

Use Analytic Hierarchy Process For Project Selection

THE METHOD CAN ASSIST STRATEGY FOCUSED ORGANIZATIONS IN PROPERLY MANAGING BUSINESS PROCESS IMPROVEMENT PROGRAMS.

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A successful organization recognizes that when an effective strategy is properly implemented, it will result in a sustainable competitive advantage. But when you examine the formulation of an organizational strategy, you quickly realize that strategy is really about choice.

In this context, choice means making the correct decisions, selecting the best alternatives and periodically optimizing your choices as the organizational environment changes. The analytic hierarchy process (AHP) method has proven to be extremely valuable in Six Sigma, lean Six Sigma and other business process improvement prioritization decisions when they involve both tangible and intangible strategic considerations.

Modeling Strategic Framework

The balanced scorecard is a framework that enables organizations to view their success from four perspectives:

1. Financial.
2. Customer.
3. Operational.
4. Human resources.

The financial perspective is an outcome—an external perspective used to view the financial results of an organization. The customer perspective is also external, articulating the customer value proposition or the benefit a customer receives from an organization.

The operational perspective provides insight into the internal operations of the organization, which in turn helps an organization achieve the financial and customer perspective outcomes. The HR perspective is a view of how to manage the human capital within an organization to enable the operations of the business.

If you model the strategic framework using the balanced scorecard model, then you can think in terms of making choices based on these four perspectives. Consider the top-down perspective of a successful strategy aligned organization with a successful Six Sigma deployment. Ideally, the organization will have:

- A clear vision.
- A mission statement.
- A well-formulated strategy articulated using a balanced scorecard model.

- Aligned metrics and goals that cascade down from the apex of the strategy pyramid through the lines of business into the divisions and functional areas and to each individual.
- A business process improvement program with a set of realistic expectations aligned to the organizational strategy.

In this context, business process improvement projects selection is based on alignment to the strategic goals of the organization. Over time, the project portfolio is optimized as the needs of the business change. Clearly, there is a need for a reliable way to make effective and consistent business decisions or choices to ensure that resources are used effectively.

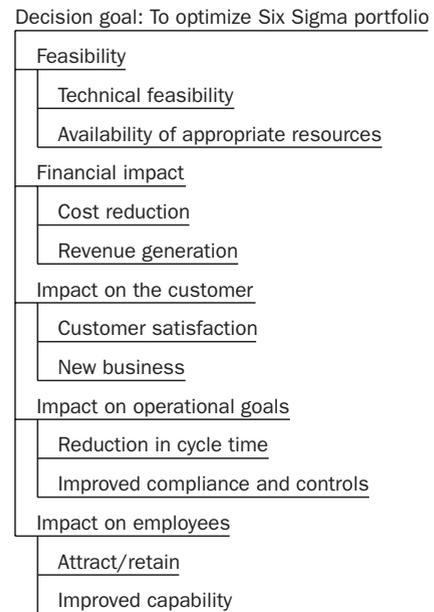
Tom Saaty, developer of AHP, has spent years examining decision making as a process, including the optimal selection of an IT project portfolio aligned to an organizational strategy. The principles of his research are completely applicable to the selection of business process improvement projects and the optimization of a project portfolio.

Simply put, AHP can be used to select those projects that are most closely aligned to the four perspectives of the balanced scorecard and therefore the organizational strategy.

There are a six advantages to using AHP over other alternative project selection and prioritization techniques:

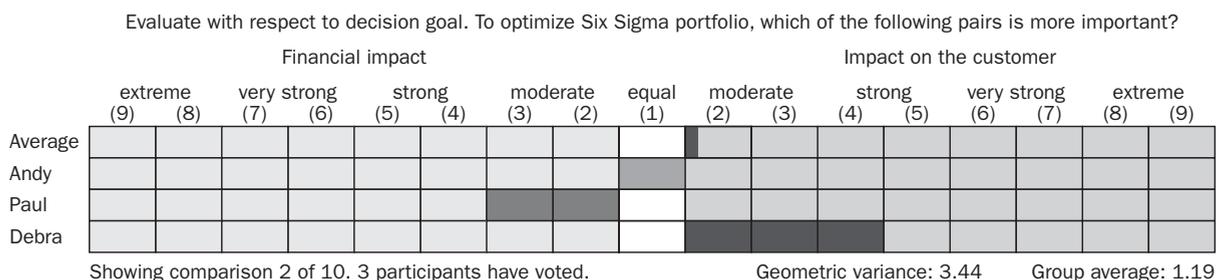
1. Because AHP uses a hierarchical structure, it enables decision makers to define high level strategic objectives and specific metrics for a better assessment of strategic alignment.
2. AHP goes beyond financial analysis by integrating quantitative and qualitative considerations as well as competing stakeholder inputs into setting priorities.

