THE CONSIDERATION OF MAINTENANCE ISSUES DURING THE DESIGN PROCESS IN THE UK PUBLIC SECTOR

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Maintenance is always required on buildings, for which budgets need to be allocated by building owners, particularly when the buildings are relatively old. However, building maintenance managers do not expect to be having to allocate excessive budgets to buildings which are suffering maintenance problems early in their life span. The aim of the research was to measure practitioners' experiences and opinions as to whether three techniques (value management [VM], whole life costing [WLC] and the Design Quality Indicator [DQI]) could be effectively utilized during the design stage of new building projects to prevent or reduce premature and unnecessary future building maintenance. The research method involved a postal questionnaire survey of a sample of UK local authority maintenance managers and architects from which 54 valid responses were obtained. Quantitative data were analysed using descriptive statistics and qualitative data, in the form of respondents' comments to some questionnaire questions, were content analysed. The results of the research show significant differences between the current utilization of the three techniques and the survey respondents' evaluation of their future potential use to reduce further, unnecessary, building maintenance. The research findings support the dilemma often faced in the public sector between the funding of new building projects from capital finances, and the funding of running and maintenance costs from revenue budgets. The research concludes that a gap exists between the current use of the three techniques and practitioners' opinions of a significantly higher use in the future. The research impact is a greater understanding of the consideration and evaluation of maintenance issues during the building design process by using analytical techniques.

Keywords: building maintenance, design quality indicator, value management, whole life costing.

INTRODUCTION

This paper investigates techniques that can be utilized on new building projects to prevent or reduce premature and unnecessary future building maintenance. Maintenance problems have existed for many years; indeed it is a certainty in some form for every building in existence. Maintenance professionals accept the need to allocate considerable budgets for their older building assets, but they do not expect to be allocating large amounts of money to their much younger or new buildings that are suffering maintenance problems early in their life span. Unfortunately it is a problem

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that maintenance professionals are facing, and this is cause for concern, as this places an unnecessary and unexpected financial burden upon the building owner and user. Most of the early maintenance problems encountered with new buildings should not occur and this research aims to identify the causes of this problem and find possible solutions to address them.

The paper begins by presenting the theoretical foundations to the research by, firstly, considering maintenance issues during design development, and then discussing three techniques which can be used during the design process to address building maintenance. Secondly, the research method used to collect and analyse data to satisfy the research objectives is explained. Next, results of the data analysis are then presented and discussed. Finally, conclusions, in the form of a comparison of theory with test outcomes, are proffered.

DESIGN DEVELOPMENT: MAINTENANCE ISSUES

The process of decay and the deterioration of the fabric and the services begin from the moment a building is completed and occupied; therefore there is a requirement to undertake maintenance activities to ensure that it performs to an acceptable level. British Standard (BS) EN 13306 (BSI 2001) defines maintenance as, "The combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function". Maintenance is not just to rectify defects it is also needed to prevent them. For this purpose new buildings are generally provided with a maintenance manual, which sets out the required maintenance regime for the key elements and components of the building (Riley and Cotgrave 2005). Clift and Bourke (1999) suggested that there is a growing awareness that, of the annual turnover in the construction industry, some 45% is spent on maintenance and refurbishment and that the unplanned or unexpected, such as premature failure, amounts to nearly half of this percentage. A Building Maintenance Information (BMI) service report stated that in 2000 maintenance expenditure represented 5% of the UK's Gross Domestic Product (GDP), and that maintenance expenditure had risen by 22% since 1993 (BMI 2001).

BS 8210 (BSI 1986) contends that a lack of maintenance may in part arise from a feeling that buildings are long-lived assets, which deteriorate only gradually. In fact this is generally true only of the more robust forms of structure, and even these can deteriorate rapidly with, for example, the ingress of moisture. Fittings, external decorations and engineering services usually have very much shorter lives than building structures. Therefore a failure to maintain buildings may affect their function, in addition to reducing their value. The extent to which the building is maintained is driven by the need to protect the financial asset as well as the need to maximize the building's functionality (Riley and Cotgrave 2005). Maintenance is often the first expense cut if an organization is facing financial difficulties and some will not consider the need for maintenance at all. Another financial aspect is the fact that often taxation favours new build and not maintenance activities (Clift and Bourke 1999). Seeley (1986) explained that traditionally designers rarely have a long-term interest in the buildings they produce – they became separated from the maintenance problems that come from bad design. To combat this he recommended that maintenance surveyors and the like should be represented on design teams, and there should be increased feedback of maintenance and performance information from users and maintenance organizations to design teams. Son and Yuen (1993) agreed with

Seeley on this and stated that design is the preplanning process of knowledgably selecting materials and determining their relative positions in a building to produce a building with predictable performance. With new procurement systems being adopted by the public sector, such as the UK Private Finance Initiative (PFI), the contractual requirement to maintain buildings for a specified ‘concession’ period (often 25 years) makes building maintenance a critical factor during the design process (Chinyio and Gameson 2009).

