DEVELOPING A FRAMEWORK FOR WHOLE OF LIFE COSTING IN THE NATIONAL HEALTH SERVICE ESTATE

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The NHS represents a major industry sector, employing well over one million people and incurring gross expenditure of some £33.4bn. It is estimated that 20% of this is apportioned to management of the estate (NHS 1999). The demands for increased accountability and value for money are some of the fundamental reasons why NHS Trusts should move towards a more holistic view of investment appraisal and this paper reports on a research project that it aiming to address the major issues. In collaboration with the Royal Liverpool University NHS Trust, this research aims to develop a robust and accurate method of collating, analysing and disseminating vital WLC information. Central to the research is considering the estate in its holistic nature and not just the systematic consideration of conventional costs-in-use. The research aims to relate all the features of the estate, quantitative as well as qualitative, with the aim of developing a set of key performance indicators and risk assessment profiles to facilitate effective investment appraisal. The paper reports on the current stage of the research and the how it will be developed over the next year.

Keywords: whole life costing, NHS estates, facilities management, uncertainty, cost-in-use, risk management

INTRODUCTION

A recent audit of the NHS Estate placed its value at approximately £23bn (NHS 1999), which naturally represents a major aspect of any NHS Trust's asset base. It follows then that the achievement of efficiency and value for money in the utilisation of the estate is of significant importance. Currently, there are several mechanisms in place that go some way to addressing these issues. The Healthcare Facilities Consortium (HFC) is a co-operative body of over 300 trusts, which exists to improve the quality of information used for facilities management. It covers all the non-clinical aspects such as the estate, catering, cleaning etc. One of the key objectives is developing information systems, which operate in a standard way throughout the NHS, a particular arduous task given the dynamic nature of the NHS, but one, which this research also hopes to overcome.

NHS Estates, which is an executive agency of the Department of Health, is the principal organisation in the formulation of estate strategy and policy within the NHS. It also acts as a consultancy to NHS Trusts, GP fund-holders and Health Authorities on estate matters. They publish a portfolio of documents, which are recommended for use by Trusts (mostly non-mandatory) in the formulation of their own particular estate strategies. The principle documents *Estatecode* (estate management), *Encode* (energy management), *Firecode* (fire protection), *Concode* (procurement) and *CIM* (Capital

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Investment Manual) provide guidance on estate management issues, which can be used in conjunction with other industry standards as appropriate.

A key feature of NHS Estates involvement in the management of health care facilities is via the ERIC (estate returns information collection) database. This is compiled directly from the NHS Trust via TFPs (trust financial proforma's), which replaced the much larger Körner data set in 1995/96. The TFP's are basically a set of key statistics such as land asset value, normalised energy cost, trust income etc. The completion of the TFP's is a mandatory requirement placed upon NHS trusts and its use is primarily as a tool for giving NHS Estates an overview of the entire NHS estate. The results are normally disseminated through the TFP Central Returns Analysis document issued to the trusts yearly, which returns key statistics on energy consumption, depreciation, trust income et cetera. The statistics are presented as a comparison and grouped according to the Trust's status (i.e. acute, primary care).

On a local level, it is primarily the responsibility of the Trust to deliver suitable healthcare facilities and management on a day-to-day basis, which is normally facilitated through the estates department. It is common practice now in many larger trusts to outsource this work to private contractors who will charge a yearly sum for maintenance and repair work. This can benefit the trust in that not only can maintenance work be tendered out on a competitive basis thus reducing costs, but also there exists a greater responsibility on the estate department to investigate new technologies and systems, which will reduce failure rates and thus reduce the amount of work they must conduct as defined under the yearly contract, and reduce possible downtime costs.

However, many NHS Trusts operate estates that are experiencing higher than normal maintenance demands and find it difficult to investigate innovate approaches to facilities management when facing such challenging levels of backlog maintenance work. Currently, *Estatecode* recommends the use of an estate database to assess condition and remaining life-spans of buildings and engineering but this is based upon subjectivity, no system is currently in place to promote investment decisions based upon a whole life approach. Similarly, there is no facility to assess whether these assessments are accurate in terms of value for money during useful life.

