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MARKETING APPLICATONS OF THE ANALYTIC HIERARCHY PROCESS*

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Several marketing applications of the Analytic Hierarchy Process (AHP) are reviewed. The paper starts with a brief description of this process, which was developed by Thomas Saaty in 1971, including an eight-point outline of how to apply it. The thrust of the paper is a discussion of a number of illustrative applications of the AHP covering the following areas:

1. the portfolio decisions of a firm whose management is concerned with the determination of the desired target portfolio and allocation of resources among its components,
2. determination of the directions for new product development, and
3. generation and evaluation of marketing mix strategies.

Various suggestions for additional research on the AHP and its marketing applications are highlighted.

(MARKETING; CORPORATE PLANNING; RESOURCE ALLOCATION)

1. Introduction

The analytic hierarchy modeling and measurement process (Saaty [6]) is a recent addition to the various approaches used to determine the relative importance of a set of activities or criteria. The novel aspect and major distinction of this approach is that it structures any complex, multiperson, multicriterion, and multiperiod problem hierarchically. Using a method for scaling the weights of the elements in each level of the hierarchy with respect to an element (e.g., criterion) of the next higher level, a matrix of pairwise comparisons of the activities can be constructed where the entries indicate the strength with which one element dominates another with respect to a given criterion. This scaling formulation is translated into a largest eigenvalue problem which results in a normalized and unique vector of weights for each level of the hierarchy (always with respect to the criterion in the next level) which in turn results in a single composite vector of weights for the entire hierarchy. This vector measures the relative priority of all entities at the lowest level that enables the accomplishment of the highest objective of the hierarchy. These relative priority weights can provide guidelines for the allocation of resources among the entities at the lower levels of the hierarchy. When hierarchies are designed to reflect likely environmental scenarios, corporate objectives, current and proposed product/market alternatives, and various marketing strategy options, the Analytic Hierarchy Process (AHP) can provide a framework and methodology for the determination of a number of key corporate and marketing decisions of the firm.

The purpose of this paper is to suggest the potential application of the AHP to various marketing decisions. The paper starts with a brief description of the AHP—what it is, its conceptual foundation, required inputs, analytical processes, output, and

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areas of application. This is followed by a discussion of three specific marketing applications to:

(1) the determination of a target product/market/distribution portfolio,
(2) generation and evaluation of new product concepts,
(3) marketing mix determination.

These first applications of the AHP to marketing decisions illustrate some of the potential that this process holds for marketing. The final section of the paper outlines a few additional marketing applications and focuses on some required directions for future research, with particular emphasis on the conceptual and methodological issues requiring additional development and testing.

2. The Analytic Hierarchy Process[1]

The AHP focuses on dominance matrices and their corresponding measurement—the ignored areas of research compared with the more popular proximity, profile, and conjoint measurement approaches (Shepard [13]). It goes beyond the Thurston [14] comparative judgment approach by relaxing the assumption of normality on the parameters; e.g., equal variance and zero covariance and restriction of the type of comparisons. Similar to the conjoint analysis approaches, the Analytic Hierarchy Process is based on a tradeoff concept. In conjoint analysis, the respondent is confronted with the tradeoff task, whereas the analytic hierarchy develops the tradeoff in the course of structuring and analyzing a series of simple reciprocal pairwise comparison matrices.

The approach is based on three major components:

1. AHP starts by decomposing a complex problem into a hierarchy; each level consists of a few manageable elements and each element is, in turn, decomposed into another set of elements. The process continues down to the most specific elements of the problem, typically the specific courses of action considered, which are represented at the lowest level of the hierarchy.

Structuring any decision problem hierarchically is an efficient way of dealing with complexity and identifying the major components of the problem. There is no single general hierarchical structure, and one of the major attributes of the AHP is the flexibility it allows management in constructing a hierarchy to fit their idiosyncratic needs. Consider, for example, the simple 3-level hierarchy of environmental scenarios, objectives, and courses of action. Such a hierarchy, as illustrated in Exhibit 1, can aid management in identifying their relevant objectives and forces them to explicate the environmental scenarios most likely to affect their business decisions and to be creative in generating specific courses of action. Whenever a number of executives are involved, the discipline forced by the need to structure the problem hierarchically may help achieve consensus over the dimensions of the problem. (The same benefits can also be achieved if management structures the hierarchy differently; for example, overall purpose, objectives, courses of action, and scenarios.)

2. A measurement methodology is used to establish priorities among the elements within each stratum of the hierarchy. This is accomplished by asking the participating managers to evaluate each set of elements in a pairwise fashion with respect to each of the elements in a higher stratum. This measurement methodology provides the frame-

[1] This discussion is based on Y. Wind and D. Gross [17] and Saaty [6].

work for data collection and analysis and constitutes the heart of the Analytic Hierarchy Process. Structurally, the hierarchy is broken down into a series of pair comparison matrices, and the participants are asked to evaluate the off-diagonal relationship in one half of each matrix. (Reciprocals are placed in the transposed positions.) Exhibit 2 illustrates one pairwise comparison matrix for part of the hierarchy presented in Exhibit 1.

