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Standard Practice for
Prioritizing Asset Resources in Acquisition, Utilization, and Disposition[1]

INTRODUCTION

Identifying assets that are most critical to a mission or practice is challenging for most entities. The ability of an entity to minimize the gap between its asset portfolio and ever-changing missions often determines its success or failure in achieving its objectives. The goal of this practice is to provide managers with a disciplined, quantitative approach to an inherently subjective decision-making process: determining which assets are critical to an entity's mission and are therefore deserving of priority attention or funding.

1. Scope

1.1 The asset priority index (API) establishes a quantitative process for prioritizing asset resources in acquisition, utilization, and disposition.

1.2 In addition to the applicability of moveable and durable assets as defined in this practice, this methodology is similarly used in the analysis of investments in buildings and building systems (see Practice E1765).

1.3 *This practice offers instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is neither intended to represent nor replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM International consensus process.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1765 Practice for Applying Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Projects, Products, and Processes

E2135 Terminology for Property and Asset Management

E2811 Practice for Management of Low Risk Property (LRP)

3. Terminology

3.1 *Definitions:*

3.1.1 *asset priority index (API), n*—numerical value assigned to an asset reflecting its value to an entity's mission or other critical assignments as defined by the criteria set forth by management.

3.1.2 *analytical hierarchy process (AHP), n*—decision-making model that reduces complex decisions to one-on-one comparisons resulting in the ranking of a list of objectives or alternatives. **Satty, 1994**[3]

3.1.3 *inconsistency measure, n*—inconsistent scoring within a square matrix (the same number of columns and rows, see the example in Appendix X1, Table X1.3) using a predefined interval scale, for example, rating all comparisons high thus disturbing the logic of the matrix.

3.1.4 *interval scale, n*—standard survey rating scale, based on real numbers, in which distances between data points are meaningful.

3.1.4.1 *Discussion*—Interval scales have no true zero point so it is not possible to make statements about how many times higher one score is than another.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *asset portfolio, n*—assets that are within the scope of the asset management system.

4. Summary of Practice

4.1 Asset prioritization relies on the analytical hierarchy process (AHP) that provides managers with the quantitative information needed to select the best alternative or to rank/prioritize a set of alternatives.

4.1.1 AHP uses pair-wise comparison matrices (see the example in Appendix X1, Table X1.3) with judgment measurements from a predefined survey scale to derive weights for the management-defined criteria used to evaluate assets.

4.1.2 AHP pair-wise comparison matrices provide the criteria used in the asset prioritization methodology for ranking assets. (This practice can be used to categorize assets according to Terminology E2135 and Practice E2811.)

4.2 The asset prioritizing methodology follows six discrete steps:

4.2.1 Step 1: Develop a set of critical criteria that answer the prioritizing question (whether it is mission alignment, security requirements, and so forth). The criteria must be mutually exclusive and collectively exhaustive, that is, the criteria must address the most important decision-making factors without overlap.

4.2.2 Step 2: Create an interval survey scale to score the criteria.

4.2.3 Step 3: Assign weights to the criteria based on a predefined scale of judgment or ratio measurements using the AHP.

4.2.4 Step 4: Create scoring guidelines for subject matter experts (SME)s (preferably based on an interval scale with sufficient definition to support a wide gradation) so that the scorers can evaluate assets according to the management-defined criteria.

4.2.5 Step 5: Evaluate each asset according to each critical criterion based on scoring guidelines.

4.2.6 Step 6: Calculate an API based on the criteria weights and scoring guidelines.

4.3 If this method is to be applied to an entire asset portfolio, a pilot study must be conducted on a representative sample of assets to determine if enhancements are needed to interval scales and scoring guidelines. The entire asset portfolio should only be scored after a prioritizing framework is established.

5. Significance and Use

5.1 The API is a metric used to communicate the relative importance of assets in terms of mission criticality, security, or other measures important to the entity. It establishes a basis for evaluating prioritization of asset resources.

