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

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INTRODUCTION

Identifying assets that are most critical to a mission or practice is challenging for most business entities. The ability of a business entity to minimize the gap between its asset portfolio and ever-changing organizational missions often determines its success or failure in achieving designed 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 designated mission and are therefore deserving of priority attention or funding.

1. Scope

1.1 ~~This practice establishes a quantitative process, an~~ The asset priority index ~~(API),~~ (API) establishes aquantitativee process for prioritizing asset resources in acquisition, utilization, and disposition to provide ~~managers~~entities with a ~~method~~ proven methodology to prioritize asset ~~resources based on predefined criteria.~~resources.

1.2 The API is a metric used to communicate the relative importance of equipment in terms of mission criticality, security, or other measures important to the business entity. It offers a method for ranking assets based on judgment/importance factors defined by the organization, creating information to justify compelling arguments for investment, security strategies, and disposition plans.

1.3 The API ~~has a wide range of applications including, but not limited to, use as a basis for~~ also provides a quantitative basis for determining and documenting operational relationships between an asset portfolio and business objectives capital investment strategies, ~~deferred~~ maintenance approaches, security design and analyses, continuity of business/risk analyses, and disposition decisions.

1.4 The API enables management to identify critical assets and allocate resources appropriately.

1.5 The API model is designed to be applicable and appropriate for entities holding equipment ~~designated as capital assets.~~with a material impact on the entity's mission.

1.6 In addition to the applicability of moveable and durable assets as defined in this practice, this methodology ~~may in whole or in part be effectively applied to intangible~~is similarly used in the analysis of investments in buildings and building systems (see Practice E1765~~property, real property, and materiel.~~).

1.7 *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 or 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

[1] This practice is under the jurisdiction of ASTM Committee E53 on Property Management Systems and is the direct responsibility of Subcommittee E53.05 on Property Management Maturity.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

E1765 Practice for Applying Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems
E2135 Terminology for Property and Asset Management
~~E2219~~E2811 Practice for ~~Valuation and~~ Management of ~~Moveable, Durable~~Low Risk Property (LRP) ~~(Withdrawn 2009)~~
~~E2220 Practice for Establishing the Full Valuation of the Loss/Overage Population Identified During the Inventory of Moveable, Durable Property (Withdrawn 2009)[3]~~
~~E2221 Practice for Administrative Control of Property (Withdrawn 2011)[3]~~

3. Terminology

3.1 *Definitions:*

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

3.1.2 *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.

3.2 ~~*Definitions:*~~*Definitions of Terms Specific to This Standard:*

3.2.1 *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]**

~~3.1.2 *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.~~

~~3.1.3 *entity, n*—agency, company, organization, or institution.~~

~~3.1.4 *equipment, n*—nonexpendable, tangible, moveable property needed for the performance of a task or useful in effecting an obligation. **(E2135)**~~

~~3.1.5 *equipment management, n*—systematic planning and control of equipment to optimize its service delivery potential; the management of associated risks and costs throughout its lifecycle in support of organizational objectives; the process management and operations of acquisition or construction of the equipment and its use, maintenance, and modification and its disposal when no longer required.~~

3.2.2 *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.

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

[3] ~~Satty, T.L., *Fundamentals of Decision Making and Priority Theory* , RWS Publications, 4922 Ellsworth Ave., Pittsburgh, PA 15213, 1994.~~ Satty, T.L., *Fundamentals of Decision Making and Priority Theory*, Pittsburgh, PA: RWS Publications, 1994.

3.2.3.1 *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.

3.3 *Acronyms:*

~~*AHP* = Analytical hierarchy process~~
~~*API* = Asset priority index~~
~~*SME* = Subject matter expert~~

AHP = Analytical Hierarchy Process
API = Asset Priority Index
ECM = Equipment Control Matrix
LRP = Low Risk Property
SME = Subject Matter Expert

4. Summary of Practice

4.1 Asset prioritizing relies on the analytical hierarchy process (AHP), a proven decision-making aid, 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~~ used, for example, to categorize assets according to Practices ~~E2219~~E2135, ~~and~~ ~~E2220~~E2811, ~~and E2221~~.)

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 shall be mutually exclusive and collectively exhaustive, that is, the criteria shall address the most important decision-making factors without overlap.

4.2.2 Step 2: Create an interval survey scale by which the criteria can be scored.

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 ~~may~~ can evaluate assets per 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 Should the practitioner wish to apply this method to an entire asset portfolio, a pilot study shall 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.

