A Framework for Making a Better Decision

How to Make More Effective Site Selection, Store Closing and Other Real Estate Decisions

Thomas L. Saaty and Michael P. Niemira*

Alan Greenspan described the Federal Reserve's decision making process—under his chairmanship—in an August 26, 2005 speech. He observed that, "Given our inevitably incomplete knowledge about key structural aspects of an ever-changing economy and the sometimes asymmetric costs or benefits of particular outcomes, the paradigm on which we have settled has come to involve, at its core, crucial elements of *risk management*. In this approach, a central bank needs to consider not only the most likely future path for the economy but also the distribution of possible outcomes about that path. The decision makers then need to reach a judgment about the probabilities, costs, and benefits of various possible outcomes under alternative choices for policy." Even if you are not making monetary policy, there are lessons to be learned from the Greenspan approach for everyday business decision making.

Decision making at all levels of an organization is about information collection, evaluation and tradeoffs to analyze complex problems. More often than not, those decisions are made by collective or individual judgment after weighing advantages and disadvantages of policy options under circumstances of risk and uncertainty. Box x-1 highlights the typical process involved in making a decision—whether the process is done consciously or unconsciously.

Lack of a coherent framework to make decisions is especially troublesome when our intuition alone cannot help us to determine which of several options is the most desirable, or the least objectionable, and neither logic nor intuition are of help. Therefore, we need a way to determine which alternative outweighs another, both in the near and long terms. Since we are concerned with real-life problems we must recognize the necessity for trade-offs to best serve the common interest. Therefore, this process should also allow for consensus building and compromise and the ability to assess the sensitivity of a decision to variation in the factors affecting that decision.

Box X-1

Steps to Structure a Decision

1. Problem Definition and Research
2. Eliminating Infeasible Alternatives
3. Structuring a Model
4. Making Judgments
5. Synthesizing
6. Examining and Verifying the Decision
7. Documenting the Decision

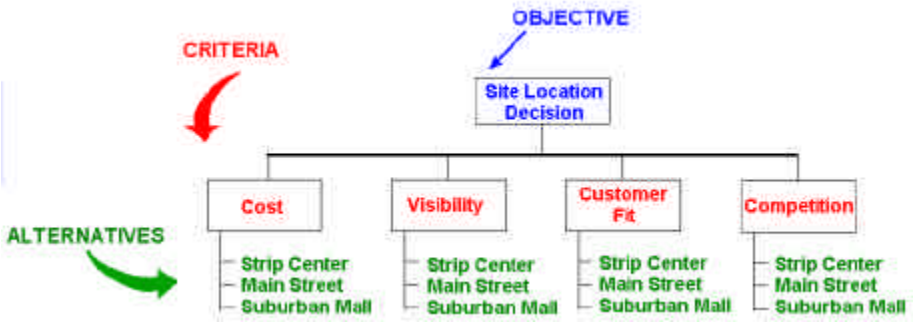
The Basic AHP Framework

Is there a simple and effective way to structure a decision? The answer is a resounding "yes." In the preface of *Decisions By Objectives*, the authors of that book take "decision makers down a new and exciting path—a path that focuses on methods and processes to structure complexity, derive ratio measures for both qualitative as well as quantitative factors, and synthesize in ways never before possible."[1] The methodology that those authors discuss is known as **Analytic Hierarchy Process (AHP), which is a "decision hierarchy, containing a goal or mission statement, objectives or criteria, and alternatives of choice" and "is evaluated by deriving ratio scale priorities from pairwise judgments."** The basic structure of this process is diagrammed in Figure X-1 for a small retailer thinking about where to locate a new store. Obviously, this example is exceedingly simplified, but it demonstrates the main components of the process. There is the **objective** ("site selection decision"), the **criteria** used (costs, visibility, customer fit and competition) to evaluate the information—some of which is qualitative (such as "customer fit") and some of which is quantitative (such as "cost")—and the **alternatives** in the decision.

Figure X-1

Setting the Framework: Goals, Criteria and Alternatives

Small Retailer Site Selection Example



AHP is a mathematical theory for measurement and decision making that was developed by the first author during the mid-1970's when he was teaching at the Wharton Business School of the University of Pennsylvania. Applications of the Analytic Hierarchy Process can be classified into two major categories: (1) *Choice*—The evaluation or prioritization of alternative courses of action, and (2) *Forecasting*—The evaluation of alternative future outcomes.

How to Structure a Hierarchy

Generically, AHP is one of a set of tools known as **multi-criteria decision making** (MCDM). The mathematics of the approach will be left to the reader to explore—since this is just an introduction to the methodology—and there are computer programs available to do that for a user as well. However, the most creative part of decision making that has a significant effect

* Professor, University of Pittsburgh, Katz School of Business.

