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Petroleum and natural gas industries — Life cycle costing —

Part 1: Methodology

Industries du pétrole et du gaz naturel — Estimation des coûts globaux de production et de traitement —

Partie 1: Méthodologie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15663 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15663-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*.

ISO 15663 consists of the following parts, under the general title *Petroleum and natural gas industries — Life cycle costing*:

— *Part 1: Methodology*

— *Part 2: Guidance on application of methodology and calculation methods*

— *Part 3: Implementation guidelines*

Introduction

The purpose of this part of ISO 15663 is to provide guidance on the use of life-cycle costing techniques within the petroleum and natural gas industry. The principal objective is to speed the adoption of a common and consistent approach to life-cycle costing within the oil industry. This will happen faster and more effectively if a common approach is agreed internationally.

Life-cycle costing is the systematic consideration of the difference between costs and revenues associated with the acquisition and ownership of alternative options required to fulfil an asset need. It is an iterative process of estimating, planning and monitoring costs and revenue differences throughout an asset's life. It is used to support the decision-making process by evaluating alternative options and performing trade-off studies. While the largest benefits can be achieved in the early project stages of evaluating major configuration options, it is equally applicable to all stages of the life cycle, and at many levels of detail.

Life-cycle costing is distinct from investment appraisal in that it is not concerned with determining the financial viability of a development. It is concerned only with determining the differences between competing options and establishing which options best meet the owners' business objectives.
In the past, the petroleum and natural gas industry has assessed the financial viability of project options on the basis of minimum capital expenditure: operating expenditures have played little part in the decision-making process. This has ignored a potentially large cost and in many cases has resulted in reduced asset value.

This omission is now recognized by the industry. As the number of new large developments has declined, the emphasis has moved towards the maintenance and update of existing assets; naturally this has focused more attention on operating expenditures. In addition, external pressures, such as a low and static oil price, have further added to the pressures to minimize costs.

Life-cycle costing techniques are used by a number of companies within the industry. However, the development of such techniques has been pursued independently and their application has been patchy, with little participation by the contractors and vendors — contracting for equipment supply is still largely on a basis of minimum capital expenditure. All participants in the process — operators, contractors and vendors — can have a substantial impact on the life-cycle costs of ownership, and it is not until all are involved that the benefits sought from the use of life-cycle costing will be realised. If this is to be achieved, a common, consistent, industry-wide approach is required.

Where the life-cycle costing approach was applied, life-cycle costing methods were developed and valuable experience was gained. However, the approaches were diverse with variable success.

This diversity has caused confusion amongst contractors and vendors. It also has resulted in higher engineering and supply costs. Experience indicated that this could potentially result in low quality information being used to support management decisions, in order to maintain project schedules and avoid delay. Therefore, in a project context, a clear, well defined methodology is needed to define how, when, where and why life-cycle costing needs to be applied.

It has also been recognized that project and asset management staff need a clear and unambiguous definition of the overall economic objectives of a project and how to apply the same business criteria when making major engineering decisions. It is further recognized that long term management commitment to life-cycle costing is crucial for its successful implementation in the project execution of an asset.

The principal benefits associated with the systematic application of life-cycle costing may include any or all of the following.

— **Reduce ownership costs**
  Operating costs in other industries such as aircraft, defence and automotive have been significantly reduced in the last decade. When users begin to consider operating expenditures before making decisions, the whole supply industry takes a different approach to quality and service.

— **the alignment of engineering decisions with corporate and business objectives**
Sound business principles must be applied to all major engineering decisions if the business objectives of a development are to be realized. Currently, in taking these decisions, the consequences on operating expenditures and the effect on the revenue profile are often ignored. If all major engineering decisions can be aligned to business objectives then the value of an investment can be optimized.

— **the definition of common objective criteria that can be used by operators, contractors and vendors and against which, business transactions may be managed and optimized**
Performance contracts which relate only to capital do not necessarily lead to improved business performance. Small increases in initial cost can, if applied in the right place, result in significant reductions in operating expenditures and/or increased revenue. Standard life-cycle costing methodologies will facilitate the development of performance contracts based on business parameters that will lead to real increases in value and benefit for all.

— **reduction of the risk of operating expenditure surprise**
When new assets are being considered and there is little information on likely operating expenditures, it is important to apply methodologies which enable high operating expenditure elements to be identified at an early stage. In such cases, operating expenditures are often underestimated and therefore real business risks exist in not achieving the required rates of return. Life-cycle costing methodologies demand that support costs of major packages are quantified on a systematic basis to reduce these risks. The methodologies would enable the industry to identify, optimize and acquire the needed support in a timely and cost-effective manner.

— **changing the criteria for option selection**
Traditionally decisions were taken on options using criteria such as best available technology or lowest price and this did not necessarily lead to maximum value for the asset. Life-cycle costing provides criteria for selection which can be directly linked to increased asset value and hence improved profitability over the asset life cycle.