TECHNIQUES FOR USE DURING DESIGN

Value management (VM)

Best value is not about cost cutting, but is about improving the understanding of the client’s requirements and business needs. Securing a clear client brief requires skilled facilitation so that misconceptions on all sides are challenged. Dallas (2006) stated that VM provides an effective process to maximize value, in line with owners’ and users’ requirements. At the outset of a project, VM provides a powerful way of exploring the client’s needs in depth by addressing inconsistencies and expressing these in a language that all parties can understand. Bennett and Peace (2006) stated that projects are more likely to be successful if the client and contractor use VM to produce the best possible new building. BSI (2000) stated that successful VM requires a robust framework and may require a change in attitude on the part of everyone, particularly from senior management who will need to be aware of the benefits of this approach. Kelly *et al.* (2002) commented that VM opportunities commence at the inception of the project and continue through the project’s life.

This research contends that VM is a useful technique to use for the reduction of future maintenance if the right emphasis is used at the outset. The client needs to have a perspective and understanding of the implications of whole life costs, which will include the future maintenance demands and therefore maintenance needs to be made a strong factor at the client brief stage. The criteria weighting that it is given in a VM exercise will influence the effect it has in the whole of the project. The client will need their appointed project manager, or a facilitator, to focus on the maintenance issue to ensure that the objective of maintenance reduction is achieved. If the client has a maintenance department with maintenance managers they can consider their involvement in VM workshops. This links logically with the contentions of Seeley (1986) about a maintenance surveyor, or other representative, having input at the design stage.

Whole life costing (WLC)

The Construction Best Practice Programme (CBPP 1998) defines WLC as, “The systematic consideration of all relevant costs and revenues associated with the ownership of an asset”. Woodward (1997) commented that the whole life cost of a physical asset begins when its acquisition is first considered, and ends when it is finally taken out of service for disposal or redeployment, when a new cost cycle begins. This comment is reinforced with the definition of ‘life cycle’ in BS EN 13306 (BSI 2001): “…time interval that commences with the initiation of the concept and terminates with the disposal of the item.” WLC is primarily an accounting procedure applied to the decisions made regarding the technology to be adopted. In the testing of these decisions against future costs it may be that a choice is altered from that first proposed (Ellingham and Fawcett 2006). A cheaper initial solution may have the greater long-term costs – a more expensive solution, with its subsequent technological implications, could be adopted in order to reduce future costs (Chandler 1994).

Flanagan *et al.* (1989) explain that what life cycle costing does is look at the balance between initial and future expenditures. The basic idea is that spending a little bit extra now may well reduce expenditures in the future. In addition, more tangible benefits may flow from increased initial expenditures in terms of: improved quality, reduced disruption during refurbishment or planned maintenance, or increased income generating power for the building. AEC (2007) explained that it is at the design stage that the greatest value gains can be achieved. Clients who have a long-term interest in the property concerned typically adopt WLC. Often such clients come from the public sector and own a large portfolio of property. It is a UK Treasury requirement that major capital projects should be let taking account WLC, through: design and build, the private finance initiative (PFI) or prime contracting (see: www.hm-treasury.gov.uk).