Figure 1. **Six Sigma Business Drivers and Evaluation Criteria Hierarchy**



3. AHP enables decision makers to measure the relative importance of projects, including their benefits, costs, risks and opportunities so resources can be allocated to get the best bang for the buck.
4. AHP can be applied in any organization with any level of maturity because the inputs are normalized using either numerical data or subjective judgments when metrics are not available.
5. The AHP process lends itself to sensitivity analysis, providing practitioners with greater analytical capabilities when examining what-if scenarios.

Figure 2. **Individual Assessments of Relative Importance**



THE BEAUTY OF THE AHP TECHNIQUE IS THAT THE EXECUTION IS SIMPLE AND INTUITIVE.

6. The auditable and explicit structure of the decision model creates a strong framework for systematically improving project selection and allocation decisions.

The execution of AHP follows a structured format. The technique is rather simple. We can establish a relative order of importance for business process improvement projects based on this four-step process:

1. Develop a hierarchy or tree of business drivers and criteria—from high level drivers at the top to more specific criteria that will be used to measure the value of projects.
2. Compare business drivers, then use decision criteria to determine their priorities in helping the organization be successful.
3. Rate projects against the criteria using accurate numerical scales derived through pairwise comparisons.
4. Optimize the allocation of resources (human and financial) by maximizing value for cost based on well-understood business rules (interdependencies, must fund projects, time based allocations). This can be accomplished using linear and integer optimization techniques.

Business Process Improvement Project Portfolio Decision

Suppose an organization has 17 candidate projects with a total projected cost of \$105 million, but only \$67 million is available. Ideally, the business process improvement project portfolio needs to reflect the value drivers of the projects relative to organizational strategy. Therefore, the goal of the decision is to optimize the allocation of the budget and other resources to get the highest overall value of projects.

The value of the projects is determined by building a prioritized list of business process improvement

projects that are most closely aligned to the five business drivers—the four perspectives of the balanced scorecard and the feasibility of the project. The list is different from a normal ranking of projects. The priority of each project is represented as a measure of its relative value toward the stated goals and objectives of an organization.

Software and Facilitating AHP

The Virginia based commercial software firm Decision Lens Inc. has helped to facilitate applying AHP to business process improvement project selection. It began by listing the five business drivers at the top of the model in the hierarchy. The value of projects were measured by their relative priorities—derived from steps one to three. The firm also refined the decision and the prioritization of the candidate projects by including more specific criteria under each business driver.

To keep the number of ratings manageable, Decision Lens developed only 10 actual criteria to rate projects because the projects are only rated against the lowest level of the hierarchy. Figure 1 (p. 23) lists the criteria.

The beauty of the AHP technique is that the execution is simple and intuitive. The process is designed to thoroughly integrate the expertise, experience and stakeholder positions of a group of decision makers into the prioritization process. It helps focus the discussion in the decision process on areas of disagreement to better inform decision makers of each other's opinions.

Suppose you assemble a group of three to five individuals who will evaluate projects by participating in the AHP process. Intuitively, ask yourselves, "With respect to the goal of optimizing the entire business process improvement portfolio in the context of the organizational strategy, which is more important, the financial impact or impact on the customer?"

After everyone has submitted judgments, display a

group of judgments on a single screen. This is illustrated in Figure 2 (p. 23), where decision maker Andy says that financial impact is equally important to the impact on the customer.

Notice that Paul says the financial impact is moderately more important than impact on the customer. Debra says impact on the customer is much more important than financial impact. We eliminate any judgment bias with a simple group facilitation technique.

