Inflation rate per annum should also be considered for each cost element. The analysis period (project duration) and discount rate should then form the basis for the NPV of the LCC cost. The result appears in a graph format in a small window in the screen of the trial version. Figure 8.2 shows the model result according to the assumed data entered.

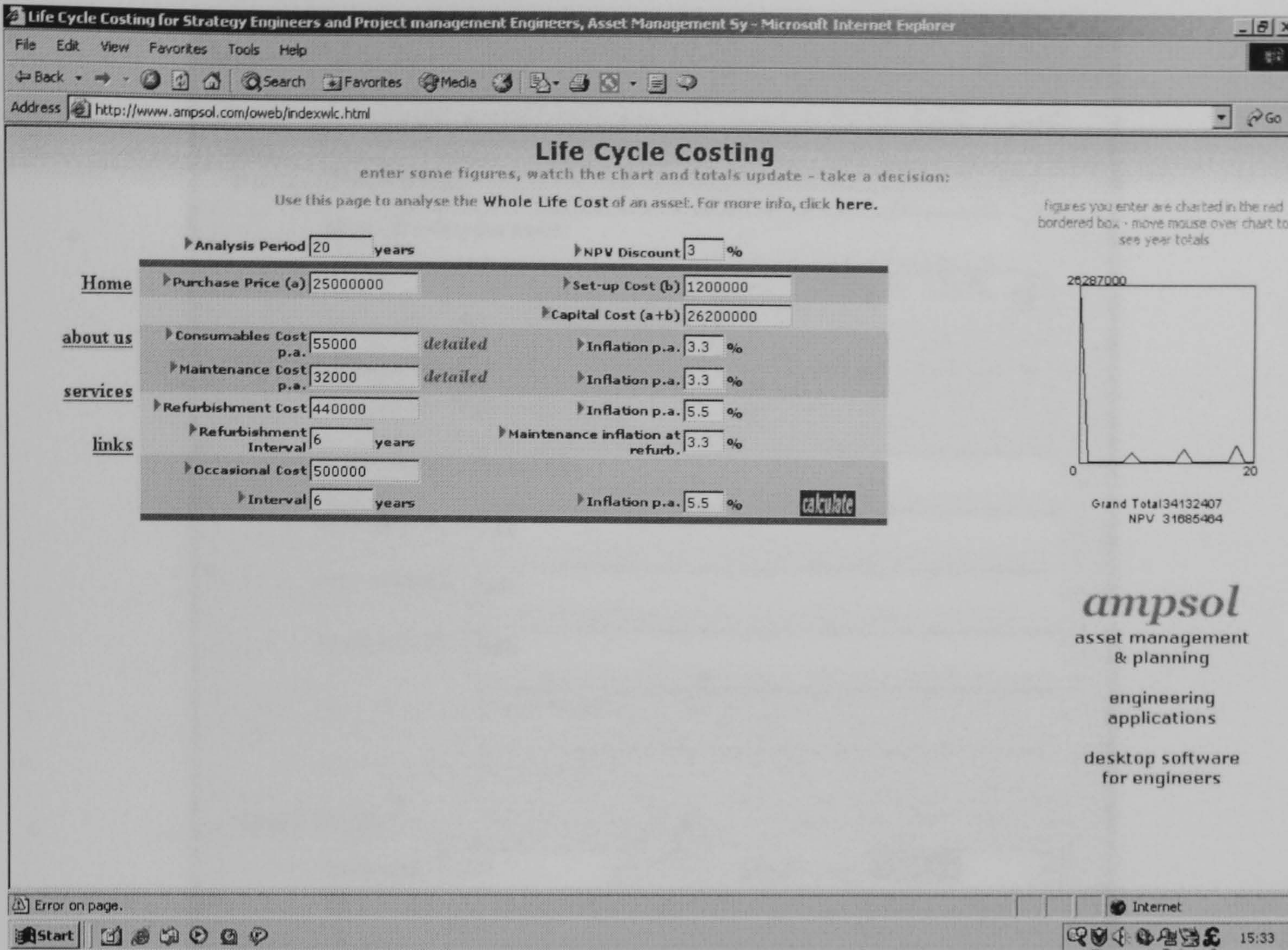


Figure 8.2: ampsol LCC model

The second model was developed by the National Institute of Standard Technology (NIST) to assess the WLCC of bridges. This model was downloaded from the NIST website (http://www.bfrl.nist.gov/bridgelcc on 02/02/2005). The model allows the user to compare the LCC between a number of alternatives. Its use is easy and clear. The new project wizard allows the user, in the first step, to define the project, alternatives, and dates. It also allows for the setting of inflation and discount rates, as shown in Fig. 8.3. The second step is to define physical elements in the structure, and step three is to define the classifying and quantifying dimensions of each structure alternative. The last step is to determine the input optional cost and service life data. The cost data entry includes construction cost, operation, maintenance and repair costs, years between repairs, and the disposal cost. The model calculates the PV of LCC cost of each alternative as shown in Fig. 8.4.

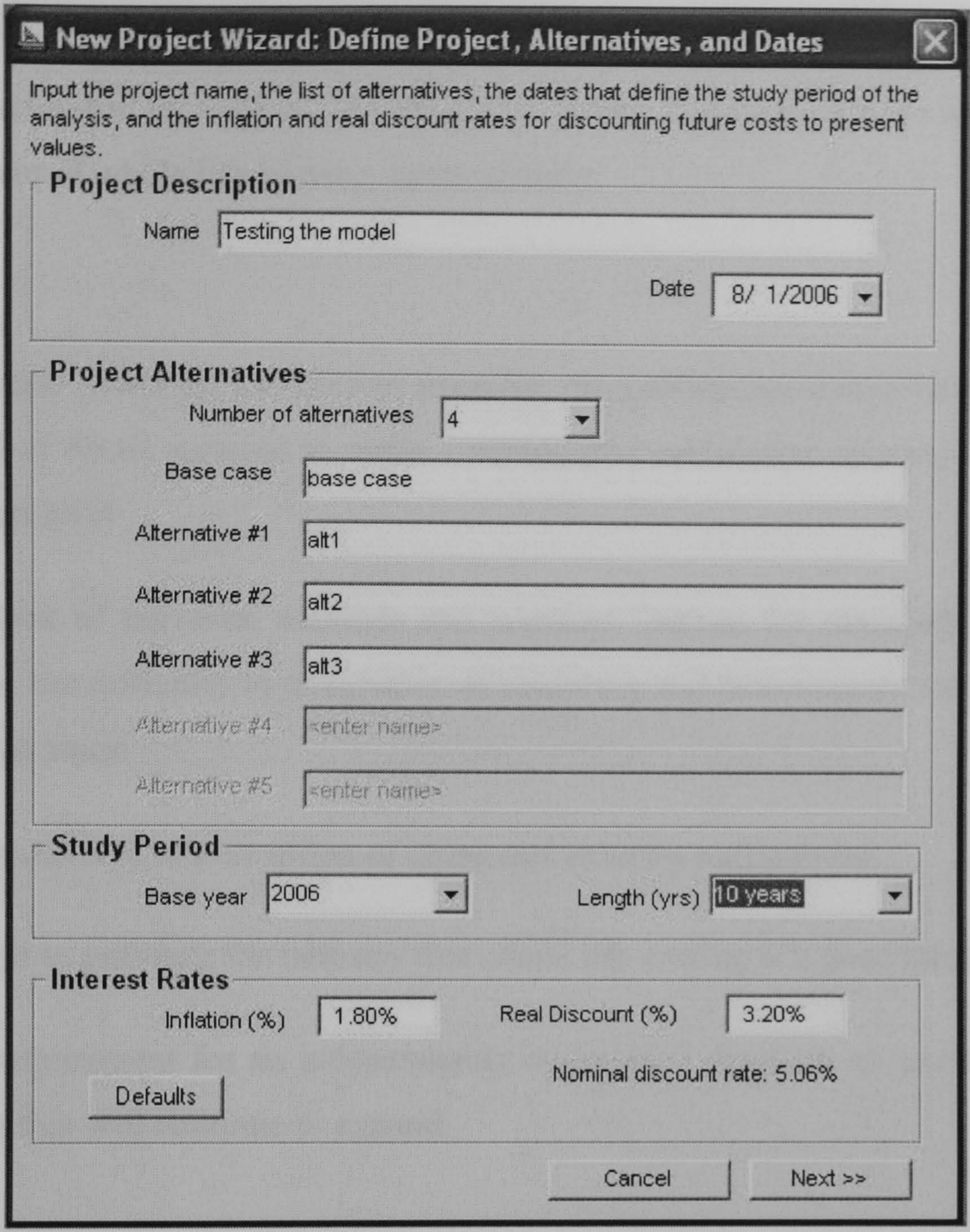


Figure 8.3: Bridge LCC model data entry.

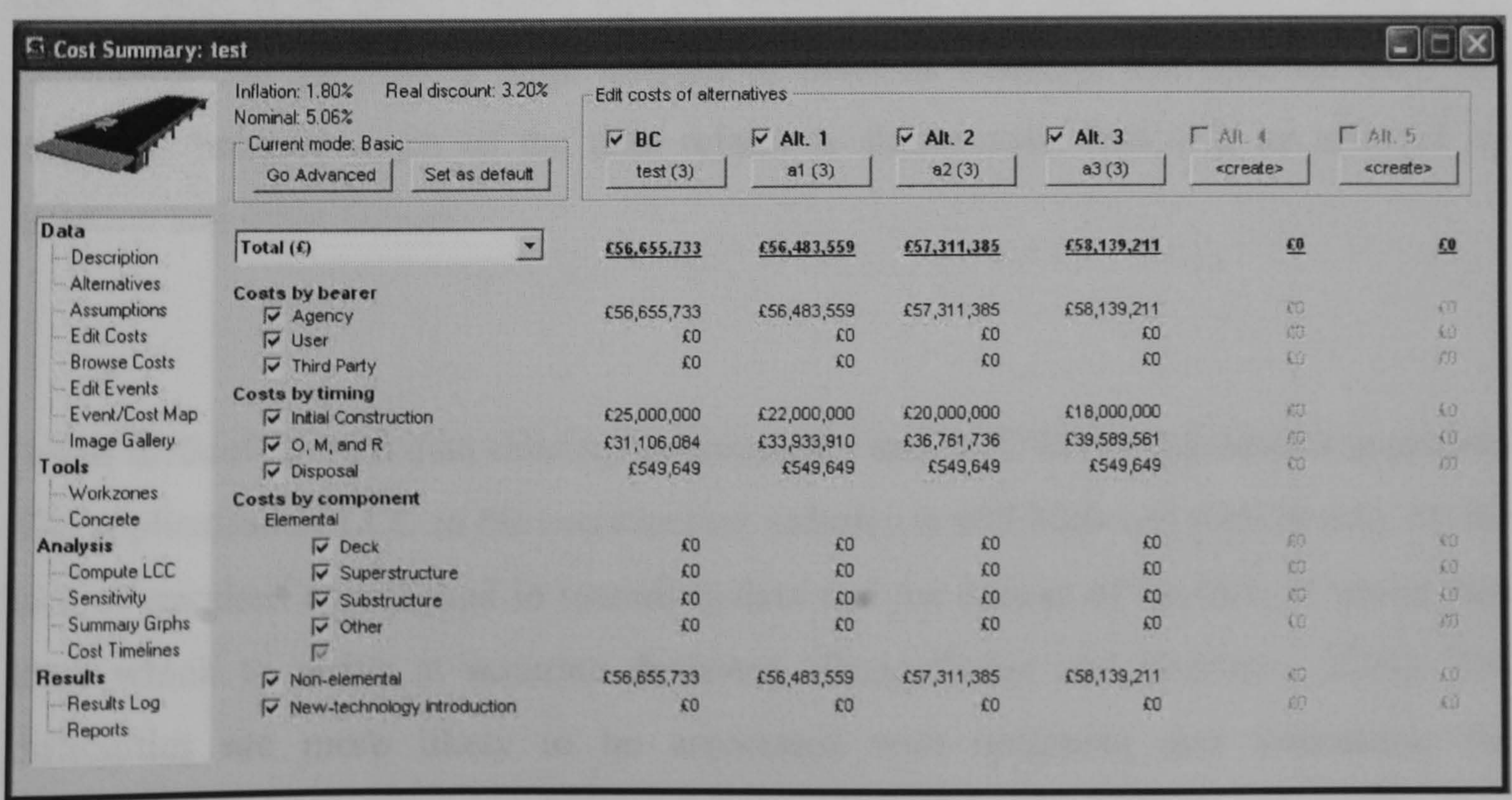


Figure 8.4: Bridge LCC model report

8.6 LCC and Data Sources

In a report published by BRE (Clift and Bourk, 1999), five barriers were identified with the assessment of whole life costing; these include:

- the scale of the data collection exercise, inconsistencies across data sets and the level of detail required to make a meaningful calculation of whole life costs at design level
- the lack of universal methods and standard formats for calculating whole life costs, the difficulty in integration of operating and maintenance strategies at the design phase
- a general lack of perception of client and industry pull/interest
- a need to persuade the industry that whole life costing is a good thing
- the requirement for an independently maintained database on performance and costs that will continue to expand.

There are some problems associated with historical data for occupancy and maintenance costs. Aouad *et al.* (2001) stated that the examination of a range of options using LCC techniques can generate a large amount of detailed working, and data for LCC are uncertain because much of the data relates to future costs that will be affected by inflation and other factors.

It was difficult to find data relating to occupancy and LCC in the appropriate approach. The application of LCC in the construction industry is still hindered significantly by the lack of standard approached in recording data and the excuse of the lack of sound data from which to arrive at accurate decisions (Boussabaine and Kirkham, 2004). The difficulties are more likely to be associated with obtaining and forecasting the operational and maintenance elements of the asset life cycle (Woodward, 1997). BMI

(2002) stated that the only accurate way to forecast maintenance expenditure on a particular building over a particular period is to carry out a detailed condition survey and prepare a detailed maintenance cost plan for the remaining life of the building. This means that the most significant LCC estimation method is to list all the item tables similar to a bill of quantities, and to cost them according to their individual quantity and specification. This method was reported by Dell'isola and Kirk (1983) in their book 'Life Cycle Cost Data', which contains a detailed actual example of LCC project information, arranged in a tabular form. Table 8.1 shows the format of the information with an explanation of the various categories, and Table 8.2 shows the table with information provided by the authors as the building LCC data. A complete design should be taken as the basis for such a study; the same concept also advocated on the example shown by BMI for the university blokes mentioned earlier.

Table 8.1: LCC documentation sheet. (Source: Dell'isola and Kirk, 1983)

Item description	Unit of measure	Maintenance description	Maintenance annual cost, $			Energy demand (EU)	Replacement life, yrs	% Replaced
			Labor	Material	Equipment			
Used to document UNIFORMAT category and describe specific facility items analyzed.	Given for each task.	Used to describe specific maintenance tasks and corresponding labor performance standard(s).	1	2	3	4	5	6

1. Used to convert labor hours into annual costs.
2. Used to convert material requirements into annual costs.
3. Used to convert maintenance equipment into annual costs.
4. Used to record energy consumption requirements for the facility items.
5. Used to document replacement life of significant components of facility items.
6. Used to estimate percent of facility item cost replaced at the year specified (see Replacement life).

Table 8.2: Life cycle data example (Source: Dell'isola and Kirk, 1983)

LIFE CYCLE DATA (*continued*)

Item description	Unit of measure	Maintenance description	Maintenance annual cost, $			Energy demand (EU)	Replacement life, yrs	% Replaced
			Labor	Material	Equipment			
Copper, type K, including fittings and supports, ½–2-in sizes	1000 LF	Maintenance and repair as required (0.01 MH/yr)	0.15	0.01	0.01	N/A	35	30
Copper, type L, including fittings and supports, ¾–3-in sizes	1000 LF	Maintenance and repair as required (0.01 MH/yr)	0.15	0.01	0.01	N/A	35	30
VALVES								
Bronze gate valves, ½–1-in sizes	EA	Maintenance and repair as required (0.1 MH/yr)	1.5	0.5	0.1	N/A	15	50
Iron body, bronze mounted gate valves, 6-in size	EA	Maintenance and repair as required (2.0 MH/yr)	30.0	4.0	1.0	N/A	15	50
Brass tee and lever handle type, ½–¾-in sizes	EA	Maintenance and repair as required (0.1 MH/yr)	1.5	0.25	0.05	N/A	15	100
Hose gate drain valves, bronze 2-in size	EA	Maintenance and repair as required (0.5 MH/yr)	7.5	1.0	0.10	N/A	15	100

Building Maintenance Information (BMI), which is a service of the RICS Building Cost Information Services Ltd., publishes periodical reports for occupancy and maintenance cost. These reports vary in their aims and range of information. BMI (2002), for example, gives estimates for the cost of maintaining a range of common building types, while BMI (2003) gives the estimates of the occupancy costs for a range of common building types. The figures are average annual costs for a typical building of each type (see Table 8.3). Detailed prices of labour, material and equipments could be found from the construction cost indices. The BMI building maintenance price book (BMI, 2005) is a price index for maintenance works. It is published annually and gives the detailed prices that could be used when budgeting and programming maintenance works.

Table 8.3: Primary schools - Summary and estimate of annual cost (Source: BMI, 2003)

3Q02

Source \ Element	Cleaning	Utilities	Adminstrative costs	Total
Audit Commission - Primary schools	716.00	797.00		
DfES - Primary schools		234.00		
DETR - Primary schools		209.00		
BMI SR 283 - Primary schools	1,278.00	444.00	1,316.00	3,038.00
BMI SR 146 - Schools		608.00	1,887.00	2,495.00
BMI Estimate	**£1,150.00**	**£550.00**	**£1,500.00**	**£3,200.00**

8.7 Proposed Data Entry

Aouad *et al.* (2001) reported that dependence on many different factors (that in many cases are complex and difficult to quantify) is one of the main problems of using LCC data. This makes the selection of which format the model should be based on not only difficult but also problematic. However, the clear scope of the requirements to be fulfilled may help in deciding the appropriate format. What is needed in this module is the cost of running the facility, in other words, the life cycle total present cost excluding the capital cost. This includes the FM cost, as well as the LCC of the elements, equipments and assets that the building includes. The format used by the report of the cost of the exemplar school design fits these requirements, and therefore it is the one that will be used in categorising the occupancy cost module.

The method on which the data entry is decided in the following module is based on the need for detailed information of the annual expenditure for all major items of LCC and FM. The cost elements were developed from the format used to calculate the LCC and FM cost in the reports of the ten exemplar designs. The reason behind selecting this format is its approval from the DfES, for whom these reports have been prepared. It was applied on schools with similar criteria to the application data of this model. These exemplar designs were prepared for use as the best examples of the outcome of PFI projects and what this type of procurement can offer for school facilities. Another reason was its practicality and simplicity according to the definitions of LCC, FM and occupancy costs.

The Cost Breakdown Structure (CBS) as shown in Table 8.4 was divided into two main categories, Life Cycle cost and Facilities Management cost; then each category was divided into different elements, which represent the total cost of some other sub-elements — examples of sub-elements are shown for substructure, internal finishes, external works and services. This categorisation was conducted in the cost analysis of the exemplar school designs that were prepared for DfES (DfES, 2005).

Table 8.4: LCC and FM cost elements

Category	Elements	sub-elements
Life cycle capital cost	substructure	
	Superstructure	structure, roofing, external walls, windows and external doors, internal walls, internal doors
	Internal finishes	wall finishes, floor finishes, ceiling finishes
	Fixtures, fixed furniture and equipments	
	M&E services	sanitary appliances, disposal installations, water installations, heating & ventilation, electrical, gas installations, lifts, fire & security alarms, voice & data cabling
	External works	car park surfacing & paving, soft landscaping, external CCTV system, external lighting, drainage, external services
	Loose furniture and equipments	
	Internal adaptations	
	ICT equipment	
Facilities management cost	Building maintenance	
	Responsive repairs	
	Cleaning and refuse collection	
	Catering	
	Caretaking / security	
	Grounds maintenance	
	ICT network management	
	Energy	
	Water	
	Insurance	
	Rates	

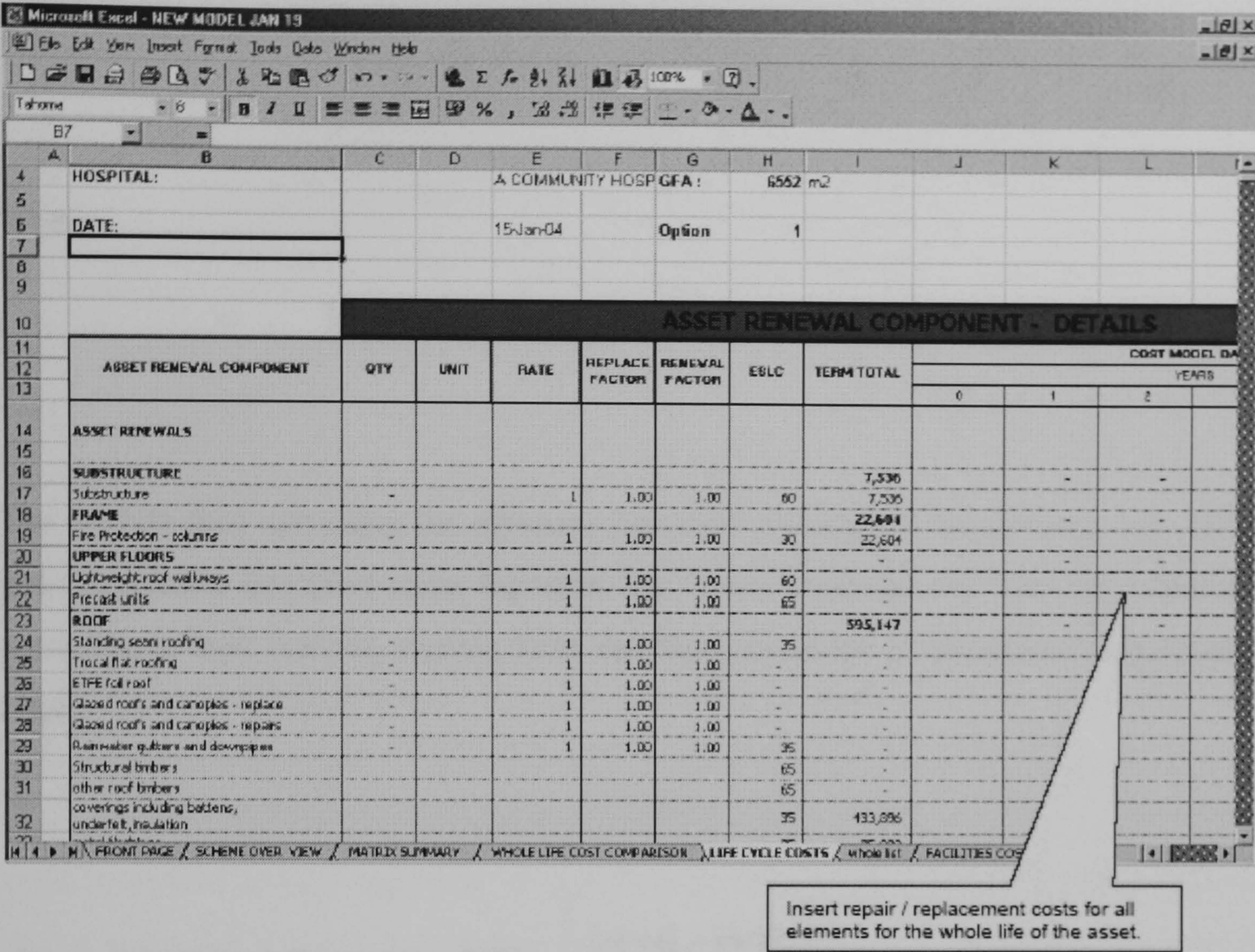


Figure 8.5: Welsh Health Estates LCC model (Source: NHS, 2004)

The user is given the flexibility to enter the cost of all elements of the LCC and FM costs. This way of entering data was found in an LCC model for NHS facilities published by Welsh Health Estates (NHS, 2004); an example of data entry of this model is shown in Figure 8.5.

The user is given the flexibility to enter the present worth cost of all elements of the LCC costs with the interval (frequency) of each item are shown in Table 8.5 for the LCC elements and Table 8.6 for FM elements. The user also is required to define the interval of cost of each LCC element. The interval of the FM elements is yearly. The module will calculate the interest rate based on the interval and the interest rate defined by the agreement according to Equation 8.3.

$$Interest\ (Int) = (1+i)^{interval-1}$$ Equation 8.3

Where

i = Interest rate defined by the contract agreement

The module then calculates the expenses per interval based on the element cost (*EPW*) and the interest rate (*Int*) using Equation 8.4. These expenses will then be distributed according to their interval, starting from the commencement of the project's operational stage.

$$Elemental\ Annual\ Expenses = EPW \times \left(\frac{Int \times (1+Int)^{\frac{n}{Interval}}}{(1+Int)^{\frac{n}{Interval}} - 1} \right)$$ Equation 8.4

Where EPW = Element Present Worth cost

Int = Interest rate calculated using Equation 8.3

n = Project duration

Table 8.5: LCC user data entry.

Element	Total cost	Interval
Substructure	?	?
Superstructure	?	?
Internal finishes		?
Fixture, fixed furniture and equipment		
M & E services		
ICT cabling		
Loose furniture and equipment		
Internal adaptations		
ICT requirement		

Table 8.6: FM user data entry.

Element	Total cost	Interval
Building maintenance	?	1
Responsive repairs	?	1
Cleaning and reuse collection	?	1
Catering		1
Caretaking / security		1
Grounds maintenance		1
ICT Network management		1
Energy		1
Water		1
Insurance		1
Rates		1

The outcome report will be detailed in a table showing the cost year by year for the project duration and total cost, which is the sum of the cost over the project duration. Table 8.7 shows the LCC cost distributed to the project duration for each element. Table 8.8 shows the FM cost distributed to the project duration for each element of FM. The annual total cost of LCC and FM elements will be transferred to the cash flow module. The total element present worth cost data entered is an estimation of a cost plan for a primary school in the exemplar school design report.

8.8 Summary

The aim of this part of the research is to develop a module to calculate and help in spreading the occupancy cost over the project duration. This is needed for the project cost, since it represents the major part of the PFI project, and the cash flow of the project since the ongoing cost of occupancy expenditure needs to be known. The obvious problem was in determining the right term to describe the building post-construction cost and selecting the format and source of data needed for obtaining the cost in the early stage of the project.

The user is given the flexibility to enter the cost of each main element and its frequency over the project life. Then the module will calculate the cost per interval and spread it over the project duration according to the intervals. This cost distribution will be used in the next chapter (Cash Flow Model) with other costs for determining the cash flow behaviour and calculating the NPV of the total project cost.

Table 8.7: LCC elemental cost

		Project duration	26.25 year			Interest rate	6%				Total LCC
	Substructure	Superstructure	Internal finishes	Fixtures, Fixed furniture and Equipment	M&E Services	ICT Cabling	External Works	Loose Furniture and Equipment	Internal Adaptations	ICT Equipment	yearly cost
Total cost	0	90,000	65,000	43,000	10,000	0	20,050	38,500	39,700	0	
Interval	0	5	3	2	2	0	3	2	3	0	
Interest	0.0000	0.3382	0.1910	0.1236	0.1236	0.0000	0.1910	0.1236	0.1910	0.0000	
Expenses		39,687	15,664	6,812	1,584		4,832	6,099	9,567		
0		0	0	0	0		0	0	0	0	0
1		0	0	0	0		0	0	0	0	0
2		0	0	1,703	396		0	1,525	0	0	3,624
3		0	15,664	0	0		4,832	0	9,567	0	30,063
4		0	0	6,812	1,584		0	6,099	0	0	14,495
5		39,687	0	0	0		0	0	0	0	39,687
6		0	15,664	6,812	1,584		4,832	6,099	9,567	0	44,558
7		0	0	0	0		0	0	0	0	0
8		0	0	6,812	1,584		0	6,099	0	0	14,495
9		0	15,664	0	0		4,832	0	9,567	0	30,063
10		39,687	0	6,812	1,584		0	6,099	0	0	54,182
11		0	0	0	0		0	0	0	0	0
12		0	15,664	6,812	1,584		4,832	6,099	9,567	0	44,558
13		0	0	0	0		0	0	0	0	0
14		0	0	6,812	1,584		0	6,099	0	0	14,495
15		39,687	15,664	0	0		4,832	0	9,567	0	69,750
16		0	0	6,812	1,584		0	6,099	0	0	14,495
17		0	0	0	0		0	0	0	0	0
18		0	15,664	6,812	1,584		4,832	6,099	9,567	0	44,558
19		0	0	0	0		0	0	0	0	0
20		39,687	0	6,812	1,584		0	6,099	0	0	54,182
21		0	15,664	0	0		4,832	0	9,567	0	30,063
22		0	0	6,812	1,584		0	6,099	0	0	14,495
23		0	0	0	0		0	0	0	0	0
24		0	15,664	6,812	1,584		4,832	6,099	9,567	0	44,558
25		39,687	0	0	0		0	0	0	0	39,687
26		0	0	6,812	1,584		0	6,099	0	0	14,495
27		0	11,748	0	0		3,624	0	7,175	0	22,547

Table 8.8: FM elemental cost.

	Building Maintenance	Responsive Repairs	Cleaning and Reuse collection	Catering	Caretaking/Security	Grounds Maintenance	ICT Network Management	Energy	Water	Insurance	Rates	Total FM expenses
		Project duration	26.25 year			Interest rate	6%					
Total cost	22,350	41,400	105,200	0	136,400	14,950	0	49,900	14,950	31,000	34,200	
Interval	1	1	1	1	1	1	1	1	1	1	1	
Interest	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	
Expenses	1,719	3,184	8,090		10,490	1,150		3,838	1,150	2,384	2,630	
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0
2	430	796	2,023	0	2,622	287	0	959	287	596	658	8,658
3	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
4	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
5	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
6	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
7	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
8	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
9	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
10	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
11	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
12	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
13	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
14	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
15	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
16	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
17	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
18	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
19	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
20	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
21	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
22	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
23	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
24	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
25	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
26	1,719	3,184	8,090	0	10,490	1,150	0	3,838	1,150	2,384	2,630	34,635
27	1,289	2,388	6,068	0	7,867	862	0	2,878	862	1,788	1,973	25,975

Chapter Nine

Cash Flow Module

9 PFI Cash Flow Model

9.1 Introduction

The previous chapters discussed the development of modules of space planning, construction cost, and occupancy cost of a school facility. The outcomes of these modules form the basis for calculating the cash flow of the project. One of the main aims of this research is to develop a model that will predict the cash flow profile of the project at the early stage of the procurement process.

The concept and development of cash flow modelling were discussed in Chapters Three and Five. This chapter highlights the process and components of the proposed cash flow model developed through this research. It describes the inputs and outputs, and shows the results of the overall PFI financial model and how they relate to the project decision-making process. The model mechanism and how these issues are processed are described wherever required.

9.2 The Cash Flow Module

The cash flow module position within the PFI financial model is the final stage of information flow from the construction and occupancy cost modules, in addition to the pre-construction cost. Inflation rate is applied in this stage to all out and in cash flows; also values are discounted where that is needed. Cost of capital was calculated based on the deficit coverage through the project duration. Investment growth is calculated in amount and ratio with other investment and profitability assessment ratios, such as NPV, IRR, and payback period. The unitary payment and Debt Service Coverage Ratio were calculated as well.

Relationships of all modules and the detailed input and output items are shown in the model structure (concept) in Fig. 9.1 below. The figure shows the major modules, and the relationship between modules, inputs, and outputs. It gives an overall description of the PFI Financial Model, which is intended to be not only structured as a concept but also developed in a computer-based environment.

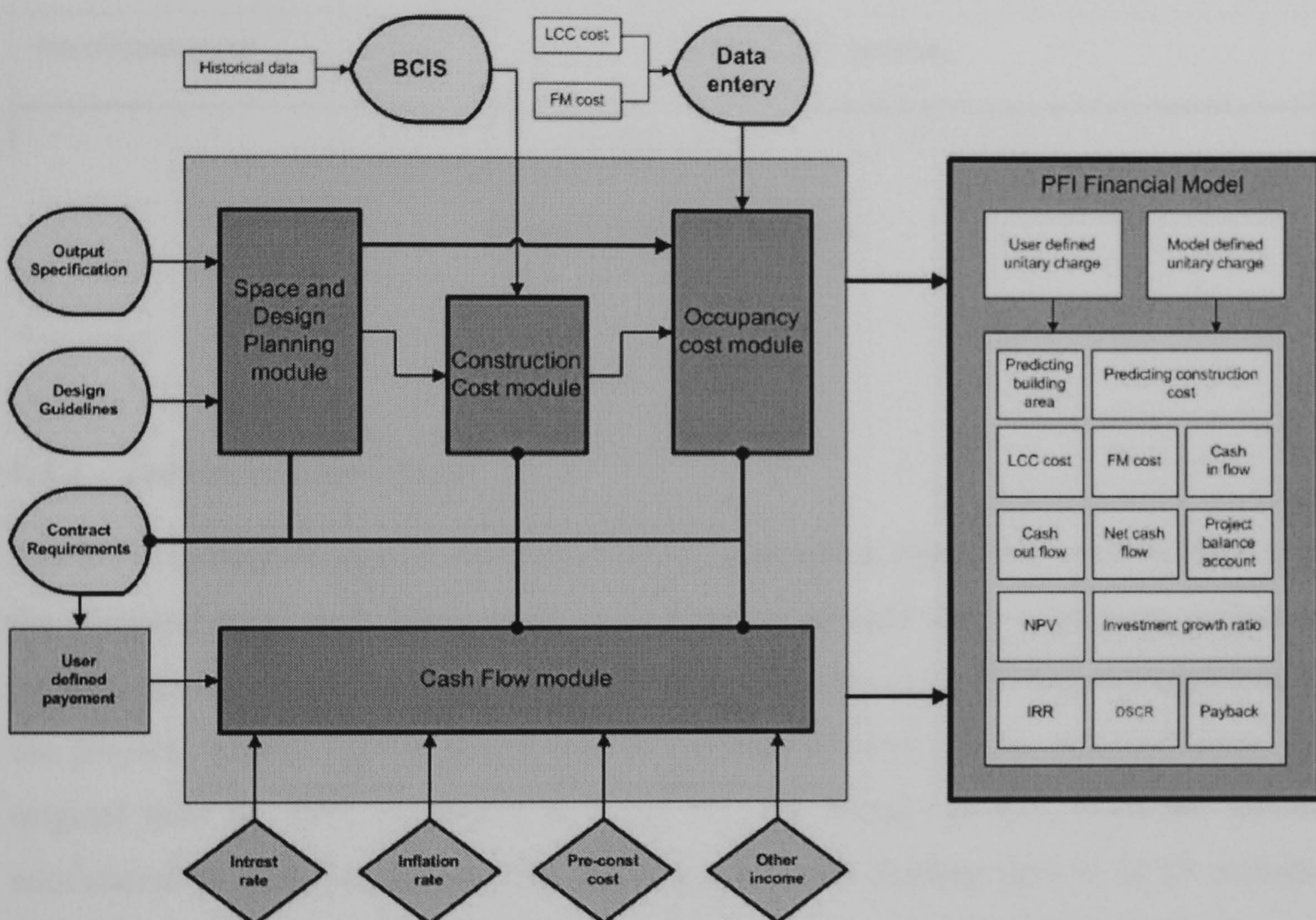


Figure 9.1: Cash flow module within the PFI Financial Management Model

9.3 Project Stages

Project duration could be a data entry value which clarifies the duration all parties agreed upon in the contract. In PFI projects, there are three main stages: pre-construction, construction and operation. The cost spent on the project at the bidding stage is added to the total project cost. This means that the cost of the project covers all stages, although the pre-construction stage is not part of the contract duration. The project duration with which this research is concerned is the whole project duration from the beginning of planning stage to the end of the operation period, as clarified in Fig. 9.2.

