Accepted for publication in Levine, Harvey A., Editor, *Project Portfolio Management: A Practical Guide to Selecting and Prioritizing Projects*, Jossey-Bass, July 2005. Chapter 4-3 - Using the Analytic Hierarchy Process to Improve Enterprise PPM - Devlin Final 12-15-04.doc

Chapter 4.3 Using the Analytic Hierarchy Process to Improve Enterprise Project Portfolio Management

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The Analytic Hierarchy Process (AHP) is a powerful and flexible methodology that improves project portfolio management (PPM) decisions in both commercial and government settings. Using AHP helps decision makers to think clearly about complex portfolio decisions, to reach consensus on project priorities, and to measure portfolio performance. Combined with advanced optimization techniques, the AHP can help a team ensure they are allocating their scarce resources to the best portfolio of projects possible. For nearly 30 years, decision makers around the globe have successfully relied on the AHP for important decisions. Over the last decade, with advances in software and hardware technology, the AHP has become an increasingly desirable methodology for ensuring optimal portfolio alignment and value, and for ensuring that the organizational culture survives through the process.

Background on the AHP

The AHP methodology was invented by Dr. Thomas L. Saaty in the 1970s. He published his original work on the theory in 1980 while teaching at the Wharton School of Business.[1] Dr. Saaty developed the methodology to address a need for improved and more intuitive decision-making processes where multiple objectives, criteria, and alternatives existed, and where the interests of multiple stakeholders were involved. In his research, he discovered that the human mind was innately capable of making difficult decisions when those decisions were properly structured and measured in a way that simplified comparison. He designed the AHP to leverage the brain's intuitiveness, in conjunction with both qualitative and quantitative information, to yield more accurate priorities and better decisions. The validity of the AHP methodology is based in large part on its widespread appeal, ease of use, and the reasonableness of its outcomes.[2] Since the 1970s, corporate and government leaders, and academicians, have successfully used the AHP in many thousands of important decisions ranging from resource allocation, strategic planning, risk assessment, project portfolio selection and analysis, and vendor selection. The methodology is perhaps the most widely used decision-making methodology in existence.

Fundamentals of the AHP Methodology

Knowing that the AHP is widely accepted in government, commercial and academic settings is important; appreciating the theoretical underpinnings of the methodology illuminates why. Essentially, the AHP is a set of set of characteristics, steps and axioms that, together, yield an elegant and reasonable approach to making difficult decisions. Importantly, the AHP methodology includes three major process steps:

1. Structure:

Complex decisions require that decision makers properly analyze and structure the benefits, costs, scenarios and risks associated with the decision. By breaking down the decision problem into its component parts and structuring them hierarchically into homogenous clusters, decision-makers can reach agreement on the nature of the problem and, in turn, minimize miscommunication and complexity.

2. Measure:

Once the hierarchy of objectives or criteria is structured, decision makers then prioritize the objectives using a simple paired comparison measurement system to determine their relative importance. When comparing all possible paired comparisons in each cluster in the hierarchy (a process known as redundant paired comparison), it has been shown that decision makers can produce ratio-scale priorities. Paired comparison judgments may also be used on the alternatives – i.e., the projects or programs – of the model, as well as ratio-based rating scales, step functions and utility curves.

3. Synthesize:

Once the decision makers have completed their measurements, they then calculate and combine the results to determine the priorities, a process known as synthesis. This process fuses together the qualitative judgment from the various decision makers with the quantitative data and other information about the projects or alternatives. Decision makers then iterate to ensure the priorities make sense, and perform sensitivity analysis to consider "what-if" scenarios. Underpinning these major process steps are four straightforward axioms, or assumptions, as follows[3]:

• **Homogeneity:** When comparing objectives, criteria or alternatives, it is essential to compare elements that are within an order of magnitude of difference, otherwise errors in judgment can occur.
• **Reciprocals:** Paired comparison judgments yield reciprocal judgments. "Thus for example, if one stone is judged to be five times heavier than another, then the other is automatically one fifth as heavy as the first because it participated in making the first judgment."[4]
• **Hierarchic composition:** Elements at higher levels in the hierarchy are independent of lower levels in the hierarchy.
• **Expectations:** This final axiom indicates that a decision maker's reasonable beliefs should be adequately reflected in the outcomes. Additionally, all relevant objectives or criteria should be included in the analysis. Understanding these axioms and the methodology through which they are applied helps to appreciate their applicability to portfolio management decision making.

Applying the AHP to Project Portfolio Management

The above discussion focused on the theoretical underpinnings and validity of the AHP methodology. Consider now the case for applying the AHP to project portfolio management (PPM) decision-making. PPM is, as Dye and Pennypacker note, a *"significant factor in long term strategic success of project oriented organizations…. At its best, it is concerned with the role of top management and key decision makers in creating purposeful project investments and in formulating and implementing goals and objectives"*.[5] Numerous writers have documented the value of applying the AHP methodology to project portfolio prioritization, selection and management.[6] While their writing is primarily focused on the selection and analysis component of PPM, additional benefit arises from measuring project performance as well. There are three main types of PPM where the AHP can and has uniquely delivered value: IT project portfolios, new product development portfolios[7], and application development portfolios. This chapter provides a general focus on PPM, outlining principles and best practices that have been successfully applied to these and other project portfolio types.