5.2 API offers a method for ranking assets based on judgment/importance factors defined by the entity, creating information to prioritize investments, security strategies, and disposition plans.

5.3 API provides a quantitative basis for determining and documenting operational relationships between an asset portfolio and entity capital investment strategies, maintenance approaches, security design and analyses, continuity of business/risk analyses, and disposition decisions.

5.4 The API enables entities to identify critical assets and allocate resources appropriately.

5.5 The API model is designed to be applicable and appropriate for entities holding assets with a material impact on the entity's mission.

6. Applicability

6.1 This practice may be applied to the entire asset portfolio of an entity or any subset in which identifying best alternatives or prioritizing a set of alternatives is imperative.

6.2 This practice may be applied to a variety of scenarios because the criteria used to evaluate assets are selected by the entity and are dependent on mission and the situational study.

6.3 The API for a portfolio can be plotted against condition or security assessments to arrive at an investment, disposition, or other business strategy.

7. Procedure

7.1 The API criteria an entity selects must reflect the overall mission goals that the assets are to support. Criteria selection is usually a management function but must *(1)* enjoy a consensus; *(2)* be well defined to facilitate scoring; *(3)* be mutually exclusive (definitions must not overlap); and *(4)* be collectively exhaustive, that is, effectively cover criteria that will allow the assets to support the entity's mission goals. Examples of API criteria include mission support, interchangeability, interruptability, reliability, exclusivity, and asset potential future need.

7.2 Weights must be assigned to each element based on importance.

7.2.1 Weights are generated by evaluating the criteria on a predetermined interval scale that reflects the importance of the asset to the mission.

7.2.2 Results of the evaluation are placed in a square matrix (the same number of columns and rows) to calculate criteria weights (see the example in Appendix X1, Table X1.3).

7.3 To score assets against each criterion, a detailed interval scale must be developed. Normally, entity SMEs are well positioned to create an asset scoring guide to ensure a valid and reliable method. This scoring guide must define each criterion, including its weight, and provide a clear explanation of each interval of the scale, for example, very important through very unimportant for each criterion. Specific asset examples from the entity's asset portfolio may be used to aid in this process.

7.4 Once the API criteria, weights, and scoring guidance are developed, it is prudent to pilot the framework on a representative sample of assets if the intent is to use the methodology on the entity's entire asset portfolio. Additions to criteria or refinement of the interval scale may be required based on feedback received from participants and observations made

during the scoring session pilots because many factors affecting the analysis can arise such as geographic or security considerations.

7.5 Management must decide on the correct population to designate as scorers. In some instances, only SMEs are an appropriate choice. In other instances, other stakeholders may be assigned as scorers. Once the API criteria framework (criteria, weights, and scoring guidance) has been finalized, SMEs or other stakeholders score the entity's assets and determine their API. The preferred method is to have all scorers physically present and to score assets one by one against each API criterion. This method typically returns lower inconsistency measures and tends to receive higher credibility throughout the entity.

7.6 For simple studies with a small number of comparisons, the example in Appendix X1 will assist in understanding how to calculate AHP. For larger more sophisticated studies, there are many AHP heuristic software packages available to assist with the calculations. The mathematical variations on this technique are numerous.

8. Analytical Measures

8.1 Create a definitive list of criteria to evaluate assets against a project or entity mission (see Table X1.3).

8.2 Devise an interval scale for weighing the criteria providing a definitive range that indicates a degree of difference between the intervals (such as "absolutely important" through "unimportant") (see Table X1.5).

8.3 Calculate weights for each pair-wise comparison using the AHP (see Table X1.3).

8.4 Devise criterion-unique interval scales to provide SMEs/stakeholders who are scoring assets a definitive range that indicate a degree of difference between the intervals (such as "very high" through "very low") (see Table X1.7, Table X1.9, and Table X1.10).