For instance, a facilitator asks each group member to explain his or her position and then allows another vote if positions change based on this focused discussion. If voters' positions do not change, then the geometric average of the votes is taken forward as the result of the comparison—in this case a 1.19, slightly in favor of impact on the customer as more important. This pooling of individual judgments has been shown to eliminate the effects of any individual judgment bias.

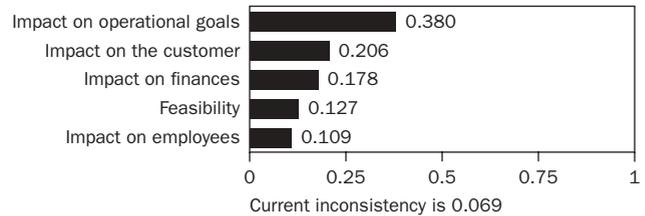
The group continues to use this process to compare each pair of factors, thereby developing a matrix of the comparisons of the group. (Software can be used to track individual priorities against the group's to see differences, and decision makers can even be weighted in the process.)

Mathematically, you achieve the criteria priorities by inserting the values determined from the pairwise calculations into a comparison matrix.

The primary approach used by AHP practitioners involves calculating the eigenvalues and eigenvector for the matrix using a simple numerical technique: To calculate the eigenvector, a matrix is multiplied by itself many times until the intermediate vectors of each iteration no longer change. The resulting vector is the priorities for the criteria, also known as the eigenvector. The principal eigenvalue is the primary root of the matrix and can be used to measure and determine the inconsistency ratio.

The AHP pairwise comparisons and priority calculation are performed on every level of criteria in the

Figure 3. **Ranking and Relative Importance Of the Judgment Criteria**



hierarchy to get the relative weights for objectives, subobjectives, and measures.

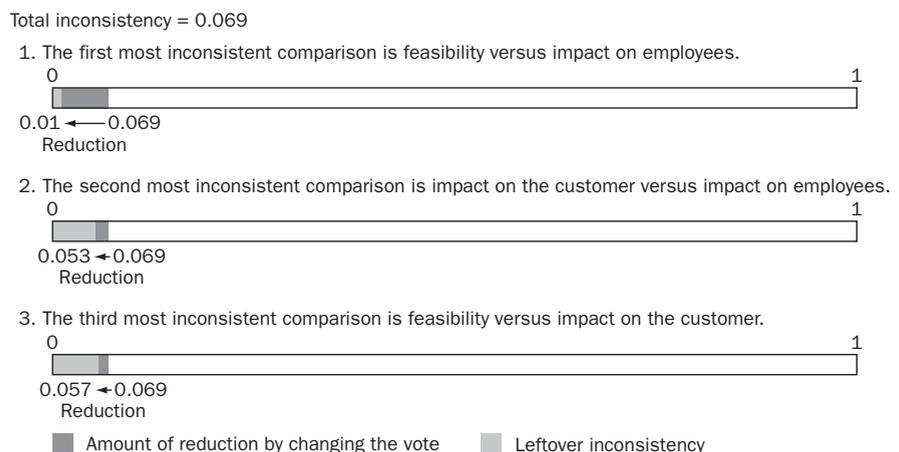
In the example, the result is a set of ratio scale priorities on the five business drivers, shown in Figure 3.

Inconsistency Ratio

As noted earlier, the integrity of the measurement system in the AHP is monitored using the inconsistency ratio. In Figure 4, the software calculates an inconsistency ratio. Inconsistency occurs if a decision maker says A is more important than B, B is more important than C, and C is more important than A. The third comparison is inconsistent with the first two because A would logically be more important than C.

The goal is to keep inconsistency under a 0.10. It has been shown in validation examples that people usually have changed the definitions of criteria in their heads halfway through the process if they are highly

Figure 4. **Illustration of Inconsistency Ratio**



inconsistent. In other words, they should review and tighten definitions and revisit the comparisons.

Inconsistency can occur by inconsistently defining dominance or voting much higher in favor of items than would be warranted based on other votes. Software provides the best capability to not only track inconsistency, but also to help identify which comparisons were inconsistent and recommend a better answer.

In Figure 4's example (p. 25), the comparison of feasibility versus impact on employees was the most inconsistent vote. If you were to change to what was recommended by the software, you could reduce inconsistency from 0.069 to 0.01. The goal is not to get perfect consistency, but rather to use inconsistency to diagnose possible problem areas with definitions and logic.