The PPM Challenge Today

Organizations today are often quite good at managing individual projects or reasonable numbers of projects. Challenges arise, however, when project numbers increase, become more complex, and must compete in an environment with constrained resources. Project Management Organizations (PMOs) have arisen within many commercial and government organizations to serve as project and portfolio process owners, financial stewards, and centers of expertise. Specifically, the following challenges are often commonly recognized:

- Increasing numbers of potential projects in which to invest
- Difficulty aligning projects and portfolios with organizational objectives
- Difficulty achieving consensus among competing stakeholders regarding project priorities
- Inadequate measurement methodologies to determine project benefits, costs and risks
- An overemphasis on project execution management, without due diligence on project portfolio selection and alignment
- More complex and challenging project constraints, to include budgets, personnel, risk, time, and compliance

A recent study by the Kellogg School of Management indicated, "An estimated 68% of corporate IT projects are neither on time nor on budget, and they don't deliver the originally stated business goals."[8] While this research focused on IT projects, – often the largest portion of projects in an organization's portfolio in both dollars and volume – it is clear that corporations are challenged with managing project portfolios and aligning them with organizational objectives. Importantly, organizations must have a sound methodology that facilitates picking project winners, and dropping losers – while building consensus and buy-in in the process – if their PPM efforts are to succeed.

How the AHP Enhances PPM

The AHP enhances PPM throughout all phases of the portfolio management process. While different approaches exist, the section below outlines a typical PPM engagement supported by the AHP methodology.

Step 1: Project Portfolio Governance

The AHP methodology supports and enhances PPM governance, by enabling leadership to clearly establish and communicate organizational objectives, allocate resources responsibly, and measure performance accurately. In fact, a recent book on IT governance by Peter Weill and Jeanne Ross notes that good governance requires active design and involvement from senior executives, requiring them to take the lead in allocating resources and supporting the overall process.[9] In the wake of recent corporate scandals, investors and regulators are scrutinizing both corporate and government leaders to ensure their organizations are in compliance. C-level leaders play an important role in ensuring the organization is protected from mismanagement or negligence, and that its efforts are delivering value. This concern for governance and stewardship of scarce resources is critically important to the organization's PPM processes. Since projects constitute a significant and increasing percentage of an organization's resources, sound fiscal management and decision making in the PPM process is essential to organizational success. In an AHP implementation of PPM, an organization typically starts by:

- Establishing a proper governance structure,
- Ensuring the right stakeholders are involved in the right steps in the process,
- Undertaking a project or business case inventory to understand the extent of the resource demand and the types of investments in the portfolio.

On the first point, establishing the proper governance structure is critical to PPM success. At the recent Gartner Project Portfolio Management Summit, Matt Light, a Gartner analyst, provided the following best practice governance structure for an organization's PPM process[10]:

Table 1: PPM Governance Structure (Gartner)

Investment Council	Provides oversight; prioritizes and selects initiatives. Typically includes: COO, CIO, CFO, strategic planning and maybe CEO
Business Sponsor	Business executive responsible for and requesting approval for an initiative
Portfolio Manager	Manages portfolio and keeps other stakeholders informed in their decisions
Program Management Office	Competency center that coordinates all programs and projects
Program Manager	Responsible for managing a program
Project Manager	Responsible for managing a single project

Note that the PMO is typically the process owner for PPM implementations, and it is there that the primary knowledge of the AHP methodology must reside. The AHP underpins and supports portfolio governance process by enabling leadership to clearly establish organizational objectives, communicate priorities, allocate resources responsibly, and measure performance accurately.

Step 2: Project Portfolio Strategic Alignment

Once a governance structure is established, decision makers are then able to focus on the objectives of the business and portfolio. The PMO typically gathers the relevant decision makers – often C-level (e.g., CIO, CFO, etc) personnel, SVPs (i.e., Senior Vice Presidents) and senior business unit leaders – to brainstorm, define, and structure their objectives[11] into a hierarchy. This step is often the most challenging because it requires leaders to collaborate about the nature of the problem or decision. They must consider all objectives for the business or portfolio, and ultimately align the portfolio objectives as best as possible with overall corporate objectives. Figure 1 outlines the objectives of a group of leaders focused on prioritizing an IT project portfolio.