— **maximization of the value of current operating experience**
Actual operating experience is a valuable resource that can be used to evaluate options for new assets and improve the performance of existing assets. This experience is only valid if it is judged against the required operating context. Equipment or configuration options that were of value when capacity utilization was high are often not of value in smaller assets, or when capacity utilization profiles decline. All operators have a wide range of equipment and configuration options. Data on actual performance, collected using modern maintenance management, are of real value when options need to be compared.

— **the provision of a framework within which to compare options at all stages of development**
When comparing options for one process function it is important to consider the effect of that decision on other process functions. A planned approach within an overall framework is vital if the best combination of options is to be achieved. Previous experience shows that life-cycle costing studies were being carried out too late, often in isolation with a variable quality output. The standard identifies planning needs and resource requirements to ensure studies are carried out at the right time, to the right depth and within planned resource budgets and targets.

— **the provision of a mechanism by which major cost drivers can be identified, targeted and reduced**
Life-cycle costing methodologies identify in a systematic way all major cost elements of an investment. Having identified the cost drivers, a sensitivity analysis can be carried out to establish critical areas where improvement will lead to increased cost effectiveness. These critical areas become targets for research and development, technology transfer and a focus for management effort.

This part of ISO 15663 is based on the principles defined in IEC 300-3-3.

Petroleum and natural gas industries — Life cycle costing —

Part 1: **Methodology**

1 Scope

This part of ISO 15663 specifies requirements for undertaking life-cycle costing for the development and operation of facilities for drilling, production and pipeline transportation within the petroleum and natural gas industries.

The life-cycle costing methodology described in this part of ISO 15663 can be applied when making decisions on any option which has cost implications for more than one cost element or asset phase, in order to estimate the cost difference between competing options.

The process is applicable to a wide range of options, particularly when decisions are being considered on the following:

— the process concept;

— equipment location, e.g template-based solutions vs. satellite-based solutions;

— project execution strategies;

— health, safety and environment;

— system concept and sizing;

— equipment type;

— equipment configuration;

— layout;

— maintenance and operation strategies;

— manning strategy;

— manning levels;

— logistic support strategy;

— facility modifications;

— spares and support strategy;

— reuse and/or disposal.

The basic methodology of this part of ISO 15663 is applicable to all asset decisions, but the extent of planning and management of the process depends on the magnitude of the costs involved and the potential value that can be created.

The methodology is of value when decisions are taken relating to new investments in projects. It also provides the means of identifying key cost drivers and provides a cost-control framework for these drivers, allowing effective cost control and optimization over the entire life of an asset.

The scope of this part of ISO 15663 is limited to life-cycle costing. It is not concerned with determining the life-cycle cost of an item of equipment, since then it would be necessary to determine all costs associated with that equipment during the life of the asset.

2 Terms, definitions and abbreviations

2.1 Terms and definitions

For the purposes of this part of ISO 15663, the following terms, definitions and abbreviations apply.

2.1.1
asset
resource owned by an organization, normally for the purposes of generating income or increasing value

2.1.2
asset life cycle
life span of a particular resource owned by an organization, from the point of discovery or acquisition through to disposal

2.1.3
asset phase
discrete stage in the asset life cycle with a specified purpose

EXAMPLE Detail design.

2.1.4
benefit
creation of a capital asset, earning of revenue or improvement of a project environment

2.1.5
budget
estimate approved by management or the client as the cost-control mechanism for a project

2.1.6
capital expenditure
money used to purchase, install and commission a capital asset

2.1.7
committed costs
those fixed costs that cannot be eliminated or even cut back without having a major effect on profits or on the organization's objectives

NOTE Committed costs may be identified as sunk costs for the purposes of a study.

2.1.8
constraint
limit imposed externally or internally by the project which rules out the selection of an option if the limit is exceeded

2.1.9
cost breakdown structure
structure related to the methods that an organization employs to record and report costs

2.1.10
cost driver
major cost element which if changed will have a major impact on the life-cycle cost of an option

2.1.11
cost element
identifiable part of the life-cycle cost of an option which can be attributed to an activity

2.1.12
cost issue
cost element which if changed will not have a major impact on the life-cycle cost of an option

2.1.13
fixed cost
cost that does not vary as the level of activity varies

2.1.14
life cycle
all development stages of an item of equipment or function, from when the study commences up to and including disposal

2.1.15
life-cycle cost
discounted cumulative total of all costs incurred by a specified function or item of equipment over its life cycle

2.1.16
life-cycle cost model
mathematical relationship between cost elements and life-cycle cost differences

2.1.17
life-cycle costing
process of evaluating the difference between the life-cycle costs of two or more alternative options

2.1.18
net present value
sum of the total discounted costs and revenues

2.1.19
operating expenditure
money used for operation and maintenance, including associated costs such as logistics and spares

2.1.20
payback period
period after which the initial capital invested has been paid back by the accumulated net revenue earned

2.1.21
sensitivity analysis
process of testing the outcome of a life-cycle costing in order to establish whether the final conclusion is sensitive to changes in assumptions

2.1.22
structured breakdown of costs
list of cost elements associated with an option which has been structured taking into account the way in which the costs are acquired and recorded

2.2 Abbreviations

CAPEX capital expenditure

IRR internal rate of return

NPV net present value

PI profitability index

SBC structured breakdown of costs

3 Management of life-cycle costing

3.1 Objectives

a) To achieve agreement at a management level on asset objectives and how life-cycle costing is linked to these objectives;

b) to communicate the asset objectives and the role of life-cycle costing throughout the organization;

c) to define the objectives of life-cycle costing prior to any study taking place.

