Rapid COEIA for complex decision making

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Abstract. Is it possible to make robust, defendable investment decisions whilst balancing operational capability with value for money? The Arke team have developed a novel, rapid Combined Operational Effectiveness and Investment Appraisal (COEIA) framework which has been adopted by the defence community. The team will present a Dynamic Option Generation Tool which embodies the framework; encompassing cost/benefit metrics, scenarios and 'What If?' functionality, measured against System of Systems Architecture Principles. Utilising a range of analysis criteria, the process simplifies complex problems and provides decision makers with the ability to make an informed choice. The analysis methods, developed in-line with UK MoD scrutiny assurance and guidelines, are able to assess a range of data types including; availability, technology readiness, operational effectiveness, value for money and affordability. An example will be presented showing application within a complex situation, where rapid assessment of a host of potential options has been undertaken to optimise cost effectiveness of an investment decision.

1. Background

Traditionally, MoD and Industry Boards have been limited in their ability to make informed decisions on complex investment strategies, as the potential benefits and disadvantages are poorly understood. This is in part because Defence investment policy requires budgets and performance targets to be set and delivered against individual capability needs, encouraging stove-piped procurement.

This challenge applies to a broad range of decision spaces, including equipment procurement, balance of investment, site rationalisation, safety measures, and any other investment or capability based decision. Furthermore, the increase in cases where a set of decisions has impact across multiple domains and Front Line Commands makes it more important to have a common analysis and decision framework across the possible options. This offers a significant challenge given the often complex communication and data channels between the Front Line Commands (FLC).

2. Introduction

This paper describes a decision support framework which facilitates a move away from parochial decision making which focuses on criteria specific to individual project teams. Instead, the supporting analysis encompasses the wider benefit to MoD, framing the decision within the context of whole defence capability, allowing a fully audited and justified decision across all potential solutions.

This paper will describe how the approach has been developed and tested as part of two large scale, pan-domain projects, both involving a variety of projects subject to MoD Cat A and B scrutiny with varying investment and benefit periods. To achieve this, the accompanying Investment Appraisal (IA) and Operational Analysis (OA) methods and their integration have undergone scrutiny within the defence community.

An informed decision is one in which the financial commitment and potential benefits are fully considered in combination, whether it be in support of business case approval, research programmes, technology demonstration or obsolescence management. This decision must also utilise military and SME judgement, balanced with an efficient method for analysing the supporting data. On this basis, an informed decision has the following qualities:

- Based on both OA and IA analysis using a common set of assumptions;
- Full visibility of data audit trail and justification;
- Based on culmination of complex thought and analysis into simple, easily digestible output;
- Ability to rapidly assimilate all possible options within the decision space;
- Consideration of affordability analysis to facilitate MoD commercial negotiation.

The focus of this approach is on complex decision environments, spanning multiple commands, which could take the form of many millions of potential options made up of individual projects and involving the potential transfer of funds from many different budget holders. An important assumption made here is that the selection of the correct decision maker(s) in combination with the necessary information available to make an informed decision results in a 'good' decision. This paper uses 'benefit' to describe either benefit (strategy, policy, safety, etc.), capability (equipment, resource, etc.), or effectiveness (technology, research, etc.), or any combination thereof.

3. Methodology

The proposed decision support framework consists of a range of activities undertaken including establishing a Concept of Analysis (COA) followed by a combination of a Whole Life Cost (WLC) and Operational Effectiveness (OE) assessment. Facilitated by a series of stakeholder workshops and working groups, the process is made up of two distinct phases; firstly, a down-select of potential individual projects, and secondly, the formulation of candidate options combining the 'best' projects. Both phases, to a greater or lesser extent, consist of benefit and cost activities described below.