Now that decision makers have priorities for each

Table 1. **Sample Ratings Scale for Technical Feasibility**

Rating	Definition	Weight
Trivial	The capability is well known with virtually no risk.	100% (1.0)
Highly feasible	The capability is known, and similar types of activities have been tried before with a high success rate.	85% (0.85)
Moderately feasible	Some capability and experience exists, but some risk is involved.	40% (0.4)
Difficult	Little or no capability exists. It would have to be completely outsourced and would be difficult to manage.	20% (0.2)
Extremely difficult	There is no capability or experience and it is highly risky.	0% (0.0)

business driver, they can pairwise compare the criteria under each driver and then distribute the weight of the driver among their children criteria, resulting in a weighted value hierarchy illustrated in Figure 5. Notice we are making trade-offs based on the relative importance of criteria, but our judgments are not necessarily based on a set of hard metrics.

Figure 5. **Illustration of Weighted Value Hierarchy**



Figure 6. **Sensitivity Analysis**



CLEARLY, SOME PROJECTS WILL BE EMPHASIZED AND SOME MIGHT BE ELIMINATED. THIS ENSURES THAT THE BUSINESS PROCESS IMPROVEMENT PROGRAM IS CONSISTENTLY ALIGNED WITH THE ORGANIZATIONAL STRATEGY.

A key benefit to AHP is its ability to quantify subjectively, which can be particularly useful for organizations with competing stakeholders and less mature decision making processes. AHP allows practitioners to make critical business decisions in a consistent manner, based on virtually any measurement system—even a subjective one.

Rating Projects

To prepare for rating projects against the weighted criteria, a team must first develop rulers or rating scales for evaluating the projects against each of the

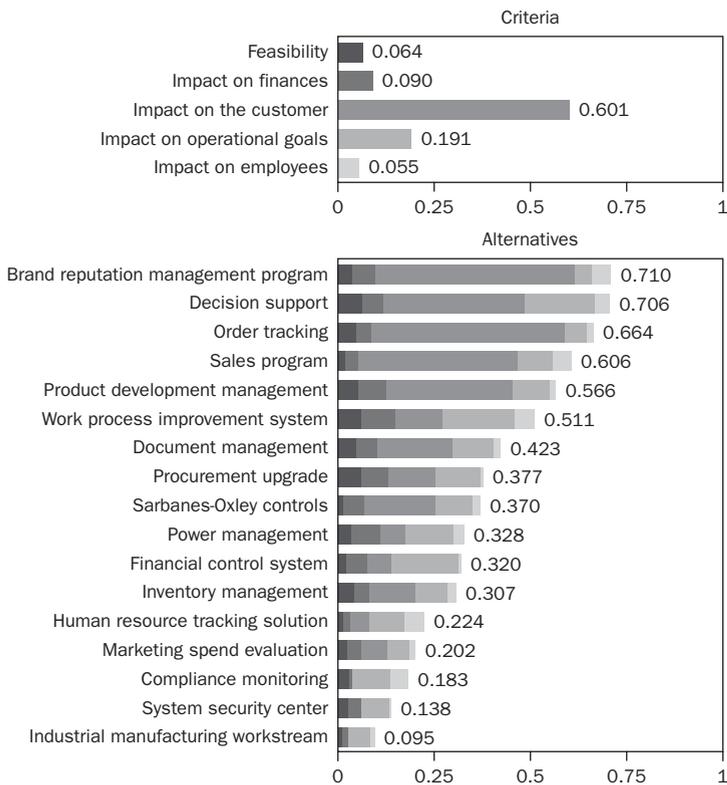
criteria. For example, technical feasibility might have a scale like that in Table 1.

The ratings scales used in AHP are not simple Likert scales. Instead, ratings are pairwise compared against each other to derive their values. For example, how much better is a trivial rating than a very highly feasible rating? The results are normalized so the highest rating gets a 1.0, and all others get a score relative to their pairwise priority.

Notice the rating scale is nonlinear—a more effective representation of what people really mean when they apply the ratings. This process is repeated to build different scales for the different criteria. Table 1 illustrates a simple ratings scale for technical feasibility.