CURRENT NHS ESTATE STRATEGY

The provision of healthcare facilities management is, by its nature, dynamic and constantly changing to support the delivery of healthcare (Payne and Rees 1999). This requires the formulation of policy that involves the input of all the stakeholders in the service if effective facilities management strategies are to be achieved. This is particularly an important feature of today's NHS, which involves a significant amount of outsourced as well as in-house facilities management work. The ability to be able to seamlessly integrate both in the delivery of estate management should be a central guiding principle, and one which can only further the development of an appropriate estate strategy.

The government's determination to modernise health service provision has recently been reflected in its drive for integration of all services in the delivery of an efficient and adaptable estate policy. This has been highlighted in the Department of Health's recent publication entitled "Developing an Estate Strategy". The desire to provide quality healthcare facilities whilst reducing estate overheads and maximising value for money are central but other non-cost significant items such as user expectations and

service change requirements need also to be part of the planning process. Opportunities exist for the provision of flexible and imaginative buildings, which reflect the nature of the services the trusts provide, but a responsive and dynamic estate policy must exist to facilitate these demands.

Of particular relevance to this research is current NHS policy on estate appraisal and performance management. Dealing with the former initially, current NHS policy suggests the formulation of an estate strategy document, which is based upon the following format (Department of Health / NHS Estates 1999):

an analysis of the trust's existing estate, including it's condition and performance

the priorities for improvement, development or disposal in relation to the estate portfolio

a comprehensive estate investment programme including all capital expenditure proposals for:

meeting the service need

meeting statutory and non-statutory standards

reducing backlog maintenance

procuring or renting new buildings

Although this would in all probability constitute a reasonable format for future capital expenditure, when placed into the context of the NHS estate, there still exists significant room for improvement. First and foremost there seems to lack a clear cohesion between NHS policy documents. As an example, the estate strategy document makes reference to other documents such as *Estatecode* or *Encode* but typically, as these documents are non-statutory guidance, little use is made of them in the formulation of the estate strategy. Indeed, the "Developing an Estate Strategy" document fails to even agree upon a definition of an estate strategy and although no one estate is the same, the general guiding principles of efficiency, value for money and adaptability are standard throughout and should therefore be reflected in the document.

The formulation of the estate strategy tends to rely upon a great deal of subjectivity and estimation. As an example, under *Estatecode*, it is suggested that in the assessment of the physical condition of the assets, a condition category should be assigned dependent upon the current functionality state (i.e. A, B, C and D – A being new and D being near imminent breakdown). Unfortunately, how do we know that these categories are assigned the correct functionality-state? It is imprudent to base capital expenditure on subjective estimates so therefore, a method of being able to assess the financial risk associated with these assessments is desirable, if not pre-requisite.

Performance management has also become an important aspect of estate management in the NHS and is considered an integral part of the estate strategy. Central to the performance management theme is the ERIC database and the subsequent ability to benchmark trust costs against similar trusts on a regional and national basis. This gives a "snapshot" view of the estate performance but does not really act as a mechanism where real change and improvements can be made. The format of the comparison is quite rigid in design and it is difficult to make accurate comparisons and thus suitable investment and expenditure decisions. It seems that too much

emphasis is placed on comparison with other estates, neglecting the finer details that really should be incorporated in this kind of exercise

A key outcome of this is the use of performance indicators that can be used to assess the efficiency of the estate. Currently, these are used to assist in the identification of surplus estate principally. However, there is scope within this research to take this one stage further and develop performance indicators that are related directly to individual buildings within the estate so that a more comprehensive overview of estate performance can be achieved.

WHOLE LIFE COSTING IN THE NHS

Hospital estates lend themselves to WLC by their very nature, large complexes with a high occupancy turnover and energy demand. Maintenance, both planned and response is always an ongoing feature and the ability to organise and cost out this work to reduce downtime costs is a considerable priority. Since the introduction of the Private Finance Initiative into the NHS in 1995, there has been an ever increasing emphasis placed upon the ability to gain value for money through partnerships with the public and private sectors, a key driver for this being the mandatory requirement under the *Capital Investment Manual* for trust's to test for the availability and feasibility of private sector funding. Also the element of risk transfer is an important aspect of the PFI (Owen and Merna 1997). All stakeholders in the decision-making processes have indicated the possible importance of the adoption of a credible WLC approach in the NHS. Currently, cost analysis is rarely carried out in any viable form post-construction but a possible explanation and one of the principle difficulties to be overcome is the perception that WLC assessments are largely dependent on a sizeable cost data set. True, the more data that is presented the better, a principle that stands firm in most formats of cost modelling technique. However, traditional approaches to WLC have failed because of their demand for esoteric data that the end user may not have access to. Paradoxically, many institutions do collate far more useful data than they are aware of but the lack of an analysis framework accentuates this problem. The skill and key to success lies in the ability to develop an approach that requires from the end user nothing more than they can provide. Therefore, the challenge within the NHS is to develop a methodology for WLC that not only is robust, but more importantly dynamic.