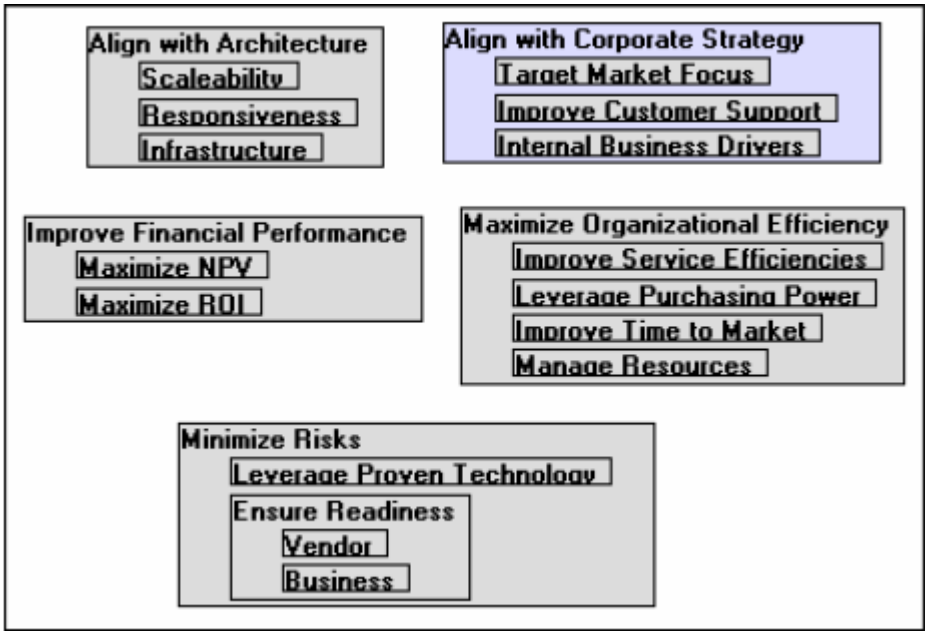

Figure 1: Sample IT Portfolio Brainstorming Output

Best practice objectives hierarchies often include objectives in the organization's strategic plan, followed by clarifying sub-objectives. Many organizations also choose to structure their objectives hierarchies along the lines of the Balanced-Scorecard.[12] Different groups of leaders will establish and prioritize their objectives differently, depending on their purpose and the current state of their organizations. After structuring, decision makers then prioritize the relative importance of their objectives using an intuitive paired comparison approach. This approach, fundamental to the AHP process, helps decision makers produce priorities that are proportionate to one another, what is known as ratio scale priorities.

Proportionality cannot be achieved by simply assigning weights to the objectives or criteria, a common mistake that is prone to produce inaccurate and/or meaningless results. Rather, decision-makers are encouraged to think clearly about the relative importance of successive pairs of objectives using a comparative verbal scale that ranges from Equal to Extreme, or a comparative numerical scale from 1 through 9.[13]

For example, the question being asked of the decision makers, in Figures 2 and 3, below is "Which is more important and by how much, Align with Corporate Strategy or Improve Financial Performance, with respect to Optimizing the IT Portfolio to Improve Corporate Performance?"[14] Decision makers then enter a judgment – either through wireless keypads, on software (AHP-specific, Internet portal, or spreadsheet), or on a paper-based survey – that best reflects their knowledge, position and expertise. Importantly, decision makers should consider the pairwise judgment in light of their position in the organization and the strategic direction of the organization at the time of measurement.

