

## **Combined Operational Effectiveness and Investment Appraisal for CIS: the Challenge**

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### ***Abstract***

*Traditionally, operational effectiveness assessments and investment appraisals for defence equipment procurements have been conducted separately. The MOD has recently launched an initiative to combine these activities in order to ensure a comprehensive approach to cost-effectiveness assessment. This approach is known as Combined Operational Effectiveness and Investment Appraisal (COEIA). Assessment of operational effectiveness of a Command, Control, Communications and Information System (CIS) is acknowledged as being more complex than for front-line systems, because of the difficulty of assessing the system's impact on overall military effectiveness. The conduct of COEIAs for CIS is therefore a particularly difficult area. The Director of Science (CIS) has sponsored the production of a Guideline to assist MOD staff in carrying out the required assessments, integrating the results and presenting them in a form acceptable to the Equipment Approvals Committee (EAC). This paper gives an overview of the problems associated with CIS COEIAs and the methods proposed in the Guideline.*

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The views expressed here and in the CIS COEIA Guideline document (Reference 1) are those of the authors and do not necessarily represent official MOD policy.

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## COEIAs - What and Why?

*“A COEIA is a formal comparison, on a cost-effectiveness basis, of the options available to respond to an operational requirement.*

*“It is a form of investment appraisal in which operational analysis is used to assess the operational benefits of the competing systems, objectively and quantitatively.*

*“The COEIA is used in the procurement process to inform a decision to select one of the procurement options and reject the others.”*

*Graham Jordan, Assistant Chief Scientific Advisor (Capabilities), MOD*

Continuing pressure on the UK defence budget means that systems will only be procured if they can be shown to offer value for money. The MOD Central Committees and the Treasury require that systems designed to meet defence requirements are assessed in terms of both their cost and effectiveness so that the various options can be compared for the additional value they provide for a given sum of money. The aim of this paper is to describe the COEIA process and the implications it has for cost and effectiveness assessment, to highlight some of the challenges that it brings, and to propose some solutions.

At major points in the system's life-cycle, the cost and effectiveness estimates come under very detailed review. Costs for each option are estimated for the whole life-cycle of the equipment; effectiveness is expressed in terms of the contribution which the system makes to the ability of forces to meet the UK's defence commitments. Scrutiny comes at points where the MOD seeks to commit significant levels of funding and the resulting recommendations are submitted to the Equipment Approvals Committee (EAC) (Figure 1).