3.2 Roles and responsibilities

3.2.1 All those having responsibility for life-cycle costing within an organization shall be identified and informed of the responsibilities assigned to them.

3.2.2 An individual or organization shall be assigned the role of life-cycle costing coordinator to undertake the following tasks:

— develop and plan the life-cycle costing strategy;

— develop life-cycle costing project procedures;

— facilitate and coordinate study activities;

— organize training of all key personnel.

The individual or organization may change depending on the asset phase.

NOTE The life-cycle costing coordinator may be a person or group already part of the project group.

3.2.3 Organizations or individuals having responsibility for performing life-cycle costing shall

— understand the life-cycle costing methodology and tailor it to the needs of the project;

— provide the focus for identification and evaluation of alternative options;

— communicate the results to others — it is only by doing this that decisions can be influenced;

— fulfil the requirements determined during the planning stage.

In order for the full benefits of life-cycle costing to be achieved, the effect on the overall value of an asset over its lifetime must be considered when making all major decisions. Life-cycle costing is therefore the responsibility of all individuals who take these decisions.

3.3 Strategy and planning

3.3.1 The strategy and policy for life-cycle costing shall be defined, together with the means of evaluating whether objectives are being achieved.

3.3.2 Life-cycle costing studies shall be carried out where benefits in terms of increased asset value can be realized by selecting the best option between competing alternatives. The options to be studied should be selected on a systematic basis by considering the major contributions to capital and operating expenditures and revenue impact.

3.3.3 A plan shall be prepared outlining all life-cycle costing activities anticipated to be necessary throughout asset life.

3.3.4 The plan shall identify the critical dates, resource requirements and the persons, departments and organizations responsible for life-cycle costing at each phase of the project.

3.3.5 The plan shall identify the training needs of the coordinator and all persons having responsibility for undertaking life-cycle costing.

3.3.6 The plan shall identify data-collection activities and sources.

3.3.7 The plan shall identify any specific requirements for tools to be used for modelling.

3.3.8 The plan shall identify the requirements for assessment (see clause 5), including the following:

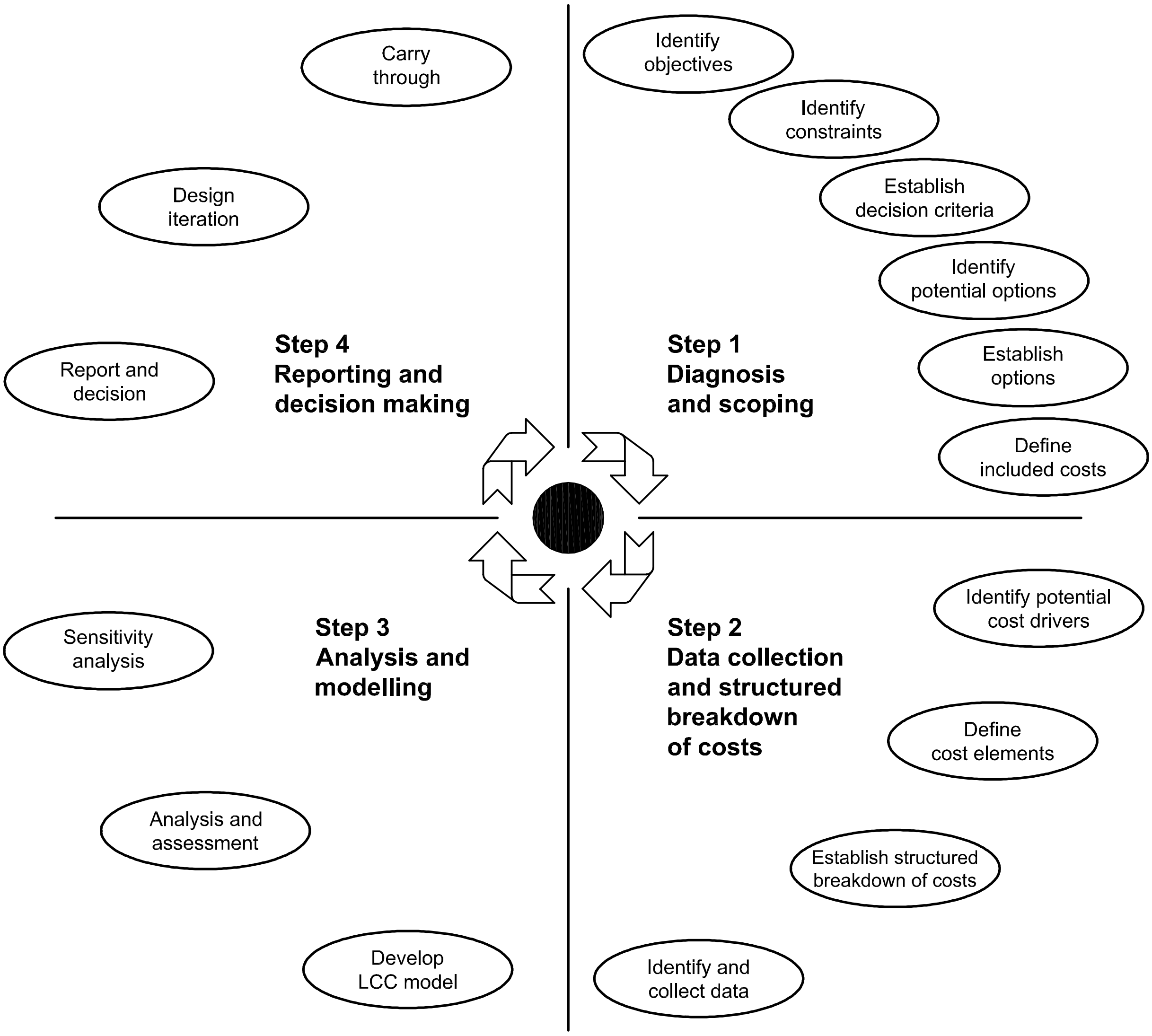
— the number of assessment stages;