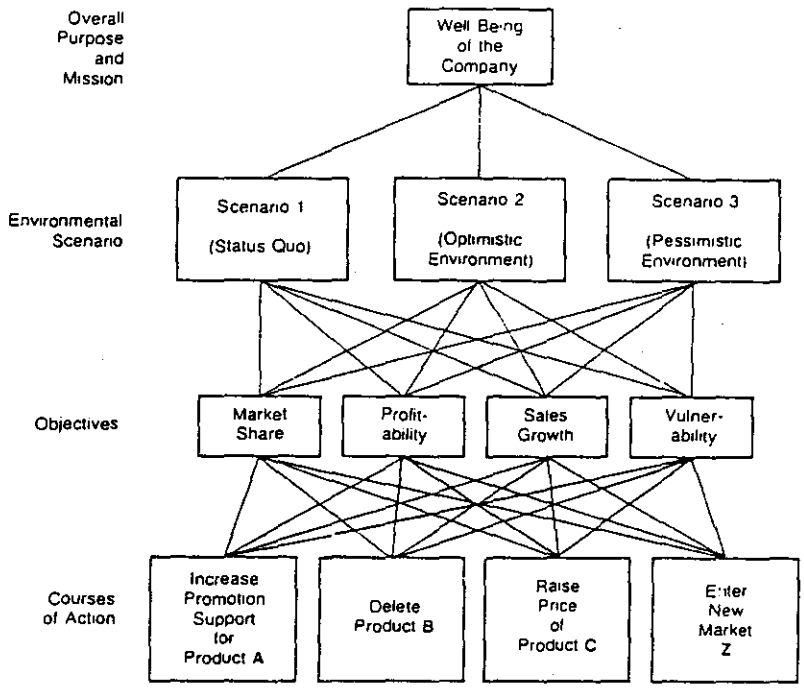

EXHIBIT 1. An Illustrative Basic Decision Hierarchy.

Profitability	1 Increase Support of Product A	2 Delete Product B	3 Raise Price of Product C	4 Enter New Market Z
1. Increase Support of Product A	1			
2. Delete Product B		1		
3. Raise Price of Product C			1	
4. Enter New Market Z				1

Reciprocal values

Judgments
(2 vs 1, 3 vs 1, 4 vs 1,
3 vs 2, 4 vs 2 and 4 vs 3)

EXHIBIT 2. An Illustrative Data Collection Matrix.

The respondent's task is to evaluate the six pairs in the matrix. Each pair is evaluated separately as to the degree to which one item of a pair dominates the other with respect to the elements from the next level in the hierarchy. In this case an illustrative instruction to the respondent would be: "which option—"increase export of Product A" or "Delete product B"—is more important in helping achieve the corporate profit objectives and how important is it?" To provide a numerical judgment in making such pairwise comparisons, a reliable and workable scale is needed.[2] We assume that the elements involved in the comparison are of the same order of magnitude; i.e., their relative weights do not differ by more than 9. If they do, they can be separated into clusters. The 9-point scale used in typical analytic hierarchy studies is:

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective.
3	Weak importance of one over another.	Experience and judgment slightly favor one activity over another.
5	Essential or strong importance.	Experience and judgment strongly favor one activity over another.
7	Demonstrated importance	An activity is strongly favored and its domimance is demonstrated in practice.
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals of above nonzero	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	

Using this scale the participating managers assess the dominance of each element over the others (within the structure) with respect to each element of the immediate higher levels of the hierarchy. Thus, judgments for a matrix such as the one illustrated in Exhibit 2 would offer the necessary data for calculating the priorities of the various courses of action. Similarly, when the objectives are evaluated with respect to their importance under the various scenarios, it allows for the calculation of the relative importance of the various objectives. The individual judgments are made in a group setting, involving the relevant decision makers, and serve as a basis for a discussion on

[2]The 9-point scale was selected since it offers a wide enough range of levels, while still being within the number of options respondents can handle (7 ± 2). In a number of scale development studies this particular scale was found to be highly reliable. For further discussion of the scale and its properties, see Saaty [7].

the reasons for specific judgments.[3] Such discussions often result in agreement and in those cases in which agreement cannot be reached, a sensitivity analysis can be conducted to assess to what extent the divergent judgments lead to significantly different results.

3. A measurement theory to establish the priorities of the hierarchy and the consistency of the judgmental data provided by the group of respondents.

Calculating the priorities. The basic premise of the Analytic Hierarchy Process is that measurement evolves out of comparisons, particularly pairwise comparisons. Let us suppose that we have n objects $A_1, \ldots, A_n$ whose vector of corresponding weights $w = (w_1, \ldots, w_n)$ is known. Let us form the matrix of pairwise comparisons of weights

$$A = \begin{array}{c} \\ A_1 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & \cdots & A_n \end{array} \\ \begin{bmatrix} w_1/w_1 & \cdots & w_1/w_n \\ \vdots & & \vdots \\ w_n/w_1 & & w_n/w_n \end{bmatrix} \end{array}$$

We note that we can recover the scale of weights $w_1, \ldots, w_n$ by multiplying A on the right by w, obtaining nw, and then solving the eigenvalue problem $Aw = nw$ which has a nontrivial solution since n is the largest eigenvalue of A. (The matrix A has unit rank, hence all but one of its eigenvalues $\lambda_1, \ldots, \lambda_n$ are zero. Since $\sum_{i=1}^{n} \lambda_n = \text{trace}(A) = n$, n is the maximum eigenvalue.)

In general, we do not know the ratios w_i/w_j but we may have estimates of them from data and experiments or even from experienced judges. We would elicit a judgment and automatically enter its reciprocal in the transpose position. In that case we have perturbations of A which lead to perturbations in the eigenvalue of A. We can show that now we must solve the problem $Aw = \lambda_{\max} w$ to obtain an estimate of the weights w. A pairwise comparison reciprocal matrix is used to compare the relative contribution of the elements in each level of the hierarchy to an element in the adjacent upper level. The principal eigenvector of this matrix is then derived and weighted by the priority of the property with respect to which the comparison is made. (That weight is obtained by comparing the properties among themselves as to their contribution to the criteria of a still higher level. The weighted eigenvectors can now be added componentwise to obtain an overall weight or priority of contribution of each element to the entire hierarchy.)

This process of principal eigenvector extraction and hierarchical weighting and composition leads to a unidimensional scale for the priorities of the elements in any level of the hierarchy. The resulting priorities represent the intensity of the respondent's judgmental perception of the relative importance of the elements represented in the hierarchy considering the importance of and tradeoffs among the criteria.