Decision makers can then rate the projects against the criteria. The scores of the ratings are multiplied by the weights of the criteria and then summed across all criteria resulting in a composite score for each project. This score is a measure of the value of the project toward the stated goals and objectives of the organization as defined by the decision makers.

Figure 7. **Sensitivity Analysis Continued**



Portfolio Priorities And Sensitivity Analysis

Sensitivity analysis enables decision makers to graphically change the priorities of the business drivers and instantly see the impact on the priorities of the business process improvement project portfolio.

In Figure 6, the graph at the top represents the priorities of the decision criteria. The graph at the bottom shows the scores of each project. In a colored graph, each bar of the project can be broken into segments and associated with the top graph to show what pieces of their value they derive from each business driver.

Suppose there is a change in the organizational environment and the decision

Figure 8. **Dependency Matrix Defining Interdependencies Between Projects**

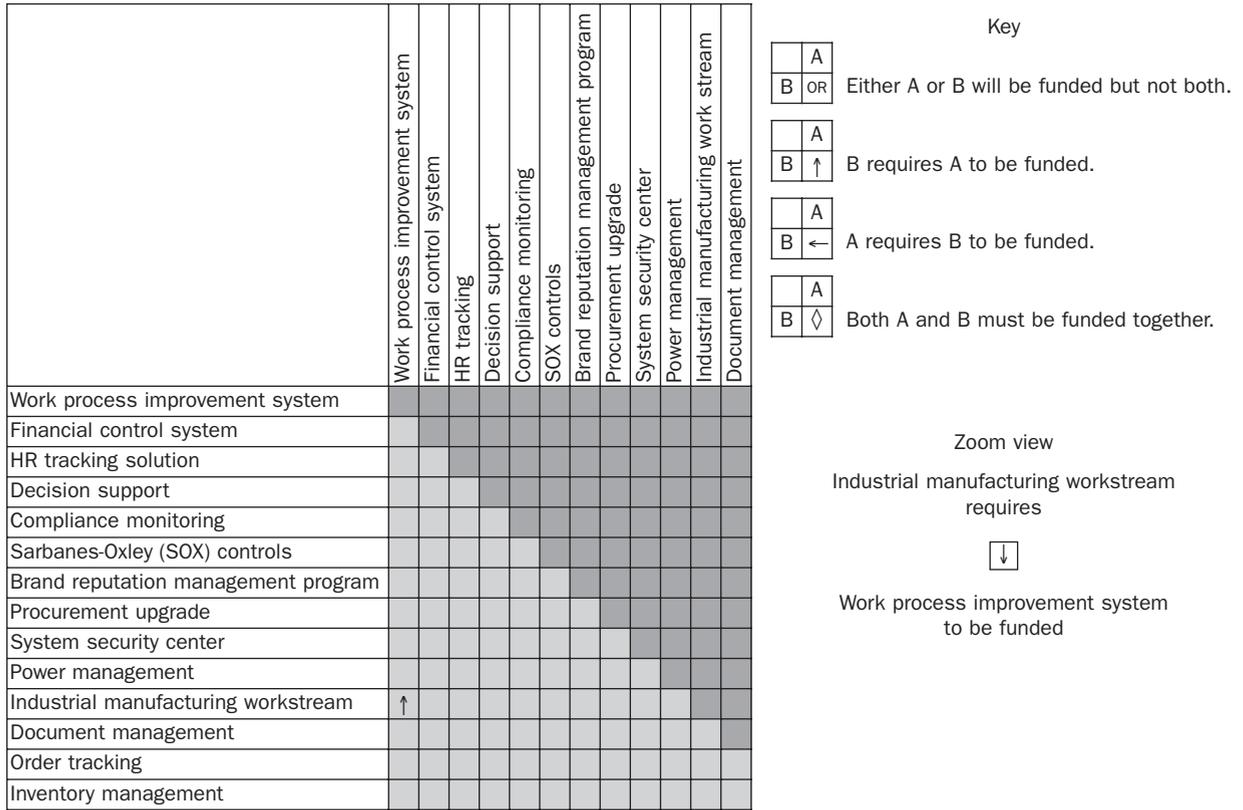


Table 2. **Project Funding Partition Aligned to Organizational Strategy**

Project	Priority	Requested budget	Amount funded	Percent funded	Funding pool
Work process improvement	0.8185	\$9,000,000	\$9,000,000	100%	Default pool
Decision support	0.807	\$2,400,000	\$2,400,000	100%	Default pool
Product development management	0.59	\$2,700,000	\$2,700,000	100%	Default pool
Brand reputation management	0.5651	\$8,700,000	\$8,700,000	100%	Default pool
Procurement upgrade	0.5512	\$19,000,000	\$19,000,000	100%	Default pool
Power management	0.5452	\$2,300,000	\$2,300,000	100%	Default pool
Sales program	0.5316	\$1,200,000	\$1,200,000	100%	Default pool
Financial control system	0.5289	\$18,000,000	\$0	0%	Default pool
Document management	0.5214	\$1,000,000	\$1,000,000	100%	Default pool
Order tracking	0.4945	\$850,000	\$850,000	100%	Default pool
Sarbanes-Oxley controls	0.4305	\$12,000,000	\$12,000,000	100%	Default pool
Inventory management	0.4126	\$800,000	\$800,000	100%	Default pool
HR tracking solution	0.3946	\$12,500,000	\$0	0%	Default pool
Compliance monitoring	0.3631	\$2,400,000	\$2,400,000	100%	Default pool
Marketing spend evaluation	0.2947	\$2,300,000	\$2,300,000	100%	Default pool
Totals		\$105,000,000	\$66,000,000		Portfolio value: 0.8559

makers determine they need to adapt their business strategy. We can use sensitivity analysis to assess the impact of the new strategy on the project portfolio by instantly applying new weights to the decision criteria and re-ranking the candidate projects.

Clearly, some projects will be emphasized and some might be eliminated. This ensures that the business process improvement program is consistently aligned with the organizational strategy.

The example continues in Figure 7 (p. 27). As one of the bars on the business drivers is increased, the impact on the order and priorities of the projects changes to show whether the priorities change. This type of sensitivity enables decision makers to test a wide range of scenarios and instantly determine what projects tend to score well across all scenarios.