Although research at the Construction Cost Engineering Unit and other institutions are making significant progress in WLC methodologies, it would be fair to say that there is still no real credible standard in place, or indeed an accepted definition. The interpretation of what would come under a WLC assessment varies between groups and individuals and this is probably why WLC is still viewed with a certain mistrust. Reasons for this include time and cost considerations in implementing a WLC exercise but also a key factor that has not been addressed sufficiently is uncertainty. Like any form of future forecasting, there will always be an element of risk. For instance, when calculating values to a present day value, a discount rate needs to be applied. The discount rate is a forecasted value in itself so we need some method of being able to place a quantitative value on the uncertainty associated with the calculated rate. Similarly, the elements within the hospital such as the M+E services will have forecasted service life estimates. Again, we need to be able place some value on the likelihood of the element either failing earlier or lasting longer (economically).

A key issue with the design and management of NHS buildings has been inefficiency, in terms of both building usage and energy utilisation. Many hospitals have been identified as incurring disproportionately high running and maintenance costs, even those that are little over 20 years old. The estates have lacked the dynamic nature that is required of a service that is constantly changing even though it is now widely accepted that well designed buildings that may have higher capital costs represent value for money and can achieve faster payback of these original capital costs.

DEVELOPING A HOLISTIC FRAMEWORK FOR WHOLE LIFE COSTING

The principal objective of this research is to develop techniques and methodologies that will facilitate the effective practical implementation of whole life cycle costing into the NHS Estate. However, currently, WLC is a technique that is used primarily for investment decision making at the pre-construction phase, to aid the ranking of competing projects. Here it is proposed that WLC can also be used as a tool for investment decision making in existing hospital estates. A key concept thought that must be stressed is that here, the aim is not to develop a system whereby a single WLC figure will be returned as output, but a series of individual models which share data collectively but can return their own WLC values appropriate to the cost centre under scrutiny. In other words, WLC can be profiled for maintenance, operational cost etc or used to collate the full cost scenario. Fig. 2 outlines the format of the proposed model. The result of the investigations carried out so far have provided us with the ability to develop an innovative spreadsheet for the computation of whole life costs. This spreadsheet though improves the more basic collection mechanisms proposed by others (Flanagan and Norman 1983, BRE 1999). Not only does this spreadsheet deal with the traditional quantitative life cycle cost categories such as operational, maintenance and capital costs; it also incorporates details of the building characteristics and qualitative information such as management techniques and cost saving measures that have been initiated by the trust. More importantly, the spreadsheet also incorporates the ability to create risk profiles, which are a major enhancement in the field of WLC. In this way, the truly holistic nature of the costs of running a hospital can be identified and subsequently modelled in a more accurate and authoritative fashion, which takes into account the whole scenario as opposed to just the “edited highlights”. Experience shows that it is inaccurate and naïve to rely solely on recorded costs if we are to build up a comprehensive cost scenario. All too often, the qualitative factors are ignored and these can have a significant bearing on the whole life cost.

Traditional WLC cost models concentrate on returning a numerical value as a WLC output in net present value terms (after an annual discount rate has been applied). However, this bears little value in investment decision making, as simply knowing a nominal sum gives us little indication of the long-term economic performance of the building. This research is aimed at developing a set of key economic performance measures that will enable the end user to have a more clarified view of the whole cost scenario. Coupled with this will be the development of risk management techniques that enable managers to assess the degree of uncertainty in the calculations. Standard WLC techniques by their very nature ignore the long-term uncertainty that is inherent in such a forecasting technique, which is imprudent. Some have argued that the scale of the data collection exercise in itself prohibits a more comprehensive coverage of risk element. This situation must be overcome in order to create a more credible case

WLC profiling. In essence, the final outputs of this research will consist of a series of spreadsheets and economic performance measures with associated risk factors which can be applied to NHS buildings at any level from sub-elemental to the whole cost scenario. The chart shown in Fig. 3 gives a clearer indication of the qualitative and quantitative factors that will be used to formulate the WLC profile in this work, which are described below.