Calculating the consistency. It has been show that $\lambda_{\max} \geq n$ always and that $\lambda_{\max} - n/(n-1)$ serves as a consistency index which gives the departure from consistency in estimating the ratios w_i/w_j, with consistency obtaining if and only if $\lambda_{\max} = n$. Consistency is defined by the relation between the entries of A: $a_{ij}a_{jk} = a_{ik}$ which means that if we have n entries that form a spanning tree, the remainder of the matrix

[3]The group discussion feature is a critical component of the AHP process whenever the decision to be made involves more than a single decision maker.

can then be generated from them. In this approach to measurement, inconsistency is stronger than transitivity and is admissible provided we can specify its effect on the final results. The consistency index is compared with what it would be if our numerical judgments were taken at random from the scale 1/9, 1/8, 1/7, . . . , 1/2, 1, 2, . . . , 9 (using a reciprocal matrix).

Using a sample of size 500 each, Saaty and Mariano [8] have established for different order random entry reciprocal matrices an average consistency index which ranges from 0 for 1 or 2 element matrices through 0.9 for 4 element matrices to 1.49 for 10 element matrices. A consistency ratio (consistency index as percentage of the appropriate random average consistency) of about 10% or less is considered very good. When the consistency is poor, one needs to get more information on the activities being compared with respect to the criterion of comparison, and typically such information gathering is then followed by another round of judgments. The measure of consistency has also been extended to an entire hierarchy.

The specific steps involved in the development and analysis of an analytic hierarchy are specified in Exhibit 3. The process offers great flexibility for the structuring of the problem but specifies the use of a 9-point evaluative scale, reciprocal matrices and the use of ratio scale estimates by solving eigenvalue problems. Whereas other scales can obviously be used, a substantial amount of experimentation has led Saaty [7] to recommend the use of this particular scale which has been easily comprehended by respondents, has exhibited high test/retest reliability scores, and is conducive for use in a group setting.

1. Define the problem and specify the solution desired.

2. Structure the hierarchy from the overall managerial purposes (the highest levels) through relevant intermediate levels to the level where control would alleviate—or solve—the problem.

3. Construct a pairwise comparison matrix of the relative contribution or impact of each element on each governing objective or criterion in the adjacent upper level. In such a matrix of the elements by the elements, the elements are compared in a pairwise manner with respect to a criterion in the next level. In comparing the i, j elements, people prefer to give a judgment which indicates the dominance as an integer. Thus, if the dominance does not occur in the i, j position while comparing the ith element with the jth element then it is given in the j, i position as a_{ji} and its reciprocal is automatically assigned to a_{ij}.

4. Obtain all $n(n-1)/2$ judgments—specified by the set of matrices developed in (3).

5. Having collected the pairwise comparison data and entered the reciprocals together with n unit entries down the main diagonal, the eigenvalue problem $Aw = \lambda_{max} w$ is solved and consistency is tested.

6. Steps 3, 4 and 5 are repeated for all levels and clusters in the hierarchy.

7. Hierarchical composition is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to each element to obtain the composite priority of the element in a level. These are then used to weight the eigenvectors corresponding to those in the next lower level and so on, resulting in a composite priority vector for the lowest level of the hierarchy.

8. Consistency is then evaluated for the entire hierarchy by simply multiplying each consistency index by the priority of the corresponding criterion and adding overall such products. The result is divided by the same type of expression using the random consistency index corresponding to the dimensions of each matrix weighted by the priorities as before. The ratio should be about 10% or less for acceptable overall consistency. Otherwise, the quality of the judgmental data should be improved.

EXHIBIT 3. An Outline of the Analytic Hierarchy Approach.

If one forces consistency of response by taking only $n - 1$ judgments and forcing the other judgments to conform with the relations among the $n - 1$ judgments, then the eigenvalue method would yield similar results to those which can be obtained from a simple addition of rows or with a normalization of each column and then averaging over the rows. However, it is easy to show by examples for which the answers can be validated that simple arithmetic estimates such as row averages yield unsatisfactory results.

Consider, for example, the optics experiment mentioned in a number of the references (Saaty [6], [7]). In this experiment an (inconsistent) judgment matrix of a given respondent's evaluation of the brightness of objects positioned in specified distances from him, was:

1	5	6	7
1/5	1	4	6
1/6	1/4	1	4
1/7	1/6	1/4	1

The eigenvalue solution of this problem yields 0.61, 0.24, 0.10, 0.05 for the eigenvector. The inverse square law of optics (the validation measure) yields 0.61, 0.22, 0.11, 0.06 as the actual answer, and the two results are close.

It can be seen from this reciprocal matrix that for this matrix to be consistent, the third entry of the second row should have been 6/5; however, that entry is 4. The normalized row sum process yields 0.51, 0.30, 0.15, 0.04, with errors in excess of 20% for some of the entries.

Despite these differences it is important to note that the rank order of the four entries is the same. Yet, the available computer AHP algorithm makes it as easy to calculate the eigenvalue solution as it is to use the row sums. This has the added advantage of calculating for each matrix the level of consistency of the input judgments.

The normalized geometric mean of the rows can serve as a good approximation, for the eigenvalue method. Yet when the matrix is consistent, the geometric mean does not usually give the correct solution. If one has only a hand calculator, the geometric mean may be used, but then one still has to estimate the index of consistency—a measure of considerable value since it informs the judges about the adequacy of their knowledge and whether they need to study the matter further in order to obtain greater coherence in their understanding of the problem.