Figure 2: John S's Individual Pairwise Comparison Judgment

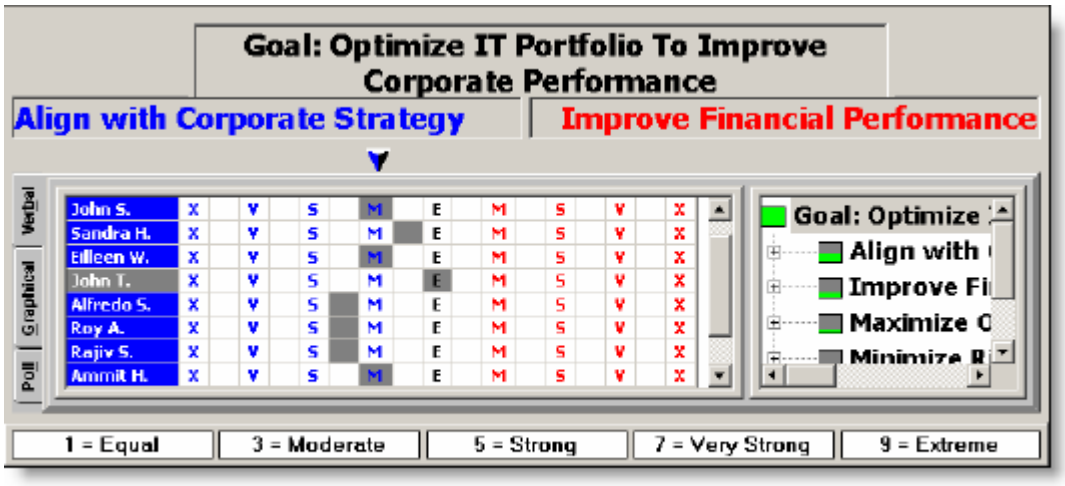

Figure 3: Example Pairwise Comparison with Multiple Stakeholders

After the first judgment, the decision makers repeat the pairwise judgment process through all possible combinations of pairs.[15] They then calculate their priorities using the eigenvector calculations of the AHP process. They also check for inconsistency using the eigenvalue calculations of the AHP process.[16] Importantly, they need to verify that their priorities make sense to them. If the priorities do not make sense, they should review and adjust their pairwise judgments using an iterative process. The collaborative nature of the AHP prioritization process cannot be understated. Because of its structuring capability and straightforward measurement system, the AHP simplifies communication about priorities. By representing all relevant stakeholder positions, each person contributes to the process. While they may not exactly agree with every result, they will agree the process was equitable and that their voice was heard, greatly building organizational consensus and buy-in in the process. Portfolio management without buy-in often fails when it comes time to implement the selected portfolio. The AHP has a distinct advantage over other measurement methodologies because it provides decision makers with an ability to derive accurate ratio-scale priorities for both quantitative and qualitative factors through the paired comparison process. Importantly, the AHP also allows decision makers to measure the inconsistency of their judgments. For example, if one said that A is greater than B, and B greater than C, then A, logically, should be greater than C. However, human beings are not always logical. The inconsistency measure of the AHP can help decision makers to better understand the reliability and/or validity of their judgments, yet it does not require them to be perfectly consistent. Indeed, one could be perfectly, consistently wrong in his or her decisions! Each decision-maker must agree to the priorities they have established and to the process used to reach them.

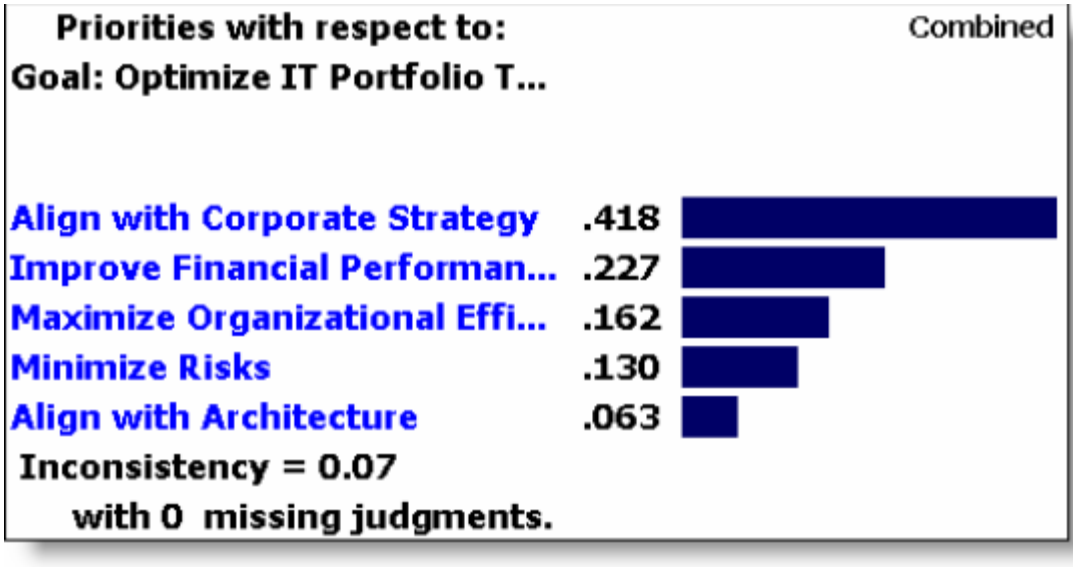

Figure 4: Example Top Level Objective Priorities

Step 3: Project Portfolio Evaluation

Having clear direction from leadership about the strategic priorities of the organization, the PMO typically coordinates with subject matter experts and middle managers, among others, to align the projects or investments with the strategic objectives. These stakeholders can use paired comparison, verbal rating scales, or utility curves to assess how well the different projects contribute to the different objectives in the hierarchy.[17] Using wireless keypads, an Internet portal, or paper-based surveys, decision makers typically measure individual project performance using a rating scale, such as noted below. Importantly, the rating scale should be developed with the stakeholder team and its priorities should be produced using pairwise comparison judgments to ensure the intensities are ratio scale and meaningful to those using it.

Intensity Name	Priority
Excellent	1.000
Very Good	.722
Good	.442
Marginal	.323
Poor	.104
None	.000

Figure 5: Example Project Rating Scale

Aside from measuring qualitative judgment, the AHP also leverages quantitative data. Financial objectives like Return on Investment (ROI) and Net Present Value (NPV), or specific quantitative metrics on sales figures or performance, can be measured using utility curves or step functions. Once the team has completed their judgments and ratings, the PMO calculates the results to review and confirm the project priorities. This important process, known as synthesis, provides critical insight into the collaborative communication of priorities the portfolio team produced. Figure 6 provides an example of the types of views a team might receive once synthesizing the input. The team then conducts sensitivity analysis to validate that the priorities are reasonable and to consider alternative scenarios. Sensitivity analysis is a powerful process that allows decision makers to ask what if types of questions. It is only valid because the priorities produced in the AHP are ratio scale, making them proportionate. Thus, if the team decides to consider an alternative scenario in which an objective is more heavily weighted than originally derived, they can simply adjust the priorities of the objectives to see how the alternative's priorities compensate.

