Decision support in selecting maintenance organization

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Abstract *Selecting a satisfactory maintenance organization to support costly and technologically advanced assets with a long life-cycle is not easy. There are numerous objectives to fulfill and many are changing. There are many fuzzy and multi-dimensional decision criteria and significant uncertainties and risks. Additionally, stakeholders from industry and government may not share similar interests, and this restricts the range of alternative solutions. Yet, we must select the complete maintenance organization for these assets to ensure product integrity through life compliant to end-user needs. This paper discusses how the Analytic Hierarchy Process is applied in a method to identity the preferred maintenance organization for one particular weapons system of the Norwegian Army. We also find it necessary to evaluate the robustness of the decision using Monte Carlo simulations and to employ sensitivity analyses to identify critical success factors.*

Practical implication

The purpose of the approach we present in this paper is to ensure a more informed and systematic decision process when selecting maintenance organization for assets with long life-cycle. Although the approach is employed on a quite abstract level to help decision-makers select the overall maintenance organization, it is employed directly on the issues decision-makers wrestle with, such as should the manufacturer of the asset also perform maintenance at maintenance echelons 3 and 4? The approach involves directly people from different maintenance echelons, and – although it seems theoretical – is consequently highly applicable and practical to most selection processes we are aware of.

Introduction

Many large assets have decades long life-cycles, both in terms of a long time from idea to market and an even longer time in use. Yet, it is during development that most costs are committed. In fact Winner *et al.* (1988) claim that 70 per cent of the life-cycle costs are committed during the design stage. For example, the current *USS Enterprise*, which was first commissioned

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November 24 1961, is still in service today albeit after several modifications and major upgrades. The fact that the *USS Enterprise* is still in duty shows that the aircraft carrier was a good design since it has been less costly to modify and upgrade than to replace. If this is by accident or intention we do not know, but it does show that the carrier has successfully evolved with changing times and requirements, which is important when designing large and costly assets. Thus, providing proper decision-support during the design stage is undoubtedly crucial to reduce life-cycle costs as well as improve other performance measures.

Selecting a maintenance organization involves many similar long-range planning decisions, which ultimately are multi-objective decisions. However, the most complicating factor is the limited availability of data, and those data that are available might be fuzzy, partial or otherwise limited. Add to this the fact that for assets with a long life-cycle, the future system objectives and usage are largely unknown at the time of making the decision. Thus, the state of knowledge to make informative decisions about current objectives is inadequate, and even more so for the resolution of future objectives.

Often, maintenance organizations are selected based on already available organizational structures. The decisions behind are not informed in the sense that a broad, information-seeking approach has been applied. *Ad hoc* analyses such as life-cycle costing are, however, often applied, but an overall, systematic decision process is lacking, which is what we present in this paper.

Needless to say, we cannot rely solely upon analytical approaches in such a context without augmenting such analyses by so-called subjective decision support. Interestingly, there are analytical approaches that put subjectivity into a system that is internally consistent. Among the better subjective methods for providing decision-support in multi-objective situations, is the Analytic Hierarchy Process (AHP) that Thomas Lorie Saaty developed in the late 1960s and first publicized for a wider audience in numerous books, such as *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation* (Saaty, 1990). AHP has been utilized in a wide array of situations including resource allocation, scheduling, project evaluation, military strategy, forecasting, conflict resolution, political strategy, safety, financial risk and strategic planning (Saaty and Forsman, 1992). Others have also used AHP in a variety of situations such as in supplier selection (Bhutta and Huq, 2002), to determine measures of business performance (Cheng and Li, 2001), and in quantitative construction risk management of a cross-country petroleum pipeline project in India (Dey, 2001). A primary reason for using AHP is that it also allows a check of the logic consistency of the answers provided by participants in the project.

