ABSTRACT

Opportunity analysis is proposed as a technological forecasting method for assessing monetary profit to a firm. The method can employ use of the Delphi committee, the Bayesian algorithm, computer conferencing, and impact analysis, with certain suggested modifications.

INTRODUCTION

Opportunity analysis involves the assessment, in terms of its monetary potential for profit, of any single or series of potential developments affecting the business. The potential developments could be a set of exogenous events, such as a reduction of taxes or the passage of favorable legislation. On the other hand, it can look at endogenous events such as a proposed cost reduction program. Finally, it can be used to evaluate such things as investment proposals which contain both internal and external variables. This paper presents the concepts underlying opportunity analysis and a suggested procedure for conducting an opportunity analysis.

UNDERLYING CONCEPTS

Opportunity analysis combines the Bayesian decision process with the Delphi method, with modifications discussed in this paper.

The Bayesian process\(^1\) involves making a roster of future possible events; assigning a subjective probability to each event; making a list of alternative actions; setting a payoff for each matrix action cell; calculating the expected value for each action; and, finally, choosing that alternative with the highest value.

The Delphi method, as originally designed\(^2\) and developed at the RAND Corporation,\(^3-7\) is a technique for obtaining group opinion. The method has three features; opinions of group members are anonymous; group members have the opportunity to change individual opinions through iteration and feedback; and, group opinion emerges (and perhaps converges) as a statistical summary of individual responses. The Delphi method was designed to overcome the effect of individual decision maker bias that might be found in the Bayesian decision process. In implementing the Delphi method, the first step is to obtain a panel of experts to whom a coordinator mails a questionnaire. Anonymity of individual panel members' opinions is preserved as the questionnaire is returned directly to the coordinator. In the second step, the coordinator summarizes opinions and mails the summary to the panel for review. The process may be iterated as members review the responses of others and the summary causing a reconsideration of opinion. Finally, a group consensus unfolds as a statistical summary of opinion.

RESEARCH AND REFINEMENTS

Within the past decade, applications of Delphi have proliferated. To mention but a few, Delphi has been used to forecast data processing technology, communications technology,\(^8\) European political events,\(^9\) automobile tire technology,\(^10\) international affairs,\(^12\) computer developments and applications,\(^14\) biomedical research and drug therapy,\(^15\) and weaponry technology.\(^16\) Delphi has also been used for policy making. Applications have been in civil defense,\(^17\) and in teacher education.\(^18\) Concomitant with the applications research have been refinements to the Delphi method. Of particular interest to us in developing opportunity analysis have been four types of refinements:

(a) Use of the Bayesian process. It has been suggested\(^19\) that probabilities be assigned to events. This
refinement has been applied to assessing threats to an organization, wherein it was felt that time periods are not necessarily mutually exclusive and that a particular event might occur in any of several time periods, each with its own probability, within the forecasting horizon.

(b) Use of the computer. The computer has been used to produce the statistical summaries of the Delphi iterations and has been used as the medium for transmitting questions to the panel and for receiving responses.

(c) Use of a preliminary panel. The question has been raised as to the source of the questions posed to the Delphi committee. One approach is to have an exploratory conference of knowledgeable individuals who produce a grocery list of issues for subsequent consideration by the Delphi panel.

(d) Consideration of dependent or interrelated events. Referred to as cross-correlations and cross-impact analysis this refinement to the Delphi method considers the likelihood of one particular event in the forecast, given the occurrence of one or more other forecasted events.

Opportunity analysis proposes to adopt these four refinements.

THE OPPORTUNITY ANALYSIS PROCESS

In developing business plans, one of the most difficult assessments is what projects or businesses a company should engage in. Commonly this work is handled by a new idea gathering unit of some type, or may be the result of approaches from outside the organization. In any case, a series of judgments must be made as to the viability and profitability of suggested new products, and this often is done for each project standing on its own.

Not uncommonly, related projects occur at one or more research locations remote from the corporate headquarters, and so the researchers and corporate staff personnel operate without benefit of each other's insight. This is particularly costly to the problem of project selection and new business development. An alternative to the deterministic discounted cash flow capital budgeting approaches is opportunity analysis. This is a five part process which utilizes the principles of the Delphi process and Bayesian algorithm as outlined previously.

Step One. Idea input.—During this stage of the process, there would be a general survey of the members of the corporation dealing with technology development. The survey can be conducted by mail or by conferencing on a computer terminal. The important element is that the technology be spelled out in terms of what need it fulfills, i.e., savings in unit labor costs, decreased raw materials cost, increased performance, the estimated cost of commercializing the technology, and the length of time it is expected to take to achieve it.

