GUIDANCE TOOLS FOR USE IN NUCLEAR MATERIAL MANAGEMENT DECISION MAKING

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ABSTRACT

This paper describes the results of Recommendation 14 of the Integrated Nuclear Materials Management Plan (INMMP) which was the product of a management initiative at the highest levels of the Department of Energy responding to a congressional directive to accelerate the work of achieving integration and cutting long-term costs associated with the management of nuclear materials, with the principal focus on excess materials. The INMMP provided direction to "Develop policy-level decision support tools to support long-term planning and decision making." To accomplish this goal a team from the Savannah River Site, Sandia National Laboratories, Idaho National Engineering and Environmental Laboratory (INEEL), and the U.S. Department of Energy experienced in the decision-making process developed a **Guidebook to Decision-Making Methods**. The goal of the team organized to implement Recommendation 14 was to instill transparency, consistency, rigor, and discipline in the DOE decision process. The guidebook introduces a process and a selection of proven methods for disciplined decision-making so that the results are clearer, more transparent, and easier for reviewers to understand and accept. It was written to set a standard for a consistent decision process. From the guidebook, decision-makers and their support staffs can learn:

- the benefits of using disciplined decision-making methods
- prerequisites to the decision-making process
- how to choose among several decision-making methods
- how to apply the method chosen

The guidebook also presents examples of the decision-making methods in action and recommends sources of additional information on decision-making methods.

The decision process and methods recommended by the guidebook have been successfully applied to several trade studies such as the Cesium-Strontium (Cs/Sr) Management Alternatives Trade Study; and the Unallocated Off-Specification HEU: Recommendations for Disposition.

INTRODUCTION

The Department of Energy's (DOE) core missions entail use of nuclear materials that are vital to national security, and the proper management of these materials is essential to the protection of the public and the environment. The Department launched a Nuclear Materials Stewardship Initiative in January 2000 to support and strengthen our strategic approach to the integrated life-cycle management of nuclear materials. The Integrated Nuclear Materials Management Plan (INMMP) was developed as a key component of the Stewardship Initiative to accelerate coordination and integrated planning among the various DOE programs that manage nuclear materials. The plan recognized the need to define and analyze a set of working assumptions about the long-term requirements of the complex that extends beyond the current planning horizon and to undertake qualitative and quantitative analyses of long-term requirements to include evaluations of future missions and potential functions that will need to be performed. The plan committed to enlarge the information resources the Department draws on for analyses, refine analytic techniques by using quantitative analyses, **and employ decision support tools**, including public involvement, to ensure a sound foundation for decision making. The intent was that the planning process would become comprehensive and institutionalized and take a systems approach that focuses on both current and future Department-wide functional requirements rather than on individual materials and program needs.

The INMMP presented a 25-point, multi-year agenda charting a path toward a more robust, efficient, cost-effective nuclear materials complex that can carry our nation securely into the future. Task 14 of this plan outlined the development of "policy-level decision support tools to support long-term planning and decision making."

To accomplish this goal a team from the Savannah River Site, Sandia National Laboratories, Idaho National Engineering and Environmental Laboratory (INEEL), and the U.S. Department of Energy experienced in the decision-making process was organized to implement Recommendation 14.

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The goal of the team was to instill transparency, consistency, rigor, and discipline in the DOE decision process. The **Guidebook to Decision-Making Methods** introduces a process and a selection of proven methods for disciplined decision-making so that the results are clearer, more transparent, and easier for reviewers to understand and accept. It was written to set a standard for a consistent decision process. From the guidebook decision-makers and their support staffs learn:

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PURPOSE

Decision-makers have to choose between alternative actions every day. Often the alternatives and supporting information presented are inadequate to support or explain the recommended action. **The goal of the Guidebook to Decision-Making Methods is to help decision-makers and the decision support staff choose and document the best alternative in a clear and transparent fashion.** The guidebook will help all parties concerned know what questions to ask and when to ask them.

What is a disciplined decision-making process?

