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OVID-BV:
Optimising Value in Decision-making for Best Value in the UK Social Housing Sector.

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OVID-BV

OPTIMISING VALUE IN DECISION-MAKING

FOR BEST VALUE IN

THE UK SOCIAL HOUSING SECTOR

By

Steve Phillips

A dissertation thesis submitted in partial fulfilment of the requirements for the award of the Engineering Doctorate (EngD) degree at Loughborough University.

December 2007.

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Finally I would like to thank my wife Deirdre who has supported my many ventures over the last 20 years and her reassurance and humour during the research process has kept me going during the times when I was flagging.

ABSTRACT

The Governments' promotion and support of Best Value within the Social Housing Sector has been a prime catalyst in the move by Registered Social Landlord's [RSL's] away from the traditional culture of acceptance of the lowest bid towards consideration of both price and quality criteria as a basis for contractor selection. Manifestly this radical change in the way the sector procures its construction services has forced many of its stakeholders to undergo significant cultural and organisational changes within a relatively short period of time, and problems have developed during this transitional period that have affected the efficiency of the best value process.

This research traced the root causes of these problems and its overarching aim was to develop an approach which will enable RSL's and their stakeholders to streamline the best value tender analysis procedure thereby allowing tenders to be dealt with effectively and efficiently whilst also creating a transparent and auditable decision making process. The approach has been established using a mixed methods research methodology utilising; case studies, surveys, rational decision analysis and system evaluation. The main output of the research is the development of a support tool known by the acronym OVID-BV which aids the multi objective decision making process. The underlying rationale for the support tool is based on the innovative use of uncertainty in decision making and the functionality of the tool uses a combination of the analytical hierarchy process (AHP), multi attribute utility theory (MAUT) and whole life costing (WLC).

Key Words: Best value, contractor selection, factor analysis, multi attribute utility theory, social housing.

PREFACE

This thesis represents the research undertaken between October 2003 and September 2007 to fulfil the requirements of an Engineering Doctorate (EngD) at the Centre of Innovative and Collaborative Engineering (CICE) at Loughborough University, Leicestershire, UK. The research was undertaken within an industrial setting and sponsored by Martin Associates Chartered Surveyors LLP, one of the UK's leading multi-disciplinary surveying consultants.

The core of the EngD is the solution of one or more significant and challenging problems with an industrial context. The project work designed to address the identified problems must demonstrate and implement innovation with the results of the research being published during the currency of the project. The structure and format of this thesis reflects the fact that the EngD is assessed upon a collection of published papers and a discourse which sets outs the aim, objectives, findings and industrial relevance/impact of the research. The main body of the thesis enables the reader to gain an overview of the work undertaken, whilst more specific aspects of the research can be found in the papers which support this discourse and can be found in the appendices at the back of the thesis. Where appropriate, references to the papers are provided throughout the main body of the thesis.

USED ACRONYMS/ ABBREVIATIONS

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process.
CCT	Compulsory Competitive Tendering
DIM	Displaced Ideal Model
DTI	Department of Trade and Industry
EngD	Engineering Doctorate
EU	European Union.
GCCP	Government Construction Client's Panel
KPI	Key Performance Indicator
LVT	Leasehold Valuation Tribunal
MAUT	Multi Attribute Utility Theory
MCA	Multi Criteria Analysis
NAO	National Audit Office
OGC	Office of Government Commerce.
OCT	Online Collaboration Tool
OVID-BV	Optimising Value In Decision-making in Best Value.
PCA	Principal Component Analysis.
PFI	Private Finance Initiative
PSD	Public Service Directive.
RSL	Registered Social Landlord
SMART	Simple Multi Attribute Rating Technique
VE	Value Engineering.
VM	Value Management
WLC	Whole Life Costing.

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LIST OF PAPERS

The following papers have been produced in the course of the research undertaken with respect to the Engineering Doctorate. Papers labelled one to five are included in the appendices and are submitted in partial fulfilment of the award requirements.

PAPER 1.

Phillips, S, Martin, J, Dainty, A and Price, A (2004). Assessing best value in social housing procurement. *Proceedings of the COBRA/RICS International Construction Conference "Responding to Change".* Leeds, UK. September 7-8, 2004.

PAPER 2.

Phillips, S, Martin, J, Dainty, A and Price, A (2007). Uncertainty in best value decision making. *Journal of Financial Management of Property and Construction*. **12** (2) pp 63-72.

PAPER 3.

Phillips, S, Martin, J, Dainty, A and Price, A (2008). Analysis of the attributes used in establishing best value tenders in the UK social housing sector. *Engineering Construction and Architectural Management. In Press for Publication.*

PAPER 4.

Phillips, S, Martin, J, Dainty, A and Price, A (2008). Renew or repair existing window units? A best value approach. *Construction Information Quarterly* **10** (1) pp 12-18.

PAPER 5.

Phillips, S, Dainty, A and Price, A (2007). The development of a tender analysis support tool for use in social housing best value procurement. *In*: Boyd, D(Ed) *Procs 23rd Annual ARCOM Conference,* 3-5 September 2007, Belfast, UK.Association of Researchers in Construction Management, 797-798.

ADDITIONAL PAPER (NOT INCLUDED IN THE THESIS).

Phillips, S, Dainty, A and Price, A (2004). Achieving best value in social housing procurement. *In*: Khosrowshahi F(Ed) *Procs 20th Annual ARCOM Conference, 1-3* September 2004, Heriot Watt University, UK. Association of Researchers in Construction Management, 639-648.

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH

The purpose of this chapter is to set out the background to the research undertaken to fulfil the requirements of the award of an Engineering Doctorate (EngD) at Loughborough University. It provides an introduction to the general subject domain, identifies the aim and objectives of the research, justifies the need for the research and puts it within an industrial and commercial context. The structure of the thesis is presented to provide clarity and direction to the reader and a synopsis of each of the published papers is provided so that they may be read in conjunction with the discourse.

1.2 DRIVERS FOR BEST VALUE IN CONSTRUCTION

The aim of this section is to provide a framework for the understanding of how current tendering practices in the UK have evolved towards value based procurement and the ramifications this has had on the structure and operation of the Social Housing Sector. Since the end of the Second World War a number of major government sponsored reports have been drawn up which have either considered and/or influenced UK tendering process and practice. Reflection upon these publications helps to understand the development of trends in tendering and allows current practices, both nationally and within the social housing sector, to be contextualised.Open tendering procedures were first criticised in the 1940's (Simon Committee 1944) due to; its inherent reliance on lowest capital cost with respect to the selection of contractors (to the detriment of any other attributes) and its inefficient use of contractors experience,

knowledge and resources. Although, *prima facie,* lowest bid selections suggest monetary savings for a client, these bids may not, in the final analysis, produce best value for the clients. The reasons for this divergence stem from; differential performance levels of contractors and consultants, the fact that many non-price attributes (such as quality of product or speed of construction) are not considered and because subsequent claims are made by contractors to offset their unrealistic priced initial tender bid. The adoption by clients of selective tendering practices as an alternative to open tendering has been addressed and developed in subsequent reports (Banwell 1964, and the Economic Development Committee for Building 1967). However the readdressing of the selective tendering issue some 25 years after the Simon Committee report underlines the reluctance of client organisations, particularly in the public sector, to move away from securing the lowest return of tender cost within the market place.

The *Constructing the Team* (Latham 1994) report was a major catalyst in persuading clients to head up the initiative to bring about a paradigmatic shift in the structure of the industry away from traditional practices and move towards collaborative working, and selective competition. Whilst Latham addressed a whole range of innovative issues within his report one of the main strands that is fundamental in assisting the process of change is the premiss that selection of contractors should be based on value for money criteria and not lowest capital cost. The Technology Foresight report *Progress Through Partnership, Number 2, Construction,* published by the HMSO in 1995 reinforced the idea that productivity could be increased within a new innovative culture supported jointly by both the government and the industry. This idea was reinforced by the government–initiated report entitled *Rethinking Construction* (Egan

1998) which recommended that client organisations, and particularly those based in the public sector, were best placed to lead the necessary challenging reform process and set out an agenda for public sector clients. The report also continued with the theme that contractors should be selected using new criteria based not on lowest price but, ultimately, about best overall value for money. In order to get the industry to change its ways the Government was advised that it would also have to change its own behaviour, practice and procedures (Levene 1995) and in 1997 the Government Construction Clients' Panel (GCCP) was established by the HM Treasury to improve Government client performance.

These reports and their recommendations have influenced how public sector clients conduct their business, not least, because of the methods chosen by the Government as they endeavour to assist these public sector bodies in their aspirations to become "best practice clients" and the problems that have been caused (Gratton and Ghosal 2005). To understand how the Government was able to force through these changes and the ripple effects that the cultural sea changes have created it is necessary to, very briefly, consider the role of the UK's social housing providers and their inter-relationship and interdependence upon the Government as the primary source of funds.

1.3 BEST VALUE AND THE SOCIAL HOUSING SECTOR

The social housing sector is responsible for a programme of construction, maintenance and refurbishment works, which is annually valued at £1 billion GBP (DTI 2003). In 2007 Professor Martin Cave undertook a review of regulation in the

social housing sector and reported that the sector comprises four million homes, housing 8.4 million people and that there are four categories of provider;

- Local Authorities as owners and managers of social housing (32% of the total).
- Arms length management organisations (ALMOs) of local authorities (20%).
- Housing Associations (48%).
- Unregistered bodies including for-profit providers (0% of ownership to date though they undertake some management).

Whilst four providers have been identified social housing provision within the UK pragmatically operates under the umbrella control of two main arms as ALMOs are effectively (though not legally) the housing department of a Local Authority and the unregistered bodies have not, to date, made any impact with respect to the provision of new homes. The first of the two arms is the housing provided and managed by Local Authorities (commonly called council housing) and the second being the housing provided and managed by Housing Associations and other organisations, which together form the "voluntary housing movement". The welfare of these housing associations falls under the umbrella control of the Housing Corporation, which is a central government financed quango formed under the 1964 Housing Act to promote and assist the development of housing associations. The Housing Corporation has the powers to provide loans to housing associations for development schemes and most associations have received such a subsidy (Stewart 1996). There is no typical profile for the housing stock of these two providers, as social housing is provided in a variety of building styles and in a huge range of locations (Harriott and Matthews 1998). The term "registered social landlord" (RSL) is used as a collective term for both housing associations and local authorities alike. Two features that the majority of RSL's share

is that (a) they are regular procuring clients to the construction industry and (b) their corporate strategy and operational procedure is shaped and regulated by Government policy which has allowed these organisations to be used as key drivers for the behaviour of the UK construction industry.

The adoption of 'best value' by the social housing sector can be attributed to political influence and the redrafting of legislation rather than a genuine desire to change which has been culturally driven by the internal corporate policy of the individual RSL's. The best value regime was introduced at a local government level in England and Wales on the 1st April 2000 by way of new legislation contained within the Local Government Act 1999 which received Royal Assent on 27th July 1999. (Best Value in Scotland was established as a statutory duty by the introduction of the Local Government in Scotland Act 2003). It was introduced to replace Compulsory Competitive Tendering (CCT) and applies to all public services controlled by local authorities and requires local councils to review, develop and to show continuous improvement with respect to their procurement strategies in terms of their efficiency, effectiveness and economy. It is intended that a system of measuring key performance indicators (KPI's) allows auditors to determine the RSL's position with respect to achieving best value and demonstrating continuous improvement. To accompany the introduction of best value Sir Ian Byatt undertook a review of local government procurement in England which recommended that local authorities should develop procurement evaluation criteria which incorporate quality and whole life costs. The criteria should be agreed in advance and should be published, transparent and auditable (Byatt 2001).In 2000 The Housing Corporation also showed its commitment to the use of a value for money approach to procurement providing that it is

implemented in a well-planned way that demonstrates probity. By 2003 the Corporations' expectations were that all RSL's construction activity is to be 'Egan Compliant' and they will only provide funding for RSL's that have achieved Client's Charter Status (Housing Corporation 2003) and in 2005 the Corporation's regulatory code stated that housing associations must aim to deliver continuous improvements and value for money in their services (Housing Corporation 2005). In other words, unless an RSL, under the umbrella control of the Housing Corporation, can demonstrate that it implements its procurement process in compliance with the ethos of collaborative working and value for money objectives it may not receive grant monies to carry out the required works.

This plethora of reports and edicts were produced within a relatively short space of time and the overarching concern for the Government must have been one of effective implementation of the new ideas and concepts. In order to assist the step change in the public procurement process the Office of Government Commerce (OGC) in conjunction with the GCCP, launched, in 1999, the *Achieving Excellence Initiative* (AEI) whose key thrust was that Government departments and public bodies ,such as RSL's, should deliver value for money and other 'Rethinking Construction' targets. The AEI set out an action plan for implementation which had to be achieved by March 2002 and one of the main aims of the action plan was that all procurement practices should be standardised around total value for money criteria. This has been particularly problematical as, historically and as acknowledged within the many abovementioned reports, government departments and public bodies are particularly resistant to cultural change (Thomas Cain 2003). These issues and problems were underscored by Sir Peter Gershon's independent review into public sector efficiency

in 2004 which stated that too much public procurement is undertaken without professional support which results in sub-optimal value for money and unnecessarily high prices being paid for goods, works and services. The goal of best value selection is clear but proposal or bid evaluation is not an easy task. Best value selection requires that value criteria can be evaluated directly against competing cost proposals. Again this is not an easy task. There is currently no standard of scoring value proposals in a best value selection and yet as the expenditure of public money is subject to audit scrutiny good clear records must be kept to demonstrate how the parties have worked together to reach decisions, how best value has accrued and probity and propriety have been maintained (HM Treasury Procurement Guidance No 5, 1995). This research aimed to provide solutions to these problems as they relate to the social housing sector.

1.4 THE RESEARCH CONTEXT

1.4.1 Researcher

The researcher is a Chartered Surveyor and a Chartered Builder with a background in dispute resolution focusing on residential landlord and tenant service charge disputes arising from regeneration and refurbishment contracts within the social housing sector. Early in 2002 the author recognised that new issues were surfacing during a number of the disputes which seemed to reflect the changes in the attitudes of client organisations towards value based procurement. Intuitively there seemed a need to proactively identify, address and resolve these new issues in order to preserve and, potentially, enhance the new spirit of value–added service delivery that is evolving within the UK construction industry.

1.4.2 The Industrial Sponsor

The sponsoring company, Martin Associates Limited Liability Partnership, are a multi-disciplinary professional practice of Chartered Building Surveyors, Cost Consultants, Project Managers and Architects and were formed in 1999. They are a very successful innovative practice with an excellent record for successfully completing difficult and intricate social housing projects which require a high degree of tenant liaison and involvement. The senior partners of Martin Associates are in agreement that value based procurement has changed the way in which tenders are analysed and in order to maintain their position as the 'best in class' in an increasingly competitive market they are encouraging and financially supporting this research, the results of which are being fed back into their client service operations.

1.5 AIM AND OBJECTIVES

1.5.1 The Overarching Aim:

To develop a transparent and auditable approach for a tender decision support tool to assist in analysing UK Best Value decision making.

1.5.2 The Objectives:

1. Identify the unique characteristics of Registered Social Landlords as a construction client within the social housing sector.
2. Identify the problems and challenges generated by the introduction of 'best value' within the sector.
3. Establish a set of core attributes assessed during the tender analysis process.

4. Develop a transparent and robust method for measuring best value.
5. Develop a generic software tool to provide a transparent and commercially effective audit trail of the best value analysis process and validate the tool by pragmatic application.

1.6 JUSTIFICATION AND SCOPE

1.6.1 Problem Definition.

The lack of knowledge around the concept of best value and its evaluation has resulted in some RSL's making a substantial financial loss when their best value procurement process has been legally challenged (Phillips 2003). Consequently the RSL's have looked to their approved consultants to provide the necessary solutions but they have also been found wanting as they too have minimal practical experience of essential best value techniques such as whole life costing, value management and value-orientated selection mechanisms (Griffith *et al* 2003). These problems are exacerbated by the fact that RSL's are under constant pressure to place large volumes of business into the industry comprising not only new build projects but also maintenance and refurbishment contracts with respect to their existing assets, all of which are subject to the rigours of the best value tender process and scrutiny by the Audit Commission or Housing Corporation. There is a clear gap in both knowledge and ,in the commercial market place, for a methodology that is not only transparent and auditable but can also be easily and repeatedly used by the officers of the RSL's and their consultants so that they can deal efficiently and effectively with the high volume of tenders they are faced with.

1.6.2 Scope of the Research

The parameters set for this research project, including definitions used, are as follows;

- There is no generically accepted definition for the term 'best value' (Choi 1999). For the purposes of this thesis best value in the UK is defined as the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users' requirements, as it is the relationship between long-term costs and the benefit achieved by clients that represents value for money (Office of Government Commerce 2003).
- The terms 'best value' and 'value for money' are interchangeable unless otherwise stated.
- Though the OGC definition refers to quality/'fitness for purpose' this research has, for the sake of completeness, investigated the meaning of value with quality/'fitness for purpose' being sub-sets of value.
- OVID-BV has not been designed to assess 'economically advantageous' tenders under EU procurement law. Therefore it is suggested that the upper limit of the monetary value of contract the support tool should be used for is the prevailing EU threshold level for the procurement of works. At the date of this thesis the level is £3.6 million.
- As a generic tool OVID-BV can be used as part of all the recognised UK construction value-based procurement systems.
- Value Management is defined as involving the use of a structured, facilitated, multi-disciplinary team approach to make explicit the client's value system using functional analysis to expose the relationship between time, cost and quality (Kelly and Male 2002).

- The whole-life costs of a facility are defined as the costs of acquiring it (including consultancy, design and construction costs, and equipment), the costs of operating it and the costs of maintaining it over its whole life through to its disposal –that is, the total ownership costs. These costs include internal resources and departmental overheads, where relevant: They also include risk allowances as required: flexibility, refurbishment costs and the costs relating to sustainability and health and safety aspects (Office of Government Commerce 2003).
- Stakeholders are defined as groups, or individuals, who have a stake in, or expectation of a projects performance (Newcombe 2003)

1.7 THESIS STRUCTURE

This thesis documents the research undertaken in the partial fulfilment of the requirements for the award of an Engineering Doctorate (EngD) from Loughborough University. The thesis is structure as follows;

Chapter 1 introduces the research project, provides background to the general subject domain, identifies the aim and objectives and justifies the need for the research, and sets it within an industrial context.

Chapter 2 provides an overview of previous research and practice in the subject domains of value and best value and highlights the gap in knowledge in the field of contractor selection in the UK social housing sector.

Chapter 3 sets out reasons why a multi-strategy research design was adopted, reviews a range of research methods applied within this framework and details those used in this research project and justifies the reason for their choice.

Chapter 4 details the work carried out to meet the research project's aim and objectives. It comprises the findings of the research including details of the development of the decision support tool, OVID-BV, and provides screenshots to demonstrate the support tool's functionality.

Chapter 5 discusses the commercial application of OVID-BV, its evaluation by its users and its implications for use by both the industrial sponsor and the wider industry.

Chapter 6 concludes the thesis by summarising how the project has contributed to knowledge and practice and the areas in which on-going research is currently being carried out.

The Appendices contain the peer-reviewed papers that resulted from and support this research. These papers are an integral part of the work and should be read in conjunction with this thesis. Supporting documents are also provided that demonstrate the commercial application of OVID-BV.

Table 1.1. SYNOPSIS OF PAPERS.

ID	Title.	Journal/ Conference	Status	Description.
Paper 1 Appendix A	Assessing best value in social housing procurement.	COBRA/RICS International Construction Conference. (2004).	Published	Identification of the unique characteristics of the social housing sector and the problems caused by the introduction of best value in the UK. [Objectives 1&2].
Paper 2 Appendix B	Uncertainty in best value decision making.	Journal of Financial Management of Property and Construction. (2007)	Published	Sets out a transparent and robust methodology for measuring best value and its application in a real tender analysis. [Objectives 2&4].
Paper 3 Appendix C	Analysis of the attributes used in establishing best value tenders in the UK.	Engineering, Construction and Architectural Management. (2008)	In Press	Details research carried out by postal questionnaire and using factor analysis to establish core attributes assessed by RSL's and their stakeholders during best value tender analysis. [Objective 3].
Paper 4 Appendix D	Renew or repair existing window units? A best value approach.	Construction Information Quarterly. (2008)	Published	Outlines the pragmatic application of an electronic version of the methodology in a real decision making situation. [Objectives 4&5].
Paper 5 Appendix E	The development of tender analysis support tool for use in social housing best value procurement.	ARCOM Conference. (2007).	Published	The paper brings together all the previous research work to show how the methodology has been converted into a windows based software support tool. [Objectives 1, 2, 3, 4&5].

CHAPTER TWO. LITERATURE REVIEW

2.1 INTRODUCTION.

The chapter puts this EngD research into context with respect to work previously carried out within the subject domains of not only best value but also of value *per se*. It details the results of both the initial literature review that was carried out which provided a sound knowledge foundation and framework from which the EngD research project was established and ongoing literature reviews that were undertaken during the research period.

As best value in the UK is a relatively new issue the review commences with a discussion on the general nature of value, how the concept of value is viewed within the UK construction industry and then outlines the implementation of value management techniques used in establishing client and project value systems. Brief explanatory notes are provided outlining general methods of assessing value based bid proposals and the review concludes by setting out the problems and challenges encountered during, both, the transition to value based procurement and the subsequent introduction of best value both in the UK and abroad. This review is by no means exhaustive but serves to demonstrate the fragmented and wide ranging nature of this research problem.

2.2 VALUE

Value is a complex concept that has intrigued academics throughout the ages and before examining methods which enabled RSL's to produce value systems it is pertinent to consider what is meant by the term 'value'. Philosophers in ancient

Greece understood the dynamics of value (Todd Lowry 1979) though the foundations for the notion of value within the field of modern economics was set by Adam Smith's seminal text published in 1776, The Wealth of Nations. Smith identified two meanings for value namely, value in use and value in exchange which were developed into the economic theory of utility (Ricardo 1817).This, in turn, was developed by Karl Marx in 1886 as part of his labour theory of value which argued that value could only be created by the application of labour in the production process. Since then, value, has been viewed from an economic perspective in terms of the ratio of costs to benefits. This economic based definition has provided a foundation for other disciplines, which have derived an understanding of value that has been measured in monetary terms, though, it has long been understood that value and lowest cost does not go hand in hand (Ruskin 1898). Other commentators have discussed and described value in numerous economic contexts including exchange properties related to the market place (Bagozzi 1975), which evolved into transaction theory (Bowman and Veronique 2000). The concept of stakeholder value was introduced to state that the principal goal of management is to maximise the level of sustainable growth in profitability and thereby enhance shareholder value, defined as the maximising of returns to those who have an ownership stake in the business (Scott 1989). Customers expectations were then integrated with business operational and strategy issues to contribute to the creation of value (Treacy and Wiersema 1993) with the market place being where customers actually create value within a commercial process (Prahalad and Ramaswamy 2000).

In the discipline of philosophy core distinctions are drawn in theories of value between subjectivism and objectivism. The former relates value to different states of

mind while the latter accepts that value can exist independently of human beings (Oliver 2000). Subjective personal feelings are a very important part of decision making and have also been studied from a social and psychological dimension with value being very much an intrinsic part of the cognitive makeup of the individual and being distinct from preferences, utility, desires and attitudes (Anderson 1993). Further definitions of value have merged the economics of marketing and selling with social psychology and have stated that value is also a matter of perception of superior qualities (Woodruff and Gardial 1996) and that customer perceived value increases proportionally as the perceived benefits grow (Monroe 1991) with the value of a product or service only having significance in economic terms when a person is prepared to give up something in order to obtain it (Harvey 1984). A number of these ideas are encapsulated by 'lean thinking' which states that value can only be defined by the ultimate customer and is only meaningful when expressed in terms of a specific product (a good or a service, and often both at once) which meets the customers needs at a specific price and at a specific time (Womack and Jones 2003). Whilst lean thinking developed directly from processes developed by the Japanese car production industry (Womack *et a*l 1991) it also overlaps with Gage's work in 1969 who perceived value as the maximisation of business efficiency through the elimination of waste and the application of the labour theory within business operations by the introduction of value-added activities at the business process level (Porter 1985).

Within the last decade attention has been turned to the definition of value purely within the public sector (Kelly G *et al* 2002) and public value holds that public services should provide what the public values and should do so efficiently (Blaug *et*

al 2006). The next section reviews how the concept of value has been addressed within both the UK construction industry and within the social housing sector.

2.3 VALUE IN THE UK CONSTRUCTION INDUSTRY

Undertaking any construction project is not an end in itself and construction is only undertaken because it delivers something of value to the client and their stakeholders. The common purpose should be, with the resources available, to maximise that value. Maximum value has been defined as obtaining a required level of quality at least cost, or the highest level of quality for a given cost or from an optimum compromise between the two (Burt 1975). Obtaining maximum value can be achieved only if all members of the team recognise what represents value for a specific project. Prior to the introduction of best value procurement within the UK construction industry value was, predominantly, linked to lowest cost as this was the basis on which contractors were selected. However the shift towards and implementation of value based procurement has caused the industry to rethink its concept of value in terms of a relationship between function, cost and quality. Manifestly a project can be executed in a cost–effective manner and be completed within budget but if it does not meet the client's business needs then the project will not have provided good value for money. Early work equated value in terms of cost reduction and increased quality standards which lead to greater client satisfaction i.e. Value = (Function + Quality) /Cost (Dell'Isola 1997) with the value deriving from the project to be owned by the client (Atkin *et al* 1995) and the clients expectations, whatever they may be, also having to be satisfied (Martinez and Bititci 2000). However, in 2002, and as part of his work on best value, Steven Male, using systems thinking terminology (Checkland 1981),

challenged the view that only the client should own any value produced and stated that a value system comprises people making judgements about best value and value for money and the view of what constitutes value is dependent upon a persons role in the construction process with the; producer, consumer and user ,potentially, having differing value perspectives with respect to the same product. At this level of perception value clearly has a utility dimension which can be defined as the intrinsic property to satisfy (Kelly *et al* 2004).

In terms of bid evaluation and contractor selection the definition of the client's value system is crucial as the fundamental notion in decision making should be values and not alternatives as the relative desirability of consequences is a concept based on values (Keeney 1992). If performance based contractor selection is to be successfully implemented using transparent and auditable procedures then value needs to be evaluated in a clear, justifiable and documented way to allow decision makers to move away from lowest price procurement (Langford *et al* 2003). Each client organisation, including RSL's, will have different requirements and value systems which will be driven by their; ownership characteristics, their corporate and strategic aims and objectives and their involvement in a specific sector of the industry. A consolidated client typology has been included to show the various client characteristics and the place of RSL's within the construction industry as a whole (See Table 2.1)

In general terms RSL's can be described as knowledgeable clients, who are regular procurers of projects within the public sector. They place large volumes of business

Figure 2.1 Client typology within the UK Construction Industry

	Private sector						Public sector				
	Knowledgeable			Less Knowledgeable			Knowledgeable		Less knowledgeable		
	Regular procurers			Infrequent procurers			Regular procurers		Infrequent procurers		
Client type Response to the Industry	Consumer clients: Large owner occupiers	Consumer clients: Small owner occupiers	Speculative developers	Consumer clients: Large owner occupiers	Consumer clients: Small owner occupiers	Speculative developers	Consumer clients: Large owner occupiers	Consumer clients: Small owner occupiers	Consumer clients: Large owner occupiers	Consumer clients: small owner occupiers
Unique	—	—	—	✓	—	—	—	—	✓	✓
Customised	—	✓	✓	✓	✓	—	—	✓	NA	NA
Process	✓	✓	—	—	—	—	✓	✓	NA	NA
Portfolio	✓	—	NA	NA	—	—	✓	—	NA	NA

Note: The ✓ denotes that this is the *probable* occurrence, NA indicates *no* occurrence and a — indicates a *possible but unlikely* occurrence

into the industry not only with respect to new build projects but also with regard to the maintenance and refurbishment of their existing assets. Their portfolio investment strategies such as 5 year maintenance plans means they have repeat demands for similar projects which can lead to a high degree of standardisation not only with respect to the construction process but also the procurement process.

Depending on the organisational structure of the RSL there will be a requirement to align projects with corporate and/or business objectives to achieve value for money and to ensure that a 'value thread' exists so that value can be transmitted, transformed and maintained either through a project network or a single project to ensure that value for money is obtained as an output of the client organisations strategic management process (Kelly *ibid*). Currently RSL's corporate value systems and project specific value systems are determined using value management techniques which necessitates that the two systems should be in alignment so that value for money is obtained.

2.3.1 Value Management

Value engineering [VE] and its predecessor 'value analysis' was developed within the USA manufacturing industry and introduced into UK construction projects during the mid 1980's. In 1988 Kelly and Male undertook research into value engineering and quantity surveying practice and concluded that VE had a place within the industry but it would need to be adapted to suit UK practice. Value Management applied to construction became popular during the 1990's with a number of guides being produced which introduced analysis techniques such as Simple Multi Attribute Rating

Technique [SMART] and Function Analysis System Technique [FAST] (Green and Popper 1990, Kelly and Male 1993, CIRIA 1995, ICE 1996 and BRE 1997). Whilst value management enjoyed continued growth in the nineties its application was almost entirely restricted for use within the private sector. Kelly and Male (1999) suggested a method for the procurement of construction related value management services by the UK public sector and in 2000 the BRE utilised this idea by producing a report *Value for Social Housing* which specifically related the concept of value management and workshops to the social housing sector for the first time. The report acknowledged that, in order to meet the requirements of the best value initiatives the social housing sector was being asked to undergo significant changes in its procuring of services in a relatively short time period. The report suggested that value management techniques could be used as a vehicle for this change (Hayles and Simster 2000).

Value Management has been defined by Kelly and Male (2002) as involving "*the use of a structured, facilitated, multi-disciplinary team approach to make explicit the client's value system using functional analysis to expose the relationship between time, cost and quality*" and many commentators have identified attributes, using both value management and value engineering techniques and processes, that are core to the value systems of various public sector client organisations (Kelly and Duerk 2002, Akintoye *et al* 2003, Morledge *et al* 2006, and Zhang 2006). Whilst there is no doubt that value management can provide important value opportunities when applied at the commencement of a project the implementation of value management techniques to define a client's value system is not straight forward and can lead to unstructured debate and disagreement between the stakeholders (Kelly and Male 2001). If too

many value attributes are considered the process of evaluation will become paralysed with too many options to consider (Woodhead and McCuish 2002) and the difficulties being encountered are exacerbated by the number and diversity of best value attributes that can be considered by the various stakeholder groups (Austin 2005).

2.4 MULTI CRITERIA ANALYSIS

Prior to assessing the problems that have been encountered with respect to analysing best value tenders it is helpful to have an understanding of the generic methods used for assessing both value and multi attribute decision problems. This is because the implementation of value based procurement has necessitated a radical rethink in how contractor's tender submissions are evaluated. The relatively straightforward acceptance of the lowest bid has been replaced by the need for tender panels to analyse submissions with respect to multiple and competing criteria together with an appraisal of the various options and their associated consequences. Multi criteria analysis [MCA] techniques have been widely used in order to address this need and before setting out how MCA has been implemented by the construction industry this section provides a general review of the differing techniques that are available. The methods described were reviewed in order to assess the appropriate choice of methodology in developing OVID-BV (See section 4.4).

MCA was used because it has a number of advantages over simply using informal judgement to make a decision as;

- It is open and explicit
- the choice of objectives are open to analysis and change if necessary,

- the scoring and weighting of criteria can be developed according to established techniques,
- it enhances and formalises communication between members of the decision making team and,
- importantly with respect to the social housing sector MCA provides a transparent audit trail.

It was also decided to use MCA over Artificial Intelligent [AI] processes such as knowledge–based expert systems of choice or neural networks as AI is difficult to extract knowledge from and extensive training needs to be given before they can used with confidence and retraining needs to be given if market conditions alter (Marzouk and Mosheli 2003). Several of the MCA processes are based on the use of pair-wise comparisons. The strength of the pair wise comparison technique with regard to the best value tender analysis process is that it promotes debate between the members of the tender selection panel with respect to the relative importance of each of the value attributes. It is anticipated that the debate may include discussion on the corporate, strategic or project specific value of each attribute.

There are a number of distinct approaches to MCA, but in general terms MCA establishes preferences between options by reference to an explicit set of objectives for which measurable criteria has been derived to assess the extent to which the objectives can be achieved. MCA offers a number of ways of aggregating the data on individual criteria to provide indicators of the overall performance of options. A standard feature of MCA is the use of a performance matrix, or consequence table, in which each row describes an option and each column describes the performance of the

options against each criterion, the matrix ,which is often the product of the analysis, can then be evaluated to assist in the decision making process (DTLR 2000).

All MCA approaches make the options and their contributions to the different criteria explicit and all require the exercise of judgment in making the decision, however they differ in how they combine the data and their procedures are distinguished from each other principally in how they process the basic information within the performance matrix. The rest of this section briefly summarises the details of the methods that have been used in construction industry selection processes and the relationships between them. All these techniques were considered during the development of OVID-BV.

2.4.1 Direct Analysis of the Performance Matrix

A limited amount of information about the relative merits of various options can be gleaned by direct inspection of the performance matrix which can show how some options are dominated by others. Once dominance has been established the decision making team can try and determine if there any appropriate trade offs that can be made between the different criteria. A variation of this technique is regime analysis in which the matrix is generated via pair wise comparisons of alternatives against each criteria but the elements comprise +, -, or 0 signs only. In this way an ordinal ranking of the importance of the criteria is produced and it does not require cardinal data to produce it. The main criticism of this type of analysis is that is usually carried out an *ad-hoc* basis and it is difficult to produce a transparent audit trail.

2.4.2 Simple Multi Attribute Rating Technique [SMART]

SMART has a focus on decision support and uses weighting and scoring systems to assist teams in reaching decisions. The methodology relies upon the construction of a tree diagram which represents a hierarchy of objectives. The highest order objective(s) describes the resultant and the 'branches' describe the means to achieving the resultant. The decision making team decide and assign a numerical value and weighting to each objective and its branches which represents the relative importance (or emphasis) of that objective to the specific project. The weighting and scoring exercise is subjective though sensitivity analysis may be used to limit any distortion of emphasis that may exist.

2.4.3 The Analytical Hierarchy Process. [AHP]

The process was developed by Thomas Saaty (1980) and uses procedures for deriving the weights and scores achieved by alternatives which are based on pair wise comparisons between criteria and between options. It is a popular decision tool supported by a large group of practitioners (Bedford and Cooke 2003) and generic software tools such as EXPERT CHOICE undertake the mathematical calculations required.

AHP commences by determining the relative importance of the attribute in meeting the client organisations goal, and then pair-wise comparisons are made between the attributes. Saaty produced a table of scales (See Table 2.2) which allows a tender panel's decisions to be assessed on a numerical basis.

Table 2.2. Fundamental ratio scale in pair-wise comparison. (Saaty 1980)

Intensity of Importance.	Definition	Explanation
1	Equal Importance.	Two activities contribute equally to the objective.
3	Weak importance of one over another.	Experience and judgement slightly favour one over another.
5	Essential strong importance	Experience and judgement strongly favour one over another.
7	Very strong or demonstrated importance.	An activity favoured very strongly over another; its dominance demonstrated in practice.
9	Absolute Importance.	The evidence favouring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between adjacent scale values.	When a compromise judgement is needed.
Reciprocals	If attribute *i* has one of the above non zero numbers assigned to it when compared with attribute *j* then *j* has the reciprocal value when compared with *i.*	A reasonable assumption.

The pair-wise comparison information is represented in a matrix. If there is *x* attributes that need to be compared for a given matrix then a total of *x (x-1)/2* judgements are required. Saaty's basic method for identifying the resultant weights used the fact that the eigenvector of each pair wise comparison matrix provides a specific project priority ordering and the eigenvalue gives a measure of the consistency of the judgement. A global consistency ratio of less than 0.10 is acceptable otherwise the judgements need to be revised.

2.4.4 The Analytical Network Process [ANP]

This process is a generic form of AHP and was also developed by Thomas Saaty (1996) to assess more complex interdependent relationships among criteria. By

incorporating interdependencies a supermatrix is developed which adjusts the eigenvectors of the relative importance weights. It comprises four steps; (a) conducting pair-wise comparisons on the criteria (b) placing the resulting relative eigenvectors in sub matrices within the supermatrix (c) adjusting the values in the supermatrix so that it is column stochastic and (d) raising the supermatrix to limiting powers until the weights have converged and remain stable.

2.4.5 Multi Attribute Utility Theory

The theory explicitly addresses the value trade-offs and uncertainties that are invariably the focus of multiple objective decisions. (Keeney and Raiffa 1976). This approach uses Savage's rational preference theorem derived in the 1950's (Savage 1972) as a corner stone and was developed by Keeney and Raiffa (*ibid*) into a set of procedures that allows MAUT to generally combine the main advantages of simple scoring techniques and optimisation models.

In essence there are three building blocks for their procedures. First is establishing the performance matrix, and second is to determine whether or not the criteria are independent of each other. The third consists of ways of allowing the decision makers to express their overall valuation of an option in terms of its value of performance as a mathematical function. (See Paper 2 Appendix B for a more detailed description of this process). The Keeney and Raffia approach to decision support has been successfully applied to many real decisions in both the private and public sectors.

2.4.6 Fuzzy Sets

Fuzzy sets try to utilise the idea that the language used in decision making is imprecise. The consequences of choices may be, say, 'reasonably effective' or 'quite expensive' rather than simply 'attractive' or 'expensive'. Fuzzy arithmetic tries to gauge these qualified assessments by what is known as membership functions so that an option belonging to the 'attractive' set of options would be given a degree of membership lying between 0 and 1. Fuzzy MCA models develop these procedures to produce weighting of fuzzy performance levels. In 1990 Seyde and Olson utilised the theory of fuzzy sets to produce a construction procurement strategy. In this approach a decision framework was developed considering the information on relative risk along with data on costs, benefits, and consequences of each contractor's methodology. The theory of fuzzy sets was used to translate these terms into mathematical measures and to estimate the risk of failure.

2.4.7 MCA and OVID-BV

Prior to choosing the preferred MCA techniques for use with OVID-BV it was necessary to review the current mechanisms that have been used for assessing value based tender proposals (See section 4.5.1 and 4.5.2 for the rationale behind the final choice of MCA techniques used in the OVID-BV methodology).

2.5 VALUE BASED PROCUREMENT MECHANISMS

In parallel with the events taking place in the UK construction industry outlined in Chapter 1 there was also a global move to revalue construction (Barrett 2002). This

call for better value in the procurement of construction services has been met with several contractor selection frameworks being developed that allow for the evaluation of criteria other than simply lowest cost. Whilst not all the selection frameworks address the specific problem of satisfying best value they all have the common theme of analysing multiple competing objectives which is at the core of evaluating best value tender submissions and they all have a provision that allows the contractors to be interviewed as apart of the selection process.

The HOLT technique published in 1996 is considered to be important in the academic field of tendering literature as it embraced multi-attribute decision making explicitly in the production of a contractor selection model (though a utility theory model had also been developed at the same time for bid mark-up decisions. See Dozzi *et al* 1996). The HOLT technique shows in some detail how different decision criteria are developed and eventually matched to contractor attributes (Griffith *et al* 2003). The main criticism of Holt's work is that multi attribute analysis is based on mathematical principles which are unfamiliar to most practioners within the industry and simply to implement Holt's model without an understanding could possibly lead to 'black box' syndrome for the user. Following on from Holt's work, in 1998 Hatush and Skitmore developed a methodology for contractor selection that used the additive form of the multi-attribute utility theory [MAUT].Utility is a measure of desirability or satisfaction and, importantly, provides a uniform scale that allows different and intangible criteria to be compared on a like for like basis. The main criticism of the work is that there was no recognition of the fact that the additive form of the MAUT can only be used if the criteria are all mutually preferentially independent of each other i.e. the evaluation of one of the attributes is not affected by the evaluation of

another. An examination of the criteria and sub criteria selected by Hatush and Skitmore reveals that they do not appear to be mutually preferentially independent of each other and therefore the additive condition probably does not exist.

As a consequence of the Latham report the Construction Industry Board (CIB 1997) produced a practical document which highlighted elements of best practice with respect to the selection of main contractors that recommended tenders should be evaluated using both quality and price as a criteria. The following year the Construction Industry Research and Information Association (CIRIA 1998) produced a best practice guide on selecting contractors by value which includes a generic framework for the process of evaluating a contractor's bid submission and also includes the provision to interview the contractors as part of the tender process. There are three main critiscms of this work. Firstly, although the guide describes eight selection criteria relating to the client's value system, they are split into numerous sub criteria which lead to an unwieldy and overlong scoring process for each bid submission. Secondly, the mathematical principle behind the scoring system is highly subjective nor does it recommend that any sensitivity analysis be undertaken. A third limitation is that the model only considers capital costs and not whole life costs.

Following on from these seminal works there have been a number of selection frameworks developed that are based around either; MAUT, AHP or a combination of both of these methods. Problems that have been encountered have included; the use of AHP for both the ranking of the criteria and the ranking of the contractor have given rise to unwieldy hierarchical structures that are difficult to interpret easily (Fong and Choi 2000*)*, the methodology has been confined to a theoretical study and does not

address a real time problem (Alhazmi and McCaffer 2000), models that don't use software to carry out the calculations are operationally time consuming (Cheung *et al* 2001, Al-Tabtabai 2002), the model has been constrained to a fixed number of criteria (Dozzi *et al ibid* and Chua and Li 2000), the results are calculated using MS Excel and MS visual basic software which is time consuming to use when compared to windows software (Marzouk and Mosheli 2003), and the results were portrayed graphically which is difficult to interpret correctly (Hatush and Skitmore *ibid,* Marzouk and Mosheli *ibid*). These criticisms were noted and taken into account, where appropriate to do so, in the development of OVID-BV.

In 2003 Griffiths reviewed a number of bespoke models based on a price/quality mechanism and noted that, (a) pragmatically, there is insufficient time to conduct a relatively standard tender evaluation process (using these types of models), (b) many are not made explicit and, as such, can prove ineffective and also that (c) contractors have a negative perception that the tender interview is a game of appearance and marketing skills. In the light of these criticisms it is little wonder that value based procurement in the UK has been challenged in the courts. In the case of Harmon CFEM Facades (UK) Ltd v The Corporate Officer of the House of Commons (1999) it was held that the term 'overall value for money' required guidance as to how subjective judgments were to be made including the selection criteria being made known (See Paper 1 ,Appendix A for more complete details of the Harmon case). This decision was supported in the case of R v Portsmouth City Council where the Court of Appeal held that if any criteria other than price were to be the basis for awarding the contract then they had to be stated explicitly in the contract and tender and that any

failure to do would mean that the contract had to be awarded on the basis of lowest price and nothing else.

2.6 BEST VALUE SELECTION IN THE UK

The introduction in Chapter 1 has already set out how and why best value has been introduced into the UK public sector to initiate continuous improvement in both procurement and delivery across the complete range of public services, not simply construction. Section 1.3 also sets out some of the problems that have been identified during the implementation of best value. One of the objectives for the literature review was to research contractor/supplier selection frameworks with respect to; (a) service delivery by local authorities in areas other than construction and (b) other areas of the public sector such as the Defence Estates or the National Health Service. The result of the search was that, whilst there are comprehensive documents available with respect to Private Finance Initiative (PFI) project procurement and best value review procedures, there is a lack of information with respect to the procurement of smaller sized projects and the contractor/supplier selection process used (Phillips *et al* 2004). This could be because these tender selection frameworks are not yet available in the public domain as best value is a relatively new subject or, perhaps, the client organisations use bespoke selection methods which are formulated for each and every tendering situation so a standard framework has not yet been developed or it could simply be that contractor selection is still being assessed on submission of the lowest bid. A similar situation exists in academia, in so far as, papers have been produced with respect to best value and PFI (Akintoye *et al* 2003, Heald 2003, Bing *et al* 2005 and Dixon 2005) and best value review procedures (Boyne 2000, and Kelly & Hunter

2003), but there is a paucity of literature on the pragmatic aspects of best value contractor selection within the UK.

The most comprehensive guidance notes are provided by the OGC which has produced a suite of documents as part of the Achieving Excellence in Construction Initiative whose key thrust is the delivery of value for money. At the core of the documents is the following definition of best value;

> *" [Best Value is] the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements, as it is the relationship between long-term costs and the benefit achieved by clients that represents value for money."* (Office of Government Commerce 2003).

This definition provides an overarching aim for all public sector procurement processes and, as such, it has been used as the underlying rationale in the development of OVID-BV. The Achieving Excellence Initiative has been monitored by the National Audit Office (NAO) and in 2004 their report 'Improving Public Services Through Better Construction' identified a number of areas where value for money savings had accrued during the construction process but did not provide any guidance as to how these savings should be assessed during the tender process.

2.7 INTERNATIONAL PERSPECTIVES ON BEST VALUE CONTRACTOR SELECTION

The best value concept has been embraced internationally but there is no universal definition of the term 'best value' or 'value for money' (Choi 1999) and, consequently, there are a plethora of different definitions produced by various government bodies, client organizations and academic researchers. Some of the definitions of best value include;

- the evaluation of time, cost image, aesethics/appearance, operation and maintenance, safety, and environmental aspects are all elements of best value (Gransberg and Ellicott 1996 & 1997);
- the goal is to obtain the optimum combination of price and technical solution for the public (Molenaar and Johnson 2003);
- Any selection process in which proposals contain both a price and qualitative components and the award is based upon a combination of price and qualitative consideration is called a best value selection (Design-Build Institute of America 1999);
- Best Value means the maximum achievable outcome from the development of an infrastructure project (Zhang 2006).