— the level of independence of the assessment;

— when assessment will take place.

3.3.9 For any life-cycle costing activity, the essential steps which constitute the methodology shall be defined.

3.3.10 The steps that shall be used as the basis for claiming conformance to this part of ISO 15663 are detailed in clause 4 and illustrated in Figure 1. If alternative steps are defined during the planning process, then these shall be justified.



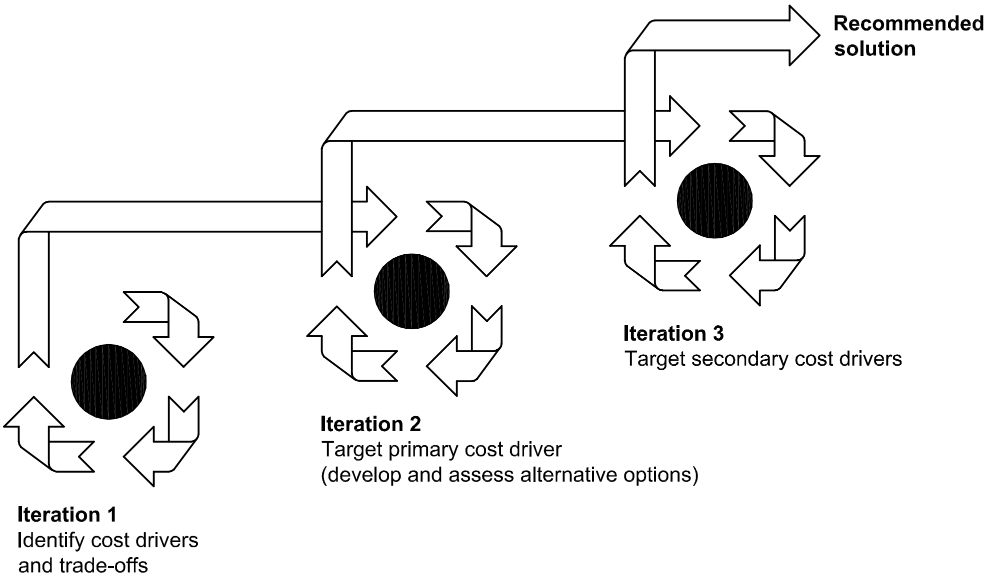
NOTE In these steps are a number of tasks which will assist the user in assessing the scope and scale of the work. These are discussed in detail in the clauses that follow. Overlaid on these tasks are a number of general considerations which, taken in conjunction, will set the agenda for the initial discussions. These considerations are set out in the clauses below.

Figure 1 — The life-cycle costing process

3.3.11 The overall process is iterative and may need to be repeated a number of times in any project. The reasons for the repetition will be many, but will typically be dependent on the outcome of the previous iteration. This may result in the need to assess further technical options, challenge initial assumptions or constraints, or respond to changes elsewhere within the programme. Figure 2 illustrates how this may apply in practice.

3.3.12 Iteration shall be carried out for all major cost drivers and areas where there is potential for creating value. This should be agreed on a project basis. The iteration may be deferred to the next project stage when this does not lead to committed costs at the next stage.