This paper presents how AHP was applied as a part of a decision process for the Norwegian Defense Logistics Organisation for Land-based forces (NDLO/Land) when identifying the preferred maintenance organization for the ARTillery HUnting Radar (ARTHUR). Furthermore, we illustrate and discuss the powerful combination of AHP, Monte Carlo simulations and sensitivity analyses. The purpose of the Monte Carlo simulations is primarily to evaluate the robustness of the decision, but as we shall see there is an equally important reason – we can use Monte Carlo simulations to understand better what makes a solution good or bad. This in turn allows us to perform an overall reality check of the entire selection process.

Case: deciding maintenance organization for ARTHUR

Arthur is the radar system for the Artillery Locating System (ALS) shown in Figure 1, more specifically Item 3. The purpose of ARTHUR is to identify and track "unfriendly" artillery grenades many kilometers away, and based on the information obtained during the course of a few seconds, calculate where the enemy positions are and direct a counterattack before enemy fire approaches friendly positions.

Evidently, ARTHUR is what most people would refer to as "high-tech". In addition, its predicted life-cycle is long, and software upgrades will be frequent, which introduces a variety of challenges for NDLO/Land. Examples of such challenges include risks of obsolete technology and unplanned use as well as unavailability of engineering and maintenance skills and spare parts. Any maintenance organization candidate must be solid and allow the life-cycle owner to cope with changing political situations nationally and internationally.

We outline the decision process we designed using ARTHUR as case. One of our primary design criterion, i.e. "... a standard of judgment ..." (Webster, 1989) from which the "goodness" of the decision process can be evaluated, is that it must be simple and readily available for project personnel who are not trained using the method. This could include highly qualified and/or experienced project managers as well as someone without a major scholastic background.

This design constraint (from our point of view) ruled out many design processes and tools found in the literature, such as the design process found in

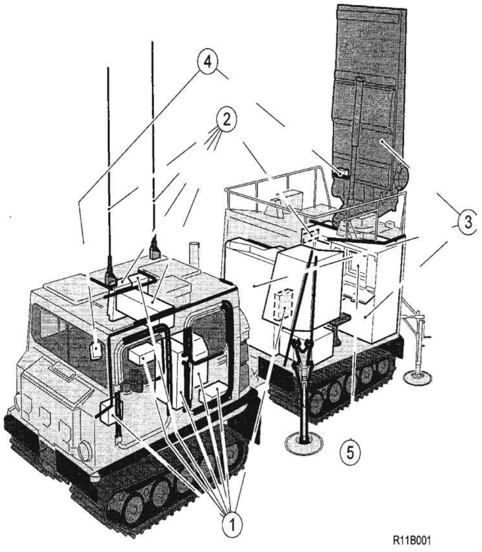

Figure 1.
The Artillery Locating System (ALS)

Pahl and Beitz (1984), that are tailored towards highly qualified engineering designers. We therefore designed our own decision process.

The decision process

Many engineering design, systems engineering and concurrent engineering methods are iterative. That is, a sequence of steps is performed over and over again until a satisfactory solution is found. Such approaches typically yield the best results, particularly for complex decision-making situations such as for ARTHUR, but they are too complicated to match our design criteria. Hence, we must find a simpler approach.

We chose to develop a simple decision process, which on its highest level can be described in an IDEF0 diagram as shown in Figure 2. From the legend we see that each box in the diagram can be thought of as a process with inputs and outputs, and with constraining factors on one hand and enabling factors on the other. The stages in this decision process may be performed as needed as well as iteratively, even though feedback data are not shown in Figure 2.

The decision process in Figure 2 is similar to so-called stage-gate processes, which are commonly found in the marketing literature (see e.g. Cooper, 1994), but allows iteration if deemed necessary. The greatest strength of both stage-gate processes and ours is the efficiency, which is "a measure of the swiftness with which information that can be used by a designer to make decisions, is generated" (Mistree *et al.*, 1990). Stage-gate processes are probably more time efficient than any other design process, but for complex processes it may not be cost effective. The lack of iteration in the process reduces its effectiveness, which is "a measure of quality of a decision (correctness, completeness, comprehensiveness) that is made by a designer" (Mistree *et al.*, 1990).