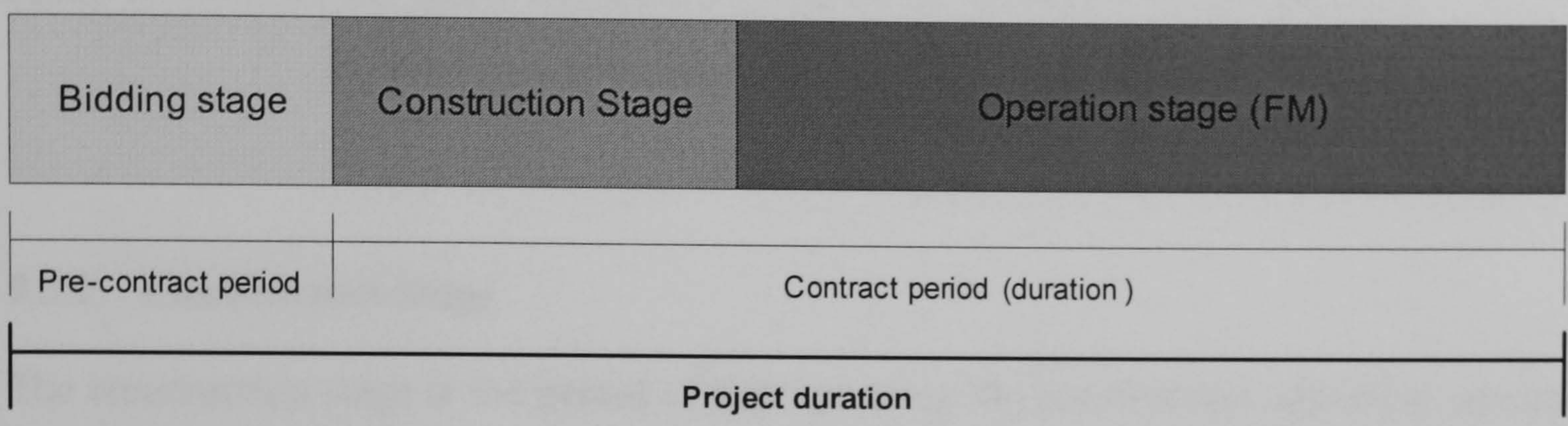


Figure 9.2: Project duration

9.3.1 Pre-construction Stage

The pre-construction stage is the stage before construction starts; this could be known as the planning stage or bidding stage. It is a period of time that varies from project to project, depending on the complexity, urgency and successful bidding management of the project. Ahadzi (2004) found that this period is likely to be extended from the original time by 75%, as shown in Table 9.1. He found out that, from the sixteen educational projects he has studied, the average actual bidding time is 26.88 months. This period of time is not considered as part of the project's contractual duration.

Table 9.1: Pre-contract time and time out-runs (Source: Ahadzi, 2004).

Project ID	Capital Value (£m)	Original time (months)	Actual time (months)	Variation months
1	85	8	12	50.00%
2	40	26	36	38.46%
3	70	9	13	44.44%
4	75	24	24	0.00%
5	37	18	36	100.00%
6	n/a	12	21	75.00%
7	24	12	25	108.33%
8	25	15	26	73.33%
9	52	9	40	344.44%
10	91	24	36	50.00%
11	20	18	39	116.67%
12	35	24	36	50.00%
13	12	12	18	50.00%
14	40	15	24	60.00%
15	20	18	24	33.33%
16	27	18	20	11.11%
Average	43.53	16.38	26.88	75.32%

This period of time covers all pre-construction activities, including the activities of forming the project company (SPV), design and cost estimation, negotiations with client, consultants, funders, contractors, subcontractors, and suppliers. This stage is costly for contractors, and is considered as one of the obstacles for PFI projects.

9.3.2 Construction Stage

The construction stage is the period of time covering the construction activities, starting with signing the contract, and ending with the completion of the construction work and the start of the operational stage. Although this stage is included in the contract, it is not covered by the project payments, which will start when the client begins using the facilities. For this reason, contractors are motivated to finish the construction stage as soon as they can to start benefiting from the project in order to cover the debt caused by the earlier stages (pre-constriction and construction).

9.3.3 Operational Stage

The operational stage is the important stage for both parties, where the client is using the facilities and paying the unitary charge to the SPV. The SPV provides the service to the required availability and performance level. Moreover, the SPV pays back the loans or overdraft to banks, depending on agreements set with them. It is the longest stage of the project, where risk lies in the long commitments in a changing world.

9.4 Model inputs

The cash flow model within this research is not simply to calculate the cash flow only, but it is part of the process of calculating the cost of the project and required income. The inputs the user has to determine are many for this model as shown in Fig. 9.3. Inputs start with the space planning module input to other modules of construction and occupancy costs, in addition to other inputs and variables needed. These inputs are as follows:

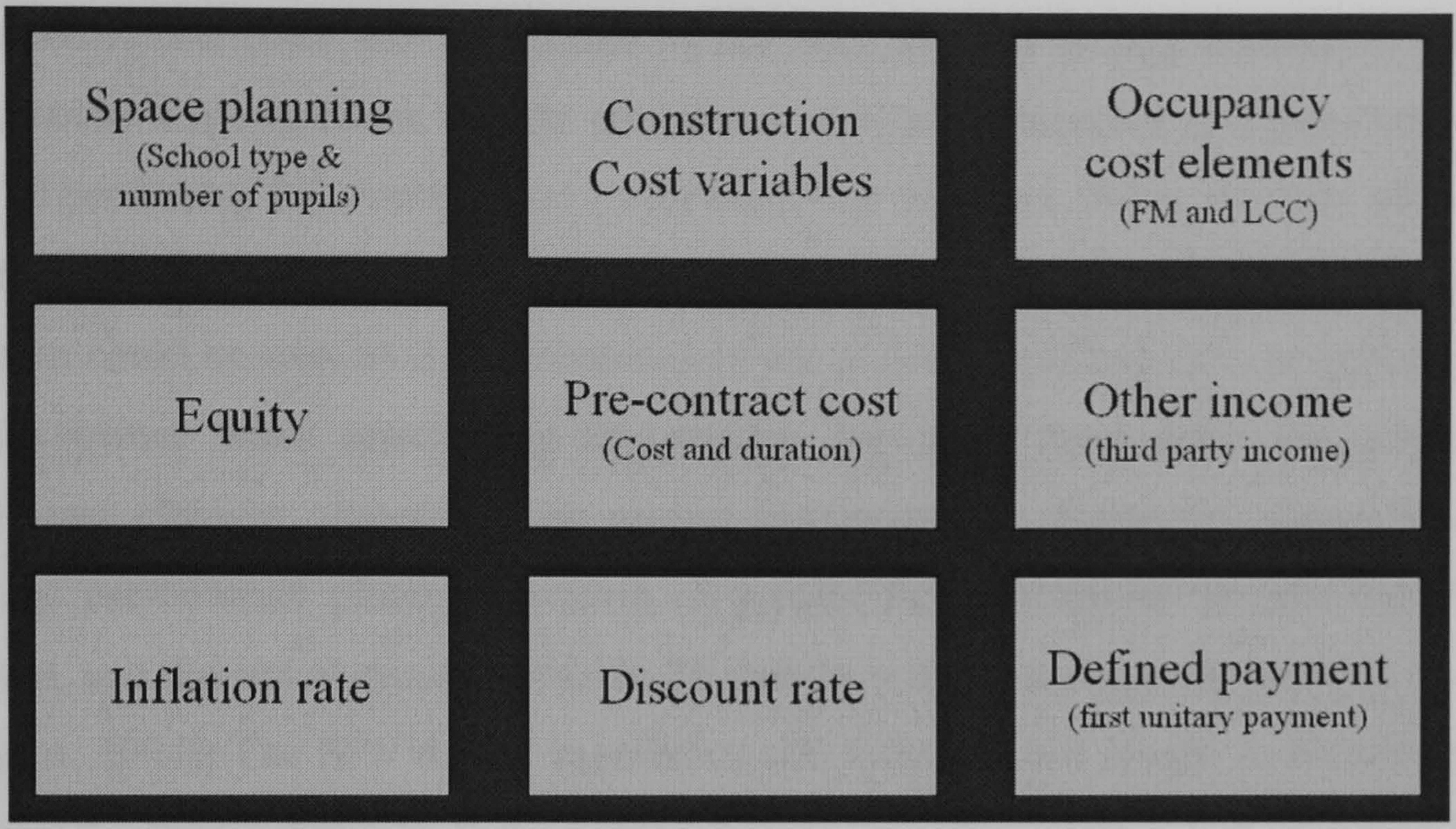


Figure 9.3: PFI Financial Model inputs.

9.4.1 Space planning

Space planning inputs are described in Chapter Six. They are the type of the school and the number of pupils to occupy it. These inputs are contract specified, they can be found in the output specification that will be issued by the client. The number of pupils affects the total gross area of the facilities required for the school based on the design guidance. The categories and the space required for each pupil differ based on the type of the school.

9.4.2 Pre-construction cost

Pre-construction costs are the costs spent on the project pre-construction period. It includes the cost of consultancies required to get things together for the tender; it includes the cost of forming and operating SPV before the project work starts. It also includes recruiting the necessary staff to start the project. This cost duration starts from the first day of the project and finishes with the start of construction works.

Pre-construction costs will be entered by the user, since it is very difficult to predict these costs. Experience on similar projects or similar agreements arrangements could help in predicting the average cost of each activity included. When the user enters the pre-construction cost, its duration should be determined as well. Forecasting this duration could be easy as it is determined in the project important dates or schedule set by the owner when announcing the project. However, these dates are subject to significant changes, depending on project circumstances. Table 9.1 shows that the average pre-contract planned duration of sixteen PFI educational project was 16.38 months, and the actual duration was 26.88 months with an average variation of 75.32% (Ahadzi, 2004). The SPV's staff experience and judgment are sought to anticipate and forecast the whole duration of the planning stage (tendering stage). The tendering stage period in PFI projects takes considerably long time and efforts before the project reaches financial close.

The project planning cost will be spread out across the planning duration, based on the direct ratio of each year from the pre-construction period, multiplied by the pre-construction cost (pro rata basis).

9.4.3 Construction cost

The construction cost will be calculated as described in the construction cost module (Chapter 7). The total cost needs to be spread across the project construction duration. This is done according to the standard cost commitment curves produced by Kaka and Price (1993) when they developed the contractors' cash flow forecasting model. Equation 9.3 shows the model to represent different types of traditional projects' procurement methods in terms of the relationship between contract cost and duration. Design and built was one of these types. They used the values parameters (α) and (β)

for design and built projects in Table 9.2 to be used in equation 9.1. This is applicable to PFI projects where the SPV is responsible for the design and construction of the project. The values, according to Kaka and Price (1993), are listed in table 9.2 for the projects groups of duration.

$$C = \frac{F}{1+F} \qquad \text{Where } F = e^{\alpha}\left(\frac{t}{1-t}\right)^{\beta} \qquad \text{equation 9.1}$$

Where (C) is the cost of construction (dependent variable) in a particular time (t) (the independent variable) and α and β are constants. The model automatically selects the value based on the construction duration.

Table 9.2: Values of α and β (Source: Kaka and Price, 1993).

Contract type	Construction period group (Years)	Values	
		α	β
Traditional	0.00-0.50	1.151	1.388
Traditional	0.58-1.00	0.213	1.223
Traditional	1.08-3.00	-0.243	1.303
Design and build	0.58-1.00	0.407	0.926
Design and build	1.08-3.00	-0.029	1.034
Management contract	0.58-1.00	-0.948	1.696
Management contract	1.08-3.00	-1.372	1.328

The construction period starts after the signing of the contract. Equation 9.3 is applied to produce a factor that will be multiplied by the construction cost to allocate the cost of each construction year cumulatively. The cost of the year is calculated by deducting the cumulative cost of the previous year(s). Tables (9.3, 9.4, 9.5) show the value of the pre-construction cost as (£200,000) and the construction cost as (£3,200,000) for different durations in each stage. This is just an example before adjusting for inflation.

Table 9.3: 10 Months for pre-construction period and 10 months for construction periods.

Year	Pre-contract Cost	Construction Cost
0	£200,000	£940,353
1	£0	£2,259,647
2	£0	£0
3	£0	£0
4	£0	£0
5	£0	£0
6	£0	£0
	£200,000	**£3,200,000**

Table 9.4: 18 Months for pre-construction period and 18 months for construction periods.

Year	Pre-contract Cost	Construction Cost
0	£133,333	£0
1	£66,667	£1,029,619
2	£0	£2,170,381
3	£0	£0
4	£0	£0
5	£0	£0
6	£0	£0
	£200,000	**£3,200,000**

Table 9.5: 26 Months for pre-construction period and 45 months for construction periods.

Year	Pre-contract Cost	Construction Cost
0	£92,308	£0
1	£92,308	£0
2	£15,385	£672,302
3	£0	£867,756
4	£0	£883,243
5	£0	£776,699
6	£0	£0
	£200,000	**£3,200,000**

9.4.4 Occupancy cost

The occupancy cost is retrieved from the occupancy cost module (Chapter Eight). It includes the cost of LCC and FM, calculated annually. These costs are due when the project is in operation, which means that the LCC and FM costs will start after the construction period finishes. The first year and the last year will be calculated according to their percentage, for example, if the pre-construction period is 14 months, and construction period is 18 months. The period before occupancy cost starts is 32 months; this means the occupancy cost in its first year is the percentage of the remaining 4 months of the third year (33.33%). The last year of the project duration will apply the same principles. Table 8.7 shows the LCC cost for the main items. Table 8.8 shows the FM cost for the main item over the project operational life.

9.4.5 Inflation adjustment

Inflation is the increase in the overall level of prices over an extended period of time. In economics, the term 'inflation' generally describes the prevailing annual rate at which the prices of goods and services are increasing (Rowlatt, 1992). In the proposed model, all cost and income components are adjusted for inflation using on Equation 9.1 below:

$$Inflated\ value = value \times (1 + in)^{n_i} \qquad \text{Equation 9.1}$$

Where (in) is the inflation rate most often fixed in PFI contracts, and (n_i) represents each year of the project.

The inflation rate is agreed upon in the contract in most of the PFI projects; this fixed inflation is different to the actual inflation.

9.4.6 Discount Rate Adjustment

The rate of discount adjusts the money values based on their relation with time. Taking time value of money into consideration is an important factor in the investment process. A pound today is worth more than its worth tomorrow and a sum of money is worth more today than an equal sum of money at some time in the future, even ignoring inflation (Ashworth, 1996). Both procurer and providers are required to decide on the discount rate to be used in the project before embarking on the costing exercise of the PFI/PPP projects (Boussabaine, 2007).

The discount rate used in this research (and other research studies) is taken to mean the cost of capital. Changing the term depends on where it is going to be used and for what purpose. It was adjusted in the model according to Equation 9.3 below:

$$discounted\ value = \frac{value}{(1+i)^{n_i}} \qquad \text{Equation 9.3}$$

Where (i) is the discount rare rate most often fixed in PFI contracts, and (n_i) represents each year of the project.

9.4.7 Equity

The equity is the capital partners put when forming the project company (SPV). It represents a small percentage in the project funds. This equity aims to cover the pre-construction cost or part of it, but undeniably not to cover the entire construction cost. The nature of PFI projects, as mentioned in chapter three, introduced a different source of funds to projects. A PFI project is normally funded by (approximately) 90% from senior debt, 9% from subordinated debt and 1% from equity.

9.4.8 Project Annual Payments

In PFI projects, where the contract commitment is long, the annual payments influence the project appraisal process. Project viability, in terms of finance and financial factors and ratio, depends on the project income. The decision to proceed and compete in the project bidding process depends mainly on the project returns. Profitability is another important factor affected positively or negatively by the project payment (income).

Annual project payment is calculated by the model based on the total cost of the project. The PV of the project cost *CoPV* is calculated as per Equation 9.4 then *CoPV* is discounted to one year before the end of both pre-construction and construction periods according to Equation 9.5. The annual payment (*pmt*) is calculated based on equation 9.6.

$$CoPV = \sum \left(\frac{Co \times (1+in)^{n_i}}{(1+i)^{n_i}} \right)$$ Equation 9.4

Where *Co* is the yearly total cost in today's price, (*in*) is the inflation rate, (*i*) is the interest rate, and (n_i) is each year of the project.

$$CoPVa = CoPV \times (1+i)^{d-1}$$ Equation 9.5

Where *CoPVa* is the cost PV discounted to one year before the end of pre-construction and construction periods, (*i*) is the discount rate, and (*d*) is the duration of planning (pre-construction) and construction as calculated in Equation 9.15.

$$pmt = CoPVa \times \left(\frac{i \times (1+i)^n}{(1+i)^{n-1}} \right)$$ Equation 9.6

The annual annuity payment (*pmt*) could also be calculated by the following equation:

$$pmt = \frac{CoPVa \times i}{1-(1+i)^{-n}}$$ Equation 9.7

The present value of the total payments (PV_{pmt}) at year Zero of the project (equation 9.8) for the same discount rate should be equal to $CoPVa$. This means that with these payments, the SPV will enable the project to break even. The PV of the annuity payment at year Zero, subtracting the PV of the project cost ($CoPV$), should equal the NPV of the project yearly cash flow if there is no other income.

$$PV_{pmt} = pmt \times \left(\frac{1-(1+i)^{-n}}{i} \right)$$ Equation 9.8

Where (PV_{pmt}) is the annuity payment's present value, (i) is the discount rate, and (n) is the project duration defined in equation 9.14.

The model also allows the user to set the payment manually to compare the results and to adjust the payments according to funds available for the project. The results are shown for both payment settings: the model defined payment, and the user defined payment. The effect of each payment setting to the project cost, project income, investment return, payback, cash flow, and profit were shown in the model reports.

9.4.9 Project's Other Income

There is a third party income for the project, this income come as a result of the use of the facilities under the management of the private sector. The third party income does not influence the clients' decision of project bidding. It has a special agreement between the client and the project company to control and manage this income. It has a provision in the model as a data entry to be defined by the user. This will enable the user to show the third party income effects on the project cash flow and the project investment result.

9.5 Cash flow variables

The cash flow variables are classified in terms of two categories; cash in and cash out. Each one of these categories contains many variables. Cash in consists of project payments from clients and other project income. Payments are due after the service has commenced, and there is an entitlement to deductions for the lack of performance or lack of availability. Since the model is intended for use in the bidding stage, it is assumed that SPV will perform well and receive full payments with no deduction at all, although there is a provision in the model for a deduction data entry by the user as a risk factor. Other income is a data entry; it has no effect on the potential payments calculations since it is most often considered as additional varying income, which is treated in the project agreements as a third party income.

Cash out consists of all the cost of the project from day one of the bidding stage to the end of the contract duration. It contains the initial cost (also called capital cost), which means the cost of the project before receiving any income. This means the initial cost is the pre-construction (planning) cost and construction cost. Cash out also consists of the cost of occupancy stage where FM and LCC costs are combined.

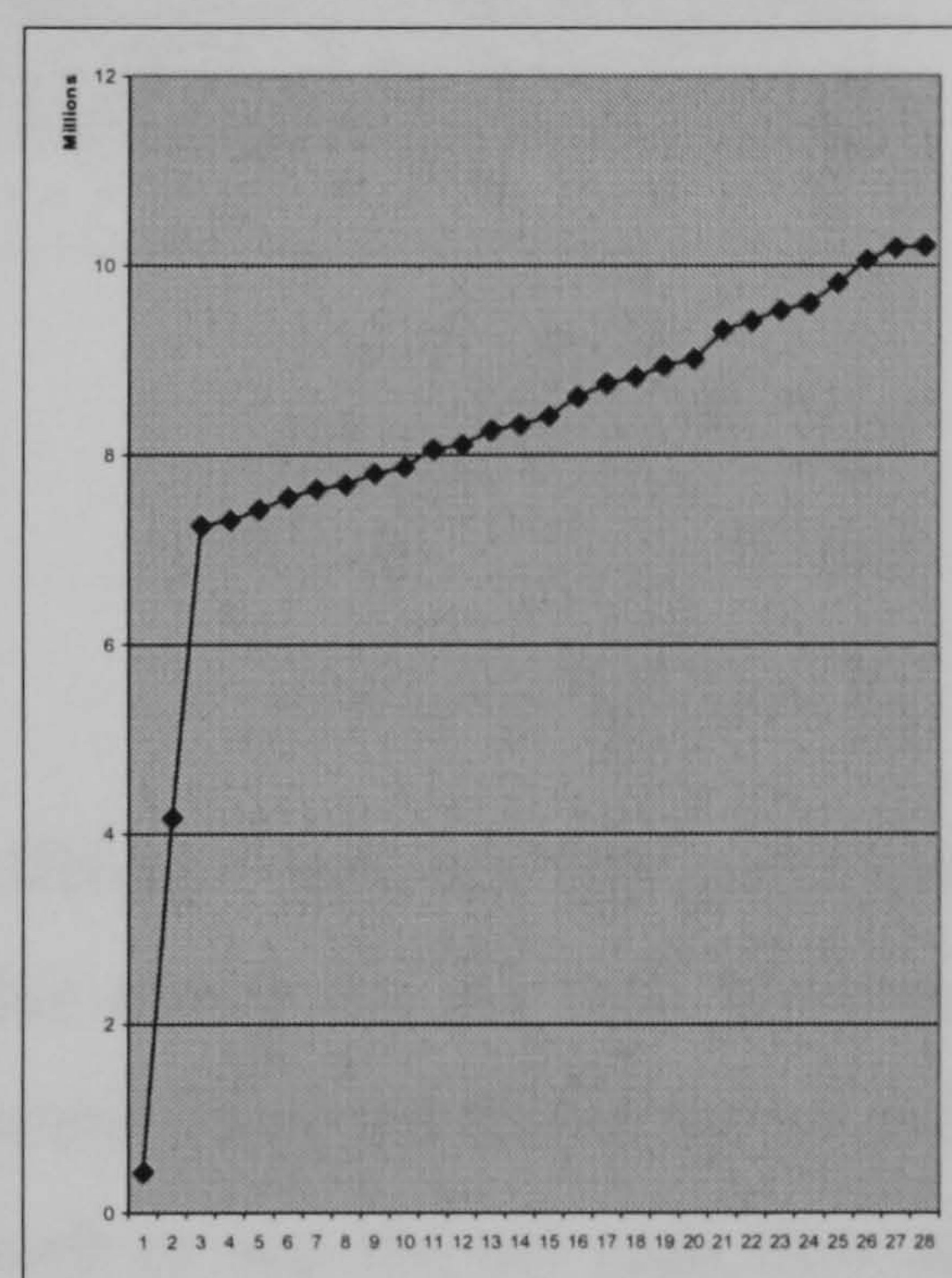
The initial cost of the project will be covered by equity and loans (or overdraft), and equity could be treated as part of the cash in items. There is also interest due to banks if there is a deficit to be covered, or earned to the SPV if the project balance is positive. The model allows for different interest rates to be entered based on paying or earning them.

9.5.1 Cash Out

The out cash flow represents all of the financial transactions towards the project cost. It consists of the pre-construction, construction, LCC and FM costs. Table 9.6 below shows the content of out cash flow, and their occurrence. All costs are inflated based on the inflation rate given by the user. The cumulative monthly cash out is then calculated for the whole project duration.

Table 9.6: Out Cash Flow of the Project

Year	Pre-Const. Cost	Const. Cost	LCC Cost	FM Cost	Total Cost	Inflated Cost	Cum. Cost
0	428,571	0		0	428,571	428,571	428,571
1	71,429	3,549,394		0	3,620,822	3,729,447	4,158,018
2	0	2,900,974	3,294	9,792	2,914,060	3,091,526	7,249,544
3	0	0	29,648	23,082	52,731	57,620	7,307,165
4	0	0	29,648	62,150	91,799	103,320	7,410,485
5	0	0	29,648	86,469	116,118	134,612	7,545,097
6	0	0	29,648	45,566	75,215	89,810	7,634,907
7	0	0	29,648	6,892	36,540	44,940	7,679,847
8	0	0	29,648	62,150	91,799	116,288	7,796,135
9	0	0	29,648	23,082	52,731	68,802	7,864,937
10	0	0	29,648	108,953	138,601	186,269	8,051,205
11	0	0	29,648	6,892	36,540	50,580	8,101,785
12	0	0	29,648	78,341	107,990	153,967	8,255,753
13	0	0	29,648	6,892	36,540	53,660	8,309,413
14	0	0	29,648	29,375	59,024	89,279	8,398,692
15	0	0	29,648	102,660	132,308	206,132	8,604,824
16	0	0	29,648	62,150	91,799	147,310	8,752,134
17	0	0	29,648	6,892	36,540	60,395	8,812,529
18	0	0	29,648	45,566	75,215	128,048	8,940,577
19	0	0	29,648	6,892	36,540	64,073	9,004,650
20	0	0	29,648	141,728	171,376	309,525	9,314,175
21	0	0	29,648	23,082	52,731	98,095	9,412,270
22	0	0	29,648	29,375	59,024	113,096	9,525,366
23	0	0	29,648	6,892	36,540	72,115	9,597,480
24	0	0	29,648	78,341	107,990	219,520	9,817,001
25	0	0	29,648	86,469	116,118	243,124	10,060,125
26	0	0	29,648	29,375	59,024	127,290	10,187,416
27	0	0	4,941	3,847	8,788	19,522	10,206,938

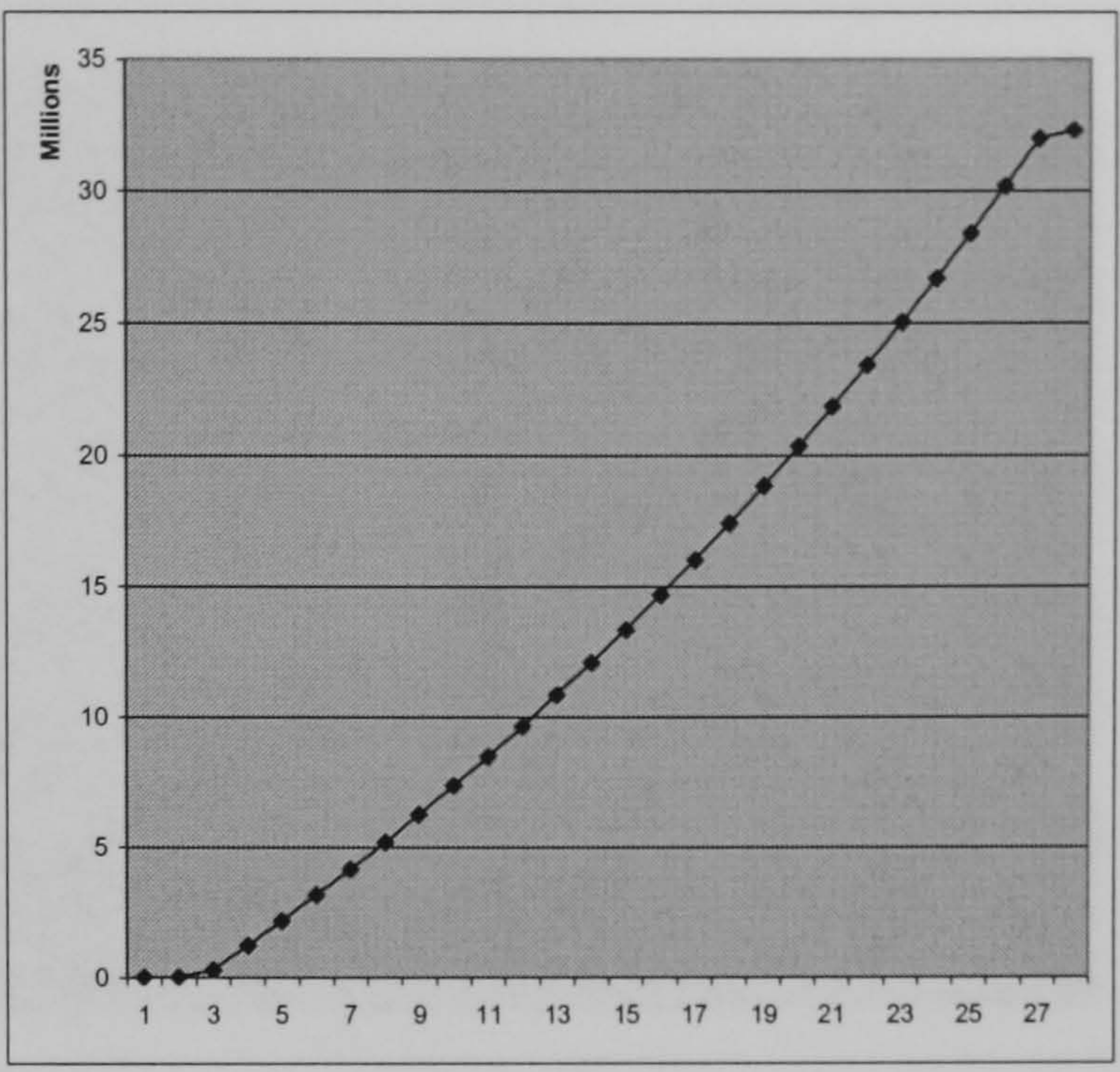


9.5.2 Cash In

The in cash flow is the total of the project income for each year, inflated and calculated cumulatively. Table 9.7 shows the components of the in cash flow, where project income (payments) are defined, together with any other project's income. The total cumulative income is again inflated to show the In Cash Flow as shown in the chart beside Table 9.9.

Table 9.7:In Cash Flow of the project.

Year	Annual Payment	Other Income	Total Income	Inflated income	Cum. Income
0	0	0	0	0	0
1	0	0	0	0	0
2	279,777	1,000	280,777	297,877	297,877
3	839,332	3,000	842,332	920,439	1,218,316
4	839,332	3,000	842,332	948,052	2,166,368
5	839,332	3,000	842,332	976,494	3,142,862
6	839,332	3,000	842,332	1,005,789	4,148,651
7	839,332	3,000	842,332	1,035,962	5,184,614
8	839,332	3,000	842,332	1,067,041	6,251,655
9	839,332	3,000	842,332	1,099,053	7,350,708
10	839,332	3,000	842,332	1,132,024	8,482,732
11	839,332	3,000	842,332	1,165,985	9,648,717
12	839,332	3,000	842,332	1,200,964	10,849,681
13	839,332	3,000	842,332	1,236,993	12,086,675
14	839,332	3,000	842,332	1,274,103	13,360,778
15	839,332	3,000	842,332	1,312,326	14,673,104
16	839,332	3,000	842,332	1,351,696	16,024,800
17	839,332	3,000	842,332	1,392,247	17,417,047
18	839,332	3,000	842,332	1,434,014	18,851,062
19	839,332	3,000	842,332	1,477,035	20,328,097
20	839,332	3,000	842,332	1,521,346	21,849,442
21	839,332	3,000	842,332	1,566,986	23,416,429
22	839,332	3,000	842,332	1,613,996	25,030,424
23	839,332	3,000	842,332	1,662,416	26,692,840
24	839,332	3,000	842,332	1,712,288	28,405,128
25	839,332	3,000	842,332	1,763,657	30,168,785
26	839,332	3,000	842,332	1,816,567	31,985,352
27	139,889	500	140,389	311,844	32,297,195

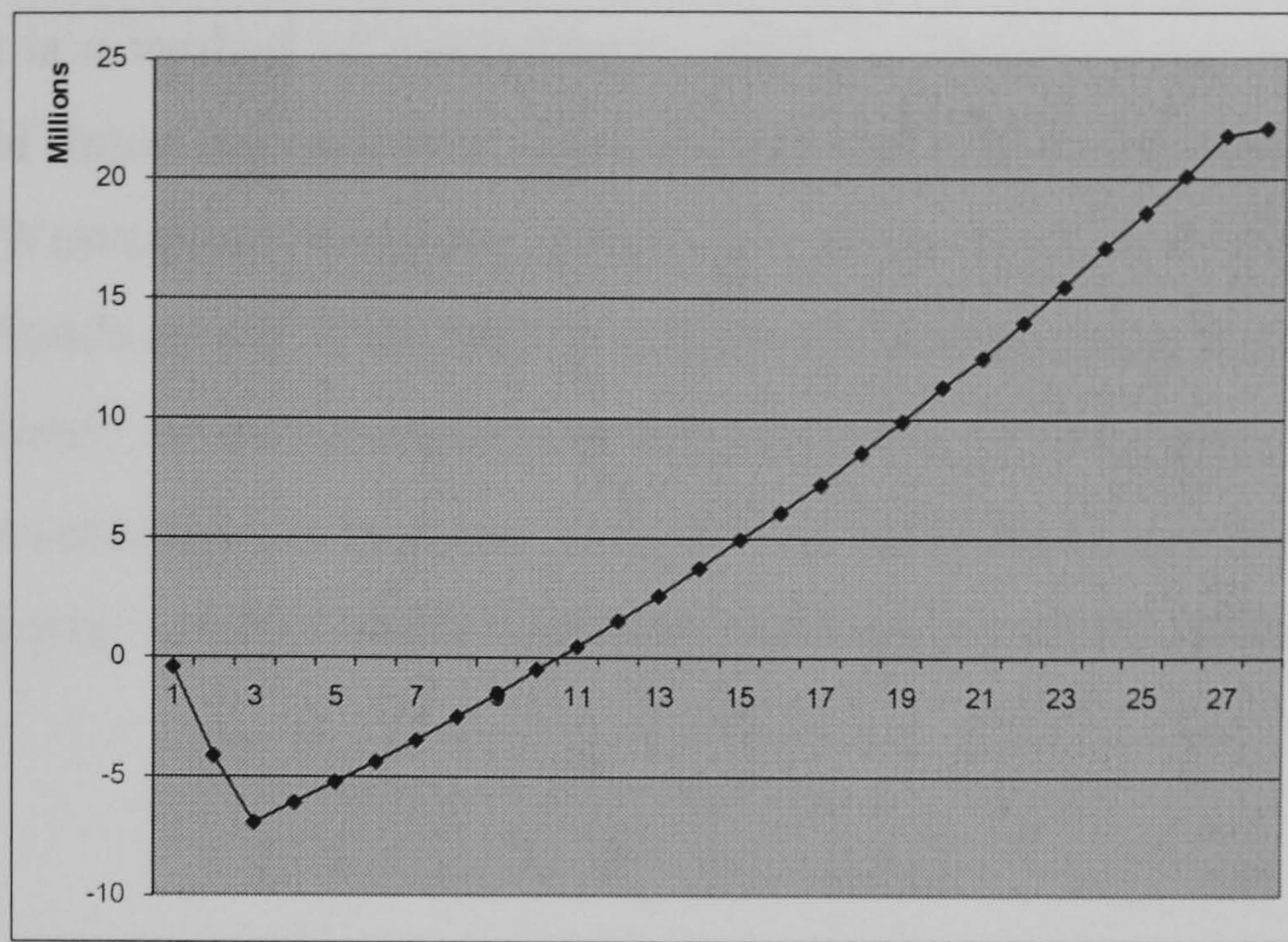


9.5.3 Net Cash Flow

The net cash flow of the project calculates the difference between the cumulative project cash in and cumulative project cash out. This shows the net cash generated cumulatively by the project, either positively or negatively. Table 9.8 shows the net cash flow table where cumulative cash out, cumulative cash in and the net cash flow are presented in addition to the chart showing the net cash flow behaviour.