NOTE For example, iteration may be deferred to the next project stage when a decision is being taken at the concept stage and it has been established from generic data on equipment reliability that the cost of lost production is likely to be significant but the alternative options on equipment configuration will be considered at the detailed design stage.



NOTE It should be noted when planning the work that the range of options identified at the start of work may not represent the full range of options actually considered. This is because the opportunities, and hence the options, do not become apparent until at least one iteration has been completed.

Figure 2 — The iterative process

3.3.13 Because the process is iterative, it shall be integrated into the overall project planning so that the outcome of each iteration can coincide with the decision points in the project. A plan also provides the means by which the interaction with other team members can be defined and established.

3.3.14 The life-cycle costing process contains a large number of tasks. Not all tasks are needed in every iteration and the level of detail considered in each task will vary according to the needs of the study. The work undertaken shall be tailored to meet the objectives and constraints defined. The life-cycle costing plan shall be adjusted accordingly.

3.3.15 The output from the process shall be documented through notes of meetings, a commentary on a plan or a more formal basis.

NOTE The value of a well-documented process will become apparent when the requirements for assessment (see clause 5) and internal consistency are considered, the results are produced and further iterations take place.

4 Methodology

4.1 Step 1 — Diagnosis and scoping

4.1.1 Objective

Step 1 is the entry point for the life-cycle costing process. This step is critical to the successful implementation of life-cycle costing in any project. The objective of this step is to develop a fundamental understanding of the issues, relationships, assumptions and requirement underpinning the work. This can only be achieved by discussion with asset owners and members of the project team.

From a planning perspective, consideration of the tasks in this step will provide the basis for identifying the scope of the work and the resources required. The requirements of the tasks also help to set the agenda for the discussions that will take place and identify how the results will be presented.

Step 1 shall never be omitted, either initially or in subsequent iterations. However, in later iterations its scope can be reduced to a check by the user that the initial task outcomes are still applicable.

The following paragraphs give a description of each of the tasks in Step 1 and practical guidance for the user on how they can be implemented in terms of the discussions that should be held, the questions that should be asked and the outputs that should be produced. Although each task is discussed separately, in reality the discussions that will take place will cover many of the tasks simultaneously.

NOTE This task is the starting point for any life-cycle costing work and will lead naturally into the other tasks in this step. It is not the responsibility of the coordinator to set the objectives for the overall work programme, but the coordinator should translate them into specific life-cycle cost objectives.

4.1.2 Identify objectives

4.1.2.1 The objectives shall be agreed and documented in accordance with project procedures prior to the commencement of the study. The functions, systems equipment or project execution strategies being examined shall be recorded.

NOTE In subsequent iterations of the procedure, this task may be limited to reconfirmation. However, it may be found that the life-cycle costing work changes the overall objective. Taking, as an example, maintenance cost optimization, the first iteration may show that downtime (lost production) is the cost driver, not maintenance costs.

4.1.2.2 The overall objectives shall be discussed with all those identified as having responsibility for life-cycle costing, particularly the manager responsible for the overall work, to ensure they have a full understanding of what needs to be achieved. Potential participants include the following disciplines:

— design and engineering;

— procurement and contracts;

— health, safety and environment;

— reliability engineering;

— estimating;

— construction;

— installation and commissioning;

— operations and maintenance;

— economics and budgeting;

— finance and cost accounting.

Discipline participants may come from vendor, contractor or operator organizations depending on project requirements.

NOTE Early scoping studies may not require the involvement of vendors/contractors, however any life-cycle costing evaluation, from concept selection on, may benefit from their involvement.

4.1.3 Identify constraints

The constraints which apply to the options being considered shall be identified. These arise from the following three principal sources:

— project constraints on what can be achieved within the life-cycle cost work. These arise from resource and time-scale limitations on the work;

— technical constraints which limit the options available;

— budgetary constraints, such as limitations on CAPEX, or alternatively the outcome may be subject to specified economic criteria, e.g. an option must achieve an IRR of 10 % before it merits further consideration.

All constraints that will impact on the life-cycle cost assessment shall be formally recorded.

4.1.4 Establish decision criteria

4.1.4.1 Decision criteria shall be agreed in accordance with asset requirements and recorded. The decision criteria shall define the mechanism by which the options will be ranked and compared.

4.1.4.2 A range of criteria may be defined, including measures such as:

— NPV;

— life-cycle cost;

— PI;

— IRR;

— payback period.

NOTE Further information on appropriate criteria is included in ISO 15663-2 [1].

4.1.4.3 For the ranking of options, measures such as NPV or life-cycle cost need not be calculated in full but limited to estimation of differences. Independent of the measure, the differences between options should be considered under the following headings:

— CAPEX;

— operating expenditure;

— revenue impact;

— disposal.

4.1.4.4 In applying these criteria, consideration shall be given to the need and ability to compare options on a like-for-like basis. This problem is most likely to occur when two options with different life expectancies are being compared. In these circumstances, alternative techniques, such as the use of equivalent annual costs, need to be agreed with the asset owner.