This diversity of definitions has given rise to a number of best value contractor selection frameworks. Whilst the lack of a universal definition means that not all the work carried out around best value in the international community can be directly applied to the situation in the UK analysis of the frameworks did provide the following learning points with respect to this research;

- The use of the Displaced Ideal Model (DIM) as opposed to AHP in attribute evaluation eliminates bias (Kashiwagi and Byfield 2002) but is difficult for users to understand as it based on the entropy equation.
- Extracting a good quality element from one bid proposal and attempting to raise the level of the other bid proposals i.e. technical levelling, should be avoided in best value evaluation as each proposal should be evaluated against the original stated criteria to avoid legal challenges from the other bidders (Palaneeswaran *et al* 2003).
- Use of a performance based procurement system can minimize risk and has a higher potential to deliver best value to the client i.e. the project will be completed on time, within budget and meet the quality expectations of the owner (Parmar *et al* 2004).
- Creating a consensus vision between key stakeholders is problematic but maintaining this over time and achieving progressive implementation is harder still (Barrett 2007).

The international implementation of best value has not been without its problems. An analysis of best value applied to design-build contracts in the USA found that; there is no standard method for scoring technical proposals in the contractor selection process (Molenaar and Johnson 2003), and that the best value tender selection process is one of perception rather than substance (Mickaliger 2001).Inexperience with the best value process had resulted in legal challenges to the system (Shane *et al* 2006). In New Zealand public sector stakeholders appear to be taking a cautious view towards best value for the simple reason that there is no precise definition of the term and should value for money be equated with affordability? (Hale and Cochrane 2004). The

difficulties encountered in the USA and New Zealand has a certain resonance with the legal problems that have emerged in the UK.

2.8 KNOWLEDGE GAP

The literature review revealed a clear void in knowledge with respect to price/quality tender evaluation mechanisms that have been developed in response to the introduction of best value in the social housing sector unless they were related directly to PFI procurement. This knowledge gap has led to best value tender procurement being carried out using an inappropriate methodology resulting in legal challenges. There is a clear need to develop a transparent and auditable approach for a tender decision support tool to assist in analysing UK Best Value decision making.

CHAPTER 3. RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter discusses briefly the epistemology, theoretical perspective and strategy behind the research that was undertaken and the methodological approaches that are available. It sets out the reasoning behind the methodology selected with respect to this research project. It then details the research methods that were used and finally provides the overall research design.

3.2 RESEARCH FRAMEWORK

At the outset of the doctorate a general research framework was established to outline all the facets of the study from assessing the general philosophical ideas behind the inquiry though to the detailed data collection and analysis procedures. The framework was developed by adapting Crotty's (1998) ideas for designing a research proposal which are based on the following three questions;

1. What epistemology/theory of knowledge informs the research and what philosophical stance lies behind the methodology in question?
2. What methodology or strategy linking the methods to outcomes governs our choice and use of methods?
3. What research techniques and procedures are to be used?

These three questions show the interrelated levels of decisions that go into the process of designing research. Moreover, these are aspects that inform a choice of approach

ranging from the broad assumptions that were brought to the project to the more practical decisions made about how to collect and analyze data (Creswell 1994).

3.2.1 Knowledge Claims and Theoretical Perspective

During the development of the research design framework four schools of thought regarding knowledge claims were briefly reviewed; post positivism, constructivism, advocacy/participatory and pragmatism. The major elements of each position are presented in Table 3.1. In the interests of brevity the philosophical ideas of each position are not restated but, suffice to say, the assumptions that were made by the researcher at the start of the project with respect to how and what would be learned from the research inquiry impinged, to a certain degree, upon all four of the positions.

Table 3.1 Alternative Knowledge Claim Positions. (Adapted from Cresswell 2003).

Postpositivism. Determination Reductionism Empirical Observation and Measurement. Theory Verification.	**Constructivism** Understanding Multiple Participant Meanings. Social and historical construction Theory Generation.
Advocacy/Participatory Political Empowerment. Collaborative. Change-oriented.	**Pragmatism.** Consequences of actions Problem-centred Pluralistic Real-world practice oriented.

The researcher's original position was that the introduction of best value had been imposed upon the social housing sector and that the relatively short time scale allowed for implementation had prevented RSL's from developing and producing a best value tender evaluation methodology that complied with central government requirements.

These requirements stipulate that any such methodology should be: transparent, auditable and should be able to be applied to all procurement situations (HM Treasury Procurement Guidance No 5, 1995).Therefore the overarching aim of this research has always been to produce a commercially acceptable solution to address the current shortcomings. As this position had been informed by the researcher's personal experience of working within the social housing sector there was a clear empathy with the pragmatic knowledge claim position.

There are many forms of pragmatism but a general thread that runs through them is that knowledge claims arise out of actions, situations and consequences rather than antecedent conditions (as in post positivism). There is a concern with 'what works' and solutions to problems (Patton 1990). Instead of methods being important, the problem is most important and researchers use all approaches to understand the problem (Cresswell *ibid*). Pragmatists are dismissive of the ontological perspective, in so far as, they believe we simply need to stop asking questions about reality and the laws of nature (Cherryholmes 1992). The pragmatist view also provides a strong philosophical underpinning for the mixed methods research strategy as pragmatists do not see the world as an absolute unity. Similarly mixed methods researchers look to many approaches to collecting and analysing data rather than subscribing to only one way. Thus in mixed methods research, investigators use both qualitative and quantitative data because they work to provide the best understanding of a research problem (Cherryholmes *ibid,* Cresswell 2003).

3.3 RESEARCH STRATEGY

There are numerous ways of carrying out research including case studies, histories, experiments, analysis of archival information/literature review and surveys. Each method has specific advantages and disadvantages depending on three conditions: (a) the type of research question, (b) the control an investigator has over actual behavioural events and (c) the focus on contemporary as opposed to historical phenomena (Yin 2003). Table 3.2 displays these three conditions and provides a helpful categorisation for selecting the most appropriate strategy.

Table 3.2: Relevant situations for different research strategies. (Yin 2003).

Strategy	**Form of Research Question.**	**Requires Control of behavioural events.**	**Focuses on Contemporary events.**
Experiment.	How, why?	Yes	Yes
Survey	Who, what, where How many How much?	No	Yes
Archival Analysis (Literature Review)	Who, what, where How many How much?	No	Yes/No
History	How, why?	No	No
Case Study.	How, why?	No	Yes.

The aim and objectives of this research project pose a number of questions including;

- What are the unique characteristics of the social housing sector?
- Why were RSL's encountering problems with the introduction of the best value initiative?
- How were RSL's evaluating best value tender bids?
- How many and what type of value attributes are assessed during the analysis of the contractor's bid proposals?
- How are other countries dealing with the issue of value based procurement?

The nature of the questions posed indicated that the sole use of either quantitative or qualitative research methods would not satisfy the needs of the research inquiry. For instance there was a need to understand and gain an insight into how and why RSL's were encountering difficulties with the best value initiative and the investigation into such beliefs , opinions and views of the people involved is very much the province of qualitative analysis. However the literature review revealed that if too many value attributes are considered the process of evaluation will become paralysed and the study of the relationship between these variables dictates the use of a quantitative approach. Therefore it was decided that a mixed methods procedure needed to be devised to capture the best of both qualitative and quantitative approaches.

3.3.1 Multi Strategy Research Design

Mixed methods procedure employ aspects of both quantitative methods and qualitative procedures. The concept of mixing different methods originated in 1959 when multiple research methods, including a 'multimethod matrix' were used to study the validity of psychological traits (Campbell and Fiske 1959). This seminal work led the way for others to combine traditional qualitative methods such as observations and interviews with quantitative approaches such as surveys (Sieber 1973). Importantly there was recognition that all methods are subject to limitations and biases and that biases inherent in any method may cancel out the biases in other methods. Additional reasons then emerged for mixing different types of data, such as; the results from one method may help inform or develop another method (Greene *et al* 1989) or one method can be incorporated within another to provide a different level of insight (Tashakkori and Teddlie, 1998) which has lead to the development of procedures for mixed methods strategies of inquiry.

In 2003 Creswell identified three general strategies for the mixed-method research process;

(i) Sequential Procedures- in which the researcher seeks to elaborate on or expand the findings of one method with another method.

(ii) Concurrent Procedures- in which the researcher converges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem.

(iii) Transformative procedures-in which the researcher uses a theoretical lens as an overarching perspective within a design that contains both quantitative and qualitative data.

This research implemented, in the main, a sequential exploratory strategy which is characterised by the initial phase of qualitative data followed by a phase of quantitative data collection. The findings are then integrated during the interpretation phase. Its two phase approach makes it relatively easy to implement and, subsequently, describe and report. This strategy is especially advantageous when a researcher is building a new instrument such as OVID-BV (Creswell *ibid*). The adoption of this approach led to the selection of a range of research methods used during the project which are detailed in the following section.

3.4 RESEARCH METHODS

This section sets out details of the research methods used in this project.

3.4.1 Literature Review

The literature review provided a comprehensive overview of the current thinking, both industrial and academic, in the field of best value. The literature was not merely

found and reviewed but was reviewed critically. The literature was considered in the context of theory and other literature so that objective evaluation could take place (Fellows and Liu 2003). In this research project the literature review served to;

(i) Identify the need for this research and define the problem.

(ii) Build upon a platform of existing knowledge and ideas.

(iii) Highlight previous research so as to avoid reinventing the wheel.

(iv) Assist in learning about different methodological approaches in the area of best value.

(v) Identify opposing views and include variables in the research which hadn't previously been considered.

(vi) Reveal gaps in knowledge and previous research.

(vii) Provide a benchmark for the relevance of this research.

The literature review for this research project was based on academic and industrial literature dating back over the past 60 years. The initial literature review examined methods of procurement in the UK construction industry, how those methods have changed due to the introduction of best value and how best value and value for money procurement has been developed internationally. The review was kept open during the research period and as new topics of relevance were encountered, such as the rational decision theorem, changes in legislation or public policy then further literature reviews were carried out in each of these areas.

3.4.2 Case Studies

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context and, in general, case studies are the preferred strategy when

'how' or 'why' questions are being posed (Yin *ibid*). This research project posed the questions; how are RSL's implementing best value procedures (if at all) and why are RSL's losing cases at arbitration tribunals resulting in significant financial losses? The two case studies undertaken were, predominantly, explanatory research aimed at testing the hypothesis that RSL's either had no or a limited methodology for assessing best value tender bids and that the conclusion to be logically inferred is that this had contributed to their loss at the dispute resolution tribunals. It is accepted that the case studies were also exploratory in as much the hypothesis provided a guide as to where to look in order to make the required observations (Runkel and McGrath 1972). Both case studies were investigated by establishing the following 5 components; (i) the study's questions, (ii) its proposition, (iii) the unit of analysis, (iv) the logic linking the data to the proposition and (v) the criteria for establishing its findings.

The following limitations of using case study research are acknowledged;

1. The small number of cases may offer no grounds for establishing reliability or generality of findings.
2. The intense exposure to study of the case biases the findings.
3. It may be considered as only an exploratory tool.

Sections 4.2.1 and 4.2.2 provides details and the results of the studies undertaken.

3.4.3 Surveys and Questionnaires

A survey is a procedure in which information is collected systematically about a set of cases (e.g. people, organisations, objects). The cases are selected from a defined population and the aim is to construct a data set from which estimates can be made

and conclusions reached about this population (Thomas 1996). This research obtained the opinions from a sample of the stakeholders involved in social housing procurement with respect to the value attributes considered during the assessment of a contractors bid proposal. Due to cost constraints the data was collected from the sample population using a postal questionnaire (See Appendix F for the questionnaire and covering letter). The questionnaire was devised using, primarily, closed questions so that the respondents opinions were measured using the Likert Scale which determined the respondent's degrees of agreement or disagreement with a given statement on a 5 point scale. The following limitations of using surveys are acknowledged as follows;

- The use of a closed questionnaire may constrain the responses artificially, (though a general response opportunity was provided within the questionnaire).
- Low response rate, particularly with postal questionnaires.

Further information on the collection of the data and the results of the survey are stated within Section 4. 4.3 and Paper 3 in Appendix C.

3.4.4 Action Research

Action Research is active participation by the researcher in the process under study, in order to identify, promote, and evaluate problems and potential solutions (Fellows and Liu 2003) and as such it falls within the applied research category. It has been defined as an approach in which the action researcher and a client collaborate in the diagnosis of a problem and in the development of a solution based on the diagnosis (Bryman 2004). Exponents of action research state that to make academic research relevant

researchers should try out their theories with practioners in real life situations and real organisations (Avison *et al* 1999). Manifestly the structure and format of the Engineering Doctorate whereby pragmatic research is undertaken within an industrial setting certainly encourages, and almost demands, action research to be part of the research methodology. Henry (2000) states that due to the nature of action research three primary requirements exist for it to be undertaken;

1. A trust-based relationship be built–up beforehand and accepted by all parties.
2. The researcher will have fully accepted the organisation's objectives for innovation or change by having negotiated the extent to which they will be involved and their freedom as regards access to information and interpretation;
3. A research and innovation project will be jointly drawn up which must be open-ended with regard to the problems to be explored but very precise in terms of methodology.

The EngD project satisfied all three requirements as the researcher had worked collaboratively with the sponsoring firm for a number of years prior to embarking upon the four year period of research. The researcher had also discussed the problems and issues that have arisen around best value with the firm's Managing Partner, Mr J Martin FRICS, on numerous occasions since value-based procurement had been introduced as a specific recommendation of the Latham Report. The structure of the EngD process and its monitoring by the CICE at Loughborough University ensured that the research methodology was precise in terms of both its content and timing.

The process of action research intentionally endeavours to effect a change in a system (Lewin 1946) and this research project seeks to change not only how RSL's assess

best value but also how dispute resolution tribunals could evaluate the reasonableness of the procedure used by the respective RSL. The obvious limitation of this is that the researcher could not simply be a complete observer (See following section for the definition of the roles of an observer) in this process and, therefore, objectivity as to the interpretation of the results may have been affected

3.4.5 Direct Observation

The accurate observation of participants is crucial to the success of this method and affects the validity of the findings. Ackroyd and Hughes (1992) describe four roles of observation ranging from participant to complete observer (See Table 3.3).

Table 3.3 Participant Observation Roles (Source: Ackroyd and Hughes 1992).

	Role	Description.
1	Complete Participant	The role in which the observer becomes a fully fledged member of the group under study, any research purpose being concealed.
2	Participant as observer.	Both researcher and subjects are aware of the fact that there is a field work relationship.
3	Observer as Participant.	Involvement with the subjects is deliberately, or for a number of practical reasons, kept to minimum.
4	Complete Observer	Requires investigators to insulate themselves from any social contact whatsoever with the subjects.

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The observation in this research was, primarily, of type 1- the 'Complete Participant'- due to the fact that the researcher's occupation entails; (a) the preparation of expert witness reports with respect to social housing sector procurement procedures for both goods and services and (b) attendance and participation at the LVT and arbitration tribunals. It is recognised that one of the limitations of the results of this research is the researchers own bias. The observation carried out with respect to the testing of OVID-BV was of type 2 as the members of the decision–making group were fully

aware that the support tool was in the prototype stage and was the subject of an ongoing research project.

3.4.6 System Evaluation

Evaluation is an important but difficult area of the development of a software programme. Many system developers adopt 'fitness for purpose' as the primary criterion for determining the success or failure of a system (Anumba and Scott 2001) but performance evaluation by the end-users can also establish the utility of a system (Miles *et a*l 2000).

The software programme OVID-BV was evaluated by a combination of self-evaluation by the researcher in conjunction with end-user evaluation via a specifically designed proforma. The proforma contained questions relating to the functionality of OVID-BV and whether or not it was user-friendly (See Appendix I for the proforma). The proforma mainly contained closed questions requiring the users to evaluate the system on a 5 point Likert scale though open questions were included so that suggestions and comments on the performance of OVID-BV could be provided.

3.4.7 Principal Component Analysis.

Factor analysis is a multivariate method which analyses relationships among difficult to interpret correlated variables in terms of a few conceptually meaningful, relatively independent factors, each of which represents some combination of the original variables (Fellows and Liu 2003). The variables are grouped into a small number of factors (factor extraction) that can be used to represent relationships among sets of many interrelated variables (SPSS 2003). This factor extraction is usually done by

means of principal component analysis [PCA] which transforms the original set of variables into a smaller set that account for most of the variation of the original set. For ease of interpretation of the factor extraction, the principal component matrix is often rotated so that the variation of the squared factor loadings for a given factor is made large to allow ease of interpretation based on the significance of the loadings.

The data reduction method using PCA was chosen for two main reasons (i) to reduce the number of attributes and (ii) to identify or detect a structure in the relationship between the attributes and classify the attributes into sets of factors. The smaller number of factors identified with reduction analysis are often called hidden or latent variables, because it is only after using PCA that we are aware of them (Dewberry 2004).

3.5 SUMMARY

This chapter has set out and discussed the methodology that was adopted for the EngD research project. It has provided an overview of the framework within which the research was conducted and has justified the implementation of the mixed method approach. Finally it has provided brief details of the methods that were used. The overall research process is illustrated in Figure 3.1 and Table 3.4 sets out which methods have been used in addressing each of the research tasks.

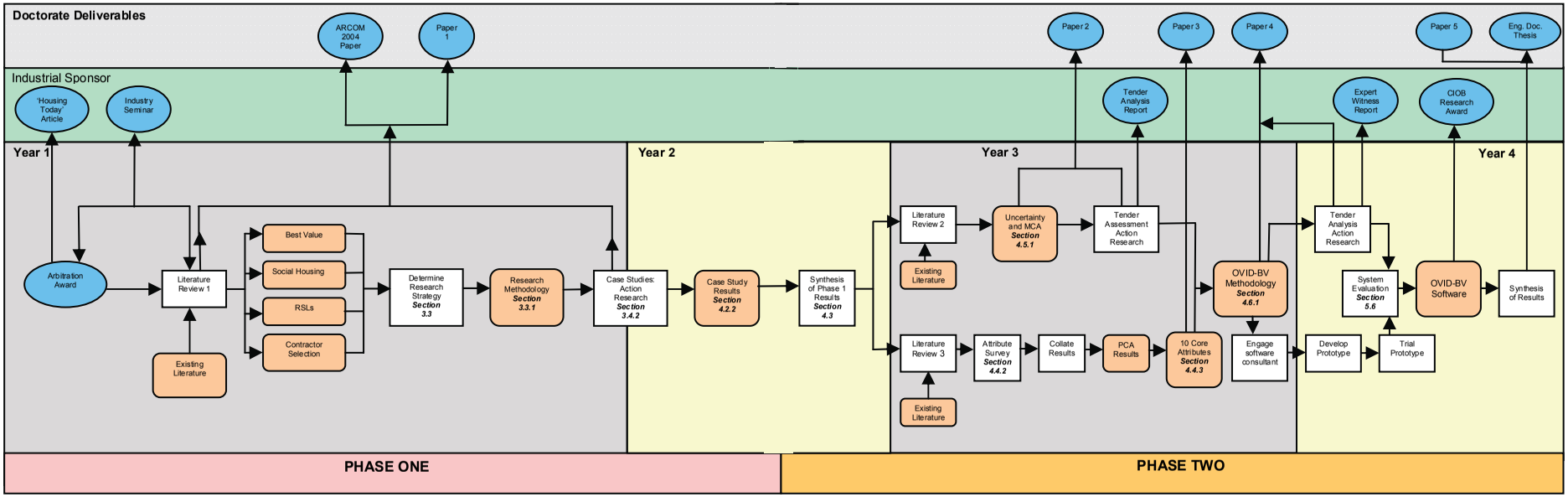
Table 3. 4 Research Map.

Overall Aim: To develop a transparent and auditable approach for a tender decision support tool to assist in analysing UK Best Value decision making in the social housing sector.

OBJECTIVES	WORK TASKS	RESEARCH METHOD	OUTPUT.
1. Identify the unique characteristics of RSL's as construction clients within the social housing sector.	1. Review the structure and operation of the social housing sector.	LR O. AR	Paper 1
2. Identify the problems and challenges generated by the introduction of best value within the sector.	2. Review of historic problems and assess problems identified in dispute resolution cases.	LR CS AR	Paper 1 Paper 2
3. Establish a set of core attributes assessed during the tender analysis process.	3. Review current attributes used in tender selection. 4. Assess stakeholders' views as to the importance of specific attributes. 5. Investigate any underlying relationship in the collected data.	LR O S PCA	Paper 3
4. Develop a transparent and robust method for measuring best value.	6. Investigate MCA techniques. 7. Analyse the best value decision making process. 8. Validate the methodology by analysing tender bids	LR O AR O	Paper 2 Paper 4
5. Develop a generic software tool to provide a transparent and commercially effective audit trail of the best value process and validate the tool by pragmatic application.	9. Critical reflection on learning points from research to provide brief to software consultants. 10. Use the software in BV decision making situations. 11. Evaluate use of OVID-BV and feedback to software consultants.	SE AR O S SE	Paper 5 EngD Thesis

Key
AR- Action Research
LR-Literature Review
O-Observation
PCA-Principal Component Analysis.
S-Survey
SE-System Evaluation.

Figure 3.1: The Research Process Map.



CHAPTER 4. RESEARCH UNDERTAKEN

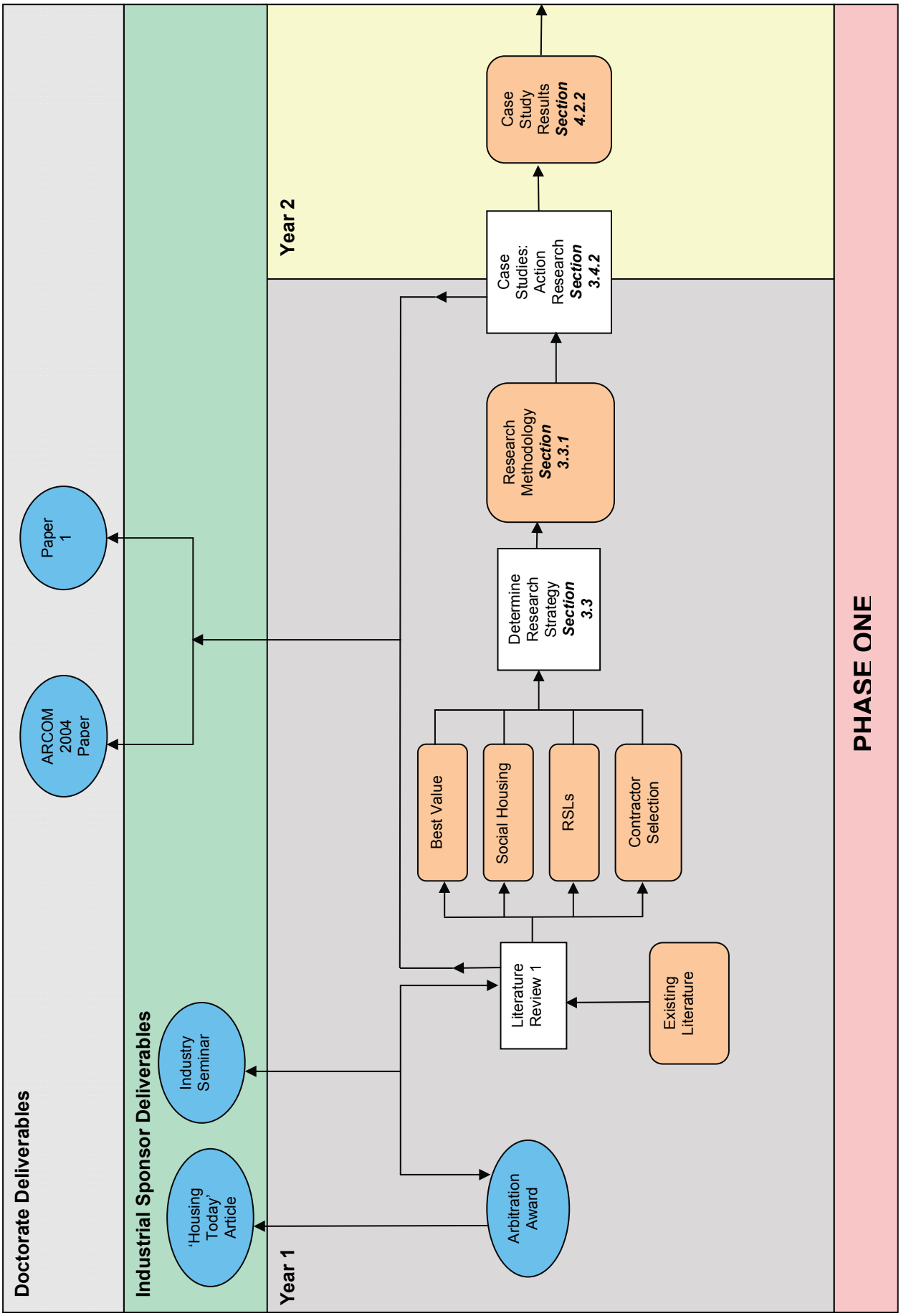
4.1 INTRODUCTION

This chapter presents the research carried out to meet the aims and objectives of the Eng D project as stated in Section 1.5. The research was undertaken as per the methodology and research map set out in Chapter 3 and was carried out in two distinct phases; Phase 1 identified the unique characteristics of the social housing sector, and investigated the problems associated with value based procurement, which met the stated research objectives 1 and 2. The Phase 2 research produced a commercial solution to the identified problems which in doing so met the stated research objectives 3, 4 and 5. The resultant innovative decision support tool has been developed into a windows based software programme which **O**ptimises **V**alue **I**n **D**ecision-making for **B**est **V**alue and has become known by the acronym of OVID-BV.

4.2 PHASE ONE RESEARCH

A literature review was carried out to ascertain the previous work that had been undertaken and identify the problems that had been encountered. Chapter 2 provides full details of the literature review undertaken. In addition to the review two case studies were carried out to provide a more in-depth investigation into the identified problems. The results of the phase one research are summarised in Paper 1 (See Appendix A) and the research process is shown in figure 4.1.

Figure 4.1 Phase 1 Research Process Map



4.2.1 Case Studies

Ideally multiple case studies would have been undertaken but lack of time and resources prevented this from being actioned. However even if only a 'two-case' case study is completed the chances of doing a good study will be better than using a single-case design (Yin 2003). The RSL in the first case study was a housing association that had been formed from a stock transfer of Local Authority dwellings, whilst in the second case study the RSL was the housing department of a London Borough Council. The circumstances involved in the case studies replicated each other in so far as both of the RSL's had undertaken multi million pound refurbishment contracts to designated estates within their respective housing stocks and had engaged the successful contractor by undertaking a best value tender assessment. The costs of the works were subsequently challenged by leaseholders on the estates, the majority of whom had purchased their dwellings under Right to Buy legislation and disputed the RSL's right to recover part of the cost of the works via the service charge recovery mechanism within their leases. Both disputes were referred to arbitration on the basis that by implementing a best value tender procedure that RSL's had failed to comply with the statutory consultation regulations as per section 20 of the Landlord and Tenant Act 1985 (as amended). The only way the RSL's could obtain dispensation from compliance was by demonstrating that they had acted reasonably in engaging the respective contractors. The main differences between the two studies was that in the first the negotiation of a single best value tender had been undertaken by a consultant surveying practice and in the second a competitive best value tender process had been carried out by the Council's in-house technical officers.

The researcher acted for both groups of leaseholders as an expert witness which provided direct access to the following multiple sources of evidence; project documentation, the RSLs' archival records, participant-observation, and the opportunity to carry out interviews. The collection of evidence was carried out as part of the researcher's duties as an expert witness and included; attending the respective RSL's head offices to inspect the relevant contract and project documentation, conducting interviews with all parties to determine their perspectives with respect to the disputes and inspecting the completed works. The evidence was also collected with the goal of 'reliability' in mind so as to minimize any errors and biases in the studies. The two fundamental questions asked of both studies was; (i) how did the RSL's evaluate the best value tenders? and (ii) what procedures were put in place to ensure the evaluation was carried out in a reasonable, transparent, and auditable manner? The unit of analysis was deemed to be the RSL's tender evaluation methodology and the proposition put forward at the commencement of the studies was that the RSL's would lose their respective cases if they could neither define best value with clarity nor demonstrate a transparent and auditable evaluation methodology.

4.2.2 Case Study Findings

The results of both arbitration tribunals confirmed the original proposition that the absence of a clear ,auditable and reasonable best value evaluation methodology for analysing the tender returns would lead to the arbitrator's ruling against the RSL's causing a consequential financial loss as the RSL's were prevented from recovering the cost of the works from the leaseholders. It was significant that neither the external consultant practice nor the in-house procurement officer had been able to deliver a

transparent and auditable best value tender analysis process. It was also pertinent that in case 1 the RSL cited both a lack of time and a lack of knowledge (i.e. they had relied solely upon their consultant) as to why they had not been able to provide an audit trail for their best value evaluation procedure. With respect to case 2 it was also found that the tender evaluation methodology was not applied in a reasonable manner due to a lack of knowledge regarding best value and value management on the part of the officer.

It was significant that the arbitrators agreed with the researcher's original hypothesis but a limitation of this is that as a 'complete participant' in the arbitration process the researcher had been able to effect the arbitrator's decisions. However both arbitrators had the powers to disagree with the opinions put forward by the researcher if they had wished to do so. A second limitation of the findings is that an arbitrator's award very rarely turns on simply one issue and both these cases were no exception. Both arbitrators awards addressed a number of different issues where the RSL's had not acted reasonably. It could be argued that the arbitrator's award's found against the RSL's due to the weight of evidence presented rather than simply because of the lack of transparency or reasonableness of the method used to evaluate the contractor's tender bid documents.

4.3 PHASE ONE: CONCLUSIONS

The literature review and case study research shows that the introduction of best value within the UK public sector has encountered a number of difficulties, some more significant than others, which are caused by a variety of factors. The problems identified are set out below. The findings of the case study directly led to the

identification of problem 1 with the remainder being identified as a result of the literature review. However the case study findings also supported the premiss of identified problems 2, 5, and 9.

1. The failure of RSL's to provide clear and transparent audit trails of their best value tender analysis process due to a lack of both knowledge and time has lead to arbitration tribunals finding against them in service charge disputes, resulting in a financial loss for the RSL's concerned (Paper 1, Appendix A and Phillips 2004).
2. The failure of a public sector client to clearly define the meaning of 'overall value for money' within procurement documentation led a court to rule that the contract should have been awarded on the basis of lowest price and substantial damages were awarded to the contractor who had submitted the lowest bid (Harmon CFEM Facades (UK) Ltd v The Corporation Officer of the House of Commons. ConLR Vol 67 2001).
3. Using value management techniques to define a client's value system can lead to unstructured debate and disagreement between the stakeholders (Kelly and Male 2001).
4. Contractors have a negative perception that the best value tender interview is a game of appearance and marketing skills and there is insufficient time to conduct a relatively standard tender evaluation process (Griffith *et al* 2003).
5. Most procurement is not carried out by designated procurement staff, the procurement staff are often consulted too late in the procurement process (Ellis *et al* 2005) and the majority of procurement staff do not hold professional

qualifications. (National Audit Office 2004) which results in sub-optimal value for money (Gershon 2004).

6. Creating a consensus vision between key stakeholders is problematic but maintaining this over time and achieving progressive implementation is harder still (Barrett 2007).
7. If too many value attributes are considered the process of evaluation will become paralysed with too many options to consider (Woodhead and McCuish 2002).
8. The difficulties being encountered are exacerbated by the number and diversity of best value attributes that can be considered by the various stakeholder groups (Austin 2005).
9. Simply advising organisations to take up "best practice' is impractical and is unlikely to lead to achieving high performance unless continuous support is provided (Gratton and Ghoshal 2005).

These above problems are compounded by the fact that, by its very nature, best value tender analysis is a subjective process and yet the demands of the social housing sector are that these subjective decisions and evaluations made at both corporate and project level must be transparent, auditable and accountable. It was decided that in order to assist RSL's to adjust to this statutorily imposed cultural sea change there was a need to formulate a generic decision process model, which endeavours to represent, in a recordable format, the preferences of rational individuals and/or groups undertaking a best value analysis. The model outcome is a decision *support* tool rather than dictating a precise result for the decision making process. Manifestly, the tool cannot and should not replace management review and judgement.

The objectives for the support tool were established in direct response to the defined problems and are set out as follows;

- Transparency;
- Openness to, and able to withstand, a third party audit process;
- The clients value system clearly stated;
- The preservation of the value thread.
- Assistance for the user group in the selection procedure.
- Provision of a base line for assessing continuous improvement throughout the life of the project.

4.4 PHASE TWO RESEARCH

4.4.1 Development of the Support Tool, OVID-BV

In order to measure best value there has to be clarity as to how best value is defined and as the methodology has been designed for commercial use within the UK social housing sector it needed to be based on the OGC definition of best value which is restated below;

> *" [Best Value is] the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements, as it is the relationship between long-term costs and the benefit achieved by clients that represents value for money."* (Office of Government Commerce 2003).

This definition, alongside the objectives established as a result of the phase one research formed the basis for the formulation of the 3 main elements of the support tool;

1. Identification of the project specific attributes which align with the RSL's value system.
2. Weighting the attributes to establish their importance to the specific project.
3. Comparison and measurement of the best value element of each proposal.

In order to construct and develop the support tool methodology the research carried out in phase 2 was designed in three stages; (The research process is shown in Fig 4.2)

Stage 1: To establish core attributes assessed during the tender analysis process. (Research Objective 3 and Paper 3, Appendix C & Paper 5, Appendix E)

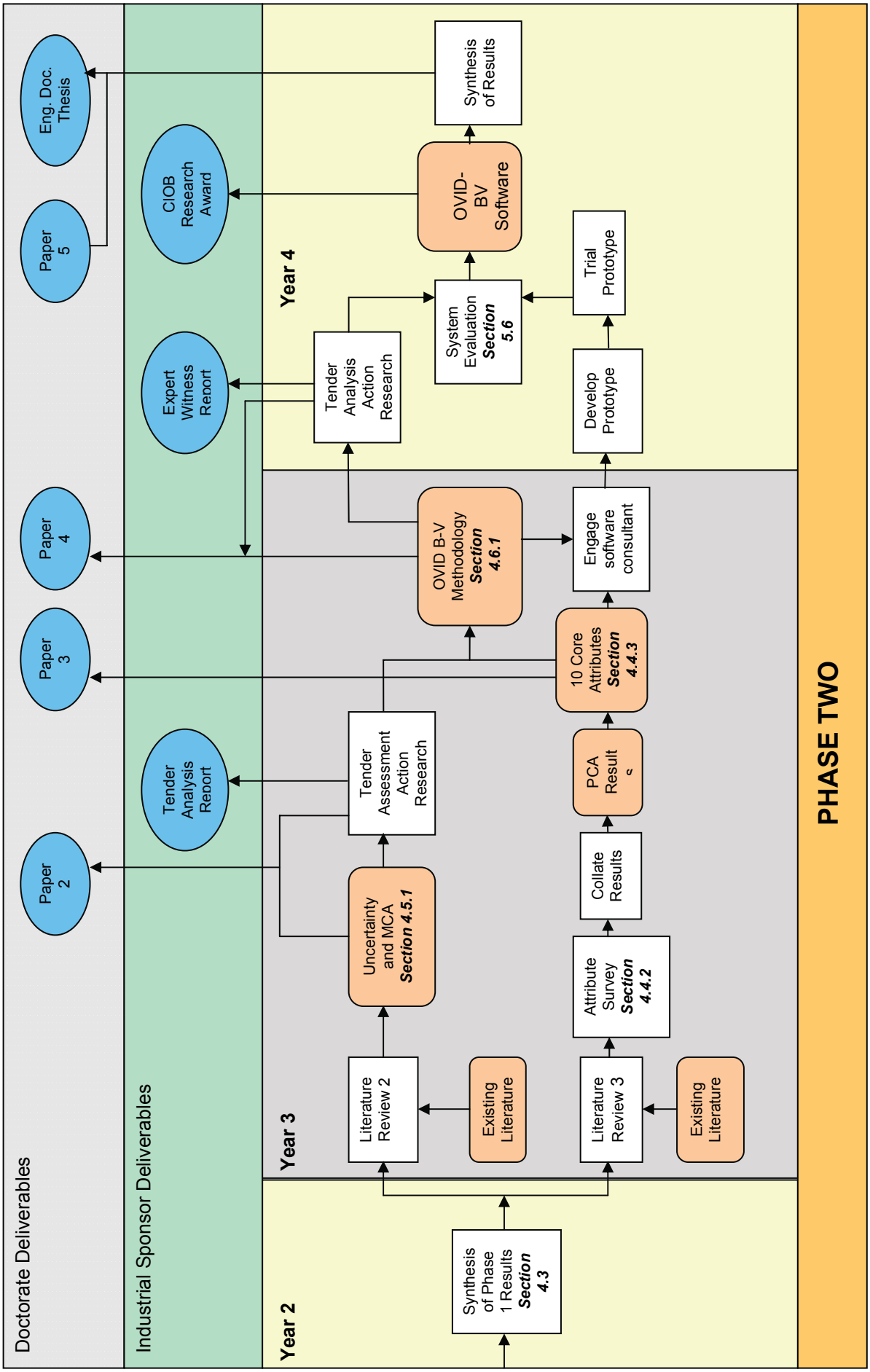
Stage 2: To develop a transparent and robust method for measuring best value. (Research Objective 4 and Paper 2, Appendix B).

(i) The importance of each attribute in regard to the specific project must be assessed and

(ii) The evaluation of the contractor's proposals against the attributes

Stage 3: Develop a generic software tool to provide a transparent and commercially effective audit trail of the best value analysis process. (Research Objective 5 and Paper 4, Appendix D & Paper 5, Appendix E).

Figure 4.2: The Phase 2 Research Process



4.4.2 Stage One: Establish Core Attributes

Section 2.3.1 sets out the importance of using value management techniques to establish both the attributes of a client's value system as the main driver for a project and for establishing a project value system which will comprise, in theory at least, shared values between all the project stakeholders. The problems associated with using such techniques have also been identified in that; the value management process can be time consuming, if too many values are considered the process can also becomes complex, and that obtaining any consensus vision between stakeholders is difficult to achieve. Therefore this research puts forward the argument that whilst the use of value management techniques are entirely appropriate for; large scale projects, say in excess of £3.6 million pounds (The current EU procurement threshold level for works), or with regard to the construction of 'one-off' developments and for PFI/PPP projects, there is also a need to standardise the clients value attributes for smaller scale projects whose value is under £3.6 million pounds. This argument is fortified by the fact that due to the distinct characteristics of the Social Housing sector identified in the phase one research, most RSL's and their stakeholder groups will have a number of common factors with respect to their value systems. Not only do RSL's have common social drivers and objectives, many RSL's are also characterised by their regular procurement of volume construction services and the standardisations and harmonisations in terms of components, design and construction techniques that exist on a project to project basis .

It is envisaged that the use of a smaller number of named core attributes could increase the efficiency of the tender analysis procedure and may assist the non-

professional support staff in their understanding of the process. This part of the research set out to establish a set of core attributes using factor and principal component analysis that can be used to standardise best value tendering mechanisms within the social housing sector in order to reduce the time and cost of the tendering process. It is anticipated that the establishment of the core attributes could, potentially, provide a stable base for an RSL's value system and will form part of a value thread that will transparently link the RSL's value system with the organisations best value tender process. Whilst the objective components of value such as price and cost can be measured in monetary units, it is proposed that the subjective components of value be assessed by a utility measure to establish an auditable hierarchy of tender attributes. These attributes should transparently link with the RSL's corporate value system so that value thread is preserved from a corporate or strategic level into the project phase of the works.

Whilst numerous researchers have highlighted essential criteria used in a contractor selection process (Holt *et al* 1996, Hatush and Skitmore 1997, Fong and Choi 2000, Wong *et al* 2000*,* Cheng and Li 2004, Swan and Khalfan 2007*)* there is no single authoritative and comprehensive listing of the different attributes considered by all the stakeholders during a best value tender analysis in the social housing sector. Therefore a wide ranging literature review was undertaken in related areas and was based upon a number of sources comprising: academic, construction practitioners, government departments and quangos such as the Housing Corporation. A list of 35 independent attributes was identified from this literature as potentially being considered by stakeholders during a best value tender analysis process .The scope of the attributes demonstrated a balance between the criteria that must be considered in both lowest

bid and value based procurement and those criteria that have been identified by researchers as directly relating to value based procurement only (CIRIA 1998, Woodhead and McCuish *ibid,* Langmaid 2003, NAO 2004, Morledge *ibid*, Potter and Smedley 2006). It is important to note that though 'cost' could have been included as one of the attributes it is, for the purposes of this methodology, considered separately because (a) in many multi attribute decisions costs should be set aside until the benefits of the value alternatives are evaluated (Haas and Meixner 2003) and (b) more importantly the OGC have stated that the recommended approach to best value evaluation is to differentiate the financial and non-financial criteria for consideration into separate strands. According to the OGC (2004) attempts to balance these criteria during the process should be avoided.

4.4.3 Survey Questionnaire

The identified attributes were listed in a survey questionnaire (See Appendix F) and respondents were requested to provide an opinion on the importance of each attribute. The respondents were identified as a cross section from the five stakeholder groups identified as being part of the contractor selection process comprising; (i) RSL's, (ii) contractors, (iii) construction consultants and residents (end users) divided up into (iv) leaseholders and (v) tenants. The responses to each question were measured on a 5-point Likert scale from 'Vital' to 'Not Required'. The questions were closed though the final section of the questionnaire was open in that it invited the respondents to suggest additional attributes if they wanted to do so. In order to test the validity of the questionnaire it was sent to a representative of each of the five stakeholder groups for comments on its clarity, terminology, and consistency of the questions/topics covered.

The recommended changes were made to the questionnaire where appropriate to do so. The survey questionnaires were finally sent to 195 representatives of the five stakeholder groups. The response rate of 41% was considered favourable compared with the norm of 20-30% expected from most postal questionnaire surveys of the construction industry.

The data reduction method using principal component analysis [PCA] was chosen for two main reasons (i) to reduce the number of attributes and (ii) to identify or detect a structure in the relationship between the attributes and classify the attributes into sets of factors. Though factor analysis has been used before to identify attributes associated with best value (Bing *et al* 2005, Zhang 2006) it is the first time that this technique has been used to establish value attributes solely for the UK social housing sector. The PCA identified the following ten core attribute shown in table 4.1 (See Paper 3, Appendix C for the complete results of the PCA);

Table 4.1: The Ten Core Attributes.

1	Understanding of Clients Objectives.
2	Innovative management.
3	Successful track record.
4	Innovative Construction practices.
5	Quality management procedures.
6	Transparency of cost data.
7	Understanding of Partnering.
8	Established Policy. (Health &Safety, Environmental)
9	Understanding of Best Value.
10	Technical Ability.

The factors are readily understandable which will assist non professional staff in gaining confidence to enable them to make competent choices during the selection process. However it is not expected that the 10 factors will be the only ones considered by the stakeholders in the tender selection process and it is fully accepted that stakeholders will need to consider other factors either alongside or in place of them. The make-up of the factors illustrate that whilst social housing stakeholders still rely on assessing contractors against time, quality and cost they are also readily embracing and considering new attributes such as innovative construction solutions and sustainability issues.

4.5 STAGE TWO: THE DEVELOPMENT OF A TRANSPARENT AND ROBUST METHOD FOR MEASURING VALUE

4.5.1 Attribute Evaluation

Once a project's specific value attributes have been established they need to be evaluated as part of the contractor selection process. The evaluation process needs to be carried out in two distinct stages;

1. The importance of each attribute in regard to the specific project must be assessed and

2. The evaluation of the contractor's proposals against the attributes must be measured. This can be carried out at either the pre-qualification stage in selective tendering and/or at the tender bid evaluation stage.

The literature review identified a number of different types of Multiple Criteria Analysis [MCA] techniques (See Section 2.4) which have been previously used or could be used for the evaluation process. AHP was the procedure chosen to evaluate the attributes and the justification for this decision is that; (a) non–specialist users find the pair wise comparison data entry procedures of AHP attractive and easy to undertake (DTLR 2000), (b) it provides clear ,measurable preferences of one attribute over another (c) it has versatility and power in structuring and analysing complex decision problems and (d) an ability to decompose a complex decision problem into a hierarchy of sub problems (Fellows and Liu 2003). However it is also acknowledged that criticisms have been raised doubting the theoretical foundations of AHP (Costa and Vasnick 2001). The decision to use AHP was also arrived at by comparing it against the other MCA techniques which were rejected as;

- Analytical Network Process [ANP] is normally used in the analysis of multiple complex interdependent relationships which is considered inappropriate for use with OVID-BV, not least, because OVID-BV is based on the analysis of attributes which are mutually preferentially independent to each other.
- The main disadvantage of both direct matrix analysis and regime analysis is that it is not highly informative about the order of magnitude and degree of preference for alternative solutions.
- The use of the Displaced Ideal Model (DIM) in attribute evaluation eliminates bias (Kashiwagi and Byfield 2002) but is difficult for users to understand as it based on the entropy equation.
- Within the UK construction industry the SMART technique is too closely associated with the choice of design alternatives (Green 1992) and

- Measurement of attributes by interpretation of language does not have a track record of success within the UK construction industry and would be unfamiliar to a tender analysis panel. Also it does not have clear theoretical foundations, and it has not yet been established that they have any critical advantages over more conventional MCA methods (DTLR *ibid*).