[1] Ernest H. Forman and Mary Ann Selly, *Decisions By Objectives: How To Convince Others That You Are Right*, World Scientific Publishing, River Edge, NJ, 2001, pp. xvii.

on the outcome is *how the problem is conceived and then modeled or structured*. This is the basis for the discussion of the remainder of this article.

In the AHP, a problem is structured as a **hierarchy**. This is then followed by a process of **prioritization**, which we describe later. Prioritization involves eliciting judgments in response to questions about the *dominance* of one element over another when compared with respect to a specific criterion or property. The basic principle to follow in creating this structure is always to see if one can answer the following question: *Are the elements in a lower level dependent on the current level's factor?*

A useful way to proceed in structuring a decision is to "come down" through the hierarchy from the "goal" or objective as far as one can by decomposing it into the most general and most easily controlled factors. One can then go up from the alternatives beginning with the simplest sub-criteria and aggregating the sub-criteria into generic higher level criteria until the levels of the two processes are linked in such a way as to make comparison possible. Although that may sound very muddled, the process is quite simple and intuitive once you have gone through the process to do it yourself.

Here are some suggestions for designing a hierarchy model: (1) Identify the overall goal. What are you trying to accomplish? What is the main question? (2) Identify the criteria and sub-criteria of the overall goal, which may be specified in terms of ranges of values of parameters or in terms of verbal intensities such as high, medium, low. (3) If relevant, identify time horizons that affect the decision. (4) Identify the key people, their goals and policies. (6) Identify options or outcomes. (7) Perform a benefit/cost analysis using marginal values (this is even built into the AHP process). Because we are dealing with dominance hierarchies, ask which alternative yields the greatest benefit; for costs, which alternative is most costly, and for risks, which alternative is most risky.

To be more specific, consider an AHP model that has been developed to determine which stores to close. Depending on the modeler, this can be structured to simply pick one of two alternatives—"to close" or "to keep open." Alternatively, a "store closing score" can be developed and ranked for each property. The structure of the question will determine the best way to model it. But for the purpose of this discussion, assume that it is a "close/no close" decision that is based on a laundry list of factors, including current demographics, future demographics, strategic fit, new competition since the store was first built, and so on. In this case, it is reasonable that under a "customer fit" criterion that you evaluate the *degree and direction of importance* of factors, such as, the trade area's current age profile, income potential and consumer spending. Using a relative scale, a researcher or a group of decision makers can evaluate the importance of those factors based on whether the factor is or is not supportive of store closure.

Judgments and Comparisons

In this decision making methodology, a judgment is developed using numerical comparisons[1] between two elements (or inputs) of the model that share a common criterion. The set of all such judgments can be represented in a square matrix in which the set of elements is compared with itself. Each judgment represents the dominance of an element in the criterion list (the set of factors) relative to another element in that list.

This discussion of the use of a relative evaluation may seem difficult to understand, but it is the kernel of the methodology. Indeed, ratio scales, proportionality and normalized ratio scales are central for comparison needed to determine and synthesize priorities, whether in AHP or any multi-criteria method.

One recent example of how AHP can be used to blend social and traditional real estate site selection decisions is in a study by Mindshare Solutions Management Consulting[2]. Those researchers used AHP to help a bank's management to decide on the most appropriate location among eight sites under consideration. The AHP framework would not exclude the use of any of the typical tools and information that a researcher would normally use. However, in the bank site selection application, the AHP model incorporated a qualitative variable (along with quantitative measures) for "social responsibility" as a factor for determining the bank's recommended site.

Consider that example of a store closure decision again. Figure X-2 demonstrates the process a little further. Let us

Figure x-2

Sample Evaluation Matrix: Using the AHP Relative 1-9 Scale

The Analytic Hierarchy Process

Using Pairwise Comparisons, the Relative Importance of One Criterion Over Another Can Be Expressed as Follows:

1 EQUAL 3 MODERATE 5 STRONG 7 VERY STRONG 9 EXTREME

	Age Profile	Income Potential	Consumer Spending	Weights*
Age Profile	1/1	1/2	3/1	0.320
Income Potential	2/1	1/1	4/1	0.558
Consumer Spending	1/3	1/4	1/1	0.122

**Derived by "normalizing" the geometric average of the row elements. For example, the first row's geometric average is calculated as the third root of 1 x 0.5 x 3 or 1.145 divided by the sum of the same calculation for the other two rows (to normalize), which equals 3.582. Hence, the row 1 weight is (1.145/3.582) or 0.320.*

[1] A nine-point evaluation scale for relative pairwise comparison is used in this system. The scale captures the **direction** and **degree of importance or intensity** of the factor relative to another factor. Or, if the factors (such as costs per square) are measurable, then the scale can be replaced with "hard" numbers.