Good decisions can best be reached when everyone involved uses a clearly defined and acknowledged decision-making process. A clear and transparent decision process depends on asking and answering enough questions to ensure that the final report will clearly answer the questions of reviewers and stakeholders. The guidebook provides:

- An eight step decision-making process
- Descriptions of specific decision methods
- Examples of the specific decision methods in action
- Written aids, suggestions, and questions to help implement the decision-making process, and
- Supporting references for further reading.

Why use a disciplined decision-making process?

For most familiar everyday problems, decisions based on intuition can produce acceptable results because they involve few objectives and only one or two decision-makers. In the DOE environment, problems are more complex. Most decisions involve multiple objectives, several decision-makers, and are subject to external review. A disciplined and transparent decision-making process employing credible evaluation methods will provide:

- Structure to approach complex problems
- Rationale for decisions
- Consistency in the decision making process
- Objectivity
- Documented assumptions, criteria, and values used to make decisions. and
- Decisions that are repeatable, reviewable, revisable, and easy to understand

Using such a disciplined approach can help avoid misunderstandings that lead to questions about the validity of the analyses and ultimately slow progress. Its use will set a baseline for continuous improvement in decision making in the DOE nuclear materials complex.

When should a formal decision-making method be used?

The decision-making methods described in the guidebook are readily applicable to a wide range of decisions, from ones as simple as picking a restaurant for a special meal to those that are complicated by interdepartmental government interfaces. Use of this decision-making process and supporting methods is recommended any time decisions:

- Require many reviews at different management levels
- Involve more than one program
- Require congressional line item approval
- Affect new or redirected funding
- Require approval for new facilities or upgrades to existing facilities
- Have alternatives with high technical risk
- Have alternatives that appear equally viable
- Require a decision to revise or discontinue work on a program
- Have impact mainly in the future
- Involve multiple or competing drivers, or
- Define data needed to support future decisions

In short the guidebook should be followed any time a clear, transparent, and understandable decision is desired.

THE DECISION-MAKING PROCESS

First priority in making a decision is to establish who are the decision-maker(s) and stakeholders in the decision - the audience for the decision. Identifying the decision-maker(s) early in the process cuts down on disagreement about problem definition, requirements, goals, and criteria.

Although the decision-maker(s) seldom will be involved in the day-to-day work of making evaluations, feedback from the decision-maker(s) is vital at four steps in the process:

1. Problem definition [step 1]
2. Requirements identification [step 2]
3. Goal establishment [step 3]
4. Criteria development [step 5]

When appropriate, stakeholders should also be consulted. By acquiring their input during the early steps of the decision process, stakeholders can provide useful feedback before a decision is made.

Figure 1 shows the steps in the decision-making process. The process flows from top to bottom, but may return to a previous step from any point in the process when new information is discovered.

It is the decision team's job to make sure that all steps of the process are adequately performed. Usually the decision support staff should include the help of skilled and experienced analysts/facilitators to assist with all stages of the decision process. Expert facilitation can help assure that all the steps are properly performed and documented. Their experience and expertise will help provide transparency to the decision making process and help avoid misunderstandings that often lead to questions about the validity of the analyses.