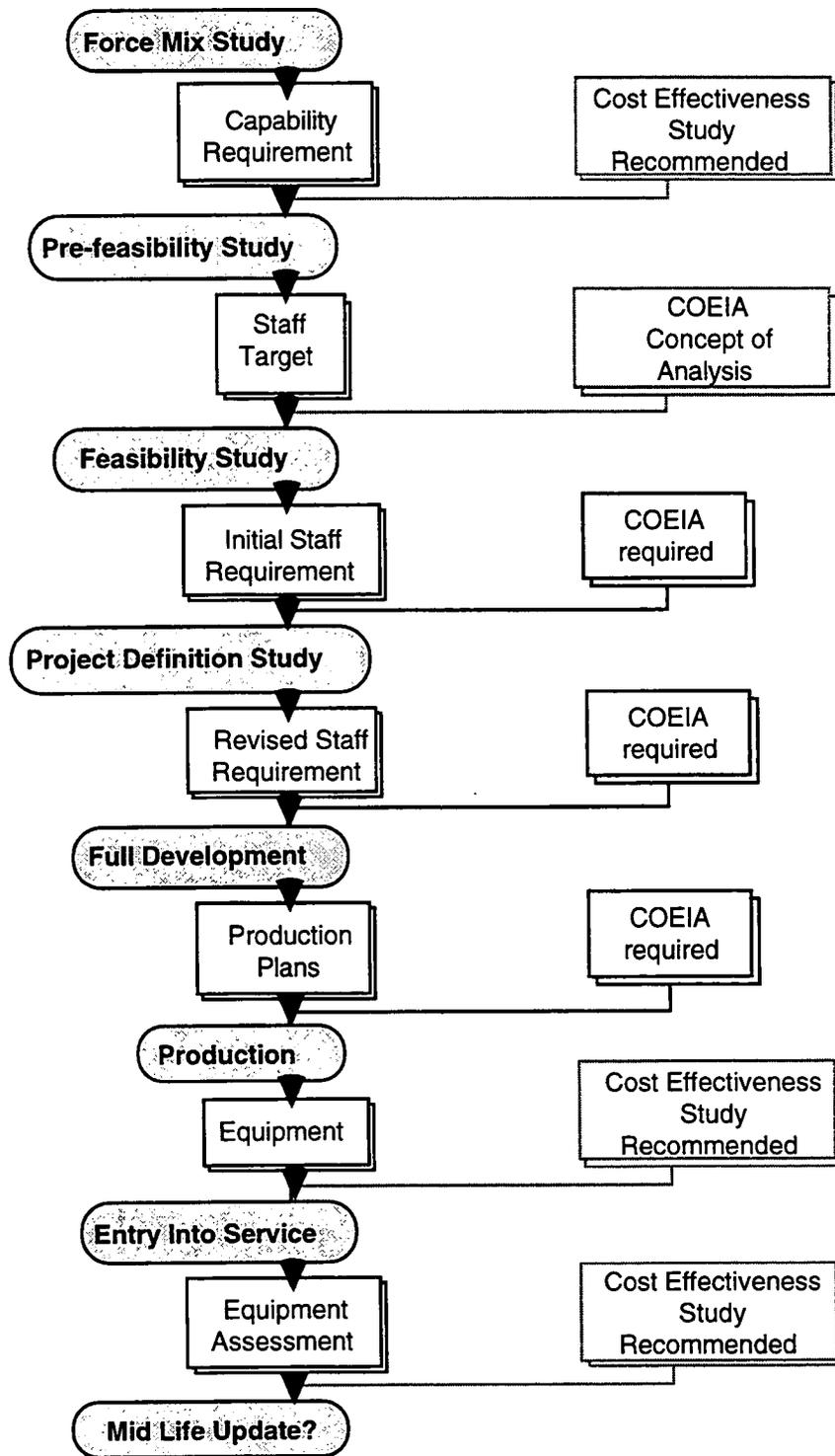


Figure 1: Requirements for COEIAs in the MOD procurement cycle

The assessment of cost-effectiveness is, of course, nothing new to the MOD or any other Government Department involved in public expenditure. Investment Appraisals (IA) are conducted in order to assess the costs of proposed system options which have been designed in response to - but not necessarily to meet in full - a specific operational requirement. Assessment of the operational effectiveness (OE) of systems has also been a requirement of an EAC submission, but in the past this has not been given the same emphasis as the IA. A recent MOD initiative now requires that a *Combined* OE and IA (COEIA) is prepared for each system and that the COEIA paper forms part of the submission to the EAC. The COEIA combines the measures of

operational effectiveness, cost, and other information previously presented in an Investment Appraisal, to provide a justified recommendation to the EAC.

COEIAs therefore require the bringing together of a variety of communities to work together from an early stage in the life-cycle of a project, melding their particular areas of expertise:

- the Procurement Executive (PE) who traditionally conduct IAs;
- the Defence Staff Desk Officer who produces the operational requirement;
- the operational analysis (OA) specialists within MOD, DRA and industry;
- contractual, risk and financial experts;
- those responsible for scrutiny of the submission.

The Defence Staff and PE share responsibility for the production of the COEIA which will be subjected to independent scrutiny by the staff of the Chief Scientific Advisor and the Office of Management and Budget. The scrutineers' task is to ensure that the requirements for cost, effectiveness and risk assessment have been met before recommendations are submitted to the EAC.

The COEIA paper is one part of the submission to the EAC in support of a particular equipment. The COEIA assessment evolves throughout the lifecycle of a system, starting with the preparation of a concept of analysis when funds are sought for Feasibility Studies (see Figure 1), continuing to a full COEIA assessment before entry into Project Definition and Full Development and prior to Production. It is important to start early in the lifecycle, involving all those who have an interest, so that the right studies are put in place to support later work; this will be emphasised later.