The user should also remember that the decision criteria are used not only to rank the options, but also to provide the basis for determining the cost drivers within an option — this has implications on the modelling required.

4.1.5 Identify potential options

4.1.5.1 A disciplined and structured approach to the identification of options shall be adopted.

NOTE Identifying and establishing options are normally split into two tasks, to prevent an evaluation of the options as they arise. The aim is to encourage speculation — evaluation will obstruct this process.

4.1.5.2 A multidisciplinary team shall identify options and sub-options for the function under review.

NOTE 1 Many techniques are available to identify options. Reference is made to ISO 15663-2 [1], in which several techniques to identify and establish options are detailed.

NOTE 2 The aim is not to attempt to define the complete range of options, but to identify within a short space of time the majority of likely options.

4.1.5.3 In some circumstances, the options may be predefined as the only potential technical solutions available. However this task is still necessary, since the team approach may lead to identification of additional options or sub-options.

4.1.6 Establish options

4.1.6.1 The objective of this task is to take the options arising from the previous task, and subject them to a screening process. The method adopted should be qualitative, as the aim is to find justifiable reasons for excluding options, not including them. The aim is to avoid unnecessary downstream work, in both technical and life-cycle costing areas. The output will be an agreed set of options that are subject to both technical and life-cycle cost evaluation.

4.1.6.2 It is recommended to use a facilitator for screening and to record the outcome.

4.1.6.3 The screening process shall be applied consistently, in that each option should be subject to the same assessment criteria. A typical range of screening criteria may include:

— is it technically feasible?

— is it practical? (constructability, operability and maintainability);

— does it meet reliability requirements?

— is the capital expenditure too high?

— can it meet the schedule?

— are the risks acceptable (technical, financial, revenue, health, safety and environmental)?

— is consistent with the objectives stated in Step 1 of the diagnosis and scoping?

— will it meet current and expected future legislation requirements (health, safety and environmental, etc.)?

4.1.6.4 The options shall be prioritized in accordance with project requirements.

4.1.7 Define costs to be included in the analysis

4.1.7.1 The costs to be included within the life-cycle costing shall be agreed and documented. A common understanding on what costs will be included and what will be excluded from consideration shall be established. The principle that should be followed is that all attributable costs should be included. In practice this is usually tailored to constrain the work to manageable proportions by limiting it to consideration of only the significant attributable costs.

4.1.7.2 The work is largely intuitive and the methodology that the project team should follow is to:

— identify the direct costs for each option which it incurs over its lifetime; these will cover costs such as purchase, operation, maintenance, support and disposal costs of the option;

— take each option in turn, consider its unique features and determine the direct costs associated with each of the following:

  — **the environment**, such as mass, footprint, other processes, safety systems and transportation;

  — **utilities,** such as demands on cooling systems, power generation and accommodation;

   — **infrastructure,** such as warehousing, administration, facility support;

   — **revenue**
   For many options the link between equipment performance and revenue will be obvious. For other options it will be less clear, e.g. power generation. It is important that a link is established wherever possible to provide a common basis for comparison of options. Where a link cannot be established, it is possible that the decision criteria will have to be reviewed. It should also be noted that the link between equipment performance and revenue may vary between options.

— compare all options to identify the common costs. Where costs are common to all options, they can either be included or excluded from the assessment. If all common costs are excluded and they represent a significant proportion of the total costs, then it can distort the perspective of the assessment. If they are included, they can swamp the variations between options and hide the opportunities for improvement. There is no simple solution to this problem, and each case has to be judged on its merits. Common costs are normally only included in those instances where there is a requirement to estimate the absolute costs of owning the asset.

The output from these activities is a list of cost issues for possible inclusion in the assessment, and taken together they define the life-cycle cost boundary. They need to be agreed with the team members. There may be some debate on some of the issues.

4.2 Step 2 — Data collection and SBC

4.2.1 Objective

The objective of Step 2 is the production of an SBC through consideration of the cost issues and cost elements. The SBC consequently defines the cost data that should be collected. A costly data-collection programme is unlikely to yield any significantly greater value than one that contains only the essential features necessary to meet the life-cycle cost objective. The essential requirement is to focus on the cost drivers.

The important feature of Step 2 is that it results in initial consideration of the following:

— how the costs will be calculated;

— how sensitivity analysis will be carried out, with focus on the cost drivers;

— the practical issues associated with data collection, such as data source, data availability, and data quality.

The objective is to align the need for information, as defined by the cost elements, with the ability of the project to respond.

4.2.2 Identify potential cost drivers

Analysis shall be carried out to identify where the effort available for the assessment should be concentrated. This can be achieved by targeting the potential cost drivers for each option. Criteria shall be agreed in order to address the targeting process. Criteria shall be in compliance with the objective set in Step 1 (see 4.1.1, 4.1.2 and 4.1.4).

For each option, taking the list determined under 4.1.7, each cost issue shall be reviewed to determine if it is likely to be a life-cycle cost driver.