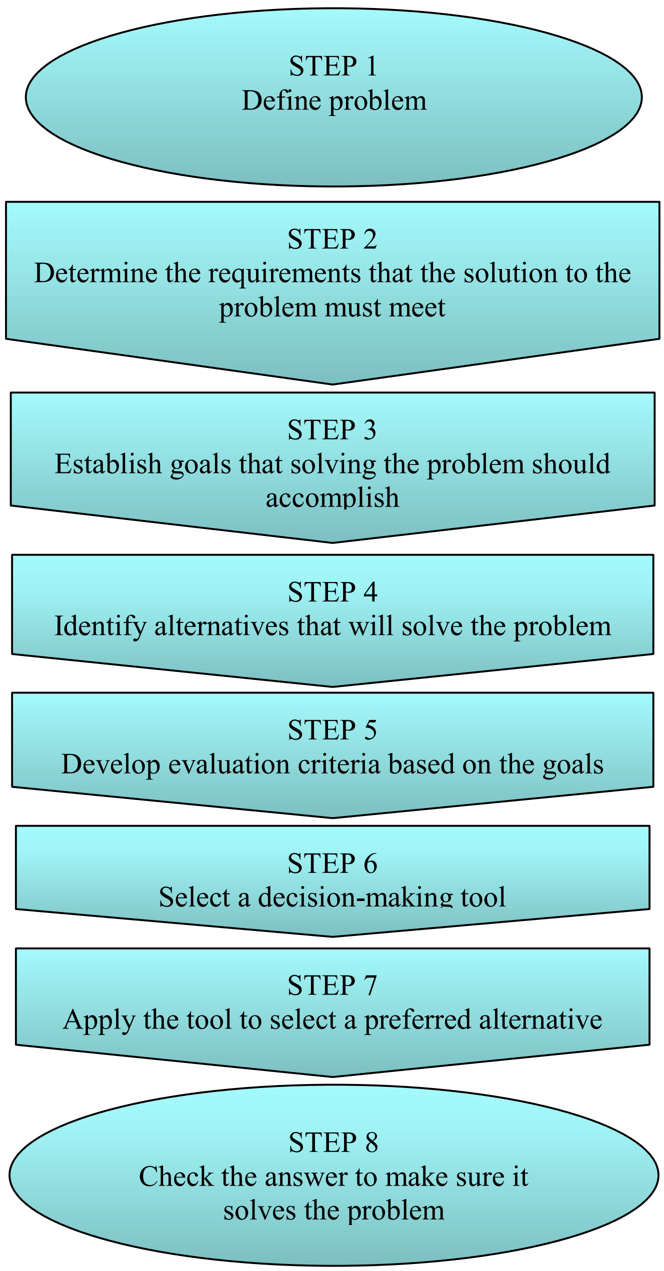

Fig. 1 General Decision–Making Process

Step 1, Define the Problem

Problem definition is the crucial first step in making a good decision. This process must, as a minimum, identify root causes, limiting assumptions, stakeholder issues, and system and organizational boundaries and interfaces. **The goal is to express the issue in a clear, one-sentence *problem statement* that describes both the initial conditions and the desired conditions.** It is essential that the decision-maker(s) and support staff concur on a ***written*** problem statement to ensure that they all agree on what problem is going to be solved before proceeding to the next steps.

The key to developing an adequate problem statement is to ask enough questions about the problem to ensure that the final report will clearly answer the questions of reviewers and stakeholders (see Figure 2 below). When stakeholders are involved, it may be appropriate to have them review the problem statement with its initial and desired state to provide an external check before requirements and goals are defined.