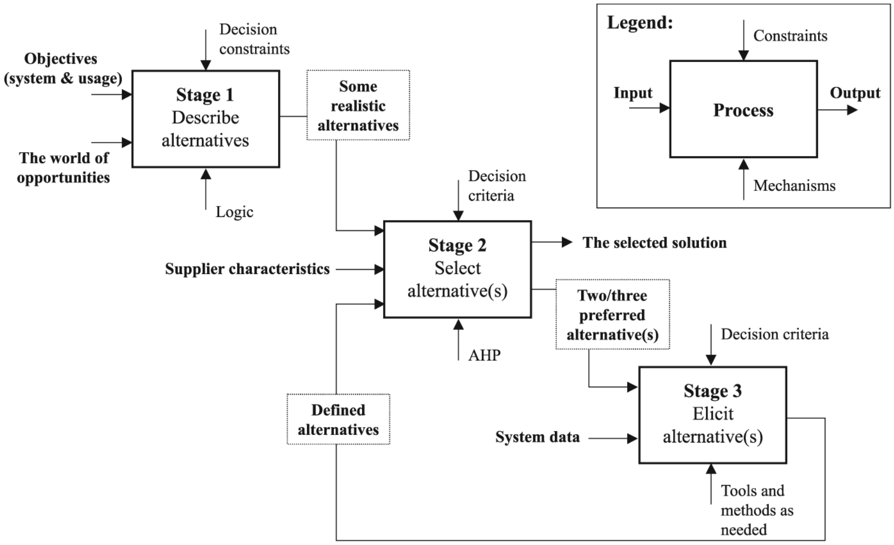

Figure 2.
The overall decision process

In the subsequent section we explain every stage in more detail. But first we shall clarify an important concept for maintenance of military equipment, i.e. the maintenance echelons that allocate roles to the maintenance organization in compliance with the needs of the end user. For ARTHUR, the following apply:

- First echelon – users operate and move assets.
- Second echelon – mobile units replace Line Replaceable Units (LRU) on assets.
- Third echelon – heavy mobile units or stationary workshops maintain incoming assets brought in by the second echelon.
- Fourth echelon – major workshops perform maintenance work that the third echelon are unable to perform due to lack of competence, equipment or similar.
- Fifth echelon – supplier remanufactures, overhauls and (re)designs the asset, qualifies parts, and resolves design related problems of asset use and maintenance.

We see from these definitions that complexity, skill intensity and the distance to the operational situation increases for higher maintenance echelons.

Stage 1 – Describe alternatives

Prior to Stage 1, the team responsible for deciding the maintenance organization must first identify all the objectives the organization must take into account in the decision-making. This will always include objectives related to the overall maintenance system, which includes both the assets and their maintenance organization, and the proposed usage of the assets. Other objectives may be specific to the individual case, and should be included when deemed necessary.

The main objective of Stage 1 is to identify and develop a set of realistic solutions for each echelon by defining those alternatives that are not exclusive to the decision constraints such as laws and regulations, absolute system requirements and so forth. It is crucial that the alternatives are developed from a broadest possible starting point, that is, we should leave all preconceptions behind. Preconceptions usually stifle innovations and lead to a poor exploration of the possible solution space. Because this is essentially a creative and logic exercise we did not apply special tools for this filtering. In other words, the mechanisms by which we deliver the output were our own logic capabilities. For the more advanced practitioner we can recommend approaches such as quality function deployment as support.

The constraints associated with the decisions are the limiting measure at this stage. That is, we develop only alternatives that do not violate any decision constraints. For any alternative of ARTHUR some decision constraints are that it must be (in random order):

(1) politically acceptable both now and in the foreseeable future;

(2) economically feasible;

(3) workable within the life-span and must support expected usage;
(4) robust enough to facilitate reasonable changes in objectives.