At this phase of the investigation it is best not to identify the donor in order to help overcome the "not invented here" problem. It is also important that all offerings are invited without imposing criteria so that a free flow is inspired.

This approach is contrasted with the method employed in where threats to the organization were identified as a result of a series of face-to-face committee meetings.

Step Two: Idea exchange.—From the array of inputs is assembled a master list of the developments, without the time or money figures shown. This list is then fed back to the group, via mail or computer conferencing, for estimation of what ideas would be likely to complement others, and what would be likely to supplant others. For each overlap area, the degree of overlap would be estimated. This degree of overlap is used to establish cross-impacts from one idea to another. This is necessary so that later in the process we can establish the total impact of an event across time, rather than its simple, immediate effect.

Step Three: Critical factor analysis.—Each group of ideas is tested for cross correlation and cross-impact. We view cross correlation analysis being appropriate for two simultaneous and related events. By contrast, we view cross-impact analysis being used for the circumstance of temporal priority when one event (or more than one event) precedes and is a prerequisite to another event. When either of the above conditions is found, a private meeting is held between the coordinator and each panel member internal to the organization to probe the key assumptions underlying the ideas. In the case of the labor saving device, this might be that wage rates will rise. For increased performance, the assumption may be that the result will be a higher price for the finished product. The factors which could change and impact these assumptions must be probed. For the critical factor analysis to be effective, the panel member should sort out in his/her mind whether events are dependent or related.

Once this is done, a series of testable statements is made by the coordinator which relate to the factors. In the case of a labor saving device, of (See Table I) this might read "Labor rates for this class of labor will rise six percent per year" . As a statement measuring the overall effect, we would also need to evaluate the event "Labor rate adjustment by union contract reflecting six percent productivity increase" . For the product with improved performance we might say "A product with this feature can be marketed at a $5.00 premium to current competitive items" . A related event would be "Introduction of a competitor's product with this feature" . These events must be clear enough to allow an evaluation of their probability of being true.
TABLE I

<table>
<thead>
<tr>
<th>Unconditional Probability</th>
<th>Cross Correlation</th>
<th>Cross Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Set 1: Labor Saving Device</td>
<td>E₁₁</td>
<td>E₁₂</td>
</tr>
<tr>
<td>Event Set 2: Product Improvement</td>
<td>E₁₂</td>
<td>E₁₃</td>
</tr>
</tbody>
</table>

Further, we should point out that it is possible for E₁₂ and E₁₃ to be cross-impacted, given that the union might ask for a wage increase due to larger business revenues.

The analyst might want to plot the probabilities for each sample space above, as illustrated in Figure 1, to show an increasing probability over time.

Step Four: Likelihood assessment.—For each of the statements made a suitable group of experts, most of whom would be external to the firm, is selected capable of weighing the probability of occurrence. For the labor-saving device, this might be labor economists or personnel specialists. For the product whose performance is enhanced, this could be a sales group or a panel of consumers of the product. These should be people knowledgeable in the area; seeking a single “expert” is to be avoided. It will be necessary to employ the Delphi procedure of resubmitting those events which do not achieve a reasonable consensus on the first pass.

Step Five: Opportunities Matrix.—The assessment is made in terms of probability of occurrence within selected time frames. For each time frame, the Bayesian algorithm is applied by multiplying the probability times the dollar value of the event. The details for this procedure have been given in Reference 29.

The summary of the above steps produces a final product grouping which shows the collected ideas, their estimated costs and benefits, and a probability of the revenues from those benefits being achieved. This is arrayed from top down, with the package of ideas having the highest probabilistic revenue relative to costs (from the Bayesian algorithm) on top and downward to those with lower and perhaps negative returns. With such a list in hand, it is much simpler for management to probe for new product ideas, and to discuss with those in research those areas with the highest promised returns. It may also be possible to discuss, using the earlier estimates, the possible trade-off of additional expenditures on favorable projects in order to reduce the time necessary to produce the benefits.

The five steps could be represented as a flow chart:

![Flow Chart]

SUMMARY

We have outlined a procedure for assessing in monetary terms the likely value of an innovation or group of innovations to a corporation. This is done using the principles of the Bayesian algorithm and the Delphi technique, as modified. The extension of the procedures from those used in impact analysis has required certain changes which are discussed.

ACKNOWLEDGMENT

The authors thank Dr. Mitchell F. Bloom, University of Puget Sound, for his review and constructive critique of the original draft of this paper.

REFERENCES

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