4.5.2 Value and Uncertainty

The second decision to be made was whether or not AHP should also be used to evaluate the contractors bid proposals against the project specific attributes. Whilst AHP could be used to carry out this task the literature review had illustrated the problems encountered by previous researchers in using AHP in this way which have given rise to unwieldy hierarchical structures that are difficult to interpret (See Section 2.5). More importantly there are more suitable methods of assessing how the contractors can add value to a specific project. An innovative feature of the research is to embrace uncertainty. Concerns have been raised that the Bayesian decision analytic approach requires decision makers to express their beliefs and values with a certain degree of precision (Pollit 2003). As a consequence of the introduction of long term collaborative contracts within the public sector tender panels are being asked to assess the suitability of contractors not simply on their value–adding activities but also over lengthy contract periods, sometimes in excess of 5 years. It is also likely that time and cost restraints, will prevent the decision makers from obtaining complete information prior to selecting the most suitable contractor. Therefore rather than asking decision makers to be precise, this research propounds that RSL's should promote the concept that decision–making is an arena of imperfect or uncertain information involving; the future, change, human action and reaction. Arguably, the only method of quantifying

this uncertainty factor is to provide it with a full mathematical representation, which, in essence, comprises three components: axioms specifying the formal properties of uncertainty; interpretations or operational definitions; and measurement procedures for interpreting the axiom system (Bedford and Cooke 2003). The representation chosen for the methodology is known as the rational decision theorem and the mathematical axioms that characterise rational preference can be examined by referral to LJ Savages seminal work (Savage 1972). However it is acknowledged that no formal representation can completely cover all aspects of an informal concept such as uncertainty.

The theorem of rational decision developed by Savage traces uncertainty, or partial belief, back to the notion of rational preference. Savage proves that rational preference can be uniquely represented in terms of a utility measure and subjective probability. Generally the degrees of belief held by a decision maker can be represented by probabilities. These will be inherently subjective as preferences may shift in the future and each individual will have their own cognitive structure made up of heuristics and biases which influence the way issues will be perceived and resolved. It is accepted that some bias is inevitable and the likelihood of not biasing is, essentially, nil (Keeney 1992). Utility is a measure of desirability or satisfaction and provides a uniform scale to compare the clients various value attributes against each other.

In Savage's theorem, the consequence of a choice being made is defined as a "state of the acting subject". This can be related to best value tender analysis as the act of choosing to engage a contractor must lead to a consequence (i.e. a social gain or a loss, which will also depend on the unknown state of the world). It is important to

note that in Savage's sense the consequences are 'the awareness of having made a social gain' or the 'awareness of having incurred losses'. In essence this replicates the decision making process undertaken by a tender panel, as the panel can never accurately predict how a contractor will perform, but they can form a belief as to how successfully the contractor may complete their contractual obligations if they were engaged to do so. Distinguishing states of the world from states of the subject in this way is crucial when deriving a representation of preference. The limitation of this approach is that in Savage's model any 'vagueness' on the part of the member of the tender panel is not allowed for. It does, however, recognise that the panel member's knowledge is imperfect, and though they cannot be sure which state will occur, they can assign numerical probabilities representing their degree of belief as to the likelihood of the occurrence of each possible state.

4.5.3 Utility and Risk

The use of the utility function enables OVID-BV to overcome one of the main challenges of best value evaluation, namely, how can each of the value attributes be compared on a level playing field? A utility function can be constructed by assuming that there are best and worst alternatives, *b* and *w*. and we can fix the parameters of the utility function *u* by the choice $u(w) = 0$ and $u(b) = 1$. Since utility is, in this situation, a cardinal concept these utility values are arbitrary, therefore the 0 does not mean utter worthlessness, but simply designates the lowest score and, similarly, 1 represents the highest score. In order to determine the utility of intermediate values where for a consequence *x* which satisfies transitivity so that $b \geq x \geq w$ the decision maker then uses the concept of certainty equivalent with respect to the following two alternative strategies:

(a) Outcome *x* with certainty. i.e. the probability of it occurring is *p*= 1

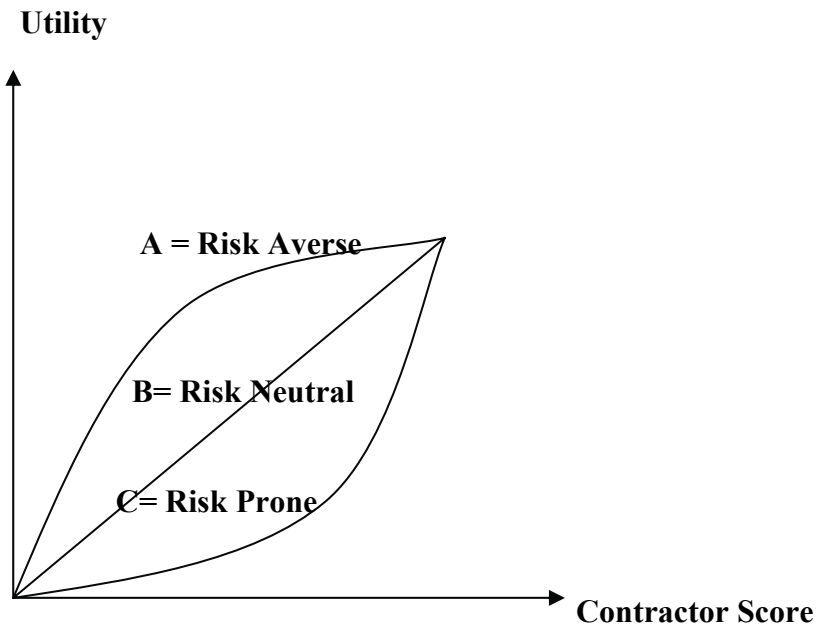
(b) Risk Option: The chance consisting of outcome *b* with probability of it occurring = *p* or outcome *w* with probability of it occurring =1-*p*.

If the probability *p* takes a value very close to (a) then the decision maker will probably choose alternative (b). If on the other hand *p* is very small the decision maker will choose alternative (a). However and most importantly for some *p* strictly between 0 and 1 he will be indifferent between the two alternatives at this point the utility value of the two alternatives is identical and we can express this as;

$U(x) = u(\text{alt (a)}) = u(\text{alt (b)}) = p.u(\text{b}) + (1-p)\,u.(w) = p$

Hence, not only can the decision maker specify the probability *p'* but they can also derive the utility value of the associated outcome. It is helpful if the utility function is depicted graphically (See Figure 4.3) as the shape of the resulting utility curve can be divided into three broad categories dependent upon whether the decision maker is risk averse [A], risk neutral [B] or risk prone [C]. It is acknowledged that the risk curves oversimplify the real situation

Figure 4.3. Three types of Utility Function Curves



It is important to note that an individual will probably have a different utility function compared to a group and utility evaluations of individuals cannot simply be added together to obtain group utility. The optimum solution is for the RSL to give guidance on their attitude to risk for a specific project or, otherwise, the tender panel could simply compare the results for each risk attitude prior to making the final decision i.e. calculate and assess the different results obtained for each of the three utility function curves shown in Figure 4.3.

The crucial step is to connect the function for assessing consequences with the correct ordering of acts as this replicates the tender decision process i.e. the tender panel can assess all the possible consequences associated with the various elements of each bid proposal but how can this be used to produce the correct decision of ranking the contractor's bids? The link is provided by the expected utility rule which states that the utility of an act is calculated as the mathematical expectation of the utilities of the associated consequences. It is also simply additive over the states of the acting subject (Hirshleifer & Riley 2002).This fact is important in that in order to derive the ranking of the contractors bids the utility value scored against each attribute can simply be added to together. The advantage of the additive form is its simplicity e.g. In order to determine the overall utility function for any alternative a decision maker need only determine *n* utility functions for that alternative, where *n*= the number of criteria used (Hatush and Skitmore 1997). The limitation is that the additive approach is only appropriate when the condition of mutual preferential independence of the attributes is satisfied. i.e. a decision maker's preference for one attribute is not affected by the preference for another attribute (Flanagan and Norman 1996).

4.6 STAGE 3: DEVELOP A GENERIC SOFTWARE TOOL TO PROVIDE A TRANSPARENT AND COMMERCIALLY EFFECTIVE AUDIT TRAIL OF THE BEST VALUE ANALYSIS PROCESS

This section provides an overview of the operation and functions of OVID-BV during the best value decision making process. OVID-BV has been used as a decision support tool not only in the analysis of best value tender bids (See Paper 2, Appendix B and Appendix H) but also in the decision to repair or replace window units (See Paper 4, Appendix D),therefore, whilst the commentary on the operation of OVID-BV relates to analysis of a best value tender bid the screen shots reflect the range of applications of OVID-BV.

4.6.1 OVID-BV Methodology

The methodology for the decision support tool, OVID-BV, operates in 8 distinct steps as shown in Figure 4.4. The first prototype of OVID-BV was developed using a combination of; Microsoft Excel worksheets (See figure 4.5), Microsoft Word and a graph drawing software package.

Figure 4.5: A screenshot of OVID-BV using an Excel Workbook.

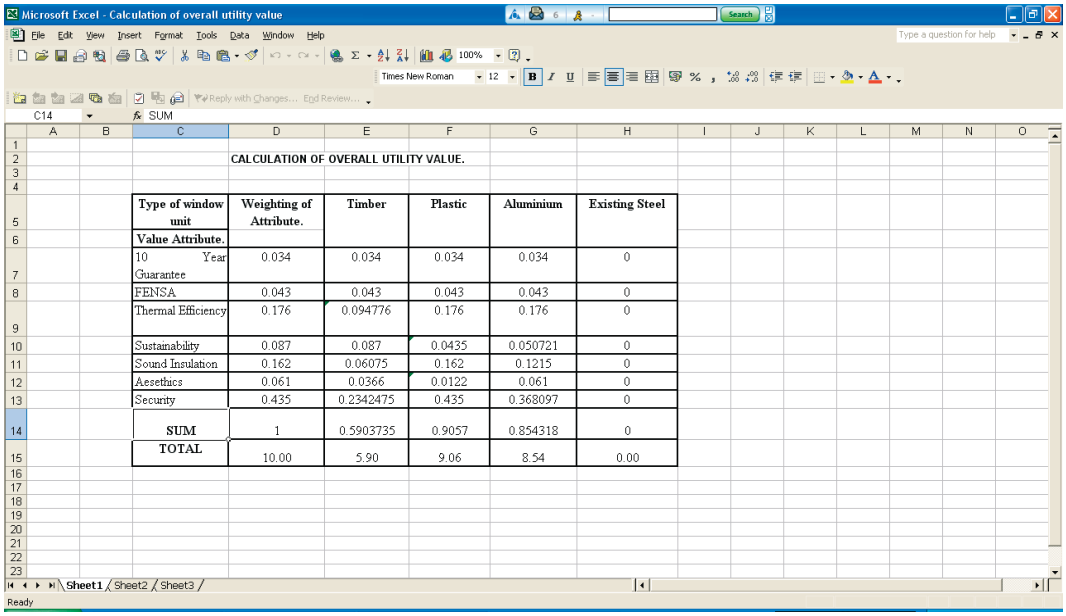
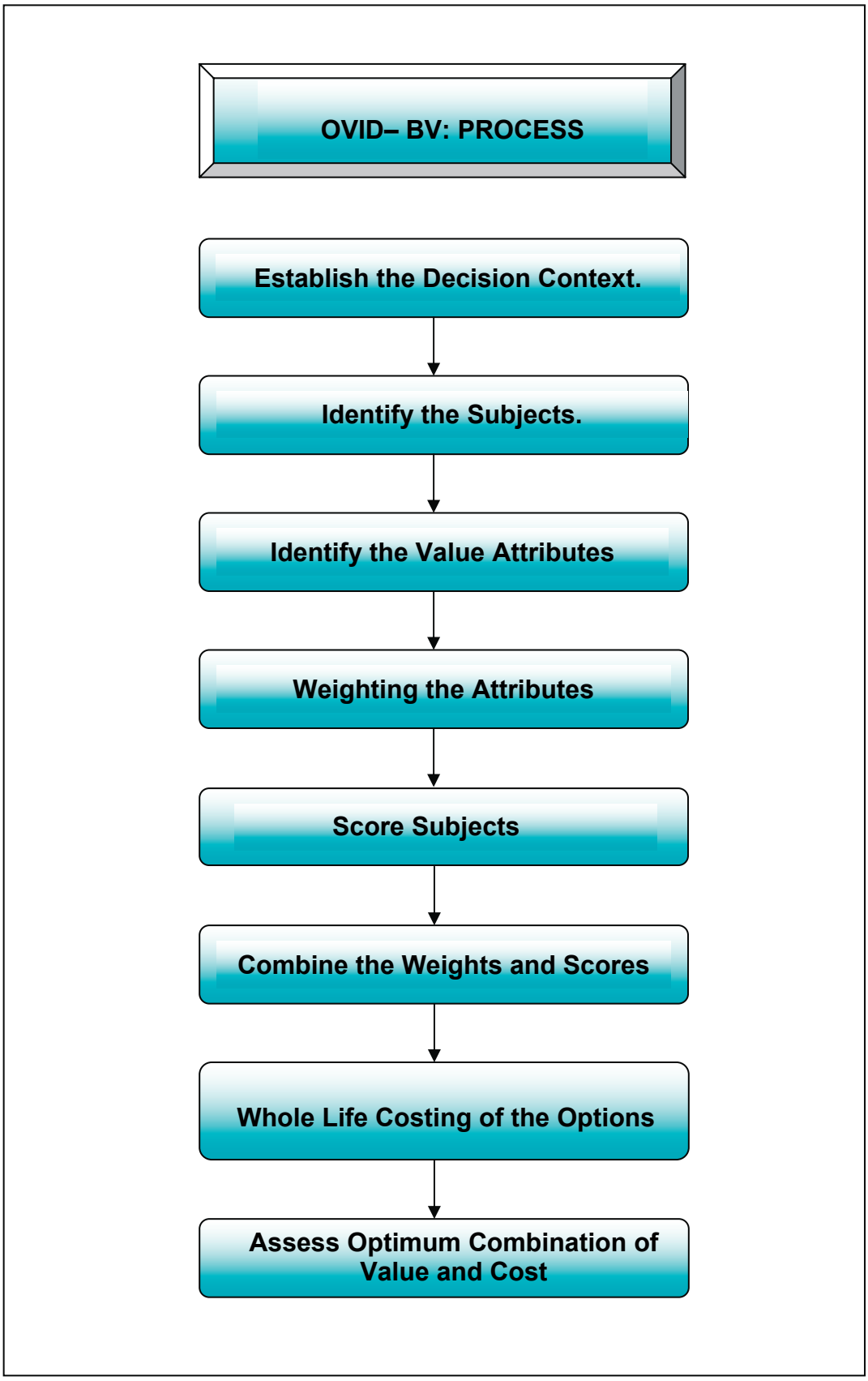


Figure 4.4: The Eight Steps of the OVID-BV Methodology.

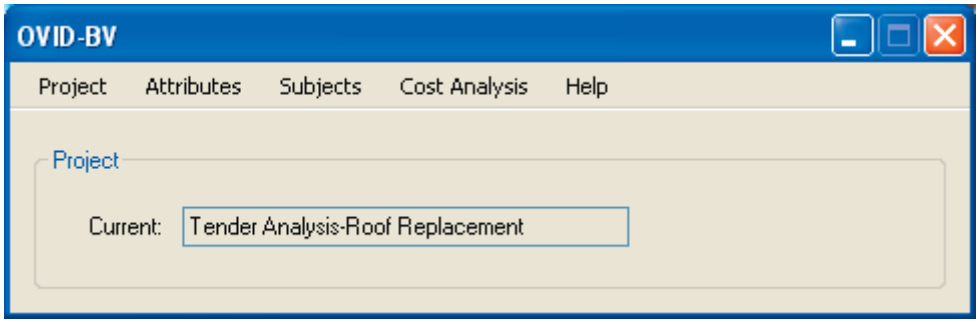


Whilst this combination of standard software packages showed that it was possible to develop the methodology in an electronic format and was used in the commercial marketplace to undertake a best value analysis (See Paper 2, Appendix B and Paper 4, Appendix D) the learning experience from carrying this out was that the choice and calculation process was too disjointed and time-consuming and that, consequently, OVID-BV needed to be converted into a single software package.

Therefore a brief was sent out to a number of IT software firms and following a best value analysis of their proposals and costs, Blueberry Consultants, were engaged in August 2006 to write the programme for the OVID-BV methodology in C# and NET. The current version of the programme has evolved as the result of; the scope of the initial brief, practical application of the support tool, and demonstration and trialling sessions with self and user evaluation followed by feedback meetings with the Consultants. The de-bugging of the functionality of the software has been carried out using a programme specially developed for the purpose known as BB Flashback.

Step One. Establish the decision context. The initial step is for the client to identify the purpose for using the decision support tool (See Figure 4.6). It is anticipated that, principally, this will be the assessing and recording of tender bids but as the tool is generic it can, in theory, be used to underpin any best value decision-making situation.

Figure 4.6: The opening OVID-BV Screen



Step Two: Identify the Subjects: At the outset of this research it was envisaged that the subjects to be scored would be purely competing contractor's tender bid proposals (See Figure 4.7) but as the commercial interest in OVID-BV grew it was clear that the same methodology could be applied to other types of best value decision problems and, consequently, the nature of the subjects has changed and has, for example, included different types of materials used in window units (See Figure 4.8).

Figure 4.7: Subject screen illustrating contractor's names.

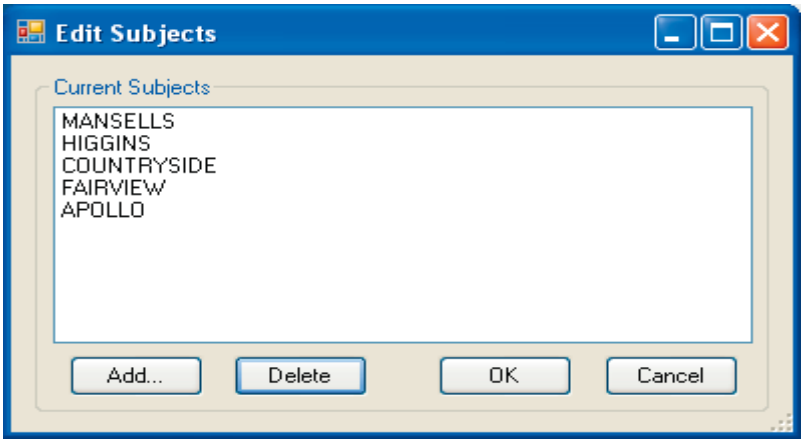
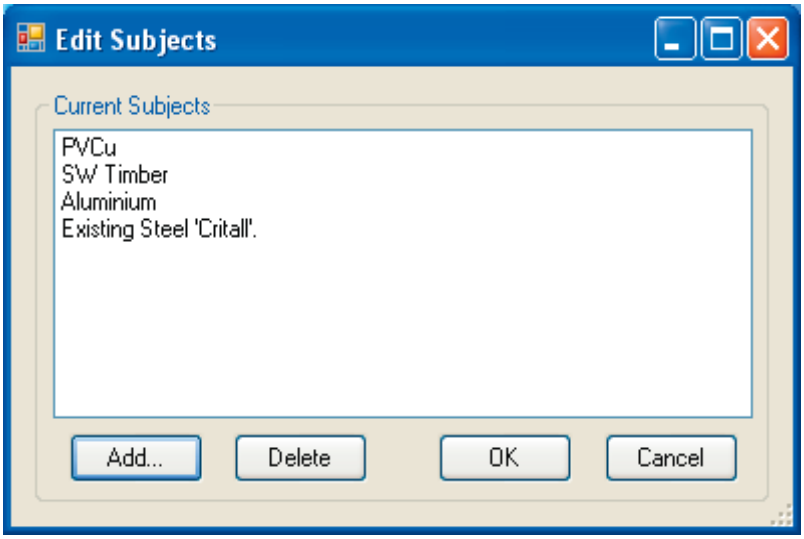
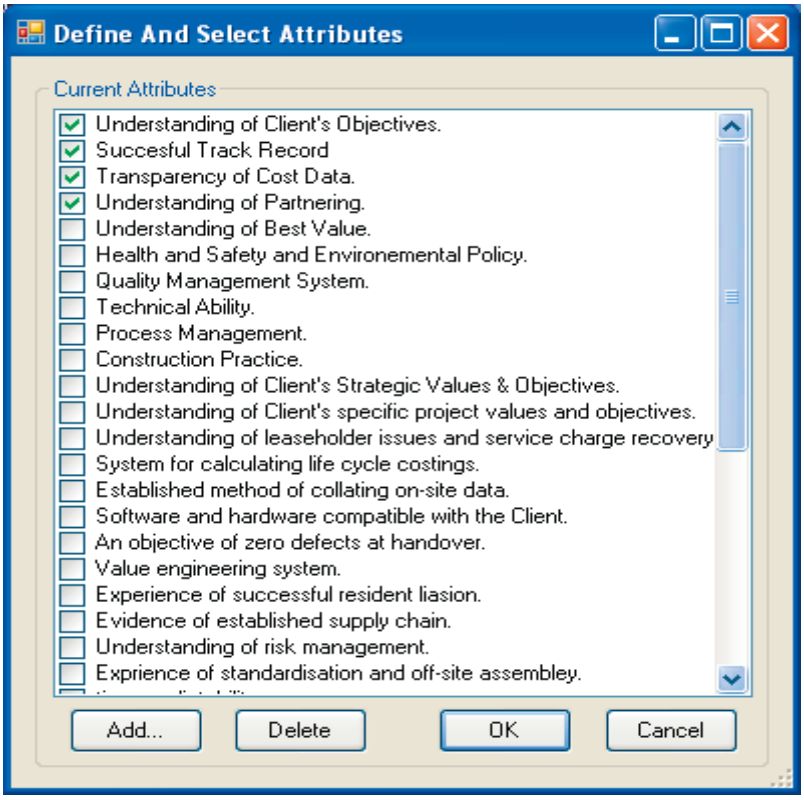


Figure 4.8: Subject screen illustrating different materials.



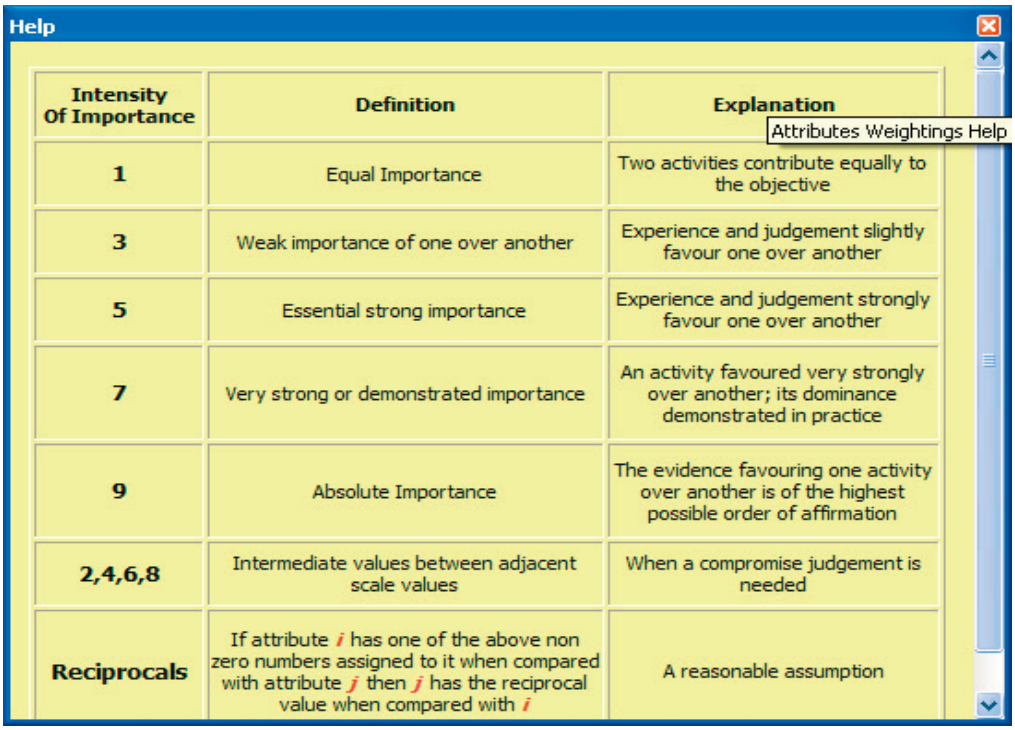
Step Three: Identify the Value Attributes: The stakeholders can choose their project specific attributes from a drop down menu which includes not only the ten core attributes identified by the PCA but also all the other value attributes established by the literature review (See Figure 4.9). The attributes are mutually preferentially independent of each other which allow the additive form of the utility function to be used. The software also provides a facility for new attributes to be added as necessary.

Figure 4.9*:* Attribute Choice Screen.



Step Four: Weighting of the Attributes: The assessment process commences by determining the relative importance of each attribute in meeting the client organisations project specific goals, by making pair-wise comparisons between them. It is envisaged that the majority of the stakeholders will be unfamiliar with Saaty's pair wise scoring system and the software has a help function that displays the system as a pop-up (See Figure 4.10).

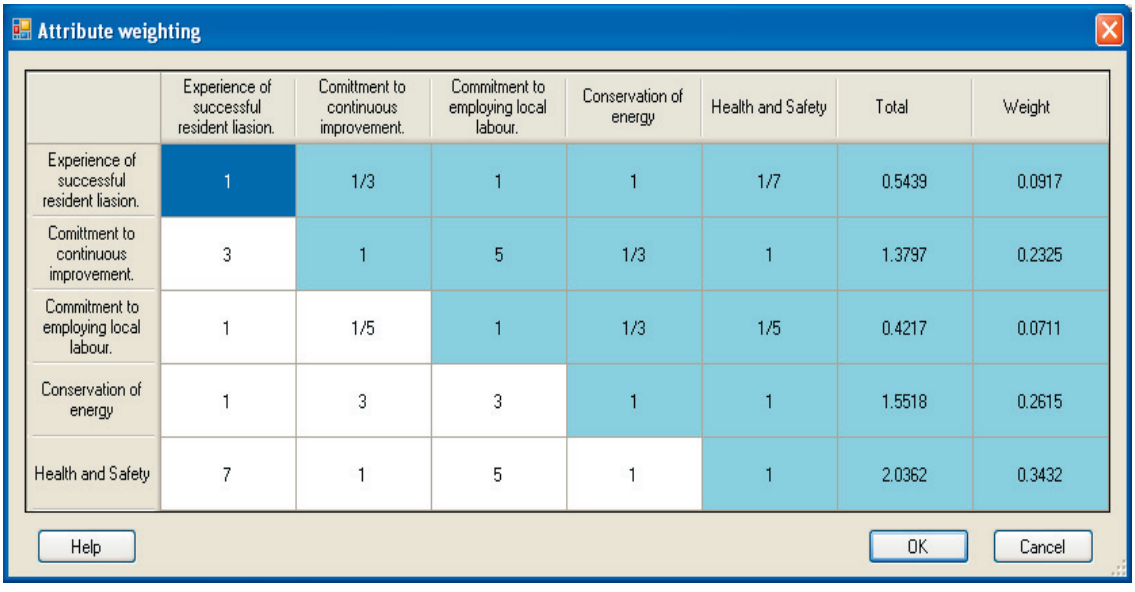
Figure 4.10: The Attribute Scoring System (Saaty 1980).



Intensity Of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgement slightly favour one over another
5	Essential strong importance	Experience and judgement strongly favour one over another
7	Very strong or demonstrated importance	An activity favoured very strongly over another; its dominance demonstrated in practice
9	Absolute Importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent scale values	When a compromise judgement is needed
Reciprocals	If attribute *i* has one of the above non zero numbers assigned to it when compared with attribute *j* then *j* has the reciprocal value when compared with *i*	A reasonable assumption

Once the pair wise comparisons are completed the weighting of each attribute is calculated using the Geometric Mean Square method and shown in the final right hand side column of the matrix. (See Figure 4.11).

Figure 4.11: Pair Wise Comparison Scores of the Chosen Attributes

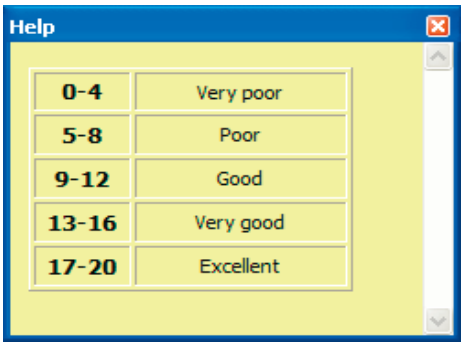


	Experience of successful resident liasion.	Comittment to continuous improvement.	Commitment to employing local labour.	Conservation of energy	Health and Safety	Total	Weight
Experience of successful resident liasion.	1	1/3	1	1	1/7	0.5439	0.0917
Comittment to continuous improvement.	3	1	5	1/3	1	1.3797	0.2325
Commitment to employing local labour.	1	1/5	1	1/3	1/5	0.4217	0.0711
Conservation of energy	1	3	3	1	1	1.5518	0.2615
Health and Safety	7	1	5	1	1	2.0362	0.3432

It is anticipated that steps 1-4 will be undertaken either before the pre-qualification stage or before the tender documents are produced so that all parties to the tender process are aware of both the scope and weightings of the attributes prior to any proposals or bids being submitted.

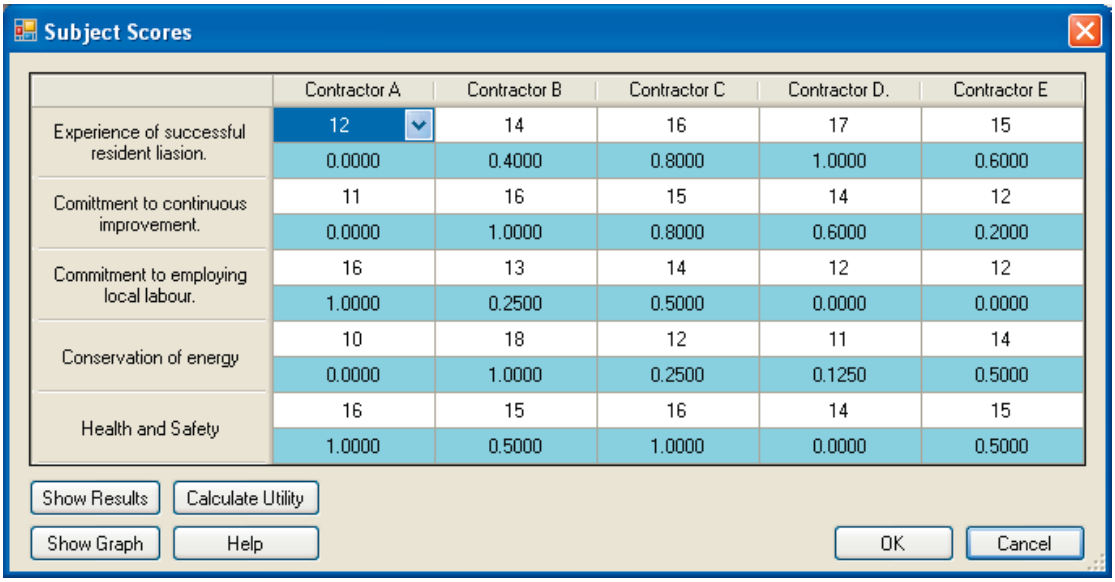
Step Five: Scoring of the Subjects: The next stage is to assess the subjects with respect to each of the chosen attributes. One of the innovative aspects of the tool is that in MAUT the utility function uses a uniform scale to assess the RSL's value attributes against each other and provides a method for comparing and scoring different types of attributes on a 'like for like' basis. As utility is a measure of desirability or satisfaction each of the subjects is scored against the chosen attributes on the basis of the decision maker's satisfaction (or belief) that the subject could successfully deliver on the claimed benefit to the end users made within the tender documentation. The point's score system used was as follows: 0-4 = very unlikely; 5-8= unlikely, 9-12=fair: 13-16=very likely, 17-20=certainty. Numerically similar scoring systems are currently being used within the UK construction industry though they assess content of the tender submission documents rather than belief in successful delivery by the contractor. The importance of scoring in this manner is that it allows the decision maker to incorporate his/her personal experience, preferences, heuristics and biases as part of the contractor selection process and should promote discussion between members of the tender analysis team. In terms of an audit trail it also provides a transparent indication of the way in which the panel viewed each subject and how they perceived the consequences of their choices. Again the programmes 'help' function produces a pop-up of the points scoring system as an aide-memoire for the decision makers (See figure 4.12).

Figure 4.12: Points Scoring System Pop-Up.



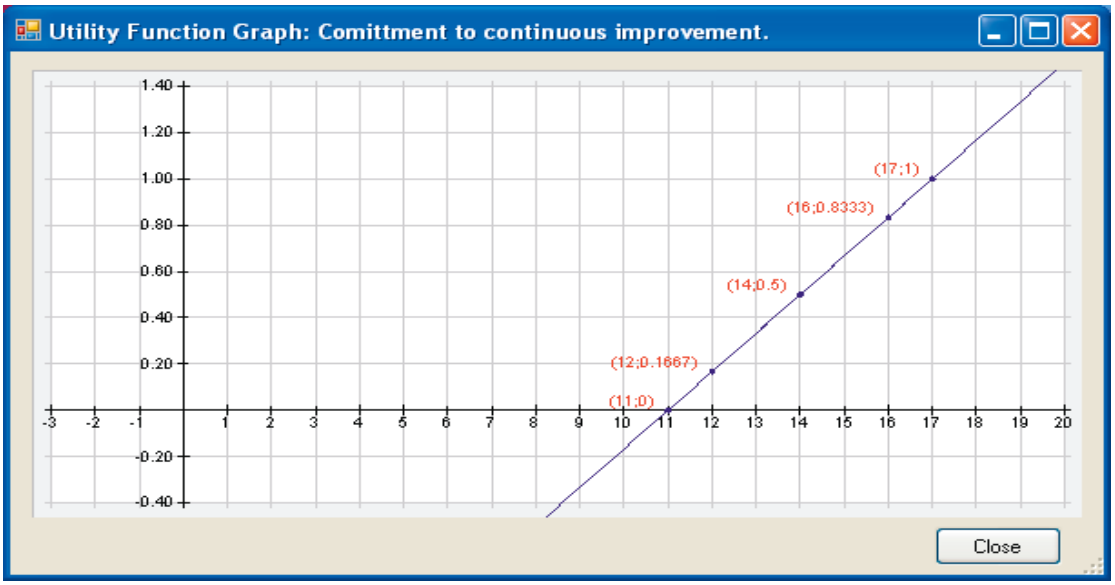
The software calculates a utility function for each of the attributes and assigns a utility value of 1 for the best contractor score and a utility value of 0 for the worst score. In Figure 4.13 each attribute has two scores shown against it, the upper figure is the score given by the tender assessment panel whilst the lower figure is the utility score. Figure

4.13: Contractors Bid Submission Scores per Attribute.



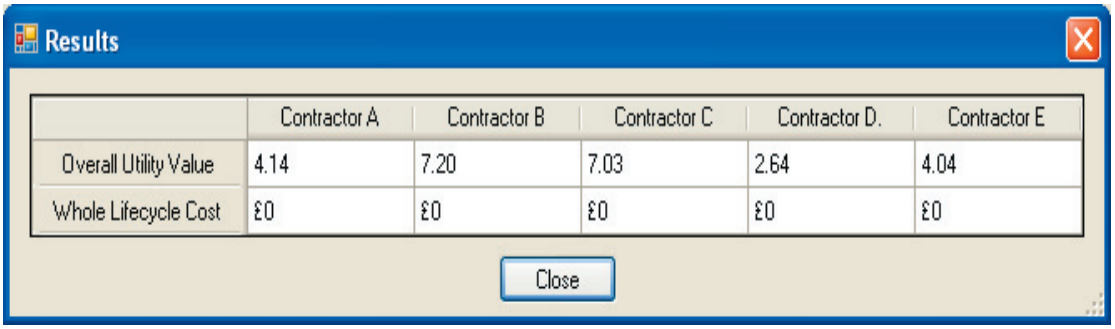
The software can also depict each attribute's utility function graphically for audit trail purposes. Currently OVID-BV calculates a neutral decision making attitude to risk and the utility function is depicted as a straight line (See Figure 4.14)

Figure 4.14: Utility Function Shown In Graphical Form.



Step Six: Combine the weights and scores: As the additive form of the utility function has been used the contractors utility scores for each attribute are first multiplied by the previously calculated attribute specific weighting shown in the far right column of figure 4.11 and then added together to produce an overall score (Figure 4.15).

Figure 4.15: The Contractor's Overall Utility Scores.



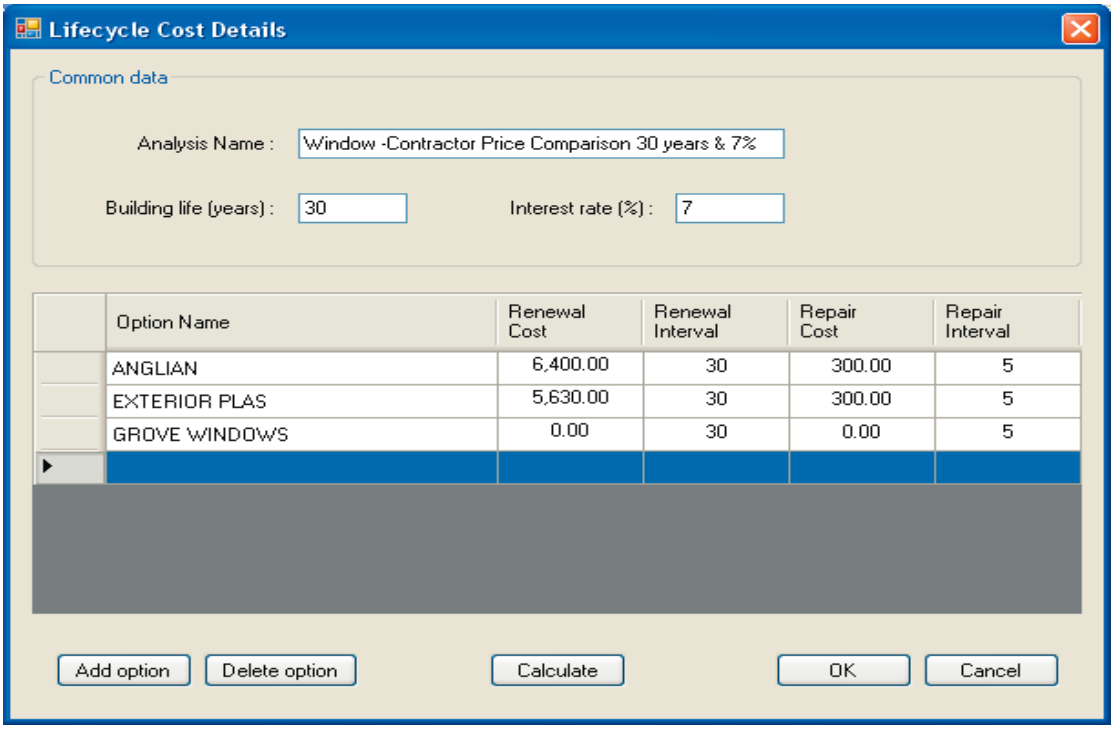
	Contractor A	Contractor B	Contractor C	Contractor D.	Contractor E
Overall Utility Value	4.14	7.20	7.03	2.64	4.04
Whole Lifecycle Cost	£0	£0	£0	£0	£0

Step Seven: Whole Life Costing of the options: Though the expected utility theory states that the rational course of action would be to appoint the contractor with the highest overall utility value the OGC definition of Best Value requires that the

successful contractor should provide the 'optimum combination of whole life costs and quality to meet the users' requirements'. In 2004 the OGC stated that the recommended approach to Best Value evaluation is to differentiate the financial and non-financial criteria for consideration in separate strands and that attempts to balance these criteria during the process are to be avoided. Therefore OVID-BV addresses the question of the importance of cost at the end of the process not at the beginning.

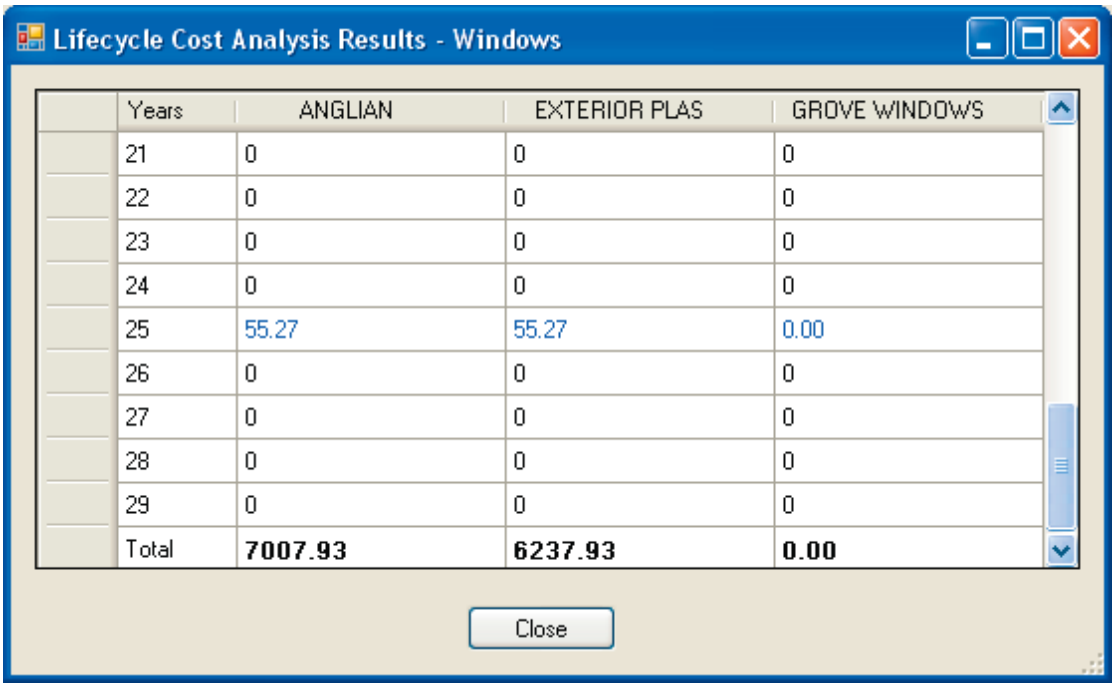
OVID-BV undertakes a WLC calculation based on the standard Present Value formula and the variables that can be inputted are (a) the initial capital cost (b) the life of the building (c) the repairs and redecoration costs during the life of the building and (d) an interest rate (See Figure4.16). In the public sector it is usual for the Treasury discount rate to be applied to the calculation (Martin and Kelly 2006).

Figure 4. 16: The WLC input screen.



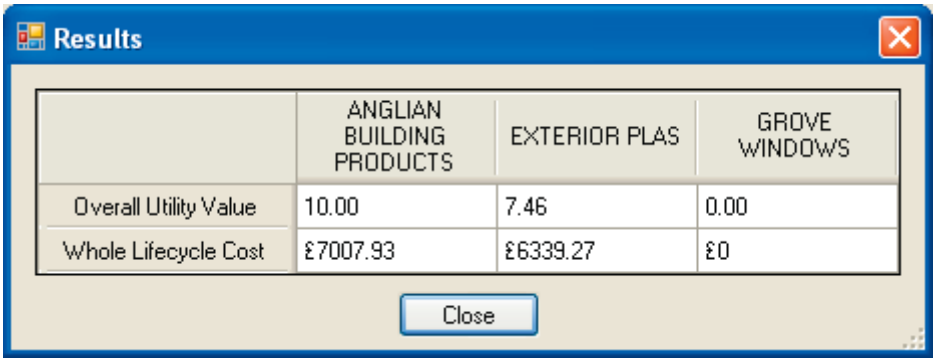
The WLC results screen is shown in Figure 4.17

Figure 4.17: The WLC results screen.



Finally, the results screen presents the Overall Utility Value score for each contractor assessed against the calculated Whole Lifecycle Cost for that contractor (Figure 4.18). Self evidently the results provide guidance only with respect to the choice of the successful contractor and the support tool cannot and should not replace management review and judgement.

Figure 4.18: The comparative results screen



Step 8: Assess optimum combination of value and cost. The function for this step is currently being developed into a windows based front end screen by the software consultant. In essence a sensitivity analysis is carried out so that a decision making panel can assess how the comparative results change at different ratios between the quality and cost elements. The quality (or fitness for purpose) figures are based on the overall utility value and the cost figures are based on the percentage difference between the respective bids. The sensitivity analysis has been carried out in the commercial application of OVID-BV and is shown in the expert witness report contained in Appendix G with the tabulated results being shown below. Figures 4.19-4.21 illustrate how the tender bid analysis results can be interpreted for different price/quality ratios. In this instance Anglian Windows had provided the most advantageous bid providing that the quality/cost ratio didn't exceed 30/70. However the decision as to which contractor should be engaged must be based on sound management judgement rather than simply relying on the numerical outputs from OVID-BV, not least, because the term 'optimum combination' may be defined differently by individual RSL's.