The COEIA must assess a variety of options in response to the requirement, including 'do nothing' (e.g. running on existing equipment to the end of its planned life) and 'do minimum' (e.g. refurbishing existing equipment). Other options might include buying second-hand, leasing, buying off-the-shelf, or contracting out (e.g. facilities management).

## **CIS COEIAs and the Need for a Guideline**

COEIAs are required for any major procurement but the conduct of COEIAs for CIS presents a number of particular problems:

- Firstly, there is a growing demand for CIS, stemming from the belief that it provides a method for significantly improving the overall effectiveness of the Armed Forces.
- Secondly, the assessment of CIS effectiveness is seen to be more difficult than for a front-line weapon system because of its indirect effect on military effectiveness. CIS is also highly complex because of the nature of its components: procedures, personnel, data, software, computers, communications.

These complexities led to the Director of Science (CIS) sponsoring the production of a guideline for the conduct of COEIAs for CIS (Reference 1). The Guideline has been given wide circulation within MOD and industry for comment. It is based on the general guidance provided by the EAC and is aimed at giving practical advice for those responsible for managing COEIAs for CIS. This may either be a military Desk Officer in the Defence Staff or a Project Manager within the MOD's Procurement Executive.

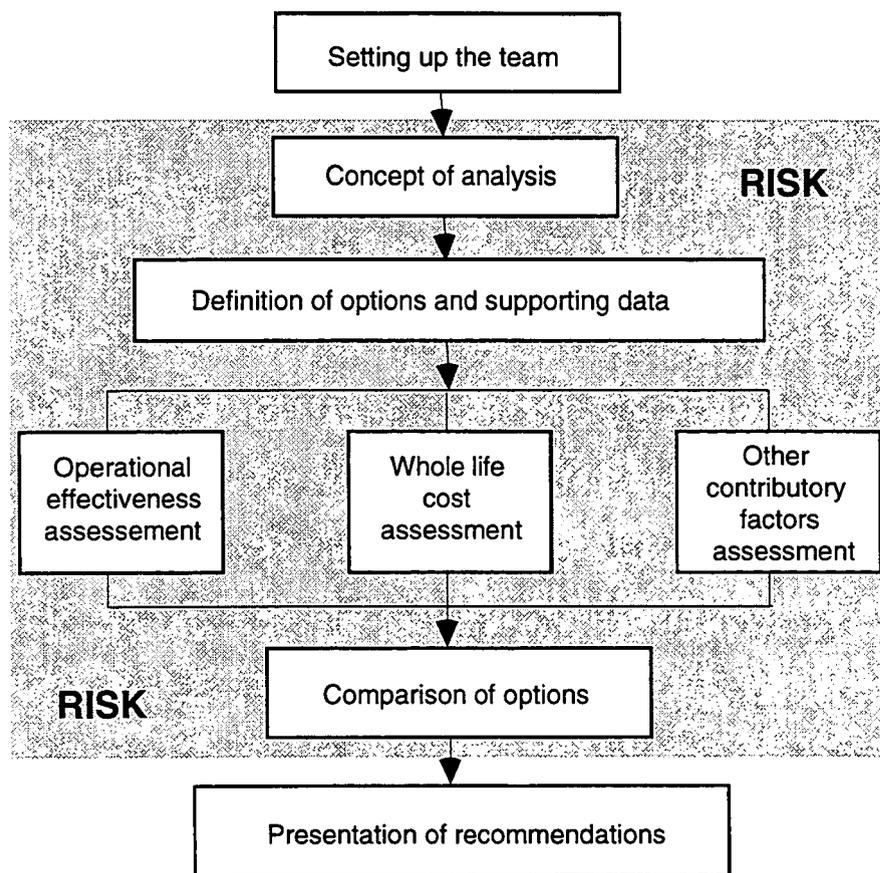


Figure 2: The activities in the COEIA process

The key activities of the COEIA process are shown in Figure 2:

- *Setting up the team:* This includes the appointment of the COEIA manager and a team with the necessary technical capabilities and resources.
- *Concept of analysis:* This establishes the initial scope of the COEIA and produces, and agrees, a concept of analysis which outlines what is required, the procurement options to be assessed, and how the assessment will be achieved. It includes a management plan showing tasks, milestones, deliverables and resources.
- *Definition of options and supporting data:* This includes a definition of the objectives, structure and functions of the organisation that the CIS will support, identifies the requirements for the CIS, and provides all the data for the various assessments including how the system will be operated and supported in service.
- *Operational effectiveness assessment, Whole life cost assessment, Other contributory factors assessment:* These three activities are conducted in parallel, on the basis of the agreed baseline provided by the data sources for the defined options. 'Other contributory factors' might include industrial, social or environmental issues and this assessment provides an opportunity to include factors which do not sit easily in the effectiveness or cost assessments but which have an impact on the discrimination between the procurement options.
- *Risk assessment* is fundamental to the entire COEIA process. Risk analysis in OE and cost assessment provides information for the associated sensitivity analyses. Risk assessment basically attempts to determine the robustness of the

recommendation to variability in the input data and analysis methods, and identifies the factors which influence it.

- *Comparison of options:* At this stage the options can be compared on the basis of operational effectiveness, cost, other contributory factors and risk. It may be necessary to iterate some of the supporting activities.
- *Presentation of recommendations:* The final stage is to produce a final recommendation and the supporting COEIA paper.

The CIS COEIA Guideline has been produced by a team of OA, cost and risk experts from the DRA and industry. It has been based on 'best practice' within the various fields which go to make up the COEIA process but is intended to be an evolving document which will be revised in the light of practical experience of CIS submissions. The remainder of this paper highlights some of the challenges which arise during a CIS COEIA and which we have addressed in the CIS COEIA Guideline.

## **Tackling the Challenges of COEIA for CIS**

The existence of the COEIA Guideline for CIS well in advance of equivalent documentation for other applications is, in itself, evidence of the special challenges facing the implementation of the COEIA process in the information system domain. These challenges have had a profound impact on both the form and content of the Guideline and will continue to influence its evolution. A good many of the challenges facing CIS COEIAs are well known and are the subject of considerable research effort throughout the international defence community.

The political importance of COEIA demands, however, that the process maintains a high degree of pragmatism. Whereas the needs of COEIAs will rightly influence the direction of future research effort, the COEIA itself is not the appropriate forum for esoteric analytical solutions. In order to convince decision makers who are accountable at the highest political levels, the approach taken to COEIA for CIS must, above all, be credible and understandable.

The challenges facing COEIA for CIS can be separated into three categories:

- *Procedural:* those which influence the form of the Guideline itself and the conduct of a COEIA;
- *Analytical:* those affecting the process of evaluating cost, effectiveness, risk etc.;
- *Presentation:* those which influence the form of the results.

## **Procedural Issues**

There has been considerable debate as to whether the process is really new. On one side there are those who argue that COEIAs represent a profound change to the way that the MOD is able to demonstrate and justify the value for money of its procurement. On the other hand there are those who claim that the COEIA is simply a re-statement of the way in which Investment Appraisals *should* always have been done.

In fact there is merit in both views. There are certainly technical and organisational aspects of the process which are a significant departure from previous MOD practice; for example, the increased emphasis on OE, and the shared responsibility of the

Defence Staff and PE. However, the key to understanding the function of the COEIA is to recognise that it is very much in the established tradition of Government Investment Appraisals.

This, in turn, has certain implications regarding the way in which the assessment of Operational Effectiveness is formally embraced within the process. The most significant issue arising is that the selection of the approach for estimating OE must take into account the end users of the analysis, and what their needs are. The scrutineers require information which allows them to decide whether the recommendation before them represents the best value for money option and justifies the commitment of resources to proceed into a further phase. Any appraisal activity which does not directly support this function is likely to be nugatory.