From the world of opportunities we use these decision constraints to identify alternative solutions for each maintenance echelon, and for system, configuration and engineering management. The alternatives we found are shown in Table I. Theoretically, we could get 18 (3 × 3 × 2) alternatives from all possible combinations of the alternatives in Table I, but many of those combinations are practically impossible or unwanted.

After eliminating all the combinations that produce unfeasible alternatives, the remaining alternatives are all feasible. From Table II we see that there are four such alternatives. Please note that:

- A technician is a soldier with some engineering skills, while a technician+ has extended training and may serve a more prolonged profession or duty to perform some third echelon tasks.
- Only echelons 2, 3 and 4 have multiple alternatives.

Once we identify a set of feasible alternatives we proceed to Stage 2.

Stage 2 – Select alternative(s)

Stage 2 concerns making a relative ranking of the feasible alternatives so that we can select the most preferred alternative. If two alternatives are close in ranking score then we let both proceed to Stage 3. The ranking is relative because we are not comparing the alternatives to some absolute measures of success; we are simply comparing the alternatives to each other in the absence of precise data. Note that by defining the alternatives according to the decision constraints in Stage 1 we ensure that all alternatives in Stage 2 are per definition feasible.

In order to assess the alternatives we need more information than in Stage 1. From Figure 2 we see that we need both supplier characteristics and decision criteria. The decision criteria are developed from the objectives prior to Stage 1 in a hierarchical manner. For ARTHUR we arrived at the following three top-level criteria:

(1) Cost – the preferred alternative(s) must be cost effective.
(2) Sustain usage – the preferred alternative(s) must sustain a wide spectrum of usage.
(3) Risk – the preferred alternative(s) must satisfactorily deal with future unforeseeable situations.

Table I. The possible alternatives for the various maintenance echelons, SM and CM

System	Echelon 5	Echelon 4	Echelon 3	Echelon 2	Echelon 1
ARTHUR	Supplier 1	Supplier 1 Supplier 2 Nor. Army	Supplier 2 Nor. Army Shared (Ech 2 and 4)	Technician Technician+	User

Each of these top-level decision criteria was broken down further as shown in Table III. The criteria are intentionally generic in nature and require further precision to support the decision process for the various assets. The criteria will also have different relative importance depending on which echelon they apply to.

Operational costs represent the cost of normal day to day usage at the echelon in question. Modification costs refer to the costs of implementing modifications throughout the life-cycle of the assets. Engineering costs are associated with major analyses or redesigns of the asset also to make it operable throughout its life-cycle. Deployment is an increasingly important aspect of Norwegian defense policy in support of allies that engage in internationally agreed collaborative efforts to sustain peace in troubled areas such as Lebanon, Kosovo and Afghanistan.

Once the decision criteria were established we used AHP to both rank the criteria and to select the preferable alternative(s). When employing a tool such as AHP it is important to be aware of the underlying axioms – or articles of faith, if you like – because as with any method, AHP is no better than the applicability of the underlying axioms for the situation in which it is employed. For a brief review of these axioms and their implications, please review Peniwati (2000). Here we are only going to discuss the one that is most pertinent for us – because we are primarily interested in the mechanisms behind the pair-wise comparison and the matrix-usage in AHP – and that is the fact that AHP is hierarchical.