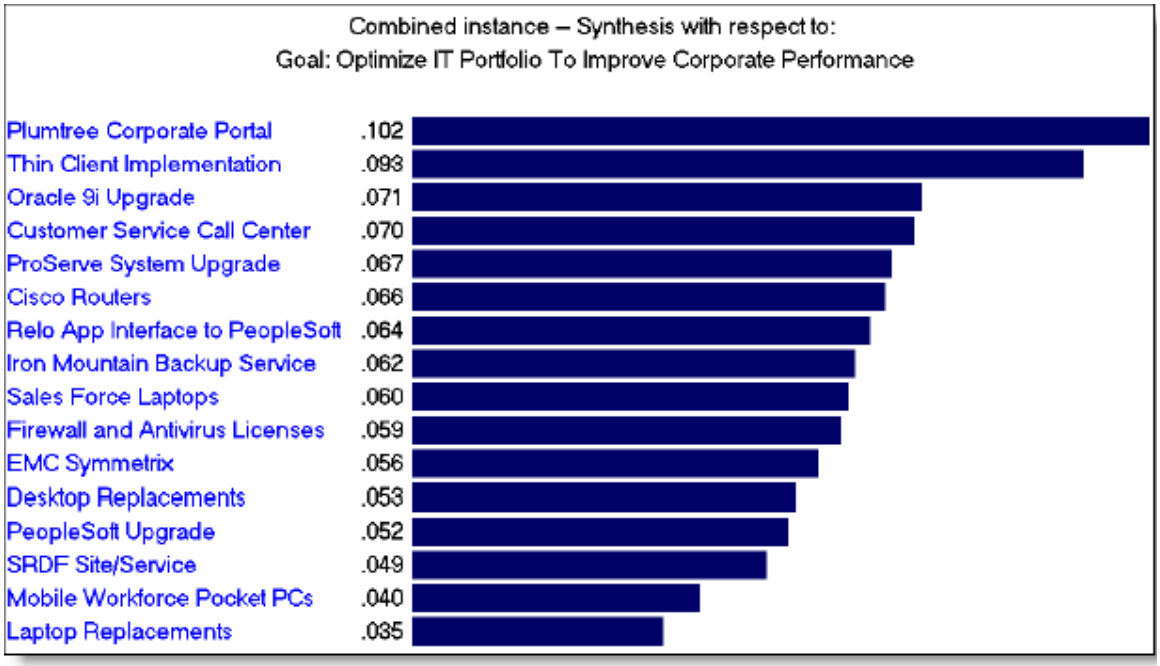

Figure 6: Example Project Priorities

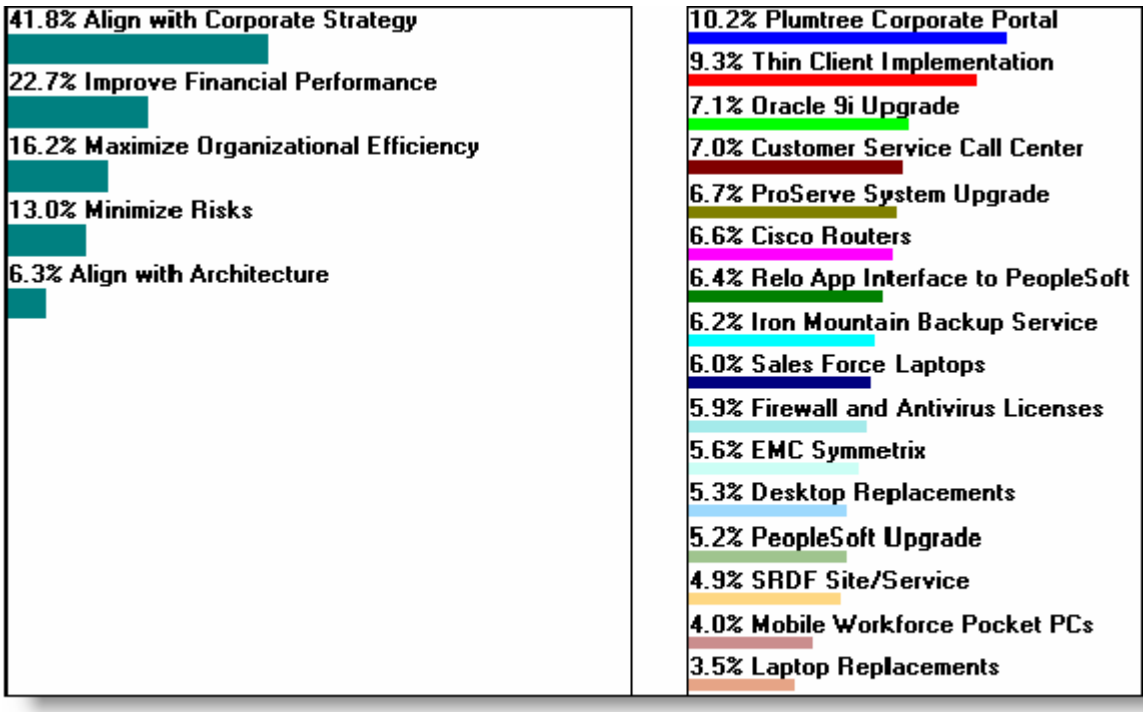

Figure 7: Example Dynamic Sensitivity Screen

Thus, the PMO leverages the AHP methodology to facilitate communication from the top down (leadership communicating strategic objective priorities to staff) and from the bottom up (staff communicating project priorities to leadership), synthesizing the results to reach acceptable priorities to all members of the team. Determining accurate project priorities (benefits) is essential to effective allocation of resources. Without accurate priority numbers for the projects, the process of allocating resources is futile, because the presumed project benefits will be misleading. The project priorities of an AHP-based prioritization process reflect *integrated* benefit numbers, and are thus more accurate than typical measurement approaches. That is, they incorporate leadership's values, expert's judgments, and financial and other quantitative metrics. The more highly a project is rated, the more tightly it aligns with organizational objectives, making it more beneficial. Traditional portfolio management methodologies, in many cases, use outdated prioritization methodologies. One such approach requires that evaluators use measurement scales that range from 1 to 5 or from 0 to 10 to score projects. While this methodology is typical of many gate based approaches, it suffers from the inappropriate use of numbers. The noted scales, 1-5 and 0- 10, are most frequently interpreted as ordinals, or at best as intervals, and convey no information about the proportionality of the judgments being made. Moreover, it is inappropriate to perform any mathematical calculations on ordinal measures – even addition – as these numbers are not meant for calculation.[18] Thus, use of these scales will produce results that are at best approximations and at worst misleading. Ratio scale measures are necessary to determine the contributions of a project to organizational objectives and to meaningfully allocate resources. AHP, through its ability to facilitate redundant pairwise *relative* comparisons, overcomes the shortcomings of the 1-5 and 0- 10 scales and allows decision makers to derive ratio scale priorities. Psychologists have long known that humans are much more capable of making relative rather than absolute judgments. The use of redundancy in the pairwise measurement process permits better accuracy and allows measurement of the consistency of a decision-maker's judgments, an important point overlooked in traditional measurement systems. An optimal alignment of projects and allocation of resources requires both ratio scale measures of benefit as well as a methodology to select the combination of projects that maximizes the total benefit while adhering to constraints.