This is especially pertinent in the CIS domain where many of the issues, and the solutions proffered to address them, are inherently esoteric. If COEIAs are to represent a change to the conventional Investment Appraisals, it will be in the tighter co-ordination and integration of the work of the cost and OA communities than has been the case in the past. The benefits in terms of a co-ordinated logical appraisal are obvious but it requires the interested parties to recognise the real significance of the 'C' in COEIA.

The production of the Guideline included a wide ranging review of the vast volume of relevant work on the evaluation of information systems being undertaken in both civil and defence domains. In the context of current research, especially in the area of information system effectiveness evaluation, the approach given in the Guideline is, however, necessarily conservative. This not only reflects the need to ensure that the results of the COEIA have adequate credibility with non-specialist decision-makers but also the fact that the Guideline has to address a wide variation in its possible application.

A CIS can be many things, within a variety of different technical and organisational contexts. Furthermore the appraisal may be undertaken at various points throughout the project life cycle. The Guideline is, therefore, focused on the generic issues to ensure that the key factors are always addressed, and also that CIS projects are tackled with some form of consistency. This latter point will improve the quality of the outputs and simplify the job of the scrutineers. Early involvement of scrutineers will ensure that any problem areas are identified and addressed in a timely way.

Although, formally, the COEIA process starts at entry to Feasibility Studies (see Figure 1), it is good practice to address the COEIA issues at the earliest opportunity. This provides a sound foundation for subsequent analyses and allows early OA to influence the direction of the project. Many of the current problems of COEIAs arise from the introduction of the related analyses in the mid-stages of procurement when appropriate foundational work has not been conducted.

A further issue which had a significant effect on the way in which the Guideline was written is the inevitable variability in the expertise and experience of the individuals responsible for managing the COEIA. Considerable thought went into the structure of the final document. A 'road-map' is provided to allow the first time user to locate the sections of the document which are most appropriate to his situation. The Guideline structure is both hierarchical and chronological. The hierarchy provides three distinct but cross-referenced levels of guidance:

- a summary is provided by way of a briefing for Assistant Director level staff who require an understanding of the process but not an intimate description of its mechanics;

- the main document provides a concise step-by-step guide to the COEIA process for those responsible for its implementation;
- the Annexes provide expositions of the main elements of the COEIA process for CIS for those who require a more detailed briefing and/or level of understanding.

The activities described in the second and third levels are presented chronologically so that the document has an easy to use 'cook-book' structure, including identifying sources of help. The result is that the Guideline should be a useful and usable guide to anyone undertaking a COEIA, irrespective of their background, and also that it provides a framework which should increase the consistency with which CIS investment appraisals are undertaken.

## **Analytical Issues**

Of all the challenges facing the definition of an approach to COEIA for CIS, the analytical issues are perhaps the most widely recognised. They also had the greatest influence on the decision to produce a Guideline specifically for CIS projects.

There are a number of key characteristics of CIS projects which define the analytical challenge and therefore have a first-order influence on the means used to undertake a COEIA. Perhaps the most fundamental issue is the difficulty in defining an appropriate and generally applicable procedure for bounding the CIS: that is, drawing a boundary around the system which properly accounts for its impact on the cost and effectiveness of the forces which it supports. This issue also has an impact on the second defining characteristic: the difficulty of defining and representing a realistic measure of the value of CIS. The third characteristic embraces the whole analytical process and that is the inherent risk and uncertainty associated with the procurement, implementation *and assessment* of CIS.

Defining a solution to the representation of the risk and uncertainty in CIS actually helps to address all the main analytical challenges, albeit indirectly. Explicit and appropriate representation of risk and uncertainty will not solve the problems of bounding and measuring CIS, but it does ensure that these problems are incorporated and represented explicitly rather than being hidden as assumptions which, in worst cases, may not even be stated.

The Guideline recommends an approach to risk analysis which extends across all aspects of the appraisal. The objective of the risk analysis is not simply to represent the risks associated with the project (i.e. the various potential problems which the project manager should be addressing in his risk management plan) but to identify all the factors which introduce some element of variability into the appraisal results. The most significant aspect of this objective is that the risk analysis should not only embrace uncertainties in the data used to drive the cost and effectiveness analyses but also the uncertainties inherent in the use of the selected assessment techniques and models. Risk analysis also helps in identifying the other contributory factors which will influence the procurement decision.

