Executive Summary

Whole Life Costs and Project Procurement in Port, Coastal and Fluvial Engineering: “How to escape the cost boxes”

N Masters
J Simm

SR 567
July 2002

Whole life costing is not a new concept. However, thinking about costs has traditionally been segregated into “boxes” of capital, maintenance, operational and disruption costs, a split often emphasised by divisions of responsibility within organisations. This manual provides the necessary guidance and data to break down the barriers between cost boxes so that costs can be considered holistically. This leads to more informed project decisions and can reduce costs over the life of an asset. It is also consistent with the present drive towards procuring solutions that are cost effective and sustainable.

Whole life costing involves estimating the total cost of a product, system or structure throughout its entire life. It is about identifying future costs and referring them back to present day costs using standard accounting techniques such as Present Value. The objective of whole life costing is to minimise total lifetime expenditure by facilitating the choice of the most cost effective project option.

Traditionally, project and design decisions in port, coastal and fluvial engineering have been based predominantly on initial capital costs and whole life costs have not been given full consideration. In recent years it has been seen that decisions made on this basis are not always best. For example, when unplanned maintenance work has arisen during the life of a project, especially in ports, disruption costs can be an order of magnitude greater than the costs of the maintenance work itself. Large scale and costly emergency works have also been required in recent years as a result of failing to undertake planned monitoring and maintenance. It is now understood that cost savings and better value can be delivered by basing project decisions on the costs incurred throughout the life of a project. For this reason, various forms of whole life cost analysis are now being used in the port, coastal and fluvial engineering sector.

This guide provides detailed information, including a database containing historic maintenance cost information, to facilitate the use of whole life costing. Case studies are presented showing the application of whole life costing at various stages in numerous port, coastal and fluvial engineering projects.

The guide is divided into three main sections. Part A provides an overview of whole life costing and its application to port, coastal and fluvial engineering. This is supported by Appendices giving information on particular techniques and on maintenance cost data. Finally, a number of case studies are described in Part B and the lessons learned from applying whole life cost analysis in each case study are identified.
Executive Summary continued

What is whole life costing about?

Whole life costing techniques, such as Present Value, are applied to the cash flows for various project options using an appropriate discount rate to adjust future costs to facilitate the choice of the best project option. The discount rate currently recommended by the UK government is 6%, commercial rates may be different.

The following costs are included in a whole life cost analysis:

- Capital
- Maintenance and Monitoring
- Risk
- Disruption
- Disposal

Understanding the accuracy of the estimation of future costs and the sensitivity of the final result to these estimations is essential in order to make informed comparisons.

What inhibits its application?

There are numerous reasons why whole life costing has not been widely used in port, coastal and fluvial engineering. Some of these include:

- Whole life costs are not viewed holistically. The traditional view of capital and maintenance budgets is that they belong in “separate boxes”.
- The inflexibility of current funding arrangements discourages the true implementation of whole life costing (e.g. the lack of MAFF grant aid for the maintenance of hard defences).
- There may be pressure to show a financial return on an asset within a short time scale, typically 5 - 10 years, without taking full account of durability issues and monitoring, maintenance and disruption costs. This short-term approach and lack of consideration of durability issues may negate any early returns by increasing costs over the life of the asset. This is contrary to the current drive towards economic and environmental sustainability.
- It is generally not required or understood by the owner and emphasis is often placed on lowest capital cost and not on the overall life of the facility.
- There are concerns over the uncertainties associated with forecasting the timing and magnitude of future costs.

Work is currently under way to address these concerns through industry forums, workshops and research projects such as this.

Why use it?

There are many benefits from adopting a whole life cost approach to investment decisions. Total lifetime expenditure is minimised, discussion between all parties involved in the project process is encouraged early on in the project programme and there is early quantitative consideration of the financial effect of the following:
Executive Summary continued

- risks
- potential problems
- monitoring and maintenance requirements
- functional performance
- material specification
- long term durability
- downtime and loss of business

Whole life costing can be used throughout the lifetime of an asset:

- to compare outline designs
- to refine the detailed design by assisting in the choice of design elements
- to assist with management decisions such as whether to rehabilitate, replace or dispose of a structure or elements of that structure.

What have we done to support the use of whole life costing?

1) Provide concise guidance (see Part A)

Part A of the manual contains concise guidance on various aspects of whole life cost analysis. This is supported with detailed background information in the Appendices.

2) HR Wallingford Database of maintenance and monitoring costs (see Appendix 3)

To develop a consistent approach for estimating the maintenance costs of port, coastal and fluvial structures, HR Wallingford have compiled an internet accessible database at www.wholelifecosts.org containing maintenance cost information for the following engineering elements:

- Groynes
- Breakwaters
- Sea walls
- Jetties
- Wharves/quays
- Beaches
- Revetments

The database can be used to provide an indication of the likely maintenance and monitoring costs associated with each of the generic elements outlined above. Environmental and other factors can be used to limit the search so the costs are more closely aligned with those of the structure and site constraints under consideration. Individual records can be viewed, which contain additional notes and explanations on the most common maintenance issues arising with each element.
Executive Summary continued

3) Provide examples of the use of whole life costing (see Part B)

Part B of the guidance manual contains detailed case examples showing the application of whole life costing at various stages of the project process in the port, coastal and fluvial engineering sector.
Foreword

The authors of this guide are employed by HR Wallingford (HR). The work reported herein was carried out under a Contract jointly funded by HR Wallingford and the Secretary of State for the Environment, Transport and the Regions placed on 29 June 1999. Any views expressed are not necessarily those of the Secretary of State for the Environment, Transport and the Regions.