During the last 5 years AHP has been applied to a variety of (nonmarketing) problem areas including: allocation of resources (e.g., the allocation of electricity to industry in case of shortage, according to industries' contribution to health, welfare, employment, national defense and other objectives, Saaty and Mariano [8], and allocation of a country's resources, e.g., the Sudan Project, Saaty [6]); conflict resolution (e.g., guidelines for negotiating with terrorists, Saaty and Bennett [9]); forecasting (e.g., predicting the outcome of the Karpov-Korchnoi match of 1978 based on a hierarchy reflecting the players' technical and psychological characteristics as judged by a group of grand masters, Saaty and Vargas [12]); input-output analysis (e.g., estimates of input-output coefficients for the Sudan Project, Saaty and Vargas [10]); planning (e.g., forward planning of the future of higher education, Saaty [7], backward planning of the Sudan transportation system, Saaty [6], and integrated forward and backward planning in designing a new product development system for a

financial service); and choice behavior (e.g., lease/buy decisions for a fleet of cars, Saaty and Vargas [11], and a number of small scale choice studies involving, for example, a choice of a school and vacation, Saaty [7]).

Conceptually the AHP is applicable to the modelling of any choice situation which lends itself to a hierarchical representation of at least two levels: objectives (criteria for evaluation) and activities (products, courses of action, etc.).

3. An Analytic Hierarchy Formulation of the Portfolio Decision

The AHP is ideally suited to the allocation of a firm's resources among the products in its target product portfolio. Most product portfolio approaches[4] (such as the Boston Consulting Group share/growth matrix, the Shell International sector profitability and competitive position matrix, and the other commonly used portfolio models of A. D. Little and McKenzie), although helpful in portraying the current position of the firm's products on the selected dimensions, do not provide explicit rules for the selection of the target portfolio (e.g., what combination of "dogs," "problem children," "cash cows," and "stars" should a company have?) and is based on a small set of a priori selected dimensions which might not include the dimensions (criteria) critical to specific management situations such as risk, demand on resources, etc. In contrast, the desired portfolio approach would provide explicit guidelines for the allocation of resources among the components of the target portfolio and base such an allocation on the relevant management criteria and their relative importance.

Current approaches to resource allocation (such as industrial dynamics, Forester [1], and mathematical programming, Gass [2]) are rarely used by top management for the allocation of resources among the various products and businesses of the firm. The limitations of the current approaches to resource allocation at the corporate level are especially evident if one considers not a simple allocation among the current products but rather an allocation which would take a more realistic posture and incorporate the following alternatives:

- new products and businesses
- existing and potential new markets
- existing and new modes of distribution

and in the case of international operations:

- existing and new countries and their associated mode of entry (export, joint venture, etc.).

This focus on both the existing products/markets and distribution outlets as well as the *new* directions of growth, is a critical component of any strategic planning effort since it incorporates not only the resource allocation under existing conditions but forces the managers/planners to incorporate their assessment of likely future scenarios and their anticipated impact on the firm and its ability to achieve its objectives.

From a conceptual point of view, therefore, the product portfolio of the firm should be extended to the portfolio of product/market/distribution options which recognizes explicitly that most companies can grow by introducing (by internal development or mergers and acquisitions) new products, entering new markets (domestic and foreign), utilizing new methods of distribution or any combination of the above. This reformulated view of a firm's portfolio options is an extension of the more conventional product by market matrix proposed by many corporate strategists (see, for example,

[4] For a discussion of the various product portfolio models, see Wind [16].

Johnson and Jones [5]). It further suggests that the portfolio decision should not be limited only to *products*.

An Illustrative Application[5]

The Colonial Penn Insurance Company is a fast growing company, specializing in developing and marketing auto and homeowner's policies to the over-50 market segment. Company management faces the key strategic question of determining the company's direction for future growth. Should the company continue to focus its efforts only on insurance products and, in particular, the over-50 market or should they diversify into other products and markets? Furthermore, given the firm's historical strength in the direct mail operation, should they focus their operation on products and markets that can be reached effectively by mail or should they consider developing new distribution vehicles such as telephone, stores, agents, etc.

The AHP was used to help guide the selection of the desired target portfolio of products/markets and distribution outlets, and direct the allocation of resources among the portfolio's components. A hierarchy was developed jointly with the company president and is presented in a disguised form in Exhibit 4. This hierarchy is based on three major levels:

1. *Environmental scenarios* expressed as three summary scenarios reflecting:
   - an optimistic environment (low risk and potentially high return environmental conditions),
   - continuation of the status quo,
   - a pessimistic scenario (high risk and potentially low return environmental conditions).
2. *Corporate objectives*—the criteria for the evaluation of the various courses of action. Five objectives were identified:
   - profit level
   - sales growth
   - market share
   - volatility
   - demand on resources
3. *The courses of action—activities*. These include the three sets of products, markets and distribution outlets but went into considerably greater specificity of potential activities including various new distribution outlets not currently used by the firm, new market segments and specific new product activities.

Given the sensitive nature of information on the firm's plans for allocation of its resources among alternative courses of action, the actual options are disguised and referred to by letters and numbers which do not correspond in any order to the items listed above.

Having selected the hierarchical structure outlined in Exhibit 4 the president evaluated all pairwise comparisons using the 9-point scale discussed earlier. These evaluations resulted in reciprocal matrices of the components of each level against the items in the level above. Consider, for example, the evaluation of the three major sets

[5]This application is based on a project conducted by the authors and reported in Y. Wind and D. Gross [17]. This application of the AHP is to the selection of a target portfolio and the allocation of resources among its components. It is not concerned with the identification of the current portfolio of the firm (the portfolio analysis part which is at the core of the existing approaches to product portfolio such as the Boston Consulting Group's model).

of activities against the objectives. This involved five pairwise matrices such as:

Profit Level	Products	Customers	Distribution
Products	1	1/3	1/5
Customers	3	1	1/4
Distribution	5	4	1