For example, as impact on the customer increases in priority, the AHP will maintain the ratio relationships between all other criteria while they give equal weight to impact on the customer. With the weight of impact on the customer at 60%, a brand reputation management program becomes the highest priority project and work process improvement slips to sixth position.

Commercially available software products allow the sensitivity analysis to multiple criteria while simultaneously using an optimizer. The purpose of the optimizer is to enable decision makers to apply all types of business rules to the system and to try to maximize the portfolio priority by selecting the best mix of projects available based on constraints.

One type of constraint is a must fund initiative. Consider the project portfolio illustrated in Figure 8. In this company, Sarbanes-Oxley Act (SOX) compliance is not an option, and it must be fully funded. Therefore, the decision maker can force fund the SOX compliance project. Other options are rules about minimums, as well as interdependent projects.

In Figure 8, the industrial manufacturing work stream requires that work process improvement be funded. The optimizer can run with rules such as “only fully fund projects,” or “allow partial funding.” In addition, the optimizer can take into account time horizons to maximize value by sequencing the best projects based on available resources over time.

After all the business rules are entered into the optimizer, the organization is ready to run the optimization. The main rule used by the team is “only fully fund,” meaning the optimizer must give projects their entire request or no money at all.

The optimizer funded the top seven priorities, but then determined that it would get more priority if it did not fund the \$18 million financial system and

instead spread that money over five to six lower ranked projects with a much higher composite priority. The portfolio value measures the overall aggregated priority of all the projects that were funded.

In this example, an organization can deal with the reality of business while still maximizing the value of the portfolio, but under a variety of constraints, such as the mandatory inclusion of certain projects, project dependencies, funding minimums and colors of money.

Table 2 illustrates how to partition funding based on organizational strategy. The optimization capability can be used for any kind of scarce resource, including money, staffing resources, subject matter expertise resources and bandwidth.

Excellent business process improvement portfolio management is critical to ensure that projects are effectively aligned to the strategic objectives of the organization. AHP is the most effective method to ensure the correct portfolio management decisions are made.

AHP creates a structured baseline for continuously improving decision making processes in an organization, which results in higher levels of efficiency and effectiveness. To properly manage a business process improvement program aligned with an organizational strategy, strategy focused organizations should use AHP.

NOTE

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