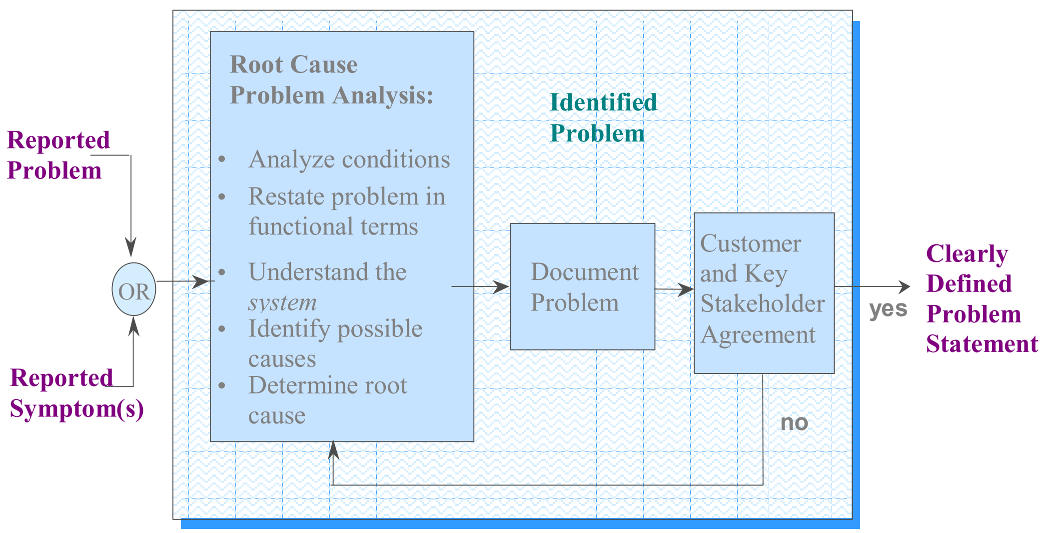

Fig. 2. Problem Definition:
Ask enough questions to be able to answer questions from others.

Step 2, Determine Requirements

Requirements are conditions that any acceptable solution to the problem *must* meet. Requirements spell out what the solution to the problem *must* do. For example, a requirement might be that a process must ("shall" in the vernacular of writing requirements) produce at least ten units per day. Any alternatives that produced only nine units per day would be discarded. Requirements that don't discriminate between alternatives need not be used at this time.

With the decision-maker's concurrence, experts in operations, maintenance, environment, safety, health and other technical disciplines typically provide the requirements that a viable alternative must meet.

Step 3, Establish Goals

Goals are broad statements of intent and desirable programmatic values. Examples might be: reduce worker radiological exposure, lower costs, lower public risk, etc. Goals go beyond the minimum essential *must have's* (i.e. requirements) to *wants* and *desires*. Goals should be stated positively (i.e. what something *should do,* not what it *shouldn't do*). Because goals define in more detail the desired state of the problem, they are developed prior to alternative identification. Goals are useful in identifying superior alternatives.

Sometimes goals may conflict, but this is neither unusual, nor cause for concern. During goal definition, it is not necessary to eliminate conflict among goals nor to define the relative importance of the goals. The process of establishing goals may suggest new or revised requirements or requirements that should be converted to goals. In any case, understanding the requirements and goals is important to defining alternatives.

Step 4, Identify Alternatives

Alternatives offer different approaches for changing the initial condition into the desired condition. The decision team evaluates the requirements and goals and suggests alternatives that will meet the requirements and satisfy as many goals as possible. Generally, the alternatives vary in their ability to meet the requirements and goals. Those alternatives that do not meet the requirements must be screened out from further consideration. If an alternative does not meet the requirements, three actions are available:

The alternative is discarded
The requirement is changed or eliminated
The requirement is restated as a goal

The description of each alternative must clearly show how it solves the defined problem and how it differs from the other alternatives. A written description and a diagram of the specific functions performed to solve the problem will prove useful.

Step 5, Define Criteria

Usually no one alternative will be the best for all goals, requiring alternatives to be compared with each other. The best alternative will be the one that most nearly achieves the goals. Decision criteria which will discriminate among alternatives must be based on the goals. It is necessary to define discriminating criteria as objective measures of the goals to measure how well each alternative achieves the project goals.

Each criterion should measure something important, and not depend on another criterion. Criteria must discriminate among alternatives in a meaningful way (e.g., if the color of all alternatives is the same or the user is indifferent to the color selection, then color should not be a criterion).

Criteria should be:
- Able to discriminate among the alternatives
- Complete – include all goals
- Operational – meaningful to the decision maker's understanding of the implications of the alternatives
- Non-redundant – avoid double counting
- Few in number – to keep the problem dimensions manageable

Using a few real discriminators will result in a more understandable decision analysis product. However, every goal must generate at least one criterion. If a goal does not suggest a criterion, it should be abandoned.

Several methods can be used to facilitate criteria selection.

Brainstorming: Team brainstorming may be used to develop goals and associated criteria.

Round Robin: Team members are individually asked for their goals and the criteria associated with them. The initial elicitation of ideas should be done non-judgmentally – all ideas are recorded before criticism of any is allowed.

When members of the goal-setting group differ widely in rank or position, it can be useful to employ the military method in which the lowest ranking member is asked first to avoid being influenced by the opinions of the higher-ranking members.