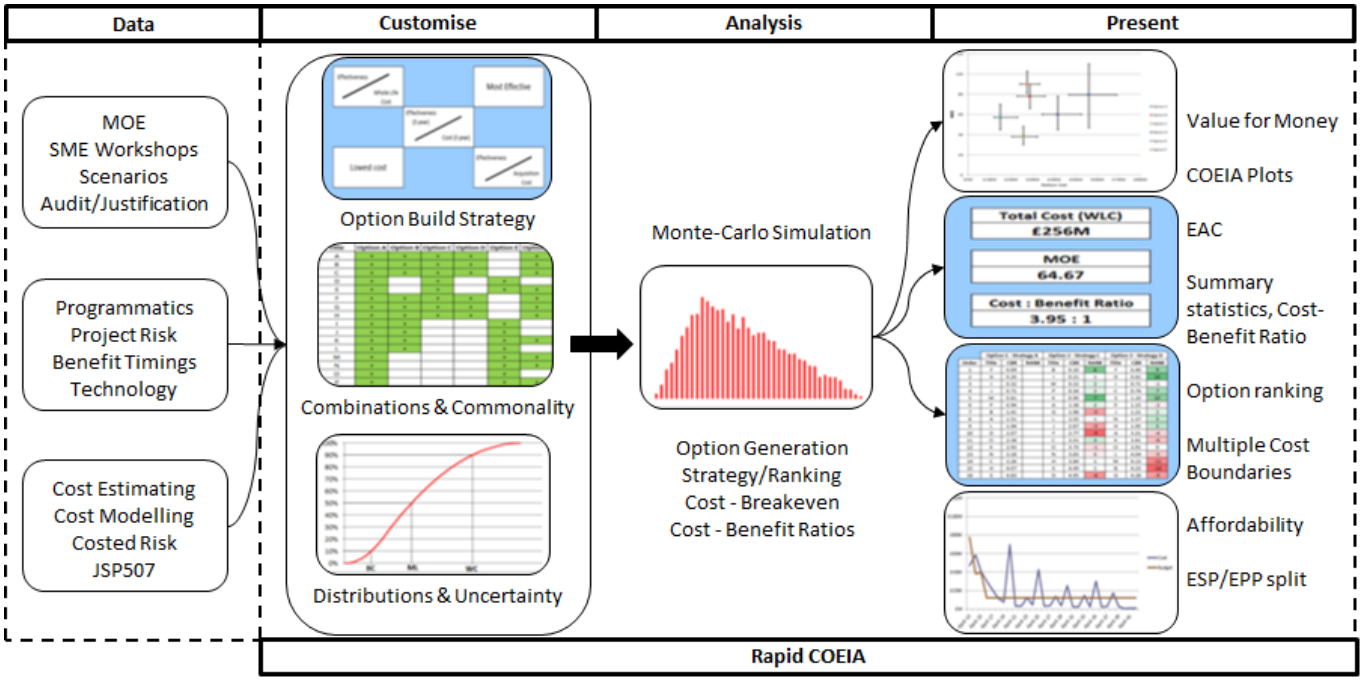

Figure 1 - Decision Environment

The figure above shows the distinction between the extensive analysis undertaken to support the decision, and the decision process itself. This means that given a well-defined and fully justified set of analyses, all relevant data can be presented to the decision maker to rapidly rationalise a potentially complex decision into an easily understandable format. The 'Customise' section represents the decision makers' ability to identify critical data formats and metrics within the scope of the underlying analysis, all of which is possible using the methods described below. This is then fed into the simulation process which enables presentation of outputs in real-time, within a stakeholder workshop or decision board. Customised inputs range from the way in which options are generated to the scope of the cost benefit ratio and form of the data and distributions which describe uncertainty in the input data.

Benefit Analysis

The capability assessment makes use of a COA which is agreed within the scrutiny community for the analysis of appropriate Measures of Effectiveness (MOE), possible futures or fully defined scenarios, as well as synergies or overlaps between projects. It is important to set out a clear and understandable MOE, weighted by relative importance within the decision space. This allows effective use of Subject Matter Experts (SME) opinion across relevant domains and capability spaces and informing uncertainty based analysis of the benefit scores. The interpretive potential of the analysis is enhanced when combined with narrative supplied by SME, describing the context and providing considerations for either analytical or subjective aspects outside of the scope of the MOE.

Cost Analysis

Cost estimates and modelling practices, as appropriate for business case submissions involving Whole Life Cost (WLC) assessment across the CADMID procurement cycle, (Concept, Assessment, Development, Manufacturing, In-Service, Disposal), fully inclusive of risk and applying all necessary financial and economic conditions, as dictated in the MoD investment appraisal and SMART approvals guidance [1,2,3]. The output of this assessment includes appropriate procurement and in-service (EPP, ESP) apportionment and risk uncertainty modelling using a fully verified and validated Monte-Carlo simulation tool.

The scope of the cost assessment can range from concept and analogous estimates to costs based on parametric or firm price quotes from industry and manufacturers. Cost estimates can be across a specific

investment period, but should always be assessed on a WLC to MoD basis to maintain consistency with the benefit axis. The process of curtailing cost or benefit over a specific time period may be simple in some scenarios (i.e. where there is a linear relationship with time). However, it may be necessary to re-assess to accurately reflect the cost or MOE over specific time intervals.

