ABSTRACT

Performance and whole life cost data for built assets are often widely dispersed, unstructured and ill-defined, making it impossible to compare or benchmark performance. This paper will describe the current UK industry-led approach to solving this problem.

The project aims to identify and structure cost and performance data covering the service life of constructed assets. The aim is to improve investment performance and reduce whole life costs of constructed assets by providing standard methodologies and benchmark data on performance of constructed assets in support of business activities.

KEYWORDS:

Built asset; Client; Performance; Whole life cost; Benchmarking

INTRODUCTION

Whole life costing has been with us since the late 1960's but has yet to become a widely-used decision support tool. The reasons for this were examined in a recent project by BRE. This led to the formation of a Whole Life Cost Forum, which has been collecting and structuring data on whole life costs, and is now starting to address the processes and techniques which allow such data to add value to construction operations and support to core business activities of clients for constructed assets. This paper describes these activities.

REPORT ON WHOLE LIFE COSTS

A report was commissioned from BRE by the Department of the Environment, Transport and the Regions (Clift and Bourke, 1999) on the current use of whole life costing. It had the objectives of identifying barriers to, and initiatives to promote, procurement on the basis of whole life rather than just lowest capital or initial cost. The report represents the views of the whole supply chain in construction of both buildings and infrastructure. The report identified a demand by construction clients and the construction industry to develop and implement whole life cost techniques and approaches to improve the construction process. The clients' view of the drivers for whole life costing is summarised in guidance produced by BRE for the Construction Clients Forum in their Client's guide to Whole Life Costing (Construction Clients Forum, 2000).

The main findings of the report included:

- Substantial research work was needed in the development of a database structure that takes account of service life, performance and whole life costing.

- The lack of a standardised approach and the need for an independent / confidential holder of such data were identified by respondents as barriers to adoption of whole life costing.
• Whole life costing was mainly confined to public procurement (in particular Private Finance Initiative [PFI] type projects where long term risks of ownership are transferred by contract from the public to private sectors)

• Over 74% of questionnaire respondents would consider using whole life costing in future, and 72% would take part in and provide feedback in a data sharing club on whole life costs

• Significant technical barriers exist to adoption of whole life costs, including lack of data on both costs and performance.

• Motivational barriers include perceived lack of client interest and trust in the value of whole life cost exercises.

• Whole life costing was most frequently carried out at the early stages of procurement

• It was most frequently used for newbuild projects

• It was commonly used for infrastructure projects (e.g. water supplies, roads and bridges) and for education projects (these type of public projects represent the typical subject matter of PFI contracts)

• Approximately one third of the respondents to the questionnaire were currently using whole life costing

Reasons given for not carrying out whole life costing included (in % terms):

![Figure 1 - Why you don't you do WLC?](image)
THE WHOLE LIFE COST FORUM

In response to this research a collaborative initiative by all sectors of the construction industry set up the Whole Life Cost Forum (WLCF). Details can be found on their website at www.wlcf.org.uk.

What is the Whole Life Cost Forum?
The WLCF was officially launched at the end of November 1999 following a development period under the guidance of an independent Steering Committee. Members are drawn from a wide spectrum of the industry ranging from the client to the supply side.

The membership of the Whole Life Cost Forum is divided into eight categories covering a broad spectrum of the interested industry parties:
1. Funders
2. Owners or Occupiers
3. Developers
4. Construction Consultants
5. Other Consultants (legal or financial)
6. Constructors
7. Facilities Managers
8. Suppliers/Manufacturers

This broad spectrum of membership enables the WLCF to gather dispersed sources of information relevant to Whole Life Costing and will, within its 3 year time frame, enable the generation of a national standard for whole life costing and generate a national database of cost and performance data.