NOTE To assist in this process it may be convenient to group the cost issues under related headings.

The output from this task shall be the list of cost issues with the potential drivers highlighted.

4.2.3 Define cost elements

4.2.3.1 The minimum level of detail necessary to discriminate between the options shall be determined. All the cost issues identified in 4.1.7 need to be addressed and estimated, however effort in this task should be concentrated on identifying the cost elements required for the potential cost drivers.

4.2.3.2 The following approach shall be used:

- for each identified cost driver, determine the minimum number of cost elements required to estimate the cost driver;
- for the remaining cost issues, determine if:
  - they can be estimated directly, i.e. are they cost elements, and;
  - it is possible to group any of the cost issues under single headings.

4.2.3.3 The cost elements defined should be documented, to be later arranged for the identification of an SBC.

NOTE It should be remembered that many costs can be estimated directly by comparison with other similar work and, as a consequence, do not require additional cost elements to be defined.

4.2.4 Establish SBC

The cost elements established in 4.1.7 shall be structured taking into account the way in which costs are acquired and recorded.

In creating the structure, how individual cost elements will be calculated should be considered.

The main purpose should be to identify and agree a list of those costs that the project can recognize and is able to provide. This list should be the closest match that can be achieved to meet the life-cycle cost requirement. This may modify how each cost element can be calculated. The output will be an agreed SBC.

4.2.5 Identify and collect data

4.2.5.1 The identification of the data sources shall be the first task when preparing for the process of collecting data. Knowledge of the sources from which correct and useful data can be retrieved will result in time-saving and increased efficiency.

4.2.5.2 The type of option(s) under consideration and the availability of the SBC will support the addressing of the correct sources of data.

4.2.5.3 Data sources shall be recognized as valid by the project.

4.2.5.4 When the sources of data necessary to obtain the cost elements of the SBC are established, a data-collection process shall be prepared. During the preparation and implementation of the data-collecting process, quality control shall be applied in accordance with project requirements.

4.2.5.5 When all the criteria, methods and data sources are agreed, data collection shall be implemented. The way data is collected influences the way later analysis will be performed.

Data collection is of prime importance to the success of life-cycle costing. During the initial introduction of life-cycle costing to a company or project, valid data collection is vital to ensure the success of the process.

4.3 Step 3 — Analysis and modelling

4.3.1 Objective

The objectives of this step are to

- produce life-cycle costing prediction showing the difference in cost between selected options;
- produce a ranking of options;

— compare and analyse the cost drivers;

— undertake sensitivity analysis to determine what can change the ranking;

— identify uncertainties and risks.

Analysis and modelling should not be conducted in isolation. The quality of both the model and the analysis will be significantly enhanced when a team is involved in the work. It provides different perspectives on the same problem and through such interaction generates additional ideas on the opportunities.

4.3.2 Develop life-cycle cost model

A suitable model shall be developed depending on the requirements of the application.

NOTE In the majority of cases, a spreadsheet will represent the most economical and flexible solution for modelling life-cycle costs. Details on the development of life-cycle cost spreadsheet solutions are given in ISO 15663-2.

The model developed should be simple enough to be transparent to the user, but accurate enough to represent the differences between options.

Where proprietary or specialized models are used, the outputs shall be integrated into the overall life-cycle cost model to allow a true comparison between options. This is needed to ensure consistency with the decision criteria defined for the overall work.

4.3.3 Analysis and evaluation

4.3.3.1 The initial output of the modelling process should be subject to evaluation. The initial results should not be taken at face value. The following information shall be compiled to enable the evaluation to be carried out:

— a ranking of the options in accordance with the decision criteria specified;

— a summary of the life-cycle costing for each option, identifying the cost drivers.

4.3.3.2 The information shall be evaluated by scrutinizing the ranking and the cost drivers. To enable confidence in the results of the modelling, it is important to question the outcome. Some of the questions which need to be asked are:

— why do some options perform better than others – can this be explained?

— how does the timing of the costs vary between options?

— are the individual cost totals in line with expectations?

Only when it has been established that the results are consistent and explainable can the next task be considered.

4.3.4 Sensitivity analysis

4.3.4.1 Once it has been established that the initial results are reasonable, decisions shall be made on the options to go forward, whether for implementation or for further evaluation. An output from this task could be the identification of further options.

4.3.4.2 The starting point for option elimination should be an examination of the bottom-ranked options. From the experience gained in the work, it should be possible to make a subjective judgement on whether these options could ever achieve top ranking. Where there is any doubt, the lower-ranked options shall be subject to the same sensitivity checks as the other options.

NOTE While estimates by their nature will be subject to some error, what is important is the relative error of one estimate to another and not its absolute error. Where estimates are produced from a common source, the relative error is likely to be reduced since all estimates will embody the same basic assumptions.