An important output which should be part of any decision support is the ability to compare Outturn costs to the available budget. Although not a contributor to the value for money decision, this can be used to inform commercial and budgetary implications for the candidate options. An example output shown below compares the WLC of an option, including all necessary VAT and inflation treatment, with the current budgetary allocation.

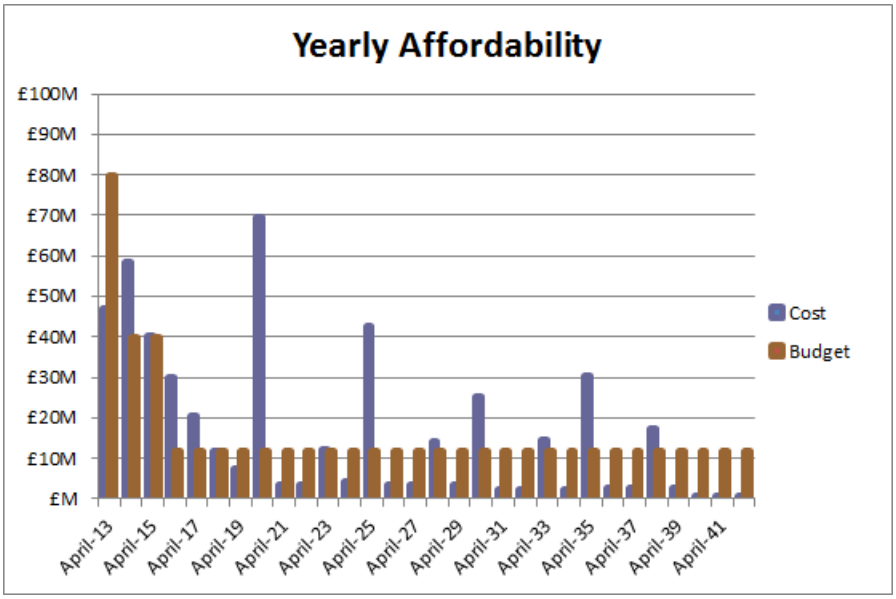

Figure 2 - Affordability Exemplar

In applying this method, there is significant opportunity to apply System of Systems Approach (SoSA) [4] principles within the decision space. Specifically, opportunities associated with delivery of agile procurement opportunities, enhanced system coherence and inter-operability, the ability to understand cross-boundary issues and responsibilities, and better targeting of development and integration funding requirements

4. Rapid COEIA

The quality of any decision support is underpinned by the quality of the data and assumptions used to generate the supporting analysis. The challenge is to efficiently consider the potentially very large number of analysis aspects to inform a set of decisions, whilst maintaining the audit trail and coherency of the input data and thought process.

The generation of many millions of potential options does not readily allow an optimised option to be selected; rather a set of automated criteria is required, as defined in the COA. This rationalises the decision making process into a well justified analysis approach coupled with simple graphical representation of the decision space. To achieve this, a Prototype excel based decision support tool, DECIDE (Dynamic Effectiveness and Cost Integrated Decision Environment), has been developed as part of a large Cat A programme review. This test case involved dozens of individual projects ranging from equipment procurement, resource, site rationalisation and capability development as part of a joint MoD and industry partnership. The tool has been extended to form a framework for use across MoD, allowing:

- Real-Time COEIA Analysis;
- Optimised option generation from individual project building blocks;
- Customised MOEs, scenarios, ranking strategies and cost metrics;
- Multiple cost boundary viewpoints;
- Value for Money assessment;
- Affordability analysis;
- Cost output as required for any main Gate business case using a JSP 507 compliant cost model, fully verified and validated by MoD cost assurance authority.

The results from the supporting analysis are considered in terms of a number of potential strategies for selecting optimum options. For example, these strategies could involve selecting the combination that best satisfies the MOEs within an affordability limit (e.g. has the best impact for the available budget), or which provides the most cost effective solution. These strategies are developed in consultation with the decision maker and other stakeholders during the development of the COA. The results are presented to the stakeholders in workshops using the DECIDE framework to down-select potential options either to facilitate a decision or further programme assessment. During the stakeholder workshops, changes to the strategies for selecting options can be undertaken in real-time to allow stakeholders to fully understand the benefits and costs of the potential options. For example, during the workshops the analysis tool can be used to change the affordability limit, the cost benefit strategy, or apply additional constraints to examine the impact on the suitability of the combinations.