This guide constitutes HR Wallingford report SR 567. The objective of the project was to draw together existing knowledge, experience and research, including that gained from case studies, to produce detailed guidance on the current and potential uses of whole life costing in port, coastal and fluvial engineering. The project was managed by Neal Masters and Jonathan Simm of HR Wallingford. This guide was also written and edited by Neal Masters and Jonathan Simm. The HR Wallingford job number was CDS 0415

Project Funder:

Financial support for the project was provided by the Department of the Environment, Transport and the Regions under the Partners in Innovation Scheme within the Construction Process Business Plan.

In-kind contributions:

In-kind contributions, in terms of data on historic projects and staff time committed to the project were provided by the following organisations:

- Environment Agency
- Arun District Council
- Railtrack
- Currie & Brown
- Brown & Root
- Dean & Dyball
- Mackley Construction
- Posford Duvivier
- Poole Harbour
- Felixestowe Port
- Associated British Ports Southampton
- Reading University
- Government Department
- Local Authority
- Private Company
- Quantity Surveyors
- Consultants
- Contractors
- Contractors
- Consultants
- Port Authority
- Port Authority
- Port Authority
- Research Organisation

Steering Group:

The research was guided by an advisory committee which was comprised of the following members:

Jonathan Simm HR Wallingford (Chairman)
Neal Masters HR Wallingford
Marco Santini HR Wallingford
John Mason Alan Baxter & Associates (DETR project officer)
Dr Geoff Sims Brown & Root
Alan Hardie Railtrack
Foreword continued

David Weight Currie & Brown
Ray Traynor Arun District Council
Peter Cross Dean & Dyball
Tony Camilleri Mackley Construction
Dr Noel Beech Posford Duvivier
Dick Appleton Poole Harbour Commissioners
Ed Evans Environment Agency
Roger Flanagan Reading University
George Steele Associated British Ports Southampton

Assistance was also received from the following people and organisations:

Ben Gouldby HR Wallingford
Tom Stevenson HR Wallingford
George Motyka HR Wallingford
Ian Mockett HR Wallingford
Andy Wheaton Currie & Brown
Maria Reis Posford Duvivier
Dr Koo Yong Park Hyundai

HR Wallingford are grateful for the support given to the project by the funders, the members of the advisory committee and all of those organisations and individuals who participated in what has proved to be a most successful project. We would also like to thank Elma Clark for her patient and careful formatting of the manuscript, Bev Reader for her efforts with the correspondence and Carol Chedzey and Helen Stevenson for their efforts in printing the draft reports.

The photograph for the cover page was provided by George Motyka (HR Wallingford).

For further information on HR Wallingford please contact:

HR Wallingford
Address: Howbery Park, Wallingford, Oxon, OX10 8BA, UK
Internet: http://www.hrwallingford.co.uk

Neal Masters is an environmental engineer who joined HR Wallingford in 1997. He has managed and worked on a number of large research projects, coastal defence strategy studies and a variety of other coastal and fluvial engineering projects. He has developed outline engineering designs and used a variety of numerical models. He has also written a guidance manual on the sustainable use of new and recycled materials, developed a software package for the analysis and presentation of wind and wave data and developed a spreadsheet tool for estimating the total environmental impact of engineering project options.

Jonathan Simm is a chartered civil engineer who worked with consulting engineers for 14 years on the design and construction of port and coastal defences before joining HR Wallingford in 1992 as manager of the Engineering Support Section. He is now Technical Director for engineering and continues to be responsible for consulting and research studies aimed at bridging the gap between theory and practice.
## Contents

**Title page**  
**Contract - Research**  
**Executive Summary**  
**Foreword**  
**Glossary**  
**Contents**

1. Background and use of the guide ............................................................... 1  
1.1 The need for an understanding of whole life costing .............................. 1  
1.2 The role of the UK government in improving the cost efficiency of construction ............................................................................... 1  
1.3 Objectives of the guide ...................................................................... 2  
1.4 Readership of the guide ................................................................... 2  
1.5 Structure and use of the guide .......................................................... 2  

2. An overview of whole life costing methodologies ..................................... 5  
2.1 An introduction to whole life costing .............................................. 5  
2.2 Barriers to the implementation of whole life costing in port, coastal and fluvial engineering ....................................................... 7  
2.3 The benefits of whole life costing ................................................... 8  
2.4 What data are required for a whole life cost approach?....................... 9  
2.4.1 Design life ........................................................................ 9  
2.4.2 Capital costs .................................................................. 10  
2.4.3 Maintenance and monitoring costs ........................................ 10  
2.4.4 Risk costs .................................................................... 11  
2.4.5 Disruption costs.............................................................. 13  
2.4.6 Disposal costs ................................................................ 13  
2.4.7 Discount rate ................................................................ 14  