Capital Costs
Capital costs nearly always account for a significantly high proportion of WLC, especially in hospital buildings. Although many practitioners are now moving towards a WLC approach to investment decision-making, capital cost still account for a high proportion of projects that were procured on that basis.

However, it is at this point where important decisions can be made which will effect the long-term economic performance of the building. Not only will effective planning and management during the construction phase of the contract reduce whole life costs, but the desire to introduce sustainable materials and components in line with the DETR's recommendations will lead to a reduction in future maintenance costs.

Operational Costs
WLC is essentially concerned with operating physical assets to minimum cost (Woodward 1997). Accordingly, accurate forecasting of operating costs is essential to minimise the total WLC of the building. This will include cleaning, rates, energy, security, porterage etc. It is important though to make the clear difference between operational and running costs, the latter being the sum of maintenance and operating costs. Current practice suggests that the estimation of these costs be based upon both the predicted and actual experience of the performance of similar buildings. It has been found that that in NHS Buildings, operational costs amount to approximately 25-30% of total whole life costs. The operational costs in this spreadsheet are forecasted using linear and non-liner regression techniques (Kirkham et al 1999) based upon a historical data set provided by the trust.

Service Life
The period during which the hospital and component within should be assessed is a very important variable. The service life being considered can make a significant impact upon the WLC. For example, the planned extension of the service life of an individual component can have consequences for unplanned responsive maintenance costs. Although many components and hospital buildings have planned services lives, it is important to consider how this can be effectively forecasted. The factor method can be used as a way of forecasting service life values (BSI 1998) but this relies on a significant element of subjectivity. More complex methods of service life prediction have also been proposed such as the use of Markovian Chains (Wirahadikusumah et al 1999) and Artificial Neural Networks (Boussabaine, Kirkham and Grew 1999). This research will draw upon the condition surveys used within NHS Trusts as defined under Estatecode as a basis for developing projected services lives of various elements.