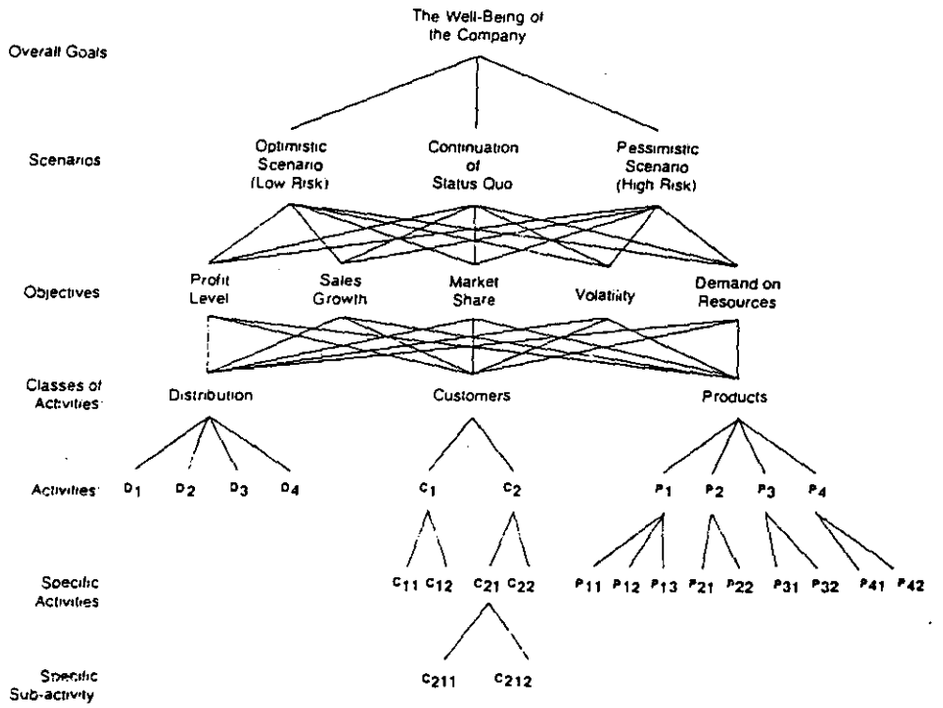

EXHIBIT 4. A Disguised Analytical Hierarchy for the Selection of a Target Product/Market/Distribution Portfolio for Colonial Penn Insurance Company.

In this case, the president judged distribution to be of strong importance (5) over product in leading to the achievement of the firm's target profit level, but somewhat less important when compared to customers (4). In evaluating customers vs. products, the president judged customers to be of weaker importance over products (3). Given the three judgments the reciprocals were added and the president continued with the pairwise comparison tasks of other matrices. These tasks included the evaluation of:

- scenarios against the overall objectives of the firm
- objectives against each scenario
- the classes of activities and subactivities against each of the objectives
- the cross impact evaluation of the likely occurrence and impact of each component given each of the other components at the same level of the hierarchy.

These data provided the input to the eigenvalue analysis (Saaty [6]) and a resulting partial hierarchy is presented in Exhibit 5.