3. Whole life costing as part of the project process ..................................... 17  
3.1 Integrating whole life costing into the project process ....................... 17  
3.2 Stage 1 - Needs identification......................................................... 17  
3.3 Stage 2 - Functional analysis .......................................................... 19  
3.4 Stage 3 - Generate alternative solutions ......................................... 20  
3.5 Stage 4 - Comparison and selection ............................................... 22  
3.6 Stage 5 - Detailed design and specification .................................... 24  
3.7 Stage 6 - Construction ................................................................ 25  
3.8 Stage 7 - Management ................................................................ 25  
3.9 Stage 8 - Decommissioning ............................................................ 26  

4. Procurement ............................................................................................ 27  
4.1 Procurement processes ..................................................................... 27  
4.1.1 The owner ....................................................................... 28  
4.1.2 Forms of procurement ....................................................... 29  
4.1.3 Influence of generic procurement strategies on whole life costs ......................................................................................... 31  
4.2 Influences of funding policies on the public sector approach to whole life costs .................................................................................. 33
Contents continued

5. Whole life costs: influences and tools .......................................................35
   5.1 Risk ..............................................................................................35
      5.1.1 Identifying risk ................................................................35
      5.1.2 Mitigating risk ..................................................................35
      5.1.3 Managing risk ..................................................................35
   5.2 Value management and value engineering ...................................36
   5.3 Life cycle management ................................................................37
   5.4 Best value in the public sector ......................................................38
   5.5 Banishing the “cost boxes”: viewing costs holistically ..............39

References ..............................................................................................................42

Tables
Table 2.1 Present Value of two project options over 25 years using a discount rate of 6% ...............................................................7
Table 2.2 Sensitivity test on the cumulative discounted costs of two project options over 25 years using discount rates of 6% and 12% ..........15
Table 4.1 Designer Led .......................................................................................31
Table 4.2 Design and Build ................................................................................32
Table 4.3 Design, Build, Finance and Operate ...................................................33

Figures
Figure 1.1 Structure of the guide .................................................................4
Figure 2.1 Whole life cost components .........................................................5
Figure 2.2 Cumulative discounted costs for two project options over 25 years using a discount rate of 6% .................................................................6
Figure 2.3 Sensitivity test on the cumulative discounted costs of two project options over 25 years using discount rates of 6% and 12% ..........15
Figure 3.1 Integrating whole life costing into the design process ..............18
Figure 3.2 Reclaimed timber after removal (courtesy of Arun District Council) 21
Figure 3.3 Recycled timber sheet piling (courtesy of Arun District Council) .....21
Figure 3.4 New timber being installed above recycled timber sheet piling (courtesy of Arun District Council) ....................................................22
Figure 6.1 Conducting a whole life cost analysis .................................................41

Boxes
Box 1.1 Terms of Reference of the Construction Task Force (DETR, 1998) ....1
Box 2.1 Calculating risk costs using a risk register (Simm (1998)) ..........12
Box 2.2 Potential Magnitude of Disruption Costs to Port Operators ........13
Box 3.1 The three “Es” (adapted from Masters, 2001) .........................17
Box 3.2 Hierarchy of material sourcing options (Masters, 2001) ..........20
Box 3.3 Using reclaimed timber in groynes at Felpham (information provided by Arun District Council, 2000 (adapted from Masters, 2001)) .................21
Box 3.4 Other useful techniques for comparing project options ..........23
Contents continued

Box 5.1 Steps required for implementing a life cycle management system (adapted from PIANC, (1998)) ......................................................... 37
Box 6.1 Steps required for conducting a whole life cost analysis ............... 39

Appendices
Appendix 1 Whole life costing methodologies for comparing costs and ranking alternative options
Appendix 2 Whole life costing in sectors other than port, coastal and fluvial engineering
Appendix 3 Summary tables for annual capital and maintenance expenditure by the Environment Agency on flood defences
Appendix 4 Database of individual scheme maintenance and monitoring costs

Case Studies
CASE STUDY 1 The Humber Sea Terminal: using whole life costing to assist in the choice of detailed design elements
CASE STUDY 2 Whole Life Cost Analysis of Transporting Beach Material by Barge or Truck at PETT Levels, near rye, east sussex
CASE STUDY 3 Repair of quay walls – estimating potential disruption costs to the port of southampton
CASE STUDY 4 Dawlish Sea Defences: a change to pro-active maintenance to achieve whole life cost savings
CASE STUDY 5 West Clacton to Jaywick Sea Defences: using whole life costing at the project appraisal stage of a coast protection scheme
CASE STUDY 6 Pevensey Bay Sea Defences: whole life cost savings through more sustainable project procurement
CASE STUDY 7 River Nar improvement scheme: use of whole life costing at the project appraisal stage of a flood defence scheme