Table 9.8: Net Cash Flow of the project

Year	Cum. Cash Out	Cum. Cash In	Net Cash Flow
0	428,571	0	-428,571
1	4,158,018	0	-4,158,018
2	7,249,544	297,877	-6,951,668
3	7,307,165	1,218,316	-6,088,849
4	7,410,485	2,166,368	-5,244,117
5	7,545,097	3,142,862	-4,402,235
6	7,634,907	4,148,651	-3,486,256
7	7,679,847	5,184,614	-2,495,233
8	7,796,135	6,251,655	-1,544,480
9	7,864,937	7,350,708	-514,229
10	8,051,205	8,482,732	431,527
11	8,101,785	9,648,717	1,546,932
12	8,255,753	10,849,681	2,593,929
13	8,309,413	12,086,675	3,777,262
14	8,398,692	13,360,778	4,962,086
15	8,604,824	14,673,104	6,068,281
16	8,752,134	16,024,800	7,272,666
17	8,812,529	17,417,047	8,604,518
18	8,940,577	18,851,062	9,910,485
19	9,004,650	20,328,097	11,323,446
20	9,314,175	21,849,442	12,535,267
21	9,412,270	23,416,429	14,004,159
22	9,525,366	25,030,424	15,505,059
23	9,597,480	26,692,840	17,095,360
24	9,817,001	28,405,128	18,588,127
25	10,060,125	30,168,785	20,108,660
26	10,187,416	31,985,352	21,797,936
27	10,206,938	32,297,195	22,090,258



9.6 Project investment appraisal

The model output is intended to identify the tools for decision-making and investment appraisal of the project. There are different methods used in any investment evaluation and appraisal, where the decision either to go for the project or not will be taken, or some of the input should be adjusted before proceeding with this step. The methods of investment appraisal include:

- Net Present Value (NPV).
- Internal Rate of Return (IRR).
- Payback method.
- Debt Service Coverage Ratio (DSCR).

Many other methods are found in the literature; the above methods were selected based on the expert emphases on them as the main methods they take into consideration in bidding for a project. The expert opinions were concluded in the industry survey done earlier.

9.6.1 Net Present Value (NPV)

Net Present Value (NPV) is a method of evaluating a capital investment proposal by finding the present value of future net cash flow, discounted at the firm's cost capital or required rate of return (Weston and Brigham, 1974). It can be used to determine whether the project is profitable or not. If the NPV is negative (less than zero), it means that the project is not profitable, while the project is profitable if the NPV is above zero. The NPV of the project is calculated as the sum of the PV of each year's net income. The PV of each individual year is calculated by applying Equation 9.9 to the cash flow of that year.

$$PV = \frac{CF}{(1+rate)^{n_i}} \qquad \text{Equation 9.9}$$

Where (CF) is the cash flow of year (n_i), and ($rate$) is the interest rate (rate of discount).

The NPV can be calculated by applying Equation 9.10 to the yearly cash flow (CF) as follows:

$$NPV = initial\ investment + \frac{CF\ year\ 1}{(1+rate)^1} + ... + \frac{CF\ year\ n}{(1+rate)^n} \qquad \text{Equation 9.10}$$

The NPV should become profitable if the internal rate of return (IRR) is higher than the rate of return (discount rate) defined by the contract agreement. This actually measures how the project is profitable, and the return expected or desired. In Excel spreadsheets, the NPV is calculated exactly according to Equation 9.11 below:

$$NPV = \sum_{i=1}^{n} \frac{CF}{(1+rate)^{n_i}} \qquad \text{Equation 9.11}$$

Where (n) is the project duration, (CF) is the cash flow of that particular year (n_i) and $(rate)$ is rate of discount.

9.6.2 Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is the discount rate which forces the PV of a project's inflows to equal the PV of the costs (Weston and Brigham, 1974). The discount rate that will reduce the NPV of the project to zero can be found by trial and error (Ashworth, 2004). For NPV to be implemented, Weston and Brigham (1974) defined the following:

- Find the present value of each cash flow, including both inflows and outflows, discounted at the project's cost of capital.
- Sum these discounted cash flows; this sum is defined as the project's NPV.
- If the NPV is positive, the project might be accepted, but if the NPV is negative, it most likely be rejected. If two projects are mutually exclusive, the one with the higher NPV should be chosen, provided the NPV is positive.

9.6.3 Payback method

The payback method is the length of time required for the net revenues of an investment to recover the cost of the investment (Weston and Brigham, 1974). In other words, it is the period it takes for an investment to generate sufficient incremental cash to recover its initial capital outlay in full (Ashworth, 1996). According to (Ferry *et al.*, 1999), the payback method is not a very meaningful way of validating building projects, and is rarely if ever used by cost planners. Furthermore, it fails to measure long-term profitability since it takes no account of cash flows beyond the payback period (Ashworth, 1996).

The payback period was calculated in the model by counting the years where the cumulative *in* cash flow is less than the total debt service, which means the SPV is still in debt. The total debt service is the total on the annuity series payments that cover the capital cost before the project generates any income. Equation 9.12 shows the calculation of total debt service, and Equation 9.13 represents the formula which calculates the payments to cover the capital cost.

9.6.4 Debt-Service Coverage Ratio (DSCR)

This is the ratio banks focus on before funding projects. Bank officers use this ratio in determining income project loan. It can be calculated using equation 9.12:

$$DSCR = \frac{Net\ Operating\ Income}{Total\ Debt\ Service} \qquad \text{Equation 9.12}$$

This ratio should be ideally more than one. If it is less than one, it means that there is only enough net operating income to cover the result ratio of the debt. If the DSCR is more than one, it means that the project can generate cash, which will cover its debt.

The net operating income was calculated as the total result of subtracting the inflated operational cost from the inflated operational income along the project duration. This does not take the capital cost into account. The total debt is the total payments to cover the capital cost discounted to the interest rate at one year before the end of pre-construction and construction periods.

The debt coverage annual payment is calculated by applying Equation 9.13 below to the present capital cost discounted to one year before the end of the pre-construction and construction periods.

$$Debt\ Coverage\ Annual\ Payment = CaPVa \times \left(\frac{i \times (1+i)^n}{(1+i)^{n-1}} \right)$$ Equation 9.13

(i) is the interest rate, and (n) is the project duration calculated by Equation 9.14 below:

$$n = Contract\ duration + Planning\ period$$ Equation 9.14

$CaPVa$ is the present value of capital cost discounted at one year before the end of the pre-construction and construction periods; it can be calculated by using Equation 9.15 below:

$$CaPVa = CaPV \times (1+i)^{d-1}$$ Equation 9.15

Where CaPV is the PV of the total project cost, and (d) is the total of pre-construction and construction periods as in Equation 9.16.

$$d = Planning\ period + Construction\ period$$ Equation 9.16

DSCR is calculated based on overdraft coverage. However, it was also calculated based on the total borrowing amount to meet the required capital cost where the required debt coverage annual payment could be calculated as per Equation 9.17. The result obtained is DSCR is greater than the one based on the overdraft.

$$Debt\ Coverage\ Annual\ Payment = (CaPVa - Eq) \times \left(\frac{i \times (1+i)^n}{(1+i)^{n-1}} \right)$$ Equation 9.17

Where Eq is the project equity.

9.6.5 Investment assessment

The SPV stakeholders need to check the investment before they become committed to the project. The model assesses the investment by calculating the amount invested by the stakeholders at the end of the project duration, depending on the cost of capital given by the contract. This amount, which will be calculated based on Equation 9. will be compared by the project closing balance in the last year of the project duration to assess the total return compared by the planned return if the equity is invested to the defined rate of interest for the project duration.

$$Planned\ investement\ worth = Equity\ invested \times (1+i)^n$$ Equation 9.18

Where i is the cost of capital (interest rate), and n is the project duration which:

$$n = Contract\ duration + Planning\ period$$ Equation 9.19

The investment planned return rate is the cost of capital (discount rate) defined by the contract. The actual investment return rate is calculated based on Equation (9.20).

$$\left(\frac{Actual\ investment\ return}{Equity\ invested}\right)^{\left(\frac{1}{n}\right)-1}$$ Equation 9.20

Where actual investment is the closing balance of the project at the last year of the project duration. Equity invested is the equity paid by the stakeholders at the initial stage. $n = Contract\ duration + Planning\ period$. The planning period is the period before signing the contract; it is referred to in some parts of this research as the pre-construction period.

By defining the investment's actual return, it will be possible to compare it with the cost of capital defined by the contract if the amount of equity was invested with a bank. This could be used as a tool for assessing the investment value in the project. The actual investment return ratio, which was calculated using Equation 9.20 above, is a good tool for the investor to check the level of competition manoeuvre by decreasing or increasing the annual project payment until reaching the right figures.

9.7 Summary

The cash flow module with the inputs and outputs of the PFI financial model was described in terms of components, process and reports. The model calculates and presents the cash flow produced in spreadsheet software. However, attempts have been made to launch a web-based programme to accommodate all these activities, and produce the required outputs. This programme will be explained in the next chapter.

The model lists the factors that influence the decision in the early stage of the project. These influencing factors have been taken from the literature review and from the interviews conducted with experts who are knowledgeable about PFI projects. These factors, which assess the investments in PFI projects, were shown to experts in the field of PFI financial model concept validation, and received no objections. The reports of the model seem to cover the major aspects needed for guiding the decision maker in the bidding stage of the project.

Chapter Ten

Model Testing and Validation

10 Model Testing and Validation

10.1 Introduction

Developing a model cannot be done without testing the workability and accuracy of it. The aim and objectives of developing a model should be supported by its outputs and results. It is one of the most difficult steps to be conducted, especially in academic research, which requires real project data. This data, if not published in the public realm, can be difficult to obtain, given its sensitive and confidential nature. This chapter reports the testing methods and results of the PFI financial model described in the previous chapters.

10.2 Validation Methods

There is no standard approach to testing and debugging a model. One almost always has to use his/her ingenuity to figure out what will be the best way to test and debug a model (Sengupta, 2004). However, the model developed throughout this study was tested and validated using five different methods to ensure that everything works exactly as designed. The methods used are:

- Model concept validation.
- Chasing, judgement, and debugging.
- Individual module testing.
- Testing by experts of the model input and output.
- Sensitivity analysis.

Each method of these has its own characteristics, parameters and result analysis.

10.3 Model Concept Validation

The model concept or structure is the basis of the work. Therefore, it was believed that validating the concept by presenting it to some experts and obtaining their feedback would support and enhance the concept, its input, integration and outputs. This was done online (web based questionnaire), where the model was introduced and its structure presented as shown in Fig. 10.1 (see appendix two); then some questions were listed for the respondents. The questionnaire was sent by e-mail to one hundred experts in PFI, PPP and other construction research fields. The e-mail addresses were extracted from PFI Journal, Construction Management and Economics Journal and from www.pppforum.com, where a list of corporate, financial and professional members is published.

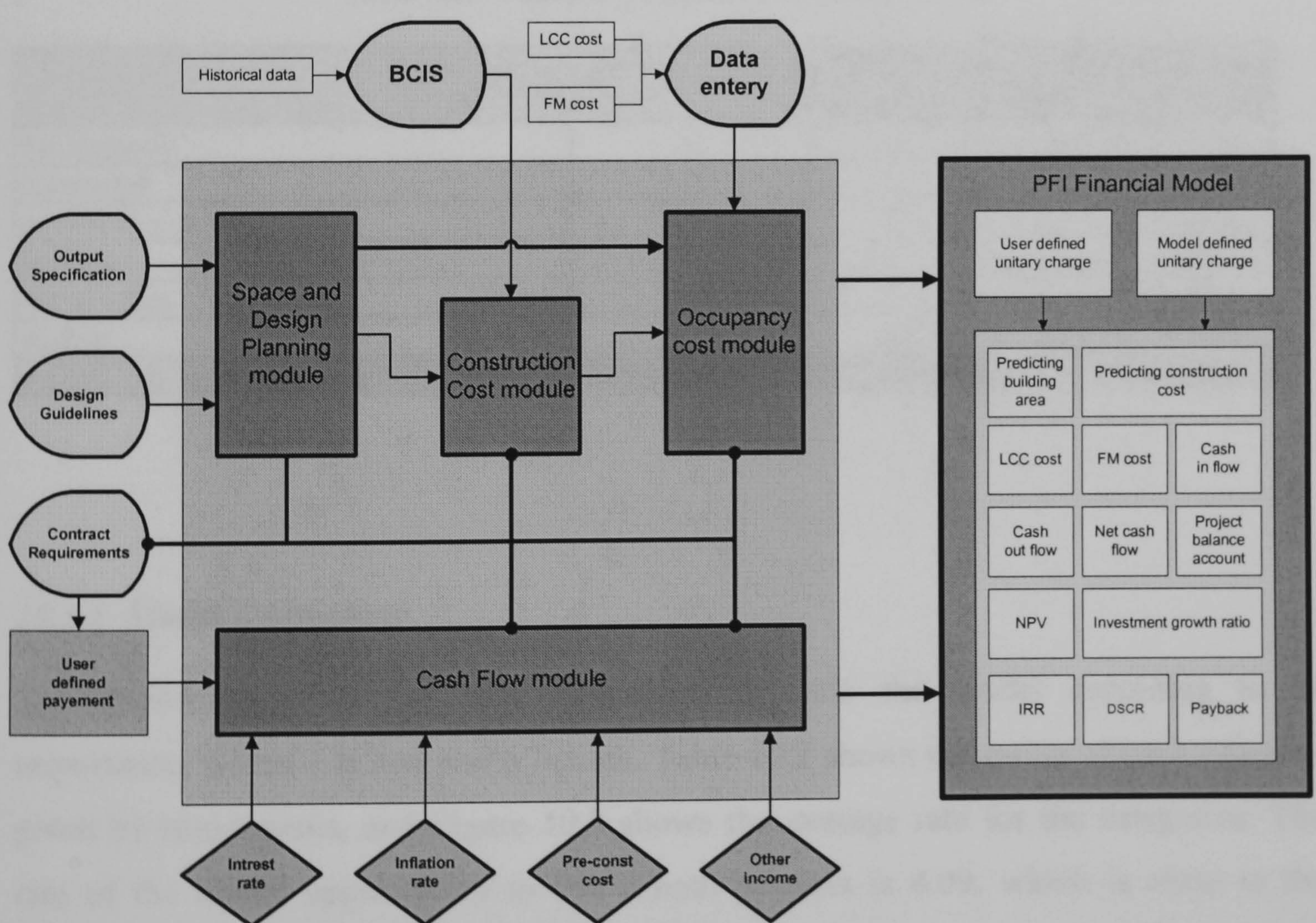


Figure 10.1: PFI Financial Model concept.

Surveymonkey.com was used to facilitate this survey — this is a web-based survey service which enables researchers to create professional online surveys quickly and easily, with the flexibility to select the type of question (single choice, multiple choice, rating scales, dropdown menus etc.). It gives powerful options that allow the user to set designated questions as required fields, control the flow with custom skip logic and even randomise answer choices to eliminate bias (Surveymonkey, 2006).

The respondent rate was fairly high:; Table 10.1 lists the number of respondents. Respondents answered the questionnaires were more than the people invited and answered. All of the people invited to participate in this survey were asked to forward the invitation to any one they know that can contribute to it. This helped to generates more respondents. The overall response rate was 21.57%.

Table 10.1: Validation responses of model concept

Type	Invited	Indirect invitation	Total	%
No response	69	0	69	67.65%
responded	20	2	22	21.57%
answer by e-mail	1	0	1	0.98%
apologies	1	0	1	0.98%
out of office	8	0	8	7.84%
decline	1	0	1	0.98%
Total	100	2	102	100.00%

10.3.1 Model Evaluation

The questionnaire allowed the respondents to rank the model according to its importance, where 1 is low and 5 is high. Table 10.2 shows the rating of each category given by respondents, and Figure 10.2 shows the average rate for the categories. The rate of the model applicability to PFI school projects is 4.09, which is close to the highest expected rate. Comprehensiveness of the model was rated 3.90 out of 5, practical relevance is 3.7 and intelligibility is 3.59.

There was one respondent who gave very low responses, making his response unique. This was not removed from the analysis reported in the previous paragraph. When this response was ignored, the rates were considerably improved Table 10.3 and Figure 10.3 show the rates for 21 responses where the above response was ignored, as it was considered an outlier.

Table 10.2: Respondents evaluation of the model concept

Category	Low 1	2	3	4	High 5	Rate
Applicability to PFI school projects	5.00%	0.00%	14.00%	43.00%	38.00%	4.09
Comprehensiveness	5.00%	0.00%	27.00%	36.00%	32.00%	3.90
Practical relevance	5.00%	5.00%	32.00%	36.00%	23.00%	3.70
Intelligibility	0.00%	5.00%	45.00%	36.00%	14.00%	3.59

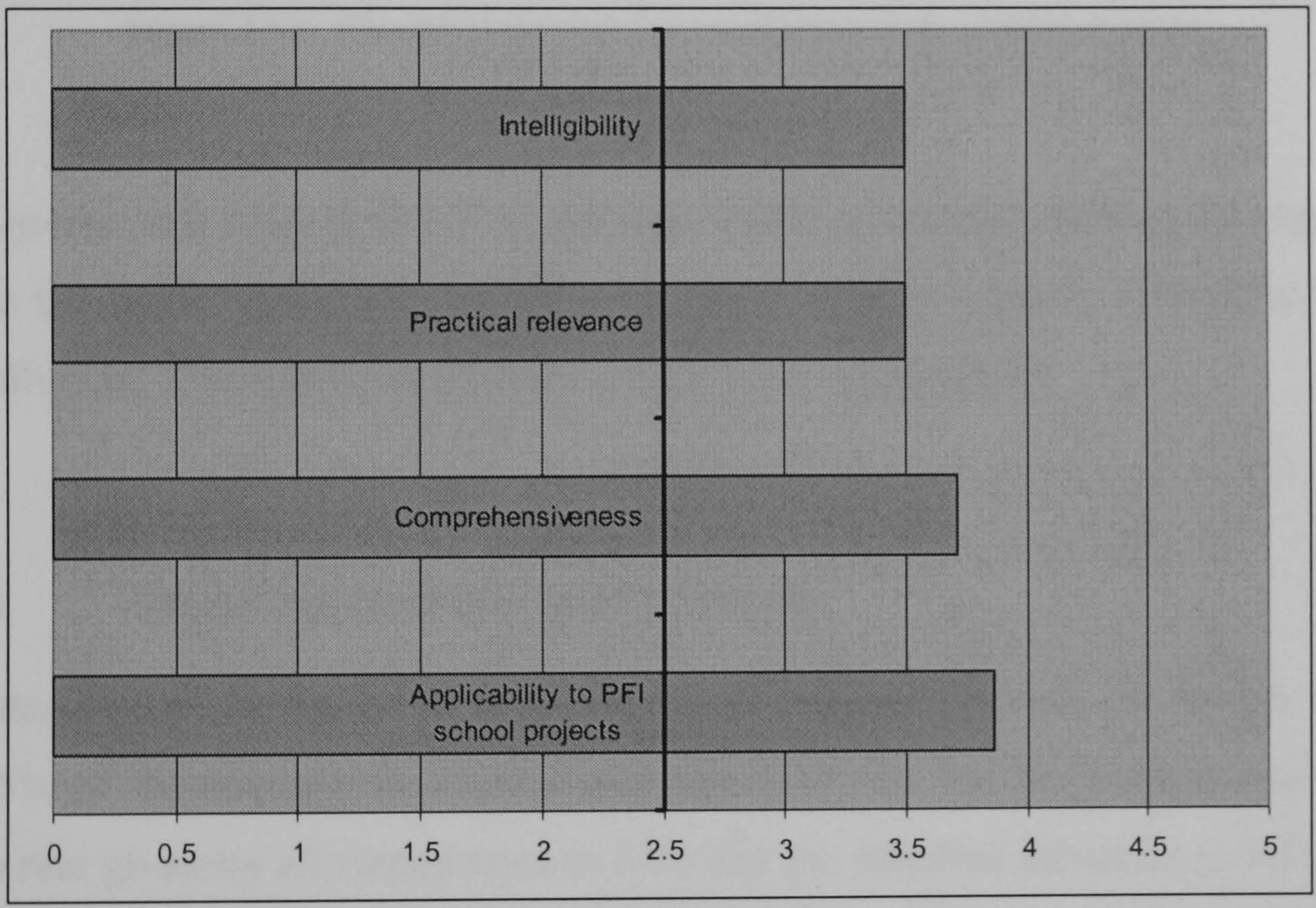


Figure 10.2: Respondent's evaluation of the model concept

Table 10.3: Filtered responses for evaluation of the model concept

Category	Low 1	2	3	4	High 5	Rate
Applicability to PFI school projects	0%	0%	15%	45%	40%	4.25
Comprehensiveness	0%	0%	29%	38%	33%	4.05
Practical relevance	0%	5%	33%	38%	24%	3.81
Intelligibility	0%	0%	48%	38%	14%	3.67

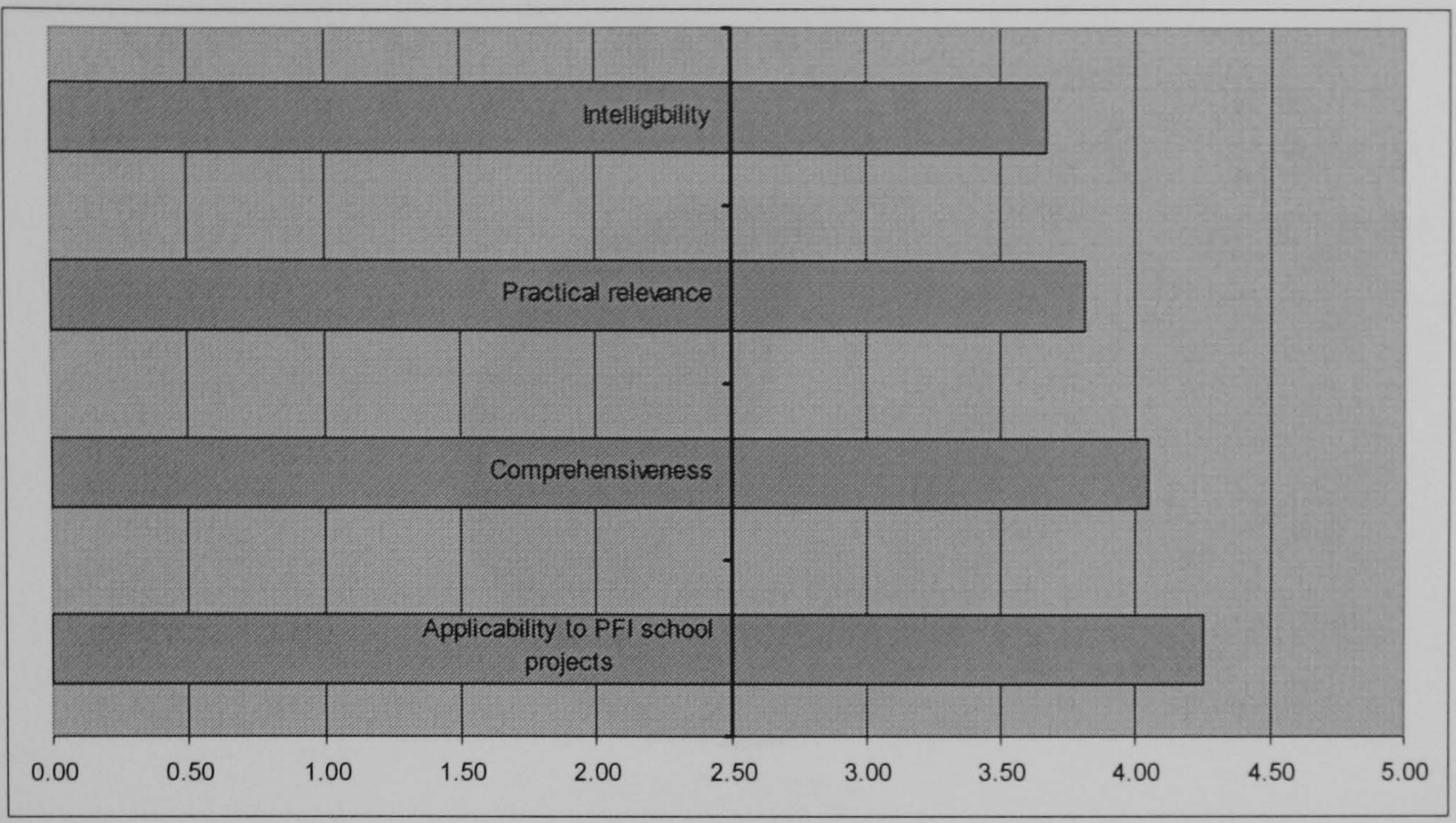


Figure 10.3: Filtered responses for evaluation of the model concept.

All categories rank more than 3.5 on average, which means that most of the respondents consider the model applicable to school projects, comprehensive, relevantly practical and intelligible. The responses on each category are listed below:

10.3.1.1 Model Applicability to PFI Schools

Respondents rated the model as applicable to PFI school projects. As shown in Figure 10.4, 95% of the respondents rated 3 and above. Given that the highest rate is 5, the average rate given by all respondents is 3.87 and the standard deviation is 0.17. That is high enough to consider the final rate as positive and the model as applicable.

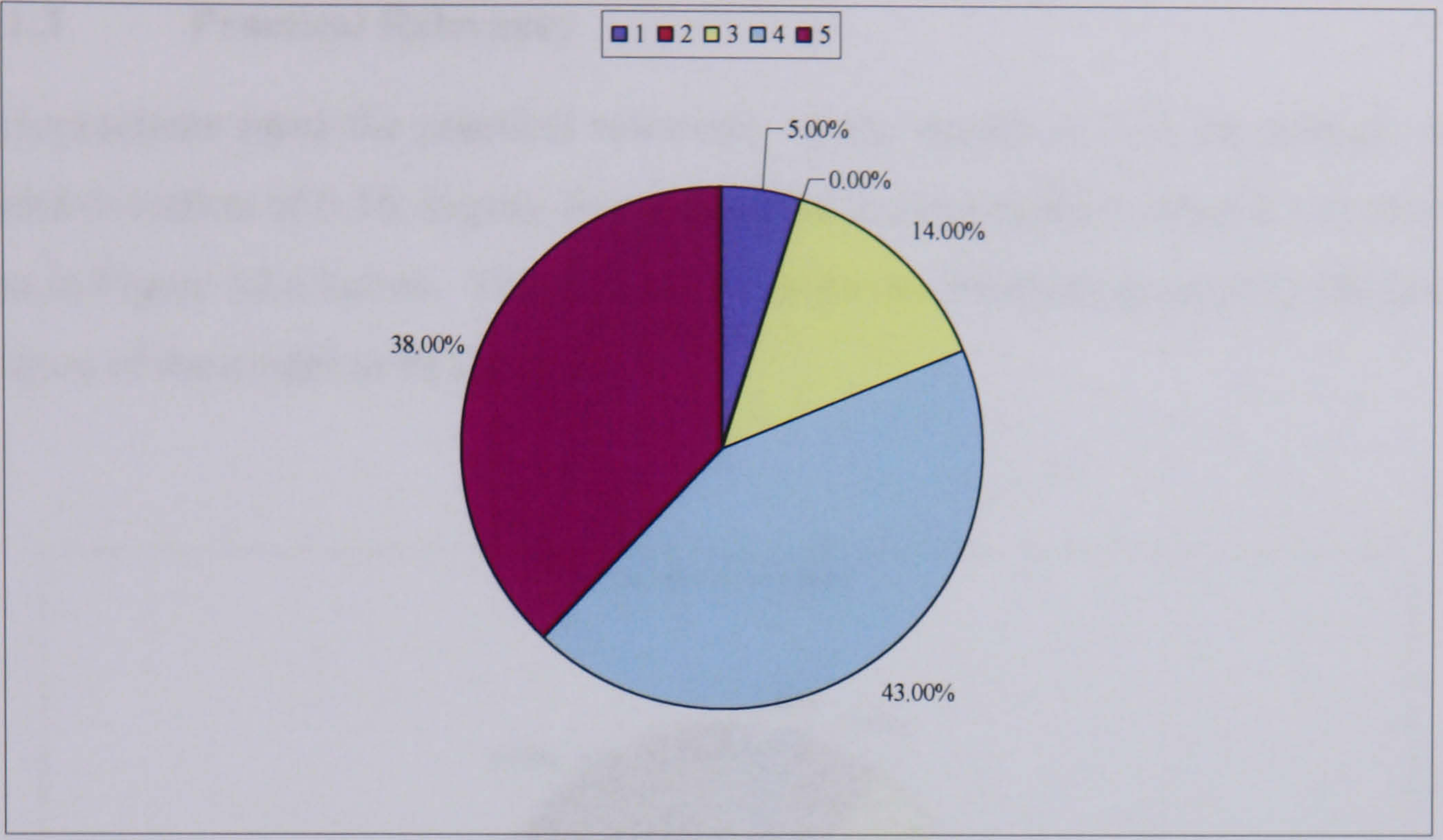


Figure 10.4: Model applicability to PFI schools

10.3.1.2 Model Comprehensiveness

The average rating of the model's comprehensiveness was 3.71, with a standard deviation of 0.17. As shown in Figure 10.5, 95% of the respondents rated the model's comprehensiveness from 3 to 5 as 27%, 36% and 32% respectively. This gives an indication that the model is quite comprehensive for its intended purpose.

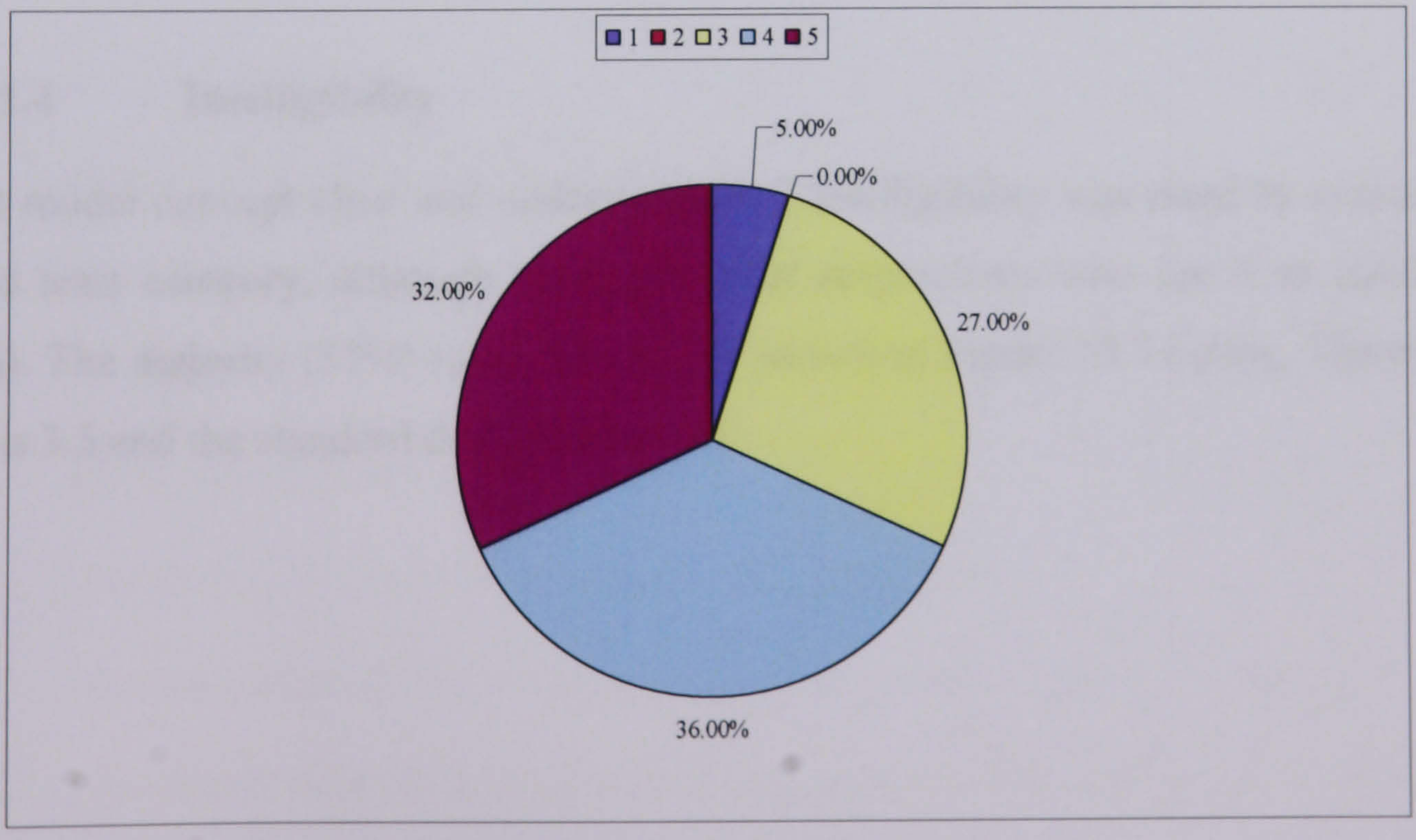


Figure 10.5: Model comprehensiveness (1 is low and 5 is high)

10.3.1.3 Practical Relevancy

The respondents rated the practical relevancy of the model as 3.50 on average, with a standard deviation of 0.16. Eighty-four percent of the respondents rated it 3 or above, as shown in Figure 10.6 below. This indicates that the respondents agree with the practical relevancy of the model to PFI projects.