Larsson and Clark (2000) described WLC as, "…the dog that didn't bark.", as although most principles of WLC were well developed in theory, it had not received a wide practical application at that time. Research has indicated that WLC was used extensively only in PFI projects and public procurement (Clift and Bourke 1999). Other surveys indicated that building sectors in other international countries had not fully adopted WLC methodologies (Wilkinson 1996; Sterner 2000). Clift and Bourke (1999) reported particular problems associated with the use of WLC. One of the problems was the scale of the data collection exercise, inconsistencies across data sets, and the level of detail required to make a meaningful calculation of whole life costs at design level (whether considering new build or, increasingly, refurbishment). Another problem was a lack of universal methods and standard formats for calculating whole life costs, and the difficulty in integrating operating and maintenance strategies at the design phase, and their impact on the business process expected to be housed within the building. There was also a general lack of perception of client and industry interest in spite of the drivers identified above. Ferry *et al.* (2001) reported that there are two fields where WLC techniques worked very well and are increasingly been used. The first is shorter life assets, such as mechanical or electrical equipment, where foreseeable energy consumption and maintenance and renewal programmes generate much of the future cost. The second is where both the present and future cost are equally real, for example in a rolling maintenance programme for a major installation, where the money is coming from the same fund, and where policy can be planned accordingly. If these conditions can be fulfilled then whole life costing is relevant to maintenance reduction.

Ellingham and Fawcett (2006) reported that although more expensive components are sometimes better value, it could not be assumed that this is always true. WLC should not be considered in isolation as, as Langston (2002) suggests, WLC is not an exact science and the technique is therefore often used in conjunction with other techniques such as risk management, VM, and value engineering.

Design quality indicator (DQI)

Quality is a major issue for all industries throughout the world and the UK construction industry is no exception. However, when people are asked to define quality they find it difficult, as what constitutes quality to one person may be different to another. McCabe (1998) commented that quality, like beauty, is in the eyes of the beholder. Building design quality is not easy to measure because everyone has different ideas about what they find attractive or useful. Rounce (1998) suggested that, in construction, quality is meeting agreed requirements or conformance to requirements and it is referred to in quality management terms and not standards of finish. Design quality in buildings has always been difficult to measure due to its subjective nature. Cook (2006) commented that everyone involved in a building project wants to achieve a better building but design quality means different things to: clients, users, architects, cost consultants and contractors. Thomson *et al.* (2003) explained that negotiating design priorities is an important part of the development process and that value and quality can be misunderstood and confused.

The Design Quality Indictor (DQI) is a toolkit to measure the design quality of buildings (Whyte and Gann 2003). Its development began in 1999, led by a multidisciplinary group convened by the Construction Industry Council (CIC) and with sponsorship from the DTI, CABE, Constructing Excellence and the Strategic Forum for Construction, and support from the OGC (CIC 2006). It was developed to complement the performance measures introduced by Rethinking Construction, in particular the Headline Key Performance Indicators that assess the process of producing a building. The DQI has been developed into a web-based tool, DQI Online, accessible to everyone involved in the procurement and use of buildings (see: www.dqi.org.uk). Sir John Egan's 'Accelerating Change' report (Rethinking Construction 2002) highlighted the key importance of design quality.

The DQI is a process that considers the present and future implications of the design and the needs of the end user. From reviewing the literature it appears that the success of the DQI depends upon ensuring that all of the relevant parties in the project are represented, and that the project team as a whole are committed to producing a product fit for the purpose of the end user. It also appears that the DQI can make a positive contribution to delivering acceptable quality buildings, but the question still remains as to whether, firstly, its usage will continue to grow in the future and, secondly, if it will be an effective method of reducing future building maintenance.

RESEARCH METHOD

Research Aim

To investigate techniques that can be used during the design process of new public sector building projects to prevent or reduce premature and unnecessary future building maintenance.

Research Objectives

1. To conduct a critical review of literature relating to: Value Management (VM), Whole Life Costing (WLC) and the Design Quality Indicator (DQI), in order to identify key issues of particular importance to the maintenance of buildings [THEORY].
2. To collect and critically analyse data from a sample of architects and maintenance managers in order to elicit their experiences and perceptions of the current and future use of VM, WLC and DQI techniques during the building design process [TEST].
3. To discuss and compare theoretical constructs with the empirical research findings and draw conclusions [CONCLUDE].

It is clear from the literature that: the three techniques could be used to reduce future maintenance, that they are used, and, that they can be effective. However, figures on their actual usage were not specific. It was established that the reduction of future maintenance is not their primary function, but, future maintenance can be reduced as a consequence of using these techniques. Both the actual and future use of the techniques for the purpose of reducing maintenance was the emphasis of the research when conducting the data collection from practitioners.