8.5 Evaluate each asset against each criterion using the interval scale and criterion-unique interval scales (see Table X1.5, Table X1.7, Table X1.9, and Table X1.10).

8.6 API for each asset is calculated and equals the sum of the products of the criteria weights and the asset item rank per criterion (see Table X1.10).

8.7 The resulting rank provides quantitative information to use in process decision making.

9. Keywords

9.1 AHP; analytical hierarchy process; API; asset management; asset portfolio; asset priority; assets; equipment; equipment management; property; tangible assets

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE 1: IDENTIFYING CAPITAL ASSETS THAT SUPPORT THE CORE/PRIORITY MISSIONS OF AN ENTITY

X1.1 Evaluation—Laboratory Assets 1, 2, and 3 are to be evaluated for alignment with the entity's mission. In this example, the following considerations have been established for evaluation: *(1)* the ability of the asset to support advanced technology research, *(2)* the exclusivity of the asset, and *(3)* its ability to meet future needs. Scoring was completed by using the interval scale of importance.

X1.2 Simplified Steps: The following steps can be followed in evaluating the asset alternatives:

X1.2.1 *Step 1: Choose the Evaluation Criteria*—See Table X1.1.

X1.2.2 *Step 2: Design an Evaluation Scale*—The scale shown in Table X1.2 displays the interval scale designed to determine how important each criterion is to the evaluation of an asset.

TABLE X1.2 Interval Scale for Scoring Management-Defined Criteria in Table X1.1

Intervals and Descriptions
In a reciprocal matrix, unity or 1 = of equal importance
2 = of very weak importance
3 = of weak importance
4 = of importance
5 = of strong importance
6 = of very strong importance
7 = absolute importance

X1.2.3 *Step 3: Apply the Analytical Hierarchy Process (AHP) Method to Determine Criteria Weights:*

X1.2.3.1 Convert the criteria considerations into pair-wise comparisons as shown in Table X1.1, that considers advanced technology versus exclusivity, advanced technology versus future needs, and exclusivity versus future needs (Table X1.3). (Assume that the scores given are the average of all scorers polled). Notice the nature of pair-wise comparisons in this example. When advanced technology compared to exclusivity is scored 4, then by default the opposite comparison, that is, exclusivity compared to advanced technology equals ¼. The logic is that if advanced technology scores high with respect to exclusivity, then conversely, when the same scorer scores exclusivity versus advanced technology, the result will be the

TABLE X1.1 Criteria for Evaluating Laboratory Equipment with Respect to Mission

Criteria
Advanced Technology
Exclusivity
Future Needs

TABLE X1.3 Computing Relative Weights for Asset Evaluation Criteria

	Advanced Technology	Exclusivity	Future Needs	Geometric Mean	Normalized Weights, %
Advanced technology	1	4	7	3.037	70.5
Exclusivity	¼	1	3	0.909	21.1
Future needs	⅐	⅓	1	0.362	8.4
Sum				4.308	100

TABLE X1.4 Interval Scale for Evaluating Laboratory Assets with Respect to Advanced Technology Research

Description: Rate the asset's ability to support the entity's requirement for advanced technology research
Criterion Weight = 70.5 %

Scoring	Definitions
1.0 Very high	Asset is critical to cutting edge research
0.8 High	Asset directly supports cutting edge research projects
0.6 Medium	Asset can support some of the entity's cutting-edge projects
0.4 Low	Asset can deliver marginal support to advanced research
0.2 Very low	Asset does not support cutting edge research

reciprocal or a low score).[4] (Note that each criterion scored against itself equals one.) The AHP uses pair-wise comparisons to generate a weight for each alternative so that the alternatives can be ranked. Scoring shows that the entity is very concerned about the ability of the laboratory equipment items to support advanced technology research (advanced technology versus exclusivity equals four and versus future needs equals seven (shaded)) and is less concerned about the exclusivity of the item (exclusivity versus future need equals three). In this example, scoring shows that management is least concerned about the ability of equipment to meet future needs. (Note that when the future needs criterion is compared against advanced technology or exclusivity, the pair-wise comparisons is less than one.)