Figure 4.19: Results with Quality/Cost Ratio at 50/50.

CONTRACTOR.	QUALITY 50%	COST 50%	TOTAL
ANGLIAN	100	-12.3	87.7
EXTERIOR PLAS	74.6	+ 0.00	74.6

Figure 4.20: Results with Quality/Cost Ratio at 40/60.

CONTRACTOR.	QUALITY 40%	COST 60%	TOTAL
ANGLIAN	80	-13.53	66.47
EXTERIOR PLAS	59.68	+ 0.00	59.68

Figure 4.21: Results with Quality/Cost Ratio at 30/70.

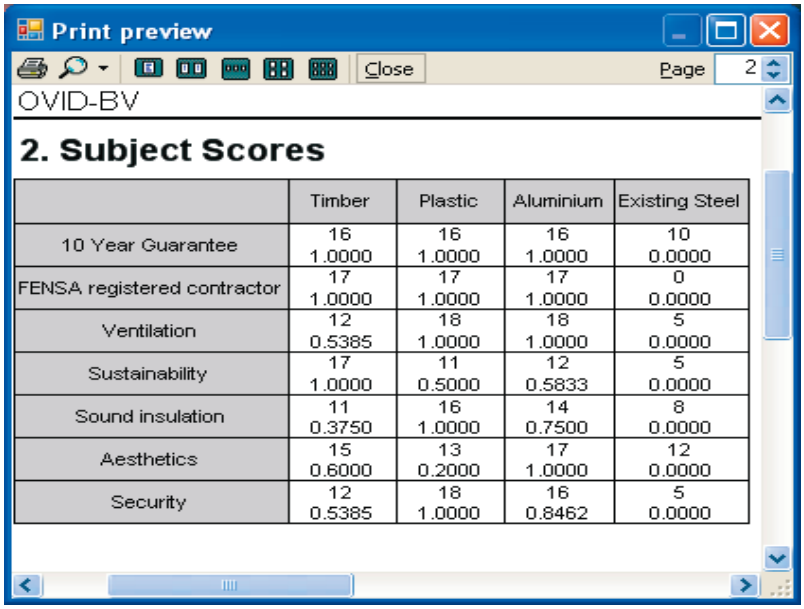
CONTRACTOR.	QUALITY 30%	COST 70%	TOTAL
ANGLIAN	60	-14.76	45.24
EXTERIOR PLAS	44.76	+ 0.00	44.76

This area of the methodology is also part of the ongoing research being carried out which is explained in further detail in section 6.3.2

Recording the Process.

One of the objectives in developing OVID-BV was that it has to be both transparent and auditable. The screen shots have demonstrated that this objective has been met. However when the software was being evaluated the feedback from one of the RSL's was that they required both a hard copy of the results and they needed a facility where they could make a written record of the core decisions made during the analysis process. Therefore a print facility screen (See Figure 4.22) and a comments screen

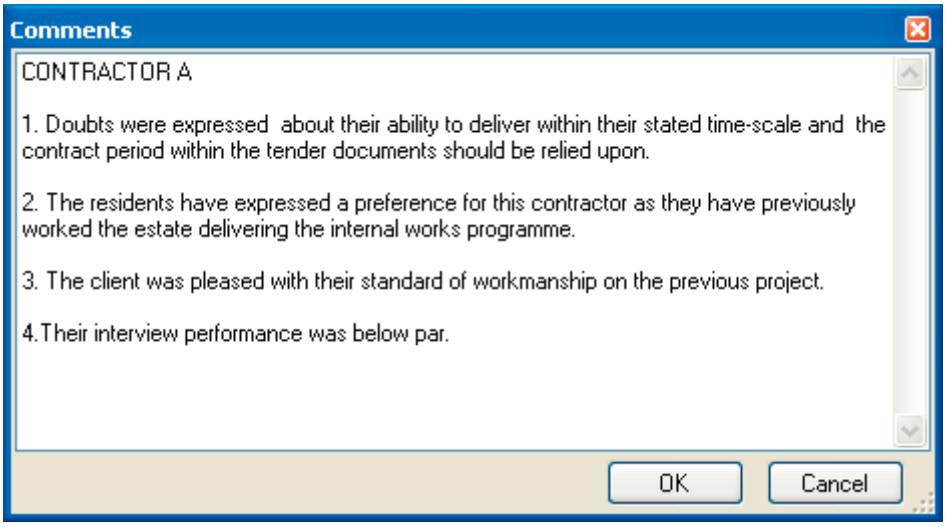
Figure 4.22 The OVID-BV print facility screen



	Timber	Plastic	Aluminium	Existing Steel
10 Year Guarantee	16 1.0000	16 1.0000	16 1.0000	10 0.0000
FENSA registered contractor	17 1.0000	17 1.0000	17 1.0000	0 0.0000
Ventilation	12 0.5385	18 1.0000	18 1.0000	5 0.0000
Sustainability	17 1.0000	11 0.5000	12 0.5833	5 0.0000
Sound insulation	11 0.3750	16 1.0000	14 0.7500	8 0.0000
Aesthetics	15 0.6000	13 0.2000	17 1.0000	12 0.0000
Security	12 0.5385	18 1.0000	16 0.8462	5 0.0000

(See Figure 4.23) has been incorporated within the functionality of the tool. This has proved to be particularly helpful as it provides individual members of the tender assessment panel the opportunity to record their individual views on any group decision.

Figure 4.23: The comments facility screen.



4.7 SUMMARY

This chapter discussed the research undertaken to meet the aim and objectives of the EngD project. It also highlights how the results from each research activity were used in subsequent activities and provided an overview of the results of each stage. The conclusions that can be drawn from the research undertaken in both phases of this project are presented in the next chapter.

CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

This chapter discusses how the support tool, OVID-BV, has already been used in the commercial market place and how its innovative concept was recognised when it was awarded the CIOB International Innovation and Research Award in 2007. The chapter also discusses the impact the research may have on the industrial sponsor and its implications for the wider construction industry. The chapter concludes by reporting on the user evaluation of OVID-BV.

5. 2 THE BUSINESS CASE FOR THE IMPLEMENTATION OF OVID-BV

The commercial need to develop a approach to analyse best value tenders is underscored by the scope of the identified problems and, not least, by the fact that the lack of transparency around this process has resulted in RSL's incurring both financial loss and criticism from the NAO. From personal experience as an expert witness in service charge disputes arising from social housing sector major refurbishment works contracts the researcher has noted an ever increasing and immediate need for RSL's to require a methodology to analyse best value bid proposals so as to demonstrate reasonableness as per sections 18 and 19 of the Landlord and Tenant Act 1985 (as amended) when (a) they wish to engage a contractor that hasn't submitted the lowest tender bid, and (b) the RSL has been challenged by their leaseholders regarding whether or not the service charge costs are reasonably incurred. The researcher has also noted that the leaseholders have a similar commercial need to use the same methodology when they wish to challenge the RSL's right to recover service charge monies. Finally, the researcher has also observed that as the scale of tender sums have

increased i.e. collaborative contracts are being let for longer time periods with a resultant increase in the scope, and therefore the cost, of works, RSL's are becoming wary of the other contractors in a bid process challenging the RSL's right not to engage the contractor who submitted the lowest bid. The research has not only established that there is a commercial need to construct a methodology that complies with the UK public sector definition of best value, but ,more importantly, instructions have already been received from RSL's to use OVID-BV as a decision support tool to assist in the analysis of best value tender bid submissions. The tool has also been used to assist in the preparation of expert witness reports focusing on the definition of 'reasonableness' as set out in section 19 of the Landlord and Tenant 1985 (as amended).

5. 3 COMMERCIAL APPLICATION AND INNOVATION

OVID-BV has been commissioned for use by a number of clients as set out in table 5.1 (Please note that clients have been named only where permission to do so has been received).

Table 5.1. The Commercial Application of OVID-BV.

Client	**Date**	**Task**
London Borough Council	March 2006	Tender analysis of contractors bid proposals for the refurbishment of part of a schools accommodation block. Approximate contract value £500,000. (See Paper 2, Appendix B).
London Borough Council	July 2006.	Expert witness report. Analysis of decision to repair or renew existing window units across the borough wide portfolio. Approximate contract value £3 million. (See Paper 4, Appendix D).
London & Quadrant Housing Association t/a Forest Homes.	March 2007	Expert Witness report/ Tender analysis of contractors bid proposals for a window renewal contract to street properties within the RSL's portfolio. Approximate contract sum £75,000. (See Appendix G).

Coopers Lane NW1 Leaseholder Association.	August 2007	Expert witness report. Opinion on the decision of a London Borough council to instruct a contractor who provided the second lowest bid. Approximate contract value £2.5 million.
East London Residents Association	October 2007	Tender analysis of contractors bid proposals to renew the covering of a flat roof. Approximate contract value £15,000.
Swan Housing Association.	November 2007	Tender Analysis of the regeneration of a residential estate. Approximate contract value £8 million.

The support tool has been used to aid a variety of best value decision making scenarios with respect to contract sums ranging from £15,000 to £8 million. Though OVID-BV wasn't intended to be used on contracts in excess of £3.6 million it was appropriate to do so for Swan Housing Association as the scope of the works was repetitive in nature as it comprised the refurbishment of 25 purpose built of blocks of flats. However it has also been made clear to Swan that OVID-BV has been developed to comply with the OGC definition of best value and not the EU procurement law definition of 'most economically advantageous' tender bid (See section 2.5 for further details re; 'the Harmon case').

Importantly, the application of OVID-BV was accepted by the Leasehold Valuation Tribunal [LVT] as a method of assessing the reasonableness of a best value tender analysis as part of their award with respect to case no LON/00AG/LIS/2007/0031. In this case a London Borough Council had accepted the second lowest bid from a large sized contractor with respect to the refurbishment of a residential estate. The monetary difference between the two lowest bids was approximately £95,000 and the additional cost was passed onto the leaseholders of the estate via their service charges. The lessee challenged the Council on the basis that the costs were not reasonably incurred.

The LVT rejected the leaseholders challenge and in doing so accepted that the argument put forward by the researcher, which was underpinned by an OVID-BV analysis, that the RSL's actions in engaging the contractor on a best value basis were reasonable and that the additional monies could be recovered.

5.3.1 Evidence of Innovation

OVID-BV has already been recognised for its innovative qualities. An entry was submitted into the Chartered Institute of Building International Innovation and Research Awards 2006/2007. The aim of the competition is to encourage the sharing of innovative ideas and practices which can provide real benefits to members of the Institute and other practioners within the construction industry. A brief report was submitted detailing the innovative features of OVID-BV including the 10 core value attributes determined by PCA and the use of MAUT (See Appendix H). The entry was awarded the Faculty of Architecture and Surveying Premier Innovation Award for innovative practice in the areas of architecture and surveying.



Photograph 1: Steve Phillips and Jim Martin receiving the CIOB International Research and Innovation award 2007 from Professor. Roger Flanagan.

5.3.2 Benefits for the Industrial Sponsor

The commercial use of OVID-BV had already added value to the delivery of the industrial sponsors business and informal feedback to the industrial sponsor has indicated that RSL's have welcomed the idea of a standardised software which

records the decision making process in a transparent and auditable way. However this must be tempered by the fact that RSL's are, by nature, resistant to change which may present a barrier to the immediate and widespread use of OVID-BV.

The research undertaken on OVID-BV has complemented Martin Associates existing web based online collaboration tool (OCT). They have developed OCT over the last few years to provide a secure method of facilitating the operation of a project team by allowing access to job related data throughout the duration of a project. The complete functionality of this tool can be reviewed at www.martinassociates.ci.uk/online. As OCT contains cost data for all Martin Associates projects it can be used for benchmarking the tender costs that are entered into the whole life costing section of OVID-BV. In addition a system of KPI's are currently being devised from information held on OCT which combined with the contractor's bid proposals could be used to assess both the meeting of targets during the currency of a project and continuous improvement over several projects (See section 6.2.1).

Figure 5.1 Martin Associates Online Collaboration Tool



Finally, in order to make OVID-BV completely accessible to Martin Associates client base it needs to be converted into a CD format so that it can be run on any computer at any location as ,currently, the software programme needs to be downloaded from the web which at least one RSL found slightly problematic to do so. It also requires a set of instructions reflecting the 8 step methodology to be produced as, to date, OVID-BV has always been used in the presence of the researcher and it needs to be converted into stand alone software to realise its full commercial potential.

5.3.3 Implications for the Wider Industry

OVID-BV has the potential to be used not only on best value tender assessments in the social housing sector but the approach can be applied to other subjective decision making processes within the public sector. Clearly if it were to be applied in other areas then there would need to be understanding of the need for the chosen attributes to be mutually preferentially independent of one another as the attributes contained on OVID-BV's drop down menu relate solely to the social housing sector.

Clearly, the successful implementation of a new tool within a business environment takes more than simply buying and installing the software. This research has benefited greatly from the support of the Industrial Sponsor who have managed and orchestrated the use of OVID-BV to meet their business needs. The true commercial test of OVID-BV will be when it is produced as a CD and is used in environments where it does not benefit from the support of both the researcher and the industrial sponsor. In these situations it is believed that OVID-BV will be most successfully used when the organisation that implements it realises it is a solution to a business need rather than simply another piece of software.

5.4 OVID-BV EVALUATION FINDINGS

The evaluation process was carried out in two phases. In the commercial application of OVID-BV the 8 step process was explained and demonstrated to decision making groups prior to its use. Verbal feedback was then received from the users after the evaluation task had been completed. The decision making groups have comprised representatives from; RSL's, the industrial sponsor, construction consultants and end users. Each user was then given a questionnaire so that they could score the performance and utility of the support tool (See Appendix I).The questionnaire addressed the functionality of OVID-BV and its contribution to the overall decision making process.

5.4.1 Functionality of the System

OVID-BV was rated as effective at facilitating the tender evaluation process. The respondents thought it was of assistance to the tender analysis and made the evaluation process, as a whole, more efficient. The users agreed that it was an improvement on existing systems which either used 'pen and paper' or results were recorded using an Excel spreadsheet. They were particularly enthusiastic about comparing and scoring the value attributes on a level playing field. Whilst the concept of the utility function is, understandably, difficult to explain, the users could relate to the concepts of preference and belief with respect to the choices they had to make. Therefore in order to assist the users understand how OVID-BV implements the utility function a straightforward explanation of decision making under uncertainty has been developed which presents the five main elements of the mathematical decision problem in a familiar context to the user. The example relates to the decision

of whether or not to carry an umbrella and the comparison exercise used is shown in table 5.2

Table 5.2: Decision Making under Uncertainty.

Element of the decision problem.	**Contextual Explanation**
A set of acts	The decision whether or not to carry an umbrella
A set of states	It will either rain or it will not rain
The consequence function showing the outcomes under all combinations of acts and states	There are 4 possible outcomes i.e. an umbrella is carried and it either rains or it doesn't or an umbrella is not carried and it either rains or it doesn't.
Probability Function.	The belief as to the likelihood of the outcome.
Utility Function	Measuring the desirability of the different possible consequences i.e if a strong belief is held that it is going to rain then a rational response would be a strong desire to carry an umbrella.

The five elements are then discussed with the users in relation to the scoring of a single attribute in a contractors bid proposal. In this way the users began to appreciate that scoring a contractors bid proposal is not simply a matter of analysing the information provided within the bid but is also based on the users own personal experience and heuristic opinions and beliefs. Finally, the evaluation process found that the use of uncertainty was welcomed as it was felt that it reflected the reality of the process. None of the users had used a tender evaluation system incorporating whole life costs before.

5.4.2 Interface

The second part of the questionnaire related to the usability of OVID-BV and its interface with the external data sources. Some difficulties were encountered with

using Constructing Excellence's web based KPI Zone though this may have been due to the user's unfamiliarity with the system. The contractors tender costs were also benchmarked against historical cost data held on the Industrial sponsors web based database and this was found to be relatively straightforward to use though the representatives of the RSL's had used the system before.

5.4.3 General Comments

A number of the general comments on the returned questionnaires were very positive. For example one resident had found comfort in the fact that the system was founded on uncertainty as it was the first time they had been involved in a tender assessment procedure and the aim of deciding upon a contractor to undertake work to their block of flats had made them anxious. Others liked the adaptability of the software, in that value attributes could be added to the drop down menu so that specific attributes to address project specific issues could be included if necessary. A print facility was included in the software in response to a suggestion put forward so that hard copies of the results could be placed on office files as required. .

CHAPTER 6: CONCLUSIONS AND FURTHER RESEARCH

6.1 INTRODUCTION.

This chapter summarises how the original aim and objectives of the research project have been met, sets out the contribution to knowledge made by the research and, concludes by briefly describing the on-going research that is currently being undertaken.

6.2 SUMMARY AND CONCLUSIONS

The main aim of this research was 'To develop a transparent and auditable approach for a tender decision support tool to assist in analysing UK Best Value decision making'. In order to do this five specific objectives were defined;

1. Identify the unique characteristics of Registered Social Landlords as a construction client within the social housing sector.
2. Identify the problems and challenges generated by the introduction of best value within the sector.
3. Establish a set of core value attributes assessed during the tender analysis process.
4. Develop a transparent and robust method for measuring best value.
5. Develop a generic software tool to provide a transparent and commercially effective audit trail of the best value analysis process and validate the tool by pragmatic application.

The research achieved the overarching aim and all of the stated objectives as detailed in the foregoing chapters of the thesis. The following are the main contributions of the research;

- Establishing a set of ten core attributes that could be used by RSL's in the best value tender analysis process to make it more efficient and less time consuming.
- The innovative use of a mathematical representation of uncertainty to underpin the assessment and measurement of value attributes in a best value decision making process.
- Development of a transparent, inclusive and auditable tender evaluation methodology for use in the social housing sector that complies with the OGC's definition of best value.
- Development of a commercial solution and production of software which embraces the acknowledged challenges and problems caused by the implementation of best value in the UK social housing sector.

From these main contributions it can be seen that the primary objectives of the research were satisfied. The first phase of the research reviewed the history of the development of the social housing sector and identified the unique characteristics of RSL's when acting as a construction client. (Objective 1). The literature review and case studies revealed the problems and challenges that have been caused by the implementation of best value both in the UK and internationally (Objective 2). The second phase of the research asked social housing sector stakeholder's to respond to a postal survey questionnaire with respect to the relative importance of the value attributes considered during a best value tender analysis. The collected data was analysed using PCA to detect an underlying relationship between the attributes which

led to ten core attributes being established (Objective 3). In parallel with this a state of the art review was carried out of MCA techniques and contractor selection models from which it was decided to use uncertainty in decision making and the expected utility rule to measure and compare the value components of contractors bid proposals (Objective 4). Finally the approach was developed through trialling and commercial application to produce windows based software that could be used to evaluate the best value decision making process in a transparent and recordable format (Objective 5).

6.2.1 Contribution to Knowledge

This research is the first which has developed a tender analysis approach that complies with the UK Government's definition of best value in analysing the combination of quality and whole life costing. It is the first time that a generic set of core value attributes of best value tender bids have been identified with respect to the social housing sector. Whilst the use of the 10 identified attributes is not prescriptive it does provides RSLs with the opportunity to standardise the project specific criteria that are assessed during the tender analysis which, potentially, means that they can (a) carry out the high volume of tendering in an efficient and effective way and (b) identify and preserve the organisations value thread from a corporate level to an individual project level. Finally, though it is not the first time that MCA techniques have been used in a contractor selection framework, it is the first time that the assessment mechanism has embraced the use of uncertainty in decision making and a utility function has been used, commercially, to compare different attributes on a like for like basis. The results of OVID-BV's evaluation have shown that the users have been able to identify with the concept of uncertainty as it reflects the way in which

best value tender bids are usually assessed. This also has the potential to assist non professional stakeholders in making a meaningful contribution to the tender analysis process.

6.3 RECOMMENDATIONS FOR FURTHER RESEARCH

Though OVID-BV is in a position where it can be used with confidence within the social housing sector it is very much a work in progress and this section sets out those areas of its operation which need to be improved and are the subject of on-going research and investigation.

6.3.1 Continuous Improvement

One of the core tenets of best value is its commitment to continuous improvement and the operation of OVID-BV reflects this fact. A system is being developed to link the scoring of each attribute to key performance indicators (KPIs) which measure factors critical to the success of projects. Currently the KPI's being used are those set out by Constructing Excellence. Following both the Latham and Egan reports a number of cross industry bodies were set up to drive change; these included the Reading Construction Forum, Movement for Innovation, Rethinking Construction, CCG and the Housing Forum. In order to streamline the effort involved all these bodies have now been united as Constructing Excellence to form an influential voice for improvement in the built environment sector. Each year they publish KPI's using performance data collected from across the UK construction sector by the Department for Business Enterprise and Regulatory Reform.

The scoring methodology which has already been used in practice (See Paper 2 Appendix B) is based on the fact that benchmark scores produced from KPI's are stated as percentages and are an indication of performance relative to the whole construction industry. If a benchmark score for a specific contractor is given as 49% this means that 49% of projects nationally have equal or lower performance and 51% of projects have higher performance (Constructing Excellence 2006). For example if the estimated annual energy use for a refurbishment scheme is 919kg CO2/ 100m2 then by using the Constructing Excellence 2006 KPI Graph this equates to a benchmark score of 65% which will probably be deemed acceptable within standard contract specification. The tender panel can then assess from the content of a contractors bid submission their belief as to whether or not the contractor could deliver the stated quality standard and can score the submission accordingly. The benefits of using this scoring method are envisaged as:

(a) A contractor will provide realistic technical details including calculations to support their bid submissions.

(b) It encourages the contractor to utilise their specialist knowledge for the benefit of the client and end user.

(c) The KPI forms the basis for both monitoring the contractor's performance and providing feedback to drive continuous improvement.

(d) The scorecard highlights potential anomalies in the assessment of the bids. If a contractor has stated they could achieve a high KPI percentage score, say 95%, for a particular attribute but are only awarded a low performance score, say 8 or less, this will be highlighted and can be discussed further between the tender panel members.

(e) It is acknowledged that the scoring system is subjective, as it must be if it is to embrace the concept of uncertainty, but it is based upon quantifiable measures i.e. KPI's and Utility.

(f) There is no problem if an attribute cannot be assessed against a KPI as the core purpose of using expected utility is that attributes can be assessed on a 'like for like basis' regardless of the original units of measurement.

Similarly another strand of this research is being undertaken to move away from the subjective scoring of an attribute using KPI values and try and link the KPI percentage to a particular score on the 0-20 scale currently being used. However even if this can be achieved it is acknowledged that it may not be possible to link all the attributes with a specific KPI and the scoring will remain, for these attributes at least, subjective. Similarly further research needs to be undertaken to bottom out the differences that occur when individual decision makers' decisions are used instead of using the unitary group approach as put forward by this thesis.

6.3.2 WLC and Optimum Combination with Quality

Currently there are two limitations with the WLC function of OVID-BV;

- Whilst it does carry out a sensitivity analysis on the results of WLC using different variables it does not collate and show the results of the analysis. The software consultant is currently working on a results screen that shows how the results of the WLC change as different elements of the tender are considered and various interest rates and different elements repair costs are inputted.

The sensitivity analysis is also being adapted so that it can illustrate to the tender assessment panel the results when assessed at different ratios of quality/price. Currently this is being undertaken using Microsoft Word Tables (See Section 4.6.1 and Appendix G).

- For clarity OVID-BV does not calculate the complete WLC for the subject properties but shows how the WLC would be affected by the contractors bid costs for various elements of the works.

Finally, the standard limitations of WLC are also recognised in that although the techniques for WLC have existed for many years, there has been relatively little success in applying these techniques to construction projects. The barriers to implementation have been identified as follows; unavailability of suitable data, the short-term interest of clients, taxation issues, and lack of clarity of professional fees (Pasquire and Swaffield 2002).

6.3.3 Risk

Section 4.5.3 sets out the graphical representation of the utility function in considering different risk scenarios. Currently OVID-BV has a default setting of risk neutral which is represented by a straight line but, clearly, if the scores were to be measured from a convex or concave curve i.e the decision makers are risk prone or risk averse then the results and ,as a consequence the rank ordering of the contractors, may change. Therefore the system is currently being developed so that the results can be assessed under all conditions of risk. Section 4.5.3 has already shown that the most desirable choice corresponds to the highest utility which has a score of one [$u(x_i) = 1.0$], whereas the least desirable corresponds to [$u(x_i) = 0$] and it also introduced the

concept of the certainty equivalent. In the risk averse attitude the value of the certainty equivalent, $\hat{x}$ (which corresponds to a utility of 0.5) is less than the average value of the attributes' limits ($\hat{x}_L$ and $\hat{x}_U$). In the risk averse case $\hat{x} \leq (x_L + x_U)/2$ must be satisfied. The utility function that represents this attitude can be recognised as an exponential function u (x) = ae^{bx} + c where the co-efficients a, b, and c are determined by satisfying the conditions at: 1) lowest utility; 2) certainty equivalent; and 3) highest utility. Similarly the risk prone attitude can be expressed by a logarithmic function u(x) = aln (x+b) +c (Marzouk and Mosehli 2003). Alternatively the certainty equivalent can be determined by a question and answer session with the decision makers in order to establish their attitude to risk (Hatush and Skitmore *ibid*). Currently the researcher is assessing whether or not the risk averse and risk prone curves can be expressed as exponential and logarithmic functions under the condition of uncertainty.

6.3.4 Attribute Selection

As previously stated in section 4.5.3 a limitation of using the additive form of the utility function is that it is only appropriate to do so when the condition of mutual preferential independence of the attributes is satisfied i.e. a decision maker's preference for one attribute is not affected by their preference for another attribute. Currently the attributes in the drop down menu conform to the necessary condition, however, the add function allows the possibility that a project team could add an attribute that would not comply. However even if this were to occur a sensitivity analysis would need to be undertaken to assess whether or not the ranking or scoring of contractors would be different.

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APPENDIX A: PAPER 1.

FULL REFERENCE

Phillips, S, Martin, J, Dainty, A and Price, A (2004). Assessing best value in social housing procurement. *Proceedings of the COBRA/RICS International Construction Conference "Responding to Change".* Leeds, UK. September 7-8, 2004.

ASSESSING BEST VALUE IN SOCIAL HOUSING PROCUREMENT.

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ABSTRACT

The Governments' promotion and support of Best Value within the Social Housing Sector has been a prime catalyst in the move by Registered Social Landlords away from the traditional culture of acceptance of the lowest bid towards consideration of both price and quality criteria as a basis for contractor selection. Although the driving principle for this trend is clear, Social Housing operates within a very particular regulatory framework that requires the selection methodology and rationale behind the decision making process to be both transparent and capable of audit. The selection procedure must also provide benchmarks against which the contractor's performance can be effectively measured and continuous improvement can be assessed as the contract proceeds on site. Manifestly this radical change in the way the sector procures its construction services has forced many of its stakeholders to undergo significant cultural and organisational changes within a relatively short period of time, and problems have developed during this transitional period that have affected the efficiency of the best value process. The paper assesses the current position of this transitional process and suggests further research that would assist in addressing the difficulties that have been encountered.

The research has shown that the effectiveness of best value tendering has been diminished for a number of reasons including; poor understanding by the stakeholders of the basic principles of best value tendering and failure to produce audit trails that record the decision making process or don't bear third party scrutiny especially with respect to the measurement of the subjective component of value. Two case studies also recorded that these difficulties have lead to legal challenges, which have directly caused the client organisations involved to suffer financial loss. These results have lead to the development of an ongoing research methodology that aims to refine a tender mechanism that transparently links the client's value system with the procurement process. This would create a formal relationship between the formation of corporate strategy and policy subsequently becoming part of the contractor selection procedure. The overarching objectives of this ongoing research seek to establish a hierarchy of value attributes by the use of factor analysis and produce an innovative contractor selection model based on decision theory. The ultimate aim is to develop a model that can be applied towards to any construction procurement process within the social housing sector.

Key Words: Best Value, Client Value Systems, Value Thread, Social Housing.

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INTRODUCTION.

The global concept of revaluing construction has been applied to many sub sectors of the UK Construction Industry including the public sector. During the latter half of the 1990's the procurement of construction services within this sector were characterised by a paradigm shift of culture away from acceptance of the lowest bid tender towards selection of the contractor perceived by the client to offer best value to any specific project. Since then "value for money" and "best value" has been the subject of numerous research projects ranging from the selection of contractors by value (CIRIA 1998), the correlation between best value and value management (Kelly and Male 1999), the benefits of value management for the social housing sector (Building Research Establishment 2000) and more specific research into a value management approach to aligning the project team to the client's value system (Kelly and Male 2001) and the definition of value from a contractors perspective (Langford *et al* 2003). There have been a number of seminal texts published outlining how best value and value management may be generically implemented into construction projects (Griffith *et al* 2003, Kelly *et al* 2003) with other texts more specifically focusing on the public sector (Thomas Cain 2003) and on the social housing sector *per se*. (European Construction Institute 2000). Underpinning all these documents is the theme that a new culture of collaborative working can generate value and that this can, initially, be implemented as a "hearts and minds operation" by a series of workshops involving all the project stakeholders and organised by a facilitator who manages the value-management process. The critical success of these workshops is dependent upon; a degree of value-management knowledge on the part of the participants, participant ownership of the value management process output, senior management support for value management and a plan for implementation. (Kelly and Male 1998).

By its very nature the research undertaken to date has, predominantly, been typically generic with systems being produced that can be applied to a range of client organisations and procurement strategies throughout a cross section of the UK Construction Industry. It is almost self-evident to state that for the effectiveness of best value tendering to be realised the application of value management techniques must be reviewed with respect to specific sectors and must take into account the pragmatic constraints and pressures on resources that are prevalent within that sector. The social housing sector was chosen to be the subject of this research as the culture of best value and collaborative working has been imposed upon it by legislative changes rather than a desire to change being driven from within by the sector's client organisations. Historically, there is an acknowledged problem with large public sector organisations embracing change (Thomas Cain 2003) and it is against this background that the implementation of best value must be reviewed in order to assess the effectiveness and efficiency of the current mechanisms that are in place. This research has become even more pertinent with the publication of the recent government review into housing supply, which advocates an increase in the provision of social housing by 26,000 new homes each year, 9000 of which are required to make inroads into the existing backlog of need. (Barker 2004). This will have the effect of further stretching already limited available resources within this sector.

Prior to outlining the methodology of the research brief details are provided for those unfamiliar with the social housing sector.

THE SOCIAL HOUSING SECTOR

The social housing sector is responsible for a programme of construction, maintenance and refurbishment works, which is annually valued at £1 billion GBP (DTI 2003). Social Housing provision within the UK operates under the umbrella control of two main arms, the first being the housing provided and managed by Local Authorities (commonly called council housing) and the second being the housing provided and managed by Housing Associations and other organisations, which together form the "voluntary housing movement". The welfare of these housing associations falls under the umbrella control of the Housing Corporation, which is a central government financed quango formed under the 1964 Housing Act to promote and assist the development of housing associations. The Housing Corporation has the powers to provide loans to housing associations for development schemes and most associations have received such a subsidy (Stewart 1996). There is no typical profile for the housing stock of these two providers, as social housing is provided in a variety of building styles and in a huge range of locations (Harriott and Matthews 1998). The term "registered social landlord" (RSL) is used as a collective term for both housing associations and local authorities alike as providers of social housing. Two features that the majority of RSL's share is that (a) they are regular procuring clients to the construction industry and (b) their corporate strategy and operational procedure is shaped and regulated by Government policy which has allowed these organisations to be used as key drivers for the behaviour of the UK Construction Industry.

The adoption of best value by the social housing sector can be attributed to political influence and the redrafting of legislation rather than a genuine desire to change which has been culturally driven by the internal corporate policy of the individual RSL's. The best value regime was introduced at a local government level by way of new legislation on the 1st April 2000; it applies to all public services controlled by local authorities and requires local councils to review, develop and to show continuous improvement with respect to their procurement strategies in terms of their efficiency, effectiveness and economy. In August 2000 the Housing Corporation also showed its commitment to the use of partnering in the procurements process "provided it [partnering] is implemented in a well-planned way that demonstrates value for money and addresses the issue of probity."(Housing Corporation 2000). By 2003 the Corporations expectations were that "all registered social landlords' construction activity is to be Egan Compliant and they will only provide funding for registered social landlords that have achieved Client's Charter Status. (Housing Corporation 2003) In other words, unless an RSL under the umbrella control of the Housing Corporation can demonstrate that it implements its procurement process in compliance with the ethos of collaborative working and value for money objectives, it will not receive grant monies to carry out the required works.

RESEARCH

Whilst it is acknowledged that the cultural sea change that organisations need to undergo to implement best value practices and techniques is one that will take time to be successfully adopted by the stakeholders involved, both the Government and its quango, the Housing Corporation, have presented the RSL's with a *fait accompli*

regarding the adoption of the best value process. Rather than allowing this culture of change to evolve at a natural pace the whole of the change process has been aligned to political timetables whether it be local government best value reviews or Housing Corporation led compliance requirements. The pressure placed upon RSL's to adopt and successfully implement best value has been exacerbated by the aspirations and expectations of a plethora of Government reports (Rethinking Construction 1998, Modernising Construction 2001 and Accelerating Change 2002) recommending that;

(a) Public sector bodies become best practice clients and substantially improve the way that the public sector procures construction while still meeting the need for public accountability.
(b) Set quantified strategic targets that include annual reductions in construction costs and delivery times of 10% and reductions of building defects of 20% per year. (This has recently been restated as 20% savings across the board on all local authority construction projects by 2009/10(Local Government Task Force 2004)).
(c) Demonstration projects be undertaken so that RSL's can share, throughout the social housing sector, their good practice, which has resulted in the successful achievement of the strategic targets. (Constructing Excellence 2003)

As Best Value has only relatively recently been introduced into the social housing sector there is a paucity of research into problems that RSL's have encountered whilst embracing this ethos of change and the initial hypothesis is that if Best Value is to be adopted by the sector in an effective, economic and efficient fashion then the initial problems caused by its implementation must be analysed, addressed and eliminated (or at the very least, diminish their effect on the business value case). The starting point for the research was to;

(a) Undertake a comprehensive literature review to assess the problems that RSL's have encountered during the implementation of the new tendering process. In particular the research investigated whether existing best value tender mechanisms could effectively and demonstrably assess value in the way demanded by the sector with respect to probity and transparency and,
(b) Two case studies were undertaken with respect to RSL's that were engaged in a dispute resolution process due to anomalies around their best value tendering procedure. (Phillips 2004).
(c) From reviewing the results produced by (a) and (b) it was decided to review the definition of the concept of best value within the social housing sector.

Best Value Tender Mechanisms

A review was undertaken of the existing literature relating to best value procurement encompassing research papers, technical documents and law reports to ascertain the effectiveness of current best value tender mechanisms. A number of factors that were causing construction practioners difficulties during best value tender evaluation with respect to design and build contracts were; (Griffith *et al* 2003):

- Insufficient time to conduct a relatively standard tender evaluation process.
- The Clients value system needs to be made explicit.
- Contractors have a negative perception that the best value tender interview is a game of appearance and marketing skills.
- Costs should ideally be considered on a whole life basis and not simply capital cost.

A further problem area is that though RSL's understand the principle of best value tender selection with respect to establishing the hierarchy of value of each individual criteria assessed and that they also understand the importance of weighting the attributes with respect to their relative importance to the clients value scheme there is an underlying mathematical weakness within the tender mechanisms that can be manipulated by contractors (if they choose to do so) so that they can inflate the cost of the works and still be awarded the contract by virtue of the evaluation of their tender submission regarding the quality attributes. (Jones and O'Brien 2003).

Legal Challenges to the Concept of Best Value

The best value concept has already been challenged in the UK court system and at arbitration tribunals with the most well known case being *Harmon CFEM Facades (UK) Ltd v The Corporate Officer of the House of Commons* in which the Court of Appeal held that the phrase "overall value for money" was both nebulous and imprecise and made the judgement that where the term "best value" or "value for money" is not specifically defined or recorded then the contract should be awarded on the basis of the lowest bid. As part of the research two descriptive case studies were undertaken of RSL's that were involved in a dispute resolution process due to anomalies around their partnering and best value tendering procedures (Phillips 2004). The case studies were based on a typology design (Yin 1993) and both identified the best value process undertaken by the RSL's and recorded the consequences of their procedural actions. It is intended that these two initial studies will be part of an ongoing development of a case study database in order to enhance the validity and reliability of the findings. (Fellows and Liu 2003). In the first study the arbitrator held that the RSL could not recover costs as they could not provide any credible evidence to show that the contractor had been engaged on the basis of a best value tender nor could they provide an audit trail to support and underpin their reasons for selecting the contractor on both a price and quality basis and in the second case the arbitrator found in favour of the residents on a number of grounds including the fact that the RSL had not acted in a reasonable manner during the contractor selection process because (a) the tender sum had not been benchmarked against other similar projects and (b) price /quality ratio within the CIRIA framework (CIRIA 1998) can be manipulated to allow the contractor to inflate the price and yet still be the successful tenderer by scoring highly on the quality factors.

Value and Social Housing.

It was clear from the results of the literature review and the case studies that there is a fundamental problem with; how the term "best value" should be defined, the inherent nature of the decision making process that is involved in a best value tender analysis and how it should be recorded to withstand audit scrutiny. Whilst, from a global viewpoint there may be no commonly agreed definition of "best value" (Choi 1999) the UK Government has defined it as;

"The optimum combination of whole life cost and quality to meet the users requirements. Long-term value over the life of the asset is a much more reliable indicator than lowest cost and it is the relationship between long term costs and the benefit achieved by clients that represents value for money". (Office of Government Commerce 2003).

The Housing Corporation has produced a similar definition with respect to the procurement of construction services by housing associations;

" Procurement in the context of property development, regeneration, and maintenance services is the activity by which a housing association obtains its buildings and properties taking account of price, quality, time and sustainability to deliver overall best value."(Housing Corporation 2003). The Housing Corporations regulatory code also states that housing associations must aim to deliver continuous improvement and value for money in the service they provide (Regulatory Code paragraph 3.3) and that associations should use Best Value techniques to:

- Challenge what they do and how they do it.
- Make comparisons with others;
- Consult people affected by their services;
- Establish that value for money is obtained.

The definitions highlight the difficulties that RSL's encounter at the point of tender analysis. The new objectives are, self evidently, a significant departure from the concept of acceptance of the lowest bid as they introduce several new factors that have to be considered during the bid analysis process such as; long term value, benefit to be achieved by the client, users requirements and value for money. None of these terms has a standard definition that can be readily understood and agreed upon. The concept of value itself can be defined from any number of different perspectives and the definition that sits most appropriately with best value is that value is the intrinsic property to satisfy. (Kelly *et al* 2002). This definition is helpful to understanding the analysis of a best value tender submission in that it readily identifies the complexity involved in making a decision by a group when each individual within that group will have their own inner preferences which they will subjectively recognise (Woodhead and McCuish 2002). Due to the transparency, accountability and probity that needs to be demonstrated in a social housing sector tender mechanism it is clear that individual preference and belief will be difficult to measure and record in a meaningful way. In this respect there are two components to value (Kelly *et al* 2004); the objective component of value, which can be defined by hard evidence such as cost or price, but the second, subjective component of value, is more difficult to define explicitly. It derives from the group making choices about cost and price and the benefits and satisfaction derived or expected from the end product. This process is further complicated by the fact that decision makers rely upon both intuition and formal models in order to assess their preference choices. Intuitive thought is not the opposite of rational thought (Isenberg 1985) but is the acknowledgement of some "gut feel" about a situation and the best course of action to take. Intuition may well stem from experience built up over time in a particular area of work, but reliance upon "gut" feelings frequently results in poor decision-making. (Flanagan and Norman 1996). Good decisions will be founded upon a balance of sound analysis, intuition and heuristic bias. In any event the central issue to be addressed is that however the cognitive structure of the individual decision maker is made up or whatever factors may or may not be taken into account in the value decision process it is a pre requisite of best value practices within this sector that this subjective component of value be measured and that the records produced be capable of withstanding an external or third party audit process. A suitable formal approach to measuring a decision maker's attitude towards subjective value is to use utility theory and, more specifically, the concept of expected utility. In general terms the utility theory says that when individuals are faced with decisions in uncertainty they make choices as if they individually wish to maximise a given criterion, the expected utility. In best value

tendering the expected utility can be defined as the individual's preference for each (and between each) of the factors that contribute to form the subjective value attributes of the clients value system. Whilst it is usual that this measure of expected utility be numerically represented by a monetary value this doesn't have to be so and it is proposed that monetary values or equivalents are not used in best value multi attribute analysis as it may lead to confusion as, manifestly, the objective component of value must be measured in monetary terms.

The research also highlighted a criticism made by stakeholders that the clients value system was not explicit enough. Whilst, *prima facie*, this could be as a result of ill prepared or ill-defined clients requirements it could also a problem of perception, in that the attributes that make up the value system are not readily apparent to all the stakeholders or it hasn't been communicated accurately throughout the organisation and the values system has subsequently become distorted. Whilst best value has been introduced to stimulate innovation of construction practice due to the inherent organisation and role in the economy of many RSL's there is an argument for standardisation of the core or crucial attributes of an RSL's value system in order to economise the time taken to produce such a system.

Conclusions and Ongoing Research Proposals.

The research has shown that the introduction of best value within the social housing sector has encountered difficulties caused by a variety of factors. As an overview the implementation of best value is a time consuming process due to the new value management procedures such as stakeholder participation workshops and the volume of ideas that need to be understood and then absorbed by the practioners within the social housing sector. The public sector is not renowned for its willingness to change and yet the Government has decided that not only should the RSL's be an integral part of this change process but that they should lead the way for this change by becoming best practice clients. The problems that RSL's would have naturally encountered within any process of change have been exacerbated by the legislative change that makes best value procurement a requirement within local government and the political influence that has made the payment of grant monies conditional upon the adoption of best value and value for money procurement processes by housing associations. Setting aside some of the rhetoric that has been produced by the results of the best value demonstration projects it is not surprising that the pressure situation created by the government intervention within the social housing sector has created the acknowledged problems of; lack of time to undertake the necessary workshops or carry out correct tender analysis procedures, consultants being accused of having insufficient knowledge of value management techniques, and the creation of poorly defined client value systems. These acknowledged problems have, in certain cases, been the subjects of a legal challenge, which has resulted in the client organisation being unable to recover monies due or having to pay substantial damages to a contractor. These problems can only become magnified if, as expected, the Government releases more money into the sector as a result of the Barker report compiled around the issue of UK housing supply. These problems are compounded by the fact that by its very nature best value tender analysis is a subjective process and yet the demands of the public sector are that these subjective decisions and evaluations made at corporate and project level must be both transparent and accountable. Clearly there is a need to provide a method of assessing and measuring

the subjective component of value so that the preferences and choices made at tender stage can be recorded in a format that can withstand audit scrutiny. A suitable formal approach to measuring a decision maker's attitude towards subjective value is to use utility theory and, more specifically, the concept of expected utility.

Therefore it is proposed that in order for these problems to be addressed and that the effectiveness and efficiency of best value tendering to be enhanced there is a need to develop a model for a best value contractor selection mechanism that, ultimately, can be applied to any procurement process within the social housing sector. There is a need to formulate an innovative contractor selection mechanism that is:

(i) Transparent;
(ii) Open to, and able to withstand, a third party audit process;
(iii) the clients value system is clearly stated;
(iv) Assesses both the subjective and objective component of value;
(v) Mathematically robust;
(vi) Assists the user group in the selection procedure.
(vii) Provide a base line for assessing continuous improvement throughout the life of the project.

Due to the distinct characteristics of the Social Housing sector, most RSL's and their stakeholder groups will have number of common factors with respect to their value systems. Not only do RSL's have common social drivers and objectives many RSL's are also characterised by their regular procurement of volume construction services and the standardisations and harmonisations in terms of components, design and construction techniques that exist on a project to project basis .It is proposed to establish a set of core attributes using factor and principal component analysis that can be used to standardise best value tendering mechanisms in order to reduce time and cost of the tendering process. It is anticipated that the establishment of the core attributes will provide a stable base for an RSL's value system and will form part of a value thread that will transparently link the RSL's value system with the organisations best value tender process. Whilst the objective components of value such as price and cost can be measured in monetary units it is proposed that the subjective components of value be assessed by a utility measure to establish an auditable hierarchy of tender attributes. These attributes should transparently link with the RSL's corporate value system so that value thread is preserved from a corporate or strategic level into the project phase of the works.

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APPENDIX B: PAPER 2.

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UNCERTAINTY IN BEST VALUE DECISION MAKING

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ABSTRACT.

The sheer volume of decisions taken within the public sector procurement process prevents perfect and complete information being obtained and applied to every best value tender analysis that is carried out. As such, uncertainty must be accepted as a feature of the best value decision-making process. This paper reports on research which is developing a methodology for utilising the uncertainty component in best value tender analysis in order to create a more transparent decision making process. The main output of the research is the production of a robust support tool which aids the multi objective decision making process within the public sector of the UK construction industry by provoking rational discussion with respect to; the industry's key performance indicators (KPIs), the client's attitude to risk and provides a transparent audit trail of the decisions taken. The underlying rationale for the support tool is based on a combination of the analytic hierarchy process (AHP), multi utility attribute theory (MAUT) and Whole Life Costing (WLC). The paper demonstrates the practical utility of the methodology of the tool through a tender decision process.