Data collection and analysis

Data were collected by conducting a questionnaire survey of public sector architects and maintenance managers. These parties were considered to be the most appropriate to survey as it is often the case, within public sector local authorities in the UK, that there are design and maintenance sections within such organizations. In addition, such a survey enables the research to be conducted throughout the UK surveying similar organizations. Therefore this research used purposive (i.e. a sample chosen with a specific purpose in mind), expert (i.e. input from people with known experience and expertise) sampling (Rosenthal and Rosnow 1991). Questions were both quantitative (e.g. rankings, use of lickert scales etc.) and qualitative – where respondents were asked for their additional comments and opinions on certain issues. Respondents were asked to confine their responses to their work experiences during the last 'financial year' in an attempt to ensure that valid, reliable and comparative data were collected.

The proposed research method was submitted to, and approved by, the University's 'Human Research Ethics Committee' before any questionnaires were distributed. A small pilot study was conducted to test the clarity of the questionnaire and revisions were made based upon the feedback received. For the main study 300 postal questionnaires were distributed to an equal sample of architects and maintenance managers. Participants were identified from publicly available details of UK public authorities (i.e. city and county councils; borough and metropolitan boroughs).

54 completed, and usable, questionnaires were returned (30 from architects and 24 from maintenance managers); a response rate of 18%. Data were extracted from the questionnaires for analysis using an excel spreadsheet. Quantitative data were analysed using descriptive statistics. Qualitative data were analysed and presented, following a content analysis of the data, using summaries and verbatim extracts from participants' responses.

RESEARCH RESULTS AND DISCUSSION

Results from the analysis of the questionnaires are now presented and discussed. The first sub-section presents issues relating to maintenance managers' involvement in the design process. The subsequent three sub-sections relate to the three techniques under investigation: VM, WLC and DQI.

Maintenance managers' involvement in the design process

Respondents were asked if any new project designs received input from maintenance managers. 50% responded yes, and 50% responded no. Where maintenance managers had been involved in project designs, only 7% of respondents deemed their input as 'always useful', with 33% and 44% rating their input as 'mostly useful' and 'sometimes useful' respectively. More specifically, only 25% of projects had received input from maintenance managers. Some key comments made by respondents relating to the maintenance managers' input were: "Client unwilling to pay the cost of this involvement."; "Arrangements for the Maintenance team to input on projects designed by our architects are somewhat ad hoc."; "Input from the maintenance team usually on the judgement of the project leader and therefore no automatic referral."; "The designers are concerned that it will restrict their ability to design and could question or delay their projects and cause design changes."

Evidence from the responses to the questionnaire suggests that the client has a choice to make at the conception of the project regarding the level of future maintenance. However, there are problems with this as the tendency appears to be that the clients often do not, or cannot, consider the future maintenance as the financial restrictions that Local Government has to adhere to makes the choice difficult. The funding for new projects is from capital finances, and the running costs, including maintenance and cleaning, are revenue costs. Therefore the preference is often to have lower initial construction costs as they are funded from the capital budgets. Unless such funding restrictions are reviewed the emphasis on prioritizing future maintenance is less likely.

Value management (VM)

48% of the respondents stated that they had experience of VM being used on their projects, and 52% indicated that they had not experienced using VM. Of the 48% who had used VM they stated that it had been used on 57% of projects. Of the 52% who had not used VM 46% stated that the use of VM was being considered for use on future projects, and also stated that they thought that VM would be used on 78% of future projects. Major reasons given by respondents as to why VM was not being used on all projects included: "Insufficient recourses to undertake VM on all projects."; "Value management / value engineering is just another name for cost cutting and dumbing down of a scheme."; "Although VM did not take place during our delivery of any design projects last year, it has been recognized as a substantial benefit. This is being introduced during our delivery of next year's capital building programme." and, "Reluctance of designers (and clients) to utilize and the timescale with which some sites must be completed."

There were prominent reasons that VM was not used on all projects, or was not likely to be used on any future projects. The responses revealed that it would not be used due to: the lack of resources (time and funding), the designers' and clients' reluctance to utilize it and timescales within which some projects are to be completed, it being covered in house under another name, only likely on larger projects, no plans for new build projects, and no method or procedure being in place.