Reverse Direction Method: Team members consider available alternatives, identify differences among them, and develop criteria that reflect these differences.

Previously Defined Criteria: End users, stakeholders, or the decision-maker(s) may provide criteria.

Input from the decision-maker(s) is essential to the development of useful criteria. Moreover, the decision-maker's approval is crucial before the criteria are used to evaluate the alternatives.

Step 6, Select a Decision-Making Tool

The method selection needs to be based on the complexity of the problem and the experience of the team. Generally, the simpler the method, the better. More complex analyses can be added later if needed. Some of these methods can be complicated and difficult to apply. The Guidebook introduces and describes these widely employed tools:

- Pros and Cons Analysis
- Kepner-Tregoe Decision Analysis (K-T)
- Analytic Hierarchy Process (AHP)
- Multi-Attribute Utility Theory Analysis (MAUT)
- Cost Benefit Analysis (CBA)
- Custom Tailored Tools

Step 7, Evaluate Alternatives against Criteria

Alternatives can be evaluated with quantitative methods, qualitative methods, or any combination. Criteria can be weighted and used to rank the alternatives. Both sensitivity and uncertainty analyses can be used to improve the quality of the selection process. Experienced analysts can provide the necessary thorough understanding of the mechanics of the chosen decision-making methodology.

Step 8, Validate Solution(s) against Problem Statement

After the evaluation process has selected a preferred alternative, the solution should be checked to ensure that it truly solves the problem identified. Compare the original problem statement to the goals and requirements. A final solution should fulfill the desired state, meet requirements, and best achieve the goals within the values of the decision makers. Once the preferred alternative has been validated, the decision-making support staff can present it as a recommendation to the decision-maker(s). A final report to the decision-maker(s) must be written documenting the decision process, assumptions, methods, and conclusions recommending the final solution.

DECISION MAKING METHODS

Decision Analysis techniques are rational processes/systematic procedures for applying critical thinking to information, data, and experience in order to make a balanced decision when the choice between alternatives is unclear. They provide organized ways of applying critical thinking skills developed around accumulating answers to questions about the problem. Steps include clarifying purpose, evaluating alternatives, assessing risks and benefits, and making a decision. These steps usually involve scoring criteria and alternatives. This scoring (a systematic method for handling and communicating information) provides a common language and approach that removes decision making from the realm of personal preference or idiosyncratic behavior.

The evaluation methods introduced here are highly recommended. They are adaptable to many situations, as determined by the complexity of the problem, needs of the customer, experience of the decision team/analysts/facilitators, and the time and resources available. No one decision-making method is appropriate for all decisions.

Pros and Cons Analysis

Pros and Cons Analysis is a qualitative comparison method in which good things (pros) and bad things (cons) are identified about each alternative. Lists of the pros and cons, based on the input of subject matter experts, are compared one to another for each alternative. The alternative with the strongest pros and weakest cons is preferred.

In September, 1772, Benjamin Franklin wrote to Joseph Priestly, "In the Affair of so much Importance to you, wherein you ask my Advice, I cannot for want of sufficient Premises, advise you what to determine, but if you please I will tell you how. When those difficult Cases occur, they are difficult, chiefly because while we have them under Consideration, all the Reasons pro and con are not present to the Mind at the same time; but sometimes one Set present themselves, and at other times another, the first being out of Sight. Hence the various Purposes or Inclinations that alternately prevail, and the Uncertainty that perplexes us.

To get over this, my Way is, to divide half a Sheet of Paper by a Line into two Columns; writing over the one Pro, and over the other Con. Then during three or four Days Consideration, I put down under the different Heads short Hints of the different Motives, that at different Times occur to me, for or against the Measure. When I have thus got them all together in one View, I endeavor to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a Reason pro equal to some two Reasons con, I strike out the three. If I judge some two Reasons con, equal to some three Reasons pro, I strike out the five; and thus proceeding I find at length where the Balance lies; and if after a Day or two of farther consideration, nothing new that is of Importance occurs on either side, I come to a Determination accordingly. And, tho' the Weight of Reasons cannot be taken with the Precision of Algebraic Quantities, yet, when each is thus considered, separately and comparatively, and the whole lies before me, I think I can judge better, and am less liable to make a rash Step; and in fact I have found great Advantage from this kind of Equation, in what may be called Moral or Prudential Algebra."