Aims And Objectives
The aims and objectives of the WLCF are to represent the Construction Industry in the field of whole life costing. It is developing as a centre of excellence providing methods and processes as a central resource for members to:
• access cost and performance data covering the service life of constructed assets
• improve investment performance and reduce whole life costs of constructed assets
• provide and access benchmark data on whole life cost and service life performance of constructed assets in support of business activities

It aims to undertake these aims by:
• creating standard methodologies on whole life costing
• benchmarking within the WLCF
• providing a central source of data on whole life costs
• commenting on developing codes and standards
• providing workshops to improve understanding and utilisation of whole life costing techniques

The Forum has become the national UK source of developing best practice in planning, controlling and managing the service life and costs of constructed assets.

DATA CLASSIFICATION

The WLCF has undertaken the task of creating a structure for storing whole life cost data at component and building level and creating a standardised methodology to ensure whole life cost analysis is carried out with high levels of consistency throughout the UK industry.

The classification of buildings and components is based on a ‘Uniclass’ system as this classification structure was considered to offer the greatest compatibility with existing datasets and ensure effective
storage and retrieval of the data collected by the WLCF. (The Uniclass system is accessible on the internet http://cig.bre.co.uk/connet/classifications/).

The WLCF has identified four datasets within whole life cost data. These datasets relate to physical, performance, quality and cost data.

**Physical Data**
This is data on the built asset to which the cost data relates (e.g., a field to describe the type of factory to which heating costs relate. This allows users to identify comparable building types and uses). To interpret the cost data the physical data must exist and be fairly detailed. With general accounting records this data is often entirely absent.

**Quality Data**
Quality is enormously variable and data on maintenance, cleaning, rates etc. may be heavily influenced if the built asset is of high or low quality. An important point here is that data is much influenced by the policy decisions of the administration. Many of these costs are more directly determined by administration policy than by any design aspects of the building. Data that are heavily coloured in this way need to be identified.

**Performance Data**
The level of achieved performance of the building to which the cost data relates (e.g. the costs of heating were low because the heating plant was undersized, with the result that the building was sometimes inadequately heated).

**Cost data**
The data which describes capital and operational costs, and what activities they represent. This may be available but without the other types of data is of little value.

Table 1 below gives examples of where different types of data fall within the WLCF data structure.

**DATA SOURCES**

The WLCF have identified the three main sources of data that will help to predict the future costs and performance of components and buildings as accurately as possible. These are:

**Specialist manufacturers, suppliers and contractors**
The manufacturers and/or suppliers of many components may be expected to know not only the cost of their products, but their anticipated lifespan on the basis of previous experience and/or accelerated test results, and their maintenance and cleaning requirements.

**Predictive calculations**
The simplest and most familiar of these are heat loss calculations from which an annual energy bill may be calculated. It is not difficult to go further and calculate, say, cleaning costs by working out the areas of all the surfaces to be cleaned, establishing how they would be cleaned, establishing unit rates and thus working out the annual cost. Quite sophisticated predicative calculations can be made in this way which reflect the likely level of certain operating costs.

**Historical Data**
This is data from existing buildings or products / projects. It will be either the result of major exercises that are published (for example, Building Maintenance Information, 2000) or individual data obtained from an organisation's own records of buildings / products / projects of which they have experience.
### Table 1: Examples of WLC Data

<table>
<thead>
<tr>
<th>Data type</th>
<th>Example</th>
</tr>
</thead>
</table>
| **Physical data** | Ceiling areas  
Wall areas  
Window areas  
Number of sanitary fittings  
Total electrical connected load  
Boiler or air conditioning capacity  
Type of heating system  
Floor areas  
Functional areas – office  
factory etc. |
| **Quality Data** | Condition of electrical & mechanical services  
Condition of sanitary fittings and pipework  
Condition of fabrics  
Condition of furnishings  
Condition of decorations |
| **Performance Data** | KWh/ m²/ p.a.  
Therms/ m²/p.a.  
Usage patterns  
Occupancy times / levels  
Maintenance strategies / cycles |
| **Cost Data** | Rates  
Fuel Bills - Oil  
Electricity  
Coal  
Gas  
Security Costs  
Cleaning Costs – Labour  
Materials  
Plant  
Water Charges  
Insurance Costs  
Management Costs  
Maintenance Costs - Labour  
Materials  
Plant  
Depreciation |

### THE DATABASE

The need for structured data on performance and on the cost of maintaining that performance over time has necessitated the creation of an electronic database. Using the findings from a 3 year project funded by DETR and EPSRC which was completed in 1995 (Clift and Butler 1995) the WLCF database is structured and accessed at a number of levels.