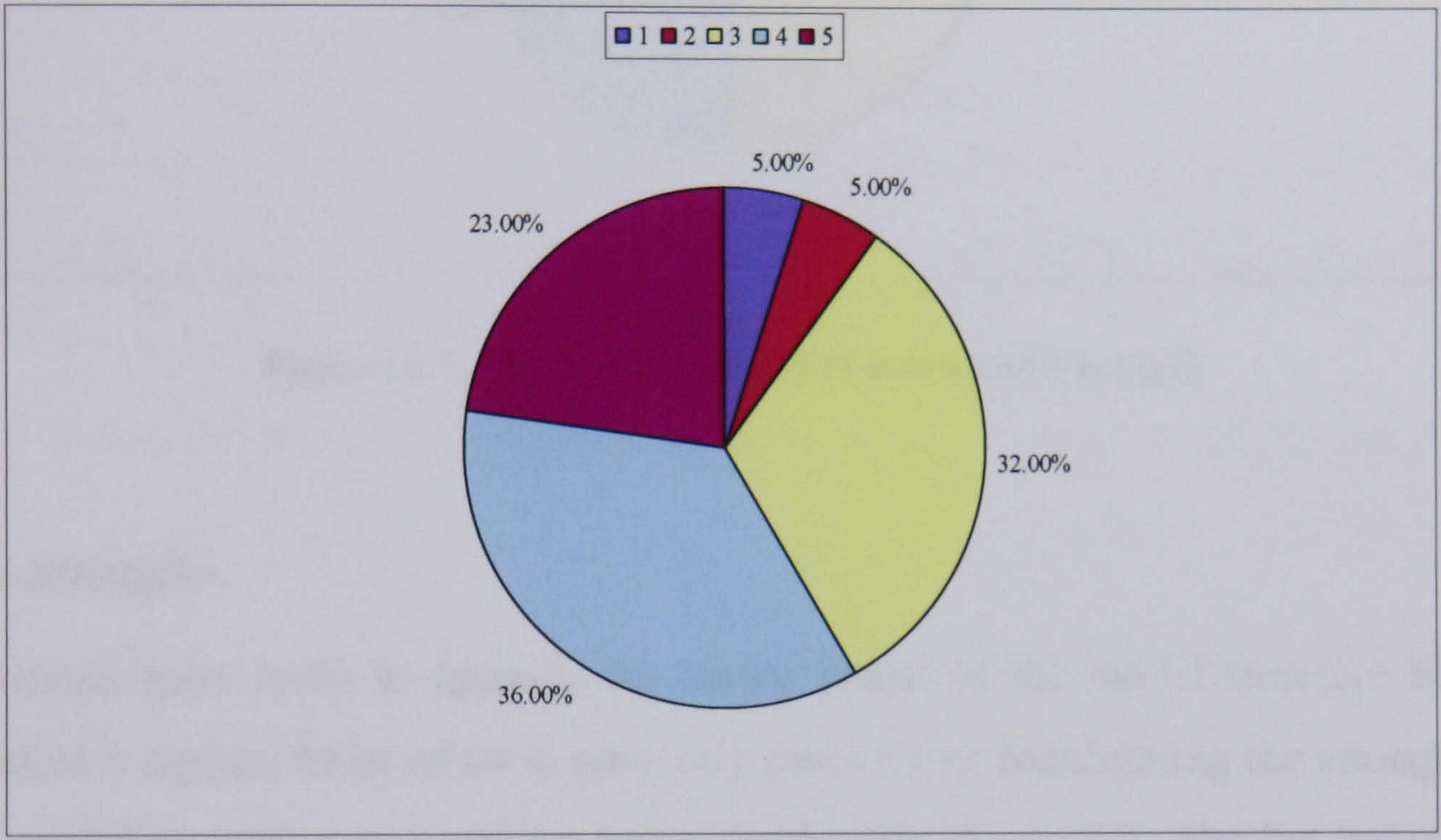


Figure 10.6: Model practical relevancy (1 is low and 5 is high)

10.3.1.4 Intelligibility

Is the model concept clear and understandable? Intelligibility was rated by respondents as the least category, although there are many respondents who see it as intelligible (43%). The majority (57%) rated this as 3 as shown in Figure 10.7 below. The average rank is 3.5 and the standard deviation is 0.25.

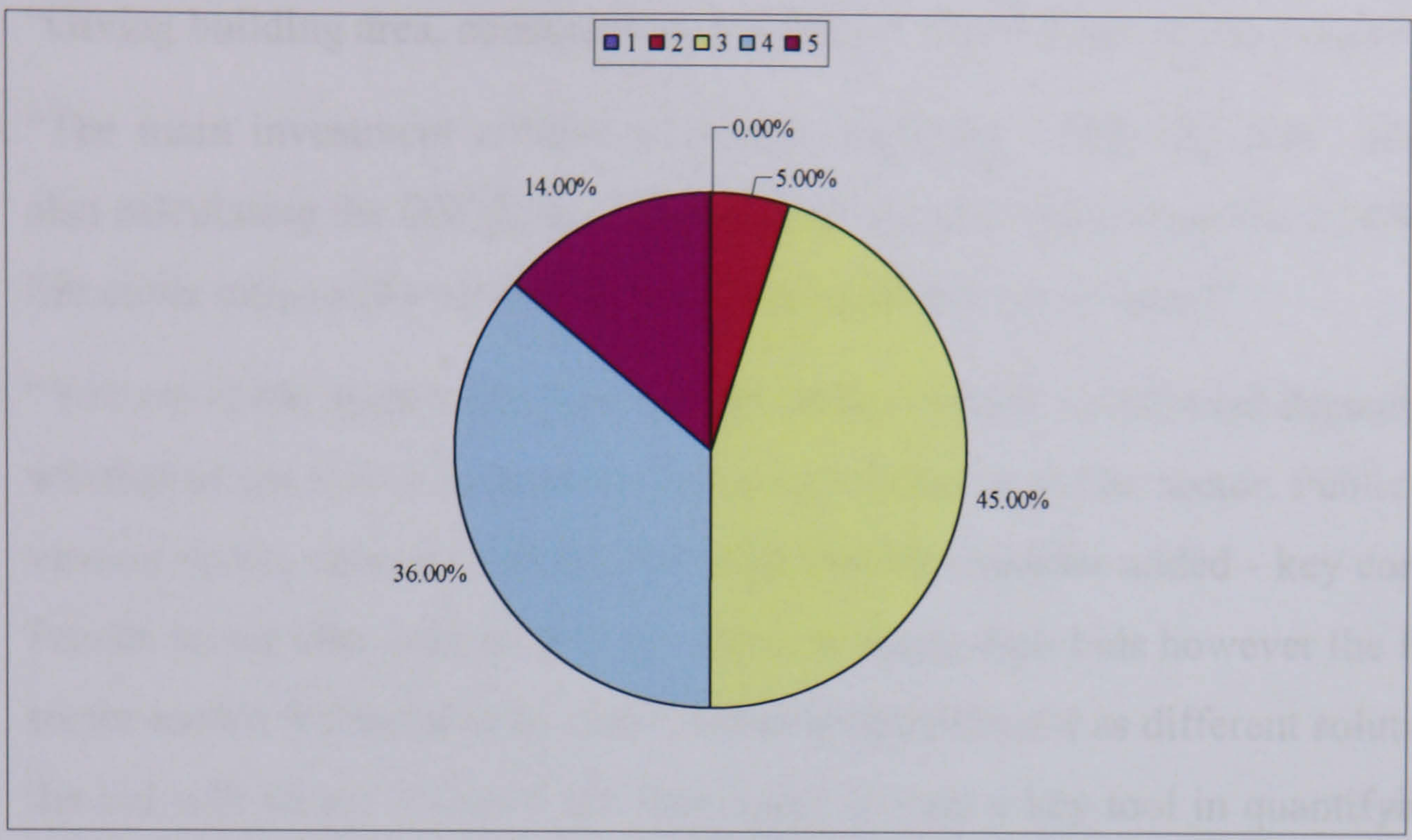


Figure 10.7: Model intelligibility (1 is low and 5 is high)

10.3.2 Strengths

The questionnaire seeks to identify the strong points of the model structure from the respondent's replies. Most of them gave responses either highlighting the strongt points of the model or giving suggestions for strengthening the model. The list below is the feedback of respondents (in their own words) on the model's strengths:

1. "This model is not limited to schools, but could be used for other type of projects. simple and comprehensive".
2. "Difficult to tell from limited information".
3. "Simple".
4. "Bottom up objective costing model".
5. "Comprehensiveness and the systematic structuring".
6. "Increases affordability confidence at a much earlier stage in the process"
7. "The model seem to have captured in practical terms the key areas to look for when developing and/or bidding for PFI projects".
8. "Simplicity".

9. "Giving building area, construction cost and LCC&FM cost of the project".
10. "The main investment criteria are being calculated - IRR and NPV. Model is also calculating the DSCR, though banks would also want to see the LLCR (loan life cover ratio) and possibly the PLCR (project life cover ratio)".
11. "You cover the main bases however the design should be different depending on whether or not it is to be used by the private sector or public sector. Public sector version needs value for money and affordability modules added - key concepts. Private sector also interested in the above to focus their bids however the Private sector model will need to be more decision/option based as different solutions to the bid will be put forward and the model will be a key tool in quantifying the optimum result and so dictate the bid strategy".
12. "Provides a structured approach to cost modelling on schools PFI projects".
13. "It seems applicable, comprehensive and practical in use".
14. "It integrates all the required cost requirements to arrive at the financial model of the PFI projects".
15. "The model contents most of the essential factors for a reliable cash flow model".
16. "Explicitly includes macro-economic variables that should refine the prediction capability of the model with regard to the economic changes. Quite comprehensive. Clear and quite easy to comprehend".
17. "With so many input variables to consider for the prediction purpose. The model should be user-friendly, extendable, multi-thread / levels of inputs facilities, interoperable and able to integrate with other systems. It may be required a feedback loop from the final prediction results, where results can be improved / altered and to predict its levels of accuracy etc".
18. "Seems comprehensive".
19. "Detail explanation at each stage, taking into consideration each component necessary".

20. "The model is very comprehensive and it does link many models together. I see the most strength of the model is the output of the cash flow and the construction cost. In addition to the entire information about the project profit".
21. "Considering the Occupancy cost module".
22. "Its modular structure".

The respondents view the strong points of the model structure as being its simplicity, comprehensiveness, integration and considering the most required input and output of a cost and cash flow models. However, one respondent mentioned that it is hard to identify the model's strong points from the limited information provided.

The suggestion stated in point (11) above is important and correct. The model design was developed to give the main decision making criteria: both the public and private sectors can use it. The model's outputs of unitary charge, space planning area, construction cost, LCC and FM cost, cash flow, project present value for the client, NPV, IRR, DSCR, and payback period are required for the public sector to check the viability of the project, and for the private sector to check the feasibility, profitability and cash flow behaviour. However, the public sector comparator (PSC) and its role in assessing value for money is outwith the scope of this study. Furthermore, this model could be used to provide the uncertain part of the comparison, which is the data of the new project.

Point No. (1) mentioned generalising the model to make it applicable to other projects, rather than limiting it to school projects. This is an important issue, which could be addressed through further work.

10.3.3 Weaknesses

The questionnaire also asked for reporting on the weak points of the model. The aim is to identify important issues and try to overcome these in order to improve the model. The twenty respondents to this question gave points and suggestions that were either taken on board in the model or discussed in this section. The following list reports what respondents said in their own words:

1. "The costly item is fm, it seems that this model is not predicting fm cost. it could be suggested to consider the future regulations and their impacts on the cost such as environments, sustainability etc..".
2. "Suggest limit to 2 models. 1st for non-financial (eg area, lifecycle basis) and the 2nd the main financial model with some inputs from 1st model and financial inputs. No links but a cut and paste import sheet from model 1. Also start with outputs and what is required. eg funders require LLCR".
3. "Too simple - lifecycle costing, confidence in quality of build, flexibility, alternative use, sensitivity analysis, Monte Carlo analysis for risk costing and finance costing".
4. "The profit and loss account and balance sheet should also be key outputs".
5. "Rigidity of the variables".
6. "Assumes all model inputs will be known at the same time. Needs a sensitivity analysis to recognise design development and cost impact of programme slippage".
7. "The apparent lack of flexibility to use historical data other than that of the BCIS in modelling the construction cost".
8. "There could be a section on historical data to populate areas of buildings e.g net to gross floor ratios; % of circulation; areas of construction wall thicknesses; areas of Wc's cleaning cupboards; plant rooms etc; external wall to floor ratios; % of glazing in external walls etc".

9. "Am unsure how the different 'modules' link together. Investors and banks will want to see the effect of various sensitivities on the model (the DSCR and LLCR in particular), and in order to do this, the model will need to be fully integrated. For example, banks will want to see the impact of changes in inflation assumptions on costs/the unitary charge - you need to be able to do this within one model (am unsure from your diagram if the different 'modules' are different Excel workbooks). Other sensitivities you could include are 1) reduction in unitary charge (due to poor performance) 2) increase in a particular cost, e.g. insurance, 3) delay in completion of construction, and therefore delay in unitary charge coming in d) combination of all of the above".

10. "No mention of Profit and Loss, Balance Sheets, Funding etc - all key outputs. Why two descriptions of UC? User and Model defined? Only one is usual. You should expand on the need for an inflation rate and interest rate - explain why these important. Also touch base on what assumptions would normally be made for each and why?".

11. "Where is cost of risk inputted to the model? Major problems currently exist in accurate prediction of 3rd party income and in future savings to be made in refinancing. Unclear how this model addresses this".

12. "There is no special weakness. It flows well".

13. "Because it contains all the cost models, it might be complicated to use as a practical tool in the industry".

14. "The model seems a bit "foggy" to me: every model needs an input and produces an output. These should be better readable on the scheme".

15. "Regional or let say country specific. To apply it outside the UK you may need to reconsider some of the building blocks and reconstruct some of the main components. The validity of the model in this case will need to be tested".

16. "With so many input variables to consider for the prediction purpose. The model should be user-friendly".

17. "Highly reliant upon quality of benchmark data (observation - not necessarily a weakness)".

18. "I have a doubt about the input of the model and the complexity in this regards".
19. "The model looks only at the monetary factors and ignores social and economical factors of sustainability which should be considered in all projects nowadays".
20. "Can't identify any".

Respondents gave important points that should be taken in consideration, such as the user-friendly interface, complexity, lack of flexibility and so on. The model considers occupancy cost as data entry. Predicting occupancy cost of a PFI project is a broad subject discussed in Chapter Eight. This could be recommended for future studies. Profit and loss account is a company level report. The model provides the profitability indicators in addition to the project balance account. Comment No. (8) regarding details of space planning is taken into consideration, as the model output shows the area of each school building component (such as basic teaching, halls, and even staff and administration facilities areas). Although simplicity was a point of strength, some respondents consider it as point of weakness.

Cost of risk is considered in the model as part of the construction contractor's costs. It is part of the occupancy cost provided by the FM contractor. Risk is related mostly with activities, and its cost is part of the cost of the activities risk associated with. The model allows for the third party income entry as other income for the project. However, in PFI project practice, this income fluctuates and is hard to predict; it is therefore not taken into consideration in the project bidding calculation. The third party income is dealt with in PFI projects via a special agreement between the client and the SPV.

10.3.4 Respondent's General Comments on the Model Concept

Respondents were asked to give their general comments on the concept and structure of the model. Thirteen gave comments that were constructive and encouraging in general. The comments are listed below in their own words:

1. "This model is a good start for such new type of procurements; it will help decision makers on both sides".
2. "Suggest that you ensure that strict modelling procedures are carried out. Separating inputs/workings/outputs, left-to-right consistency, short formulas. A good book to read would be Practical Financial Modelling by Jonathon Swan".
3. "Nice straightforward approach".
4. "As highlighted above this is already been done in a more comprehensive way. Therefore, this project is re-inventing the wheel. The predicted Unitary Charge is very important but is just one of the key models for the public sector. The public sector also has their affordability and value for money models".
5. "It is hoped that the possible differences between the prevailing interest rates and the rates for borrowed fund (cost of financing) can be taken care of by the model. Also, given the increasing complexity in the structure of recent PFI-variants, such as Schools for the Future scheme, I am not sure the model can capture the cash-outflows to the various partners".
6. "This should be a valuable tool especially for the public sector organisations in developing the Public Sector Comparators".
7. "Good model".
8. "I do not have solid background in PFI but I see the model comprise all the components that might affect cost".
9. "The model needs to have a Profit and Loss account output as well as the cash flow statement and balance sheet. Although PFI models are primarily concerned with cash flows and whether these can support the level of debt required for the project, firms will want to see the accounting profits of the PFI project. Good luck with you project!!".
10. "Appears to be concentrated on UK PFI model only. Worldwide PPP market is much wider".
11. "It can be a good tool for PFI projects".

12. "I am not so much aware of PFI school projects but some general points have to be applied to all cash flow models: - which is the equity/debt ratio - the opportunity costs and the depreciation have to be taken into account - the taxes and the business profit that can be reinvested should be shown - ROE and ROI are useful as output".
13. "This is rather a question than a comment. How will the model consider the economic turbulence that may occur over the life span of the project. The inclusion of variables like the interest rate or inflation is good in theory. However, to extent can you project accurate estimates to such variables? 3 yrs sure, 5 yrs may be but more than that is most unlikely. Does this affect the accuracy of the model? we need the interest rate to calculate the cash flow so what discount rate shall you use for the long term say 15 years down the line? These are just my thoughts. May be I am not that much acquainted with PFI models still it useful to share thoughts".
14. "It is a very interesting model. As long as keep in simple and easy to use it will win the heart of the users. Hope this helps!"
15. "Very interesting concept".
16. "An elaborate conceptual model which may be used to predict cost and cash flow of PFI school projects".
17. "The model explains all the complicated processes of cost estimating in a very simple and clear way and covers all main areas which should be taken into account for this type of project".
18. "Need more information to properly judge on the model".

The public sector has their affordability and value for money model of PFI. This has nothing to do with the model except using its output for the Public Sector Comparator, which is the main assessment criteria for affordability and value for money for the public sector. The model calculates the main ratio used for decision-making in the very early stages of the project. More ratio could be applied if the decision is to take the project further. The main output report items required, according to interviewees are: unitary charge for public sector, IRR for private sector, and DSCR for investors (banks).

10.3.5 Information About Respondents

Respondents were asked for some simple information to check their background, work experience, and their knowledge about PFI financial management. This included the organisation they are working for, and their country of origin to show the distribution of the respondents globally. The details of this information are shown below:

10.3.5.1 Experience in PFI

The number of respondents with knowledge of PFI is quite high. Table 10.4 and Figure 10.8 show the respondent's experience in regards to PFI projects. 45.45% of them have worked on PFI projects, while 36.36% are doing research/studies on PFI projects.

Table 10.4: Respondent's background

Experience	Number	%
I have some knowledge	4	18.18%
My field of study/research	8	36.36%
I have worked on PFI projects	10	45.45%
Other (please Specify)	0	0.00%
	22	100.00%

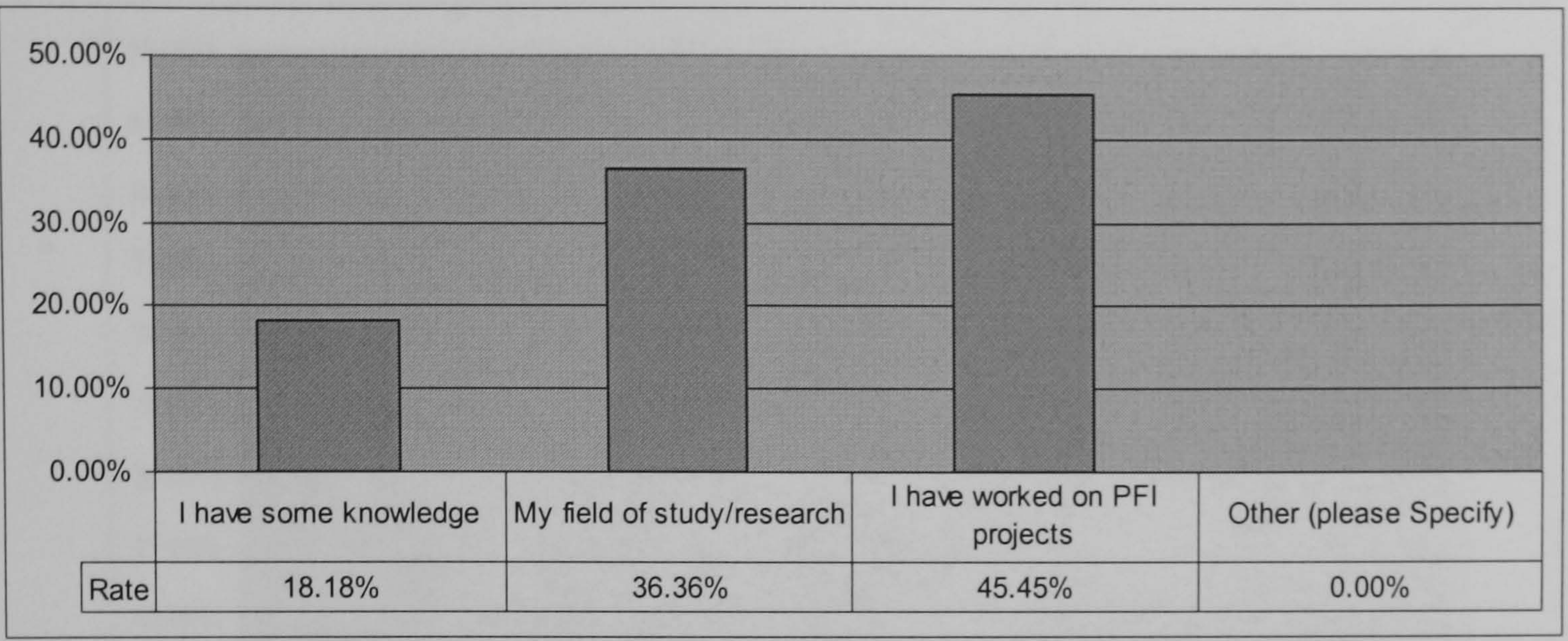


Figure 10.8: Respondent's experience in PFI projects

10.3.5.2 Respondent's Designation

The designation was relatively high ranking: five directors responded, representing 23% of the respondents. Two of the respondents are in positions closely related to the subject; they work as financial modellers, and represent 14%. The other high category is researchers, who represent 45% of the respondents, as shown in Table 10.5 and Fig. 10.9, 64% of the respondents are from industry, while 34% are from academic centres.

Table 10.5: Respondent's designations/positions

Designation / Positions	Number of Respondents	%
financial modeller	2	9.09%
Director	5	22.73%
Researcher	10	45.45%
Cost planning manager	3	13.64%
Facilities Manager	2	9.09%
	22	100.00%

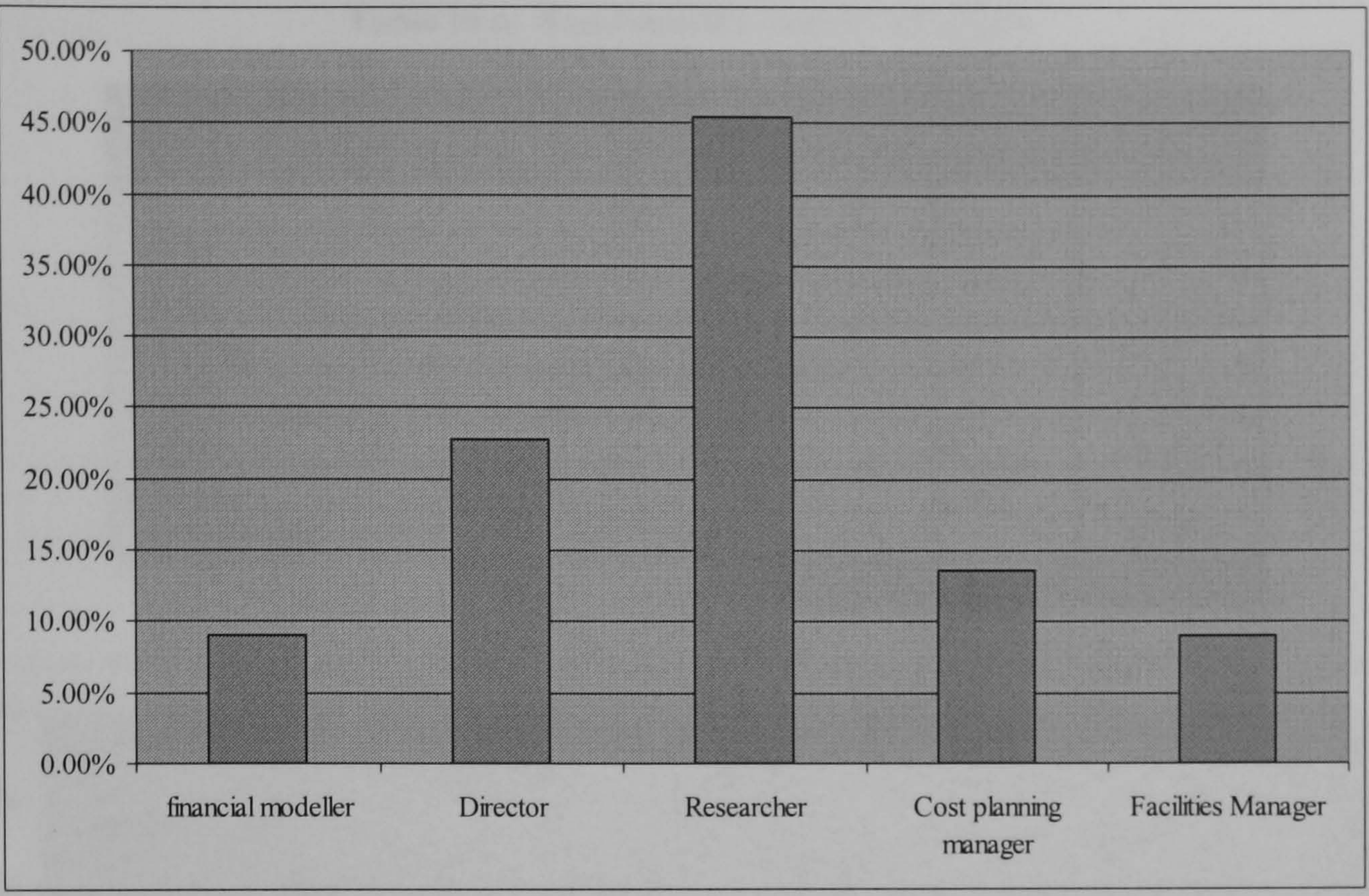


Figure 10.9: Respondent's Designations

10.3.5.3 Country of Origin

The questionnaire was sent to experts in different countries; although the concentration was on the UK, it was also sent to countries including China, Singapore, Malaysia, Australia, Netherlands, Finland, Swede, United Arab Emirates, Saudi Arabia, Oman, Germany, Greece, Turkey and others. Table 10.6 and Figure 10.10 show the distribution of respondents in these five countries. It is clear that 68% of the respondents are from the UK, which reflects many issues. The concentration of respondents of experts are from the UK whose e-mail addresses are available and publicised, and the interest of expert in the model since information used in developing it are UK based. One of the respondents mentioned that clearly in his answer.

Table 10.6: Respondent's country of origin

Country	Number of Respondents	%
UK	15	68.18%
Oman	1	4.55%
Eygpt	1	4.55%
Malaysia	1	4.55%
Greece	1	4.55%
Turkey	1	4.55%
Ireland	1	4.55%
Saudi Arabia	1	4.55%
	22	100.00%

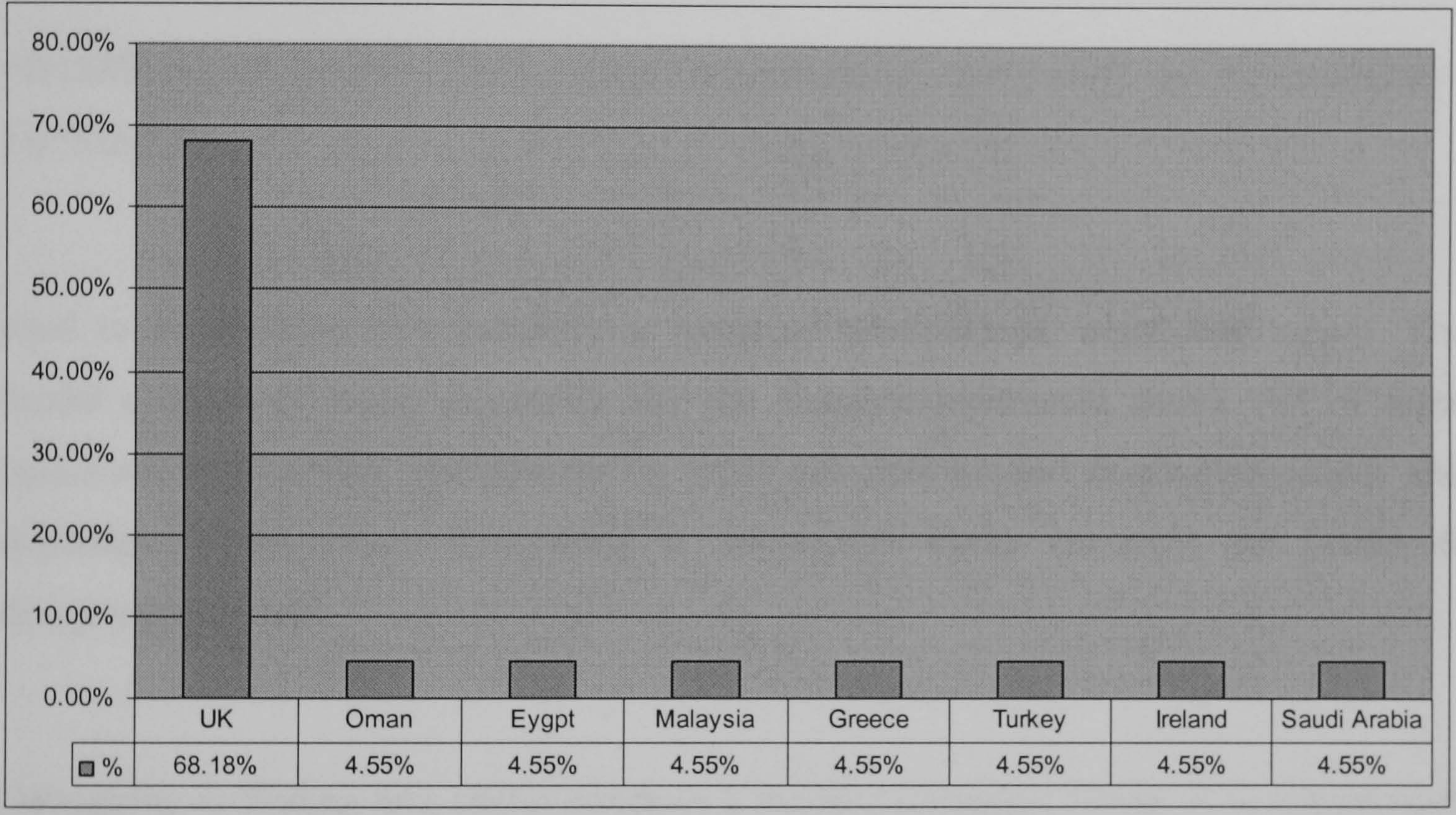


Figure 10.10: Respondent's country of origin

10.4 Chasing, Judgement and Debugging

The model consists of logical mathematical relationships and equations. These relations and equations are formed in a computer-based spreadsheet and give the required outputs. The model needs to be chased for each entry and output; precedents and dependent relationships should be traced carefully and judged according to the required results and the right entries. Equations in the model need to be checked for their accuracy, especially with the use of so many conditional functions. Sengupta (2004) advised that models should be checked by hand calculation as well as by judging them for reasonableness. This method of testing the computer-based models seems to be simple but it was found when applied that it is very important.

The model was traced from the precedents and dependent relationships, checked using hand calculations. External calculators, when applied to the equations in the model, found some errors because of the way equations are written in the programming language. Equations such as this one:

```
=IF(S88>0;((S90*(1+S90)^ROUND($C$81/S89;0))/((1+S90)^ROUND($C$81/S89;0)-1))*S88;" ")
```

need to be checked very carefully in terms of relationships, input, and output. The model consists of many equations like the example mentioned above. All of these equations were tested individually by hand calculations and tracing precedent and dependent relationships. Everything in the model works correctly and fulfils its designated purpose.

