The Analytic Hierarchy Process: Structuring, Measurement, and Synthesis

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INTRODUCTION

The challenges of evaluation and decision making are encountered in every sphere of life and on a regular basis. The nature of the required decisions, however, may vary between themselves. While some decisions may reflect individual solutions on simple problems, others may indicate collaborative solutions on complex issues. Regardless of their distinctive nature, all decisions are outcomes of a mental process. The process involves careful evaluation of merits of all the available options leading ultimately to the choice of a single solution. Numerous efforts have been made in the literature to develop decision models ideal for choosing the best solution for a given problem. The dilemma in using these decision models, however, can hardly be avoided. With differences in underlying methodology, each model serves a specific decision-making need of the decision maker. In the absence of a universal framework suitable for handling a variety of problems, decision makers are often required to identify the model best suited for their particular need. Furthermore, they need to take account of the advantages and disadvantages associated with the chosen model.

Recognizing the difficulty of model selection, Thomas L. Saaty, the mathematician, developed a decision-making approach known commonly as the analytic hierarchy process (AHP), which relies mainly on the innate human ability to make sound judgments about small problems (Saaty, 1994, 1996; Saaty & Alexander, 1981). The AHP is a popular method for assessing multiple criteria and deriving priorities for decision-making purposes. This model is different from all other models in that it is able to handle both tangible and intangible attributes of the decision maker. In addition, it has the ability to monitor the consistency with which a decision maker makes his or her judgments (Roper-Lowe & Sharp, 1990). Unlike other available models, AHP can be universally adapted to a wide range of problems and, hence, is an excellent choice for decision making in diverse problems in the fields of quality control, finance, balanced scorecard, and forecasting. It is for these reasons that AHP is now one of the most highly regarded and used models in a wide range of organizations including major corporations, government agencies, and academia (Liedtka, 2005).

BACKGROUND

Dr. Thomas L. Saaty worked for the U.S. Department of State in the 1960s. It was during this time that he realized that many of the available models were too general and abstract for application in a wide range of decision-making needs (Forman & Gass, 2001). In his attempt to create a universal framework as opposed to a specialized framework for modeling real-world problems, Saaty developed the AHP model in the 1970s while working as a professor at the Wharton School of Business (Saaty & Vargas, 1991). As narrated by Saaty, he utilized the methodology taught by his grandmother in developing the model. The methodology consisted of breaking down a complex problem and weighing the decision options against each other (Palmer, 1999).

AHP has three primary functions: structuring complexity, measurement, and synthesis. The first function, structuring, involves configuration of the problem into a hierarchy that describes the problem. With the overall goal placed at the top, the main attributes are placed at a level below the top one. These

attributes can further be subdivided in consecutive lower levels thereby simplifying the decisions at hand. The second function, measurement, involves deriving weights for the lowest level of attributes. This is done by a series of pair-wise comparisons in which every attribute on each level is compared with its siblings in terms of its importance to the parent. Following this, the options available to the decision maker are scored with respect to the attributes. Finally, matrix algebra is used to calculate the final score for each available option (Roper-Lowe & Sharp, 1990).

MAIN FOCUS

Benefits of AHP

The AHP has the ability to elicit decision maker's responses on the relative importance of the problem in three different ways: numerically, verbally, and graphically. These elicited responses are inspired by a pair-wise comparison process. With an option to submit responses in alternative formats, decision makers using the AHP model provide meaningful responses and, thus, produce better results.

Structuring the problems into a hierarchy with the AHP allows the decision makers to deal with the associated complexity in a simple way. The methodology reflects Saaty's observation that human beings deal with complexity simply by structuring it into homogeneous clusters of factors (Forman & Gass, 2001). With problems broken up into clusters, individuals find it easier to evaluate the importance of each alternative available for solution. Other scientists have shared Saaty's views in this respect.

The effectiveness of structuring incorporated in the AHP model is backed up by evidence. Most of today's organizations use a hierarchy structure in order to ease the decision-making process.

Hierarchy building is a powerful instrument at the initial stages of setting up problems and considering alternatives. By allowing information to be organized, the structure allows the decision maker to better understand the interaction of the elements of a problem (Gass, 1985). Additionally, the structure minimizes the possibility of overlooking elements of the problem; is-

sues and ideas ignored at previous levels can become apparent at advanced levels.

The ability to measure consistency is also a major strength of the AHP. AHP uses the eigenvalue technique that allows for computation of a consistency measure, an estimated arithmetical indicator of the inconsistencies or intransitivity in a set of pair-wise ratings (Warren, 2004). This measure is popularly referred as the consistency index. Pair-wise comparison ratings are considered consistent and acceptable as long as the consistency ratio (CR) is lower than 0.10. A ratio higher than 0.10 warrants additional review and evaluation of the results. The management team in charge of the evaluation process can take precautionary measures to avoid costly mistakes of repeated trials. In particular, the team should take precaution when dealing with a large number of alternatives capable of producing inconsistencies.

The AHP is also well known for its ability to compare intangible and tangible factors. This is easily accomplished through pair-wise comparisons with a nine-point scale. Even though it is feasible to do these comparisons, it has been suggested not to mix both factors in the same hierarchy. For cases that fail to satisfy this condition, an alternative approach of using a link attribute can prove useful. This link attribute helps to make a meaningful comparison of both tangible and intangible factors (Roper-Lowe & Sharp, 1990). The link attribute is weighed against the tangible and intangible factors in pair-wise comparisons. In the following stage, the intangible factors can be weighed against tangible ones by scaling the weight of the link attribute.

Finally, AHP is also useful in providing records about circumstances surrounding each decision. Records can be reviewed at a later point in time to determine how and why a particular decision was arrived at. This can become very useful when evaluating decisions that were previously made but need to be considered again for changes in circumstances. For example, additional information about the alternatives used in pair-wise comparisons can become available in the future. Decision makers can quickly process this new information in order to reevaluate original scores and measure the impact of new data on their initial decision. In cases where organizations are required to make similar decisions on an ongoing basis, the same hierarchy can be reused as a background for constructing a new hierarchy.

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