- **Level 1** represents the level of information needed to describe the whole building. It would be used at early design stage to set the budget for whole life costing. Budgets for capital costs have traditionally been agreed early in the design process; the database provides the means to set the budget for recurring costs. The two budgets can be combined and discounted to prepare a whole life cost budget presented at net present value (see Table 2).
- **Level 2** of the database provides more detailed information on the performance of building elements and would be appropriate at the outline design stage of building life (see Table 3).
- **Level 3** of the database covers sub elements for use at early detail design stage (see Table 4).
- **Level 4** covers components and systems and reflect the typical chronology of detail design, construction and occupancy stages. This Level includes information about failure modes,
agents of failure, action required to maintain component and system performance, likely effects of failure and capital and maintenance costs for that component or system.

Each Level provides the user with more detailed data. The performance and costs can be constantly checked against the original requirements and budget as building life progresses. The tables below are examples taken from Levels 1 to 3 of the database framework developed under the project and populated with sample data for demonstration purposes only. (The tables are based on a 10,000 sq m 3 storey, city centre office)

<table>
<thead>
<tr>
<th>Specification level*</th>
<th>Capital cost £/sq m</th>
<th>Occupancy cost £/sq m pa</th>
<th>Maintenance levels**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Low*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>800</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Mean</td>
<td>900</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Max</td>
<td>1000</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>Medium*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>920</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>Mean</td>
<td>1000</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Max</td>
<td>1200</td>
<td>53</td>
<td>75</td>
</tr>
<tr>
<td>High*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>1100</td>
<td>28</td>
<td>33</td>
</tr>
<tr>
<td>Mean</td>
<td>1300</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Max</td>
<td>1650</td>
<td>61</td>
<td>82</td>
</tr>
</tbody>
</table>

Table 2 Whole building capital and occupancy costs

Notes
* Specification levels start with a basic low cost cladding and roofing with little or low quality finishes through to pressure equalised cladding, copper roofing, high quality finishes and four pipe fan coil air conditioning.
** Maintenance levels
1 repair only
2 scheduled maintenance and repair
3 condition based maintenance.

<table>
<thead>
<tr>
<th>Element</th>
<th>Life expectancy yrs</th>
<th>Maintenance level</th>
<th>% capital cost</th>
<th>Target capital cost £/sq m</th>
<th>Occupancy cost £/sq m pa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substructure</td>
<td>60</td>
<td>2</td>
<td>10.5</td>
<td>105</td>
<td>0</td>
</tr>
<tr>
<td>Superstructure</td>
<td>60</td>
<td>2</td>
<td>45</td>
<td>450</td>
<td>1.2</td>
</tr>
<tr>
<td>Finishes</td>
<td>15</td>
<td>2</td>
<td>9.5</td>
<td>95</td>
<td>2.4</td>
</tr>
<tr>
<td>Fittings</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>20</td>
<td>0.45</td>
</tr>
<tr>
<td>Services</td>
<td>25</td>
<td>2</td>
<td>21</td>
<td>210</td>
<td>7</td>
</tr>
<tr>
<td>External works</td>
<td>15</td>
<td>2</td>
<td>4</td>
<td>40</td>
<td>0.95</td>
</tr>
<tr>
<td>Unallocated</td>
<td>8</td>
<td>80</td>
<td>5.65</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100</td>
<td>12</td>
<td>7</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Table 3 Element capital and occupancy costs (based on Table 2)
Improved Value

The WLCF is trying to promote decisions made on whole life terms. This, by definition implies the need for collaborative and multi-disciplinary design and construction teams. Value and performance improvement are key objectives, rather than just competition on price. The WLCF have therefore developed working groups to provide information on alternative procurement routes, as promoted in the Egan report (Department of the Environment, Transport and the Regions, 1998) and by major clients such as the Ministry of Defence.