Debugging is finding and fixing errors in a model (Sengupta, 2004). It is a term used mostly with software development. Metzger (2004) defined debugging as the process of determining why a given set of inputs causes an unacceptable behaviour in a program and what must be changed to cause the behaviour to be acceptable. According to Sengupta (2004), there is no standard approach for debugging, but using ingenuity to calculate what the best way to test and debug a model would be an accepted method. Moscato (1997) reported that most practitioners self-validate their financial models.

The model was debugged by entering many different sets of data to check the workability of the model. The data entries differ in their size and quantities; some times unpractical for their size either very low or very high. The debugging process was applied to the model in its Excel spreadsheets and the web-based software format. The results show nothing that could be considered as strange; outputs and reports seem to be compatible with the expected results from the entered data.

10.5 Individual Modules Testing

The FPI financial model developed consists of four modules: space planning, construction cost, occupancy cost and cash flow. The tests for these modules are reported in the previous chapters. However, for clarity it is worth summarising the validation done for each module.

The space planning module was tested in various ways, described in detail in Chapter 6. The module was sent to the public authorities responsible for schools' design and building. Their evaluation of the module was that the module "seems to work well". It was tested for the space requirements of exemplar schools and the mean error was 1.34% for primary schools and 2.61% for secondary schools. Furthermore, the module was tested to calculate areas of school building published in BCIS index. The mean error was 7.35% for fifty primary school and 6.84% for seven secondary schools.

The construction cost module was developed based on the historical data of seventy schools' bidding data published by BCIS. The module output was tested on the same data, and the mean prediction error was 9.98%. The module was validated on the raw data of 15 schools not used in the model's development. The result was 8.23% as a mean prediction error. These results could be considered as acceptable compared with other models. Ling and Boo (2001) found in their research on improving the accuracy of approximate estimates of building projects that clients may take a calculated risk and not seek more funds if quantity surveyor estimates are higher than their budget by less than 10%.

The occupancy cost module is based on the user data entry. It is treated for the interest rate to reflect the natural value of the invested amounts, based on the interval of the activities. The results of LCC and FM main categorised items cost, distributed according to the amount and interval, were tested in terms of its accuracy and found to be acceptable.

10.6 Online Model Test

The model was programmed using the Javascript and PHP languages. It was launched on the World Wide Web using a reserved domain and hosting agreement. The sequences and results of the web site model were tested before sending the link to experts and practitioners. Figures 10.11 to 10.29 show screen shots of the model stage by stage. Hypothetical numbers and rates were entered to show the result and report pages.

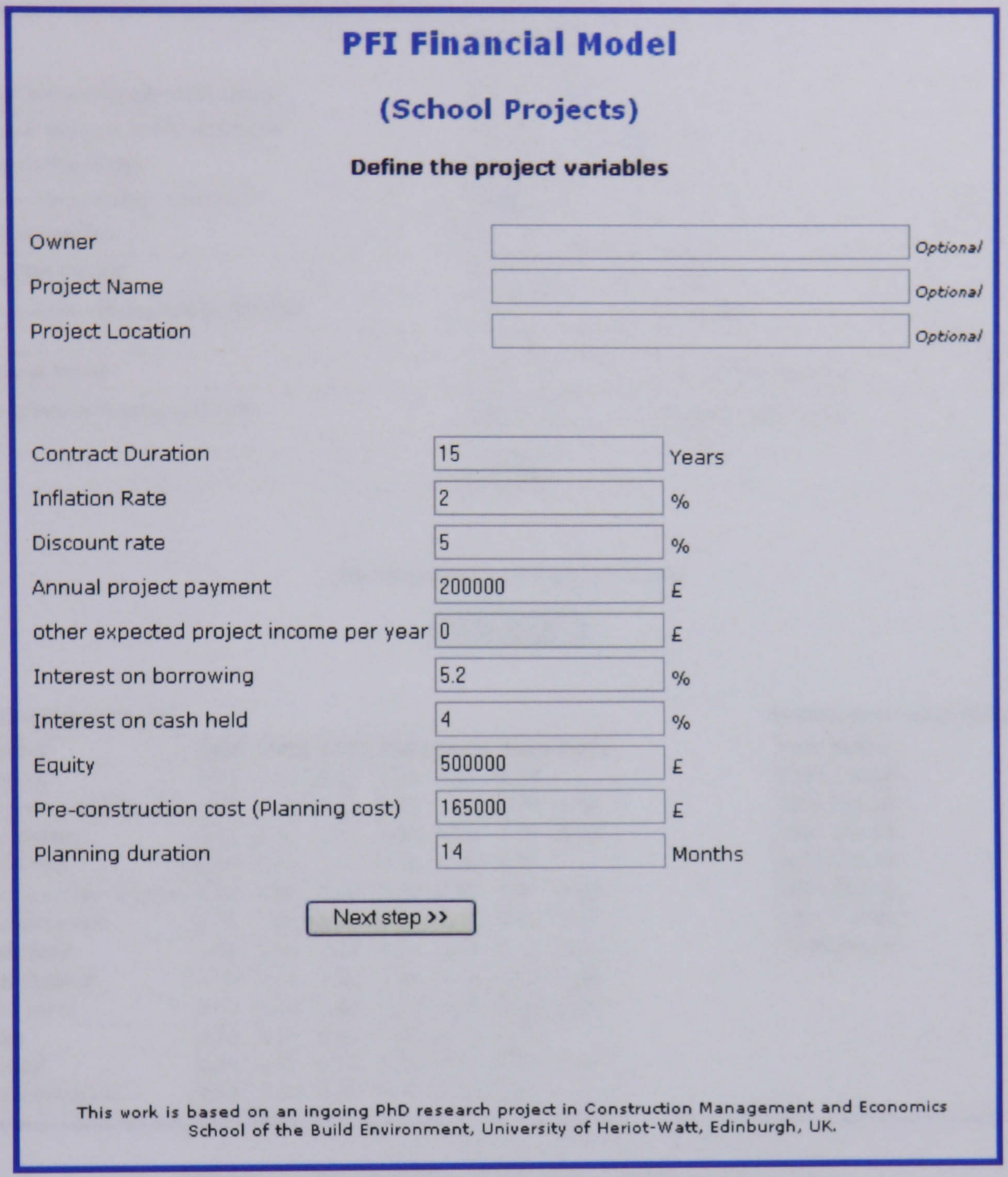


Figure 10.11: First data entry to define the projects variables

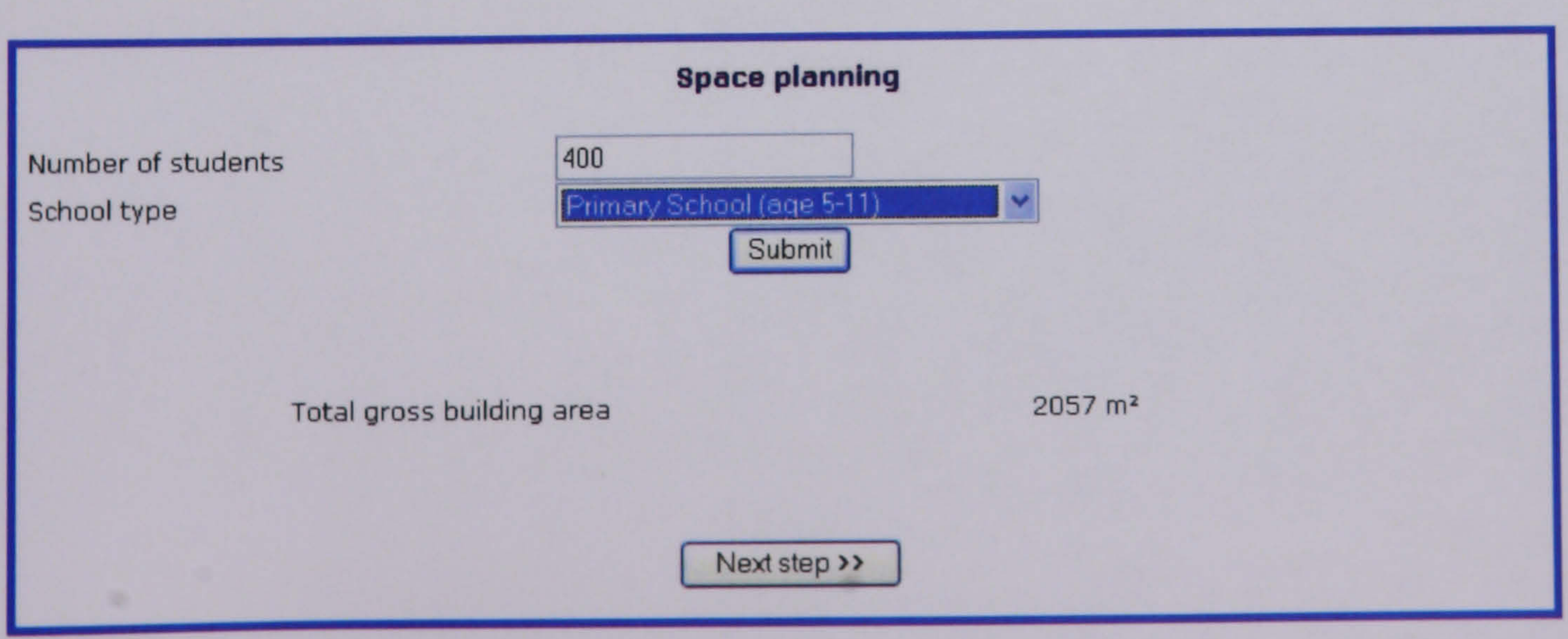


Figure 10.12: Space planning entries and result.

Construction Cost

What is the GROUND CONDITION?	Good	
What is the type of FOUNDATION?	STRIP	
What is the FRAME?	STEEL	
What is the number of STORY?	2	
PRELIMINARIES	10	%
CONTINGENCIES	5	%
What is the construction DURATION?	18	Months
Location factor	1.06	Check table below
Construction building cost index	254.34	Check table below
	Submit	

The construction cost is £3,913,861.36

Next step >>

Location factors (BCIS)

Location	2000	2001	2002	2003	2004	2005	2006
Northern	0.97	0.97	0.97	1.00	1.01	1.04	
Yorkshire & Humberside	0.95	0.94	0.96	0.99	1.02	1.08	1.02
East Midlands	1.06	1.04	1.01	0.98	1.04	1.02	1.03
East Angila	0.93	0.93	1.01	0.98	0.96	0.94	
South East (Ex. London)	0.99	0.98	1.00	0.98	0.97	0.97	0.90
Greater London	0.96	1.05	1.01	0.97	0.94	0.93	0.99
South West	1.03	1.03	1.04	1.04	1.04	1.03	1.03
West Midlands	1.02	1.01	1.00	1.02	0.98	1.00	0.98
North West	0.97	0.96	0.94	0.97	0.99	0.96	0.92
Wales	0.98	0.94	0.97	0.99	0.96	0.95	
Scotland	0.94	0.92	0.93	0.90	0.92	0.95	1.06
Northern Ireland	0.97	0.85	0.89	0.86	0.90	0.78	

Building construction cost index

Year	Index
2000	190.38
2001	196.28
2002	204.53
2003	215.20
2004	227.40
2005	241.28
2006	254.34

Figure 10.13: Construction cost variables and results.

LCC cost elements

Please enter the total life cycle cost (In present worth terms) and the interval of the LCC major work:

	Substructure	Superstructure	Internal finishes	Fixture, fixed furniture and equipment	M & E services	ICT cabling	External Works	Loose furniture and equipment	Internal adaptations	ICT equipment	Total LCC yearly cost
Total cost	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	
Interval (in years)	1	2	3	4	5	1	2	3	4	5	
Interest	0.05	0.10	0.16	0.22	0.28	0.05	0.10	0.16	0.22	0.28	
Expenses	2,768.10	5,674.60	9,111.57	11,930.85	15,970.56	2,768.10	5,674.60	9,111.57	11,930.85	15,970.56	
REPORT											
0											0
1											0
2	923	1,892				923	1,892				5,630
3	2,768		9,112			2,768		9,112			23,760
4	2,768	5,675		11,931		2,768	5,675		11,931		40,748
5	2,768				15,971	2,768				15,971	37,478
6	2,768	5,675	9,112			2,768	5,675	9,112			35,110
7	2,768					2,768					5,536
8	2,768	5,675		11,931		2,768	5,675		11,931		40,748
9	2,768		9,112			2,768		9,112			23,760
10	2,768	5,675			15,971	2,768	5,675			15,971	48,828
11	2,768					2,768					5,536
12	2,768	5,675	9,112	11,931		2,768	5,675	9,112	11,931		58,972
13	2,768					2,768					5,536
14	2,768	5,675				2,768	5,675				16,886
15	2,768		9,112		15,971	2,768		9,112		15,971	55,702
16	2,768	5,675		11,931		2,768	5,675		11,931		40,748
17	461					461					922

Submit

Next step >>

Figure 10.14: LCC data entry and result.

FM expenses elements

Please enter the total Facilities Management cost (In present worth terms):

	Building Maintenance	Responsive Repaires	Cleaning and Refuse collection	Catering	Caretaking/Security	Grounds Manintenance	ICT Network Management	Energy	Water	Insurance	Rates	Total FM expenses
Total cost	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	
Interval (in years)	1	1	1	1	1	1	1	1	1	1	1	
Interest	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Expenses	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	1,845.40	
REPORT												
0												0
1												0
2	615	615	615	615	615	615	615	615	615	615	615	6,765
3	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
4	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
5	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
6	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
7	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
8	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
9	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
10	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
11	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
12	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
13	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
14	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
15	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
16	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	1,845	20,295
17	308	308	308	308	308	308	308	308	308	308	308	3,388

Submit

Next step >>

Figure 10.15: FM data entry and result.

Report 1

Project cash flow

(Model defined payment)

Cash out

Years	Pre-Construction cost	Construction cost	LCC cost	FM cost	Total	Inflated Total	Com. Total	Com. Inflated total	Present worth
0	141,429	0	0	0	141,429	141,429	141,429	141,429	141,429
1	23,571	2,153,650	0	0	2,177,222	2,220,766	2,318,651	2,362,195	2,115,015
2	0	1,760,211	5,630	6,765	1,772,606	1,844,219	4,091,257	4,206,414	1,672,761
3	0	0	23,760	20,295	44,055	46,752	4,135,312	4,253,166	40,386
4	0	0	40,748	20,295	61,043	66,075	4,196,355	4,319,241	54,360
5	0	0	37,478	20,295	57,773	63,786	4,254,128	4,383,027	49,978
6	0	0	35,110	20,295	55,405	62,395	4,309,533	4,445,422	46,560
7	0	0	5,536	20,295	25,831	29,672	4,335,364	4,475,094	21,087
8	0	0	40,748	20,295	61,043	71,522	4,396,407	4,546,616	48,409
9	0	0	23,760	20,295	44,055	52,650	4,440,462	4,599,266	33,939
10	0	0	48,828	20,295	69,123	84,261	4,509,585	4,683,527	51,729
11	0	0	5,536	20,295	25,831	32,118	4,535,416	4,715,645	18,779
12	0	0	58,972	20,295	79,267	100,530	4,614,683	4,816,175	55,979
13	0	0	5,536	20,295	25,831	33,415	4,640,514	4,849,590	17,721
14	0	0	16,886	20,295	37,181	49,060	4,677,695	4,898,650	24,779
15	0	0	55,702	20,295	75,997	102,282	4,753,692	5,000,932	49,199
16	0	0	40,748	20,295	61,043	83,799	4,814,735	5,084,731	38,389
17	0	0	922	3,388	4,310	6,035	4,819,045	5,090,766	2,633

Figure 10.16: Report (1): Cash out table

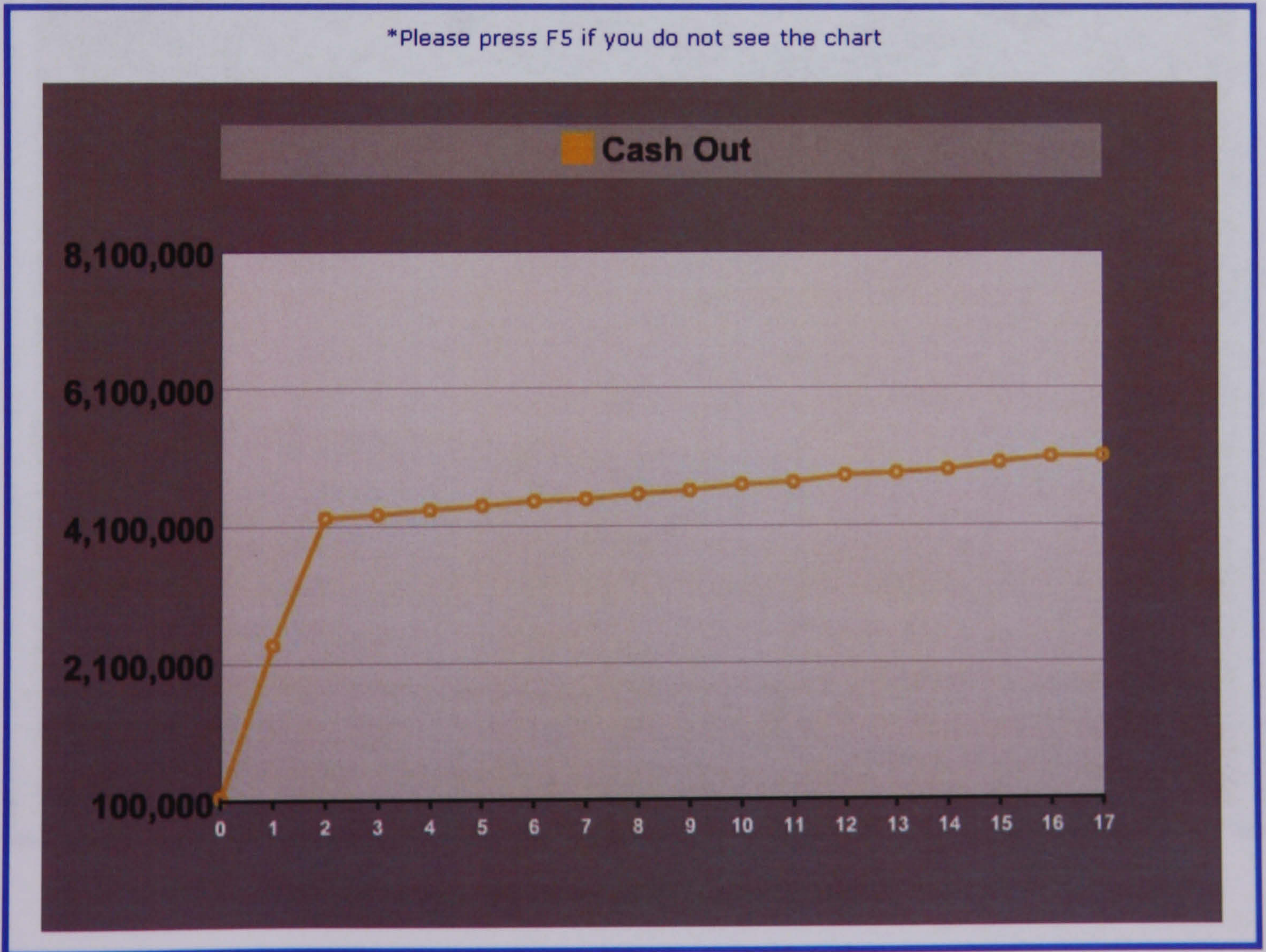


Figure 10.17: Report (1): Cash out chart.

Cash In (Model Defined Payment)

Years	Annual Project Payment	Other Income	Total Income	Com. Income	Inflated income	Com. Inflated income
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	148,550	0	148,550	148,550	154,551	154,551
3	445,650	0	445,650	594,200	472,927	627,479
4	445,650	0	445,650	1,039,850	482,386	1,109,864
5	445,650	0	445,650	1,485,500	492,033	1,601,898
6	445,650	0	445,650	1,931,149	501,874	2,103,772
7	445,650	0	445,650	2,376,799	511,912	2,615,684
8	445,650	0	445,650	2,822,449	522,150	3,137,833
9	445,650	0	445,650	3,268,099	532,593	3,670,426
10	445,650	0	445,650	3,713,749	543,245	4,213,671
11	445,650	0	445,650	4,159,399	554,110	4,767,781
12	445,650	0	445,650	4,605,049	565,192	5,332,972
13	445,650	0	445,650	5,050,699	576,496	5,909,468
14	445,650	0	445,650	5,496,348	588,026	6,497,494
15	445,650	0	445,650	5,941,998	599,786	7,097,280
16	445,650	0	445,650	6,387,648	611,782	7,709,061
17	74,275	0	74,275	6,461,923	104,003	7,813,064

Figure 10.18: Report (1) Cash in table.

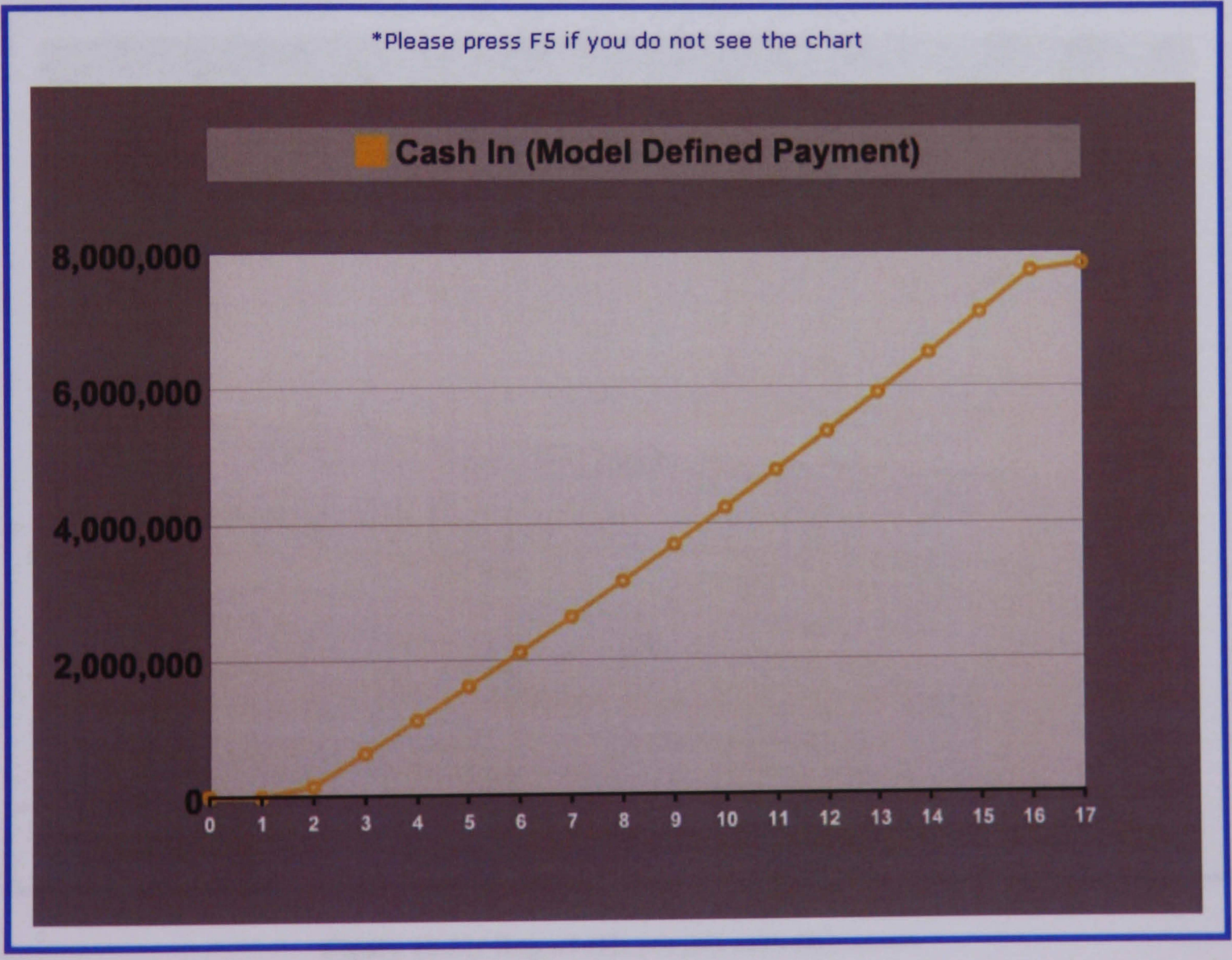


Figure 10.19: Report (1) cash in chart.

Cash Flow (Model Defined Payment)

Years	Cum. Cash out	Cum. Cash In	Cum. Cash flow
0	141,429	0	-141,429
1	2,362,195	0	-2,362,195
2	4,206,414	154,551	-4,051,863
3	4,253,166	627,479	-3,625,687
4	4,319,241	1,109,864	-3,209,377
5	4,383,027	1,601,898	-2,781,129
6	4,445,422	2,103,772	-2,341,650
7	4,475,094	2,615,684	-1,859,410
8	4,546,616	3,137,833	-1,408,783
9	4,599,266	3,670,426	-928,840
10	4,683,527	4,213,671	-469,856
11	4,715,645	4,767,781	52,136
12	4,816,175	5,332,972	516,797
13	4,849,590	5,909,468	1,059,878
14	4,898,650	6,497,494	1,598,844
15	5,000,932	7,097,280	2,096,348
16	5,084,731	7,709,061	2,624,330
17	5,090,766	7,813,064	2,722,298

Figure 10.20: Report (1): project cash flow.

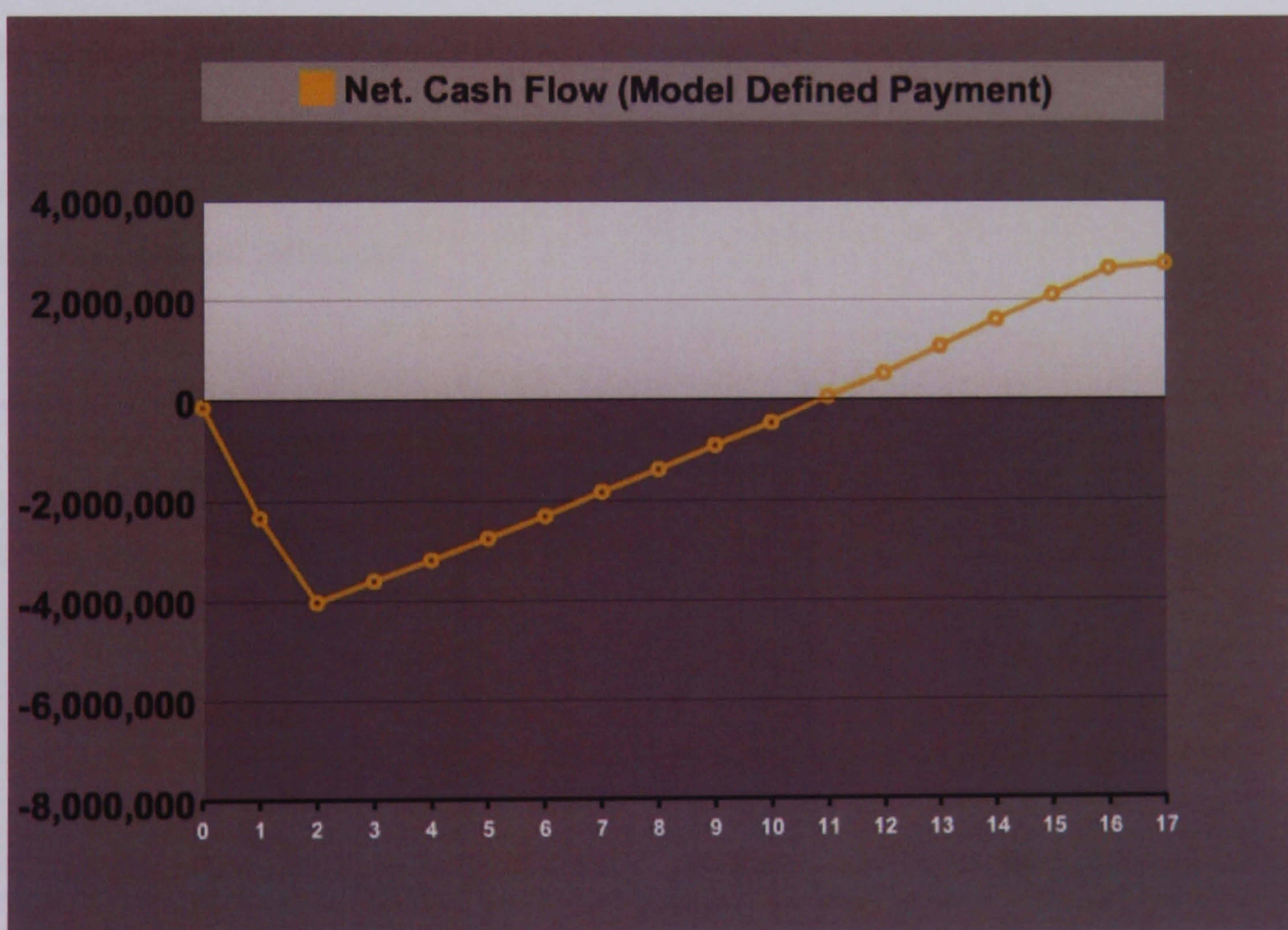


Figure 10.21: Report (1): project cash flow chart.

Cash Flow Balance (Model Defined Payment)

Years	Opening Balance	Interest	Closing Balance
0	358,571	14,343	372,914
1	-1,847,852	-96,088	-1,943,940
2	-3,633,608	-188,948	-3,822,556
3	-3,396,380	-176,612	-3,572,992
4	-3,156,682	-164,147	-3,320,829
5	-2,892,581	-150,414	-3,042,995
6	-2,603,516	-135,383	-2,738,899
7	-2,256,659	-117,346	-2,374,005
8	-1,923,378	-100,016	-2,023,394
9	-1,543,451	-80,259	-1,623,710
10	-1,164,726	-60,566	-1,225,292
11	-703,300	-36,572	-739,872
12	-275,211	-14,311	-289,522
13	253,559	10,142	263,701
14	802,667	32,107	834,774
15	1,332,278	53,291	1,385,569
16	1,913,551	76,542	1,990,093
17	2,088,061	83,522	2,171,583

Next step >>

Figure 10.22: Report (1): Cash flow balance.

The cash out report, if the user defines the payment, is similar to the cash out report if the payment is model defined. Defining the payment will have impact on the cash out, cash flow, and project balance account. Therefore, the screen shots for report (2) are from the cash out table only.

Cash In

Years	Annual Project Payment	Other Income	Total Income	Inflated income	Com. cash in
0	0	0	0	0	0
1	0	0	0	0	0
2	133,333	0	133,333	138,720	138,720
3	400,000	0	400,000	424,483	563,203
4	400,000	0	400,000	432,973	996,176
5	400,000	0	400,000	441,632	1,437,808
6	400,000	0	400,000	450,465	1,888,273
7	400,000	0	400,000	459,474	2,347,747
8	400,000	0	400,000	468,664	2,816,411
9	400,000	0	400,000	478,037	3,294,448
10	400,000	0	400,000	487,598	3,782,046
11	400,000	0	400,000	497,350	4,279,396
12	400,000	0	400,000	507,297	4,786,692
13	400,000	0	400,000	517,443	5,304,135
14	400,000	0	400,000	527,792	5,831,926
15	400,000	0	400,000	538,347	6,370,274
16	400,000	0	400,000	549,114	6,919,388
17	66,667	0	66,667	93,350	7,012,738

Figure 10.23: Report (2): Cash In.

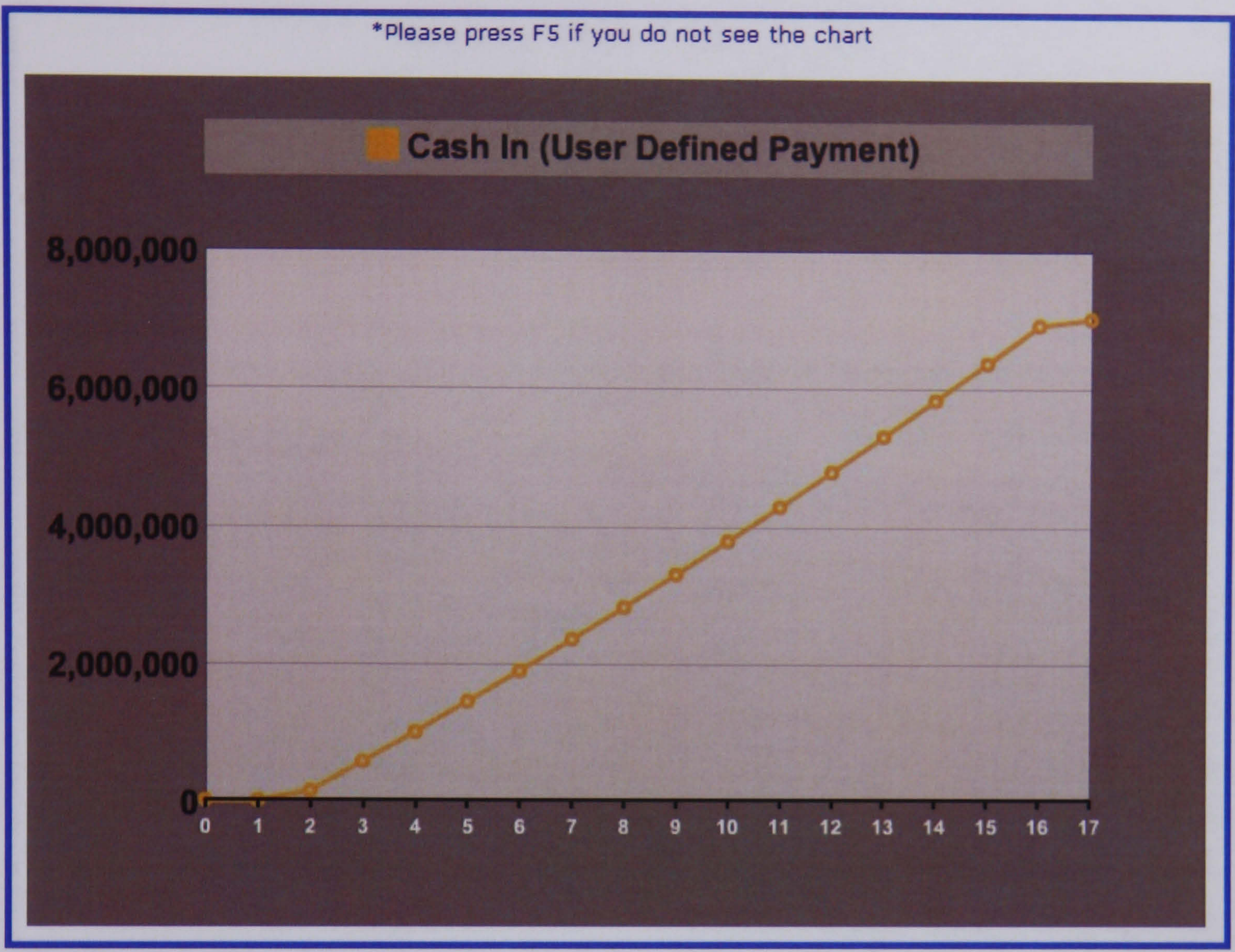


Figure 10.24: Report (2): Cash In chart.