Step 4: Project Portfolio Optimization and Balancing

Having prioritized the projects with accurate benefit numbers, the evaluation team can now allocate resources to the portfolio. Rather than simply sort on the benefit number, a much more effective and efficient approach is to optimize the portfolio. To achieve the best utilization of resources, the AHP has been successfully combined with optimization and constraint modeling techniques to ensure maximum efficiency in the portfolio.[19] Using linear integer optimization, it is possible to leverage the priorities from the projects (i.e. the integrated project benefit numbers) to solve for the optimal combination of projects that maximizes total portfolio benefit, while staying within portfolio constraints. This technique is superior to sorting on a benefit number (or NPV or benefit-to-cost ratio) and funding from the top until monies expire because it will produce at least the same or higher total portfolio benefit.

It can also consider multiple constraints such as budgetary constraints, human resource constraints, dependencies between projects, funding pools, time periods, project risks, and groups of projects. When done properly, decision makers can produce an "efficient frontier" portfolio that identifies the best bang-for-the-buck at multiple potential portfolio funding levels.

	Alternatives	7,650	8,550	9,450	10,350	11,250	12,150	13,050	14,850	16,650	18,450
	Benefit %	28.6%	35.9%	42.4%	45.9%	52.3%	54.5%	60.9%	65.7%	65.9%	70.7%
	Cost	7,370	8,350	9,340	9,695	10,685	11,795	12,785	14,455	16,225	17,895
A7	Relo App Int			FUNDED		FUNDED		FUNDED	FUNDED	FUNDED	FUNDED
A2	Cisco Router	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A16	Customer Se		FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A12	Desktop Rep										
A3	EMC Symme	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A11	Firewall and	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A4	Iron Mounta										
A10	Laptop Repl										
A14	Mobile Work	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A8	Oracle 9i Up										
A6	PeopleSoft U								FUNDED		FUNDED
A1	Plumtree Co				FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A15	ProServe Sy	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
A13	Sales Force I										
A5	SRDF Site/S									FUNDED	FUNDED
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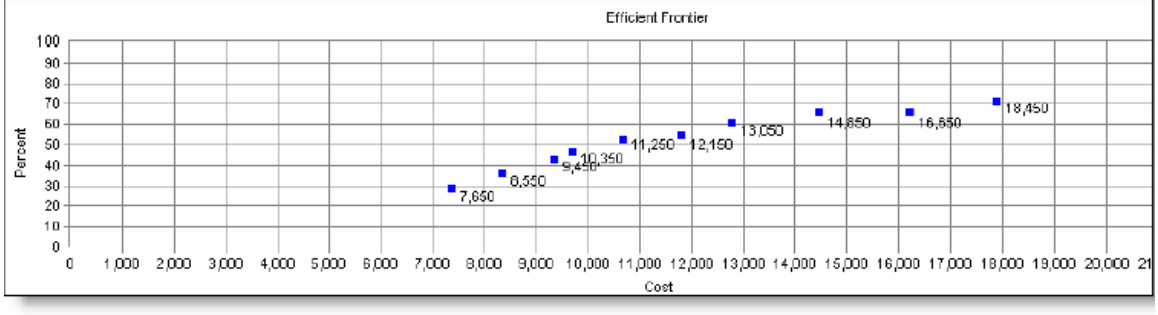