Key words: uncertainty, audit trail, transparent, subjectivity, utility function, risk.

INTRODUCTION.

Best Value has sought to establish positive-sum trust–based relationships of service quality enhancement (DETR 1997). An important objective of best value in the UK is to secure further improvements in the procurement process with respect to the efficiency and effectiveness of service quality through the creation of a more supportive regulatory environment. This represents a significant departure from traditional lowest bid tendering and introduces new variables into the decision making process. It involves the identification of those attributes which represent value to a particular client on a specific project and measuring those crucial components the contractor/bidder must be able to offer and deliver if they are to add value to a project. A transparent, open and fair procurement process is essential to attracting bids that provide the optimum combination of whole-life cost and quality. All decisions should be based on measures that are justifiable in terms of the performance of the service specified under the contract. Authorities should therefore have clear procurement strategies, procedures and written policies for evaluating tenders (DETR *ibid*). Auditing involves both protecting the expenditure of public money and ensuring that the required quality of service is given, and so all processes must be open to scrutiny, which is endorsed by the HM Treasury Procurement Guidance No 5 that states:

> *"Good clear records must be maintained to demonstrate how the parties have worked together to reach decisions, how best value has accrued and probity and propriety have been maintained. It is essential to be able to demonstrate proper accountability".*

The public rightly demands outstanding value for the money it puts into public services (Audit Commission 2005). As such, a failure to analyse a best value tender in a transparent way, which illustrates how the clients objectives and value system has been considered as part of the contractor selection process, can lead to the courts awarding damages to unsuccessful contractors involved in the tender bid. An example is the case of *Harmon CFEM Facades (UK) Ltd v. The Corporate Officer of the House of Commons 1999 CA*. This dealt with the best value tender of the cladding package for Portcullis House. The court held that the phrase "value for money" was "nebulous and imprecise" and, consequently, awarded Harmon £7.4 million pounds in damages. Arbitration tribunals have also found against Local Authorities and Housing Associations where best value cannot be demonstrated as part of a tender analysis process (Phillips *et al* 2004). This underscores the importance of public sector organisations developing transparent procedures for evaluating tender bids.

The problem of public sector organisations considering how to choose and measure the plethora of attributes that can make up any specific definition of value is exacerbated by the parameters set by the government's definition of best value which states;

> *" [Best Value is] the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements, as it is the relationship between long-term costs and the benefit achieved by clients that represents value for money."* (Office of Government Commerce 2003).

In essence this means that the benefit derived by the client from the subjective quality component of each bid must also be quantifiable and measurable to ensure that probity of the process prevails. The difficulties being encountered are exacerbated by the number and diversity of best value attributes that can be considered by the various stakeholder groups (Austin 2005). In addition there is an acknowledged problem with large public sector organisations embracing change (Thomas Cain 2003). As such, the premise of this paper is that, in order to assist client organisations such as Local Authorities and Housing Associations to adjust to this statutorily imposed cultural sea change there is a need to formulate a generic decision process model, which endeavours to represent the preferences of rational individuals and/or groups undertaking a best value analysis using the definition supplied by the Office of Government Commerce (OGC). The model outcome is a decision support tool rather than dictating a precise result for the decision making process. Manifestly, the tool cannot and should not replace management review and judgement.

BEST VALUE AND UNCERTAINTY.

One of the effects of the implementation of the recommendations of Government reports such as Latham (1994) and Egan (1998) has been the introduction of long term partnering and collaborative contracts within the public sector. Consequently tender panels are being asked to assess the suitability of contractors with respect to lengthy time periods, sometimes in excess of 5 years. It is also likely that time and cost restraints, will prevent the decision makers from obtaining complete information prior to selecting the most suitable contractor. Therefore rather than asking decision makers to be precise, this paper suggests that client organisations should promote the

concept that decision–making is an arena of imperfect or uncertain information involving; the future, change, human action and reaction. The hardest part of client organisations advocating this type of shift will not be in developing the techniques or tools to analyse risk and uncertainty, but in accepting that life is uncertain (Flanagan & Norman 1996).

Arguably, the only method of quantifying this uncertainty factor is to provide it with a full mathematical representation, which, in essence, comprises three components: axioms specifying the formal properties of uncertainty; interpretations or operational definitions; and measurement procedures for interpreting the axiom system (Bedford and Cooke 2003). The representation addressed in this paper is known as the rational decision theorem and the mathematical axioms that characterise rational preference can be examined by referral to LJ Savages seminal work (Savage 1972). However it is acknowledged that no formal representation can completely cover all aspects of an informal concept such as uncertainty.

The theorem of rational decision developed by Savage traces uncertainty, or partial belief, back to the notion of rational preference. Savage proves that rational preference can be uniquely represented in terms of a utility measure and subjective probability. Generally the degrees of belief held by a decision maker can be represented by probabilities. These will be inherently subjective as preferences may shift in the future and each individual will have their own cognitive structure made up of heuristics and biases which influence the way issues will be perceived and resolved. It is accepted that some bias is inevitable and the likelihood of not biasing is, essentially, nil (Keeney 1992). Utility is a measure of desirability or satisfaction and

provides a uniform scale to compare the clients various value attributes against each other; in general, it provides a method of comparing manifestly different types of attributes on a ‘like for like’ basis.

In Savage’s theorem, the consequence of a choice being made is defined as a “state of the acting subject”. This can be related to best value tender analysis as the act of choosing to engage a contractor must lead to a consequence (i.e. a social gain or a loss, which will also depend on the unknown state of the world). It is important to note that in Savage’s sense the consequences are ‘the awareness of having made a social gain’ or the ‘awareness of having incurred losses’. In essence this replicates the decision making process undertaken by a tender panel, as the panel can never accurately predict how a contractor will perform, but they can form a belief as to how successfully the contractor may complete their contractual obligations if they were engaged to do so. Distinguishing states of the world from states of the subject in this way is crucial when deriving a representation of preference. The limitation of this approach is that in Savage’s model any ‘vagueness' on the part of the member of the tender panel is not allowed for. It does, however, recognise that the panel member’s knowledge is imperfect, and though they cannot be sure which state will occur, they can assign numerical probabilities representing their degree of belief as to the likelihood of the occurrence of each possible state.

When a rational decision involves the consideration of multiple objectives (and it must do if the OCG definition of best value is used) then multiattribute utility theory (MAUT) may be used as the basic foundation for applying decision analysis. The theory explicitly addresses the value trade-offs and uncertainties that are invariably

the focus of multiple objective decisions. (Keeney and Raiffa 1976). This approach uses Savage's rational preference theorem as a corner stone and was developed by Keeney and Raiffa (*ibid*) into a set of procedures that allows MAUT to generally combine the main advantages of simple scoring techniques and optimisation models. (Hatush and Skitmore 1998).

The key to understanding the application of utility in this way is to appreciate that if a rational decision maker's direct preferences over consequences can be defined, then they can be used to order the desirability of the actions open to him/her. If an appropriate utility is assigned to each possible consequence and the expected utility of each alternative is calculated then the best course of action is the alternative with the highest expected utility.

There are a number of different sets of axioms including Savage's (*ibid*) and Von Neumann and Morgenstern's (1990) that imply the existence of utilities with the property that the expected utility is an appropriate guide for consistent decision making. The importance of the Keeney and Raiffa work (*ibid*) is that they produced a linear additive model of the expected utility theory that mathematically can be shown as;

$$U_i = p_1 u_{i1} + p_2 u_{i2} + \ldots + p_n u_{ix} = \sum_{j=1}^{n} p_i u_{ij}$$

Where:

U_i is the overall utility (preference score of option *i).*

u_{ij} is the utility of option *i*, if having chosen option *i,* it actually transpires that the state of the acting subject *j* occurs.

p_j is the decision makers' best judgement of the probability that the future state of the world *j* will occur.

This says that the overall utility, U_i of an option *i* is calculated in a relatively simple way; as the mathematical expectation (the probability-weighted average) of the elementary utilities, u_{ij} of all the associated consequences. The equation is also simply additive over the states of the acting subject (Hirshleifer & Riley 2002) .The advantage of the additive form is its simplicity e.g. In order to determine the overall utility function for any alternative a decision maker need only determine *n* utility functions for that alternative ,where *n*= the number of criteria used.(Hatush and Skitmore *ibid*). The limitation is that the additive approach is only appropriate when the condition of mutual preferential independence of the attributes is satisfied. i.e. a decision maker's preference for one attribute is not affected by the preference for another attribute. (Flanagan *ibid*).

THE MECHANICS OF THE SUPPORT TOOL.

One of the key drivers for establishing the support tool mechanism is the need in the public sector to ensure that the decision process is transparent and auditable and, that to be capable of audit, the process must also be measurable (Kelly & Hunter 2003).

In order to build a rational model for the decision making process we must know and understand what needs to be modelled. A set of objectives for the support tool have been established as follows:

1. It is open and transparent.

2. The attributes taken from the stake holder's value system may be open to analysis and to change if they are felt to be inappropriate.

3. The scoring and weighting of the attributes should be explicit and be developed according to established techniques.

4. The quantification and setting of probabilities can be sub-contracted to experts, if required, and does not need to be left in the hands of the decision makers.

5. The support tool framework should promote discussion within the tender panel and assist in the rationalisation of the decision making process.

6. The preferences of the tender panel are recorded and provide an audit trail.

The choice and weighting of the attributes.

The attributes that make up a client's value system will be particular and specific to the type and structure of the individual organisation, its stakeholders and the environment and context within which the organisation operates (including the implementation of appropriate political polices and the nature of the individual project itself). The derivation of these attributes within the Public Sector using both value management and value engineering techniques and processes, adopted from America, has been the subject of much research over the last twenty years (see Male and Kelly 1989, Shillito & DeMarle 1992, Boyne 2000, Kelly *et al* 2002). This has culminated in the engineering of a process known as 'The Three Wheels of Best Value' (Kelly and Hunter *ibid*) which was formed to establish both corporate and project specific best value attributes.

Although costs *per se* could have been included as one of the value attributes it is considered separately in this model because (a) in many complex decisions costs should be set aside until the benefits of the value alternatives are evaluated (Haas and Meixner 2003) and (b) more importantly, the OCG have stated that the recommended approach to Best Value evaluation is to differentiate the financial and non-financial criteria for consideration in separate strands. Attempts to balance these criteria during the process is to be avoided. (OGC 2004).

It is proposed that the weighting of each attribute be decided using the analytic hierarchy process (AHP). The process was developed by Thomas Saaty (1980) to assist individuals and groups deal with multi –attribute decision making problems. It is a popular decision tool supported by a large group of practitioners (Bedford and Cooke *ibid*). The strengths of the AHP method lie in its; (1) ability to decompose a complex decision problem into a hierarchy of sub problems, (2) versatility and power in structuring and analysing complex decision problems and (3) simplicity and ease of use (Fellows and Liu 2003).

The process commences by determining the relative importance of the attribute in meeting the client organisations goal, and then pair-wise comparisons are made between the attributes. The strength of the pair wise comparison technique in regard to the Best Value tender analysis process is that it promotes debate between the members of the tender selection panel with respect to the relative importance of each of the value attributes. It is anticipated that the debate may incorporate discussion on the corporate, strategic or project specific value of each attribute. In addition, non–

specialist users find the pair wise comparison data entry procedures of AHP attractive and easy to undertake (DTLR 2000).

Saaty produced a table of scales; (See Table 1).which allows the tender panels decisions to be assessed on a numerical basis.

Table 1. Fundamental ratio scale in pair-wise comparison. (Saaty 1980)

Intensity of Importance.	Definition	Explanation
1	Equal Importance.	Two activities contribute equally to the objective.
3	Weak importance of one over another.	Experience and judgement slightly favour one over another.
5	Essential strong importance	Experience and judgement strongly favour one over another.
7	Very strong or demonstrated importance.	An activity favoured very strongly over another; its dominance demonstrated in practice.
9	Absolute Importance.	The evidence favouring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between adjacent scale values.	When a compromise judgement is needed.
Reciprocals	If attribute *i* has one of the above non zero numbers assigned to it when compared with attribute *j* then *j* has the reciprocal value when compared with *i.*	A reasonable assumption.

The pair-wise comparison information is represented in a matrix. If there is *x* attributes that need to be compared for a given matrix then a total of *x (x-1)/2* judgements are required. Saaty's basic method for identifying the resultant weights used the fact that the eigenvector of each pair wise comparison matrix provides a specific project priority ordering and the eigenvalue gives a measure of the consistency of the judgement. A global consistency ratio of less than 0.10 is

acceptable otherwise the judgements need to be revised. In forming the best value support tool the eigenvector method was rejected for the more straightforward geometric mean method (GMM) which calculates the geometric mean of each row in the matrix, totals the geometric means, and normalises each of the geometric means by dividing by the total which provides the weighting for each attribute. This method of calculation is transparent, more likely to be understood by the decision makers and avoids the inherent problems associated with weighting using the right eigenvector method. (Costa and Vasnick 2001).

The Utility Function and Risk.

As discussed earlier, decision-making under uncertainty requires use of a utility function to represent the decision maker's attitude to uncertainty. A utility function can be constructed by assuming that there are best and worst alternatives, *b* and *w*. and we can fix the parameters of the utility function *u* by the arbitrary choice $u(w) = 0$ and $u(b) = 1$. Since utility is an ordinal rather than a cardinal concept these utility values are arbitrary, therefore the 0 does not mean utter worthlessness, but simply designates the lowest score and, similarly, 1 represents the highest score. In order to determine the utility of intermediate values where for a consequence *x* which satisfies transitivity so that $b \geq x \geq w$ the decision maker then uses the concept of certainty equivalent with respect to the following two alternative strategies:

(a) Outcome *x* with certainty. i.e. the probability of it occurring is $p = 1$

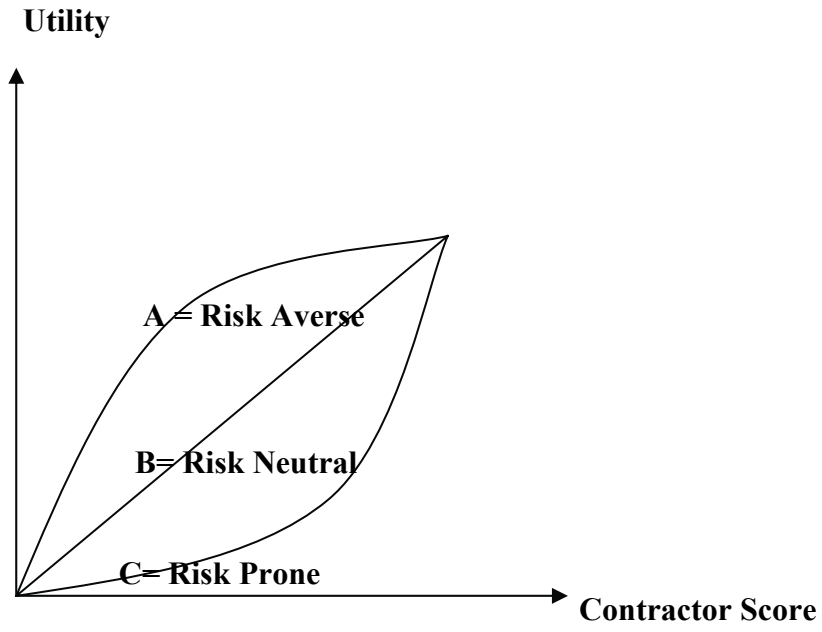
(b) Risk Option: The chance consisting of outcome *b* with probability of it occurring = *p* or outcome *w* with probability of it occurring =1-*p*.

If the probability *p* takes a value very close to (a) then the decision maker will probably choose alternative (b). If on the other hand *p* is very small the decision maker will choose alternative (a). However and most importantly for some *p* strictly between 0 and 1 he will be indifferent between the two alternatives at this point the utility value of the two alternatives is identical and we can express this as;

$U(x) = u(\text{alt (a)}) = u(\text{alt (b)}) = p.u(\text{b}) + (1-p)\,u.(w) = p$

Hence, not only can the decision maker specify the probability *p'* but they can also derive the utility value of the associated outcome. It is helpful if the utility function is depicted graphically (See Figure 1) as the shape of the resulting utility curve can be divided into three broad categories dependent upon whether the decision maker is risk averse [A], risk neutral [B] or risk prone [C]. It is acknowledged that the risk curves oversimplify the real situation

Figure 1. Three types of Utility Function Curves



It is important to note that an individual will probably have a different utility function compared to a group and utility evaluations of individuals cannot simply be added together to obtain group utility. The optimum solution is for the client organisation to give guidance on their risk attitude or simply compare the results for each risk attitude prior to making the final decision. This would simplify the process of determining the certainty equivalent as it could be produced on a corporate, rather than individual, basis

CASE STUDY.

The support tool has been trialled with a Local Authority to analyse the Best Value bids submitted by 5 contractors with respect to a contract for the refurbishment of a school's residential accommodation block. The Authority needed to assess the subjective element of each contractor's tender submission against five attributes which represented the value system of the stakeholders involved in the project. The attributes chosen were as follows; user liaison, energy use of the completed scheme, commitment to continuous improvement, employment of local labour, and their health and safety policy.

The tender assessment panel was made up of 4 people who comprised 2 members of the client organisation, a representative from the contract administrators and the lead researcher. In this trial the decisions were made on a group, rather than individual, basis and the panel recorded the group's decisions and results using an Excel spreadsheet.

Weighting the attributes.

The tender panel discussed and assessed the relative merits of each of the attributes by AHP using the Geometric Mean Method to produce the weighting for each attribute. The simplicity of using the Geometric Mean Method for the calculation of the attribute weighting is that (a) its theory can be relatively easily understood by the members of the tender panel as opposed to, say, the right eigenvector method of Saaty's original work and (b) the software calculation can be checked using the POWER function on an Excel spreadsheet which illustrates the relative simplicity and transparency of the calculation that is required. The pair wise matrix produced by the tender assessment panel was as follows (See Table 2);

Table 2. Pair wise comparison of attributes.

	Criteria	User Liaison	Energy Use	Continuous Improvement	Local Labour	Health and Safety
1	User liaison	1	1/3	1/3	1	⅓
2	Energy use	3	1	3	3	1
3	Continuous improvement	3	1/3	1	5	1
4	Local Labour.	1	1/3	1/5	1	1/5
5	Health and safety	7	1	1	5	1

The weights calculated for each of the attributes indicates their relative importance to this specific project. (See Table 3).

Table 3. Weighting of the attributes.

	Criteria	**Geometric Mean**		**Weight**
1.	User Liaison	$(1 \times 1/3 \times 1/3 \times 1 \times 1/7)^{1/5}$	0.4366	0.07
2.	Energy Use	$(1x\ 3 \times 3 \times 3 \times 1)^{1/5}$	1.9331	0.31
3.	Continuous improvement	$(3 \times 1/3 \times 1 \times 5 \times 1)^{1/5}$	1.3797	0.22
4.	Local Labour.	$(1 \times 1/3 \times 1/5 \times 1 \times 1/5)^{1/5}$	0.4216	0.07
5.	Health and safety	$(7 \times 1 \times 1 \times 5 \times 1)^{1/5}$	2.0361	0.33
	Sum		6.2074	(=1.00)

Determining the Utility Function.

One of the main objectives in obtaining the utility function was to create a process of scoring tender submissions that would be both familiar to the members of the tender panel and produce an audit trail.

The panel was supplied with the tender submission documents for each of the contractors and was asked to score the contractors submission by rating on an individual criteria basis their confidence (or belief) that the contractor could actually successfully deliver on the claims made within their tender documentation. The point's score system used was as follows: 0-4 = very unlikely; 5-8= unlikely, 9-12=fair: 13-16=very likely, 17-20=certainty. Numerically similar systems are currently being used within the UK construction industry though they assess content of the tender submission documents rather than belief in successful delivery by the contractor. The importance of scoring in this manner is that it allows the decision maker to incorporate his/her personal experience, preferences, heuristics and biases as part of the contractor selection process and should promote discussion within

members of the tender analysis team. In terms of an audit trail it also provides a transparent indication of the way in which the panel viewed each contractor's submission and how they perceived the contractors chance of successfully delivering the product. In addition it was decided, where possible, to link the scoring of each attribute to key performance indicators (KPIs) which measure factors critical to the success of projects. Benchmark scores produced from KPI's are stated as percentages and are an indication of performance relative to the whole construction industry. If a benchmark score for a specific contractor is given as 49% this means that 49% of projects nationally have equal or lower performance and 51% of projects have higher performances (Constructing Excellence 2006).

The assessment of each contractor's anticipated performance against the value attributes was then carried out. For example with respect to criteria number 2 a contractor stated in their bid documents that the estimated annual energy use for the refurbishment scheme is 919kg CO2/ 100m2. By using the Constructing Excellence KPI Graph this equates to a benchmark score of 65% which was deemed acceptable within the contract specification. The tender panel then assessed from the content of the bid submission their belief as to whether or not the contractor could deliver the stated quality standard and marked the submission accordingly. The benefits of using this scoring method are envisaged as:

(g) A contractor will provide realistic technical details including calculations to support their bid submissions.

(h) It encourages the contractor to utilise their specialist knowledge for the benefit of the client and end user.

(i) The KPI forms the basis for both monitoring the contractor's performance and providing feedback to drive continuous improvement.

(j) The scorecard highlights potential anomalies in the assessment of the bids. If a contractor has stated they could achieve a high KPI percentage score, say 95%, for a particular attribute but are only awarded a low performance score, say 8 or less, this will be highlighted and can be discussed further between the tender panel members.

(k) It is acknowledged that the scoring system is subjective, as it must be if it is to embrace the concept of uncertainty, but it is based upon quantifiable measures i.e. KPI's and Utility.

(l) There is no problem if an attribute cannot be assessed against a KPI as the core purpose of using expected utility is that attributes can be assessed on a 'like for like basis' regardless of the original units of measurement.

The scoring of the 5 contractors for attribute number 4 was as follows (See Table 4):

Table 4: Scores for value attribute no 4

Contractor	A	B	C	D	E
KPI Benchmark	65%	75%	70%	65%	65%
Energy Use Score	10	18	12	11	14

The initial step in determining the expected utility is for the panel to identify the best and worst scores for the attribute, which is inputted into proprietary software which calculates the utility function. The software simply sets up the utility scale as previously described and assigns a utility value of 1 for the best outcome (i.e. contractor B with a score of 18 units) and a utility value of 0 for the worst outcome (i.e. contractor A with a score of 10 units).

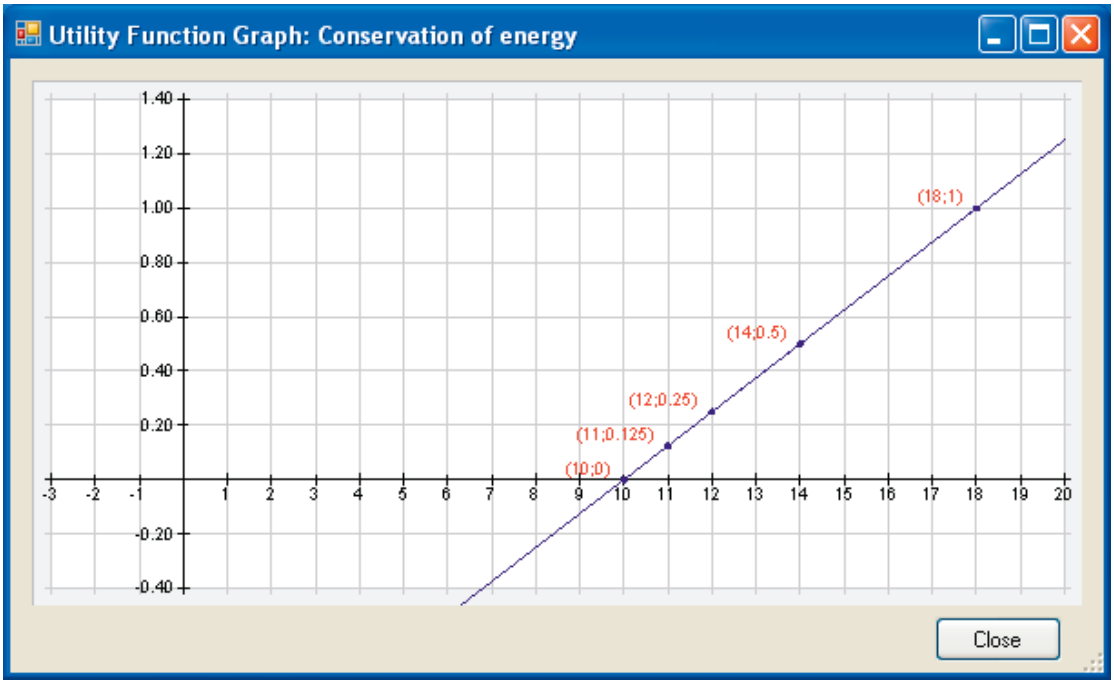
In the interests of simplicity it was agreed that the client attitude to risk was neutral which from figure 1 provides a straight line utility function. However the use of graph drawing software means it is relatively straight forward to produce curves for both risk prone and risk averse clients also shown in figure 1. The indifference probability of p=0.5 was assigned to the contractors performance of 14 units. This indifference value of 14 units is a certainty equivalent. The expected utility of the indifference choice is *p x (utility of the best outcome score) + (1-p) x utility of the worst outcome score) = 0.5 U (17) + (1-0.5) U (10) =0.5 (1) + 0.5(0) = 0.5,* hence *U (14) =0.5.* (See Table 5).

Table 5: Utility Value Scores.

Contractor	A	B	C	D	E
Score for criterion no 2.	10	18	12	11	14
Utility Value	0	1	0.25	0.125	0.5

Alternatively the values can be read directly from the co-ordinates of the graph of the utility function. (See Graph 1)

Graph 1: The utility function for the conservation of energy attribute.



Calculation of the Expected Utility Value.

The overall score for each contractor is obtained by multiplying the utility value by the weighting that was previously calculated for the specific attribute being analysed and scored, i.e. for the second attribute it is equal to 0.31 and the final scores were as calculated as follows (See Table 6).

Table 6. Overall Utility Value for Criteria No 4.

Contractor	A	B	C	D	E
Overall utility value Attribute 4.	0 x 0.31	1 x 0.31	0.25 x 0.31	0.125 x 0.31	0.5 x 0.31
Total	0	0.31	0.0775	0.0465	0.155

The procedure is repeated for each of the criteria in turn until an accumulative score is obtained for each of the contractor's submissions. The scores can then be simply added together to provide the expected utility for each contractor, which represents the tender panels mark for the subjective or 'quality' section of the contractor's tender bid. As stated earlier the expected utility theory indicates that the best course of action is to engage the contractor with the highest overall expected utility score though it is reiterated that the support tool is intended to assist rather than replace the decision making process.

SUMMARY.

The paper has demonstrated that it is possible to develop a methodology to underpin the production of a robust support tool that addresses the uncertainty factor via AHP and MAUT in best value decision-making. The developed approach uses a contractor

scoring and ranking process based on preference and belief that can be readily implemented by members of a best value tender assessment panels. The next stage of the work is developing windows based software that will make the whole process more transparent and user friendly including graphical representation of the utility function. Though the interpretation of graphs is a relatively new concept within the construction industry this process has been simplified by the use of software that automatically calculates the graphs coordinates. Similarly the use of the software allows the AHP pair wise comparison process to be carried out expeditiously for any number of attributes as opposed to the time consuming process using Excel to calculate the attributes weightings. .

Clearly, the OGC definition of 'best value' is wider than simply the subjective element of the bid and analysis of the cost function is core to the analysis of any Best Value bid submission. As such, further research is being carried out in order to (i) develop a whole life costing framework to bolt onto the developing software to analyse bid returns, and (ii) produce pragmatic guidance for Local Authorities on the consequences of the percentage combinations used in bid analysis in order to achieve an optimum combination of WLC and quality for a tender bid to comply with the OCG definition of BV assessment.

The limitations to the methodology are acknowledged and further research is addressing these issues. In this trial the tender panel used Excel spreadsheets to record their decision making process but as the research develops the support tool functions are being converted in a windows based software package. It is proposed that the software will contain a drop down menu of value attributes that the stakeholders choose to incorporate within their tender evaluation. The list of attributes will satisfy

the condition of mutual preferential independence which allows the additive from of the utility function to be used. Similarly further research is being undertaken to move away from the subjective scoring of an attribute using KPI values and try and link the KPI percentage to a particular score on the 0-20 scale currently being used. Even if this can be achieved it is acknowledged that it may not be possible to link all the attributes with a specific KPI and the scoring will remain, for these attributes at least, subjective. Similarly further research needs to be undertaken to bottom out the differences that occur when individual decision makers' decisions are used instead of using the unitary group approach as put forward by this paper.

It is envisaged that the support tool could be used for a wide spectrum of projects ranging from repair and maintenance contracts through to the analysis of multi million pound residential estate regeneration schemes not least because the BV tender analysis process is fundamentally the same regardless of the project type it is applied to. Manifestly the support tool can be used in areas other than tender analysis, already the methodology has been used to assist a London Borough Council in their decision to renew or repair window units throughout the whole of their Borough and it is also anticipated that the support tool will be used (i) to short list a limited number of contractors for subsequent detailed appraisal (ii) to rank contractors, or (iii) simply to distinguish acceptable from unacceptable possibilities.

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APPENDIX C: PAPER 3.

FULL REFERENCE

Phillips, S, Martin, J, Dainty, A and Price, A (2008). Analysis of the attributes used in establishing best value tenders in the UK social housing sector. *Engineering Construction and Architectural Management. In Press.*

ANALYSIS OF THE ATTRIBUTES USED IN ESTABLISHING BEST VALUE TENDERS IN THE UK SOCIAL HOUSING SECTOR.

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Abstract

Research Paper.

Purpose-A number of studies have highlighted the problems and challenges that have been encountered with the analysis of best value and partnering tenders carried out in the UK public sector. One of the principal issues is that client organisations and decision makers have to assess numerous diverse quality attributes as part of the contractor selection process. This paper presents the findings of research which aimed to identify the core factors which could be used to differentiate bids in the context of social housing.

Methodology-A questionnaire was sent to a cross-section of stakeholders within the social housing sector asking the respondents to rank the importance of 35 attributes with respect to selecting a successful contractor. The responses were subjected to principal component analysis to detect a structure in the relationship between the attributes and classify the attributes into a set of factors.

Findings-The results indicated that the 35 attributes could be grouped together and reduced to 10 core factors.

Research Limitation-It is not expected that client organisations would limit their tender analysis to the ten core factors only. They are not intended to be prescriptive and only provide a starting point in the choice of contractor selection quality attributes.

Practical Application-. Application of this result could enable the stakeholders to streamline the tender analysis procedure allowing the high volume of tenders to be dealt with more effectively and efficiently.

Keywords: Best value, principal component analysis, quality attributes.

Introduction.

Changing world markets, coupled with the introduction of new technology and a rise in clients expectations have put construction practices and processes under scrutiny and have stimulated reviews of how the construction industry delivers value. The International Council for Research and Innovation in Building and Construction has clarified the definition of 'revaluing construction' as "*the maximisation of value jointly created by stakeholders to construction and the equitable distribution of the resulting rewards*" (Barrett 2005). For the purposes of this paper stakeholders are defined as groups, or individuals, who have a stake in, or expectation of a projects performance (Newcombe 2003). Within the UK this global concept of revaluing construction has been applied to many sub-sectors of the industry, particularly public sector projects. In 2003 the Gershon Review examined the process of acquisition in the public sector and indicated that these changes to the method of procurements could deliver value for money gains of 1 billion. This research focuses on the effect that the implementation of the value-based procurement of partnering and best value has had on the structure and operation of the tendering process within the social housing sector and examines how best value procurement can be approached more effectively and efficiently to assist in delivering the savings identified by the Gershon Review. The social housing sector was identified for research as it is responsible for a programme of construction, maintenance and refurbishment works, which is annually valued at £1 billion GBP (DTI 2003) with a significant proportion of those works being financed by the public purse. The client organisations within the sector are regular procuring clients to the construction industry and their corporate strategy and operational procedure can be influenced and regulated by Government policy which

has allowed these organisations to be used as key drivers for the required change in behaviour and culture the UK Construction Industry.

The UK Social Housing Sector.

Social Housing provision within the UK is governed by two main groups of organisations. The first is the housing provided and managed by Local Authorities (commonly called council housing), and the second is the housing provided and managed by Housing Associations and other organisations, which together form the "voluntary housing movement". The welfare of these housing associations falls under the umbrella control of the Housing Corporation, which is a central government financed quango formed to promote and assist the development of housing associations. The term "registered social landlord" (RSL) is used as a collective term for both housing associations and local authorities as providers of social housing.

RSL's are regular procuring clients to the construction industry and in 1998 the Egan report identified that their corporate strategy and operational procedure can be influenced and regulated by Government policy so that these organisations could be used as key drivers for the implementation of best value and partnering procurement in the UK Construction Industry. The Government has taken positive steps to ensure that the public sector have to embrace value based procurement and on the 1st April 2000 new legislation was enacted so that Local Authorities in England and Wales must implement the best value process to all the public services that they control and requires them to review, develop and to show continuous improvement with respect to their procurement strategies in terms of their efficiency, effectiveness and economy. Also Local Authorities are specifically directed towards the implementation of

partnering or long term collaborative working methods through the National Procurement Strategy. (ODPM 2002). The Housing Corporation has issued similar instructions so that Housing Associations must aim to deliver continuous improvements and value for money in their services by using best value techniques. These include challenging what they do, making comparisons with others, consulting people affected by their services and providing the services at competitive standards and prices. The wishes of residents and others are to be balanced against available resources within a clear and transparent framework according to the principles of best value (Housing Corporation 2005).

The edict from the housing corporation and the change in legislation has lead to a significant departure from traditional lowest bid tendering and introduces new variables into the decision making process. It involves the identification of those attributes which represent value to a particular client on a specific project and creates a need to be able to measure on a non-monetary basis those crucial components the contractor/bidder must be able to offer and deliver i.e. zero carbon technology, if they are to add value to a project and improve service quality so that it qualifies as non-cashable efficiency gains (CIH 2006). Ideally, service users and stakeholders should also be proactively involved at all stages of the procurement and service design /delivery process to enable them to exercise informed choices upon the project cost and quality (Housing Inspectorate AC 2005).

Identification of Problems.

Historically, there are acknowledged problems with large public sector organisations embracing change (Thomas Cain 2003) and the adoption of new routines and

processes in construction tend to happen through gradual absorption rather than by overnight transformation (Barrett & Stanley 1999). Therefore there is no reason why the cultural change required to implement collaborative working and best value procurement should have been received any differently by the public sector, particularly as partner selection for longer-term relationships is further complicated by the need to assess future as well as present capabilities. A number of studies have been carried out to assess how effectively and efficiently value based procurement has been implemented within the public sector. These studies have identified the following challenges currently being encountered by public sector client organisations;

- Too much public procurement is undertaken without professional support which results in sub–optimal value for money and unnecessarily high prices being paid for goods, works and services (Gershon 2003).

- Most procurement is not carried out by designated procurement staff, the procurement staff are often consulted too late in the procurement process and the majority of procurement staff do not hold professional qualifications. (National Audit Office 2004).

- Simply advising organisations to take up "best practice' is impractical and is unlikely to lead to achieving high performance unless continuous support is provided. (Gratton and Ghoshal 2005).

- Creating a consensus vision between key stakeholders is problematic but maintaining this over time and achieving progressive implementation is harder still (Barrett 2005).

- The difficulties being encountered are exacerbated by the number and diversity of best value attributes that can be considered by the various stakeholder groups (Austin 2005); and

- If too many attributes are considered the process of evaluation will become paralysed with too many options to consider (Woodhead and McCuish 2003).

The above problems are further exacerbated by the fact that value for money must also be considered in parallel with collaborative working. Whilst the present criteria used to evaluate the performance of contractors often include; the quality of products and services, cost predictability, time predictability, and their health and safety record (Jones & O'Brien 2002), in longer term relationships the RSL also needs to be as clear as possible with respect to its corporate policies and strategies so that contractors can be assessed on new factors such as; their willingness to work collaboratively and synergistically as partners, their understanding of RSL objectives and cultures, and their openness and willingness to share information and their ability to manage supply chains (Jones & O'Brien *ibid)*.

Research Aim and Objectives.

There are two consistent themes that run through the identified problems: (a) the number of varied and different attributes to be considered are causing difficulties in the decision making process of tender panels and (b) that the high volume of tenders cannot be dealt with effectively as there is a lack of professional staff/support to assist in the new procurement process. The main aim of this research was to ascertain

whether or not the quality attributes currently being assessed in best value and partnering tender assessments could be reduced in number. It is envisaged that the use of a smaller number of named core attributes could increase the efficiency of the tender analysis procedure and may assist the non-professional support staff in their understanding of the process. The use of standard criteria to lighten the selection burden for both clients and contractors has been mooted before in 2000 by Wong *et al,* but this is the first time that research has been undertaken to identify standard criteria for contractor selection with respect to value based and collaborative working procurement.

Numerous researchers have highlighted essential criteria used in a contractor selection process (Holt *et al* 1996, Kumaraswamy 1996, Hatush and Skitmore 1997, Fong and Choi 2000, Wong *et al ibid,* Cheng and Li 2004*)* and, similarly, many commentators have identified attributes, using both value management and value engineering techniques and processes that are core to the value systems of public sector client organisations (Shillito & DeMarle 1992, Male and Kelly 1992, Kelly *et al* 2002, Morledge *et al* 2006). However as there is no single authoritative and comprehensive listing of the different quality attributes considered by all the stakeholders during a best value tender analysis a wide ranging literature review was undertaken in related areas and was based upon a number of sources comprising: academic, construction practitioners, government departments and quangos such as the Housing Corporation. A list of 35 independent attributes was identified from this literature as potentially being considered by stakeholders during a best value tender analysis process (See Table 4 for the list of identified attributes). The scope of the attributes demonstrated a balance between the criteria that must be considered in both lowest bid and value

based procurement and those criteria that have been identified by researchers as directly relating to value based procurement only (CIRIA 1998, Woodhead and McCuish 2000, Langmaid 2003, NAO 2004, Morledge *et al* 2006, Potter and Smedley 2006). Independence between the attributes was seen as a desirable feature as though Fong and Choi (*ibid*) identified 68 criteria many of them addressed, fundamentally, the same issues which consequently lead to a lack of definition between the final 8 core criteria they established.

Method.

The identified attributes were listed in a questionnaire and respondents were requested to provide an opinion on the importance of each attribute. Responses to each question were measured on a 5-point Likert scale from 'Vital' to 'Not Required'. It was decided to gather the data using a postal survey as (a) it is a relatively low cost method of collecting data and (b) because of the varied and numerous locations of the respondents. In total 195 questionnaires were sent to a cross section of the five stakeholder groups that have been identified comprising: (i) RSL's, (ii) contractors, (iii) construction consultants and residents (end users) divided up into (iv) leaseholders and (v) tenants.

Whilst much literature exists in the area of questionnaire design the two factors focused upon to increase the rate of response was (a) personal engagement and (b) process simplification (Root and Blismas 2003). To this end, the questionnaires were sent to known individual contacts within the social housing sector and the format of the questionnaire was contained to four pages in length. The questionnaire was sent out together with a comprehensive, personally addressed covering letter which tried to

engage the intrinsic interest of the respondent. The questionnaires were also sent out with stamp addressed envelopes thereby reducing the reasons for not responding. 80 questionnaires were returned in a useable format and the response rate of 41% was considered favourable compared with the norm of 20-30% expected from most postal questionnaire surveys of the construction industry.

Data Analysis and Results.

The responses to the questionnaire were collated and were subjected to analysis using the Statistical Package for Social Sciences (SPSS) v.15 for Windows. The frequency of the response with respect to the various stakeholder categories completing the questionnaire is shown in Table 1.

Table 1 : Frequency of Response per Stakeholder Category.

Stakeholder	Frequency	Percent	Valid Percent	Cumulative Percent
Consultant	12	15.0	15.0	15.0
Contractor	13	16.3	16.3	31.3
Rent Act Tenant	7	8.8	8.8	40.0
Leaseholder	15	18.8	18.8	58.8
Client Organisation/RSL	33	41.3	41.3	100.0
Total	80	100.0	100.0	100.00

The reliability of the questionnaires measurement scale was assessed using Cronbach's alpha coefficient (Norusis1992). The size of Cronbach's alpha is a function of two things; the average correlation between a set of items and the number of the items with an alpha coefficient of 0.70, which is usually taken as being the minimum level acceptable (Dewberry 2004). The Crohnbach's alpha coefficient in

this case is 0.910 (See Table No 2) indicating that the 5 point Likert scale used is reliable at a 5% significance level.

Table 2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.910	0.912	35

Data Reduction

The data reduction method using principal component analysis [PCA] was chosen for two main reasons (i) to reduce the number of attributes and (ii) to identify or detect a structure in the relationship between the attributes and classify the attributes into sets of factors. The smaller number of factors identified with reduction analysis are often called hidden or latent variables, because it is only after using PCA that we are aware of them (Dewberry *ibid*).

The 35 attributes were subjected to PCA with varimax rotation. The first stage of the analysis was to determine the strength of the relationship between the variables based either on correlation coefficients or partial coefficients of the variables which are shown in a correlation matrix. Various tests are required to check the appropriateness of PCA in the reduction process including; the Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy, the Bartlett test of sphericity and anti–image correlation, measure of sampling activities (MSA). The Bartlett's test of sphericity examines the hypothesis that the correlation matrix is an identity matrix. In this case the value of the test statistic (See Table No 3) is large (Bartlett's test of sphericity = 1399.02) and the associated significance level is small (Sig= 0.00) suggesting that the population

correlation matrix is not an identity matrix. The value of the KMO statistic is 0.736 which according to Kaiser (1974) is satisfactory for PCA. In essence these tests show that PCA is appropriate for the data reduction.

Table 3: Results of the KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.736
Bartlett's Test of Sphericity	Approx. Chi-Square	1399.016
	df	561
	Sig.	.000

The results of the anti image matrix show the variance or commonality between the attributes. The results also display the MSA on the diagonal of the matrix. The value of the MSA must be reasonably high for a good factor analysis. In the initial test the MSA values were between 0.364-0.836. The MSA of 0.364 was considered to be too low a value and the attribute, which related to the minimisation of tenants future running costs, was removed. The analysis was run again and this time the MSA values ranged between 0.544 and 0.874 suggesting there was no need to eliminate any further variables from the analysis.

The analysis produced a ten factor solution with eigenvalues greater than 1, explaining 71.3% of the variance. The eigenvalue is a mathematical property of a matrix which can be used both as a criterion for determining the number of factors to extract and as a measure of variance accounted for by a given dimension (Kim and Mueller 1994). If the solution is adequate it is expected that the number of factors with eigenvalues over 1 to be somewhere between the number of items divided by 5 (34/5 in this case) and the number of items divided by 3 (34/3 in this case). In this

instance the number of expected components is between 7 and 11 and actually 10 were identified which suggest that a good factor solution was possible. A varimax orthogonal rotation was used to further interpret the 10 factors. Rotation techniques, such as the varimax method, transform the component matrix produced from an unrotated principal component matrix into one that is easier to interpret. The results of the factor analysis indicate the amount of variance between the attributes that each factor accounts for and provides loadings of all the attributes on each factor. The convention is to take seriously any loading that is greater or equal to 0.32. According to Comrey and Lee (1992) factor loadings of; over .71 can be considered excellent, 0.63 to 0.70 very good, 0.55 to 0.62 good, 0.45 to 0.54 fair and 0.32 to 0.44 poor. In examining the pattern of component loadings, ideally, each attribute should load satisfactorily on just one factor and if it is found that a substantial proportion of items load on two or more components this suggests a messy component solution (Dewberry *ibid*). In this instance loadings that were considered poor (i.e. those between 0.32 and 0.50) were discounted which gave a satisfactory speared of loadings. (Please see table no 4).

Table 4. Results of the Varimax Rotation.