Cash Flow (User Defined Payment)

Years	Cum. Cash out	Cum. Cash In	Cum. Cash flow
0	141,429	0	-141,429
1	2,362,195	0	-2,362,195
2	4,206,414	138,720	-4,067,694
3	4,253,166	563,203	-3,689,963
4	4,319,241	996,176	-3,323,065
5	4,383,027	1,437,808	-2,945,219
6	4,445,422	1,888,273	-2,557,149
7	4,475,094	2,347,747	-2,127,347
8	4,546,616	2,816,411	-1,730,205
9	4,599,266	3,294,448	-1,304,818
10	4,683,527	3,782,046	-901,481
11	4,715,645	4,279,396	-436,249
12	4,816,175	4,786,692	-29,483
13	4,849,590	5,304,135	454,545
14	4,898,650	5,831,926	933,276
15	5,000,932	6,370,274	1,369,342
16	5,084,731	6,919,388	1,834,657
17	5,090,766	7,012,738	1,921,972

Figure 10.25: Report (2): Cash flow.

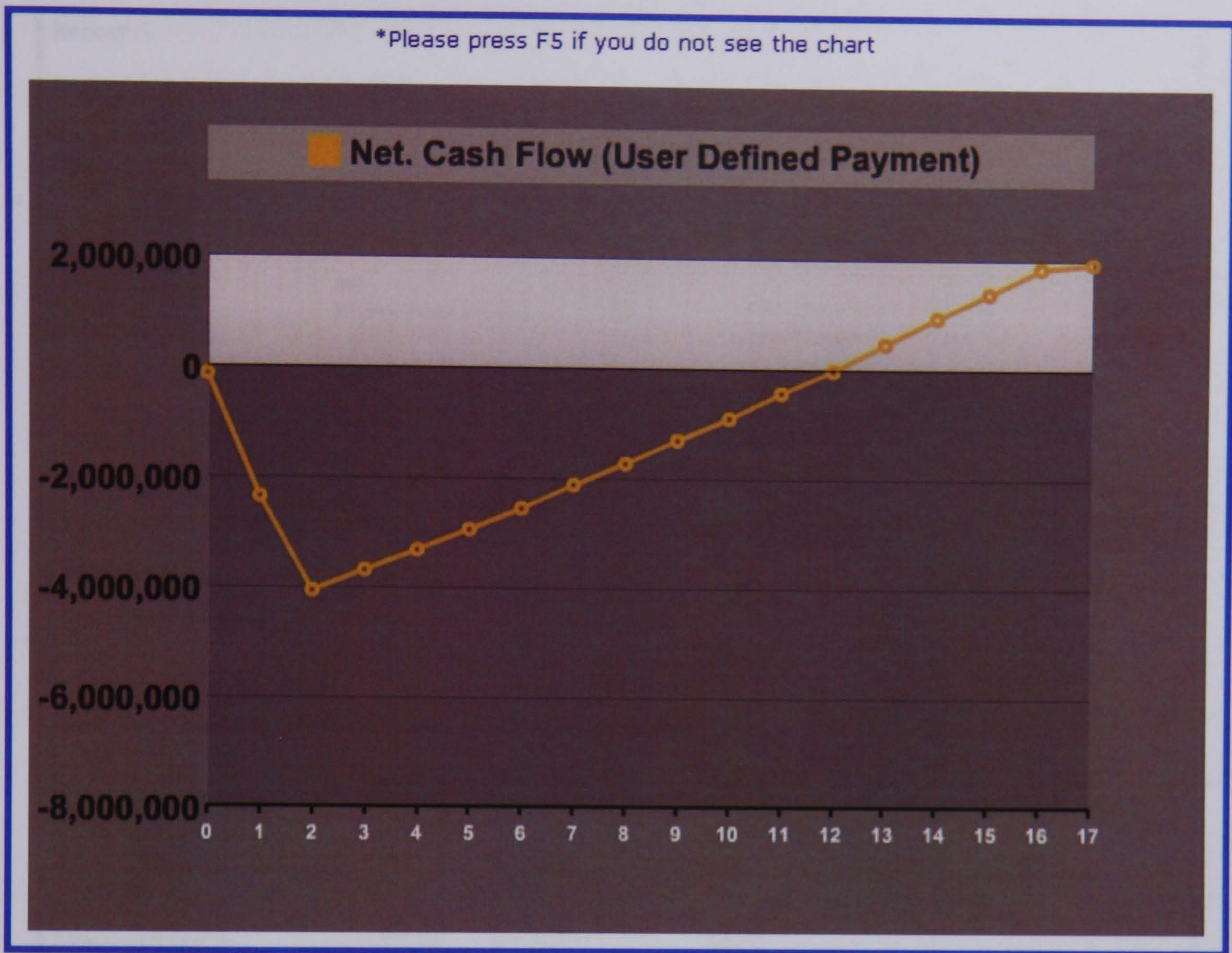


Figure 10.26: Report (2) Cash Flow Chart.

Cash Flow Balance (User Defined Payment)

Years	Opening Balance	Interest	Closing Balance
0	358,571	14,343	372,914
1	-1,847,852	-96,088	-1,943,940
2	-3,649,439	-189,771	-3,839,210
3	-3,461,479	-179,997	-3,641,476
4	-3,274,578	-170,278	-3,444,856
5	-3,067,010	-159,485	-3,226,495
6	-2,838,425	-147,598	-2,986,023
7	-2,556,221	-132,923	-2,689,144
8	-2,292,002	-119,184	-2,411,186
9	-1,985,799	-103,262	-2,089,061
10	-1,685,724	-87,658	-1,773,382
11	-1,308,150	-68,024	-1,376,174
12	-969,407	-50,409	-1,019,816
13	-535,788	-27,861	-563,649
14	-84,917	-4,416	-89,333
15	346,732	13,869	360,601
16	825,916	33,037	858,953
17	946,268	37,851	984,119

Next step >>

Figure 10.27: Report (2): Project balance account.

Report 3

Project bidding financial report

Owner:
Project Name:
Project Location:

Number of places	400
School type	Primary School (age 5-11)
Basic teaching	840 m²
Halls	220 m²
Learning resources	75 m²
Staff and admin	110 m²
Storage	145 m²
Dinning and social	0 m²
Float	50 m²
Total net building	1440 m²
Total gross building area	2057 m²

Project variables:

Contract Duration	15 Years
Inflation Rate	2 %
Discount rate	5 %
Annual project payment	£ 400000
other expected project income per year	£ 0
Paid Interest	5.2 %
Earned Interest	4 %
Equity	£ 500000
Planning cost	£ 165000
Planning duration	14 Months

Contract Duration: 15 Years
Overall project duration 16.1666666667 Years (incoluding the pre-construction stage).

	Total Cost	Cost in Year Zero	Cost per square meter
Pre construction Cost (£)	165,000	164,327	80
Construction Cost (£)	3,913,861	3,753,182	1,825
LLC Cost (£)	1,357	339,957	165
FM Cost (£)	289	225,665	110
Total project Cost (£)	4,080,507	4,483,130	2,179

Figure 10.28: Report (3): Project bidding financial report (1).

Project Present Value for the client

Model defined value (£)	4,955,204
User defined value (£)	4,447,621

Investment Growth

Planned Investement return	5 %
Actual return rate	9 %

Planned investement growth	1,100,349
actual investement growth	2,171,583

Project closing balance	2,171,583 if payment is set by the model
	984,119 if payment is set by the user

Unitary Charge	445,650 Model Output
	400,000 User Intery

Investement appraisal		Model defined return		User defined return	
Project Net Present Value	NPV	472,072	*Project is profitable*	-35,511	*Project is not profitable*
Debt-Service Coverage Ratio	DSCR	0.78	*Project is not secured*	0.69	*Project is not secured*
Pay-back Period		14 Years		16 Years	

Repeat the test | Evaluate the model, please

Figure 10.29: Report (3): Project bidding financial report (2).

10.6.1 Model Evaluation

The PFI financial model was developed as an internet-based application as shown in section 10.6. Due to the absence of actual data to enable testing of the model by the researcher, it was necessary for the model to be tested and validated by experts and practitioners using data either based on real projects they have access to or based on their experience and knowledge of PFI projects and their financial management. The web-based model makes this possible; the model web site link was sent to experts and practitioner by electronic mail. All the respondents of the first questionnaire on model concept validation were selected to test the model by entering variables to test and validate the use of the model and its reports. Moreover, the link was sent to another fifteen practitioners. The total number of e-mails the link was sent to was thirty-seven. Due to the long process and complexity of the model's test requirements and result checking, the response was low. During the PFI financial management survey for current practice, one of the respondents, who is a financial modeller, replied that they charge about thirty thousand pounds for validating a financial model. Some e-mails replies were received promising to review the model later, but none of these were followed through. Apology and promise e-mails example are such as:

- "We are all very busy at present time so cannot commit to review for now. Will keep on radar screen though and get back to you at some point".
- "I will forward your details to a colleague who will have a look at it. Give me a couple of weeks for a response".
- "I cannot test the model as I don't have any valid information to key in. Sorry about that".
- "Thank you for your email to .... It has been forwarded to the relevant member of staff to be dealt with and you will have a reply as soon as possible".
- "I had a quick look (not really got the time to fill something like that in). It seems fairly complete and I shall point it out to a few other folks".

Only eight valid responses were received after three weeks (a reminder e-mail was sent seven days after the first one). Experience from conducting four on-line surveys concluded that 90% to 95% of responses will be received in the first two day of sending the request. Four of the respondents are practitioners and four are researchers. In terms of their knowledge of PFI projects, three respondents have worked on PFI projects, one has some knowledge, and PFI is the area of research/study of four of them. Six respondents were from the UK, one from Oman, and one from Greece.

Respondents were requested to rate the model after their exploration of it; the rating scale was 1 for the lowest score and 5 for the highest. The mean rate of model applicability to PFI school projects was 4.38, with standard a deviation of 0.52. Table 10.7 and Figure 10.29 show the mean scores of the model, as rated by respondents, for applicability to PFI school projects, comprehensiveness, practical relevance, and intelligibility. The mean scores were 4.34, 4.13, 4.50, and 3.75 respectively. This result could be considered high since it higher than the mean score of 2.5.

Table 10.7: Practical rate of the model.

Category	Mean	%	STD
Applicability to PFI school projects	4.38	87.50%	0.52
Comprehensiveness	4.13	82.50%	1.13
Practical relevance	4.50	90.00%	0.76
Intelligibility	3.75	75.00%	1.16

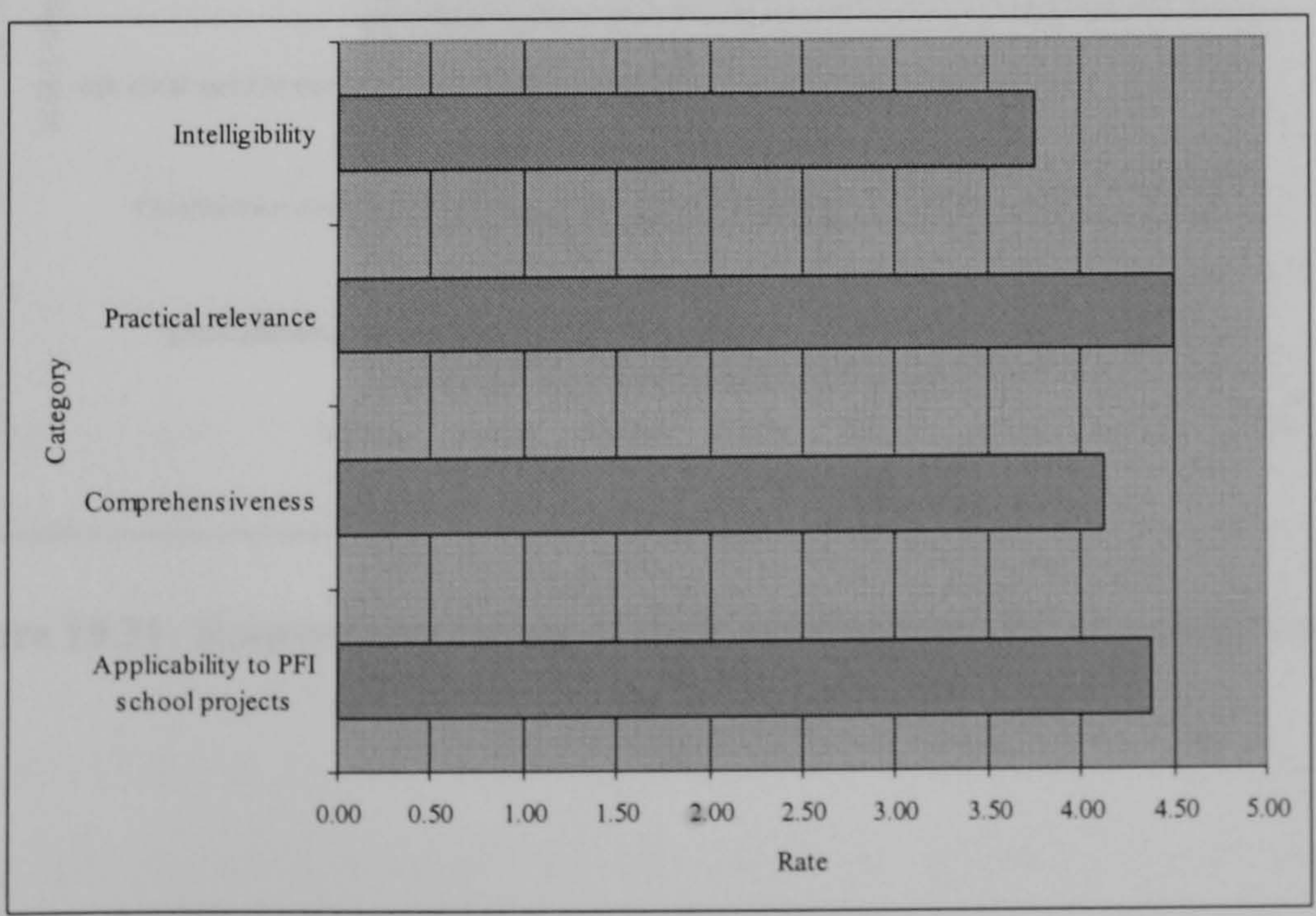


Figure 10.30: Model numerical test rate.

Respondents were requested to use the model and rate their satisfaction with its results in terms of percentage. Six model outputs were mentioned, from the space planning to the overall model performance. The mean respondent's satisfaction of the model results was fairly high. Table 10.8 and Figure 10.30 show the respondents and the mean percentage of satisfaction about the model parts when they use it numerically. Their satisfaction is over 86% for all parts. This show a relatively satisfactory result of the mode use.

Table 10.8: Respondents satisfaction with the model results.

Category	No. of Responses	Mean %	STD
Space planning	6	90.67%	8.98%
Construction cost	6	89.00%	10.49%
Life cycle and FM cost	6	88.00%	11.30%
Cash flow	7	88.43%	10.11%
Model Reports	8	86.25%	14.08%
Overall model performance	7	87.86%	11.04%

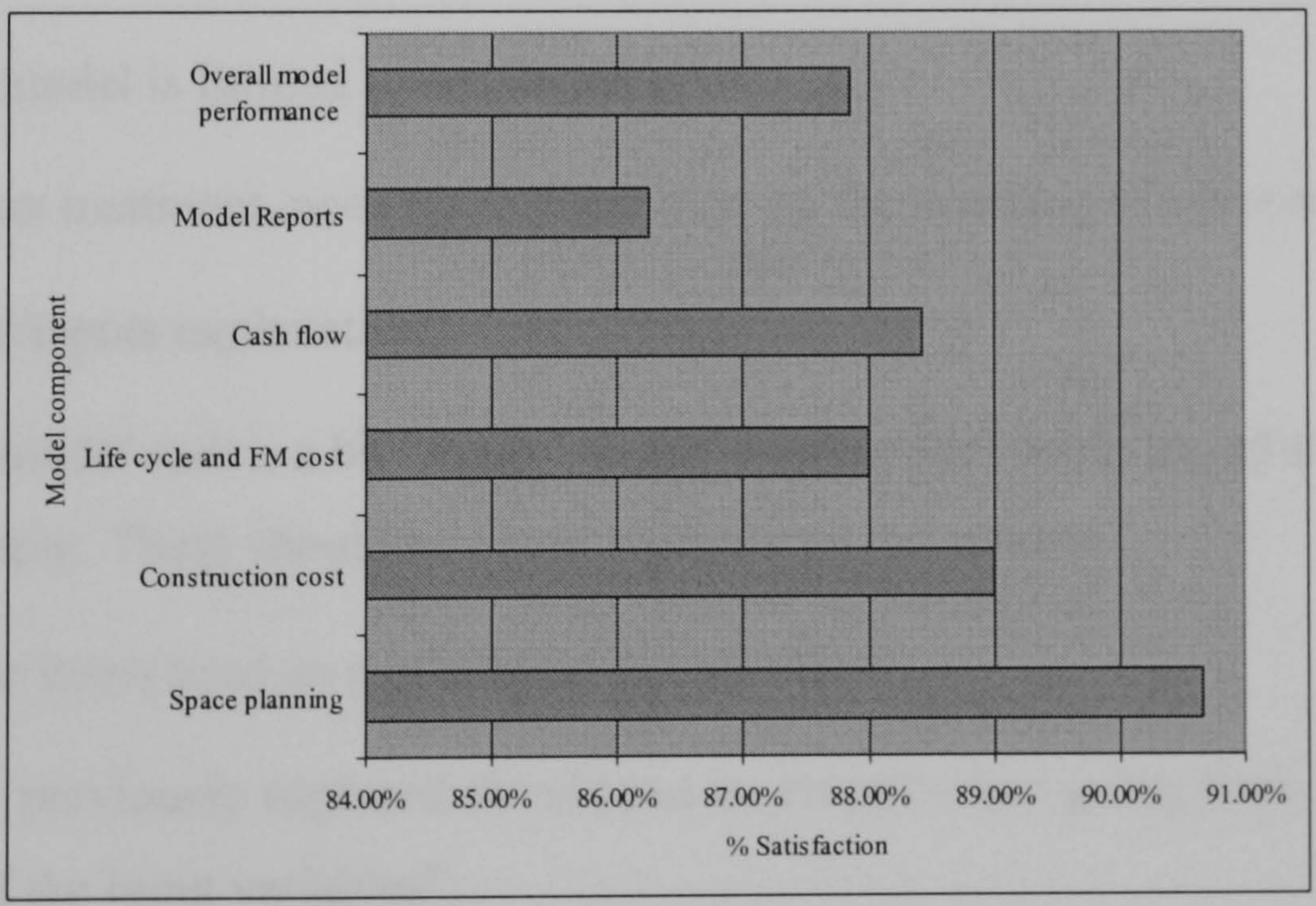


Figure 10.31: Respondents rating of their satisfaction with the model results.

10.6.1.1 Model Points of Strength

Respondents were requested to comment on the model's strengths based on their testing of the model. Seven respondents reported that the model had strong points, such as comprehensiveness, user-friendliness, simplicity of use and usefulness in saving time and effort. The model contains most of the essential factors for a reliable cash flow model. One respondent gave his advice and point of view in this context as *'a very valuable tool for analysing the viability of PFI/PPP projects. The reports should be very valuable in convincing financiers. It is a very remarkable piece of work and I suggest you develop this further as your future project because it has a huge market potential.'*

10.6.1.2 Model Points of Weakness

Respondents were requested to comment on the model's weaknesses based on their testing of the model. Six responded to this request, and they mention points such as:

- "The model is limited to one country".
- "No tax treatment, need more discussion on the meaning of some of the inputs".
- "Need inputs explanation".
- "The model seems a bit "foggy" to me: every model needs an input and produces an output. These should be better readable on the scheme".
- "Some items need an explanation or definition".
- "Data previously captured should not be erased when going back to correct any one of the input variables".

The model generalisation is limited to the source of data that is used in developing it; such data is not general enough to be used in different environments without considering validity and adjustment. However, the model generalisation is an important point to be taken into consideration, and will be discussed further in the next chapter.

The model is a project-based model; the tax issue would have to be dealt with at the corporate level.

10.6.1.3 Respondent's General Points on the Model Test

Respondents were requested to report their general comments on their test of the model. Five respondents wrote comments as detailed below.

- "It is a comprehensive Model that will help practitioners in PFI projects".
- "I like the idea and would be keen to discuss this further".
- "Good luck with your research, it seems very valuable".
- "It is good work. I am sure it will help people who work in PFI".
- "Model to be allowed for testing using sensitivity analysis. Optional analysis to be made possible. Some explanation of the variables to allow for easy understanding. Sequencing of the report: Report 3 to come first. The reports to have main headings".
- "I have had a go with the computer-based model and find it remarkably useful. However, because I did not have any real data to work with, I had to use hypothetical figures but the model values were quite fascinating and very reasonable. It is my considered opinion that the model is practicable and can be of tremendous aid to both financial consultants and private sector bidders on PFI projects. The most important features of the model includes the possibility of the evaluator to specify his own values which can be compared with that of the model, and the range of reports generated by the model such as the cash flow, profitability, etc."

10.7 Sensitivity Analysis

Sensitivity analyses were applied to assess the effects of some variables on outputs. The sensitivity of net cash flow to the discount rate is shown in Figure 10.32. The inflation rate was fixed at 3% when the sensitivity analysis was applied. Cash flow sensitivity to the inflation rate is shown in Figure 10.33. The discount rate was fixed at 6% when the sensitivity to inflation rate was applied. It is clear that net cash flow is sensitive to both discount and inflation rates. The effect of inflation rate is more significant in minimising the negative cash flow period. This could be explained by observing the sensitivity of other outputs to the discount and inflation rates. The NPV is shown to be highly sensitive to inflation rate. It is however not as sensitive to the discount rate, as shown in Figure 10.34. The NPV increases significantly with the increase of the inflation rate, and it decreases with the increase of the discount rate.

IRR is sensitive to discount and inflation rates as shown in Figure 10.35, although it is more sensitive to the inflation rate. The effect of inflation is clear on the DSCR as shown in Figure 10.36, while its sensitivity to the discount rate is almost Zero. This effect is different on the payback period. As shown in Figure 10.37, the payback period decreases with the increase of inflation rate, while it is almost Zero with the change of discount rate. The effects of inflation and discount rates on the unitary payment is almost similar, as shown in Figure 10.38, while the project cost is positively sensitive to inflation rate and negatively sensitive to discount rate as shown in Figure 10.39.

The impact of inflation and discount rates changes on the models' outcome is summarised in Figure 10.40. NPV goes down when discount rate goes up, and goes up when inflation rate goes up. IRR increases with higher inflation and discount rates. DSCR is not sensitive to the change of discount rate while increases when inflation rate moves up. The payback period is not sensitive to the change in discount rate but it goes down when inflation rate goes up. The unitary charge and investment growth go up when both inflation and discount rates rise. The project cost reduces when discount rate goes up, and it increases with the increase of inflation rate.

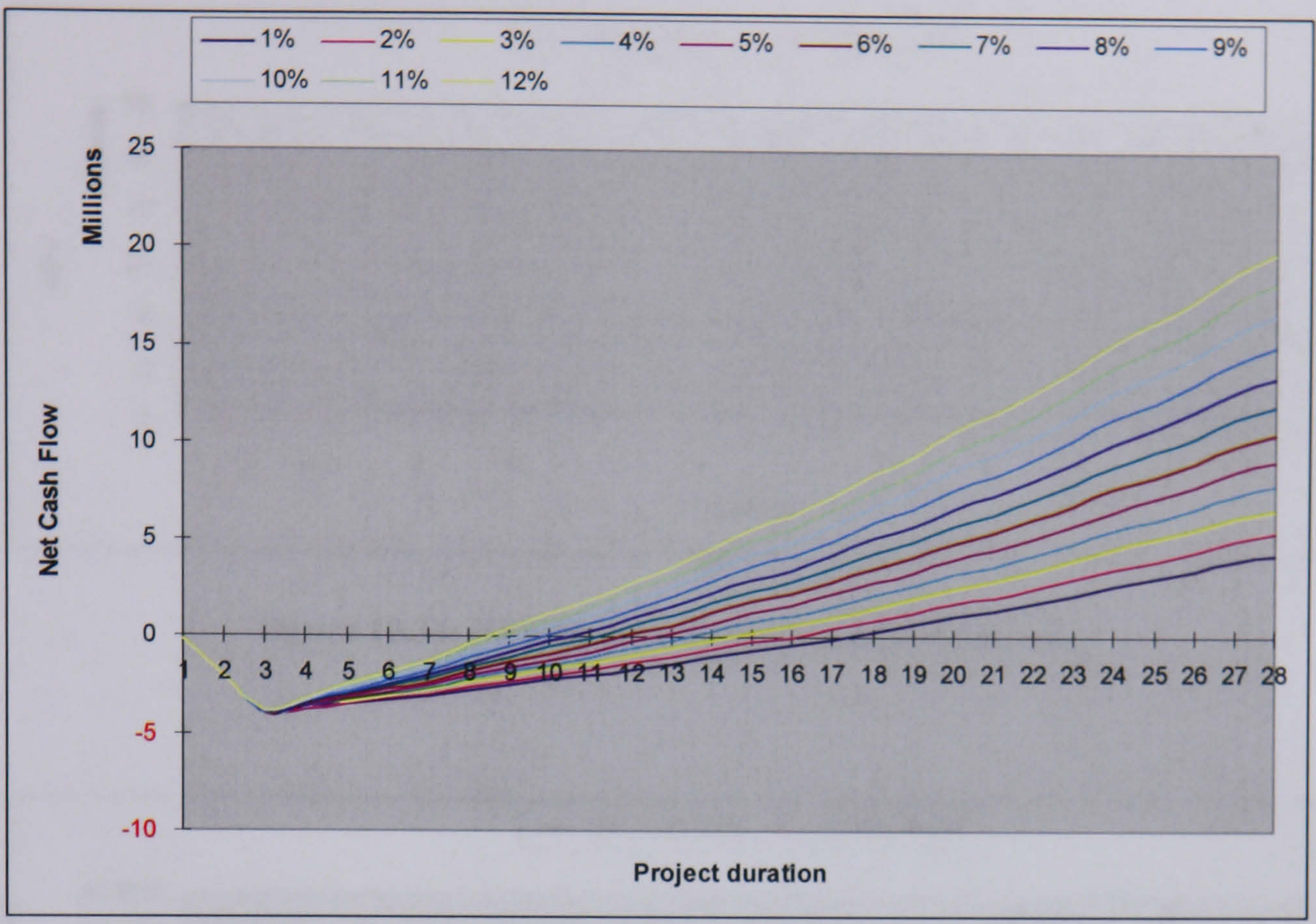


Figure 10.32: Sensitivity of cash flow to discount rate.

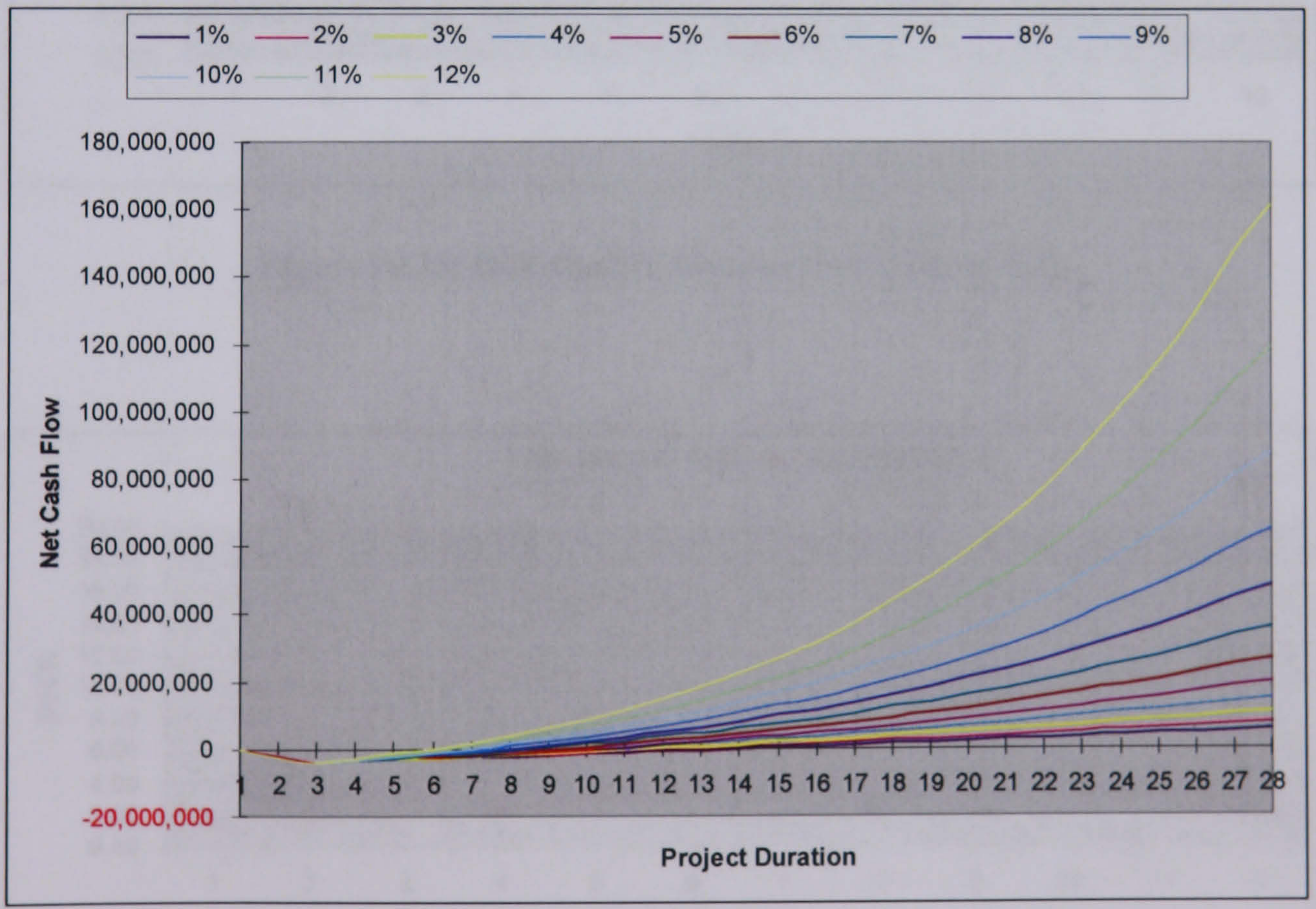


Figure 10.33: Sensitivity of cash flow to inflation rate.

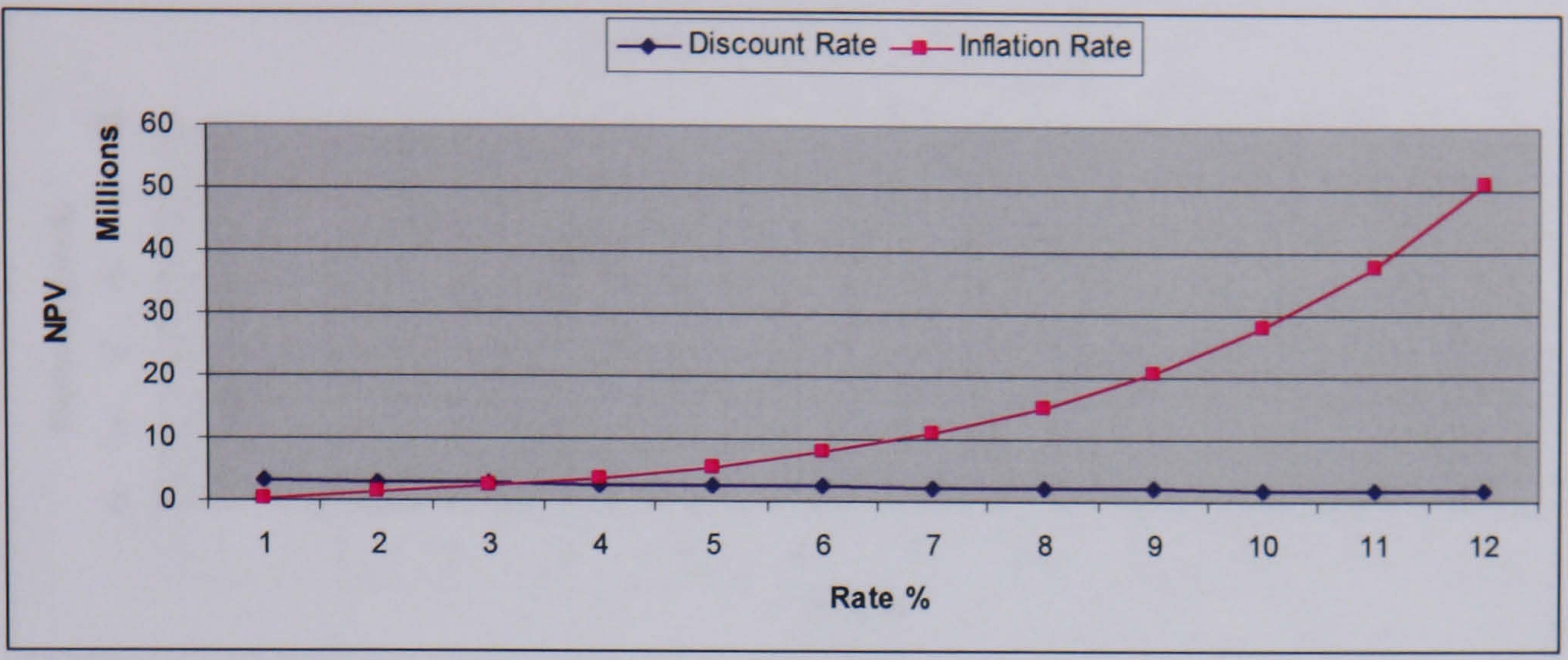


Figure 10.34: NPV against discount and inflation rate.