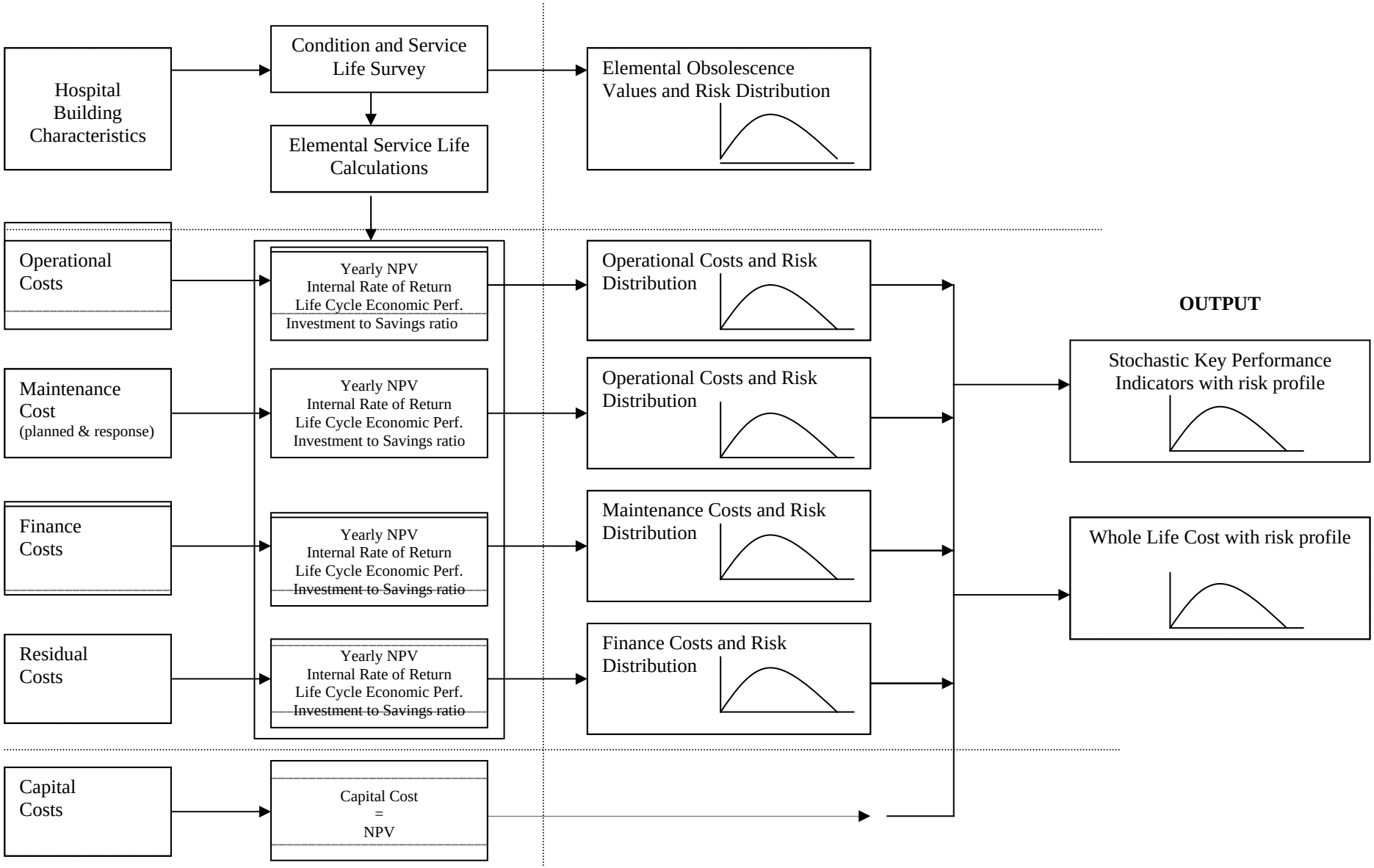

Figure 2 Format of Whole Life Cost Model

Building Charactersitics
Little research has been published with regard to the impact of building characteristics on WLC. For example, does function follow form or vice versa? How can we apply a quantitative or subjective judgement against this? We know from experience that an indirect link exists through many factors such as energy cost for instance. A poorly insulated building will consume more energy thus increasing the WLC and possible downtime costs associated with more reactive and planned maintenance. In NHS buildings, again we must consider how form may follow function. Energy intensive buildings such as hospitals require extensive M+E services. This will naturally have a bearing on the layout and characteristics of the building. It is also important to relate other features of the building such as type of frame, cladding, foundation type, glazing type etc so that some meaningful assessments can be made regarding energy usage and failure rates and maintenance

Maintenance Costs
The intensity of M+E services and the demands made upon them, coupled with the high occupancy turnover and in-use time lead to the conclusion that maintenance cost will be much higher in the NHS than in other buildings. The high maintenance backlog within the NHS Estate's older buildings has led to an ad-hoc rather than planned approach to maintenance, which has compounded these problems. Reductions in Trust budgets and building decay has seen maintenance cost become more of an issue in the total WLC scenario. If WLC are to be reduced in the future, it is essential that estate managers can effectively assess and plan a more appropriate maintenance regime for the future so that budgets can be manipulated in a more efficient and methodical fashion. Naturally, there will always be a need for some level of reactive maintenance but if these problems can be foreseen, then an increased programme of preventative maintenance can reduce long-term equipment replacement cost and downtime costs caused through reactive maintenance.

Financing and Opportunity Costs
Naturally, the costs of financing the project and future refurbishment will need to be taken into account. Interest on loans and public sector finance charges will incur costs during the life of the building. It is important here that the discount rate is calculated in an accurate and methodological fashion given the current financial conditions. If the discount rate is calculated too high, future costs may appear insignificant but if calculated too low, then capital investment proposals may be discouraged but high operational costs may result.

The opportunity cost of the investment must also be built into the WLC model. We have to be able to quantify by whatever means the costs of not investing in an alternative capital project.

Economic Performance Measures
This research is primarily aimed at moving away from the tradition approaches used in WLC with regard to data output. Most systems that are currently in use return a single WLC value (Leicester University 1999) as output. However, it is argued here that a more useful measure of the cost effectiveness of the hospital is called for so here, a set of key performance indicators will be developed. These enable the end user to gain a quick insight into how the estate is performing without having to collate banks of WLC figures individually. These performance indicators can then be used to identify efficiently where changes in investment need to be made.

Risk Management
Organisations are quickly realising that in many aspects of the construction and facilities management disciplines, risk management is a useful tool in which a quantitative assessment of the uncertainty associated with an investment decision can be made. However, currently, risk analysis depends mainly upon intuition, judgement and experience (Akintoye and Macleod 1997). Formal mathematical risk analysis techniques are rarely used due to lack of knowledge and doubts as to the suitability of complex mathematical theory for the purposes of facilities management.