Pros and Cons Analysis is suitable for simple decisions with few alternatives (2 to 4) and few discriminating criteria (1 to 5) of approximately equal value. It requires no mathematical skill and can be implemented rapidly. The decision documentation should include an exposition, which justifies why the preferred alternative's pros are more important and its cons are less consequential than those of the other alternatives.

Kepner-Tregoe (K-T) Decision Analysis

K-T is a quantitative comparison method in which a team of experts numerically score criteria and alternatives based on individual judgements/assessments. The size of the team needed tends to be inversely proportional to the quality of the data available – the more intangible and qualitative the data, the greater the number of people that should be involved.

In K-T parlance each evaluation criterion is first scored based on its relative importance to the other criteria (1 = least; 10 = most). These scores become the *criteria weights*. "Once the WANT objectives [have] been identified, each one [is] weighted according to its relative importance. The *most* important objective [is] identified and given a weight of 10. All other objectives [are] then weighted in comparison with the first, from 10 (equally important) down to a possible 1 (not very important). When the time comes to evaluate the alternatives, we do so by assessing them *relative to each other* against all WANT objectives – one at a time."

The alternatives are scored individually against each of the criteria based on their relative performance. "We give a score of 10 to the alternative that comes *closest* to meeting the objective, and score the other alternatives *relative to it*. It is not an ideal that we seek through this comparative evaluation. What we seek is an answer to the question: 'Of these (real and attainable) alternatives, which best fulfills the objective?'"

A total score is determined for each alternative by multiplying its score for each criterion by the criterion weights (relative weighting factor for each criterion) and then summing across all criteria. The preferred alternative will have the highest total score.

K-T Decision Analysis is suitable for moderately complex decisions involving a few criteria. The method requires only basic arithmetic. Its main disadvantage is that it may not be clear how much better a score of "10" is than a score of "8", for example. Moreover, total alternative scores may be close together, making a clear choice difficult.

Analytic Hierarchy Process (AHP)

AHP is a quantitative comparison method used to select a preferred alternative by using pair-wise comparisons of the alternatives based on their relative performance against the criteria. "The Analytic Hierarchy Process is a systematic procedure for representing the elements of any problem, hierarchically. It organizes the basic rationality by breaking down a problem into its smaller and smaller constituent parts and then guides decision makers through a series of pairwise comparison judgements (which are documented and can be reexamined) to express the relative strength or intensity of impact of the elements in the hierarchy. These judgements are then translated to numbers (ratio scale estimates). The AHP includes procedures and principles used to synthesize the many judgements to derive priorities among criteria and subsequently for alternative solutions."

Alternatives and criteria are scored using a pair-wise comparison method and mathematics. The pair-wise comparisons are made using a nine-point scale:

1 = Equal importance or preference
3 = Moderate importance or preference of one over another
5 = Strong or essential importance or preference
7 = Very strong or demonstrated importance or preference
9 = Extreme importance or preference

Matrices are developed wherein each criterion/alternative is compared against the others. If Criterion A is strongly more important compared to Criterion B (i.e. a value of "5"), then Criterion B has a value of 1/5 compared to Criterion A. Thus, for each comparative score given, the reciprocal is awarded to the opposite relationship. The "priority vector" (i.e. the normalized weight) is calculated for each criterion using the geometric mean of each row in the matrix divided by the sum of the geometric means of all the criteria. The geometric mean is the nth root of the product of n scores. Thus, the geometric mean of the scores: 1, 2, 3, and 10 is the fourth root of (1 x 2 x 3 x 10), which is the fourth root of 60. $(60)^{1/4} = 2.78$. The geometric mean is less affected by extreme values than is the arithmetic mean. It is useful as a measure of central tendency for some positively skewed distributions. This process is then repeated for the alternatives comparing them one to another to determine their relative value/importance for each criterion (i.e. determine the normalized alternative score). The calculations are easily set up in a spreadsheet, and commercial software packages are available.