Identified Attributes	Component									
	1	2	3	4	5	6	7	8	9	10
A clear understanding of the term 'best value'.	.354	.066	.159	.091	.101	.033	-.013	-.112	.761	.154
An understanding of partnering and collaborative working.	.532	.026	.006	.215	.182	.063	.537	.010	.149	.054
A clear understanding of the RSL's strategic values and objectives.	.602	.173	-.021	.288	-.085	.175	.054	-.030	.188	.121
A clear understanding of the RSL's specific project values and objectives.	.820	.067	-.035	.029	.033	.111	.008	.013	.042	-.054
A clear understanding of leaseholder issues and recovery of service charges.	.159	.082	.111	.336	-.196	.340	-.516	.053	.335	.066

A quality management system in place.	.020	.138	.074	.172	.706	.024	.011	.092	.283	-.065
A health and safety policy	-.102	.166	.013	-.010	-.042	.058	.457	.722	.166	-.133
An environmental policy and validated awareness.	.273	.170	.082	.096	.141	-.050	-.003	.779	-.094	.223
A system of establishing life cycle costing for the work proposals.	.600	.029	.350	.282	.167	.214	-.167	.118	.148	.092
An established method of collating on site performance data.	.345	.150	.092	.656	.038	.091	.123	.084	.104	.081
Software and hardware compatible with the RSL's system.	.226	-.040	-.211	.493	.316	.390	-.339	-.020	.146	.045
Implementation of value engineering and value management techniques.	.586	.252	.100	.306	.374	-.076	.019	-.051	-.197	.015
An objective of zero defects at handover.	.060	.176	-.053	.012	.008	.135	-.035	.132	.126	.716
Experience in successful resident liasion.	-.047	.592	-.011	.035	-.020	.485	.296	-.164	.070	.122
Evidence of established supply chain.	.578	.480	.212	.270	-.022	-.108	-.009	.127	.094	-.012
A track record in formal risk management.	.674	.229	.223	.079	.191	.109	.061	.244	.181	.128
A track record of success in similar projects.	-.034	.379	.585	-.085	.342	-.110	.123	-.014	-.053	.387
Experience of standardisation and off-site assembley.	.294	.311	.313	.566	.248	.000	.023	.036	.102	.017
A track record of time predictability.	.156	-.087	.594	.320	.230	.096	.236	.196	.118	.042
Evidence of successful performance over their past 5 comparable projects.	-.133	.354	.633	.326	.022	.049	-.071	-.037	-.089	-.188
Qualified experienced technical staff.	-.011	.080	.289	.356	-.232	-.057	.264	-.109	-.049	.576
Health and safety training for site personnel.	.105	.161	.183	.093	-.007	-.065	.776	.248	-.020	.102
Evidence of training in sustainability issues.	.314	.208	-.079	.451	.343	.179	-.010	.377	-.046	.268
Proof of a system of open book accounting.	.078	.171	.388	.236	.150	.624	.000	-.172	.139	.109
Evidence of a non-adversarial approach to agreeing costs and final accounts.	.257	.003	.346	-.008	.619	.271	.128	.003	-.015	-.061
A track record of final account cost predictability.	.229	.047	.761	-.118	-.003	.236	.046	.028	.156	.051
Willingness to exchange cost data with other contractors.	.305	.141	.192	.038	.201	.774	-.242	.163	-.021	.070

A track record of sensitivity to public perception.	.496	-.045	-.016	.024	-.291	.420	.089	.305	-.009	-.090
Commitment to continuous improvement.	.251	.533	.068	.411	.002	.157	.144	-.011	.285	.101
A track record of implementing green construction.	.196	.704	.123	-.021	.263	.189	-.115	.134	-.045	.142
A track record of implementing innovative construction solutions.	.252	.727	.098	.051	-.105	-.018	.061	.194	.091	.188
Experience of increasing flow of work to the partners in the supply chain.	.368	.695	.179	.272	.033	-.037	.011	.105	.067	-.093
A commitment to employing local labour.	-.221	.620	-.056	.099	.352	.118	.202	.091	.292	.177
Attainment of the Investor in People award.	-.005	.446	.007	.127	.329	.067	-.028	.205	.676	-.041

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 47 iterations.

Subjective analysis was carried out on the nature of the items loading on the 10 principal factors to interpret the core element being measured by the groupings around each factor and consequently to provide a collective name for the factor. The results are shown in Table 5 which represents the 10 core areas that stakeholders believe should be assessed in a contractors best value tender bid.

Table 5: The 10 Identified Factors.

Component Number.	Name of Component Grouping	% of Variance	Cumulative %
1	Understanding of Clients Objectives.	28.146	28.146
2	Innovative management.	8.232	36.377
3	Successful track record.	6.623	43.000
4	Innovative Construction practices.	5.820	48.820

5	Quality management procedures.	4.837	53.658
6	Transparency of cost data.	4.234	57.891
7	Understanding of Partnering.	3.840	61.732
8	Established Policy. (Health &Safety, Environmental)	3.446	65.178
9	Understanding of Best Value.	3.161	68.340
10	Technical Ability.	2.968	71.308

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Factor analysis results.

A limitation of the PCA process is that interpretation of the output is subjective and, therefore, the result of the rotated component matrix was interpreted heuristically rather than treating the results as an absolute. The constituent variables of each of the ten factors extracted are discussed below.

Factor 1: Understanding of Clients Objectives.

Variables grouped within this factor encompassed recognition by the contractor of the RSL's core business aims and included RSL's strategic values and objectives, their specific project values, evidence of established supply chains, implementation of value engineering management and formal risk management.

Factor 2: Innovative Management:

Variables grouped within this factor encompassed the contractor being able to demonstrate implementation of new and innovative construction techniques including; an understanding of the green construction issues such as sustainability , introducing innovative constructions solutions into project specific situations, commitment to continuous improvement and employing local labour

Factor 3: Successful Track Record:

Variables grouped within this factor related to the contractor being able to demonstrate the successful completion of social housing projects and included; a track record of success in similar projects, a track record of time predictability, evidence of successful performance over the past 5 years, and a track record of final account predictability.

Factor 4: Construction Practices.

Variables grouped within this factor encompassed new construction processes currently being implemented in the social housing sector including experience of standardisation and off site assembly and an established method of collating on site performance date for comparing against the performance of other partnering contractors. .

Factor 5: Quality Management Procedures.

Variables grouped within this factor encompassed the current standard requirement for a contractor to operate a fully accredited quality management system and also included evidence of a non adversarial approach to agreeing final accounts.

Factor 6: Transparency of cost data.

Variables grouped within this factor encompassed variables that are vital to a contractor being able to effectively agree and produce costs and estimates within a long term collaborative framework agreement and included proof of a system of open book accounting and willingness to exchange costs data with other contractors.

Factor 7: Understanding of Partnering.

Variables grouped within this factor has some relationship with those included in factors 1 and 8 and included the contractor having an understanding of partnering and collaborative working and ensuring that site personnel undertook health and safety training

Factor 8: Established Policy.

Variables grouped within this factor were fairly defined and dealt with the contractor having a comprehensive corporate policy with regard to health and safety and an environmental policy with validated awareness.

Factor 9: Understanding of Best Value.

Variables grouped within this factor were limited and related to the contractor having a clear understanding of the term Best Value which included recognition of the positive benefits of the Investor in People award.

Factor 10: Technical Ability.

Variables grouped within this factor encompassed the need for contractors to use qualified operatives and management personnel to provide reassurance to RSL's with respect to both on site and off site performance and the quality of the finished workmanship and included the employment of technical qualified staff and an objective of zero defects at practical completion and/or handover.

Discussion.

The 35 quality attributes were distilled into 10 core factors which has produced an acceptable fit under the designated titles for each factor. There were some interpretable patterns between the factor groups as discussed below.

Factors 1, 2, 6, 7 and 9 embody the new criteria that are currently being considered by tender assessment panels as a direct result of the implementation of ideas on best value and partnering mooted by a whole succession of Government reports (Egan *ibid,* Modernising Construction 2001, The Achieving Excellence suite of briefings 2003 and the Strategic Forum for Construction, Accelerating Change 2002) and the Housing Corporation. It shows that stakeholders are not only aware of the importance of the creation of supply chains and working in partnership but are also embracing ideas that contractors should be able to demonstrate competence in addressing green construction issues and innovative construction solutions. It also illustrates that contractors must now possess a range of attributes in terms of knowledge, skills, resources and attitudes as it is no longer enough for a contractor to simply employ a commercially minded quantity surveyor in order to win contracts.

Factors 3, 5 and 10 comprised those criteria that have, traditionally, always been considered in UK contractor selection and can be put under the generic headings of time, cost and quality. However the remaining factors 4, and 8 show a cross fertilisation between the two systems of procurement, in so far as, though they encompass traditional attributes such as the provision by the contractor of cost data and a heath and safety policy these issues have been further developed so that the cost data should be shown as part of an open book accounting process and an

environmental policy should be provided alongside the standard health and safety document.

There is a definite synergy between these results and the research undertaken by Swan and Khalfan (2007) who set out to identify mutual objectives for partnering projects in the public sector with responses obtained from stakeholders via a series of partnering workshops. They found that that whilst time, cost and quality are still vitally important issues that have to be considered they also have to be counterbalanced against issues of social and environmental importance both during the construction phase and over the life the building. In both pieces of research there is the limitation that the respondents could have identified value criteria as being important simply because these were among the attributes that they were asked to assess and rate.

The results of this research also show how the UK construction industry has moved on since the work undertaken by Hatush and Skitmore (*ibid*) which found that, despite good practice guides such as The Code of Practice for the Selection of Main Contractors (1997) published by the Construction Industry Board advocating selection of a successful contractor based on overall value for money, it was still the lowest bid that decided the winner of a contract irrespective of the technical managerial and security information available. However it is now clear that clients are now fully aware of their responsibility to consider other crucial value driven non-financial data. This point is reinforced by the fact that in 2000 the findings of Wong *et al* pointed towards the formulation of 'universal' criteria none of their top 15 identified attributes were directly related to value based procurement or addressed issues such as long

term collaborative working which is, potentially, an example of how stakeholder's perception of crucial factors has changed within the last 6-7 years.

It is self evident that the RSL's, assisted by Government policies and relevant legislative changes, have played a fundamental role in introducing best value tenders assessments into the social housing sector. However it is now incumbent upon them to drive the continuous improvement of the tender analysis process by clearly defining their own value systems and strategies so that contractors can prepare and execute their best value tender proposals in accordance with the RSL's specific value criteria which should ultimately benefit all the stakeholders in the process, not least, the end users.

Conclusions and Further Research.

The research aim was successfully met in that 10 core factors have been identified by the principal component analysis which can be used by stakeholders within the social housing sector to assist the selection of contractors in best value tender analysis. The factors are readily understandable which will assist non professional staff in gaining confidence to enable them to make competent choices during the selection process. However it is not expected that the 10 factors will be the only ones considered by the stakeholders in the tender selection process and it is fully accepted that stakeholders will need to consider other factors either alongside or in place of them. The make-up of the factors illustrate that whilst social housing stakeholders still rely on assessing contractors against *the holy trinity* of time, quality and cost they are also readily embracing and considering new attributes such as innovative construction solutions and sustainability issues. Further research needs to be undertaken to show whether

this shift in outlook can be part of the process that will achieve the £1 billon savings forecast by the Gershon Review though the fact that traditional thinking is being challenged and RSL's recognise the need to balance quality and commercial issues does provide a greater chance of the aims and objectives set out by the leading advocates of partnering and best value being fulfilled (Wood and Ellis 2005).

The results of the reduction analysis have been applied to a larger body of research which has developed a best value tender analysis support tool that has the capability to enable the identified attributes to be assessed on a project specific basis using a combination of the Analytic Hierarchy Principle, Multi Attribute Utility theory and whole life costing. The methodology underpinning the support tool has already been used by RSL's to assist them in best value decision making processes (Phillips *et al* 2007) and as the support tool has been produced as windows based software it is anticipated that it can be used to assist RSL's in evaluating the high volume of best value tenders in a more effective and efficient manner.

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APPENDIX D: PAPER 4.

FULL REFERENCE

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RENEW OR REPAIR EXISITNG WINDOW UNITS? A BEST VALUE APPROACH.

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ABSTRACT.

The movement in the public sector away from the culture of accepting the lowest tender bid towards Best Value and Value for Money assessments has presented client organisations with a golden opportunity to consider the time value of money throughout the life of a building project. However decisions of choice based on quality issues as well as capital cost have given rise to problems within the public sector, leading to financial loss for client organisations in instances where they have failed to adhere to statute or regulatory codes requiring the evaluation processes to be both transparent and auditable. Manifestly a new approach to decision making is required to reflect the analysis of best value criteria. An innovative research methodology has been developed to address this issue with its foundations being firmly rooted in the previous research areas of value management, whole life costing and multi criteria decision making. The synergy between these areas has yielded the development of a new support tool to evaluate best value criteria. This paper outlines the practical use of the support tool in assisting a Registered Social Landlord to use the principles of Best Value in choosing between either repairing or renewing the existing metal window units within its housing stock of over 15000 dwellings.

Keywords: Uncertainty, reasonableness, multi criteria decision making, life cycle costing, value threads,

INTRODUCTION.

The decision to renew or repair an existing element of a building is an every day problem for client organisations and landlords within the UK Construction Industry. In the public sector the decision making process is subject to the scrutiny of independent organisations such as the Audit Commission to ensure probity. The introduction of Best Value [BV] procurement has increased the complexity of the choices that client organisations have to make and, in parallel; it has become increasingly more difficult to demonstrate transparency of the decision making process.

An innovative support tool known as OVID-BV [Optimising Value in Decision Making for Best Value] is being developed at Loughbourgh University to aid management decisions taken during BV analysis. This paper provides details of the practical application of the tool to assist the housing department of a London Borough Council ['The Council] in deciding whether or not to undertake a multi million pound contract to replace all the existing metal single glazed "critall type" windows within their housing stock with new double glazed window units. The support tool was also used to justify the reasonableness of the Council's decision as under section 19 of the Landlord and Tenant Act 1985 (as amended) a Landlord cannot recover the costs of works from its long leaseholders unless it can be demonstrated that the costs were reasonably incurred. As approximately 20% of the Council's residents are leaseholders the sum of monies they were seeking to recover was estimated to be approximately £2.5 million.

SOCIAL HOUSING AND BEST VALUE.

Social Housing provision within the UK operates under the umbrella control of two main arms known collectively as Registered Social Landlords [RSL]. The first being the housing provided and managed by the Local Authorities (commonly called council housing), and the second being the housing provided and managed by Housing Associations and other organisations, which together form the "voluntary housing movement". The Housing Corporation was established in 1964 to promote and assist the development of Housing Associations. Section 3.3 of the Housing

Corporations Regulatory Code states that Housing Associations must aim to deliver continuous improvements and value for money in their services by using Best Value Techniques, challenging what they do and how they do it. (Housing Corporation 2005).

The development and use of best value by local authorities was originally introduced to "release the shackles of compulsory competitive tendering and unleash the potential for innovation and responsiveness and thereby promote continuous improvements in local service standards" (Boyne 2000). The Best Value regime applies to all public services controlled by local authorities (in England and Wales) and is not just applied to construction procurement. The regime came into force on 1st April 2000 and requires councils to show continuous improvement in their procurement in terms of efficiency, effectiveness and economy. Importantly with respect to construction, Best Value requires local authorities to review and develop their procurement strategies.

The UK Governments' promotion and support of Best Value [BV] within the social housing sector has been a prime catalyst in the move by regular procuring client organisations, such as RSL's, away from the traditional culture of acceptance of the lowest bid towards consideration of both price and quality criteria as a basis for the selection of; materials, components and contractors. Research has been undertaken to determine the problems that have been encountered by RSL's as a result of this change in culture and it was found that the failure of an RSL to both define 'best value' and to provide a transparent and auditable BV analysis procedure has lead to RSL's suffering a financial loss.(Phillips *et al* 2004). These results have lead to the development of an ongoing research methodology that aims to refine a BV analysis support tool that transparently links an RSL's value system with a BV selection process thus creating an auditable relationship between the formation of an RSL's corporate strategy and their BV procurement process for a specific project.

RELATED RESEARCH.

The public rightly demands outstanding value for the money it puts into public services (Audit Commission 2005) and the starting point for the development of the

support tool was to establish a definition for 'best value' as applied within the social housing sector.

> *"Value for Money is the optimum combination of whole life costing and quality (or fitness for purpose) to meet the user's requirements; long-term value over the life of the asset is a much more reliable indicator of value for money. It is the relationship between long-term costs and the benefit achieved by clients that represents value for money."* (Office of Government Commerce 2003 [OGC]).

This led to a literature review of recent work in three main areas: value management in the construction industry, whole life costing and multi criteria decision making, in order to understand the current academic thinking behind the term 'Best Value'. There are numerous interpretations of the concept of value which can be as diverse as value denoting a relationship between function, cost and quality where value equals function plus quality divided by costs (Dell' Isola 1997) or value being defined as the intrinsic property to satisfy (Bell 1994). The BV definition put forward by the OGC specifically addresses 'long term value' and the most helpful definition of value with respect to this paper is that maximum value is obtained from a required level of quality at least cost, or the highest level of quality for a given cost or from an optimum compromise between the two. (Burt 1975). The additional variable addressed by this paper is the time-value of money with the quality attributes being determined by the RSL and their stakeholders.

BV analysis needs to incorporate and recognise the values of not only the RSL but also the various stakeholders involved in the procurement process and the 'value thread' ,which binds the stakeholders together, must be consistently maintained to ensure value for money is obtained from the formulation to the implementation process (Bell 1994). OVID-BV enables the value attributes that form the 'value thread' to be recorded, assessed and subjectively measured.

There have been numerous theoretical models developed to address the issues involved in decision-making for a variety of different construction procurement scenarios and different types of clients. (e.g. Holt *et al* 1995, Hatush and Skitmore

1997 & 1998, Alhazmi and McCaffer 2000, Palaneeswaran and Kumarswarmy 2000 & 2003, Wong et al 2001) None of the aforementioned models were developed specifically for best value evaluation but they all incorporate the underlying methodology of multi criteria decision-making. In many decision problems more than one factor influences the preferences over the possible outcomes and these systems have been developed as a response to increasing awareness of the complex nature of decision making with respect to large scale construction projects and that the long term impact of such decisions (or preferences) are of such a significant nature that they warrant a systematic approach to decision making to be carried out. Decision theory addresses the value trade-offs and uncertainties that inevitable surround multiple-objective decisions. Decision theory and the concept of utility were used by Keeney and Raiffa (1976) to develop a set of procedures to allow decision makers to evaluate multi-criteria options in practice. OVID-BV utilises these procedures to enable the decision maker's choice preferences to be transposed into numerical measured values.

The essence of whole life costing is accounting for all possible costs associated with constructing and operating a building and considering these costs at their present day values. Cost advisers must embrace new ideas and techniques where they will enable clients to consider the relative importance of various attributes and identify the optimum solution. (Pasquire and Swaffield 2002). A framework document and Whole Life Costing IT Tool has been developed as an output of a research project commissioned by the Society of Construction Quantity Surveyors (SCQS). The aim of the tool is for it to be used in local government to produce a life cycle costing analysis with a minimum of effort. (Hunter & Kelly 2005).OVID-BV incorporates an Excel based spreadsheet that can be used to produce Whole Life Costing calculations.

THE MECHANICS OF OVID-BV.

One of the key drivers to establishing the support tool mechanism is the need in the public sector to ensure that the decision process is transparent and auditable and, that to be capable of audit, the process must also be measurable (Kelly & Hunter 2003).

In order to build a rational model for the decision making process we must know and understand what needs to be modelled in the first instance. A set of objectives for OVID-BV have been established as follows:

- It is open and transparent.
- The attributes that are taken from the stake holder's value system may be open to analysis and to change if they are felt to be inappropriate.
- The scoring and weighting of the attributes should be explicit and be developed according to established techniques.
- The quantification and setting of probabilities can be sub-contracted to experts, if required, and does not need to be left in the hands of the decision makers.
- The support tool framework should promote discussion within the tender panel and assist in the rationalisation of the decision making process.
- The preferences of the tender panel are recorded and provide an audit trail.

The 8 steps of the process framework utilised by OVID-BV are set out in figure1. The process uses 3 distinct measurement stages which have been designed to assess the BV of a decision as defined by the OGC. Theoretical notes on each of the three stages are provided to aid the reader in understanding the mathematical framework that underpins the operation of OVID-BV.

FIGURE 1.

Figure 1. OVID-BV Process Framework: Step by Step

GENERIC STEP	PROJECT SPECIFIC RESULTS	NOTES.
1. Establish the Decision context.	Council to upgrade its stock to comply with the UK Govts Decent Homes Standard.	
2. Identify the options to be appraised.	Repair the existing window units or replace using either timber, plastic or aluminium double glazed units.	

3. Identify Objectives and Value Attributes.	Value Attributes Thermal efficiency, Sound Insulation, Security, 10 year Guarantee, FENSA Contractor, Sustainability, aesethics.	
4. Weighting the Attributes.	Attribute Weights. Thermal efficiency= 0.176 Sound Insulation= 0.162, Security=0.435 10 year Guarantee =0.034, FENSA Contractor=0.043, Sustainability=0.087, aesethics=0.061.	Measurement Stage 1. Using Analytical Hierarchy Process.
5. Scoring the Options.	Measurement Scale. 0-4 = very poor; 5-8= poor, 9-12=good: 13-16= very good and 17-20=excellent.	Measurement Stage 2 Using Expected Utility Value.
6. Combine the Weights and Scores to produce an overall value.	Overall Utility Value x Attribute Weighting.. Timber=5.90, Plastic= 9.06 Aluminium= 8.54 Existing Steel = 0.00	
7. Cost the Options.	WLC. Timber=8216, Plastic= 5182.08 Aluminium= 7733.05 Existing Steel = 4336.66	Measurement Stage 3 Using Whole life costing and Net Present Value.
8. Examine the Results.	The optimum combination of whole life costing and quality.	Further research to define 'optimum combination'.

Measurement Stage 1: The Analytic Hierarchy Process. (AHP)

The weighting of each value attribute is decided using the analytic hierarchy process. (AHP). This transparent and mathematically robust method has been chosen as it overcomes the difficulties associated with subjective judgements as is the case with Best Value decision making. The process was developed by Thomas Saaty (1980) to assist individuals and groups deal with multi –attribute decision making problems. It is a popular decision tool supported by a large group of practitioners (Bedford and Cooke 2003). The strengths of the AHP method lie in its; (1) ability to decompose a complex decision problem into a hierarchy of sub problems, (2) versatility and power

in structuring and analysing complex decision problems and (3) simplicity and ease of use (Fellows and Liu 2003).

The process commences by determining the relative importance of the attributes in meeting the client organisation's goal, and then pair-wise comparisons are made between the attributes. The strength of the pair wise comparison technique in regard to the Best Value tender analysis process is that it promotes debate between the decision makers with respect to the relative importance of each of the value attributes. In addition, non–specialist users find the pair wise comparison data entry procedures of AHP attractive and easy to undertake (DTLR 2000).Saaty produced a table of scales, which allows the decisions maker's choices to be assessed on a consistent and uniform numerical basis. (See Table 1).

Table 1. Fundamental ratio scale in pair-wise comparison. (Saaty 1980)

Intensity of Importance.	Definition	Explanation
1	Equal Importance.	Two activities contribute equally to the objective.
3	Weak importance of one over another.	Experience and judgement slightly favour one over another.
5	Essential strong importance	Experience and judgement strongly favour one over another.
7	Very strong or demonstrated importance.	An activity favoured very strongly over another; its dominance demonstrated in practice.
9	Absolute Importance.	The evidence favouring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between adjacent scale values.	When a compromise judgement is needed.
Reciprocals	If attribute *i* has one of the above non zero numbers assigned to it when compared with attribute *j* then *j* has the reciprocal value when compared with *i.*	A reasonable assumption.

In terms of calculation of the Attribute Weighting, the simplicity of using the Geometric Mean Method is that (a) its theory can be relatively easily understood by the decision makers as opposed to, say, the right eigenvector method of Saaty's original work and (b) the calculation can be undertaken using the POWER function on an Excel spreadsheet rather than using bespoke software such as EXPERT CHOICE that could act as a 'black box' and mask the relative simplicity and transparency of the calculation that is required.

Measurement Stage 2: The Expected Utility Rule.

The 'Expected–Utility Rule' of Neumann and Morgenstern provides a basic normative model for rational choice under uncertainty showing how individuals should choose between competing options or multi attributes. The rule states that, given certain axioms of rational choice, there is a way of assigning preference scaling over consequences so that that Expected Utility rule determines the decision makers preference ranking over the actions available to him/her. The rule shows by mathematical reasoning that the only way a rational individual could behave is by choosing the option that possessed the maximum expected utility.

The key to understanding the application of utility within OVID-BV is to appreciate that if a rational decision maker's direct preferences over consequences can be defined, then they can be used to order the desirability of the actions open to him/her. The core step is to link the utility of denoting preference over consequences with a utility function being defined over the actions. In broad terms the model converts the measurement of the different types of attributes into a common unit known as utility using a scale that is common to all measurements.

In 1976 Keeney and Raiffa (ibid) produced a linear additive model that, in certain circumstances can be a robust and straightforward approximation to the expected utility rule. Mathematically this can be shown as;

:

$$U_i = p_1 u_{i1} + p_2 u_{i2} + \ldots + p_n u_{ix} = \sum_{j=1}^{n} p_i u_{ij}$$

Where:

U_i is the overall utility (preference score of option *i).*

u_{ij} is the utility of option *i*, if having chosen option *i,* it actually transpires that the state of the acting subject *j* occurs.

p_j is the decision makers' best judgement of the probability that the future state of the world *j* will occur.

This says that the overall utility, U_i of an option *i* is calculated in a relatively simple way; as the mathematical expectation (the probability-weighted average) of the elementary utilities, u_{ij} of all the associated consequences. The equation is also simply additive over the states of the acting subject (Hirshleifer & Riley 2002).The advantage of the additive form is its simplicity e.g. In order to determine the overall utility function for any alternative a decision maker need only determine *n* utility functions for that alternative ,where *n*= the number of criteria used.(Hatush and Skitmore 1998).

Measurement Stage 3: Whole Life Costing (WLC)

Long-term costs over the life of a building are more reliable indicators of BV than initial construction cost because money spent on appropriate materials and products can be saved many times over in the construction and maintenance costs. WLC is an economic evaluation method that accounts for all relevant costs over the investor's time horizon adjusting for the time value of money. The relevant costs include; (i) the investment costs such as construction costs, fees, development grants (ii) energy costs and (iii) Maintenance costs including planned cyclical maintenance and servicing and unplanned maintenance and repair. The investor's time horizon is the period for which the investor has an interest in the buildings life and the time value of money is shown by calculation of the present value of the relevant costs expended over the specific time horizon using the standard Present Value formula. In the public sector it is usual for the Treasury discount rate to be applied to the calculation. (Martin and Kelly 2006).

REPAIR OR REPLACE? AN ANALYSIS USING OVID-BV.

Choice and weighting of the quality attributes.

The overarching decision context is that the Council has to upgrade its stock by 2010 to comply with the Government Decent Homes Standards[7] and provide dwellings with (a) reasonably modern facilities and services and (b) a reasonable degree of thermal comfort. As part of the Council's programme of compliance it was decided to upgrade the existing window units throughout their stock and the decision options they required to be appraised were (a) repair the existing steel 'crittall-type' windows or (b) replace the existing windows using double glazed units made of either (i) aluminium (ii) plastic or (iii) timber.

OVID-BV was used as a decision support tool to assist the Council for 3 main reasons;

(i) It was specifically developed to analyse BV decisions in the UK Public Sector.

(ii) It provides a method for assessing the relative merits of using different materials for the new window units.

(iii) It provides an audit trail for the decision to repair or renew the existing windows which is crucial to showing that the costs of the works were 'reasonably incurred'.

The nature of the value attributes to be assessed were driven by the aim and objectives of complying with the Decent Homes Standard and was determined by consultation between the Council and its stakeholders, including tenants, leaseholders and professional consultants. The full list of attributes considered by the decision making group [DMG] is shown in table 2.

Table 2: Full list of value attributes considered by the decision making group.

	List of Attributes to be Considered.
1	Compliance with Decent Homes Standards
2	Security.
3	FENSA registered contractor,
4	aesthetics,
5	means of escape requirements,
6	sound insulation,
7	thermal insulation/energy efficiency
8	ventilation

[7] For the full definition of 'Decent Homes Standard' please refer to the Office of the Deputy Prime Ministers website. http://www.communities.gov.uk/index.asp?id=1153924

9	Planning approval.
10	Sustainability/Green construction.

The attributes only addressed subjective quality issues i.e. none of the attributes addressed cost which is accounted for in the whole life costing process. By discussion and using value judgements a final list of seven criteria was agreed upon. The attributes reflected the client's value system at both a corporate and project level by including issues to be considered such as sustainability, thermal efficiency and use of FENSA registered contractors. Using the AHP spreadsheet the DMG ranked the value attributes in accordance with their perceived value to the overall aim and objectives of the project. The decisions taken are illustrated in table 3 with the overall weighting calculation for each attribute being set out in table 4.

Table 3. Pair Wise Comparison of the Chosen Attributes.

Criteria.	10 Year Guarantee	FENSA	U-Value	Sustainability	Sound	Aesthetics	Security
10 Year	1	1	1/5	1/3	1/5	1/3	1/9
FENSA	1	1	1/3	1/5	1/3	1	1/9
U -Value	5	3	1	3	1	3	1/3
Sustainability	3	5	1/3	1	1/3	1	1/5
Sound	5	3	1	3	1	5	1/3
Aesethics	3	1	1/3	1	1/5	1	⅓
Security	9	9	3	5	3	7	1

Table 4: The final weighting of the chosen attributes.

	Criteria	**Geometric Mean**	**Total**	**Weight.**
1	10 Year Guarantee.	(1x1x1/5x1/3x1/5x1/3x1/9) ⅐	0.337	0.034
2	FENSA	(1x1x1/3x1/5x1/3x1x1/9) ⅐	0.424	0.043
3	Thermal Efficiency.	(5x3x1x3x1x3x1/3) ⅐	1.723	0.176
4	Sustainability	(3x5x1/3x1x1/3x1x1/5) ⅐	0.855	0.087

5	Sound Insulation	(5x3x1/3x1x3x1x5x1/3) ⅐	1.584	0.162
6	Aesethics	(3x1x1/3x1x1/5x1x1/7) ⅐	0.602	0.061
7	Security .	(9x9x3x5x3x7x1) ⅐	4.261	0.435
	Sum		9.785	1.00

Measuring the design options against the criteria.

The DMG then carried out an assessment of the anticipated performance of each type of window units against each of the value attributes they had decided upon. A point's score system was used as follows: 0-4 = very poor; 5-8= poor, 9-12=good: 13-16= very good and 17-20=excellent. Numerically similar systems are currently being used within the UK construction industry so the DMG was familiar with the process. The importance of scoring in this manner is that it allows the decision maker to incorporate his/her personal experience, preferences, heuristics and biases as part of the process and should promote discussion within members of the DMG. In terms of an audit trail it also provides a transparent indication of the way in which each individual decision maker perceived the performance of the different types of window units. The scores were recorded in a performance matrix and a completed matrix for one member of the DMG is shown in table 5.

Table 5: Completed score matrix for an individual member.

Type of window unit / **Value Attribute.**	**Timber**	**Plastic**	**Aluminium**	**Existing Steel**
10 Year Guarantee	16	16	16	10
FENSA	17	17	17	0
Thermal Efficiency	12	18	18	5
Sustainability	17	11	12	5
Sound Insulation	11	16	14	8
Aesethics	15	13	17	12
Security	12	18	16	5

Scoring System:

0-4 = very poor; 5-8= poor, 9-12=good: 13-16= very good and 17-20=excellent.

Once the scorings were completed the software created the utility function which represents the decision maker's attitude to uncertainty. The utility function was constructed on an attribute by attribute basis by taking the best and worst scores , *b* and *w*. for each attribute fixing the parameters of the utility function *u* by the arbitrary choice *u(w) =0* and *u(b)* =1. The scale is an arbitrary interval scale and, customarily, the two arbitrary end points often used for utility scales are 0 and 1. The 0 does not mean utter worthlessness, but simply designates the lowest score and, similarly, 1 represents the highest score. The shape of the utility function represents and provides a set of preference judgements about the relative desirability or satisfaction. The software assigns intermediate levels on the scale between the highest and lowest score to provide a measure for the preference judgment.

In this particular case it was agreed that that the DMG comprised individuals who were all risk neutral which means that the utility function is represented by a straight line and that each unit in the scoring results in an equal change in a measure of utility level. In future versions of OVID-BV it is anticipated that utility functions could also be constructed to represent decision makers who are risk averse or risk prone by the use of concave and convex curves respectively.

Calculating the Overall Utility Values.

The results of the conversion of scores to utility is best shown graphically and graph 1 shows the utility function for the scores given against the sustainability attribute and the intermediate levels produced from using the scale of the highest score = 1 and the lowest score =0. The same results are shown in a tabulated form in table 6. The process is repeated to produce a utility function for each of the attributes and the software provides both a graph and utility value for the other scores. The completed matrix showing the utility values for each individual attribute is shown in table 7.

Graph No 1: The utility function for the sustainability attribute.

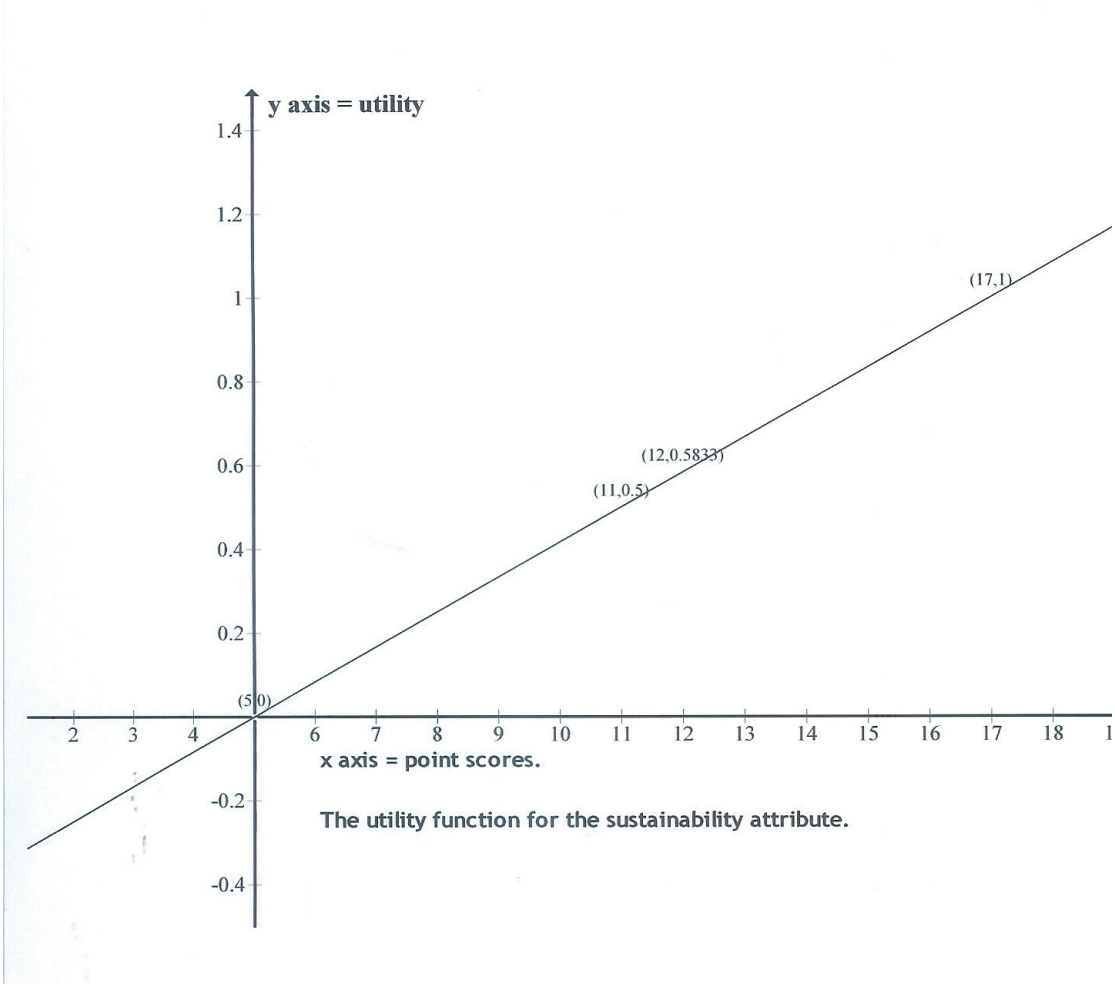


Table 6: Conversion of scores to utility.

Type of window unit / **Value Attribute.**	**Timber**	**Plastic**	**Aluminium**	**Existing Steel**
Sustainability	17	11	12	5
Utility.	1	0.5	0.583	0

Table 7: Completed score matrix for utility values for an individual member.

Type of window unit / **Value Attribute.**	**Timber**	**Plastic**	**Aluminium**	**Existing Steel**
10 Year Guarantee	1	1	1	0
FENSA	1	1	1	0
Thermal Efficiency	0.5385	1	1	0

Sustainability	1	0.5	0.583	0
Sound Insulation	0.375	1	0.75	0
Aesethics	0.6	0.2	1	0
Security	0.5385	1	0.8462	0

The next step is to determine the overall utility for each criteria which is simply the utility multiplied by the weighting that was previously worked out in measurement stage 1 using AHP. The overall utility values are shown in table 8 with the utility values having been multiplied by a factor of 10 to make them easier to interpret.

Table 8: Completed overall utility values for an individual member. [Utility value multiplied by the attribute weighting].

Type of window unit / **Value Attribute.**	**Timber**	**Plastic**	**Aluminium**	**Existing Steel**
10 Year Guarantee	0.034	0.034	0.034	0
FENSA	0.043	0.043	0.043	0
Thermal Efficiency	0.094776	0.176	0.176	0
Sustainability	0.087	0.0435	0.050721	0
Sound Insulation	0.06075	0.162	0.1215	0
Aesethics	0.0366	0.0122	0.061	0
Security	0.2342475	0.435	0.368097	0
SUM	**0.5903735**	**0.9057**	**0.854318**	**0**
TOTAL	**5.90**	**9.06**	**8.54**	**0.00**

The Whole Life Costs.

The third and final stage of the measurement process was to calculate the whole life costs for each of the alternatives. The costings were calculated using an Excel spreadsheet with the investor's time horizon of 50 years being equal to the time period of commercial loans taken out by the Council against the bricks and mortar asset of the housing stock. The cost data for the installation works of the various window units was provided by the Council's cost consultant and comprised; historical cost data of similar works, repairs and redecoration costs taken from the Council's in-house schedule of rates, all supplemented by data from standard pricing books. It was agreed

that in order to ensure that the present value calculations were comparable the WLC would be calculated on the basis of the repair/renewal costs to a ground floor traditional build flat comprising 7 window openings. Finally, the treasury discount of 4% was applied to the WLC though the calculation also took account of a range of interest rates. The results of the WLC are shown in table 9. A comparison of the results for both the overall utility and the WLC at the treasury discount rate are shown in table 10.

Table 9: Whole Life Costing Results Comparison Table.

Interest Rate ---------- Window Unit	**4%**	**6%**	**7%**	**8%**	**10%**
Renew in UPVC	5182.08	5063.29	5019.44	4983.14	4927.45
Renew in Timber	8216.37	7461.11	7254.11	7113.01	6950.25
Renew in Aluminium	7733.05	7022.22	6827.39	6694.60	6541.41
Repair existing	4336.66	3979.83	3846.63	3735.84	3564.31

Table 10. Comparison of expected utility and WLC process.

Course of Action	**Renew in UPVC**	**Renew in Timber**	**Renew in Aluminium**	**Repair Existing windows.**
Overall Utility Value	9.06	5.90	8.54	0.00
WLC at 4%	5182.08	8216.37	7733.05	4336.66

Interpretation of the Results.

The results indicate that if lowest cost was the only factor to be considered then the best course of action, even over the life of the housing stock, would be to simply undertake repairs to the existing window units. However it is important to recall that the terms of reference for the development of OVID-BV were framed around the Office of Government Commerce's definition of BV which states that BV is the optimum combination of whole life costing and quality to meet the user's requirements and provide benefit to the client. Therefore if the existing windows were to be only repaired then the Council would not be able to comply with the

Governments Decent Homes Standard criteria and their resident's expectations i.e. the user's requirements, would be left unfulfilled, consequently, the repair of the existing windows cannot represent the BV option .
The results of the evaluation of the quality attributes indicate that the rational option would be to install new double glazed plastic window units though clearly the installation of aluminium window units is also worthy of consideration as an alternative course of action. Whilst the results and opinions of the other members of the DMG would need to be considered there is a case for undertaking further evaluation of these two options in order for the DMG to produce a final decision. OVID-BV can be used to undertake the further evaluation work as the same process can be used to compare and evaluate specific plastic or aluminium window products.

OVID-BV can also be used to evaluate the choice of a window unit where certain restrictions are applied to the choice process. For example the same process could be undertaken for the repair or renewal of windows located within buildings in the housing stock that are over, say, 4 storeys, as throughout the UK construction industry there is a general preference for installing aluminium window units in medium and high rise blocks of flats.

The final requirement of the Council was that OVID-BV would indicate whether or not the costs of any renewal works could be deemed to be *reasonably incurred* so that the Council could recover service charge costs for the works from their leaseholders. Though the repair of the existing the window units represents the best option with respect to whole life costing it is argued that, it would be unreasonable for the Council to fail to comply with the terms of the Decent Homes Standard programme and it would also be unreasonable for Councils residents, both tenants and leaseholders, to use window units that didn't fulfil their expectations with respect to security, thermal efficiency, and sound insulation criteria. It is proposed that the results of the OVID-BV assistance in the decision making process could be used to underpin the Councils case in any challenge they may face from their lessees either at the Leasehold Valuation Tribunal or through the courts.

CONCLUSIONS.

The paper has demonstrated that OVID-BV is a meaningful support tool in aiding management decisions and choices relating to Best Value based procurement. The tables and graphs that record the choices made provide a transparent and auditable trail for the decision making process. Further research is being undertaken at Loughborough University to address the current limitations of OVID-BV such as producing windows front end software to allow the process to be user friendly and enhance the variety of available functions so that OVID-BV can also take into account not only risk neutral decision makers but also risk prone and risk averse decision makers as well so that the results can be subjected to sensitivity analysis. Research is also being carried out to explore the term 'optimum combination' with the objective of producing a mathematically robust process for assisting in the interpretation of the results to provide a view as to the course of action which provides the optimum combination of whole life costing and quality to meet the users requirements.

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APPENDIX E: PAPER 5.

FULL REFERENCE

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The Development of a Tender Analysis Support Tool for Use in Social Housing Best Value Procurement.

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A number of studies have highlighted the problems and challenges that have been encountered with the analysis of best value tenders carried out in the UK public sector. This research has developed a methodology which enables project stakeholders to streamline the tender analysis procedure allowing tenders to be dealt with effectively and efficiently whilst also creating a transparent and auditable decision making process. A robust support tool has been developed which aids the multi objective decision making process by provoking rational discussion with respect to; the construction industry's key performance indicators (KPI's), the client's attitude to risk and provides a transparent audit trail of the decisions taken. The underlying rationale for the support tool is based on a combination of the analytic hierarchy process (AHP), multi utility attribute theory (MAUT) and whole life costing (WLC). The methodology has been developed into user friendly software and the paper demonstrates the practical utility of the tool in operation.

Key Words: Best value, contractor selection, factor analysis, multi attribute utility theory, whole life cycle costing.

Introduction

Changing world markets, coupled with the introduction of new technology and a rise in clients expectations have stimulated reviews of how the construction industry delivers value. The International Council for Research and Innovation in Building and Construction has clarified the definition of 'revaluing construction' as "*the maximisation of value jointly created by stakeholders to construction and the equitable distribution of the resulting rewards*" (Barrett 2005). For the purposes of this paper stakeholders are defined as groups, or individuals, who have a stake in, or expectation of a projects performance (Newcombe 2003). Within the UK this global concept of revaluing construction has been applied to many sub-sectors of the industry, particularly public sector projects. In 2003 the Gershon Review examined the process of acquisition in the public sector and indicated that these changes to the method of procurements could deliver value for money gains of £1 billion. This research focuses on the effect that the implementation of best value procurement has had on the structure and operation of the tendering process within the social housing sector and examines how best value procurement can be approached more effectively and efficiently to assist in delivering the savings identified by the Gershon Review. The social housing sector was identified for research as it is responsible for a programme of construction, maintenance and refurbishment works currently valued at £1 billion GBP (DTI 2003) with a significant proportion of those works being financed by the public purse.

Background.

Social Housing provision within the UK operates under the control of two main groups of organisations. The first is the housing provided and managed by Local Authorities (commonly called council housing), and the second is the housing provided and managed by

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Housing Associations and other organisations, which together form the "voluntary housing movement". The welfare of these housing associations falls under the umbrella control of the Housing Corporation, which is a central government financed quango formed to promote and assist the development of housing associations. The term "registered social landlord" (RSL) is used as a collective term for both housing associations and local authorities as providers of social housing.

RSL's are regular procuring clients to the construction industry. In 1998 the Egan report identified that their corporate strategy and operational procedure could be influenced and regulated by Government policy so that these organisations could offer better value. The Government has taken positive steps to ensure that the public sector have to embrace value based procurement and on the 1st April 2000 new legislation was enacted so that Local Authorities in England and Wales must implement the best value process to all the public services that they control and requires them to be reviewed. This compelled them to develop and to show continuous improvement with respect to the efficiency, effectiveness and economy of their procurement practices. The Housing Corporation has issued similar instructions so that Housing Associations must aim to deliver continuous improvements and value for money in their services by using best value techniques. These include challenging what they do, making comparisons with others, consulting people affected by their services and providing the services at competitive standards and prices. The wishes of residents and others are balanced against available resources within a clear and transparent framework according to the principles of best value (Housing Corporation 2005). The edict from the housing corporation and the change in legislation has lead to a significant departure from traditional lowest bid tendering and introduces new variables into the decision making process. When selecting a best value proposal the RSL's should carefully balance the procurement objectives and value for money criteria within the need to comply with public procurement principles and governing rules/regulations in a public accountability framework (Palaneeswaran *et al* 2003). Ideally, service users and stakeholders should also be proactively involved at all stages of the procurement and service design /delivery process to enable them to exercise informed choices upon the project cost and quality (Housing Inspectorate AC 2005).