For now it suffices to acknowledge this fact about AHP; later we will discuss it in more detail. To employ AHP we used the scales of measurement and the

Alternative	Echelon 5	Echelon 4	Echelon 3	Echelon 2	Echelon 1
1	Supplier 1	Supplier 1	Nor. Army	Technician	User
2	Supplier 1	Supplier 2	Supplier 2	Technician	User
3	Supplier 1	Nor. Army	Nor. Army	Technician	User
4	Supplier 1	Supplier 1	NA	Technician+	User

Table II. The realistic maintenance organization alternatives for ARTHUR

Top-level criteria	Sub-criteria
Cost	Operational costs (costs of use and support)
	Modification costs
	Engineering costs
Sustain usage	Sustain usage in peace
	Sustain deployment
	Sustain mobilization
	Sustain usage in war
Risk	Outdated technology
	New areas of usage
	Political aspects
	Norwegian Army policy

Table III. Decision criteria

average Random Index (RI) values suggested by Saaty (1990) as provided in Tables IV and V. According to Peniwati (2000), the RIs are defined to allow a 10 per cent inconsistency in the answers because as the old management dictum goes – it is better to be approximately right than precisely wrong. More specifically, the answers provided by the ALS team have to be 90 per cent logically consistent in order to proceed in the decision process.

In Table VI the weighting matrix of the top-level decision criteria for Echelon 3 is shown. We see, for example, that "Sustain usage" is considered moderately more important than cost. Logic consistency refers to the facts that if "Cost" get a score of 0.1 compared with "Sustain usage" and 0.3 compared with "Risk", then it would be logically inconsistent if "Sustain usage" got a score of say 1 compared with "Risk" because "Sustain usage" and "Risk" are not equally important. The "OK" indicates that the numbers in Table VI are logically consistent and hence we can proceed.

There are several advantages of this consistency check because "it is able to prevent respondents from responding arbitrarily, incorrectly, or non-professionally" (Cheng and Li, 2001). With the decision criteria structure found in Table III we need four matrices like the one in Table VI per maintenance echelon for which we have multiple alternatives. The reason we did this analysis per maintenance echelon is their differing functions and objectives. For example, the second echelon is much more usage-oriented while the fourth is more cost-oriented. Thus, the weights for the various echelons will be different as will the evaluation of the various alternatives.

In Table VII the cost evaluation of the four alternatives with respect to the third echelon is shown. The relevant weights are found in the bottom row and

Table IV.
Scales of measurement in pair-wise comparison

Intensity of importance (1)	Definition (2)	Explanation (3)
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favor one over another
5	Strong importance	Experience and judgement strongly favor one over another
7	Very strong importance	An activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	The importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocals of above numbers		If activity *i* has one of the above non-zero numbers assigned to it when compared with activity *j*, the *j* has the reciprocal value when compared with *i*

Source: (Saaty, 1990)

Size of matrix (1)	Average random index (2)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Source: (Saaty, 1990)

Table V. Average random index values

Criteria	Cost	Sustain usage	Risk	Relative weight
Cost	1.0	0.3	0.2	0.1
Sustain usage	3.0	1.0	0.3	0.3
Risk	5.0	3.0	1.0	0.6
Sum	9.0	4.3	1.5	
Consistency ratio (CR)	3	0.58	OK	0.033

Table VI. Top-level decision criteria weighting for echelon 3

Alternative	Operational cost	Modification costs	Engineering costs	Evaluation
1	7.0	5.0	3.0	6.3
2	5.0	7.0	7.0	5.5
3	7.0	5.0	3.0	6.3
4	9.0	9.0	9.0	9.0
Weight	0.7	0.2	0.1	

Table VII. Cost evaluation of the maintenance organization alternatives for echelon 3

they are developed similarly to those shown in Table VI. To set the scores in Table VII we used the definitions in Table VIII. The reason Alternative 4 gets such good evaluation is that Echelon 3 is eliminated in that alternative and consequently that alternative is very cost effective.

Once similar evaluations to Table VII are done for "Sustain usage" and "Risk" we can compute the overall score for the alternatives concerning the third echelon as shown in Table IX. The weights in the bottom row are those derived from Table VI.

We then aggregate similar results for all the columns that have multiple alternatives in Table I, that is, echelons 2, 3 and 4. The columns that have only one alternative are of no interest because they cannot provide any relative comparison between the alternatives.