Figure 10.35: IRR against discount and inflation rate.

Figure 10.36: DSCR against discount and inflation rate.

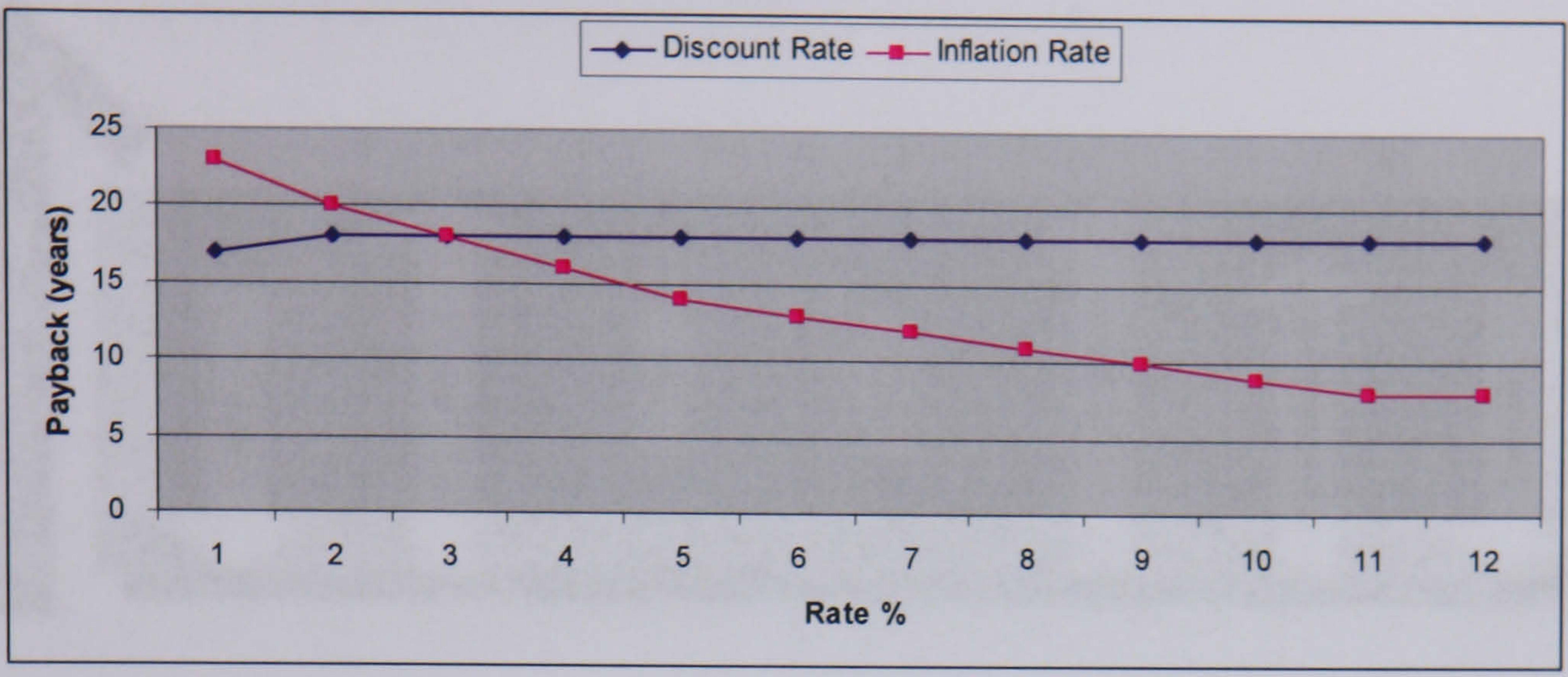


Figure 10.37: Payback period against discount and inflation rate.

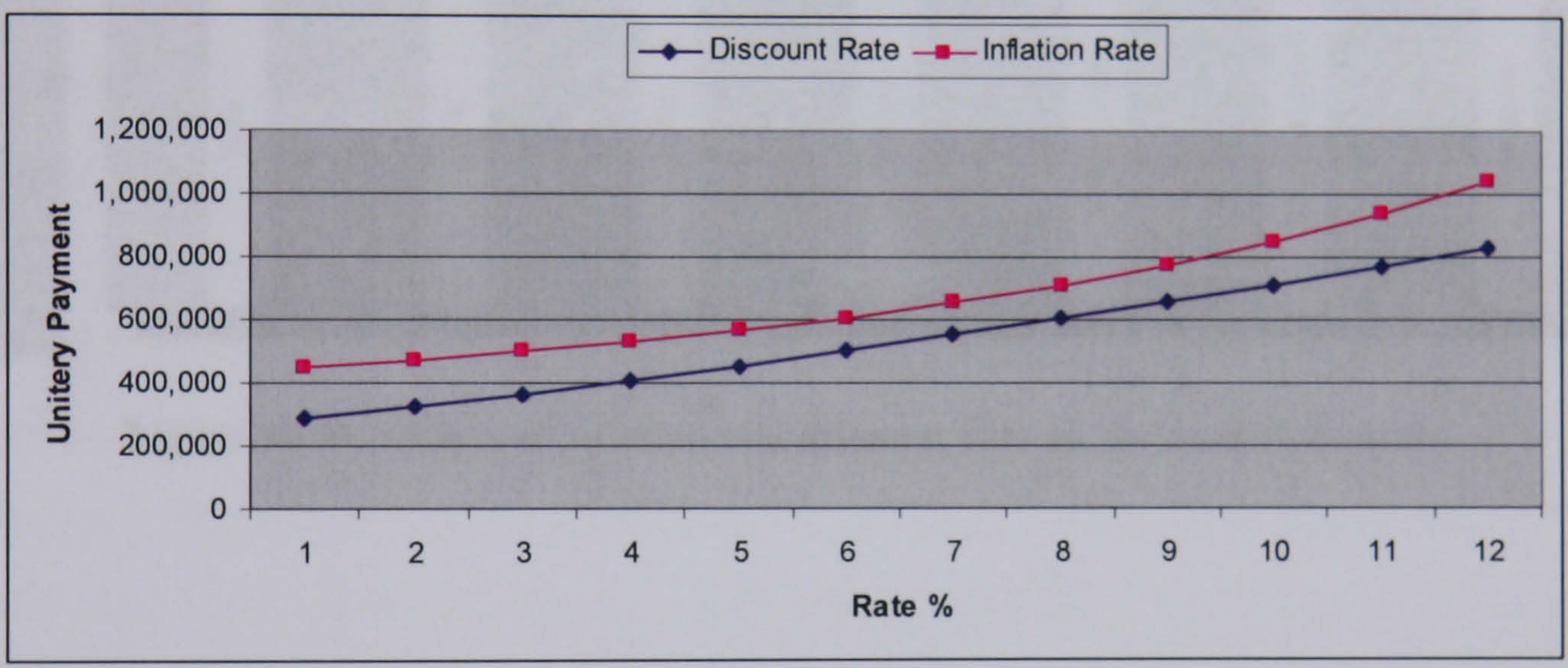


Figure 10.38: Unitary payment against discount and inflation rate.

Figure 10.39: Project cost (£/m2) against discount and inflation rate.

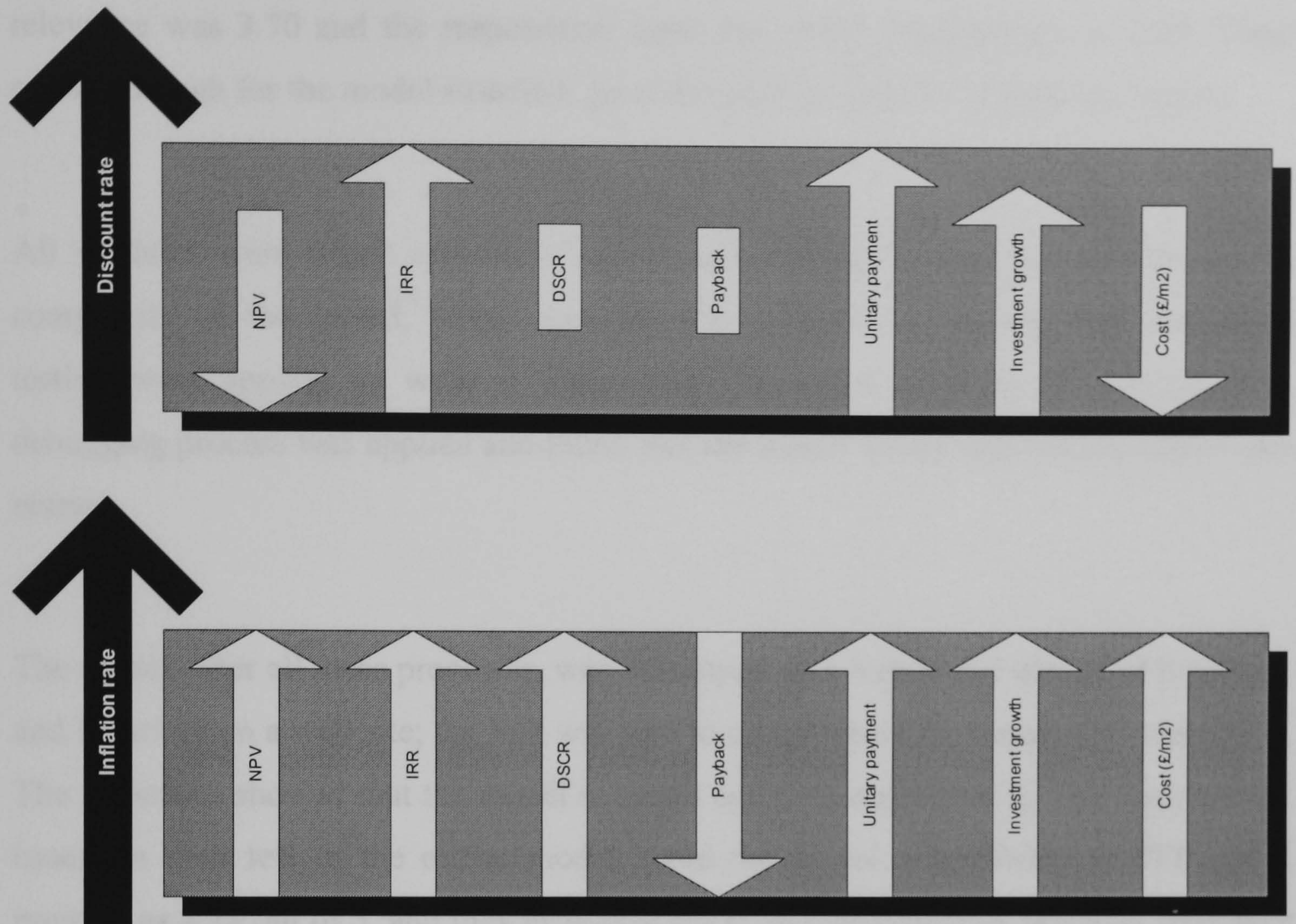


Figure 10.40: Effects of inflation and discount rate on the model's outputs.

10.8 Summary

The model was tested and validated using different methods. The concept of the model was validated first of all by 22 practitioners, and the model was tested by chasing and judgement, validating each module separately, debugging, and sending the model link (web-based model) to experts and practitioners to allow them test it and give their evaluation via an electronic questionnaire.

The model concept was validated and the responses received show the model concept is accepted. The reviewers rated the model concept applicability, comprehensiveness, practicality, and intelligibility as relatively high. The rating scale was from 1 to 5, where 1 is the lowest score and 5 the highest. The average score for applicability of the model to PFI school projects was 4.09. Comprehensiveness rating was 3.90, practical relevance was 3.70 and the respondents rated the model intelligibility as 3.59. These rates, although for the model structure, gave the model a positive overall evaluation.

All modules were tested separately and found adequately accurate. Because of the complexity of the model, which contains many equations, chasing and judgement testing were applied as well; it found that the model is relatively integrated. A debugging process was applied and found that the model works well with different data entries.

The model, after all these processes, was developed on a web-based advanced language, and launched on a web site; the link was sent to practitioners for testing and evaluation. The responses showed that the model is useful and they appreciate it. The respondents, based on their test of the online model, rated the model applicability to PFI school projects as 4.38 out of 5, and they evaluated the comprehensiveness, practical relevance and intelligibility as 4.13, 4.50, and 3.75 respectively. These gave an overall positive evaluation of the model. The respondents, when asked about their satisfaction with the model components, gave an average rating of above 85% .

Chapter Eleven

Conclusions, Limitations, Contributions and Recommendations for Future Studies

11 Conclusions, limitations, contributions and recommendations for further studies

11.1 Introduction

Development of the PFI Financial Model and its validation has been discussed in previous chapters. The aim was to develop a financial model for PFI projects to predict the cost and model the cash flow in the early stages. This last chapter details the conclusions and findings achieved — the research limitations will also be discussed, in addition to the research contribution to knowledge. This chapter highlights some recommendations for further studies following from the experience of this research.

11.2 Conclusions

The review of the literature and the surveying of current practice in PFI financial modelling have revealed that the research problems are the high cost of bidding. Such has been the drain on PFI expertise within the UK during the past few years that single-tender bidding has started to appear. For example, in the context of PFI healthcare, the client may receive just one bid, in effect turning the process into a negotiated contract which may give the single consortia too much power (Cartlidge, 2006). This addresses the need for a tool to enable clients to know the project's affordability before they commit non-compensated funds to it. At the same time, the private sector needs a tool to enable them to take the right decision(s) on the project before they spend a large amount, and to enable them to assess whether they are capable of competing for it, or if the project is compatible with their bidding strategies. Based on this, the research aim was formed to develop a computer-based model that would enable project teams to assess the financial results of the project, including the cost and cash flow. Research objectives were then defined to attain the research aim. These objectives and their conclusions are as follows:

11.2.1 Literature Review on PFI

The objective of exploring a PFI procurement system and its related issues was used as an introduction to gain theoretical knowledge and understanding of PFI procurement methods, and to review and analyse the process and application of PFI projects. As a result from this review, PFI was launched in 1992 when the UK government considered this method of procurement as the cornerstone in modernising its public services. The concept of PFI can be described as a government policy to bring the financial and management skills of the private sector to the provision of public services and infrastructure projects in order to increase efficiency, effectiveness, and quality. It is a type of PPP where project financing rests mainly with the private sector, which will be responsible for building the facilities and operating them. This private sector investment will be recovered through the project unitary payments, based on the performance and availability of the facilities.

A distinguishing feature of PFI procurement is the timing of responsibility and payment. The public sector procurer no longer pays capital over the construction period but rather pays for the service during the operational period, whilst the private sector pays the capital cost which it recoups through the service payments (Ahadzi, 1999). The contractual relationship in PFI is not simply one in which is entered into to deliver an asset, but also to provide an on-going service (Broadbent and Laughlin, 2005). PFI contractual relationships are very complex, and discipline of the contract is more subtly applied in the context of building an on-going relationship between the parties (Broadbent *et al.*, 2003). Therefore, the centre of any PFI project is a concession contract where the public sector specifies the outputs it requires from a public service facility, and the basis for payment for those outputs (HM Treasury, 2003).

The PFI procurement system is believed to be a tool for developing the construction industry through innovation and the perfecting process (Al-Sharif and Kaka, 2003). In the UK, PFI has offered a solution to the problem of securing necessary investment at a time of severe public expenditure restraint (Akintoye *et al.*, 2003). The increase in the implementation of PFI as a government initiative to enable public sector works to be carried out using input from the private sector has been marked by evolution as well as growth since its formal inception. The total value of PFI signed deals rose to £42,699.50 million by the end of 2004, while the capital value of PFI projects signed in 2003 was £14,854 million, representing 19.19% of the UK construction industry output of the same year. This shows the importance of PFI as a major procurement method in the UK and worldwide.

11.2.2 Project's Costing and Financial Modelling

This objective is focused on the project's costing and financial modelling with emphasis on PFI projects. It is intended to gain theoretical knowledge and understanding of these issues by reviewing what has been published on construction cost and finance, including PFI. The author was then able to start from what has been achieved using the comprehensive knowledge obtained from literature review. This review reveals that there are many studies on construction projects' costing and financial issues in textbooks and research papers. In terms of PFI projects' costing and finance, so far there have been limited studies in literature. This was reflected by Al-Sharif and Kaka (2004) when they found that PFI/PP papers represent only 2.61% of the total papers published in four of the top journals of the construction sector in a six-year period (1998-2003).

A PFI project's finance can be provided either from equity or senior debt. In PFI projects, private companies come together to form the consortia or the SPV; they have to demonstrate their commitment to the project by providing a small amount of capital. This capital is not sufficient to finance the construction activities (Akintoye *et al.*, 2001). This equity proportion may be as low as 1-2% of the capital cost (Bdp, 2003; Fox, 2002), while the larger proportion comes from the senior debt, which is normally provided by financial institutions.

The cost components of PFI projects are comprised of the bidding cost (pre-contract costs), construction cost, occupancy cost and the cost of financing the project. The bidding cost is high and the amount can be uncertain; it is believed that bidding costs are the reason behind several high profile tender withdrawals (Ahadzi and Bowles, 2004; BDO, 2003; Dick and Akintoye, 1996; Owen and Merma, 1999). The PFI project's payment should not be made until the service is available, and this payment would be based on the availability and performance of the facility.

11.2.3 Current Practice Survey

The objective of exploring and reporting on the current practices of modelling PFI financial management was to document the current development and use of financial models, and to investigate the gaps in current practices to enable the development of better and more effective models.

Financial modelling firms develop PFI financial models in practice. Neither construction organisations nor clients have their own models for PFI projects: Their view is that this is a very specialised work that needs to be undertaken by accountancy and financial modelling professionals. The fees of these independent firms charge to model a financial deal of a PFI project are very high. One interviewee reported that his company has paid £500,000 for the financial modelling of one PFI project comprising fourteen school buildings.

The construction cost is prepared by the construction contractor, and the occupancy cost by the FM contractor. The cost of the pre-contract stage will be estimated by the SPV, and all this information will be submitted to the financial modeller to generate the cash flow. The advantage of PFI, with one contractor responsible for the project to overcome the fragmented nature of the process of the construction industry, is not taken into consideration when modelling the project financial issues. In addition, modelling PFI financial management in its current practice is one driving force which makes the PFI project bidding cost high and some time sufferance.

The client has a very real need for a cash flow forecast, and accordingly the contractor has a requirement to provide a reasonable forecast when requested in the contract (Kenley, 2003). Contractors are required to provide a detailed cash flow included in the financial model submitted with their proposals. The PFI financial model, according to Fox (2002) should provide a demonstration that the project is compatible with the basic terms, such as cover ratio, margins and IRR.

11.2.4 Model Development

The research aim is to develop a computer-based model which can forecast and predict the cash flow of PFI projects at the bidding stage. The model structure comprises four integrated modules to give the results required for assessing the ability of the client to pay, and the profitability of the project to the SPV. The development process and results of the four modules are as follows:

11.2.4.1 Space planning module

The aim of this module is to calculate the superficial area of the school building, based on two variables: number of pupils and type of school. The data used to develop this module was collected from published guidance for public school buildings. The module calculates the net and non-net area and proposes the area required for the main activities of the school. The building gross area will be used in calculating the project cost.

The Department for Education and Skills (DfES) has checked the module and found it to work well in general. It was tested using the exemplar school design, and the mean error was 1.23% in primary schools and 2.61% in secondary schools. It was also tested by applying the module to past schools published in the BCIS list. The mean error was 7.35% in fifty primary schools and 6.84% in seven secondary schools. This result indicates that the module's accuracy is acceptable.

11.2.4.2 Construction cost module

Construction cost is a significant part of project capital cost. It is important for the project because it is provided by the SPV through the project financing arrangements. The construction cost module is designed to predict the construction cost in the early stages based on the space planning module results and the historical data collected from BCIS. A regression data analysis was applied to produce a predicting equation of the school projects cost. The regression model when tested shows a mean prediction cost absolute error of 9.98% in the training data, and 8.23% using the historical data from fifteen schools not used in the model development.

11.2.4.3 Occupancy cost module

The private sector is responsible for providing the required services with the level of quality agreed upon. The payment mechanism of PFI projects is dependent on the performance and availability of the project. The operation and maintenance of a project play a significant part in maintaining the project income flows as planned. The occupancy cost prediction covers LCC and FM costs for the operational life of the project. The amount of information required for modelling the occupancy cost is not available. The occupancy cost of the school buildings report and the reports of exemplar school designs were used as an example of LCC and FM categories and component classification.

The user was given the flexibility to enter the total amount that could be invested in present value to cover the cost of LCC and FM categories. The interval of LCC cost occurrence should be defined, while the distribution of FM will be predicted on a yearly basis. The interest rate is applied to each category to normalise the cost distribution along the operational life of the project.

11.2.4.4 Cash flow module

The PFI financial model works by the integration of four different modules. The cash flow module collects the results of the space planning, construction cost, and occupancy cost modules; it then applies other entries, such as inflation and discount rates, pre-contract cost and duration, SPV equity, and the unitary payment that has been defined by the user. The cash flow will then be generated based on two different unitary charges. One is calculated by the model to meet the project cost with the defined discount rate at the required rate of return. The other is based on the unitary charge that has been defined by the user to match the investment goal. The model produces detailed reports to show cash out, cash in, cash flow, and the project balance account tables and charts.

The model also reports the calculations of the project investment results, such as the investment growth, Net Present Value (NPV), Internal Rate of Return (IRR), Debt Service Coverage Ratio (DSCR), and payback period. These results, in addition to the project value of the client and project's closing balance, will be shown in two different outcomes. The first is based on the unitary charge defined by the model, while the second report is based on the unitary charge that is defined by the user. Space planning and project costs are also reported in the required form to help in taking the right decision.

The model results and reports are designed to meet the research aim, which is to develop a computer-based model to predict the cost and cash flow of PFI projects to enable the project teams to take the right bidding decision. The model, when validated and tested by practitioners and other validation methods, seems to work adequately and accurately to meet the research aim and objectives.

11.3 Limitations

Developing a model can be a long process depending on the number of variables incorporated and the range of assumptions taken. The final PFI financial model presented in this research does have some limitations; these are:

- This model as an integrated package is limited to PFI school projects.
- Unlike the construction module, the occupancy cost module isuser-specific and hence will require detailed input from the user.
- Construction cost is based on BCIS data. This was a driver of the selection of the variables based on the availability and completeness of the BCIS historical project data.
- The model is project based, hence no consideration is given to the impact of tax and VAT. This could be considered via other company level of administrative accountancy processes.
- PFI project data was not available to meet the research requirements; therefore, normal project data was used in the model's development.

11.4 Generalization of the Outcome

Generalising a model is always a question for which the modeller should prepare the answer. The proposed model in its integrated package was developed for a purpose. It cannot be generalised to predict areas, cost, and cash flow for types of buildings other than schools. This is because it starts with school-building space planning and a school-building construction cost model.

The model could be used as a cash flow prediction and decision-making tool for any building, if the building area and construction data are prepared by the user and fed into the model. In this case, the model could be used for any type of PFI projects. At the same time, the model will not be restricted to the UK PFI project environment, but could be used internationally.

11.5 Contribution to Knowledge

The model was developed and tested as part of a PhD research project aimed at contributing to knowledge — there can be no meaning to the research if it does not add to this area of knowledge. Research is assessed mostly by its significant contribution to knowledge. The contributions this research add to knowledge are as follows:

- Developing a financial model for FPI project financial management. It is the first model to have been undertaken in academia for modelling the cost and cash flow of PFI projects.
- The integration between space planning cost models and the cash flow model is established in order to assess the investment viability of PFI project to help project teams in decision making at the bidding stage. This shows the possibility of developing such an integrated cost/cash flow model to be used for assessing the investment through the project life cycle.
- High bidding cost is seen as a barrier preventing construction firms from entering the PFI market. Contractors will not be compensated for their bidding cost if the client awards the project contract to a competitor, or does not award it at all. This model could provide a tool for the early assessment tool for the visibility of the project, and could, therefore, increase the attractiveness of PFI projects within the majority of small and medium construction organisations.
- Public authorities have to spend a substantial amount of money before they know if they are going to go with the PFI option or not. This model could be used to provide the assessment information needed for the public sector comparator to compare the value for money of the PFI option with traditional procurement methods.

11.6 Benefits from the Research

The aim of this research is to develop a computer based financial model that would help in assessing the viability of PFI project at the early stage of the project. This aim is believed to have been achieved through this research. In addition, there are some other benefits that derived from the process, as follows:

- The model provides a tool for the private sector to take the appropriate preliminary decision on PFI projects based on the financial results of the project.
- The model can help in reducing high bidding costs.
- In the project preparation of the bid, all parties need to have the financial information on which to base their negotiations. This model could provide such financial information.
- The model shows the impact of economic factors such as interest rates and inflation on the project life cycle, and on the project's financial results.

11.7 Recommendations to Further Research

Areas that would benefit from further research have been identified during the progress of this research. These areas are related to either the proposed model or to PFI projects and modelling issues. Areas that could be taken further include the following:

- Focusing on an occupancy cost prediction system for PFI projects will complete the automated system for PFI projects financial management. This will require collecting reliable occupancy historical data and modelling the cost.
- Use the same methodology to expand the scope of the model to include other types of building.
- The Public sector comparator (PSC) plays a significant role in the client's decision-making process. It is the key factor in selecting PFI/PPP as the

procurement method. Further studies on standardizing and modelling PSC will help authorities to consider a PFI project.

- Modelling the risk of PFI on a quantitative basis would help in providing clearer and more accurate assessments of this type of project.

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Appendix One

Examples of BCIS records

Concise Elemental Analysis

BCIS *Online* analysis number: 22144

New build

BCIS code: C - 1 - 517

Job title:	Nursery Unit, Cavendish and Shawgrove Primary Schools
Location:	Withington, Greater Manchester
Client:	Manchester City Council
Dates:	Receipt: 27-May-2003 Base: 17-May-2003 Acceptance: Possession: Oct-2003
Project details:	Single storey nursery school together with external works including precast concrete, rubber and macadam paving, metal fencing, landscaping, services, drainage, site lighting and demolition of existing buildings.
Site conditions:	
Market conditions:	Project tender price index was 203 on a base of 1985 BCIS Index Base Indices used to adjust costs to base price level: TPI for 2Q2003 198; location factor 0.97

Tender documents:	Bill of quantities	**Contract:**	JCT LA 1998 contractors designed portion sup
Procurement:	Selected competition	**Cost fluctuations:**	Firm
Number of tenders:	Issued: 6 Received: 6	**Contract period:**	Stipulated: 8 Offered: Agreed: 8

Contract breakdown	Contract £	Analysis £	Competitive tender list: Tender £	% above lowest
Measured work	553,850	553,850		
Provisional sums	36,500	36,500		
PC sums	12,000	12,000		
Preliminaries	131,598	131,598		
Contingencies	31,400	31,400		
Contract sum	765,348	765,348		

Accommodation and design features: Single storey nursery school. Concrete foundations and ground slab. Facing brick, facing block and curtain walling. Timber trussed roof with concrete tiles. Double glazed aluminium windows; roller shutters. Block and cubicle partitions. Flush doors. Plaster and tiles to walls; vinyl and carpet flooring; mineral fibre suspended ceilings. Fittings. Sanitaryware. Gas LTHW underfloor heating, local ventilation, electric light and power. Emergency lighting, fire and intruder alarms. External works with paving, fencing, landscaping, services, drainage, site lighting.

Storeys as a % of gross floor area		
single 100%		

Average Storey Heights	
Below ground floor	-
At ground floor	-
Above ground floor	-

Functional unit	Rate

Areas	
Basement floors	- m2
Ground floor	517 m2
Upper floor	- m2
Gross floor area	517 m2
Usable area	- m2
Circulation area	- m2
Ancillary area	- m2
Internal Divisions	- m2
Gross floor area	517 m2
Area not enclosed	- m2
External wall area	290 m2
Wall to floor ratio	0.56
Internal cube	1396 m3

Element	Percentage	Total cost of element £	£ per m2	£/m2 incl Preliminaries: Tender prices	1995 constant prices
Substructure	9%	65,222	126.15	153.72	104.05
Superstructure	35%	270,595	523.39	637.74	431.67
Internal finishes	6%	44,776	86.61	105.53	71.43
Fittings	2%	13,001	25.15	30.64	20.74
Services	14%	108,721	210.29	256.24	173.44
Building sub-total	66%	502,315	971.60	1,183.86	801.32
External works	13%	100,035	193.49	235.76	159.58
Preliminaries	17%	131,598	254.54	-	-
Contingencies	4%	31,400	60.74	60.74	41.11
Total		765,348	1,480.36	1,480.36	1,002.01

Submitted by: Manchester City Council

Detailed Elemental Analysis

BCIS *Online* analysis number: 22652

Horizontal extension

BCIS code: C - 1 - 114

Job title:	Erewash Surestart Facilities - Kirk Hallam Extension
Location:	Ilkeston, Derbyshire
Client:	Derbyshire County Council
Dates:	Receipt: 24-Feb-2004 Base: 14-Feb-2004 Acceptance: 7-Sep-2004 Possession: 1-Nov-2004
Project details:	Surestart facilities on 2 sites 3 miles apart constructed concurrently. External works include block and macadam paving, timber fencing, brick walls, services and drainage.
Site conditions:	Green field site with poor ground conditions though excavation generally above water table. Unrestricted working space and access.
Market conditions:	Delay in start on site due to legal problems with site acquisition. Increased costs allocated between elements. Project tender price index was 183 on a base of 1985 BCIS Index Base Indices used to adjust costs to base price level: TPI for 1Q2004 199; location factor 0.93

Tender documents:	Bill of quantities	**Contract:**	JCT local authority contract 1980 edition
Procurement:	Selected competition	**Cost fluctuations:**	Firm
Number of tenders:	Issued: 4 Received: 4	**Contract period:**	Stipulated: 9 Offered: Agreed: 9

Part of a complex contract - see also CI/SfB 711. Nursery schools/creches - 31
Altered - see market conditions text

Contract breakdown	Contract £	Analysis £	Competitive tender list	Tender £	% above lowest
Measured work	1,045,802	176,343	1	1,314,198	-
Provisional sums	56,000	13,636	2	1,368,141	4.1
PC sums	110,636	9,000	3	1,414,325	7.6
Preliminaries	106,582	17,591	4	1,446,581	10.1
Contingencies	39,513	6,500			
Contract sum	1,358,533	223,070			

Accommodation and design features: Single storey community centre extension to provide Surestart facilities. RC trenchfill foundations, PCC beam/block floor. Facing brick/block walls; double glazed metal windows and doors. Timber pitched roof with plastic insulated panels. Block partitions, WC cubicles. Flush doors. Plaster to walls; vinyl and carpet on screed; suspended ceilings. Fittings. Sanitaryware. HW central heating extended from existing boiler, electric light and power. External works, work to existing. Larger facility analysed separately.