The processes of change is never easy and, historically, there are acknowledged problems with large public sector organisations embracing change (Thomas Cain 2003).Therefore there is no reason why the cultural change required in implementing best value procurement should have been received any differently by the public sector. A literature review was carried out and the following challenges were identified as currently being encountered by public sector client organisations when implementing value based procurement;

> Most procurement is not carried out by designated procurement staff, the procurement staff are often consulted too late in the procurement process and the majority of procurement staff do not hold professional qualifications. (National Audit Office 2004).
>
> Creating a consensus vision between key stakeholders is problematic but maintaining this over time and achieving progressive implementation is harder still (Barrett 2005).
>
> The difficulties being encountered are exacerbated by the number and diversity of best value attributes that can be considered by the various stakeholder groups (Austin 2005).
>
> If too many attributes are considered the process of evaluation will become paralysed with too many options to consider (Woodhead and McCuish 2003).

- Contractors have a negative perception that the best value tender interview is a game of appearance and marketing skills and there is insufficient time to conduct a relatively standard tender evaluation process. (Griffith *et al* 2003).
- The failure of RSL's to provide clear and transparent audit trails of their best value tender analysis process has lead to arbitration tribunals finding against them in

service charge disputes, resulting in a financial loss for the RSL's concerned. (Phillips *et al* 2004).

The Aim and Objectives of the Research.

A research project was established with the overarching aim of developing a robust, transparent methodology to assist RSL's and their stakeholders in analysing best value tender documents in the social housing sector. It was intended that the methodology should address, both, the identified problems and be used as the underpinning rationale to produce a tender decision support tool. Prior to developing the methodology it was important to establish a definition of best value that could be readily adopted for use by the RSL's. There is no universal definition for the term 'best value' (Choi 1999) but for the purpose of this research the following definition produced by the Office of Government Commerce for use within the UK public sector has been applied;

> *" [Best Value is] the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements, as it is the relationship between long-term costs and the benefit achieved by clients that represents value for money."* (Office of Government Commerce 2003).

On establishing the best value definition the main objectives for the development of the support tool were set as follows; (a)Establish the core value attributes assessed during the tender analysis process, (b)Identify and develop a transparent and robust method for subjectively measuring best value which assess multi attribute criteria and utilises whole life costing rather than simply using the initial capital costs of the project, (c) utilise the identified core value attributes and the developed methodology to develop a software tool to provide a transparent audit trail of the best value analysis process and (d) validate the tool by pragmatic application.

The Development of the Methodology For The Tender Analysis Support Tool.

Establishing the core value attributes.

There were two consistent themes that ran through the identified problems: (a) the number of different attributes to be considered are causing difficulties in the decision making process of tender panels and (b) that the high volume of tenders cannot be dealt with effectively as there is a lack of professional staff/support to assist in the new procurement process. It was envisaged that the use of a smaller number of named core attributes could increase the efficiency of the tender analysis procedure and assist the non-professional support staff in their understanding of the process. The use of standard criteria to lighten the selection burden for both clients and contractors has been mooted before in 2000 by Wong *et al* but this is the first time that research has been undertaken to identify standard criteria for contractor selection with respect to value criteria. A comprehensive literature review was carried out and 35 independent attributes were identified as potentially being considered by stakeholders during a best value tender analysis process.

To obtain information on these 35 attributes a postal questionnaire survey was undertaken. The attributes were listed in the questionnaire and the respondents were requested to provide an opinion on the importance of each attribute. Responses to each question were measured on a 5-point Likert scale from 'Vital' to 'Not Required'. In total 195 questionnaires were sent to known individual contacts operating within the UK social housing sector representing a cross section of the five stakeholder groups comprising: (i) RSL's, (ii) contractors, (iii) construction consultants and residents (end users) divided up into (iv) leaseholders and (v) tenants. 79 questionnaires were returned in a useable format and the response rate of 42% was considered favourable compared with the norm of 20-30% expected from most postal questionnaire surveys of the construction industry. The responses to the questionnaire were collated and were subjected to analysis using the Statistical Package for Social Sciences (SPSS) v.15 for Windows. Principal component analysis [PCA] was chosen as the data reduction method for two main reasons (i) to reduce the number of attributes and (ii) to identify or detect a structure in the relationship between the attributes and classify the attributes into sets of factors. The

analysis produced a ten factor (or core attribute) solution with eigenvalues greater than 1, explaining 71.3% of the variance. A varimax orthogonal rotation was used to further interpret the 10 factors. Rotation techniques, such as the varimax method, transformed the component matrix produced from an unrotated principal component matrix into one that was easier to interpret.

The nature of the items loading on the 10 principal factors was analysed to interpret the core element being measured by the groupings around each factor and consequently to provide a collective name for the factor. The results are shown in Table 1 which represents the 10 core attributes to be assessed in a contractors best value tender bid.

Table 1: The 10 Identified Core Attributes.

Component Number.	Name of Component Grouping	% of Variance	Cumulative %
1	Understanding of Clients Objectives.	28.146	28.146
2	Innovative management.	8.232	36.377
3	Successful track record.	6.623	43.000
4	Innovative on-site practices.	5.820	48.820
5	Quality management procedures.	4.837	53.658
6	Transparency of cost data.	4.234	57.891
7	Understanding of Partnering.	3.840	61.732
8	Established Policy. (Health &Safety, Environmental)	3.446	65.178
9	Understanding of Best Value.	3.161	68.340
10	Technical Ability.	2.968	71.308

Consideration of Multi Attribute Criteria.

In best value procurement analysis the individual attributes need to be assessed as to how important they are with respect to a specific project. There are many methods of considering and assessing competing multiple objectives in decision making (DTLR 2000). When a rational decision involves the consideration of multiple objectives (and it must do if the OGC definition of best value is used) then multiattribute utility theory (MAUT) may be used as the basic foundation for applying decision analysis. The theory explicitly addresses the value trade-offs and uncertainties that are invariably the focus of multiple objective decisions. (Keeney and Raiffa 1976). This approach was developed by Keeney (1992) into a set of procedures that combines the main advantages of simple scoring techniques and optimisation models. (Hatush and Skitmore 1998). Utility is a measure of desirability or satisfaction and provides a uniform scale to compare the clients various value attributes against each other. In general, it provides a method of comparing manifestly different types of attributes on a 'like for like' basis which is essential in best value decision making as tender panels are expected to judge the relative benefits of diverse attributes such as health and safety and innovative construction methods on a level playing field The key to understanding the application of utility in this way is to appreciate that if a rational decision maker's direct preferences over consequences can be defined, then they can be used to order the desirability of the actions open to him/her. If an appropriate utility is assigned to each possible consequence and the expected utility of each alternative is calculated then the best course of action is the alternative with the highest expected utility. The importance of the Keeney and Raiffa work (ibid) is that they produced a linear additive model of the expected utility theory that mathematically can be shown as;

$$U_i = p_1 u_{i1} + p_2 u_{i2} + \ldots + p_n u_{ix} = \sum_{j=1}^{n} p_i u_{ij}$$

Where: U_i is the overall utility (preference score of option *i).* u_{ij} is the utility of option *i*, if having chosen option *i,* it actually transpires that the state of the acting subject *j* occurs. p_j is the decision makers' best judgement of the probability that the future state of the world *j* will

occur. This says that the overall utility, U_i of an option *i* is calculated in a relatively simple way; as the mathematical expectation (the probability-weighted average) of the elementary utilities, u_{ij} of all the associated consequences. The equation is also simply additive over the states of the acting subject providing the attributes being considered are mutually preferentially independent of each other. (Hirshleifer & Riley 2002).The advantage of the additive form is its simplicity e.g. In order to determine the overall utility function for any alternative a decision maker need only determine *n* utility functions for that alternative ,where *n*= the number of criteria used.(Hatush and Skitmore *ibid*).

A utility function can be constructed by assuming that there are best and worst alternatives, *b* and *w*. and we can fix the parameters of the utility function *u* by the arbitrary choice *u (w) =0* and *u(b)* =1. Since utility is an ordinal rather than a cardinal concept these utility values are arbitrary, therefore the 0 does not mean utter worthlessness, but simply designates the lowest score and, similarly, 1 represents the highest score. It is helpful if the utility function is depicted graphically as the shape of the resulting utility curve can be divided into three broad categories dependent upon whether the decision maker is risk averse, risk neutral or risk prone .It is also important to note that an individual will probably have a different utility function compared to a group and utility evaluations of individuals cannot simply be added together to obtain group utility. The optimum solution is for the client organisation to give guidance on their risk attitude or simply compare the results for each risk attitude prior to making the final decision.

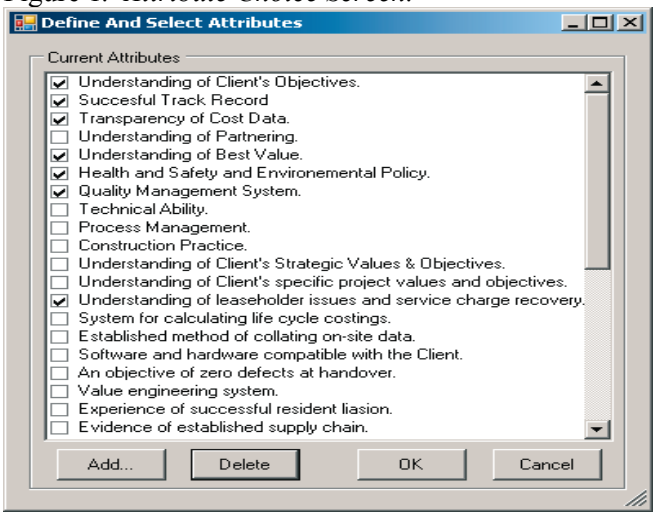
Whole Life Costing.

The final part of the best value definition to be considered was that long-term costs over the life of a building are more reliable indicators of best value than initial construction cost because money spent on appropriate materials and products can be saved many times over in the construction and maintenance costs. Whole Life Costing [WLC] is an economic evaluation method that accounts for all relevant costs over the investor's time horizon adjusting for the time value of money. The relevant costs include; (i) the investment costs such as construction costs, fees, development grants (ii) energy costs and (iii) Maintenance costs including planned cyclical maintenance and servicing and unplanned maintenance and repair. The investor's time horizon is the period for which the investor has an interest in the buildings life and the time value of money is shown by calculation of the present value of the relevant costs expended over the specific time horizon using the standard Present Value formula. In the public sector it is usual for the Treasury discount rate to be applied to the calculation. (Martin and Kelly 2006).

The Functionality of The Support Tool.

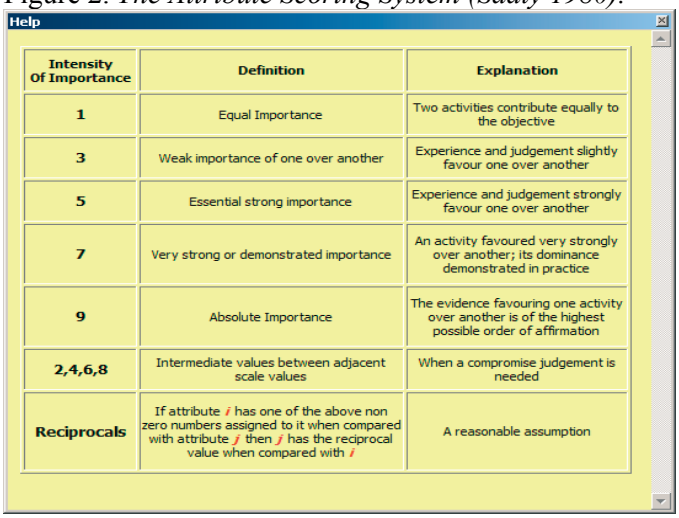
The support tool methodology has been developed into a software package which **O**ptimises **V**alue **I**n **D**ecision-making for **B**est **V**alue and has become known by the acronym of OVID-BV.It has been successfully used by RSL's and their stakeholders to provide a transparent audit trail of the tender analysis decisions in a number of projects . This section provides an overview of the operation and functions of OVID-BV during the best value decision making process but does not reproduce the complete tender analysis process. The initial step is for the stakeholders to choose their project specific attributes from a drop down menu which includes not only the ten core attributes identified by the PCA but also all the other value attributes established by the literature review. The attributes are mutually preferentially independent of each other which allows the additive form of the utility function to be used. The software also provides a facility for new attributes to be added as necessary. In this example the stakeholders decided that it was appropriate to consider 7 key project specific attributes. (*Figure 1*).

Figure 1. *Attribute Choice Screen.*



The assessment process commences by determining the relative importance of each attribute in meeting the client organisations project specific goals, by making pair-wise comparisons between them. The pair wise comparison method utilises the analytic hierarchy process (AHP). The process was developed by Thomas Saaty (1980) to assist individuals and groups deal with multi –attribute decision making problems and Saaty's scoring system is shown in Figure 2. The weighting of each attribute is calculated using the Geometric Mean Square method and shown in figure 3.

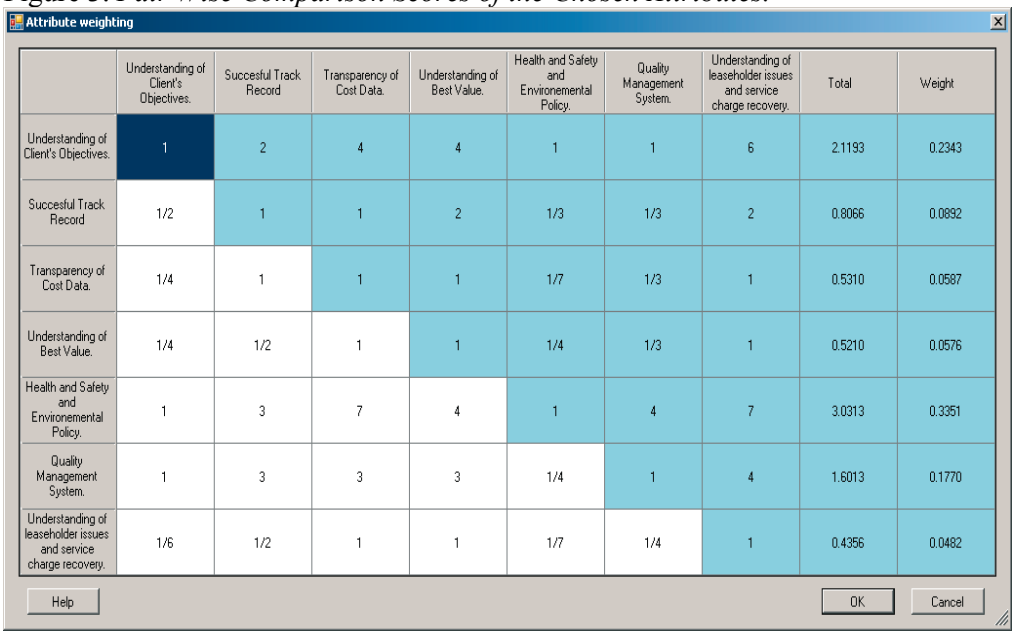
Figure 2. *The Attribute Scoring System (Saaty 1980).*



Intensity Of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgement slightly favour one over another
5	Essential strong importance	Experience and judgement strongly favour one over another
7	Very strong or demonstrated importance	An activity favoured very strongly over another; its dominance demonstrated in practice
9	Absolute Importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent scale values	When a compromise judgement is needed
Reciprocals	If attribute *i* has one of the above non zero numbers assigned to it when compared with attribute *j* then *j* has the reciprocal value when compared with *i*	A reasonable assumption

AHP is a popular decision tool supported by a large group of practitioners (Bedford and Cooke 2003). The strengths of the AHP method lie in its; (1) ability to decompose a complex decision problem into a hierarchy of sub problems, (2) versatility and power in structuring and analysing complex decision problems and (3) simplicity and ease of use (Fellows and Liu 2003). The strength of the pair wise comparison technique in regard of the best value tender analysis process is that it promotes debate between the members of the tender selection panel with respect to the relative importance of each of the value attributes. In addition, non–specialist users find the pair wise comparison data entry procedures of AHP attractive and easy to undertake (DTLR 2000).

Figure 3. *Pair Wise Comparison Scores of the Chosen Attributes.*



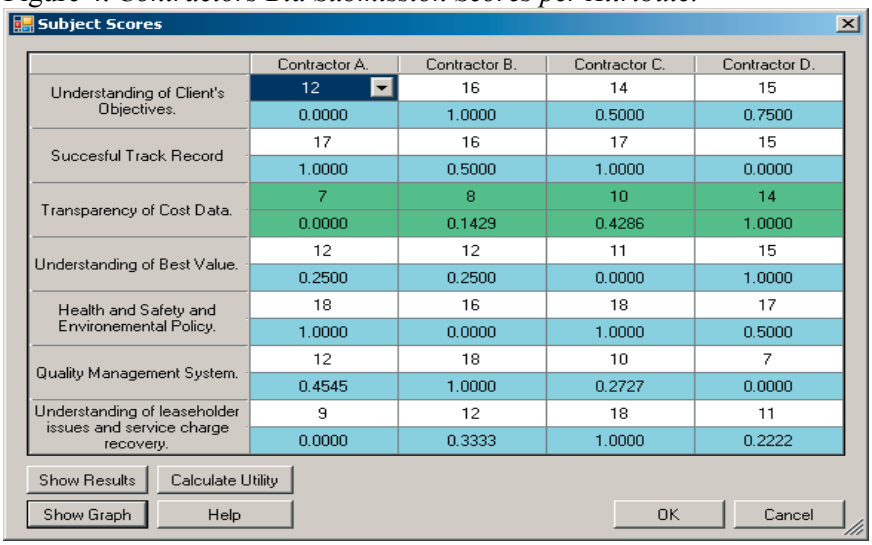
	Understanding of Client's Objectives.	Succesful Track Record	Transparency of Cost Data.	Understanding of Best Value.	Health and Safety and Environemental Policy.	Quality Management System.	Understanding of leaseholder issues and service charge recovery.	Total	Weight
Understanding of Client's Objectives.	1	2	4	4	1	1	6	2.1193	0.2343
Succesful Track Record	1/2	1	1	2	1/3	1/3	2	0.8066	0.0892
Transparency of Cost Data.	1/4	1	1	1	1/7	1/3	1	0.5310	0.0587
Understanding of Best Value.	1/4	1/2	1	1	1/4	1/3	1	0.5210	0.0576
Health and Safety and Environemental Policy.	1	3	7	4	1	4	7	3.0313	0.3351
Quality Management System.	1	3	3	3	1/4	1	4	1.6013	0.1770
Understanding of leaseholder issues and service charge recovery.	1/6	1/2	1	1	1/7	1/4	1	0.4356	0.0482

The next stage is to assess the contractor's tender submissions with respect to each of the chosen attributes. One of the innovative aspects of the tool is that in MAUT the utility function uses a uniform scale to assess the RSL's value attributes against each other and provides a method for comparing and scoring different types of attributes on a 'like for like' basis. As utility is a measure of desirability or satisfaction each of the contractor's tender submissions is scored against the chosen attributes on the basis of the decision maker's satisfaction (or belief) that the contractor could successfully deliver on the claimed benefit to the end users made within the tender documentation. The point's score system used was as follows: 0-4 = very unlikely; 5-8= unlikely, 9-12=fair: 13-16=very likely, 17-20=certainty. Numerically similar systems are currently being used within the UK construction industry though they assess content of the tender submission documents rather than belief in successful delivery by the contractor. The importance of scoring in this manner is that it allows the decision maker to incorporate his/her personal experience, preferences, heuristics and biases as part of the contractor selection process and should promote discussion between members of the tender analysis team. In terms of an audit trail it also provides a transparent indication of the way in which the panel viewed each contractor's submission and how they perceived the contractors chance of successfully delivering the product. In addition it was decided, where possible, to link the scoring of each attribute to key performance indicators (KPI) which measure factors critical to the success of projects. Benchmark scores produced from KPI's are stated as percentages and are an indication of performance relative to the whole construction industry. If a benchmark score for a specific contractor is given as 49% this means that 49% of projects nationally have equal or lower performance and 51% of projects have higher performances (Constructing Excellence 2006).

The assessment of each contractor's anticipated performance against the value attributes was then carried out. For example with respect to criteria number 5 addressing a contractors environmental policy a contractor stated in their bid documents that the estimated annual energy use for a refurbishment scheme is 919kg CO2/ 100m2. By using the Constructing Excellence KPI Graph this equates to a benchmark score of 65% which was deemed acceptable within the contract specification. The tender panel then assessed from the content of the bid submission their belief as to whether or not the contractor could deliver the stated quality standard and marked the submission accordingly. The benefits of using this scoring method are envisaged as: (i) a contractor will provide realistic technical details including calculations to support their bid submissions. (ii) It encourages the contractor to utilise their specialist knowledge for the benefit of the client and end user. (iii) The KPI forms the basis

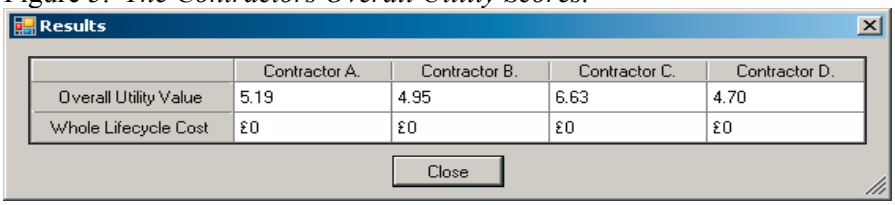
for both monitoring the contractor's performance and providing feedback to drive continuous improvement. (iv) The scorecard highlights potential anomalies in the assessment of the bids. If a contractor has stated they could achieve a high KPI percentage score, say 95%, for a particular attribute but are only awarded a low performance score, say 8 or less, this will be highlighted and can be discussed further between the tender panel members. It is acknowledged that the scoring system is subjective but it is based upon quantifiable measures i.e. KPI's and Utility.

Figure 4. *Contractors Bid Submission Scores per Attribute.*



The software calculates a utility function for each of the attributes and assigns a utility value of 1 for the best contractor score and a utility value of 0 for the worst score, though as utility is an ordinal concept the 0 does not mean utter worthlessness. In Figure 4 each attribute has two scores shown against it, the upper figure is the score given by the tender assessment panel whilst the lower figure is the utility score. The software can also depict each attribute's utility function graphically for audit trail purposes and as it was decided that the RSL's group attitude to risk was neutral the utility function was depicted as a straight line. As the additive form of the utility function has been used the contractors utility scores for each attribute are first multiplied by the previously calculated attribute specific weighting shown in the far right column of figure 3 and then added together to produce an overall score.*(Figure 5)*.

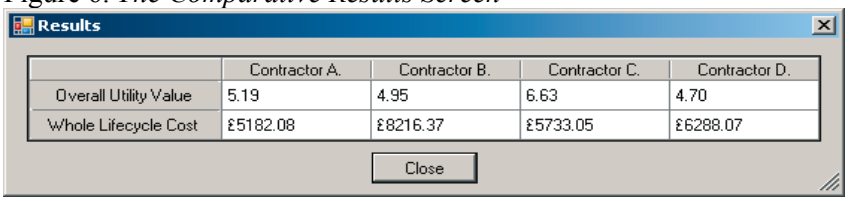
Figure 5. *The Contractors Overall Utility Scores.*



Though the expected utility theory states that the rational course of action would be to appoint the contractor with the highest overall utility value the OGC definition of Best Value requires that the successful contractor should provide the 'optimum combination of whole life costs and quality to meet the users' requirements'. The importance of cost could, in theory, have been considered as one of the original project specific attributes, but the OGC have stated that the recommended approach to Best Value evaluation is to differentiate the financial and non-financial criteria for consideration in separate strands and that attempts to balance these criteria during the process are to be avoided (OGC 2004).Therefore OVID-BV addresses the question of the importance of cost at the end of the process not at the beginning. There are a number of software packages that can calculate whole life costs though OVID-BV calculates the required costs using a specially adapted Excel spreadsheet. Finally, the results screen presents the Overall Utility Value score for each contractor assessed against the calculated Whole Lifecycle Cost for that contractor. *(Figure 6)*. Self evidently the results provide

guidance only with respect to the choice of the successful contractor and the support tool cannot and should not replace management review and judgement.

Figure 6. *The Comparative Results Screen*



Conclusions

OVID-BV has met the original aim and objectives of the research in providing a standardised format for analysing Best Value tenders in the UK social housing sector with the use of a comprehensive but standard set of value attributes allowing the tender analysis process to be carried out in a more expeditious and efficient manner. Whilst MAUT has proved to be a notoriously difficult concept to explain, the sub-concepts of satisfaction, belief, and end user benefit have been readily understood and embraced by the various stakeholder groups in trialling the support tool which has allowed them to carry out the scoring process with a minimum of difficulty. Though not all the users of OVID-BV have been able to grasp the concept of the additive utility function, the concept of the value attributes being assessed on a 'level playing field' has been ,almost, universally accepted by the users. The windows based software has not only made the tender analysis process more user friendly for non professionals but has also assisted the stakeholders in understanding that best value is not simply about measuring capital cost or quality but is concerned with the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements. The limitations of the methodology are acknowledged and further research is addressing these issues. Research is being undertaken to move away from the subjective scoring of an attribute using KPI values and try and link the KPI percentage to a particular score on the 0-20 scale currently being used. Even if this can be achieved it is acknowledged that it may not be possible to link all the attributes with a specific KPI and the scoring will remain, for these attributes at least, subjective. Similarly further research needs to be undertaken to bottom out the differences that occur when individual decision makers' decisions are used instead of using the unitary group approach as put forward by this paper. Similarly additional research is being undertaken to provide guidance to RSL's as to how to define the 'optimum combination' between whole life cost and quality which , it is anticipated will reduce contractor manipulation of the price/quality mechanism. The support tool has already been used for a wide spectrum of projects ranging from repair and maintenance contracts through to the analysis of multi million pound residential estate regeneration schemes not least because the BV tender analysis process is fundamentally the same regardless of the project type it is applied to. Manifestly the support tool can also be used in areas other than tender analysis and the methodology has already been used to assist a London Borough Council in their decision to renew or repair window units throughout the whole of their Borough. It is also anticipated that the support tool will be used (i) to short list a limited number of contractors for subsequent detailed appraisal (ii) to rank contractors, or (iii) simply to distinguish acceptable from unacceptable possibilities.

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APPENDIX F: SUPPORTING DOCUMENT

SURVEY QUESTIONAIRRE

Steve Phillips
7 Hart Court
317 Burges Road
London E6 2EQ.

Dear Sir/Madam

MEASURING BEST VALUE IN SOCIAL HOUSING PROCUREMENT: DOCTORATE RESEARCH PROJECT

Martin Associates Chartered Surveyors together with the Centre for Innovative Construction Engineering (CICE) at Loughborough University are sponsoring research into the development of a tendering framework for contractor selection, using best value/value for money principles. The framework will provide a transparent audit trail for the RSL's decision making process.

Changes in the EU Public Procurement regime will create new pressures on contracting authorities. In addition, the implementation of long term contracts, and collaborative working practices coupled with the movement away from acceptance of the lowest bid means that it is becoming increasingly more difficult for RSL's to truly justify their contractor selection process.

The aim of this research is to produce an electronic contractor selection framework that independent bodies such as the Housing Corporation or the Audit Commission can use to inspect the audit trail, ascertain the factors that influenced the final decision of a tender assessment panel and understand how those factors were weighted and assessed by individual members of the panel. The audit trail could also be used by RSL's to establish the "reasonableness" of their decision when challenged by leaseholders at the Leasehold Valuation Tribunal or similar dispute resolution forum.

I would be most grateful if you would complete the attached questionnaire, which focuses on identifying those attributes that the various stakeholder groups consider to be most important in the contractor selection process.
The questionnaire should only take a few minutes to complete and can be returned in the enclosed SAE. The findings of the research will be published and a copy of the results of this survey can be sent to you, if you wish.

Thank you for taking the time to complete the questionnaire.
Your participation is greatly appreciated.

Yours faithfully,

Steve Phillips BSc MSc MRICS MCIOB MCIArb.
Research Engineer

COMPANY INFORMATION

Any Information you provide will be kept completely confidential.

Name of Respondent ……

Company Name. …….

Position in Company ……

Telephone Number …….

Do you wish to receive the results of this research? **YES / NO** (*Please circle as applicable)*

QUESTIONNAIRE

How important do you feel each of the following 35 factors are when evaluating and selecting contractors for long term collaborative construction or repairs projects? *(Please tick as applicable.)*

Knowledge & Understanding **The contractor needs:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**
1 A clear understanding of the term 'best value'.					
2 An understanding of partnering and collaborative working					
3 A clear understanding of the RSL's strategic values and objectives.					
4 A clear understanding of the RSL's specific project values and objectives					
5 A clear understanding of leaseholder issues and recovery of service charge.					
Policy & Systems **The contractor should have:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**
6 A quality management system in place					
7 A health and safety policy					
8 An environmental policy and validated awareness					
9 A system of establishing life cycle costing for the work proposals.					

Policy & Systems (continued) **The contractor needs:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**
10 An established method of collating on site performance data					
11 Software and hardware compatible with the RSL's system.					
12 Implementation of value engineering and value management techniques.					
13 An objective of zero defects at handover.					
Previous Experience **The contractor should show:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**
14 Experience in successful resident liaison					
15 Evidence of an established supply chain.					
16 A track record in formal risk management					
17 A track record of success in similar projects.					
18 Experience of standardisation and off-site assembly.					
19 A track record of time predictability.					
20 Evidence of successful performance over their past 5 comparable projects.					
Staff & Training **The contractor has:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**
21 Qualified, experienced technical staff.					
22 Health and safety training for site personnel.					
23 Evidence of training in sustainability issues.					
Financial Considerations **The contractor should show:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**

24 Proof of a system of open book accounting.					
25 Evidence of a non-adversarial approach to agreeing costs and final accounts.					
26 A track record of final account cost predictability.					
27 Willingness to exchange cost data with other contractors.					
28 Solutions that minimise running costs for tenants.					
Ethos or Way of Working **The contractor should be able to demonstrate:**	**Vital**	**Extremely Important**	**Fairly Important**	**Hardly Important**	**Not Required**
29 A track record of sensitivity to public perceptions.					
30 Commitment to continuous improvement					
31 A track record of implementing green construction.					
32 A track record of implementing innovative construction solutions.					
33 Experience of increasing flow of work to the partners in the supply chain.					
34 A commitment to employing local labour.					
35 Attainment of the Investor in People Award.					

Which 5 of the 35 attributes listed above do you consider to be most vital in the contractor selection process?
Please identify them by their number in the boxes below. E.g. If you consider that "A commitment to employing local labour." is one of the 5 most vital attributes; write 34 in one of the boxes below.

Do you consider that additional attributes should have been included within the list? If so please provide further details……..
……..

Thank you again for the time you have given to help with this research
Steve Phillips BSc MSc MRICS MCIOB MCIArb

APPENDIX G: SUPPORTING DOCUMENT

EXPERT WITNESS REPORT.

BEST VALUE TENDER ANALYSIS OF THE FOREST HOMES STREET PROPERTY WINDOW REPLACEMENT PROGRAMME 2006/2007.

EXPERT REPORT OF STEVE PHILLIPS BSc. MSc. PG (Cert) MRICS. MCIOB. MCIArb. CHARTERED SURVEYOR AND CHARTERED BUILDER, ON BEHALF OF MARTIN ASSOCIATES CHARTERED SURVEYORS.

Specialist Field	Disputes arising from building works to residential properties, particularly, disputes in relation to the Landlord and Tenant Act 1985 (as amended).
Instructed By:	Forest Homes,
Subject Matter	A Best Value Analysis of the Street Property Window Replacement Tender.
Preparation Date	March 2007.
Report Prepared By	Steve Phillips BSc. MSc. MRICS. MCIOB. MCIArb. Director
	Asset Management Surveyors Ltd 15 Malmesbury Road Bow London E3 2EB.
	Tel No 0208 980 1967. Web: www.assetman.org
`	steve@assetman.org

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1.00 Experience & Qualifications

I am Steve Phillips MSc(Merit) BSc(Distinction) PGCert(Distinction). MRICS. MCIOB. MCIArb. I commenced work in the Construction Industry in 1979 and I am now a Chartered Building Surveyor (qualifying as a corporate member in 1996), a Chartered Builder (qualifying as a corporate member in 1996), and a Member of the Chartered Institute of Arbitrators (qualifying as a member in 2000). In 1987 I obtained a Distinction in my BSc Degree in Building Surveying and, in the same year I was the Royal Institution of Chartered Surveyors Prize-winner. In 2005 I received a Post Graduate Certificate with Distinction in Construction Engineering from Loughborough University.

I have been the Director of Asset Management Surveyors Ltd since August 1999. Prior to this I was a Property Services Manager at Broomleigh Housing Association and the Chief Building Surveyor with Gross Fine Residential Property Management Company in London WC1.

I have the knowledge, experience, qualifications and training appropriate for the brief due to the fact that I have over sixteen years experience in the resolution of Landlord and Tenant disputes at a strategic and operational level in the both the Private and Public sector.

In 1998 I was awarded an MSc Degree with Merit in Construction Law and Arbitration from King's College, London. Part of my final year MSc thesis analysed a number of the particular problems associated with contributions to service charges by long leaseholders in the public sector and how these problems had been addressed by; case law, statutes, the courts, the Leasehold Valuation Tribunal (LVT) and arbitration tribunals.

Since forming Asset Management Surveyors Ltd in 1999, I have undertaken the following roles:

- I was a member of the Government Working Party for Leasehold Reform in the Public Sector that assisted in the drafting of the new consultation requirements to be introduced as part of the Common hold and Leasehold Reform Act 2002.

- I have acted as an expert witness at: The Central London County Court, the Leasehold Valuation Tribunal (London Region) and at the London Borough of Southwark Arbitration Tribunal with respect to disputes concerning the reasonableness of costs and standards of workmanship as per the definitions set out in section 19 of the Landlord and Tenant Act 1985(as amended)

- I held seven instructions to act as "the Qualified Surveyor" under section 84 of the Housing Act 1996 for recognised tenants associations (as defined in section 29 of the Landlord and Tenant Act 1985 (as amended)) situated in various London Boroughs.

- In addition to having a hands-on role leading Asset Management Surveyors Ltd I am also currently engaged as a Research Engineer by The Centre of Innovative Construction Engineering at Loughborough University to undertake a Doctorate of Engineering (EngD). My main area of research is to produce a mathematical model to help assess the reasonableness of contractor's costs over a five to ten year period for implementation with "Best Value" procurement methods in the public sector. My work includes research into the legal definition and interpretation of 'reasonableness' as per sections 18, 19 and 20 of the Landlord and Tenant Act 1985 (as amended).

- I co-authored and presented a paper at the RICS International Construction Conference held at Headingly, Leeds in November 2004 entitled " Assessing Best Value in Social Housing Procurement"

- I am regularly engaged by Landlord organisations in the Social Housing Sector to provide advice as to how they should draw up consultation notices in order to comply with the relevant requirements set out in Section 20 of the Landlord and Tenant Act 1985 plus the amendments required by Statutory Instrument 2003 No. 1987 "The Service Charges (Consultation Requirements) (England) Regulations 2003".

- I have contributed case examples of service charge disputes to the barrister, Justin Bates of Arden Chambers, in his capacity as the co-author of the book entitled 'Leasehold Disputes: a guide to Leasehold Valuation Tribunal'.

List of Published Academic Papers

1. Phillips S, Martin J, Dainty A and Price A, (2004) "Assessing Best Value in Social Housing Procurement" RICS/*COBRA 2004, Responding to Change Conference Proceedings,* pp 178.

2. Phillips S, Price A and Dainty A (2004) "Achieving Best Value in Social Housing Procurement" ARCOM 20th Annual Conference Proceedings,pp 639-647

3. Phillips S, Martin J, Dainty A and Price A, (2006) "Renew or Repair Existing Window Units? A Best Value Approach" Accepted for Publication by the *Construction Information Quarterly*, the Academic Journal of the CIOB.

4. Phillips S, Martin J, Dainty A and Price A, (2007) "Uncertainty and Risk in Best Value Decision Making". Accepted for Publication by the *Journal of Financial Management in Property & Construction*.

2.00 Introduction

2.1 London & Quadrant Housing Association t/a Forest Homes wish to replace all their existing windows throughout their residential street property stock. Due to the fact that the stock comprises mixed tenure residents the cost of the works will, in general, be paid by either;

(a) revenue collected from the statutory tenants or
(b) recovered from leaseholders via the service charge mechanism within the relevant lease document.

2.2 Forest Homes agents, Martin Associates Chartered Surveyors, sent the window unit renewal work tenders out to three contractors, two of whom, Anglian Building Products and Exterior Plas, returned bids. Martin Associates reviewed the bid submissions and concluded that though Anglian's matrix of costs was approximately 12.72% higher than those costs put forward by Exterior Plas they believed that the Anglian submission represented the 'best value' bid.

2.3 Forest Homes has engaged me to provide an opinion as to whether or not they can recover the extra monies (i.e. the cost difference between the Anglian tender and the Exterior Plas tender) from the leaseholders affected by the works? My opinion is that if a Landlord such as Forest Homes can show that the costs of the window renewal works were 'reasonably incurred' as per section 19 of the Landlord and Tenant Act 1985 (as amended) then a case can be made for recovery of the additional costs if Forest Homes were to be challenged by an individual leaseholder(s).

2.4 It is also my opinion that as all Registered Social Landlords must procure services in accordance with a Best Value framework then if Forest Homes can clearly demonstrate that the decision to engage Anglian Windows has been taken on a Best Value basis it will

underpin their argument that the additional cost of the window replacement works have been 'reasonably incurred'.

2.5 I have been sponsored by Martin Associates Chartered Surveyors to develop a Best Value Analysis Support Tool known as OVID-BV [Optimising Value in Decision Making for Best Value].at the Centre of Innovation and Collaborative Engineering at Loughborough University under the supervision of Professor Andrew Price and Professor Andy Dainty. The underlying rationale of the tool is that it produces an audit trail of the decisions made by Landlords such as Forest Homes and demonstrates that they have considered not only the costings relevant to the proposed works but also the more subjective quality issues that are crucial to Best Value decisions being made.

2.6 I make it perfectly clear that the overarching aim of the research is to produce a robust decision support tool which provides guidance to the decision maker(s), provoking rational discussion around the choices to be made rather than dictating a precise result for the decision process, clearly the tool cannot and does not replace management review and judgement

3.00 Optimising Value in Decision Making in Best Value [OVID-BV].

3.1 OVID-BV has been designed to assess Best Value as defined by the UK Government which is set out below:

"Value for Money is the optimum combination of whole life costing and quality (or fitness for purpose) to meet the user's requirements; long-term value over the life of the asset is a much more reliable indicator of value for money. It is the relationship between long-term costs and the benefit achieved by clients that represents value for money." (Office of Government Commerce 2003).

OVID-BV has been developed into user friendly software and the process is split into two distinct phases.

(a) The assessment and measurement of the quality criteria and
(b) The calculation of the whole life costs.

This two strand evaluation process has been developed in accordance with the OCG Best Practice Note entitled 'Value for Money Evaluation in Complex Procurements'.

4.00 Assessment and Measurement of the Quality Criteria.

4.1 Establish the Quality Criteria.

4.2 The list of quality attributes contained within OVID-BV has been derived from qualitative research undertaken in conjunction with various stakeholders in the social housing procurement process including: RSL's, Contractors, Consultants, Leaseholders and Protected Tenants.

4.3 It is suggested that the criteria to be assessed are produced by the project stakeholders and will relate specifically to the terms 'user's requirements' and 'benefit to the clients' with respect to the window installation works.

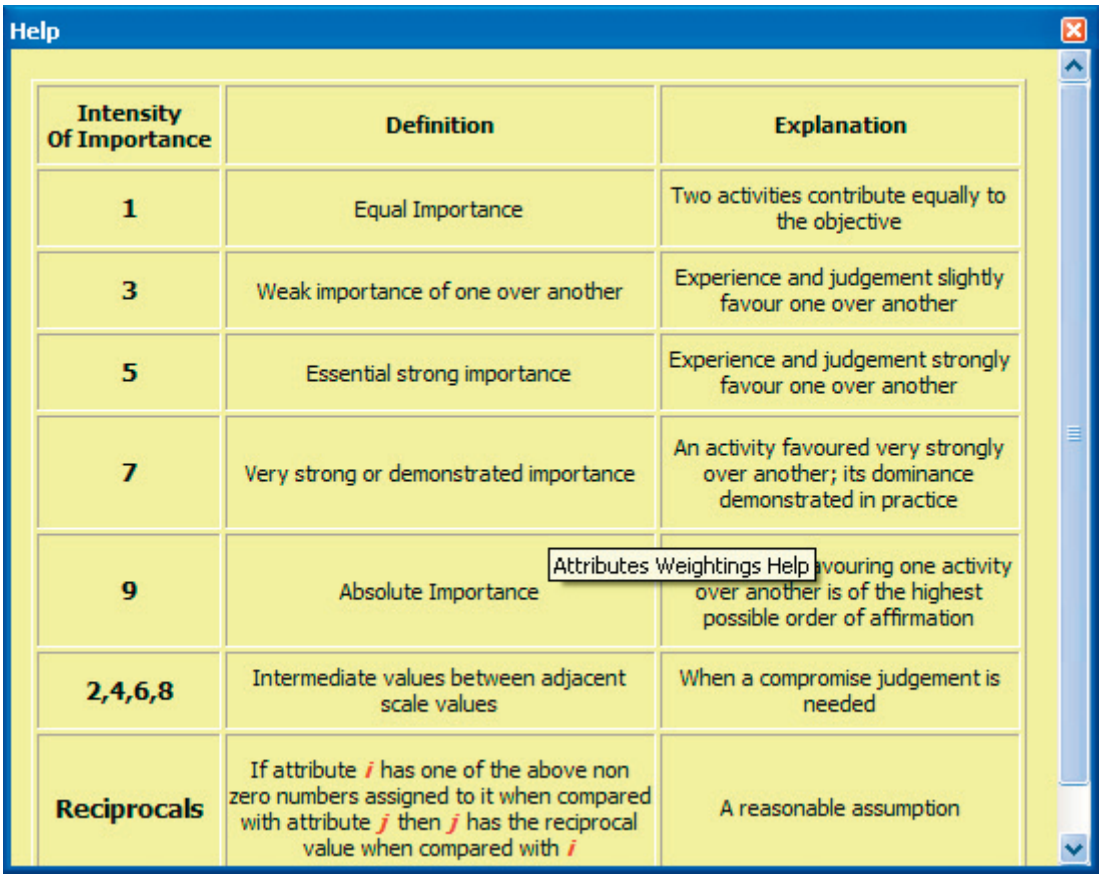
4.4 The criteria can be established using formal value management techniques or can be decided upon at a meeting of representatives of all the stakeholder groups. However ,and in this instance, I have simply contacted representatives of Forest Homes, Martin Associates and the leaseholders involved (i.e the end users) and they have agreed upon the important criteria that they believe should be used to assess the contractors bid which are as follows: (they are not given in any specific order):

(i) Understanding of the Clients Objectives.
(ii) Successful Track Record.
(iii) Cost predictability.
(iv) Understanding of partnering.

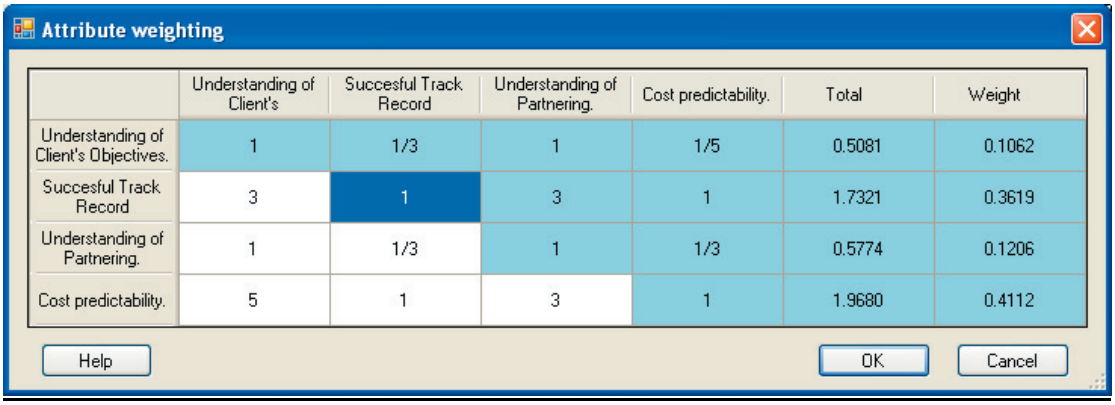
There is no definitive list of value attributes and the list contained within OVID-BV can be tailored to suit the requirements of the specific circumstances of the project. It can include both corporate, strategic and project specific value attributes if it is deemed appropriate to do so.

Rank ordering of the value attributes.

4.5 The value attributes are to be ranked in order of their relative importance to each other using a method known as pair wise comparison. The strength of the pair wise comparison technique in regard to the Best Value analysis process is that it promotes debate between the members of the tender selection panel with respect to the relative importance of each of the value attributes. A table of scales has been devised which allows the relative merits of the attributes to be assessed on a numerical basis.