When we have come so far it is important to recall the limitation that a hierarchical approach carries, namely, that interactions between the elements in a hierarchy are ignored. For ARTHUR this is important because we need to evaluate the synergies within the alternatives. Ideally, we should have employed the successor to the AHP method, the Analytical Network Process (ANP) that Saaty later developed, but according to Peniwati (2000) a study has suggested that "... a complex hierarchy can adequately replace a network model". For this application both alternatives are too complex, hence, we add a matrix where we explicitly evaluate the synergy effects of the various alternatives. That is done using a pair-wise comparison, normalizing the relative weights (see Table X).

Then we scale the maximum attainable evaluation score linearly according to the number of echelons for which there are multiple alternatives, to prevent the synergy score dominating the other scores. Since echelon 1 has no alternatives but the user, the maximum evaluation score for synergy will be 9 for synergy that incorporates echelons 1 through 5. The reason is that for those echelons there will exist multiple alternatives in the generic case. For ARTHUR, however, only echelons 2 through 4 have multiple alternatives and by using linear interpolation the maximum evaluation score becomes 9 × 3/4, or 27/4 (= 6.75). We see from Table XI, for example, that alternative 4 gets the best synergy scores (6.8) due to the fact that it has the least number of organizations and transactions involved.

Table VIII.
Evaluation scores

Definition	Score
No good	1
Some good	3
Good	5
Very good	7
Excellent/ideal	9
Intermediate values	2, 4, 6, 8

Table IX.
Echelon 3 evaluation

Alternative	Cost	Sustain usage	Risk	Evaluation
1	6.3	8.1	4.7	5.7
2	5.5	5.0	6.9	6.2
3	6.3	8.1	4.7	5.7
4	9.0	2.7	9.0	7.4
Weights	0.1	0.3	0.6	

Table X.
Evaluating the synergy effects

Alternative	1	2	3	4	Relative weight	Normalised weight
1	1.0	5.0	3.0	0.5	0.3	0.7
2	0.2	1.0	0.3	0.1	0.1	0.1
3	0.3	3.0	1.0	0.3	0.2	0.4
4	2.0	9.0	3.0	1.0	0.5	1.0

With all this weighting and scoring done, we aggregate all information into a total evaluation matrix, which is found in Table XI. We see that alternatives 1 and 4 are clearly preferable to alternatives 2 and 3. In fact, the analysis suggests that alternative 4 is also so much better than alternative 1 that we are quite sure that alternative 4 is the preferred alternative.

In order to estimate the robustness of this recommendation we ran a Monte Carlo simulation (see e.g. Emblemsvåg, 2003) for a thorough explanation on Monte Carlo simulations). The robustness is evaluated by letting every number in the AHP matrices vary randomly by ±1. That is, if we give a score of 6 in the AHP matrices, during the Monte Carlo simulations the same score would vary continuously between 5 and 7 with no preference, as shown in Figure 3. All in all we have 192 input variables in the Monte Carlo simulation and 25 output variables.

In the first simulation we identify that the "risk weighting matrix" for echelon 2 turned inconsistent in 55 per cent of the trials. Hence, we must make some slight adjustments in the pair-wise comparison after which this problem disappeared. A couple of the other matrices also had some trials in which they turn inconsistent, but most of them were inconsistent in less than 5 per cent of the Monte Carlo simulation trials.

The Monte Carlo simulation provides the overall result presented in Figure 4. We see that alternative 4 is always better than alternative 1 given the (1 variation in the scoring. In fact, if we increase the variation to ±2, alternative 4 is preferable in more than 95 per cent of the trials, and if synergy effects are included alternative 4 is preferable in roughly 99 per cent of the cases, as shown in Figure 5. Although the ±2 variation increases the aforementioned problem of inconsistency considerably, that is irrelevant here because the purpose of the variation is not to check consistency but to evaluate the robustness of the overall evaluation of the alternatives. Thus, alternative 4 is undoubtedly the most satisfactory alternative.