X1.2.3.2 *Mathematical Calculations Required to Arrive at Normalized Criteria Weights:*

$$\text{Advanced technology} = \sqrt[3]{1 \times 4 \times 7}$$
$$= 3.037/4.308$$
$$= 0.705 \times 100 \qquad \text{(X1.1)}$$
$$= 70.5\%.$$

$$\text{Exclusivity} = \sqrt[3]{1/4 \times 1 \times 3}$$
$$= 9.09/4.308$$
$$= 0.211 \times 100 \qquad \text{(X1.2)}$$
$$= 21.1\%.$$

$$\text{Future needs} = \sqrt[3]{1/7 \times 1/3 \times 1}$$
$$= 0.362/4.308$$
$$= 0.084 \times 100 \qquad \text{(X1.3)}$$
$$= 8.4\%.$$

X1.2.4 *Step 4: Design the Scoring Scales for Each Evaluation Criterion Defined in Step 1*—After management has defined the importance or weight of each criterion in the decision-making process, consider each asset with respect to each criterion by using a predetermined scale such as demonstrated in Table X1.4. (Assume the scores given are the average of all scorers polled.)

X1.2.5 *Step 5: Rank Each Asset (to be Accomplished by Scorer)*—Use the scoring scales for each evaluation criterion identified in Step 1 and the criteria weights developed in Step 3. See Table X1.5.

TABLE X1.5 SME Evaluation of Laboratory Assets Using Table X1.4 Interval Scale

	Advanced Technology Weight	SME Evaluation	Advanced Technology Rating
Lab equipment 1	0.705	0.8	0.564
Lab equipment 2	0.705	1	0.705
Lab equipment 3	0.705	0.4	0.282

X1.2.5.1 *Mathematical Calculations Required to Arrive at Criteria-Specific Asset Ratings:*

$$\text{Advanced technology rating} = (\text{Advanced technology weight}) \qquad \text{(X1.4)}$$
$$*(\text{scorer evaluation per interval scale})$$

$$\text{Lab equipment 1} = (0.705)(0.8) = 0.564 \qquad \text{(X1.5)}$$
$$\text{Lab equipment 2} = (0.705)(1) = 0.705 \qquad \text{(X1.6)}$$
$$\text{Lab equipment 3} = (0.705)(0.4) = 0.282 \qquad \text{(X1.7)}$$

X1.2.6 *Repeat Steps 4 and 5*—See Table X1.6 and Table X1.7.

X1.2.6.1 Mathematical calculations required to arrive at a criterion-specific rating follow the same technique as in Table X1.5.

X1.2.7 *Repeat Steps 4 and 5*—See Table X1.8 and Table X1.9.

X1.2.7.1 Mathematical calculations required to arrive at normalized weights for pair-wise comparison of lab equipment items with respect to the future needs criteria will follow the same technique as in Table X1.5.

TABLE X1.6 Interval Scale for Evaluating Laboratory Assets with Respect to Exclusivity

Description: Rate the degree to which an alternative asset could be used in place of the asset being evaluated.
Criterion Weight = 21.1 %

Scoring	Definitions
1.0 = Very high	Asset is unique and with no viable alternatives.
0.8 = High	Alternatives would require cumbersome and costly processes be used.
0.6 = Medium	Alternatives exist.
0.4 = Low	Using an alternative would have marginal impacts on the bottom line.
0.2 = Very low	Using an alternative would have no bottom line impacts.

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[4] Paired comparisons in the AHP are given in terms of consistent and near consistent matrices. Although substantial inconsistencies can arise and additional mathematical calculations are available to address them, this standard will not speak to this issue as heuristic software is available to the practitioner for a higher number of criteria.