Storeys as a % of gross floor area		
single 100%		

Average Storey Heights	
Below ground floor	-
At ground floor	-
Above ground floor	-

Functional unit	Rate

Areas	
Basement floors	- m2
Ground floor	114 m2
Upper floor	- m2
Gross floor area	114 m2
Usable area	- m2
Circulation area	- m2
Ancillary area	- m2
Internal Divisions	- m2
Gross floor area	114 m2
Area not enclosed	- m2
External wall area	- m2
Wall to floor ratio	-
Internal cube	- m3

Element	Percentage	Total cost of element £	£ per m2	£/m2 incl Preliminaries: Tender prices	£/m2 incl Preliminaries: 1995 constant prices
Substructure	8%	18,225	159.87	174.00	122.22
Superstructure	30%	66,513	583.45	635.04	446.07
Internal finishes	8%	19,366	169.88	184.89	129.88
Fittings	2%	4,010	35.18	38.29	26.90
Services	27%	60,111	527.29	573.89	403.12
Building sub-total	75%	168,225	1,475.66	1,606.11	1,128.19
External works	14%	30,754	269.77	293.62	206.25
Preliminaries	8%	17,591	154.31	-	-
Contingencies	3%	6,500	57.02	57.02	40.05
Total		223,070	1,956.75	1,956.75	1,374.49

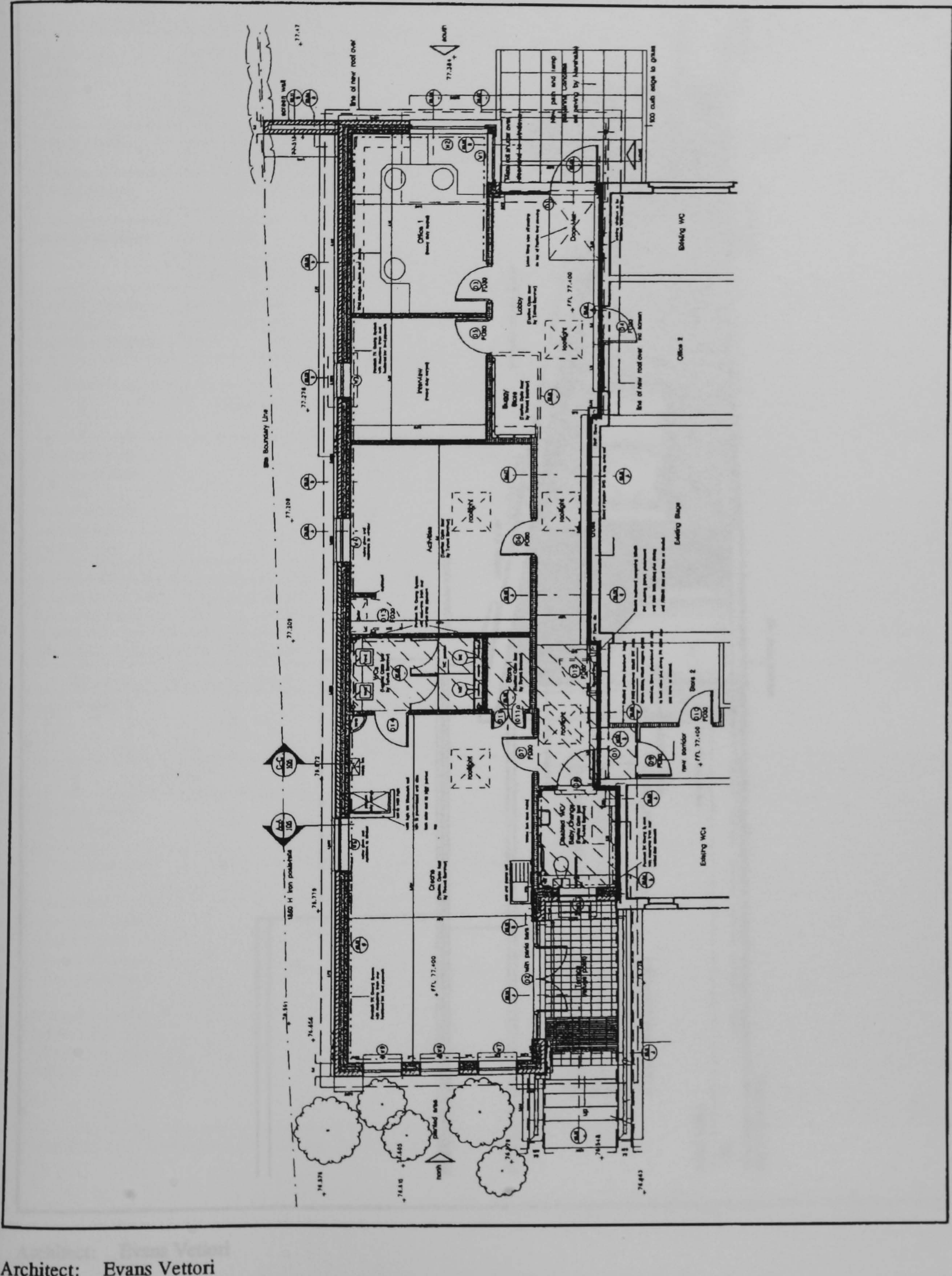
Submitted by: Derbyshire County Council

Element		Preliminaries shown separately: Total cost	Cost per m2	Element unit quantity	Element unit rate	Preliminaries spread: Total cost	Cost per m2
1	Substructure	18,225	159.87			19,836	174.00
2A	Frame	-					
2B	Upper floors	-					
2C	Roof	21,322	187.04			23,207	203.57
2D	Stairs	-					
2E	External walls	16,660	146.14			18,133	159.06
2F	Windows and external doors	12,935	113.46			14,079	123.50
2G	Internal walls and partitions	7,054	61.88			7,678	67.35
2H	Internal doors	8,542	74.93			9,297	81.55
2	Superstructure	66,513	583.45			72,394	635.04
3A	Wall finishes	7,296	64.00			7,941	69.66
3B	Floor finishes	7,280	63.86			7,924	69.51
3C	Ceiling finishes	4,790	42.02			5,213	45.73
3	Internal finishes	19,366	169.88			21,078	184.89
4	Fittings	4,010	35.18			4,365	38.29
5A	Sanitary appliances	4,890	42.89			5,322	46.68
5B	Services equipment	-					
5C	Disposal installations	included in	5A				
5D	Water installations	-					
5E	Heat source	-					
5F	Space heating and air treatment	24,866	218.12			27,064	237.40
5G	Ventilating systems	-					
5H	Electrical installations	25,947	227.61			28,241	247.73
5I	Gas installations	-					
5J	Lift and conveyor installations	-					
5K	Protective installations	954	8.37			1,038	9.11
5L	Communications installations	-					
5M	Special installations	-					
5N	Builder's work in connection	3,454	30.30			3,759	32.97
5O	Builder's profit and attendance	-					
5	Services	60,111	527.29			65,424	573.89
	Building sub-total	168,225	1,475.66			183,097	1,606.11
6A	Site works	1,296	11.37			1,411	12.38
6B	Drainage	14,344	125.82			15,612	136.95
6C	External services	1,467	12.87			1,597	14.01
6D	Minor building works	13,647	119.71			14,853	130.29
6	External works	30,754	269.77			33,473	293.62
7	Preliminaries	17,591	154.31			-	
	Total (less Contingencies)	216,570	1,899.74			216,570	1,899.74
8	Contingencies	6,500	57.02			6,500	57.02
	Contract sum	223,070	1,956.75			223,070	1,956.75

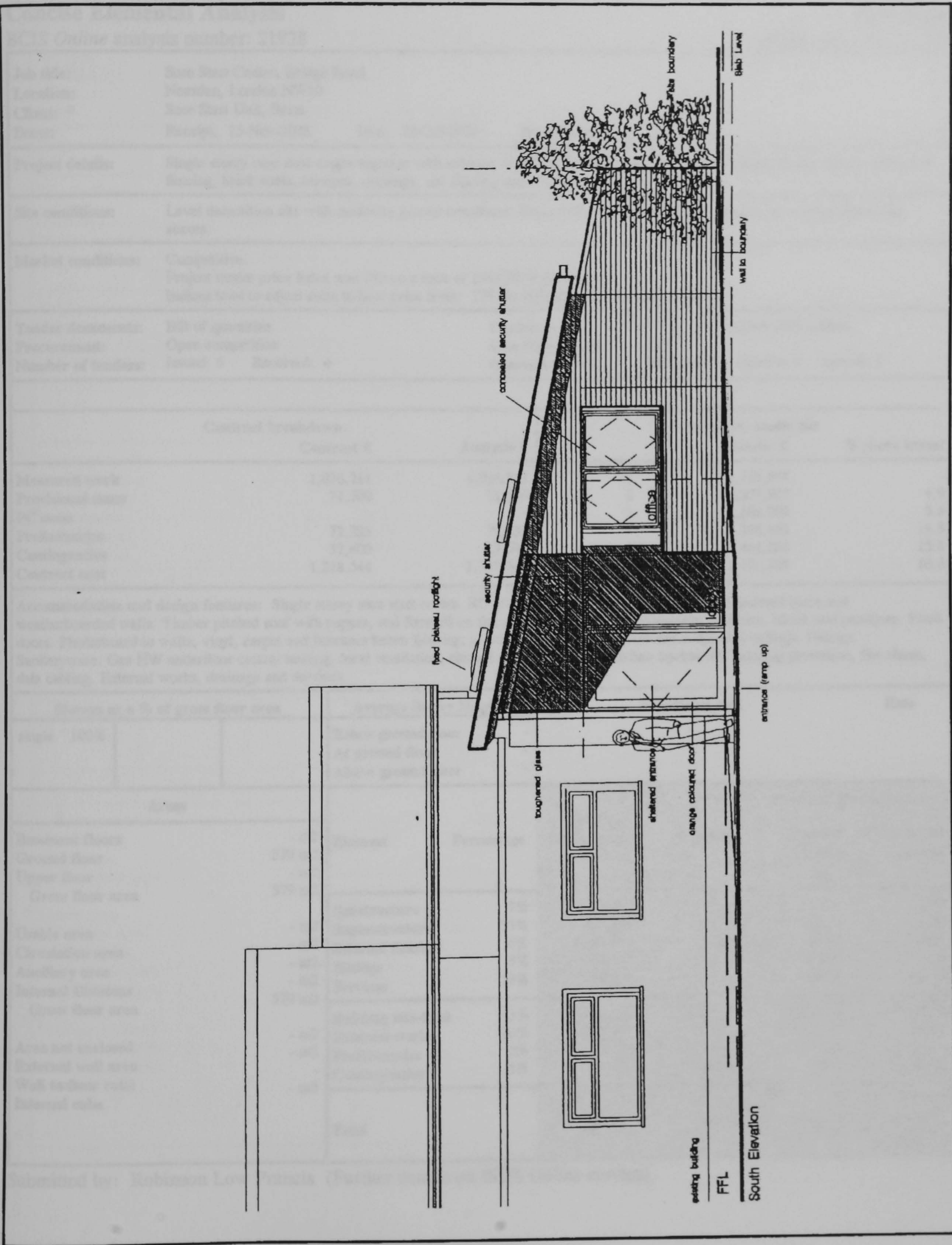
Element		Specification
1	Substructure	RC trenchfill foundations; PCC suspended beam and block floor.
2C	Roof	Timber pitched roof with plastic coated insulated panel cladding. Aluminium rainwater goods.
2E	External walls	Masonry cavity walls with facing brick outer skin, insulated cavity and block inner skin. Furfix extension profiles. Steel lintels.
2F	Windows and external doors	Metal windows and doors.
2G	Internal walls and partitions	Block, timber stud and WC cubicle partitions. Concrete lintels.
2H	Internal doors	Timber doorsets.
3A	Wall finishes	Plaster and emulsion. Ceramic tile splashbacks.
3B	Floor finishes	65mm screed. Sheet vinyl and carpet. Painted timber skirting.
3C	Ceiling finishes	Suspended ceilings.
4	Fittings	Cupboards, shelves and pinboards.
5A	Sanitary appliances	7No fittings.
5B	Services equipment	PC £13,000 to supply kitchen equipment.
5C	Disposal installations	uPVC soil and waste pipes.
5F	Space heating and air treatment	Extension of heating from existing boiler.
5G	Ventilating systems	Local mechanical ventilation.
5H	Electrical installations	Electric light and power.
5K	Protective installations	Extension of existing alarms.
5L	Communications installations	Intruder and fire alarms.
5N	Builder's work in connection	Holes for pipes etc, pipe boxings.
6A	Site works	Sundry site clearance. 17m2 concrete sett paving; sundry walling. 48m2 planting steps with wing walls and handrails. Door holders.
6B	Drainage	94m clayware drains and alteration to existing. 9No brick manholes.
6C	External services	28m service trench.
6D	Minor building works	Work to existing building.
7	Preliminaries	8.79% of the remainder of the Contract Sum (excluding Contingencies).
8	Contingencies	3.26% of the remainder of the Contract Sum (excluding Preliminaries).

Credits

Submitted by:	Derbyshire County Council
Client:	Surestart Erewash
Architect:	Evans Vettori
Qs/planning supervisor:	Derbyshire County Council
Structural engineer:	Erskine Hunt Consultants Ltd
Services engineers:	ESD Engineering Services Ltd
General contractor:	Baggaley & Jenkins



Architect: Evans Vettori



Architect: Evans Vettori

Concise Elemental Analysis

New build

BCIS *Online* analysis number: 21938

BCIS code: A - 1 - 579

Job title:	Sure Start Centre, Bridge Road
Location:	Neasden, London NW10
Client:	Sure Start Unit, Brent
Dates:	Receipt: 15-Nov-2002 Base: 22-Oct-2002 Acceptance: Possession:
Project details:	Single storey sure start centre together with external works including precast concrete and block paving, timber and metal fencing, brick walls, services, drainage, site lighting and bin store.
Site conditions:	Level demolition site with moderate ground conditions. Excavations below water table. Restricted working space and access.
Market conditions:	Competitive. Project tender price index was 190 on a base of 1985 BCIS Index Base Indices used to adjust costs to base price level: TPI for 4Q2002 190; location factor 1.23

Tender documents:	Bill of quantities	**Contract:**	JCT private contract 1998 edition
Procurement:	Open competition	**Cost fluctuations:**	Firm
Number of tenders:	Issued: 6 Received: 6	**Contract period:**	Stipulated: 9 Offered: 9 Agreed: 9

Contract breakdown	**Contract £**	**Analysis £**	**Competitive tender list**	**Tender £**	**% above lowest**
Measured work	1,036,211	1,036,211	1	1,218,544	-
Provisional sums	71,500	71,500	2	1,277,977	4.9
PC sums	-	-	3	1,288,900	5.8
Preliminaries	73,233	73,233	4	1,358,662	11.5
Contingencies	37,600	37,600	5	1,411,256	15.8
Contract sum	1,218,544	1,218,544	6	1,421,338	16.6

Accommodation and design features: Single storey sure start centre. RC ground beams and slab. Steel frame. Rendered block and weatherboarded walls. Timber pitched roof with copper, and Sarnafil on flat areas. Double glazed aluminium windows. Metal stud partitions. Flush doors. Plasterboard to walls; vinyl, carpet and Junckers beech flooring; plasterboard, plywood, MDF and suspended ceilings. Fittings. Sanitaryware. Gas HW underfloor central heating, local ventilation, electric light and power. Kitchen equipment, lightning protection, fire alarm, data cabling. External works, drainage and services.

Storeys as a % of gross floor area			**Average Storey Heights**		**Functional unit**	**Rate**
single 100%			**Below ground floor**	-		
			At ground floor	-		
			Above ground floor	-		

Areas	
Basement floors	- m2
Ground floor	579 m2
Upper floor	- m2
Gross floor area	579 m2
Usable area	- m2
Circulation area	- m2
Ancillary area	- m2
Internal Divisions	- m2
Gross floor area	579 m2
Area not enclosed	- m2
External wall area	- m2
Wall to floor ratio	-
Internal cube	- m3

Element	**Percentage**	**Total cost of element £**	**£ per m2**	**£/m2 incl Preliminaries: Tender prices**	**£/m2 incl Preliminaries: 1995 constant prices**
Substructure	7%	87,406	150.96	160.94	89.53
Superstructure	33%	405,974	701.16	747.52	415.82
Internal finishes	8%	98,149	169.51	180.72	100.53
Fittings	5%	54,147	93.52	99.70	55.46
Services	18%	218,478	377.34	402.28	223.78
Building sub-total	71%	864,154	1,492.49	1,591.16	885.11
External works	20%	243,557	420.65	448.46	249.47
Preliminaries	6%	73,233	126.48	-	-
Contingencies	3%	37,600	64.94	64.94	36.12
Total		1,218,544	2,104.57	2,104.57	1,170.71

Submitted by: Robinson Low Francis (Further details on BCIS *Online* service)

Concise Elemental Analysis

New build

BCIS *Online* analysis number: 21938

BCIS code: A - 1 - 579

Job title:	Sure Start Centre, Bridge Road		
Location:	Neasden, London NW10		
Client:	Sure Start Unit, Brent		
Dates:	Receipt: 15-Nov-2002	Base: 22-Oct-2002	Acceptance: Possession:

Project details: Single storey sure start centre together with external works including precast concrete and block paving, timber and metal fencing, brick walls, services, drainage, site lighting and bin store.

Site conditions: Level demolition site with moderate ground conditions. Excavations below water table. Restricted working space and access.

Market conditions: Competitive.
Project tender price index was 190 on a base of 1985 BCIS Index Base
Indices used to adjust costs to base price level: TPI for 4Q2002 190; location factor 1.23

Tender documents:	Bill of quantities	**Contract:**	JCT private contract 1998 edition
Procurement:	Open competition	**Cost fluctuations:**	Firm
Number of tenders:	Issued: 6 Received: 6	**Contract period:**	Stipulated: 9 Offered: 9 Agreed: 9

Contract breakdown	Contract £	Analysis £	Competitive tender list	Tender £	% above lowest
Measured work	1,036,211	1,036,211	1	1,218,544	-
Provisional sums	71,500	71,500	2	1,277,977	4.9
PC sums	-	-	3	1,288,900	5.8
Preliminaries	73,233	73,233	4	1,358,662	11.5
Contingencies	37,600	37,600	5	1,411,256	15.8
Contract sum	1,218,544	1,218,544	6	1,421,338	16.6

Accommodation and design features: Single storey sure start centre. RC ground beams and slab. Steel frame. Rendered block and weatherboarded walls. Timber pitched roof with copper, and Sarnafil on flat areas. Double glazed aluminium windows. Metal stud partitions. Flush doors. Plasterboard to walls; vinyl, carpet and Junckers beech flooring; plasterboard, plywood, MDF and suspended ceilings. Fittings. Sanitaryware. Gas HW underfloor central heating, local ventilation, electric light and power. Kitchen equipment, lightning protection, fire alarm, data cabling. External works, drainage and services.

Storeys as a % of gross floor area		
single 100%		

Average Storey Heights	
Below ground floor	-
At ground floor	-
Above ground floor	-

Functional unit	Rate

Areas	
Basement floors	- m2
Ground floor	579 m2
Upper floor	- m2
Gross floor area	579 m2
Usable area	- m2
Circulation area	- m2
Ancillary area	- m2
Internal Divisions	- m2
Gross floor area	579 m2
Area not enclosed	- m2
External wall area	- m2
Wall to floor ratio	-
Internal cube	- m3

Element	Percentage	Total cost of element £	£ per m2	£/m2 incl Preliminaries: Tender prices	£/m2 incl Preliminaries: 1995 constant prices
Substructure	7%	87,406	150.96	160.94	89.53
Superstructure	33%	405,974	701.16	747.52	415.82
Internal finishes	8%	98,149	169.51	180.72	100.53
Fittings	5%	54,147	93.52	99.70	55.46
Services	18%	218,478	377.34	402.28	223.78
Building sub-total	71%	864,154	1,492.49	1,591.16	885.11
External works	20%	243,557	420.65	448.46	249.47
Preliminaries	6%	73,233	126.48	-	-
Contingencies	3%	37,600	64.94	64.94	36.12
Total		1,218,544	2,104.57	2,104.57	1,170.71

Submitted by: Robinson Low Francis (Further details on BCIS *Online* service)

Appendix Two

Online evaluation of the model structure

The e-mail sent to experts electronically where the program will insert the first name of each expert after Dear as follow:

Dear John,

I am conducting a feedback survey for a concept of a PFI Financial Model, which I am developing as part of my PhD research project. Could you please contribute to this survey by giving your comments on the model concept, which is at the link below:

http://www.surveymonkey.com/s.asp?A=151624536E11688

It will not take much of your time, five minutes is estimated time it will take, only few and simple questions. If you know of anybody who can contribute to this, please pass this email to them.

Thank you for your valuable feedback.

Best regards.

Faisal Alsharif
Heriot-Watt University
Edinburgh, UK

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.

http://www.surveymonkey.com/r.asp?A=151624536E11688

The questionnaire:

PFI Financial Model (Concept)

Introduction

The aim of developing this model is to have a computer based tool that is able to predict the cost and cash flow of PFI school projects at the bidding stage. The structure of this model is shown below. It is to help public and private sectors to assess PFI school projects in terms of feasibility and profitability. In brief, the model consists of four modules as follow:

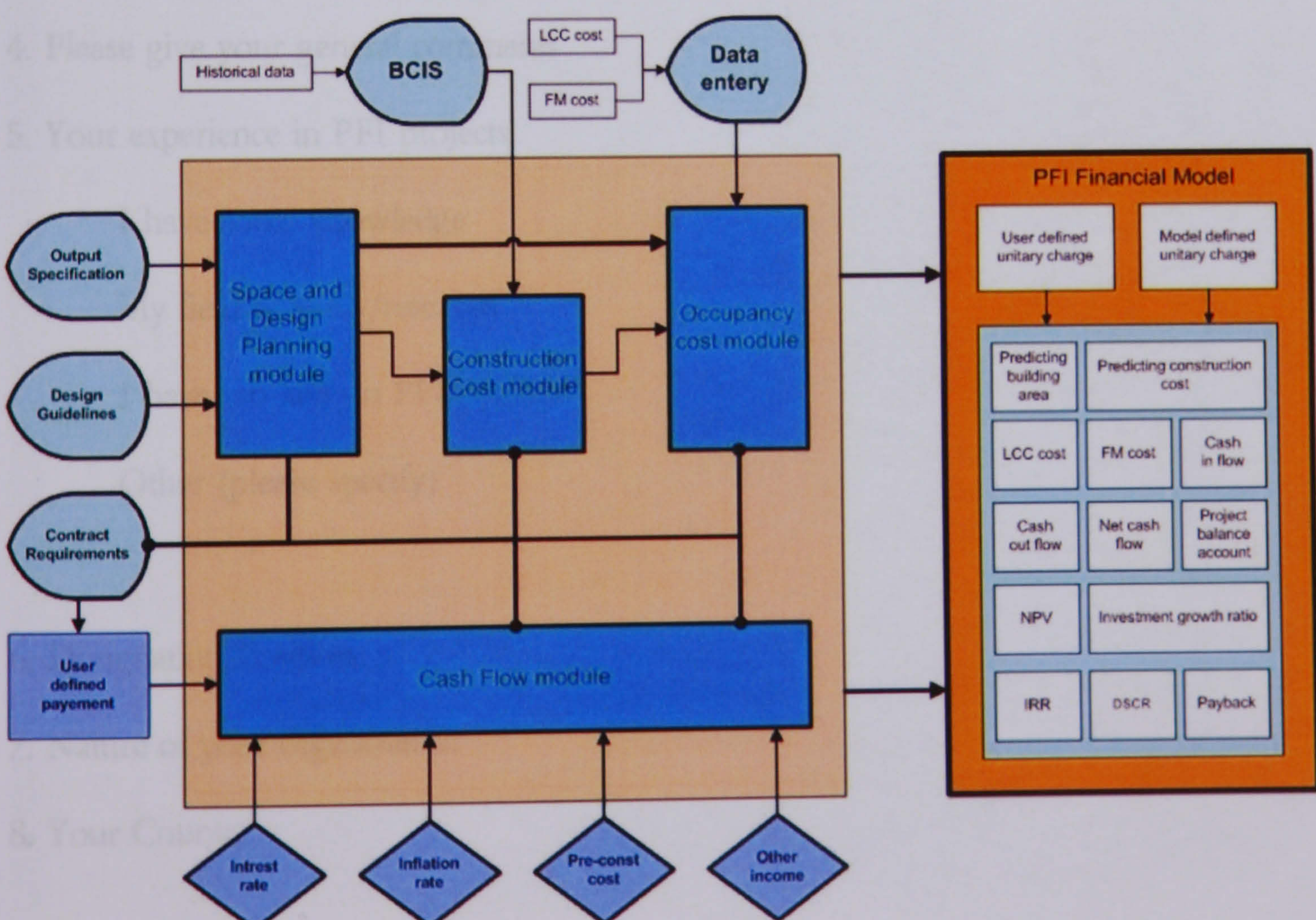
- Space planning module: to calculate the building area based on the number of pupils and type of school.
- Construction cost module: to predict the construction cost based on BCIS historical data of school projects.
- Occupancy cost module: this cost will be entered by the user for main cost items of LCC and FM with their intervals, and the model will index the cost and spread it on the project duration according to their intervals.
- Cash flow module: to calculate the cash flow of the project.
- The Model is primarily designed to compute the proposed unitary charge of the project. There is also an option for the user to set the unitary charge that suits him for the model to generate the other outputs.

The output will be as follows:

- Building area, with indication for the main items areas to help in the design.

- Construction Cost.
- LCC & FM cost for the project duration.
- Cash in-flow, Cash out-flow, Net Cash flow in tables and graphs.
- Project balance account.
- Net Present Value (NPV), Internal Rate of Return (IRR), Debt-Service Coverage Ratio (DSCR) and Bay-back period.
- Investment growth ratio.

PFI Financial Model concept



1. Please rate the model concept according to the following (1 is Low and 5 is High):

	1	2	3	4	5
Applicability to PFI school projects					
Comprehensiveness					
Practical relevance					
Intelligibility					

2. Model's point of strength

3. Model's points of weakness

4. Please give your general comments

5. Your experience in PFI projects

    I have some knowledge

    My field of study/research

    I have worked on PFI projects

    Other (please specify)

6. Designation/Position

7. Nature of your organization

8. Your Country

The questionnaire snapshots are listed below:

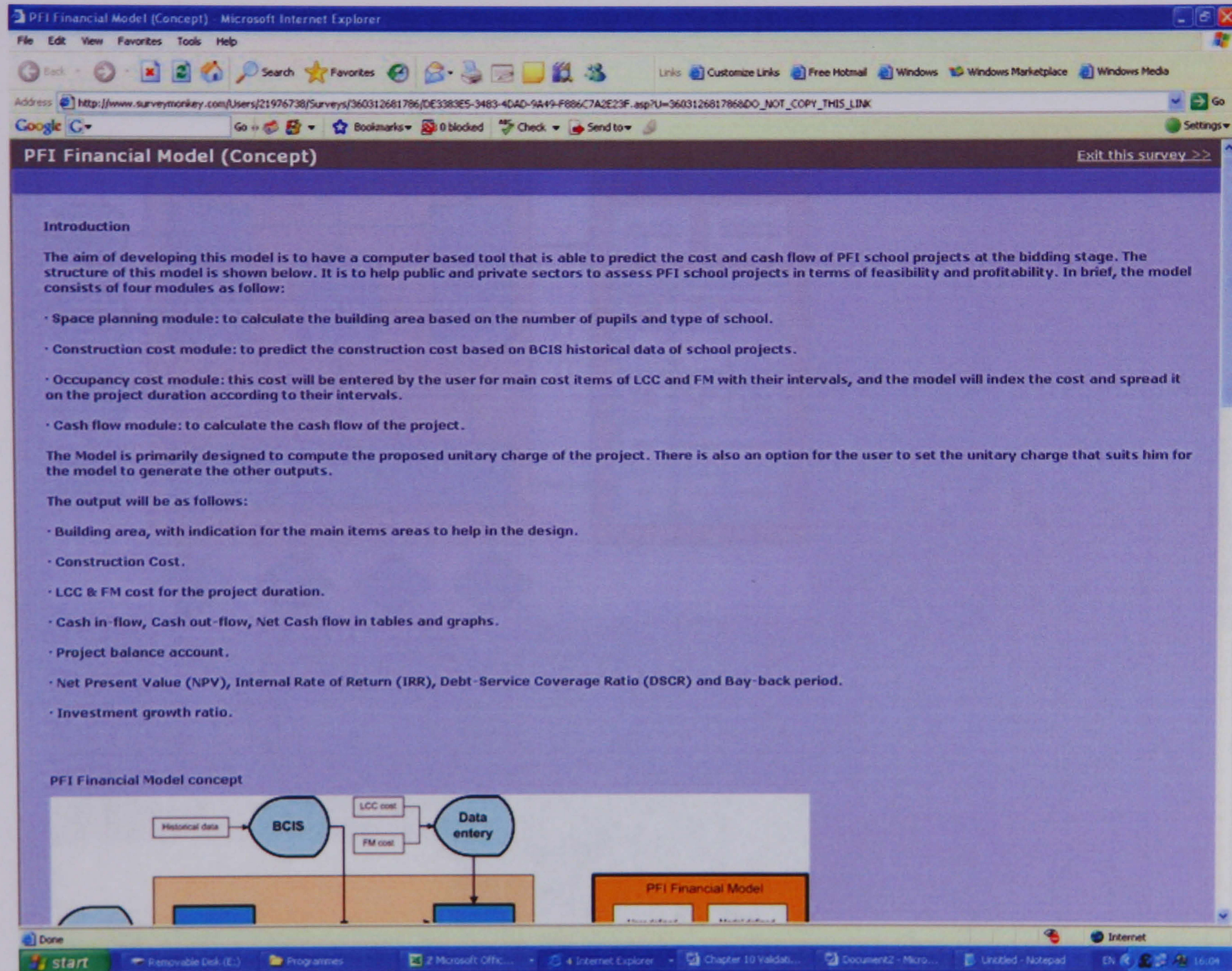


Figure 1: Model concept validation snapshot 1

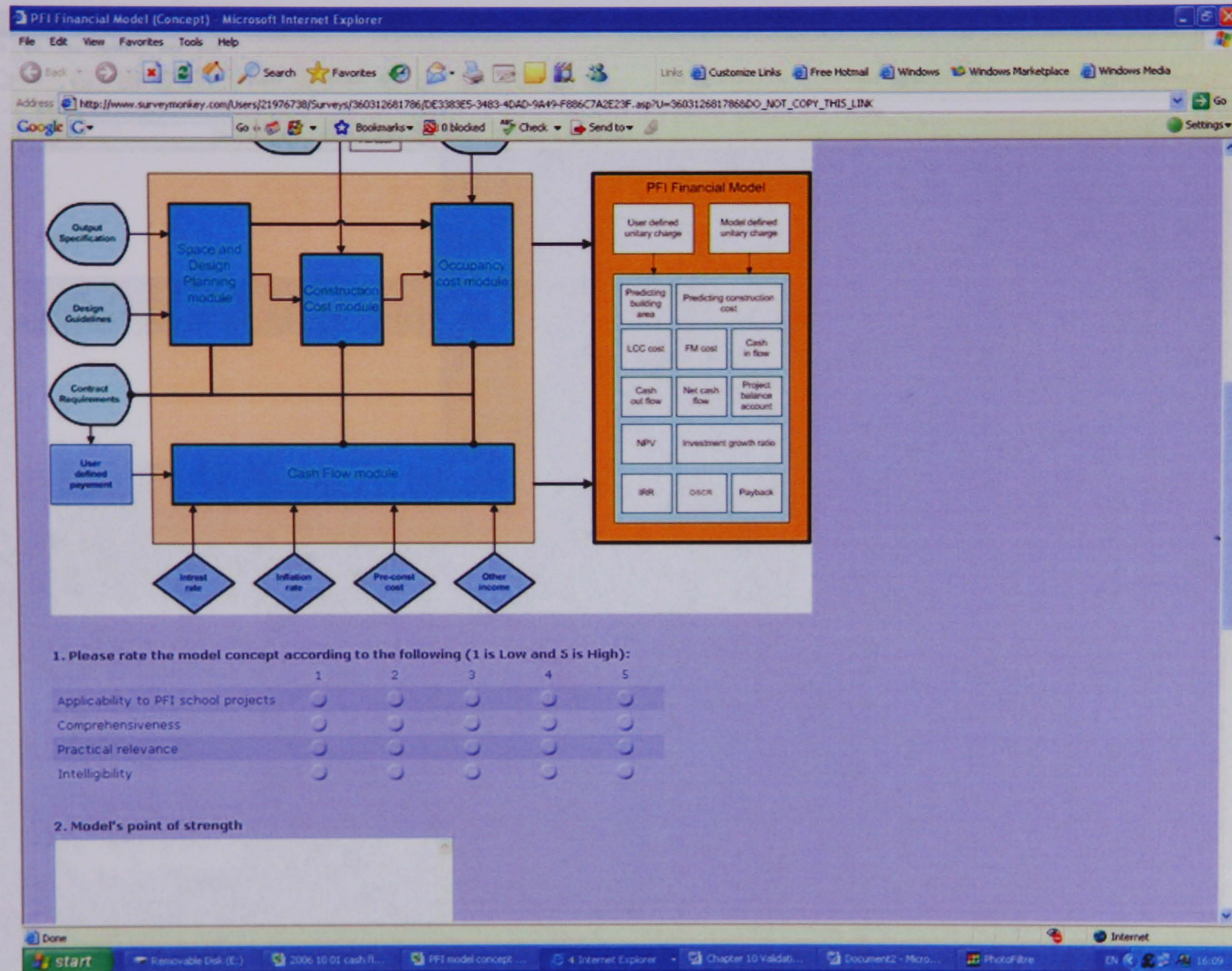


Figure 2: Validation of the model concept, snapshot 2

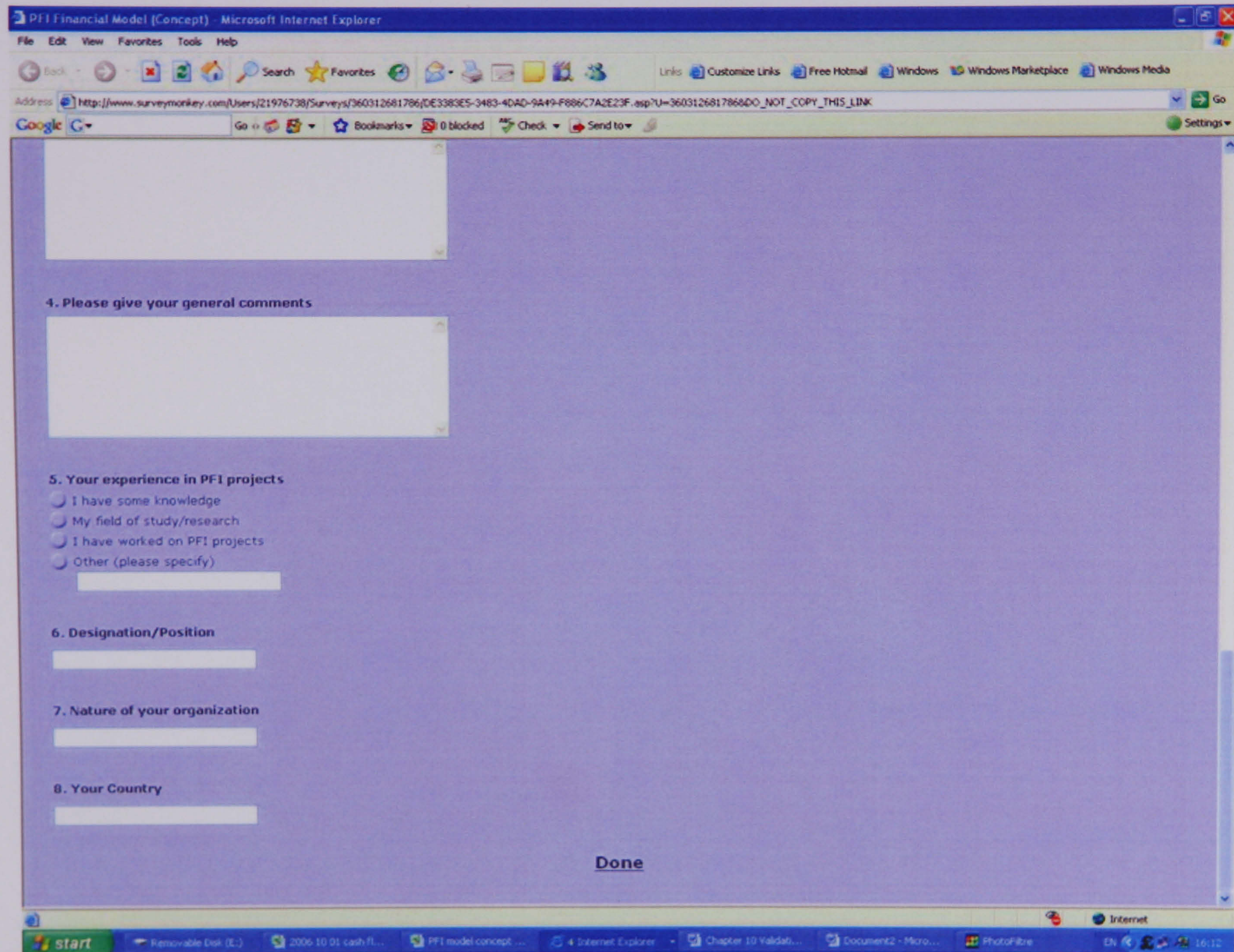


Figure 3: Validation of the model concept, snapshot 3