Stage 3 is therefore not needed for ARTHUR in order to choose a maintenance organization on the level of detail that we currently operate on. However, for completeness sake we describe Stage 3 in "Stage 3 – Elicit alternatives", but Stage 3 will apply at a later stage to refine alternative 4 further and choose among sub-alternatives to produce a solution that can be implemented (alternative 4 as described here is still conceptual). Nonetheless, identifying the factors that matter the most for the total evaluation of the

Alternatives	Echelon 2	Echelon 3	Echelon 4	Total evaluation	%	Synergy	Total evaluation w/synergy	%	
1	5.1	5.7	8.6	23.5	85.9	4.2	28.5	81.2	2
2	5.1	6.2	3.3	18.6	68.1	0.7	20.0	57.0	4
3	5.1	5.7	4.8	19.6	71.8	1.9	22.3	63.5	3
4	7.3	7.4	8.6	27.3	100.0	6.8	35.1	100.0	1

Table XI.
Total evaluation matrix

alternatives and understanding the results is important. Thus, we run a sensitivity analysis of the numbers generated during the Monte Carlo simulations. The result is found in Figure 6.

Interestingly, we see that the main reason for alternative 4 receiving such a high evaluation score is that its echelon 2 solution performs very well in war situations. But because echelon 3 is eliminated in alternative 4 this alternative is penalized by the fact that "Sustain usage" is relatively more important than "Cost" for echelon 3 and to sustain usage is difficult when the entire echelon is missing. Conversely, we see that "Risk" is even more important than "Sustain usage" for echelon 3 and eliminating echelon 3 is therefore well rewarded because then the echelon 3 risks are also eliminated.

In a similar fashion every factor in Figure 6 can be discussed to provide further insight into why alternative 4 is the most satisfactory alternative and what the potential pitfalls are. Thus, we see that using Monte Carlo simulations

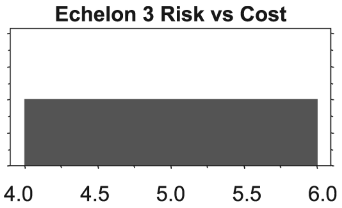

Figure 3.
A uniform distribution in the Monte Carlo simulation

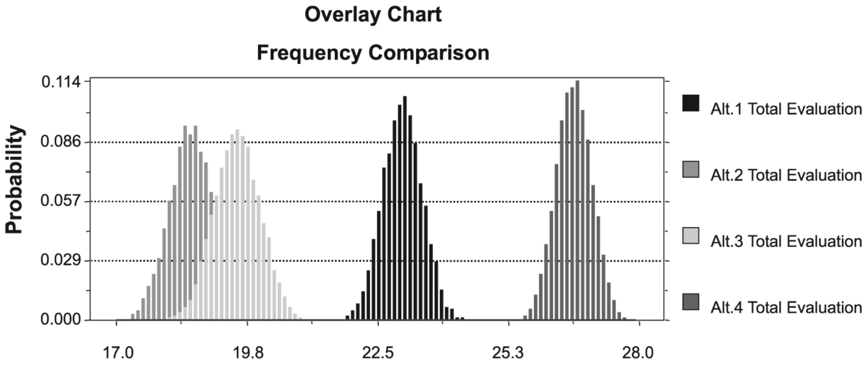

Figure 4.
Total scores from the Monte Carlo simulations with ±1 variation

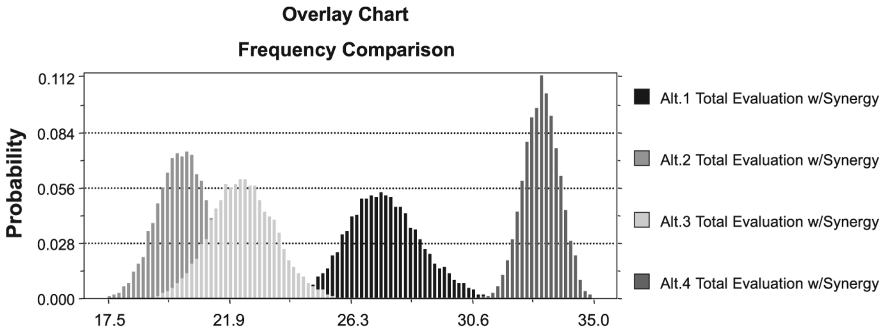

Figure 5.
Total scores with synergy from the Monte Carlo simulations with ±2 variation