Benchmarking

Benchmarking is seen as an active way to measure and compare the performance of an organisation's activities. It can provide valuable information for organisations to improve performance in meeting customer/user needs and requirements by establishing effective goals and objectives. Measurement and comparison can be:

- Internal – a comparison of internal operations such as one site (or project team) against another within the same company.
- Competitive – a comparison against a specific competitor for the product, service or function of interest.
- Generic – a comparison of business functions or processes that are the same, regardless of industry or country.

The UK construction industry has embraced the idea of measuring performance and quality by benchmarking. The drive for this came from a government sponsored independent report into the future direction of the construction industry (the Construction Task Force Report, also known as the Egan report (Department of the Environment, Transport and the Regions, 1998)). This report recommended benchmarking as a means of driving continuous improvement, following the example of the automotive industry. Following the publication of the report, an industry-led movement (the Movement for Innovation, or M4I) was established. Details of initiatives and case studies under the M4I programme can be accessed at their website (www.m4i.org.uk). By assessing performance based upon a set of Key Performance Indicators (KPI's), clients, their professional advisers, contractors and
suppliers can measure their own performance and that of the construction supply chain. This permits identification of areas where improvement is required.

Typical KPI’s developed by the Movement for Innovation include:
- client satisfaction – product
- client satisfaction – service
- defects
- predictability – cost
- predictability – time
- profitability
- productivity
- safety
- construction cost
- construction time

The WLCF have been in close discussion with government and organisations that have been producing guidance and benchmarks for the existing KPIs, listed above. The Forum have chosen to produce a new set of KPIs on whole life costs. These highlight the relationships and proven competitive advantages that can arise from improved design, material specification, and reductions in energy consumption. An example of typical benchmark data from the WLCF is shown below.

### Figure 2. Example of typical WLCF data reporting on defined data proportions at building level.

**Partnering and supply chain management**

The work has highlighted the significant performance enhancement of applying best practice collaborative relationships with the supply chain as early as possible in the project process. Partnering is one approach that is seen as potentially improving the construction process. It involves two or more organisations working together to improve performance through mutually agreed objectives, devising a way for resolving any disputes and committed to continuous improvement and sharing gains. Partnering is essentially about communication and provides an opportunity for collaboration but if misused can provide opportunities for collusion.
Value management

Value Management is a technique that the WLCF are investigating as a possible tool to improve construction procurement because of the clear relationship between satisfying needs and expectations and providing the resources needed to achieve them. The aim of a VM study is to attain optimum value by providing the necessary functions at least cost without prejudice to specific quality and performance.

Environmental significance

The environmental and economic significance of building design and product selection is a key issue in ensuring whole life value for a built asset. The WLCF is therefore investigating ways to reduce environmental impacts cost effectively over time, through combining whole life costing and life cycle analysis techniques.

CONCLUSIONS

Clients are leading demand for whole life costing techniques to be developed and evaluated within the UK. They are not satisfied with a purely economic evaluation of whole life performance risks and opportunities. They are requesting whole life cost estimation earlier in the business planning and design development phases, and are allying it to risk evaluation, benchmarking and value management.

The Whole Life Cost Forum was set up in response to this demand, and in recognition of the need for an objective and independent source of data in a structured and accessible form. This has necessitated development of a data structure which acknowledges that data inputs are presently held in many different formats and levels of detail. While the recommended data structure is under development, and will drive new data to be collected in a more organised and coherent structure, in the meantime data collection and benchmarking has commenced using admittedly partial and variable datasets that are already available. The Forum has broad support from across the industry, in particular from organisations committed to continuous improvement and measurement of performance.

REFERENCES