An examination of this exhibit suggests explicit rules for allocating the firm's

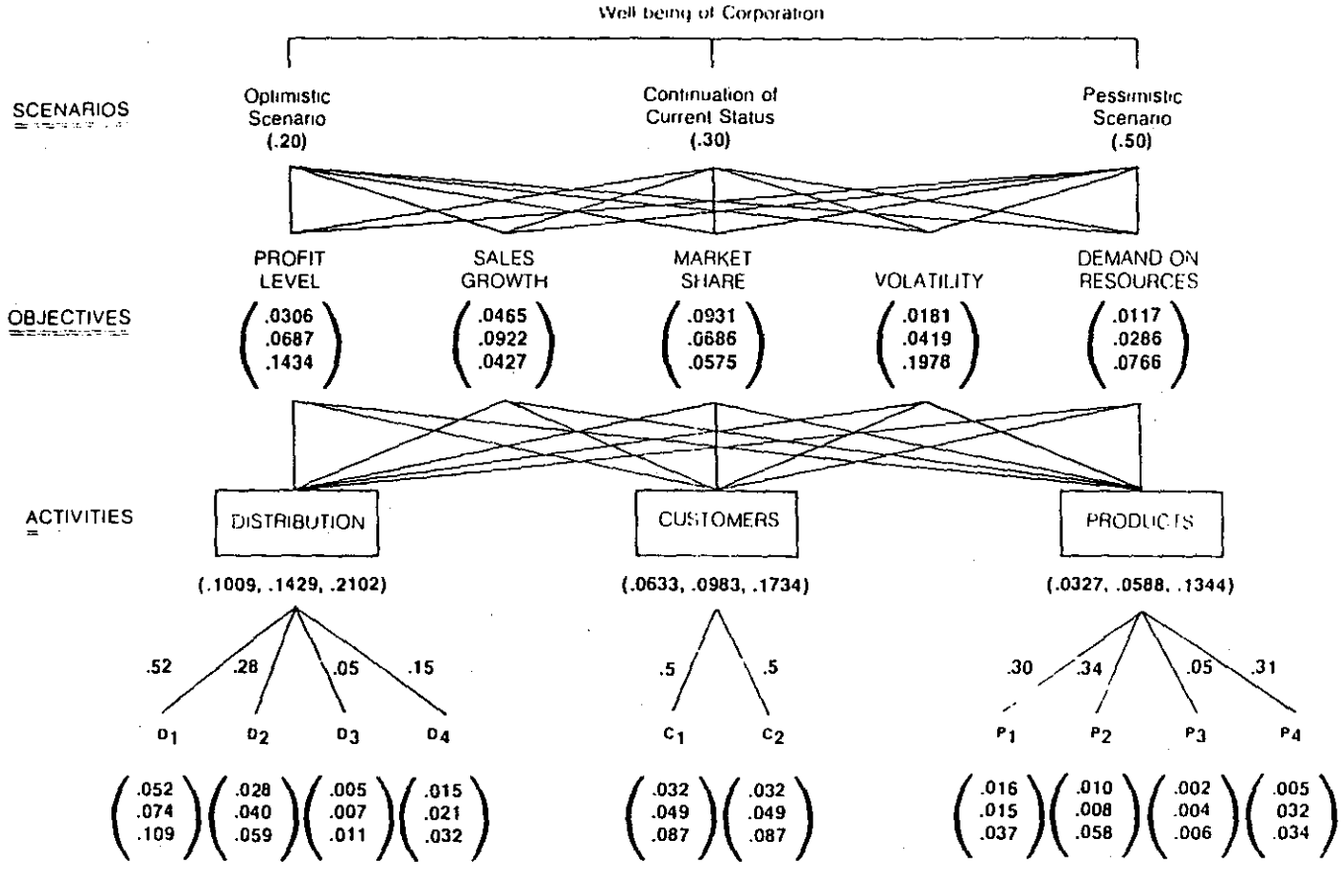

Exhibit 5. An Analytical Hierarchy of the Products/Customers/Distribution 'Portfolio' of an Insurance Firm.

resources in developing products, markets, and distribution vehicles under three alternative scenarios. In the disguised example presented in Exhibit 5, the president has a strong preference for the development of distribution outlets. In fact, the allocation of the developmental resources of the firm under this example should be 0.45 to the development of (current and new) distribution outlets, 0.35 to (current and new) market segments, and 0.22 to (current and new) products. This rule suggests allocating resources in proportion to the priorities. (Other resource allocation rules, such as the ratio of priorities (benefits) to costs, can also be used.) The output as presented in Exhibit 5 provides a significant amount of information such as:

- The perceived likelihood of occurrence of the three scenarios is:

optimistic	0.2
status quo	0.3
pessimistic	0.5

- The relative importance of the five objectives are:

profit level	0.2427
sales growth	0.1814
market share	0.2192
volatility	0.2578
demand on resources	0.1169

- The overall weight of each objective reflects the importance of the objective under the three scenarios (e.g., the overall importance of profit level is 0.2427 which is based on 0.0306 under optimistic scenarios, 0.0687 under condition of status quo and 0.1434 under pessimistic conditions). An examination of the results suggests that the relative importance of the various objectives varies considerably by the anticipated scenario. For example,
- sales growth is twice as important under continuation of status quo as the other two scenarios (0.92 vs. 0.045 and 0.042);
- market share is most important under an optimistic scenario (0.093 vs. 0.068 and 0.057)
- profit level, volatility, and demand on resources are most important under pessimistic scenarios.

A sensitivity analysis was conducted using alternative hierarchical formulations, as well as different assumptions concerning the likely occurrence of the various scenarios. These analyses resulted in a *range of priorities*. Given that this range suggested an allocation of resources significantly different from the firm's current resource allocation pattern, it has led the president to reevaluate his firm's activities and assign task forces to those aspects of the portfolio (as suggested by the detailed priorities of Exhibit 5) which did not receive the attention and resources they deserve.

4. AHP Formulation for the Generation and Evaluation of New Product Concepts

New product development efforts in many cases have resulted in a focus on low risk "me too" products, or at the other extreme in new products which, although innovative, do not capitalize on the firm's strengths. In both cases, the firm loses the benefits of a potentially synergistic new product entry. In these cases, it might be desirable to determine the boundaries of and direction for the new product development efforts.

Such explicit consideration could help increase the likelihood that at least some of the new product development efforts will be directed toward truly innovative new products. This latter consideration is critical given the prevailing risk avoidance tendency and the time pressures often imposed on many new product development activities.

The AHP can offer a useful approach to the determination of the new product development directions. Furthermore, utilization of the AHP in this context allows management to concurrently proceed with three other critical phases of the new product development efforts and integrate them with the first phase of determining the direction for the new product development efforts. These three additional tasks are:

1. Generation of new product ideas. Managers participating in the AHP often possess a tremendous amount of knowledge about their product category and markets. It is desirable, therefore, to capture this cumulative knowledge and utilize the AHP sessions also as a "brainstorming" session aided by relevant background information—in the form of a synthesis of previous research—to generate additional new product ideas.

2. Grouping new product ideas that were generated from a variety of sources (e.g., R & D, marketing research, etc.). This clustering of ideas is essential for any new product development system since it collapses hundreds of ideas, many of which are closely related to each other, into a manageable number of groups of ideas.

3. Evaluation of the various ideas based on the degree to which they can help achieve the desired corporate objectives under a variety of scenarios.

An Illustrative Application

A leading manufacturer of a frequently purchased product line concerned with the lack of innovativeness of the firm's new product activities applied the AHP. Seven executives representing diverse groups within the firm (marketing, marketing research, new product development, technical R & D) and an advertising agency spent 2 days in a concentrated effort, following the AHP framework aimed at determining the directions the firm should take to achieve its long and short term objectives and identifying specific new product opportunities.

The overall hierarchy developed by the group is presented in Exhibit 6 together with disguised results. This hierarchy provided only the first phase in the overall process. The entire process involved 3 phases:

1. Identification of a basic hierarchy (Exhibit 6) relating the 1980 new product opportunities of the firm to action criteria, market segment opportunities, and specific product areas. An examination of the priorities of the action criteria with respect to the importance of achieving the firm's 1985 objectives suggested that the importance of these objectives is not likely to change in evaluating projects for 80 or 85.

2. Detailed evaluation of high priority product areas and the establishment of the *desired project mix*. This phase included:

(a) Selection of the 5 top product areas—A, B, F, D, &H—for each area, identification of major project areas.

(b) Identification of criteria for evaluating new product development projects. Four criteria were identified—speed of entry, required investment, long-run ROI and likelihood of success.