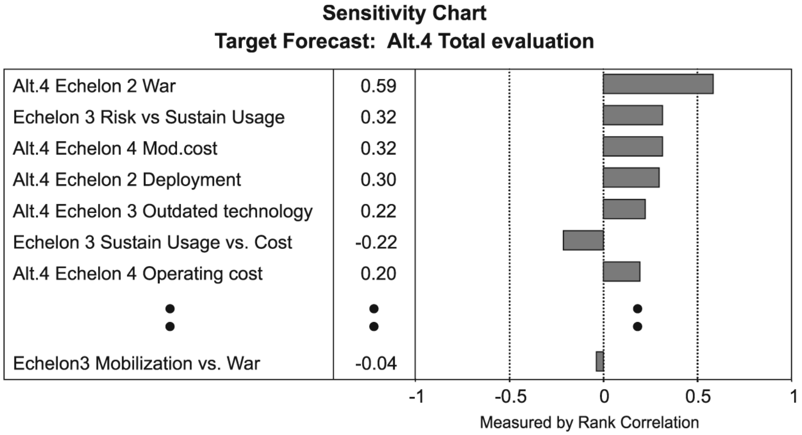

Figure 6.
Sensitivity analysis of total evaluation of alternative 4

in an AHP structure not only gives guidance with respect to the robustness of the alternative, but also can be used to deepen our insight about an alternative and give input to a final reality check of an alternative. We therefore believe the combination of Monte Carlo simulations, statistical sensitivity analyses and AHP provides a powerful tool.

Stage 3 – Elicit alternatives

For ARTHUR a decision is found before Stage 3 because the best maintenance organization in Stage 2 is clearly preferable to the second best alternative. In the generic case, however, Stage 3 is a detailed assessment stage to identify crucial differences between two alternatives from Stage 2 that are indistinguishable at a reasonable level of confidence. It is quite similar to Stage 2 in that AHP is employed to weight the decision criteria by translating the preferences of the decision-makers. Unlike Stage 2, however, the decision criteria are more precisely defined and other approaches are needed to provide accurate decision information and knowledge concerning everything from Mean-Time-To-Failure (MTBF) and Mean-Time-To-Repair (MTTR) to life-cycle cost. This decision information is then used to evaluate the alternatives (as opposed to the more subjective scoring in Stage 2).

Closure

The outlined decision process is simple, but by utilizing AHP and Monte Carlo simulations we believe it has been significantly strengthened without adding much complexity. AHP provides a reliable approach to capturing the opinions of various experts and stakeholders, while the Monte Carlo simulations allows us to estimate the robustness of the decision while at the same time gain more understanding about the decision. Furthermore, why a certain choice is made is documented throughout the decision process, which allows tracing later on if desirable.

We believe that although this decision process is simple it does perform well as is evident from the case. The ALS team, their superiors and, in our opinion, we have found the desirable solution, but of course, the ultimate test is yet to come. In fact, we have probably not found "the best" solution. We have found a satisfactory solution that in the light of all the uncertainty in the years to come seems also to be a robust one.

Knowing what is satisfactory is the point in complex situations because "good enough" solutions can endure while "optimum" solutions often loose their edge. As Lao-Tzu expresses it in *Tao Te Ching*:

> He who knows contentment is rich; he who preserves in action has purpose. Not to lose one's station is to endure . . .

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