However, making problems explicit does not reduce them: indeed the effect may be simply to reduce the apparent robustness of the recommendations. The Guideline does therefore specifically address the bounding and measuring issues. As well as clarifying the problem, bounding also ensures that the cost and OE are evaluated on a common basis. The Guideline suggests a basis for scoping CIS which is based on its relationship with the organisation which it supports. There is no hard and fast rule for all cases because of the variety of CIS applications. The Guideline emphasises the need to bound the system early and to ensure that the definition is accepted by all

interested parties. Tackling the problem of bounding does of course help to define measurement and provides a foundation for the whole appraisal.

Defining system value remains the key challenge to any form of CIS assessment. Again the Guideline's approach is to emphasise the importance of logic and consistency rather than to detail a prescriptive solution which may not be appropriate to all applications. A clear distinction is made between performance and effectiveness. It is the latter, representing the value provided by CIS in terms of the ability of the supported organisation to meet its operational objectives, which is the strongly preferred attribute.

Analysts are also encouraged to use multiple sources of data and methods as far as is practical. Hence, for example, the measurement of effectiveness maybe informed not only by simulation but also by the structured use of military judgement, and by data from Technical Demonstrator Programmes. Again, risk analysis provides a means of explicitly representing the confidence in the various elements of the analysis.

## **Presentational Issues**

A competent and effective analysis is never enough to ensure that the decision maker ultimately has the information to make the 'right' decision. Equally as important is the way in which the results are presented. The results must not only fairly reflect the analysis (i.e. including its weaknesses) but also ensure that the arguments, assumptions and conclusions are clearly represented.

There may, for example, be a perception difficulty relating to the CIS bounding problem discussed earlier. The COEIA must recognise the fact that the representation of a CIS for the purposes of appraisal, may be far from intuitive. Obviously a loss of the scrutineer's commitment at this stage will undermine the whole of the appraisal. Entangled with this factor are the 'people issues': the fact that a CIS is not simply hardware and software but a complex socio-technical organisation with physical and functional inter-relationships with a wide range of other systems.

A particular challenge arises from the need to present the results of the analyses within the COEIA paper which is limited to eight pages (plus four pages of annexes). The results of the OE assessment must be presented alongside those of the IA in a way which makes the trade-offs between cost and effectiveness clear to the decision makers. In attempting to present the COEIA results there is, of course, a danger of over-simplifying the results of underlying complex analyses. The challenge is to present sufficient information, in an easily assimilable form, to allow informed decisions to be made. Figure 3 illustrates one method which has been used in a recent EAC submission.