As expressed earlier, the lack of willingness to adopt WLC in some organisations is the perceived unreliability of the calculations, based upon the assumption that any amount of forecasting will introduce financial and economic uncertainty. It is quite clear that investment decision making never takes place under conditions of certainty, but only under those of uncertainty and risk. It is therefore necessary to define and locate the investment decision-making problem in its real conditions, and possibly find suitable and appropriate solutions (Jovanović 1999). If the WLC model can introduce some quantitative method of assessing the probabilities of uncertainty, then this kind of barrier can be overcome. This research reflects the concerns noted by some academics (Edwards and Bowen 1998) that financial risk attracts less attention than other forms such as legal, technical, health etc. One example of a suitable method of risk application in the NHS estate is through the use of the Monte Carlo method (Wing 1997), which is currently being explored.

OUTCOMES

Currently the data that has been collected so far is being used to create mathematical profiles of the cost categories identified using statistical and artificial intelligence techniques. Service life prediction is also currently being modelled using a variety of techniques, particularly conditional probability based methods such as Markovian Chains. These are then to be used to develop a Visual Basic based spreadsheet which will enable the end user to create likely whole life cost profiles of future expenditure within the estate. The spreadsheet will also have the ability to return a set of key performance indicators, which will give a quantitative profile of the likely future costs over an assigned period. More importantly though, each profile within the WLC assessment will have an assigned probability profile which will give a clear indication of element of uncertainty within the calculations, thus providing the end user with a basis on which

CONCLUSION

The need for a more authoritative approach to investment decision-making and cost control has been a requirement of NHS spending for many years now. The NHS finds itself in an increasingly demanding position to allocate its budgets as wisely and prudently as possible. The significant percentage of total NHS spending on buildings demands a more accurate and adaptable method of achieving quality of service within the constraints on the budgets. By adoption of WLC techniques with risk management, practitioners have the ability to make accurate forecasts of likely future running costs. This facilitates the ability to manipulate budget levels effectively thus enabling hospital estates to run at a high level of economic efficiency, but with the ability to identify where risk does exist and the subsequent ability to formulate decisions around this.

REFERENCES

Akintoye, A.S and Macleod, M.J. (1997) Risk analysis and management in construction. *International Journal of Project Management*, **15**(1): 31-38.

Boussabaine, A.H, Kirkham, R.J. and Grew, R.J. (1999) Modelling total energy costs of sport centres. *Facilities Journal*, **17**(12/13): 452-461.

BRE (1999) *Study on Whole Life Costing for the Department of the Environment Transport and the Regions.* Building Research Establishment, Watford.

BSI (1998) *ISO 15686 Buildings – Service Life Planning Part 1*: *General Principles.*

Department of Health and NHS Estates (1999) *Developing an Estate Strategy.* HMSO, London.

Edwards, P.J. and Bowen P.A. (1998) Risk and risk management in construction: a review and future directions for research. *Engineering Construction and Architectural Management*, **5**(4): 339-349.

Flanagan, R and Norman, G (1983) *Life Cycle Costing for Construction*. RICS, Surveyors Publications

Jovanović, P. (1999) Application of sensitivity analysis in investment project evaluation under uncertainty and risk. *International Journal of Project Management*, **17**(4): 217-222.

Kirkham *et al.* (1999) Forecasting the running costs of sport and leisure centres. *8th International Conference on the Durability of Building Materials and Components,* National Research Council Canada.

Leicester University (1999) *Whole Life Costing Model for Purchase Supply*, University of Leicester Purchasing Department.

NHS (1999) *The National Health Service Handbook 1999*, HMSO, London.

Owen, G. and Merna, A. (1997) The Private Finance Initiative. *Engineering Construction and Architectural Management*, **4**(3): 163-177.

Payne, T. and Rees, D (1999) NHS facilities management: a prescription for change. *Facilities Journal*, **19**(7/8): 217-221, MCB University Press, Bradford.

Wing, C.K. (1997) Monte Carlo simulation of construction costs using subjective data: response. *Construction Management and Economics,***15**: 109-115.

Wirahadikusumah *et al.* (1999) Markov decision process for sewer rehabilitation. *Engineering Construction and Architectural Management*, **6**(4): 358 370.

Woodward, D. (1997) Life cycle costing – theory, information acquisition and application. *International Journal of Project Management*, **15** (6): 335-344.