[2] *North Coast Bank of Ohio Strategy and Location Project*, unpublished paper, 2002.

assume that the trade area's income potential is moderately good, but the consumer spending pace is anemic. So, it might be your judgment that income is stronger than consumer spending by a moderate amount. Hence, the relative comparison (as shown in Figure X-2) might be evaluated by assigning income a rating of "4" relative to spending. In words, that would imply that income is judged to be moderately strong relative to consumer spending. This process of relative evaluation by "pairs" of factors is simple, but quite powerful.

Moreover, if the pairwise comparison between income potential and consumer spending is set to "4 "(or 4/1), then, by design, the pairwise comparison of consumer spending relative to income would be the inverse of that relationship or a "1/4" (0.25) rating. This process is repeated as many times as there are alternatives and criteria (including multi-layered criteria). But, hopefully, this gives the flavor of the process.

There are other technical application issues with AHP—such as consistency of judgments—but this is beyond the scope of this introduction to the technique. The basic point of these relationships (comparison matrices) are to develop weights for the factors. Additionally, once the model is fleshed out, you can ask "what-if" questions to evaluate the robustness of your decision. For example, you might be interested in how sensitive is your decision to a different age profile evaluation in the above example. Mathematically, the rankings of these priorities are determined using eigenvectors or approximated using geometric averages. Here too, we will leave that discussion to the reader to explore the references.

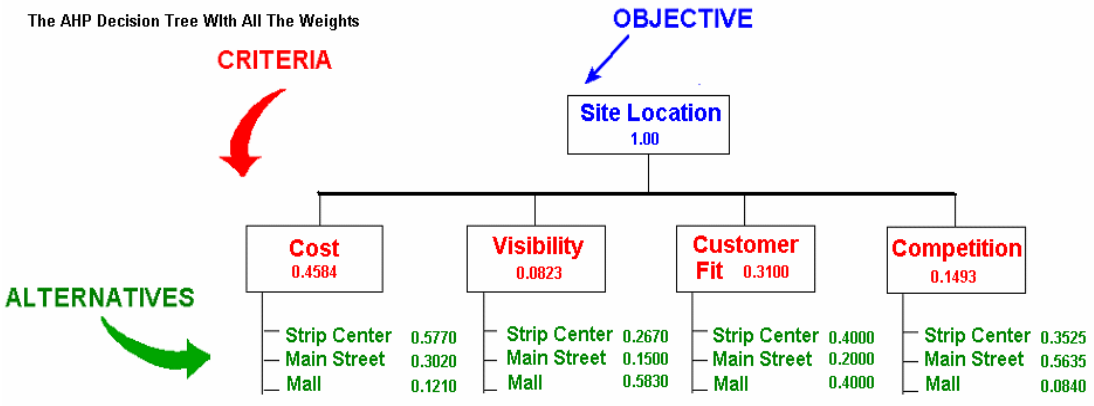
Putting the Pieces Together

Once all of the evaluations are made, it is a matter of some fancy arithmetic. In our original example of a site selection question, the output of that process might look like Figure X-3.

But we are not quite done, since the evaluated components need to be regrouped on each of the alternatives. By doing that, the weighted average of this example for a small retailer yields the following site selection scores by property: strip centers equals 0.463, main street equals 0.297, and the suburban mall location scored 0.240. So, when it came to the retailer's interests to have the lowest cost, highest visibility, best customer fit and least competition, this evaluation suggested that, as evaluated, the small retailer should choose a strip center for its needs.

Figure X-3

Sample Matrix With Weights Evaluated for Retailer's Site Selection Decision



Final Thoughts—AHP Matters for Important Decisions

AHP has appeal to managers and decision makers at all levels of decision making. It enables one to include both the strength of feelings needed to express judgment and the logic and understanding relating to the issues involved in the decision. It combines the multiplicity of judgments into a systematic framework to obtain the best outcome or mix of actions. Finally and more significantly, these outcomes derived in an agreeable and transparent way are in harmony with our intuition and understanding and are not forced by technical manipulations. There are easy to use software packages to use that implement this approach and make decision-making clear and defensible whether it is done by an individual or a group.

The Applications

There are a lot of business and government applications of AHP in decision making. To get you thinking about how it might be applied in your business, consider some of these examples.