Option generation

Option generation works on the basis of automatically and sequentially adding the most advantageous projects and converging towards an optimum option. The sequence, or ranking, of each project is based on one of a number of pre-defined strategies allowing live generation of optimised options, such as:

- Lowest cost;
- Highest benefit;
- Highest benefit per unit cost through life of investment (within a budgetary constraint if necessary);
- Highest benefit per unit cost within specific investment period (e.g. 5 or 10 year window);

The rapid assessment uses a set of rules set out in the COA defining how the cost and benefit of an option is calculated based on the cost and benefit of the individual project within the option. This also takes account of synergies such as potential savings from selecting project which can be applied to multiple capability or equipment areas (e.g. the same platform) with minimal adaptation, either using standard commonality metrics or by assimilating previous analysis done on the basis of combining multiple projects.

Cost-Benefit

The overall cost-benefit ranking measure for the options can take any number of forms, but the decision process is greatly improved when intervention from the decision maker can facilitate real-time re-calculation of the cost-benefit ratio for each option generated. Possible definitions of a cost-benefit ratio can be found within current investment decision guidelines, in terms of the scope of the cost assessment and benefit scoring (i.e. what to include within each side of the ratio). This may appear at first to be a clear-cut definition, but the relevant domain may have conflicting guidelines in terms of what can be considered as costs or benefits [5,6,7]. Critically, the metrics used by the decision makers should be clearly defined and selected with all relevant information at hand.

Simulation plays an important role in describing uncertainty on both the cost and benefit inputs to the COEIA analysis. Uncertainty can be defined as specific distributions for each MOE factor or cost estimate, or through variation within the SME judgement scores. The uncertainty in the analysis should be considered carefully in making any decision, with appropriate risk management levels dependent on the nature of the decision space.

Equivalent Annual Cost (EAC) is used to rank relative value for money across options with different investment lives [2,8]. This appropriately discounts investment made later and represents better value for money on projects with larger benefit years. An example of a COEIA output with uncertainty described by 10^{th}, 50^{th} and 90^{th} percentiles on both the cost and benefit scores is shown in the figure below.

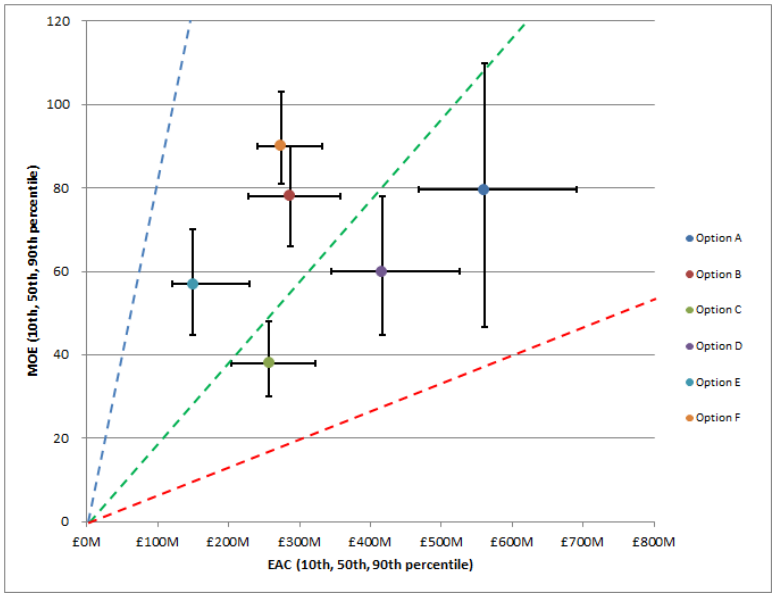

Figure 3 - COEIA Exemplar

5. Conclusions and Recommendations

Expectations of good decision making will grow as a greater number of examples are demonstrated where investment decisions are based on a fully audited and justified process, whether it be in support of equipment procurement, capability development, research or technology demonstration programmes. There is a difficulty in articulating some of the challenges which MoD face when making informed choices, particularly in developing complex optimised investment programmes. This may stem out of a risk averse culture where individuals are afraid of going against the norm.

The decision framework discussed in this paper could allow MoD to balance investment across hugely varied domains and potentially move away from managing process and into contracting for capability. Furthermore, the MoD is able to remain agile in their decision making against current capability drivers, and hence achieve real value for money prior to committing funds rather than attempting to prove the correct decision was made after the end of a competition.

References

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