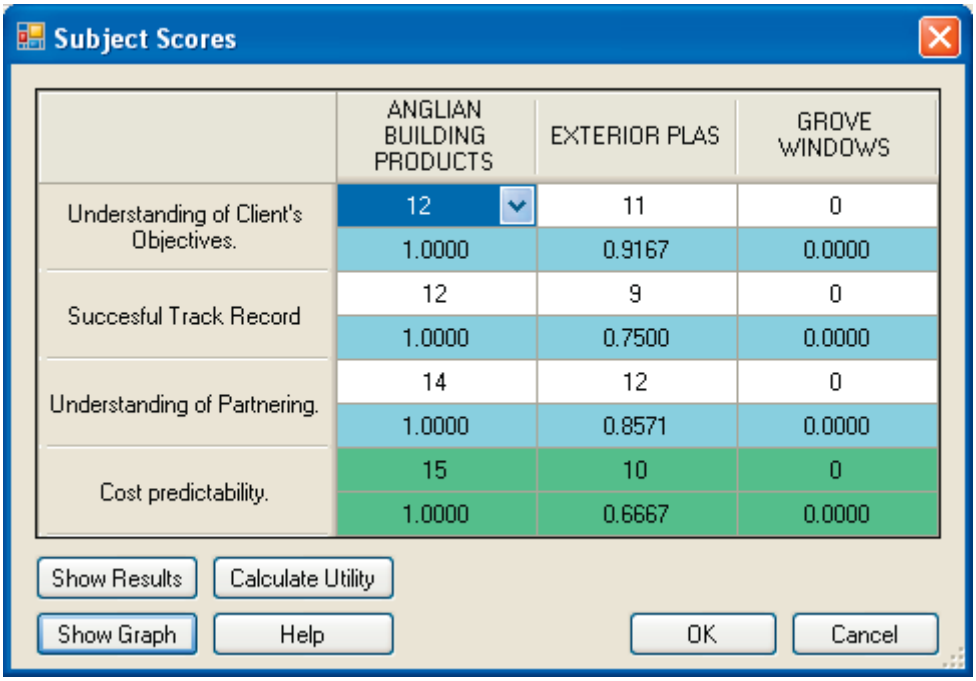
Once the client has compared the attributes the OVID-BV software calculates the weighting of each individual attribute using the Geometrical Mean Method. The results of the assessment of the importance of each attribute when compared with the other are shown below;



	Understanding of Client's	Succesful Track Record	Understanding of Partnering.	Cost predictability.	Total	Weight
Understanding of Client's Objectives.	1	1/3	1	1/5	0.5081	0.1062
Succesful Track Record	3	1	3	1	1.7321	0.3619
Understanding of Partnering.	1	1/3	1	1/3	0.5774	0.1206
Cost predictability.	5	1	3	1	1.9680	0.4112

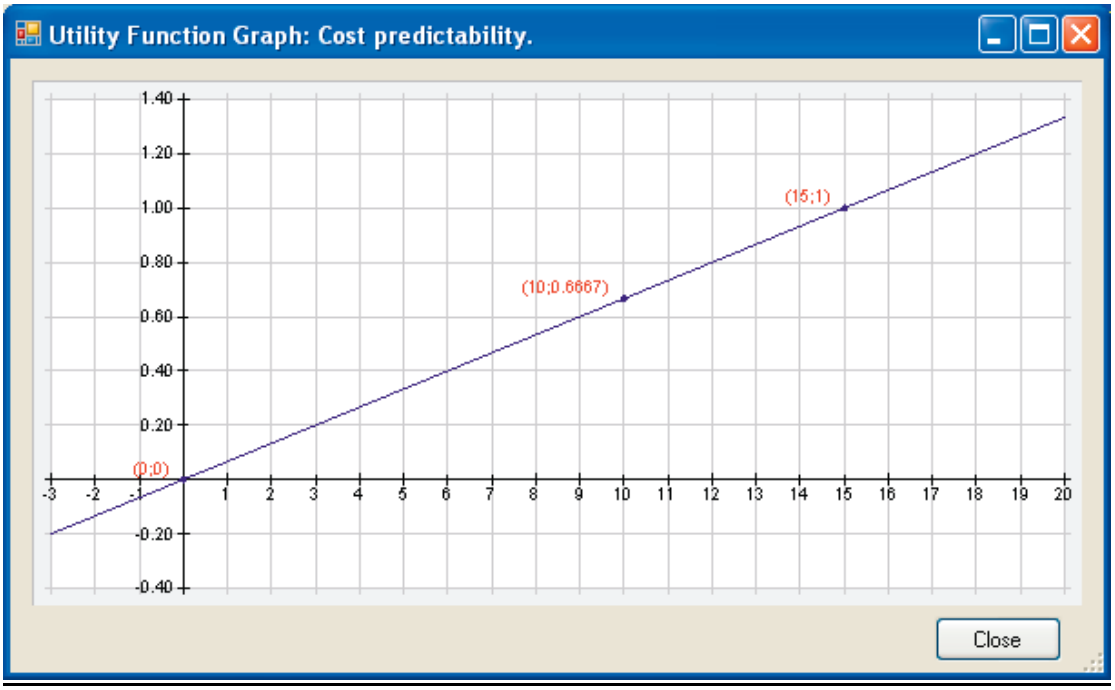
Measuring the contractor's capabilities against the criteria.

4.6 The anticipated performance of each contractor against each of the value attributes is then carried out. The point's score system is as follows: 0-4 = very poor; 5-8= poor, 9-12=good: 13-16= very good and 17-20=excellent. The importance of scoring in this manner is that it allows the decision maker to incorporate his/her personal experience, preferences, heuristics and biases as part of the process and should promote discussion. The score matrix completed by the stakeholders is shown below:



	ANGLIAN BUILDING PRODUCTS	EXTERIOR PLAS	GROVE WINDOWS
Understanding of Client's Objectives.	12	11	0
	1.0000	0.9167	0.0000
Succesful Track Record	12	9	0
	1.0000	0.7500	0.0000
Understanding of Partnering.	14	12	0
	1.0000	0.8571	0.0000
Cost predictability.	15	10	0
	1.0000	0.6667	0.0000

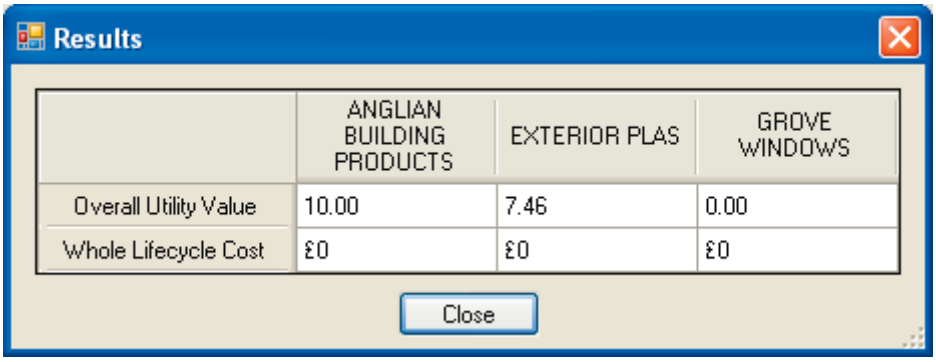
4.7 The above screenshot shows two figures against each attribute. The upper figure is the score given by the tender assessment panel and the lower is the utility value. The real problem encountered by clients is how to compare scores of the various attributes against each other? How is it possible to compare the value of a contractor understanding the client's objectives against, say, the benefit achieved from cost predictability? OVID-BV achieves this by implementing the Expected Utility Rule and converts the individual scores to a common scale where the results are measured in 'utility' or units of desirability or satisfaction. The important point is that the scale is uniform and allows for the attributes to be compared with each other. The software automatically calculates the utility figure but the client can also see the result in graph form. Please see below for the graphical representation of the cost predictability scores for a risk neutral individual. (The software is currently being developed to allow the results to be interpreted for both risk prone and risk averse individuals).



As the software automatically calculates the utility value for each attribute the graphical representation provides a transparent audit check for the calculation of the utility values.

The key to understanding the application of the Expected Utility Rule is to appreciate that if a rational decision maker's direct preferences over consequences can be defined, then they can be used to order the desirability of the actions open to him/her. If the expected utility of each alternative is calculated, then the best course of action is the alternative with the highest overall utility value. OVID-BV calculates a utility score for each contractor against each weighted attribute and the highest accumulative score will, in theory at least, indicate the preferred contractor with respect to the quality attributes.

The results table for the street properties contract shows that Anglian Building Products have produced, in my opinion, the better of the two quality bid submissions.



Whole Life Costing [WLC]:

4.8 The second strand of the best value evaluation process is the implementation of whole life costing. Long-term costs over the life of a building are more reliable indicators of Best Value than initial construction cost because money spent on appropriate materials and products can be saved many times over in the construction and maintenance costs. WLC is an economic evaluation method that

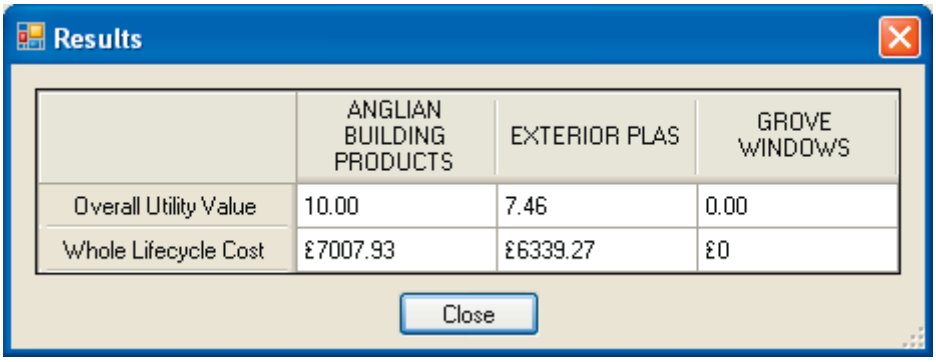
accounts for all relevant costs over the investor's time horizon adjusting for the time value of money. The relevant costs include; (i) the investment costs such as construction costs, fees, development grants (ii) energy costs and (iii) Maintenance costs including planned cyclical maintenance and servicing and unplanned maintenance and repair. The investor's time horizon is the period for which the investor has an interest in the buildings life and the time value of money is shown by calculation of the present value of the relevant costs expended over the specific time horizon using the standard Present Value formula. In the public sector it is usual for the Treasury discount rate to be applied to the calculation.

OVID-BV calculates the WLC for each of the options using the price data provided by each contractor. Manifestly the subject tender analysis is relatively straight forward as the contractors are pricing exactly the same make and type of window unit and, therefore, the differential between capital cost figures will not radically alter when subjected to the WLC process. In this instance the parameters I selected for the WLC exercise were as follows;

- Building Life of 30 Years.
- Interest Rate of 7%.
- Product expectancy life of 30 years.

5.00 Interpreting the Results.

5.1 The results are summarised below:



5.2 The results indicate that if lowest cost was the only factor to be considered then the best course of action, even over the life of the housing stock, would be to engage Exterior Plas to carry out the works and if it were to be purely a quality based decision then Anglian Building Products would be preferred contractor. However it is important to recall that the terms of reference for the development of OVID-BV were framed around the Office of Government Commerce's definition of Best Value which states that Best Value is the optimum combination of whole life costing and quality to meet the user's requirements and provide benefit to the client. Therefore there is a management judgement to be made as the 'optimum combination 'of price and quality. Manifestly the definition of the term 'optimum combination' can be interpreted in many different ways and in the absence of any specific instruction from Forest Homes is has been assumed that the optimum combination is 50:50 and therefore the results are represented thus:

CONTRACTOR.	**QUALITY 50%**	**COST 50%**	**TOTAL**
ANGLIAN	100	-12.3	87.7
EXTERIOR PLAS	74.6	+ 0.00	74.6

Under these conditions the preferred bidder is Anglian Building Products even though their WLC is 12.3% higher than the Exterior Plas WLC. In addition if Forest Homes decided that the quality component of the bid is more important than the monetary side of the bid then Anglian will always be the preferred bidder and it would, in my opinion, be reasonable for Forest Homes to engage them to carry out the works.

5.3 However the combination also needs to be assessed in the other direction i.e. that WLC cost part of the bid could be more important to Forest Homes than the quality attributes and if the optimum

combination is set at say 40:60 then the results would be represented thus:

CONTRACTOR.	QUALITY 40%	COST 60%	TOTAL
ANGLIAN	80	-13.53	66.47
EXTERIOR PLAS	59.68	+ 0.00	59.68

And if the optimum combination was set at say 30:70 then, similarly, the results would be represented thus:

CONTRACTOR.	QUALITY 30%	COST 70%	TOTAL
ANGLIAN	60	-14.76	45.24
EXTERIOR PLAS	44.76	+ 0.00	44.76

5.4 From the above sets of results it is clear that Exterior Plas would only be the preferred bidder if the cost component of the tender submission would be worth in excess of 70% of the bid. Whilst a Landlord could take this view about the quality/cost ratio it does seem to be counter productive to the core ethos of best value tendering assessments and, in many respects, it could be considered a movement back towards acceptance of the lowest cost bid.

7.0 Summary

7.1 OVID-BV provides a framework for demonstrating the different stages of an RSL's decision making process in a transparent and auditable way.

7.2 Forest Homes must be able to demonstrate that they have used Best Value frameworks in their procurement procedures. OVID-BV provides a method of demonstrating that Best Value has been considered.

7.3 In order to recover service charge monies from leaseholders Forest Homes must be able to demonstrate that the monies have been reasonably incurred. OVID-BV provides a means to demonstrate that a RSL has considered not only the issue of costs but also quality issues which are an equally important part of addressing the user requirements of their residents.

7.4 Ideally the *optimum combination* of whole life costing and quality should be determined by the RSL and their stakeholder prior to the works commencing. However , in this instance a range of combinations have been considered and it has been shown that Anglian Building Products have submitted the Best Value tender *unless* the quality/cost combination is weighted in excess of 70:30 in favour of cost. Manifestly if the combination was set at this high level in favour of the cost element then it could be suggested that the RSL was seeking to implement a covert return to acceptance of the lowest bid.

7.5 It is recommended that all the stakeholders involved in this project should complete the OVID-BV analysis so that the complete range of results can be assessed prior to engagement of the successful contractor.

7.6 It is emphasised that use of OVID-BV does not obviate the need for RSL's to follow statutory consultation procedures.

RESULTS SUMMARY

Project - FOREST HOMES-WINDOWS ST PROPS

1. Attribute Weighting

	Understanding of Client's	Succesful Track Record	Understanding of Partnering.	Cost predictability.	Total	Weight
Understanding of Client's	1	1/3	1	1/5	0.5081	0.1062
Succesful Track Record	3	1	3	1	1.7321	0.3619
Understanding of Partnering.	1	1/3	1	1/3	0.5774	0.1206
Cost predictability.	5	1	3	1	1.9680	0.4112

2. Subject Scores

	ANGLIAN BUILDING	EXTERIOR PLAS	GROVE WINDOW
Understanding of Client's Objectives.	12 1.0000	11 0.9167	0 0.0000
Succesful Track Record	12 1.0000	9 0.7500	0 0.0000
Understanding of Partnering.	14 1.0000	12 0.8571	0 0.0000
Cost predictability.	15 1.0000	10 0.6667	0 0.0000

3. Results

	ANGLIAN BUILDING	EXTERIOR PLAS	GROVE WINDOWS
Overall Utility Value	10.00	7.46	0.00
Whole Lifecycle Cost	£6730.16	£5899.44	£0

4. Comments

1. SP's choice of client value attributes for this specific project was based upon the content of Martin Associates tender analysis.

2. The inclusion of the third contractor asked to provide a tender submission within the bid assessment process enables the client to effectively compare the utility scores for each contractor. i.e if only 2 contractors were used the utility scores for each contractor will be either 0 or 1.

3. The Whole Life costs were calculated assuming the following;
(a) A building life of 30 years.
(b) An interest rate of 7%.
(c) A product life of 30 years.

APPENDIX H: SUPPORTING DOCUMENT

AWARD WINNING SUBMISSION FOR THE CIOB INTERNATIONAL INNOVATION & RESEARCH AWARDS 2006/2007

THE CHARTERED INSTITUTE OF BUILDING

INTERNATIONAL INNOVATION & RESEARCH AWARDS

2006/2007.

THE DEVELOPMENT OF OVID-BV:

A SUPPORT TOOL TO

OPTIMISE VALUE IN DECISION MAKING FOR

BEST VALUE TENDERS.

SUBMITTED BY

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1 PREFACE.

1.1 Changing world markets, coupled with the introduction of new technology and a rise in client expectations, have stimulated reviews on how the UK construction industry delivers value. The concept of providing best value has been applied to many sub-sectors of the industry including social housing projects. The movement away from the traditional culture of acceptance of the lowest monetary bid, towards the consideration of both price and quality criteria as a basis for contractor selection, has been readily embraced by the social housing sector but the change in process has presented the sector with a number of challenges and problems that need to be overcome before the best value decision making process can become fully transparent and auditable.

1.2 Steve Phillips MCIOB, director of the Chartered Building Consultancy, Asset Management Surveyors Ltd, first identified the problems associated with assessing value based tenders when carrying out expert witness work on disputes involving multi-million pound residential estate regeneration projects. He sought the advice of a highly experienced practitioner in the field of social housing procurement, Jim Martin, BSc Dip Proj Man FRICS, Senior Partner of Martin Associates Chartered Surveyors, and their subsequent research into how these problems could best be addressed and resolved has been part-funded by the Centre for Innovative Construction Engineering (CICE) at Loughborough University. One of the outputs of their research is the development of an innovative support tool to assist stakeholders in carrying out the best value tender analysis process.

2 CHALLENGES

2.1 In order to identify the range of problems encountered during the tender assessment process a number of sources of information were accessed including:

- anecdotal evidence from practitioners,
- feedback from non professional stakeholders acting on tender assessment panels,
- dispute resolution awards made by the Leasehold Valuation Tribunal,
- trade literature and peer reviewed papers published in academic journals.

2.2 The main factors highlighted as causing difficulties were:

1. There is a tendency for Registered Social Landlords [RSL's] to 'reinvent the wheel' with respect to identifying value attributes for each individual project.

2. The RSL's stakeholders often have a poor understanding of the basic principles of best value tendering.

3. The RSL's value system needs to be made explicit.

4. Time constraints prevented workshops being set up to determine the value attributes for each individual projects.

5. Costs should ideally be considered on a whole life basis and not simply capital cost.

6. The assessment process fails to produce audit trails that record the decision making process or bear third party scrutiny, especially with respect to the measurement of the subjective component of value.

2.3 Each of these problems could have become a topic of research in its own right but there appeared to be a clear and overarching commercial need to standardise the best value analysis framework so that stakeholders could become familiar with the nature of the value attributes and with the tender assessment process itself.

2.4 It was decided that a support tool should be developed which would assist in these specific areas and would also allow for the decision making process to be recorded to form a transparent audit trail.

2.5 Originally the support tool was developed using Microsoft Excel, though, as the research develops it is being converted into a bespoke software package. This innovative support tool which **O**ptimises **V**alue **I**n **D**ecision making for **B**est **V**alue has become known by the acronym of **OVID-BV**

3 DESIGNING OVID-BV

3.1 In order to provide a consistent focus for the research, it was felt appropriate to use the Office of Government Commerce's [OCG] definition of best value which states:

> *" [Best Value is] the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements, as it is the relationship between long-term costs and the benefit achieved by clients that represents value for money."* (Office of Government Commerce 2003).

3.2 This definition provided the underlying structure for the best value tender analysis process and OVID-BV has been developed to assist the stakeholders in carrying out the following functions;

(a) Establishing the project specific value attributes which align with the RSL's value system.
(b) Weighting the attributes in order of importance to the project.
(c) Assessing each contractor's quality bid against the benefit gained by the stakeholders.
(d) Calculating the life cycle costs for the project works.
(e) Assessing the optimum combination of whole life costs and quality to meet the users' requirements.

4 INNOVATION.

4.1 There are two main innovative aspects incorporated within the design of the support tool;

(a) 10 core value attributes have been determined with respect to social housing procurement.

(b) The value attributes are assessed on a 'like for like' basis using the tenets of expected utility theory.

4.2 Determining the Core Value Attributes.

Many of the problems encountered in the tender assessment process could be minimised by standardising the number of value attributes to be considered by the stakeholders.

4.3 A comprehensive literature review was carried out which identified 35 value attributes that were usually considered in best value tender assessments. These attributes were formulated into a 4-page questionnaire and a postal survey was carried out in which respondents were requested to provide an opinion on the importance of each attribute. *(Please see Appendix 1 for a copy of the questionnaire).*

4.4 A response rate of 41% was achieved and the responses were subjected to principal component analysis which identified 10 core attributes as shown in *Table No 1.*

Table 1: The 10 Identified Core Attributes.

Component Number.	Name of Component Grouping
1	Understanding of Clients Objectives.
2	Successful track record.
3	Understanding of Best Value.
4	Technical Ability.
5	Quality management procedures.
6	Transparency of cost data.
7	Understanding of Partnering.
8	Established Policy. (Health &Safety, Environmental)
9	Construction practices.
10	Process management of costs and the final account.

4.5 Assessing the Value Attributes.

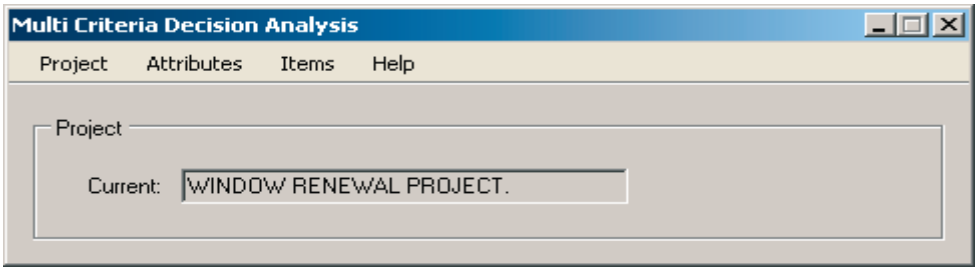
Multi Criteria Decision Analysis [MCDA] has already been used to assess best value tenders in America but this is the first time that Multi Attribute Utility Theory [MAUT] has been used to assess and compare value attributes in a UK Best Value contractor selection process and combine the selection decision with whole life costing.

4.6 The key to understanding the application of MAUT is to appreciate that if a rational decision maker's direct preferences over consequences can be defined, then they can be used to order the desirability of the actions open to him/her. If the expected utility of each alternative is calculated, then the best course of action is the alternative with the highest expected utility. OVID-BV calculates a utility score for each contractor (See Sections 5.4-5.7) and the highest score will, in theory at least, indicate the preferred contractor.

5 SUCCESSFUL IMPLEMENTATION OF OVID-BV.

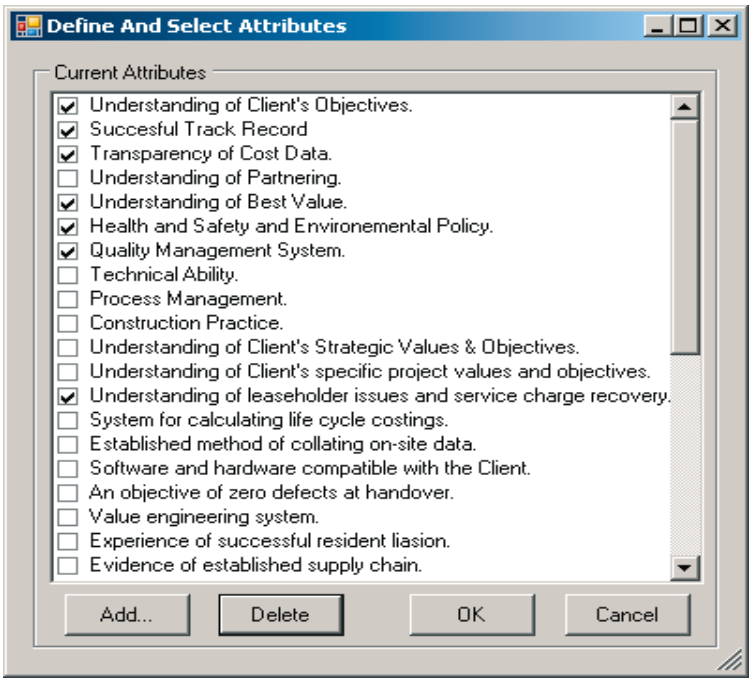
5.1 The support tool has been successfully used by RSL's and their stakeholders to provide a transparent audit trail of the tender analysis decisions in a number of projects. (*Figure 1*).

Figure 1. Project Title Screen.



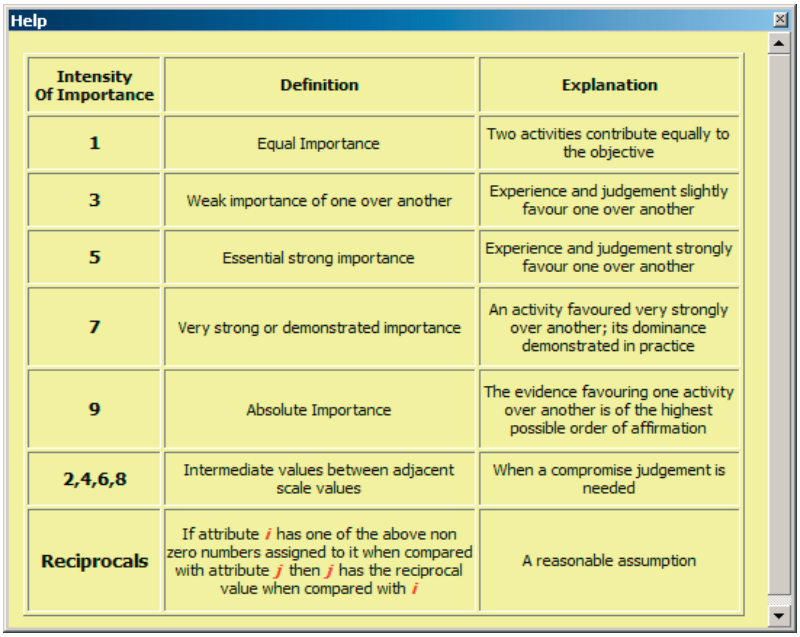
5.2 The stakeholders were able to choose the specific project attributes from a drop down menu which included not only the ten core factors but also all the other value attributes established by the literature review. The software also provides a facility for new attributes to be added as necessary. (*Figure 2*).

Figure 2. Attribute Choice Screen.



5.3 The relative importance of each attribute with respect to the specific project is then assessed and scored by pair wise comparison which provides a weighting score for each attribute calculated using the geometric mean method. *(Figures 3 & 4)*

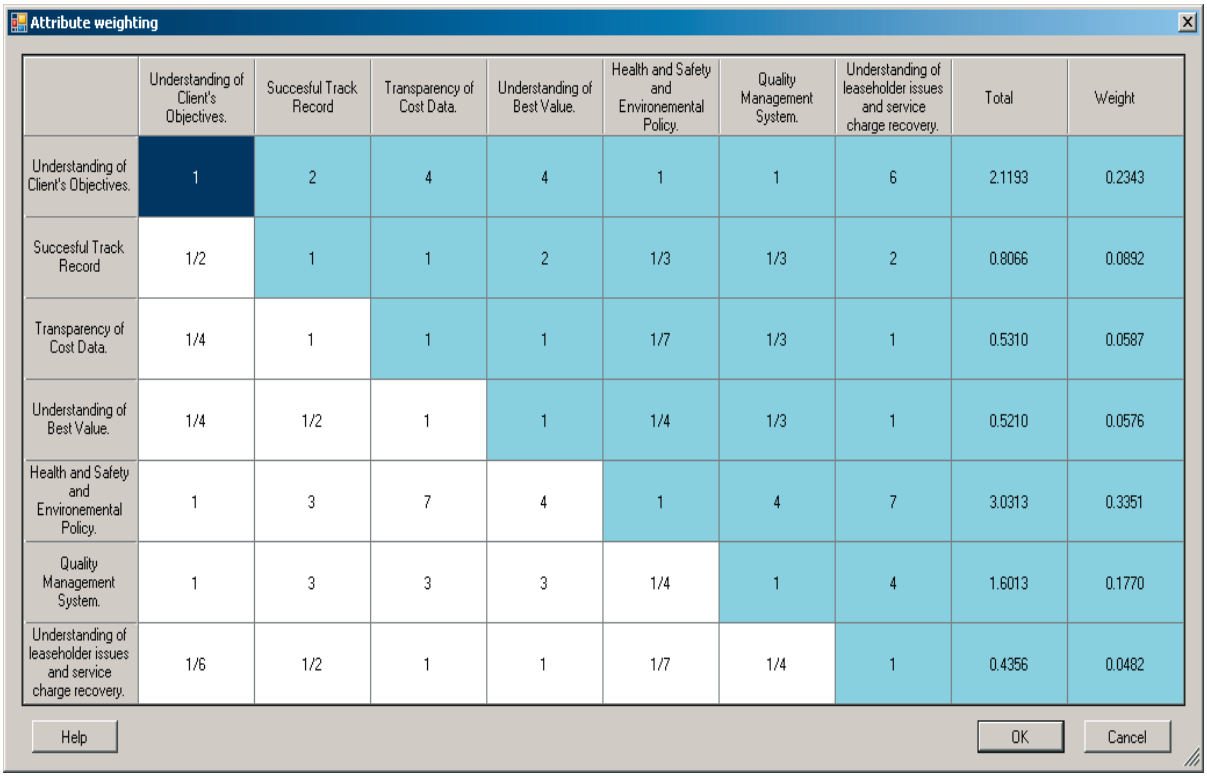
Figure 3. The Attribute Scoring System (Saaty 1980).



Help

Intensity Of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgement slightly favour one over another
5	Essential strong importance	Experience and judgement strongly favour one over another
7	Very strong or demonstrated importance	An activity favoured very strongly over another; its dominance demonstrated in practice
9	Absolute Importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent scale values	When a compromise judgement is needed
Reciprocals	If attribute *i* has one of the above non zero numbers assigned to it when compared with attribute *j* then *j* has the reciprocal value when compared with *i*	A reasonable assumption

Figure 4. Pair Wise Comparison Scores of the Chosen Attributes.



Attribute weighting

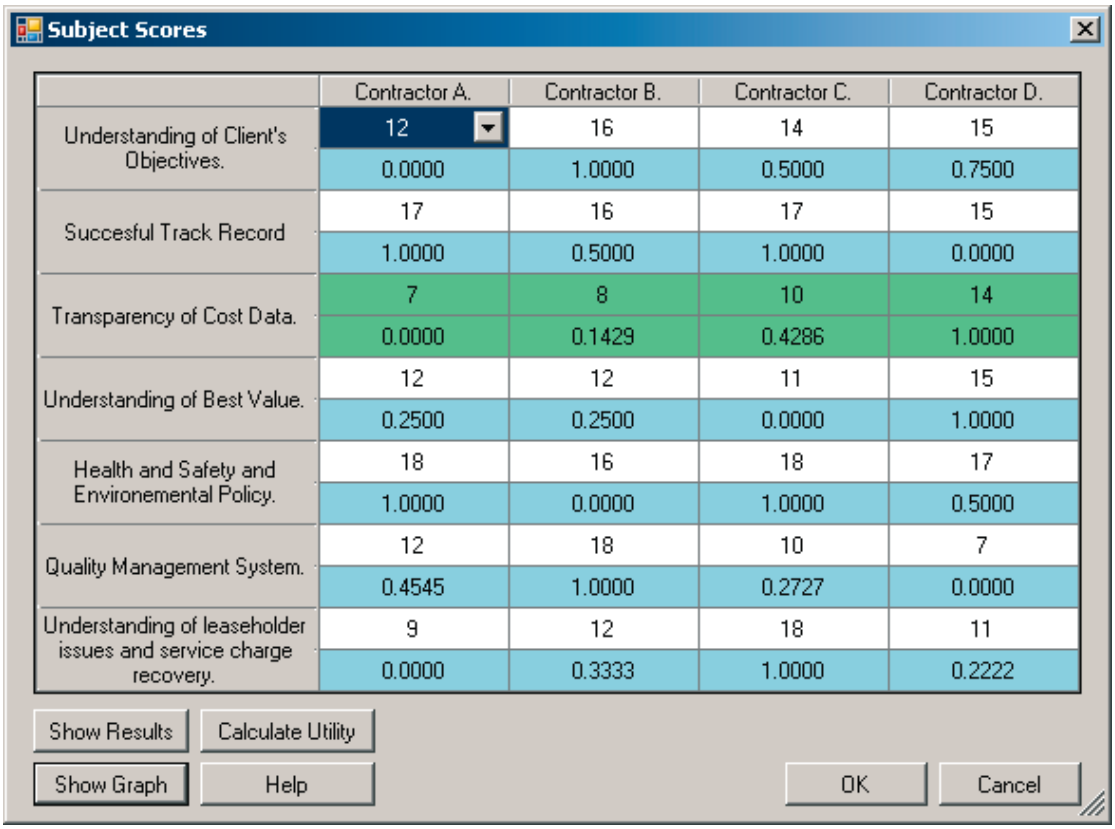
	Understanding of Client's Objectives.	Succesful Track Record	Transparency of Cost Data.	Understanding of Best Value.	Health and Safety and Environemental Policy.	Quality Management System.	Understanding of leaseholder issues and service charge recovery.	Total	Weight
Understanding of Client's Objectives.	1	2	4	4	1	1	6	2.1193	0.2343
Succesful Track Record	1/2	1	1	2	1/3	1/3	2	0.8066	0.0892
Transparency of Cost Data.	1/4	1	1	1	1/7	1/3	1	0.5310	0.0587
Understanding of Best Value.	1/4	1/2	1	1	1/4	1/3	1	0.5210	0.0576
Health and Safety and Environemental Policy.	1	3	7	4	1	4	7	3.0313	0.3351
Quality Management System.	1	3	3	3	1/4	1	4	1.6013	0.1770
Understanding of leaseholder issues and service charge recovery.	1/6	1/2	1	1	1/7	1/4	1	0.4356	0.0482

Help OK Cancel

5.4 One of the innovative aspects of the tool is that the utility theory uses a uniform scale to assess the RSL's value attributes against each other and provides a method for comparing and scoring different types of attributes on a 'like for like' basis.

5.5 As utility is a measure of desirability or satisfaction each of the contractor's tender submissions is scored against the individual attributes on the basis of the decision maker's satisfaction (or belief) that the contractor could successfully deliver on the claimed benefit to the end users made within the tender documentation. The point's score system used was as follows: 0-4 = very unlikely; 5-8= unlikely, 9-12=fair: 13-16=very likely, 17-20=certainty and was linked to national Key Performance Indicators. (*Figure 5).*

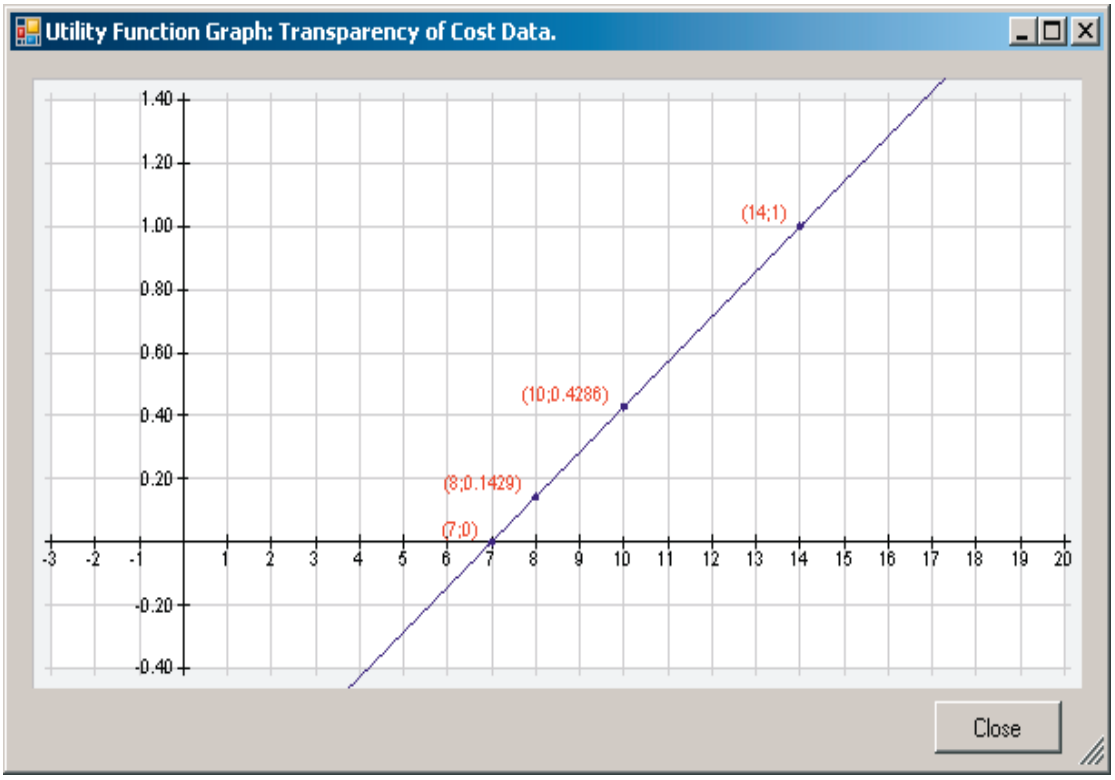
Figure 5. Contractors Bid Submission Scores per Attribute.



5.6 The software provides a graphical representation of the utility scale and assigns a utility value of 1 for the best score and a utility value of 0 for the worst score, though as utility is an ordinal concept the 0 does not mean utter worthlessness. In Figure 5 each attribute has two scores shown against it, the upper figure is the score given by the tender assessment panel whilst the lower figure is the utility score

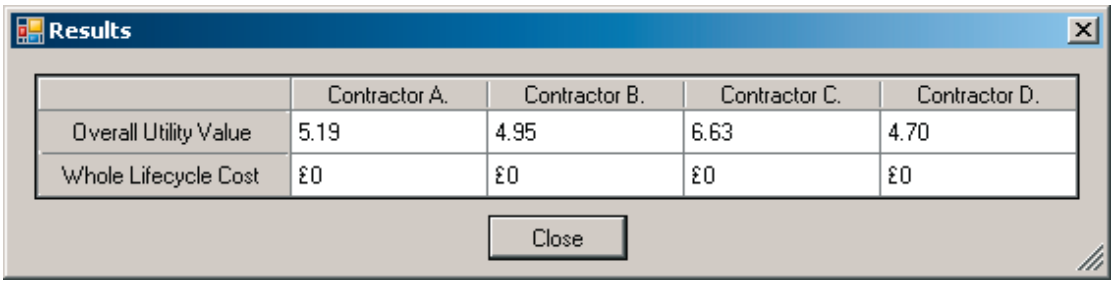
5.7 In the first version of OVID-BV the scores had to be read directly from a graph *(Figure 6)* but the new software automatically calculates the utility scores and the graphs have instead become part of the audit trail. In future versions of the software it is proposed that the clients various attitudes to risk can be addressed by different graphical representations.

Figure 6. Utility Scores for Transparency of Cost Data.



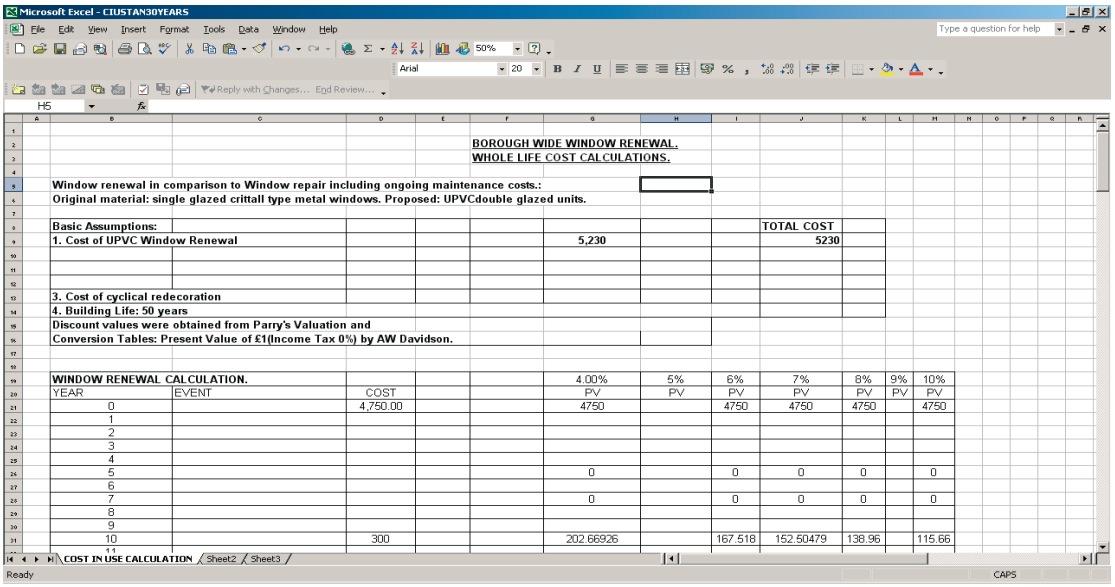
5.8 The utility scores for each attribute are multiplied by the appropriate project specific weighting to produce an overall score for each contractor. *(Figure 7).*

Figure 7. The Contractors Overall Utility Scores.



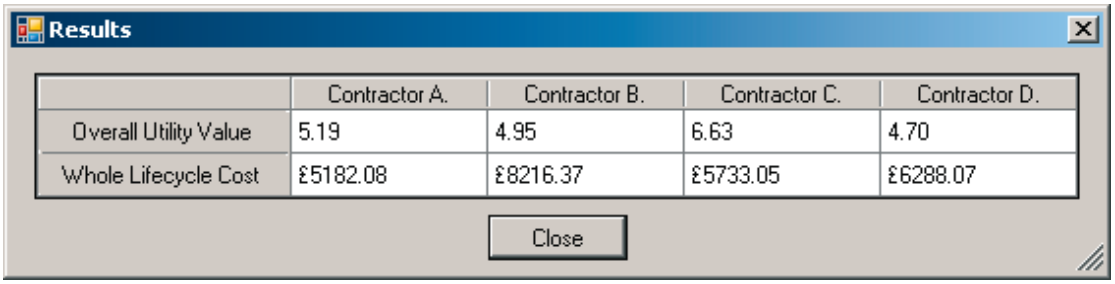
5.9 Though the expected utility theory states that the rational course of action would be to appoint the contractor with the highest overall utility value the OCG definition of Best Value requires that the successful contractor should provide the 'optimum combination of whole life costs and quality to meet the users' requirements'. There are a number of software packages that can calculate whole life costs though OVID-BV calculates the required costs using a specially adapted Excel spreadsheet. (See Figure 8).

Figure 8. Excel Workbook used to Calculate Whole Life Costs.



5.10 Finally, the results screen presents the Overall Utility Value score for each contractor assessed against the calculated Whole Lifecycle Cost for that contractor. Self evidently the results provide guidance only with respect to the choice of the successful contractor and the support tool cannot and should not replace management review and judgement *(Figure 9)*

Figure 9. The Comparative Results Screen



6 BENEFITS.

6.1 OVID-BV has met the original aim of the research in providing a standardised format for analysing Best Value tenders in the UK social housing sector. The use of a comprehensive but standard set of value attributes has allowed the tender analysis process to be carried out in a more expeditious and efficient manner.

6.2 Whilst MAUT has proved to be a notoriously difficult concept to explain, the sub-concepts of satisfaction and end user benefit have been readily understood and embraced by the various stakeholder groups in trialling the support tool and this allowed them to carry out the scoring process with a minimum of difficulty.

6.3 Though not all the users of OVID-BV have been able to grasp the graphical conversion of scores into utility, the concept of the value attributes being assessed on a 'level playing field' has been ,almost, universally accepted by the users.

6.4 The windows based software has assisted the stakeholders in understanding that best value is not simply about measuring capital cost or quality but is concerned with the optimum combination of whole life costing and quality (or fitness for purpose) to meet the users requirements,

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APPENDIX I: SUPPORTING DOCUMENT

EVALUATION QUESTIONNAIRE.

EVALUATION OF OVID-BV

OVID-BV is being developed as a decision support tool for best value tender analysis. The aim of this questionnaire is to collect responses and opinions which will help to evaluate and improve OVID-BV.

For each statement below, please indicate, by ticking the appropriate box, the extent to which you agree or disagree with the statement.

1. OVID-BV is a useful tool in the overall tender analysis process.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

2. OVID-BV represents an improvement to the existing process of tender analysis.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

3. You would consider the use of OVID-BV in your organisation as part of the tender analysis process.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

4. OVID-BV facilitates the precise definition of requirements in the first stage of the tender analysis process.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

5. OVID-BV assists focused discussion among stakeholders during the tender analysis process.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

6. OVID-BV supports a common understanding of the requirements of the tender analysis process among different groups of stakeholders.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

7. OVID-BV could be usefully applied to other best value decision-making situations in your organisation.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

8. OVID-BV is 'user-friendly'.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

9. It is easy to perform tasks using OVID-BV.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

10. OVID-BV can be tailored to meet the requirements of different tenders under analysis.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

11. OVID-BV allows the user to achieve the objectives of the tender analysis process.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

YOUR FURTHER COMMENTS:-

a) Please identify any other best value decision-making situations to which you feel OVID-BV might be applied.

b) How do you feel OVID-BV and/or its inter-face with the user might be improved?

Any other comments?