HINT: The order of comparison can help simplify this process. Try to identify and begin with the most important criterion and work through the criteria to the least important. When comparing alternatives try to identify and begin with the one with the greatest benefits for each associated criterion.

To identify the preferred alternative multiply each normalized alternative score by the corresponding normalized criterion weight, and sum the results for all of an alternatives criteria. The preferred alternative will have the highest total score.

AHP, like other methods, can rank alternatives according to quantitative or qualitative (subjective) data. Qualitative/subjective criteria are based on the evaluation team's feelings or perceptions about how an alternative ranks. The criteria weights and alternative comparisons are combined in the decision synthesis to give the relative value (ratio/score) for each alternative for the prescribed decision context. A sensitivity analysis can be performed to determine how the alternative selection would change with different criteria weights. The whole process can be repeated and revised, until everyone is satisfied that all the important features needed to solve the problem, or select the preferred alternative, have been covered.

AHP is a useful technique when there are multiple criteria since most people cannot deal with more than seven decision considerations at a time. AHP is suitable for decisions with both quantitative and qualitative criteria. It puts them in the same decision context. It facilitates discussion of the importance of criteria and the ability of each alternative to meet the criteria. Its greatest strength is the analytical hierarchy that provides a structured model of the problem, mimicking the way people generally approach complex situations. Another strength is its systematic use of the geometric mean to define functional utilities based on simple comparisons and to provide consistent, meaningful results. The size of AHP matrices make this method somewhat less flexible than either K-T or MAUT when newly discovered alternatives or criteria need to be considered. Commercially available software, however, can reduce this burden and facilitate the whole process. Although software is not required for implementation, it can be helpful especially if a large number of alternatives (>8), or criteria (>5) must be considered.

Multi-Attribute Utility Theory (MAUT)

MAUT is a quantitative comparison method used to combine dissimilar measures of costs, risks, and benefits, along with individual and stakeholder preferences into high-level, aggregated preferences. The foundation of MAUT is the use of utility functions. Utility functions transform diverse criteria to one common, dimensionless scale (0 to 1) known as the multi-attribute "utility". Once utility functions are created an alternative's raw data (objective) or the analyst's beliefs (subjective) can be converted to utility scores. As with the other methods, the criteria are weighted according to importance. To identify the preferred alternative multiply each normalized alternative's utility score by its corresponding criterion weight, and sum the results for all of an alternatives criteria. The preferred alternative will have the highest total score.

Utility functions (and MAUT) are typically used, when quantitative information is known about each alternative, which can result in firmer estimates of the alternative performance. Utility graphs are created based on the data for each criterion. Every decision criterion has a utility function created for it. The utility functions transform an alternative's raw score (i.e. dimensioned – feet, pounds, gallons per minute, dollars, etc.) to a dimensionless utility score, between 0 and 1. The utility scores are weighted by multiplying the utility score by the weight of the decision criterion, which reflects the decision-making support staff's and decision-maker's values, and totaled for each alternative. The total scores indicate the ranking for the alternatives.

The MAUT evaluation method is suitable for complex decisions with multiple criteria and many alternatives. Additional alternatives can be readily added to a MAUT analysis, provided they have data available to determine the utility from the utility graphs. Once the utility functions have been developed, any number of alternatives can be scored against them.