Figure 8: Example Efficient Frontier Graph

At each potential funding level on the curve, billions – even trillions or more – of potential combinations of projects can be checked to find the best combination that yields the maximum total benefit in the portfolio (the Y, or left, axis) while staying with the constraints on the portfolio.[20] In addition to the optimization, balancing is another core concept that improves portfolio effectiveness. Since the projects in a portfolio often pertain to different aspects of the business – e.g., run the business, grow the business, and transform the business or utility, enhancement, frontier – it is often necessary to ensure that the organization allocates its funding adequately across all relevant areas, or pools. To that end, having an ability to optimize across multiple different types resource areas is essential to meeting diverse allocation needs that today's portfolio management environment requires. Combined, the AHP and optimization yield synergistic benefits for an organization's PPM efforts, and ensure that the project portfolio continues to align with and reflect organization objectives. Importantly, this entire process is under full control of the management team implementing the solution. Decision makers may get nervous at first reference to "optimization", yet they will soon see its benefits when they are allowed to account for realistic, often political, constraints that organizations face daily.

By incorporating "must fund" and "must not fund" constraints, leaders retain control over the portfolio, yet ensure they are attaining the most value in the portfolio given those constraints. Combined, the AHP and optimization yield synergistic benefits for an organization's PPM efforts, and ensure that the project portfolio continues to align with and reflect organization's (and leadership's) objectives.

Project Portfolio Risk Assessment and Forecasting

Another dimension to consider is whether or how to include measures of project risk. The AHP has been successfully used to assess business risk and project risk, among other types of risk. Within PPM, the AHP is uniquely able to leverage expertise from diverse decision makers regarding the risks and/or probabilities of success associated with a project. Using the same structuring and measuring methodology described above, decision makers can construct a hierarchy of risk objectives or categories – essentially a risk scorecard or risk breakdown structure[21] – against which they can measure project risk, severity of impact, and likelihood of occurrence. Common risk areas include schedule risk, scope risk, budget risk, and compliance risk among others. This process typically leverages expert judgment using rating scales with words like Extreme Risk, High Risk, Moderate Risk, Low Risk, and Little-to-No Risk. Importantly, the decision makers must perform paired comparison on the words to determine their relative priorities, a distinct advantage over using linear rating scales. Additionally, decision makers can leverage historical data, if available, in conjunction with judgments to forecast probabilities. With project risks or probabilities of success (the inverse of risk) in hand, decision makers can now discount the project benefits with the probability of success to arrive at a risk-weighted project priority number or benefit. The discounted benefit, thus, is a more realistic assessment of expected value that a project is likely to deliver. Determining accurate project risks extends the meaningfulness of the AHP prioritization effort, in that it now considers realistic constraints and/or failures the project might encounter in implementation. While the approach is straight forward, PMOs should first focus on optimizing their portfolios based on accurate benefit numbers, saving risk-discounting practices for future iterations of the process when the organization has more maturity with the methodology.

Step 5: Project Portfolio Execution Management

With the selected portfolio in hand, the PMO is now able to execute on the projects to see them through to completion. Various portfolio and project management software products are available on the market.[22] These products, such as Microsoft Project, typically serve as a central repository for project information, task management, resource utilization, and various other crucial project management activities. The execution process is a dynamic and crucial component of overall project success. It will continue to be relevant to the organization's needs only if the projects executed are aligned with the organization's objectives. A rolling portfolio planning, execution, and measurement effort will continuously ensure the relevance of the portfolio (discussed in more detail below).

Step 6: Project Portfolio Performance Measurement

Lastly, having selected and implemented the best portfolio of projects, it is important to monitor project and portfolio performance to ensure they deliver the expected value. To accomplish this, the AHP methodology facilitates performance measurement of the projects against their objectives. As project and program managers update project performance metrics, the updates can be imported into an AHP-based performance dashboard to display project and portfolio performance in an intuitive way. Again, the AHP methodology here ensures that the priorities on the objectives, and the performance measures, are accurate and reflect a consensus of all necessary stakeholders.

Rolling Portfolio Forecasting and Alignment Process

While presented above as discrete steps, a best practice approach to implementing an AHP based PPM process is to consider a rolling portfolio. Depending on the type of portfolio, it is fruitful to create a standard bi-weekly, monthly or quarterly meeting to reassess the portfolio on an ongoing basis. During these portfolio "refresh" meetings, decision makers consider the performance of the current project portfolio, in conjunction with new projects in the pipeline, to determine the new portfolio. Ideally, the portfolio undergoes regular refreshing and balancing in which it is tweaked and more tightly aligned with organizational objectives. This process entails reconsideration of sunk costs on the projects already begun, and it will certainly involve holding, continuing or killing projects that are currently in the portfolio. Importantly, projects that are already in the portfolio should have a fair and balanced consideration when compared competitively with newly proposed projects. Since sunk costs on the existing projects are unrecoverable, they no longer count against the project and thus should not penalize it. This approach helps to ensure that projects already in place are not unfairly compared to new projects being considered. It also recognizes the that the future investment in on-going projects is likely to be less than for new projects, and that killing on-going projects that are meeting their original business plans, but may not be as competitive as newly proposed projects, may kill morale.