(c) Evaluation of these criteria with respect to their importance for 1980 and 1985. This evaluation was conducted using two AHP matrices resulting in the following

priorities:

	1980	1985	Change
Speed of entry	0.47	0.14	− 0.33
Investment	0.05	0.05	—
Long-Run ROI	0.16	0.45	+ 0.29
Likelihood of Success	0.31	0.36	− 0.05

(d) Evaluation of the projects identified in (a) on the criteria for 1980 and 1985.

(e) Selection of two sets of projects: First tier projects with the highest priority on the 1980 "speed of entry" objective and second tier projects with high priority on the 1985 ROI objective.

(f) Evaluation and selection of the desired mix of 80/85 projects consistent with the allocation of resources suggested in Exhibit 6 between projects with short-term payoff (80%) and long-term projects (20%). This process resulted in the identification of 10 first-tier projects aimed at achieving the short-term corporate objectives. The projects involved 3 for product A, 3 for B, 2 for C, and one each for D and E. In addition, 5 second-tier projects were identified with expected long-term payoff. Management reaction to the results was favorable and they started implementing the recommendation.

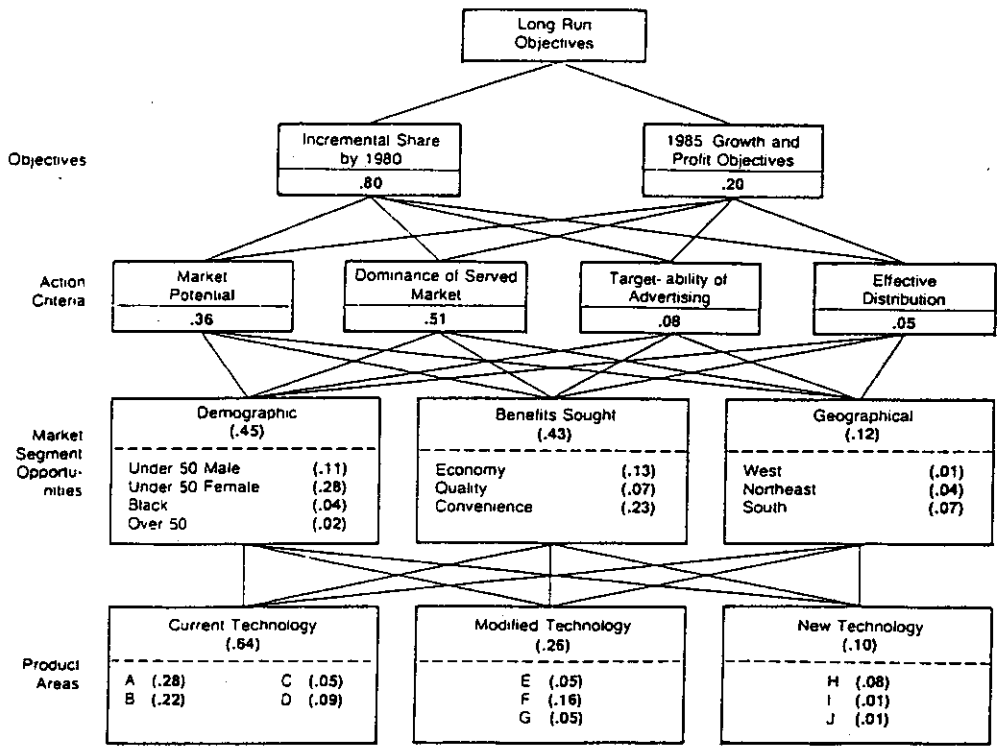

EXHIBIT 6. Overall Long Run New Product Opportunity Hierarchy (Disguised).

5. AHP Formulation for Marketing Mix Determination

Exhibit 7 illustrates a structure of a marketing mix hierarchy for a consumer service. The managers who constructed this hierarchy had some difficulty with the formulation of the marketing mix decisions (the bottom level of the hierarchy) and therefore also examined a number of alternative formulations. The alternate selected used the same top 5 levels but changed the bottom level of the hierarchy from a set of *mixes* to *components*.

The pairwise reciprocal matrices were completed by the participating managers and analyzed resulting in priorities for each of the levels of the hierarchy. This hierarchical structure captured the *benefit* side of the marketing decisions. A second hierarchy—a cost hierarchy—was constructed focusing on three cost components: monetary costs, time costs, and management time costs. This hierarchy included the evaluation of the costs under three sets of conditions: (a) various marketing mix strategies (for specified segments and positionings), (b) competitive, market, and government actions, and (c) overall environmental conditions. The separate cost hierarchy reflected management preference to base its decision on an explicit and detailed cost/benefit analysis. In other cases, the cost can be included as one of the objectives of the basic hierarchy.