Simple Multi Attribute Rating Technique (SMART)

SMART can be a useful variant of the MAUT method. This method utilizes *simple* utility relationships. Data normalization to define the MAUT/SMART utility functions can be performed using any convenient scale. Five, seven, and ten point scales are the most commonly used. In a classical MAUT the full range of the scoring scale would be used even when there was no real difference between alternatives scores. The SMART methodology allows for use of less of the scale range if the data does not discriminate adequately so that, for example, alternatives which are not significantly different for a particular criterion can be scored equally. This is particularly important when confidence in the differences in data is low. In these cases, less of the range is used to ensure that low confidence data differences do not present unwarranted large discriminations between the alternatives. When actual numerical data are unavailable, subjective reasoning, opinions, and/or consensus scoring can be substituted and documented in the final report instead. Research has demonstrated that simplified MAUT decision analysis methods are robust and replicate decisions made from more complex MAUT analysis with a high degree of confidence.

Cost-Benefit Analysis

Cost-Benefit Analysis is "a systematic quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects." CBA is a good approach when the primary basis for making decisions is the monetary cost vs. monetary benefit of the alternatives, or when the Cost-Benefit measurement is used as a criterion in other, more general decision support approaches. General guidance for conducting cost-benefit and cost-effectiveness analyses is provided in the U.S. Office of Management and Budget, OMB Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. The discount rates for this methodology are updated annually by the OMB.

The standard criterion for deciding whether a government program can be justified on economic principles is net present value -- the discounted monetized value of expected net benefits (i.e., benefits minus costs). Net present value is computed by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement. Programs with positive net present value increase social resources and are generally preferred. Programs with negative net present value should generally be avoided. When "benefits" and "costs" can be quantified in dollar terms (as, for example avoided cost) over several years, these benefits can be subtracted from the costs (or dollar outlays) and the present value of the benefit calculated. "Both intangible and tangible benefits and costs should be recognized. The relevant cost concept is broader than the private-sector production and compliance cost or government cash expenditures. Costs should reflect opportunity cost of any resources used, measured by the return to those resources in their most productive application elsewhere." The alternative returning the largest discounted benefit is preferred.

In Pros and Cons analysis cost is regarded intuitively along with the other advantages and disadvantages ("high cost" is a con; "low cost" is a pro). The other techniques provide numerical ranking of alternatives based on intangible (i.e. unable to be quantified in dollar terms) benefits.

Custom Tailored Tools

Customized tools may be needed to help understand complex behavior within a system. Very complex methods can be used to give straightforward results. Because custom-tailored tools are not off-the-shelf, they can require significant time and resources for development. If a decision cannot be made using the tools described previously, or the decision must be made many times employing the same kinds of considerations, the decision-making support staff should consider employing specialists with experience in computer modeling and decision analysis to develop a custom-tailored tool.

FIELD APPLICATIONS

The *Unallocated Off-Specification HEU: Recommendations for Disposition* employed the Analytic Hierarchy Process (AHP) to rank 26 different disposition paths against decision criteria to support its final disposition recommendations. In the *HLW Salt Disposition Alternatives Identification* AHP was used to down select from a multitude of potential alternatives to three final alternatives. The Simple Multi Attribute Rating Technique (SMART), a variant of Multi-Attribute Utility Theory Analysis (MAUT), was then used to select the final alternative. Both the *INEEL HLW and Facilities Dispositioning* and the *Cesium-Strontium (Cs/Sr) Management Alternatives Trade Study* employed the Guidebook process and methodologies to evaluate and report their efforts.

Each of these studies demonstrates both the defensibility and clarity of understanding obtainable when a consistent process combined with an appropriate decision tool is employed by knowledgeable analysts.

CONCLUSION

A team of DOE managers and subject-matter experts from around the Complex was used to implement Recommendation 14 of the INMMP. Their assignment was to select or develop a decision-support tool for use by the INMM Program. The team considered the kinds of decisions likely to be made in the INMM Program, examined existing decision-support methods and tools and their applicability, discussed the circumstances in which each tool might be useful, and studied examples of the application of each tool. The team determined that the decision-support method or tool needed at any given time depends on the decision to be made, the experience level of the decision makers and support staff involved, and the goals and criteria identified during the decision making process. The team developed a Guidebook that provides a consistent, clear, defensible, and transparent decision process. It provides proven decision methods/tools, examples, aids, and supporting references to guide decision-support staff.

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