Conclusion: AHP's value to PPM

With such a strong presence in management decision-making, what makes the AHP so appealing for portfolio managers today? In short, the methodology is relatively simple, very flexible, and extremely powerful. The methodology is valuable for multi-objective decision making, in general, and for PPM in specific. The AHP shows considerable advantages for organizations challenged with complex portfolio decisions involving long (or even short!) lists of projects, constrained resources, multiple stakeholders, multiple objectives, and compliance challenges. Adopting the AHP combined with advanced optimization can deliver immediate value to an organization's PPM efforts, primarily through the methodology's inherent ability to:

- Structure complex portfolio challenges
- Measure benefits, costs and risks on ratio scales
- Leverage and synthesize data, information, and judgments from multiple stakeholders
- Conduct sensitivity analysis with "what if" scenarios
- Generate and examine an efficient frontier of optimum portfolios over varying budget amounts
- Measure and improve portfolio performance
- Pick project winners, and losers, quickly and effectively

In sum, organizations that adopt the AHP as the measurement method of choice for their PPM efforts can expect improved portfolio alignment, better stakeholder buy-in and stronger organizational confidence in portfolio decisions.

Author Bio

James Devlin is Vice President of Professional Services for Expert Choice, Inc. During the last three years, he has helped senior leaders from America Online, Sovereign Bank, the Mayo Clinic, the Office of the Secretary of Defense, the Federal Aviation Administration, and the Bureau of Alcohol Tobacco and Firearms, among other organizations, to make complex portfolio, risk and governance decisions using the Expert Choice Portfolio Alignment software solution. James is also working on his Doctorate in knowledge management at the George Washington University, where he is focusing on leveraging knowledge in project portfolio management decision-making. He may be reached at jdevlin@expertchoice.com. The author would like to thank the consulting team of Expert Choice for their valuable comments and improvements on this paper.

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[10] Paraphrased from Light, Matt (2004). “Project Portfolio Management in Reach.” Presented July 12, 2004 at the Gartner Project Portfolio Management Summit, p. 12.
[11] The terms “objective”, “criteria”, and “attribute” are often interchanged in the literature of decision-making. For this chapter, the term objective will be used as it expresses intentionality and more directly identifies the purpose sought. Moreover, experience indicates that organizations that focus on the accomplishment of objectives are more likely to do just that.
[12] For a complete treatment of the Balanced Scorecard see Kaplan, R. S., D. P. Norton, et al. (1998). Balancing the corporate scorecard. [Boston], Harvard Business School Pub.
[13] On the verbal comparative scale equal indicates the two objectives being compared are of equal importance to the parent objective, and extreme indicates that one is extremely more important - nearly an order of magnitude more important - than the other with respect to the parent objective. On the numerical comparative scale, a one indicates the two objectives are equally important with respect to the parent, and a nine indicates that one objective is nine times more important with respect to the parent. Graphical scales representing proportionality are also frequently used.
[14] At this point software can greatly facilitate the implementation of the methodology. While it is possible to perform basic AHP calculations in a spreadsheet application like Microsoft Excel, one will find that off-the-shelf packages, such as Expert Choice, can greatly simplify collection, calculation and display of priorities.
[15] The formula for calculating the number of judgments in a cluster of objectives is N(N-1)/2.
[16] Both eigenvector and eigenvalue calculation methods are taught in most engineering and higher math courses. Again, off-the-shelf software packages can perform these calculations automatically so that decision makers can focus on their decisions, rather than getting bogged down with math.
[17] While paired comparison is more accurate than rating scales, due to the redundancy of measurement, it can become cumbersome when more than nine alternatives are considered due to the large number of possible pairs that would be necessary to measure.
[18] An ordinal scale is a set of numbers that is invariant under monotone increasing transformations. No mathematical operations can meaningfully be applied to ordinal measures. For specific details on the scales of measurement refer to (Saaty 1996).
[19] Dr. Matthew L. Liberatore of Villanova University was one of the first writers to make the connection between AHP and optimization. For details, see: Liberatore, Matthew L. (1987). An Extension of the Analytical Hierarchy Process for Industrial R&D Project Selection and Resource Allocation. IEEE Transactions on Engineering Management, Vol. EM-34, Issue 1, pp. 12-19.
[20] Due to the large number of possible combinations, software optimization is necessary for this effort. The screen captures shown are from the Expert Choice Resource Aligner product, developed by Dr. Ernest H. Forman of Expert Choice.
[21] Note in particular David Hillson’s work in this area. Hillson, David. “Use a Risk Breakdown Structure (RBS) to Understand Your Risks.” Proceedings of the Project Management Institute Annual Seminars & Symposium. October 3-10, 2002, San Antonio, TX, USA. Article available at http://www.risk-doctor.com/pdf-files/rbs1002.pdf. Hierarchic risk structures like the RBS are easily measured and leveraged with the AHP.
[22] Example project portfolio management products include Artemis, Business Engine, Mercury Interactive, Microsoft Project, Niku Clarity, PlanView, Primavera Team Play, ProSight, UMT, and others.