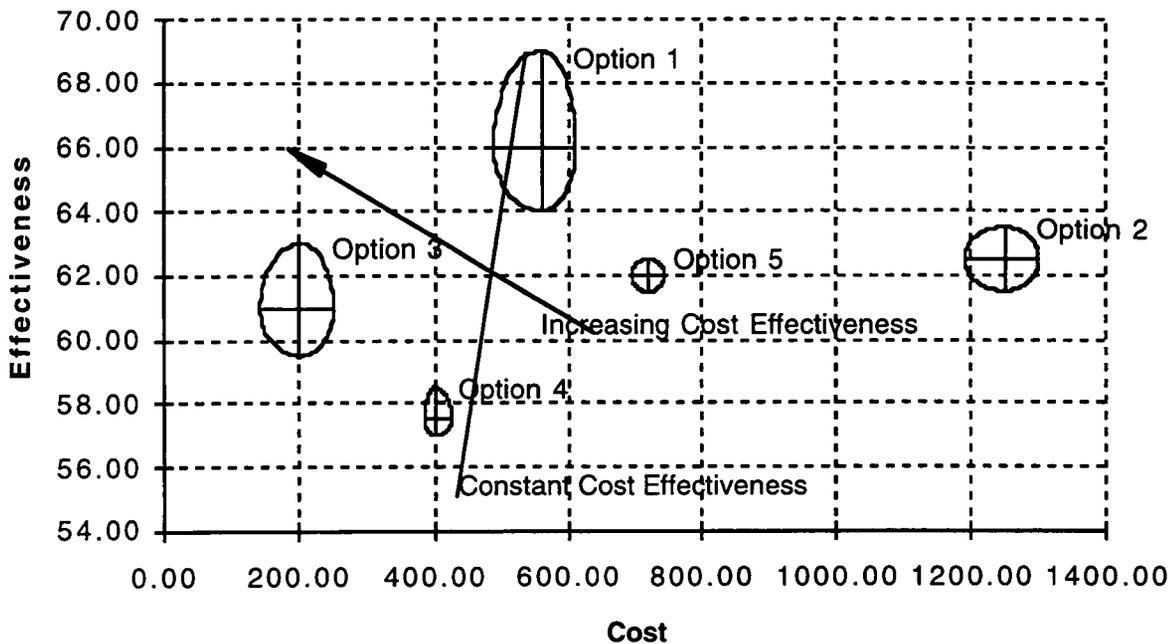


Figure 3: Cost-effectiveness comparison

Figure 3 shows the various procurement options plotted on a cost and effectiveness graph. The ellipses represent the uncertainty in the results and the variability in the input data, and provide bounds for the cost and effectiveness measures. In this example, Option 3 is the most cost-effective; the fact that the error ellipse is well separated from the other options shows that this is a robust recommendation. If Option 3 had not been available, it would have been necessary to discriminate between Option 1 and Option 4 which are closer to the line of constant cost-effectiveness and therefore more difficult to compare. Option 4 represents a low risk solution which is cheaper than Option 1. Discrimination between these two options might involve discussion of minimum acceptable levels of effectiveness which Option 4 may not be able to meet.

Experience has shown us that the assumptions upon which information system procurements are based (in both defence and civil applications) are *inherently* lacking in robustness: that is, they are likely to change significantly as a result of changes in technology and the application and external environments. The Guideline suggests that risk analysis should be formally used to scope and drive sensitivity analysis and to generate confidence bounds around the estimates of effectiveness and cost. This is the best way of ensuring that the robustness of the conclusions is properly represented in the final decision.

These challenges need to be met because of the importance of CIS to the effectiveness of the armed forces at large. Just as an effective CIS can improve the utility of a wide range of defence systems, so a poor one can have a negative impact. The challenges of presenting a CIS COEIA in such a way as to properly and simply represent the cost and value of the system, whilst also reflecting the potential volatility of the results, is the greatest challenge of all.

## Summary and the Way Forward

We have discussed a range of challenges arising from the MOD's COEIA initiative and which we have addressed in the CIS COEIA Guideline. These include:

- the evolving nature of COEIAs themselves,
- the problems arising from their introduction in the mid-stages of existing procurements;
- the need to integrate OE assessment with a wider community of cost and risk analysts;
- the analysis of CIS effectiveness and the risks and uncertainties inherent in that process;
- the presentation of the results of a *combined* OE and IA in a way which reflects the uncertainties of the underlying process while still assisting MOD decision makers to make robust decisions;
- the need to start OE, cost and risk assessment early in the procurement cycle when the analysis can contribute positively to a successful procurement outcome rather than being seen as a final obstacle to be overcome.

These challenges have been highlighted by our work in preparing the Guideline for conduct of CIS COEIAs; a task which has been informed by many experts in cost, risk and effectiveness assessment. However, the Guideline is intended to be a 'live' document which continues to evolve and encapsulate the best of current practice. This practice can only be gained from experience in conducting COEIAs for real systems and must come, in great part, from OA practitioners. The challenge has been laid down by those responsible for making investment decisions. The time is right for the OA community to take up that challenge and prove the importance of OA within the COEIA process.

## Reference

1. DRA/OS/N/CR93011/2.0 dated March 1994 "CIS Cost and Effectiveness: COEIA Guideline", D.J. Harris, J.A. Gadsden and R.N. Davis (Naval Studies Department, Defence Research Agency), P. Staton and B. Harmsworth (Data Sciences UK Ltd.), C. Dalton (HVR Consulting Services Ltd.).