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

5. Significance and Use

5.1 The API is a metric used to communicate the relative importance of equipment in terms of mission criticality, security, or other measures important to the business entity. It offers a method for ranking assets based on judgment/importance factors defined by the organization, creating information to justify compelling arguments for investment, security strategies, and disposition plans.

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

5.3 It enables management to identify critical assets and allocate resources appropriately and should therefore be an integral process in equipment management.

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

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

7.2 Because the importance of each criterion element is usually not equal, weights must be assigned to each element according to the input of management.

7.2.1 Weights are generated by requiring managers to evaluate the criteria on a predetermined interval scale that reflects the importance of the criteria.

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 shall be developed. Normally, organizational SMEs are well positioned to create an asset scoring guide to ensure a valid and reliable method. This scoring guide shall 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. Management may provide scorers with specific asset examples from the organization's asset portfolio 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 organization'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 shall 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 criteria. This method typically returns lower inconsistency measures and tends to receive higher credibility throughout the ~~organization.~~entity.

7.6 For simple studies with a small number of comparisons, the example in Appendix X1 will suffice 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 endless and numerous.

8. Analytical Measures

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

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

8.3 Weights for each criterion are calculated by management's pair-wise comparisons using the AHP (see Table X1.3).

8.4 The practitioner devises criterion unique interval scales to give those SMEs/stakeholders who are scoring assets a definitive range that indicates 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 SMEs or other stakeholders 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 management with quantitative information to use in business 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 A BUSINESS ENTITY

X1.1 Evaluation—Laboratory Assets 1, 2, and 3 are to be evaluated for alignment with the business entity's mission. In this example, management has established the following considerations for evaluation: *(1)* the ability of the equipment item to support advanced technology research, *(2)* the exclusivity of the item, 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.

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

Criteria
Advanced Technology
Exclusivity
Future Needs

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

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

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.

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

X1.2.3.1 Management converted 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). (You can 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 the SME scores advanced technology high with respect to exclusivity, then conversely, when the same SME scores exclusivity versus advanced technology, the result will be the 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 management 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:*

$$\begin{aligned}\text{Advanced technology} &= \sqrt[3]{1\times4\times7}\\ &= 3.037/4.308\\ &= 0.705\times100\\ &= 70.5\,\%.\end{aligned} \tag{X1.1}$$

$$\begin{aligned}\text{Exclusivity} &= \sqrt[3]{1/4\times1\times3}\\ &= 9.09/4.308\\ &= 0.211\times100\\ &= 21.1\,\%.\end{aligned} \tag{X1.2}$$

$$\begin{aligned}\text{Future needs} &= \sqrt[3]{1/7\times1/3\times1}\\ &= 0.362/4.308\\ &= 0.084\times100\\ &= 8.4\,\%.\end{aligned} \tag{X1.3}$$

[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.

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 criteria in the decision-making process, the subject matter experts (SMEs) consider each asset with respect to each criterion by using a predetermined scale such as demonstrated in Table X1.4. (You can assume the scores given are the average of all SMEs polled.)

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

X1.2.5.1 *Mathematical Calculations Required To Arrive At Criteria Specific Asset Ratings:*

$$\text{Advanced technology rating} = (\text{Advanced technology weight}) \quad \text{(X1.4)}$$

$$*(\text{SME evaluation per interval scale})$$

$$\text{Lab equipment 1} = (0.705)\,(0.8) = 0.564 \quad \text{(X1.5)}$$

$$\text{Lab equipment 2} = (0.705)\,(1) = 0.705 \quad \text{(X1.6)}$$

$$\text{Lab equipment 3} = (0.705)\,(0.4) = 0.282 \quad \text{(X1.7)}$$

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.

X1.2.8 *Step 6: Calculate the Asset Priority Index from the Rankings in Step 5:*

$$\text{API} = (\text{Advanced Technology Rating}) \quad \text{(X1.8)}$$

$$+(\text{Exclusivity Rating})+(\text{Future Need Rating})$$

X1.2.8.1 The API synthesis for this example given in Table X1.10 ranks how well the lab equipment in this subset would support the entity's needs with respect to the three criteria established by management. Lab equipment 2 is the highest ranked at 0.924, Lab equipment 1 is second at 0.725, and Lab equipment 3 is a distant third at 0.493.

X1.2.8.2 In this example, the rankings were used to align assets with the mission according to the chosen criteria; however, this example demonstrates that rankings could be used for a myriad of purposes such as implementation of investment strategies or disposition plans.

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

Description: Rate the asset's ability to support to 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