Whole life costing (WLC)

37% of the respondents stated that they had experience of WLC being used on their projects, with 63% indicating that they had not experienced using WLC. Of the 37% who had used WLC they stated that it had been used on 30% of their projects. Of the 63% who had not used WLC 39% stated that it would be considered for use on future projects. Major reasons given by respondents as to why VM was not being used on all projects included: "Because the funding of capital projects is divorced at source from revenue costs – e.g. DfES building cost budgets."; "PFI projects are very strong on whole life costs – but in house projects are usually funded from capital budgets and running costs from revenue. As revenue is being squeezed there is a lot more interest in reducing costs as well as meeting the sustainable targets and carbon ratings. This is one of the highest priorities we must raise the profile."; "No procedures or resources to implement such a strategy."; "Our projects are driven by the capital budget. Future costs are not given a high priority compared with delivering the scheme at the time."; "Although consideration to Whole Life Costing did not take place during our delivery of any design projects last year, it has been recognized as a substantial financial benefit to the client. This has gradually being introduced in our delivery of next year's capital building programme."; "Clients initial budgets are controlled by the amount of money granted to them, Most do not even consider running costs other than a cursory visit at this moment in time – some don't think about it until close to completion."

Again there were dominant reasons why WLC was not used on all projects, or was not likely to be used on any future projects. The respondents revealed that: a lack of resources, the limitation of time, financial pressures, the relationship between capital costs and revenue costs, and the size and value of project were all factors that limited its use. There were comments about the involvement of the client and their preference for low construction costs as opposed to lower maintenance and running costs. The literature review of WLC revealed that the client needs to have a perspective and understanding of the implications of whole life costs, which will include the future maintenance demands, and therefore, maintenance needs to be made a strong factor at the client brief stage.

Design Quality Indicator (DQI)

9% of the respondents stated that they had experience of the DQI being used on their projects, with 91% indicating that they had not experienced using the DQI. Of the 9% who had used the DQI they stated that it had been used on 29% of their projects. Of the 91% who had not used the DQI 45% stated that it would be considered for use on future projects. Major reasons given by respondents as to why the DQI was not being used on all projects included: "DQI was used on our Building Schools for the Future(bsff) One School Pathfinder for Secondary projects, which has a value of c. £22m. The other schemes within the capital programme are too small to afford the cost and time implications of the DQI process. We are considering it for use on our Building Schools for the Future One School Pathfinder for primary school (value c. £6.5m) at the moment."; "DQI's have been applied to some 'prototype' projects with varying degrees of success in terms of outcomes. I suspect that this will become more significant as it becomes a funding requirement with some organizations."; "Initial trial to understand process. Insufficient resources to undertake on all projects." and, "Lack of knowledge and understanding of the processes and lack of expertise."

Key reasons that the DQI was not used on all projects, or was not likely to be used on any future projects, were identified. The respondents revealed that it was only considered suitable for larger projects and some stated that it was only used where it is mandatory; such as on schools projects. A lack of understanding, knowledge and resources were commented upon and the difficulty of use. Clients' reluctance to pay for this was also an issue. The literature review of the DQI revealed that if this technique were undertaken correctly, it would ultimately influence the level of future maintenance, as the end user is part of the process as a respondent. The success of the DQI depends upon the guidance of a facilitator, who can take an unbiased view of the whole process. The facilitator will ensure that all of the relevant parties in the project, including maintenance managers, are represented, and that the project team as a whole are committed to producing a product that is fit for the purpose for the end user.

CONCLUSIONS

The literature reviewed identified that VM, WLC, and the DQI are techniques that can be used to reduce building maintenance. It was also established that the reduction of future maintenance is not their primary function. However, future maintenance can be reduced as a consequence of using these techniques. In order to achieve this, clients need to have a perspective and understanding of the implications of future maintenance so that they can ensure that the right emphasis is attributed to its reduction at the outset of a project.

The literature review also suggested the inclusion of maintenance personnel at the design stage to help to reduce the future maintenance burden. This seemed to be an obvious observation. However, some comments from the research participants suggested that architects are not prepared to take advice from others. There are mixed feelings here. Some of the maintenance managers refer to the reluctance of the architects to accept the input from the maintenance team. By contrast, some of the responses from the architects indicated that input from the maintenance teams is desired. One of the most interesting findings from the research was that 100% of the survey respondents stated that all project designs should receive input from the maintenance team. However, data collected showed that maintenance teams were only involved in 25% of project designs. This clearly raises a key research question, worthy of further investigation: why are maintenance teams are not involved in a significantly larger percentage of project designs.

The research concludes that a gap exists between the current use of the three techniques and practitioners' opinions of a significantly higher level use in the future. The research findings support the dilemma often faced in the public sector between the funding of new building projects from capital finances, and the funding of running and maintenance costs from revenue budgets. The research impact is a greater understanding of the consideration and evaluation of maintenance issues during the building design process.

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