4.3.4.3 For the options that remain, the robustness of the ranking shall be established by examining the uncertainty associated with the cost drivers in each option. In addition to the cost drivers, the sensitivity of the options to changes in a number of standard parameters should be examined. These generally include factors such as oil price and exchange rates.

NOTE Some options may be better than others in accommodating changes in the production stream such as earlier-than-expected water breakthrough. Where a number of cost drivers are outside the control of the asset, then it may be appropriate to run a sensitivity analysis in which more than one parameter is changed so as to determine the accumulated effect.

4.3.4.4 For each factor subject to sensitivity analysis, the following shall be established:

— by how much does the estimate have to change to alter the ranking and hence the decision?

— how likely is the estimate to change by that amount?

4.4 Step 4 — Reporting and decision-making

4.4.1 Objective

The objective of this step is to report on the findings, establish the optimum economic solution and decide on the strategy for the next project-implementation phase. The role of life-cycle costing is to evaluate the effect that any decision will have on the value of the asset over its lifetime, so that this can be taken into account during the decision-making process.

In the majority of instances, the life-cycle cost work will identify further opportunities and options for possible study. These may or may not be examined in the current work programme, depending on a variety of factors including their impact on potential profitability. For this reason, this step also involves considering the requirements for further iterations in the current work, or looking to the future for work in subsequent project phases.

4.4.2 Report and decision

4.4.2.1 The form of reporting will have been established and agreed in Step 1. The results shall be presented together with the supporting arguments. The following should be considered in preparing recommendations:

— the ranking allows the lower-order options to be eliminated;

— sensitivity analysis provides the arguments for the preferred solution;

— sensitivity analysis also identifies opportunities to improve the solution;

— cost drivers identify the potential magnitude of the improvement, either through the definition of new options or changes to existing options.

4.4.2.2 The recommendations may take three forms, as follows:

— the preferred option — with supporting arguments;

— further iterations — where there is potential to provide a significant improvement over the preferred option;

— future studies — what work is required in subsequent project phases.

4.4.2.3 The life-cycle costing model and results should be included in the final project documentation and operating manuals.

NOTE Life-cycle costing is only one of the issues that should be considered when making a decision on the best option to use for a particular application. Options may have different impacts on issues which cannot be quantified in terms of costs, and all relevant issues should be considered before a decision can be made.

4.4.3 Design iteration strategy

Where further iterations are required, whether to reduce the uncertainty associated with existing options or to examine new options, a plan shall be prepared for the iteration activities.

If further iterations are required, the following shall be established:

— what further data is needed;

— what tasks should be repeated;

— whether all work is required to the same level of detail.

4.4.4 Future studies

When no further iterations are required and an option has been selected for implementation, consideration shall be given to what work is necessary during the next project phase.

5 Assessment and feedback

5.1 Objective

An asset owner may require evidence that all of the decisions and assumptions made at all stages of the life-cycle costing methodology meet the needs of the business. This requires that an assessment method is established to meet the needs for internal audit (consistency checks) and external audit (feedback to others).

5.2 Requirements

5.2.1 Assessment and feedback activities may be required at the end of each step of the methodology or after all steps have been completed or after a project stage has been completed. In the life-cycle costing procedure, the assessment tasks at each stage are given below.

5.2.2 The assessment should confirm that prior to undertaking any life-cycle costing (i.e. prior to Step 1) the following activities were carried out:

— the life-cycle costing objectives were defined and communicated throughout the project team;

— the decision criteria had been defined and agreed;

— the responsibilities within the organization for life-cycle costing had been defined and appropriate training had taken place;

— planning of life-cycle costing had been carried out;

— a management system is in place for life-cycle costing.

5.2.3 Life-cycle costing assessment activities carried out after Step 1 should confirm the following:

— the functions, systems, equipment and project execution plans being considered have been defined;

— constraints have been specified and agreed;

— options have been identified and refined using a systematic approach;

— cost categories which differentiate between options have been agreed.

5.2.4 Life-cycle costing assessment activities carried out after Step 2 and SBC should confirm the following:

— cost drivers have been identified;

— cost elements have been defined;

— an SBC has been established;

— data have been identified and collected from valid sources;

— the decisions and assumptions arising from Step 2 were recorded;

— the information obtained was modelled.

5.2.5 Life-cycle costing assessment activities carried out after Step 3 should confirm the following:

— the model was appropriate for the application;

— the output of the model has been assessed;

— a sensitivity analysis has been carried out.

5.2.6 Life-cycle costing assessment activities carried out after Step 4 should confirm the following:

— the options have been ranked;

— justification for the preferred options has been documented and agreed;

— whether any further iterations should have been carried out;

— further work has been identified and documented for later stages as necessary;

— the outcomes from all the tasks have been recorded.

Bibliography

[1] ISO 15663-2, *Petroleum and natural gas industries — Life-cycle costing — Part 2: Guidance on application of methodology and calculation methods.*

[2] IEC 300-3-3:1996, *Dependability management — Part 3: Application guide — Section 3: Life-cycle costing.*

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