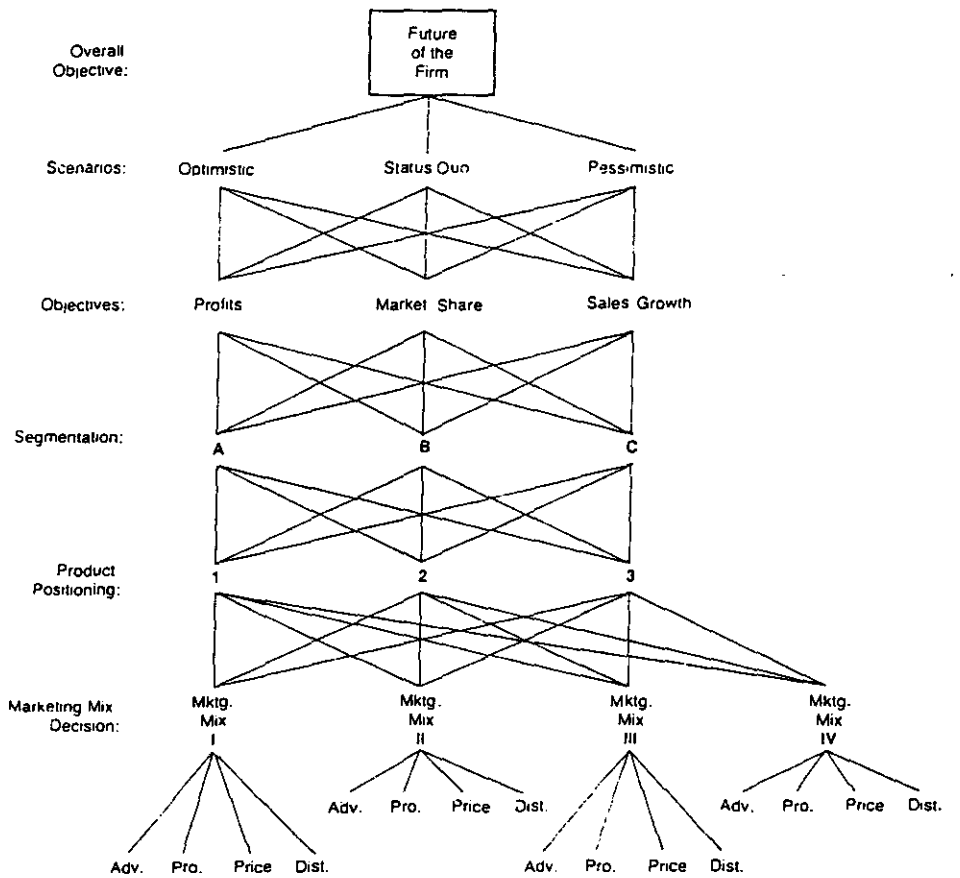

EXHIBIT 7. Analytic Hierarchy Process Application to the Marketing Mix Decision: Benefits Hierarchy.

The experience with this approach is more limited than that with the application of the AHP to portfolio decisions or the generation and evaluation of new products. Yet even the pilot study helped management to: (a) generate more innovative marketing mix strategies, (b) evaluate the various strategies, (c) reach consensus among conflicting interests, and (d) identify areas for needed further research (i.e., those relationships for which consensus could not be reached and to which a sensitivity analysis revealed that the results were sensitive).

6. Directions for Future Research

The AHP has been applied to three marketing decisions: (a) determining the desired target product portfolio and allocation of resources among the components of the portfolio (at any level of specificity), (b) determining the desired directions for new product development, and (c) generating and evaluating marketing mix strategies.

The AHP, when applied to these types of decisions, offers specific guidelines for resource allocation among the firm's current and potential products, market and distribution outlets; among various new product ideas; and among various marketing mix strategies under alternative environmental conditions and various objectives. The guidelines suggested by the AHP can be subjected to a number of sensitivity analyses aimed at establishing the critical priority range for each of the strategy alternatives considered. This approach can be undertaken at any level of the organization (corporate, SBU, or product group) and at various degrees of specificity including, for example in the case of portfolio analysis, portfolios of specific brand positioning by specific market segments and distribution outlets. The procedure described in this paper can also be extended to more complex cases such as the construction of nonlinear hierarchies, time dependent judgments, and the weighting of the judgments by the respondents' perceived expertise.

Conceptually, AHP can be applied to any allocation of resources (e.g., selection of channels of distribution) and choice prediction (e.g., concept or product testing) situations. In addition, it can be applied to cases in which the buying or marketing decision involves a number of participants (e.g., the buying center, Wind [15]) with conflicting perceptions or objectives.

The extent to which the analytic hierarchy would offer a better (more reliable and valid) procedure than some of the other existing approaches to these decisions is an empirical question. Managers have had no difficulty in completing pairwise matrices. In fact, many of them find the task challenging, interesting and of intrinsic value by forcing them to examine relationships which are often left unexamined. Will consumers be able to respond to such a demanding task? It is not clear.

Future research on the AHP and its marketing applications should explore the following areas:

1. Conceptually, can a set of general hierarchical structures be developed to provide management with a basis from which they can deviate (to reflect their idiosyncratic characteristics) in the structuring of the hierarchy. The attractiveness of having a general conceptual framework for the structuring of hierarchies should be weighted against the advantages of flexibility, i.e., the ability of the AHP to process *any* structure.

2. The structuring, data collection, and analysis of hierarchies which take into consideration the real world complexity of many allocation type problems, i.e., interdependencies among elements within the same level, symmetric relation with the

environment (the environment affects the actions, but the actions in turn can affect the environment), and the occasional need to deal with incomplete hierarchies.

3. Simplification of the data collection procedure. Although some shortcut designs have been utilized to reduce the number of pairwise judgments required for the analysis, a more systematic effort is required to explore the suitability of experimental designs of the fractional factorial type. The development of designs which would require only a small number of judgments is essential if top management is to participate and provide input to the process. This latter issue is especially critical given the current magnitude of the data collection task and the reluctance of many top executives to spend much time on such a process.

4. Given that there are a number of areas in which the AHP is only one of a number of possible approaches, studies should be undertaken to compare the results of the competing approaches, assess the conditions under which each is more appropriate, and explain the advantages, if any, of incorporating AHP with other research procedures.

Although other procedures such as conjoint analysis can and have been used to assess the relative importance of management's objectives (Green and Wind [3] and Green and Srinivasan [4]), conjoint analysis to date has not been used for the solution of problems such as the ones discussed in this paper. In some cases both AHP and conjoint analysis can be used, and it is desirable to compare the results of the two approaches in areas which conceptually, at least, can be measured by either approach. The determination of the relative importance of corporate objectives is one such area.

5. Assessing the validity of AHP's recommendations. This would require the setting up of an implementation and tracking program aimed at monitoring the outcomes resulting from decisions based on AHP recommendations.

The conceptual advantage of the AHP approach and the experience gained with it to date suggest that further experimentation with this approach could lead to the establishment of an important addition to the arsenal of marketing models and measurement approaches.

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