- British Airways used it in the late 1990's to decide on the vendor to use for the entertainment system on its entire fleet of airplanes in the new century.
- An oil company used it in the late 1980's to determine the best type of platform to build for drilling for oil in the North Atlantic. A platform costs around 3 billion dollars to build, but the demolition cost was an even more significant factor in the decision.
- Xerox Corporation used the AHP to allocate close to a billion dollars to its research projects.
- The Ford Motor Company, in 1999, used the process to establish priorities for criteria that improve customer satisfaction. Ford gave Expert Choice Inc, the software company which helped them with the study, an Award for Excellence for helping them achieve greater success with their clients.
- In 1986 the Institute of Strategic Studies in Pretoria, a government-backed organization, used the process to analyze the conflict in South Africa and recommended actions ranging from the release of Nelson Mandela to the removal of apartheid and the granting of full citizenship and equal rights to the black majority. All of these recommended actions were implemented within a relatively short time.
- AHP has been used in student admissions, military personnel promotions and hiring decisions.

Since AHP helps organize one's thinking, it can be used to deal with many decisions that are often made intuitively. As a minimum the process allows one to experiment with different criteria and different judgments. *Hope you make a good decision and explore the references!*

Reading List

Forman, Ernest and Mary Ann Selly. *Decision By Objectives*, World Scientific Publishing, River Edge, New Jersey, 2001.

Forman, Ernest. "The Analytic Hierarchy Process – An Exposition." *Operation Research*, Vol. 49 (No. 4), 2001, pp. 469-485.

Palmer, Brian. "Click Here for Decisions: FORTUNE 500 Companies are Discovering New Software that Better Manages the Process of Making Complex Decisions," *Fortune*, May 10, 1999, pp.153-156.

Saaty, T.L., *Decision Making for Leaders: The Analytical Hierarchy Process for Decisions in a Complex World*, RWS Publications, 4922 Ellsworth Ave., Pittsburgh, PA 15213, 2000.

Saaty, T.L., "The Analytic Hierarchy and Analytic Network Processes for the Measurement of Intangibles and for Decision-Making," in *Multiple Criteria Decision Analysis: The State of the Art Surveys*, edited by Figueira, J., Greco, S. and Ehrgott, M., Kluwer Academic Publishers, Dordrecht, 2004, pp. 346-408.

Saaty, T.L., "Fundamentals of the Analytic Hierarchy Process," *The Analytic Hierarchy Process in Natural Resource and Environmental Decision Making*, D.L. Schmoldt, J. Kangas, G. A. Mendoza and M Pesonen, (eds.), Kluwer Academic Publishers, 2001, pp. 15-36.

Saaty, T.L., "The Seven Pillars of the Analytic Hierarchy Process," *Multiple Criteria Decision Making in the New Millennium*, Murat Köksalan and Stanley Zionts, (eds.), Springer, 2001, pp. 15-38.

Zahedi, F. "The Analytic Hierarchy Process: A Survey of the Method and Its Applications," *Interfaces*, Vol. 16 (No. 4), 1986, pp. 96-108.

Thomas L. Saaty holds the position of University Chair, Quantitative Group of the Katz Graduate School of Business at the University of Pittsburgh. He is the architect of the decision theory, the Analytic Hierarchy Process (AHP) and its generalization to decisions with dependence and feedback, the Analytic Network Process (ANP). He has published numerous articles and more than 12 books on these subjects and countless journal articles. His non-technical book on AHP, *Decision Making for Leaders*, has been translated to more than 10 languages. His book, *The Brain: Unraveling the Mystery of How It Works*, generalizing the ANP further to neural firing and synthesis, appeared in the year 2000. Some of the research on neural synthesis was done in collaboration with Luis G. Vargas. He is currently involved in extending his mathematical multicriteria decision-making theory to how to synthesize group and societal influences. He also has developed the *Super Decisions* software that implements the ANP and it is available free at www.superdecisions.com. Saaty was a professor at the Wharton School, University of Pennsylvania for 10 years and before that was for seven years in the Arms Control and Disarmament Agency at the U.S. State Department. He is a member of the National Academy of Engineering and holds editorial positions with the *European Journal of Operational Research, Nonlinear Analysis with Applications, Socio-Economic Planning Sciences, The International Journal of Systems, Measurement and Decisions, The Journal of Fuzzy Sets and Systems, The Journal of Mathematical Modeling, The Physical Review, Journal of Multi-Criteria Decision Analysis* and the *Journal of Systems Science and Systems Engineering* (JSSSE). Among his many honors, Professor Saaty was awarded the gold medal in 2000 for his work on decision making by the International Society of Multi-criteria Decision Making.

Michael P. Niemira is Vice President, Chief Economist and Director of Research for the International Council of Shopping Centers.