Perceptions of the Value of a Management Information System

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A method for determining the monetary value of an existing MIS report is presented based on user perceptions and the semantic differential technique. An empirical test demonstrated the feasibility of the methodology and showed that information value was: (a) enhanced by participation in report design, (b) related to organizational position.

For the management of a resource to be effective, it must be possible to measure, in some sense, the benefits derived from its use and the costs incurred. When the resource is a management information system, if one seeks to make an economic evaluation of a given set of reports, the question arises, "Are we getting our money's worth?" While the costs of reports usually can be ascertained, measuring their economic worth is frequently impossible. Thus, a dollar comparison of costs with benefits cannot be made.

There are three basic approaches to valuing information. These approaches vary, depending on where measurements are made in the sequence of events associated with the purposeful use of the information (see Figure 1). The preferred approach is to make information value measurements after the consequences of the use of the information are known: at point number one in Figure 1. If all other things could be held equal while results are observed with and without certain information, then the value of the information could be determined.

This technique has been implemented in simulated environments as well as in real environments. Haseley and Mock studied information value in a simulated business environment, concluding that delay time was important to information value (7, 9). Green, Robinson and Fitzroy studied information buyer behavior under simulated decision-making conditions (4). They found a consistent preference for information about states of nature.

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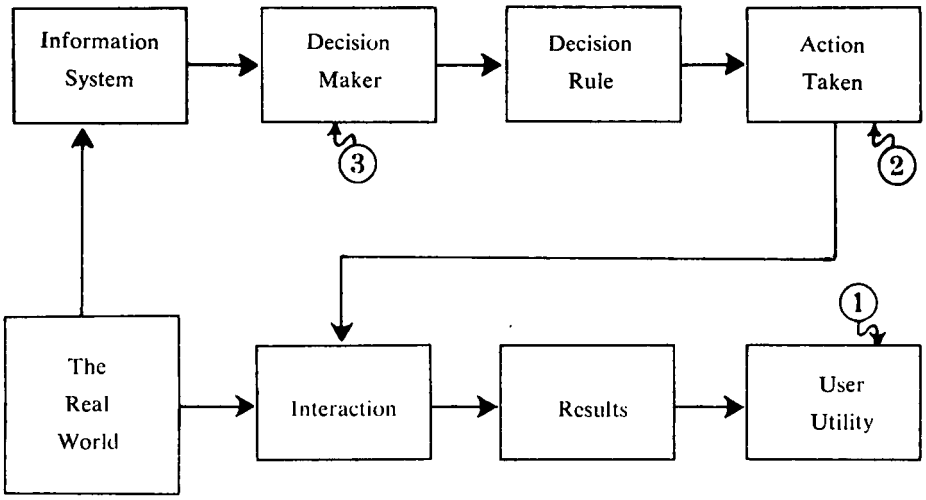
FIGURE 1
An Information Economics Model



Note: Adapted from Robert H. Crandall, "Information Economics and Its Implications for the Further Development of Accounting Theory," *The Accounting Review*, Vol. 44 (1969), 457-66.

Greenridge and Wilson sought to determine the value of an actual management information system by observing financial performance following its implementation. The influence of noncontrollable variables prevented their reaching a conclusion (5, 14).

The difficulty with this approach lies in holding *all other things equal.* In the real world this is only approximately possible, at best. Difficulties in isolating information cause and effect are usually insurmountable. Also, information effects are long term and usually slow to appear. Simulation can reduce these difficulties by providing greater control over noninformation variables and contracting time. But simulation has been limited to simple information systems and programmed decisions. While useful for general research on factors affecting information value, it is a tool too complex for evaluating a variety of specific information systems.

The second basic approach is to examine the actions which result from the application of a given decision rule under varying information conditions (point number two, Figure 1). This approach requires knowledge of the decision rule and the economic consequences of alternative actions, i.e., the payoff function. It is limited to programmed decisions but has the advantage of being analytically tractable. Several models employing this approach have been developed.

Ackoff's model yields a measure of relative value for a static case (1).

Dollar value over multiple periods is the output of Gregory and Van Horn's model (6). Stigler applied the notion of expected value to the case of a buyer seeking the minimum price for a commodity offered by many sellers and showed that information is subject to diminishing returns (12). Marschak and Feltham argue for the joint selection of an information system and a set of decision rules rather than separate selection, as is usually the case. They developed analytic expressions to accomplish this within the framework of an information economics model (2, 3, 8). Swanson employed the concepts of control theory to determine information value (13).

Compared to the first approach, this method is limited by the necessity of assuming the results of alternative actions. The major limitation, however, is the need to know the decision rule and/or payoff function. While this may be possible in certain instances, such as inventory control, most situations involve nonprogrammed decisions for which neither the decision rule nor the payoff function is known.

The third basic approach is to move further up in the chain of events and ask the decision maker to estimate information value (point three, Figure 1). Compared with the first two, this approach is limited in that it relies on the perceptions of individuals and thus is subject to unmeasurable bias and inaccuracy. It has the advantage of being suitable for nonprogrammed decisions, is easily adapted to a variety of specific systems, and is easily implemented.

This study employs the third approach to measuring information value. The principal challenge lies in designing questions which will minimize the effects of bias and inaccuracy in user perceptions.

METHOD

Scope

A questionnaire was developed which could be used to determine the value of an existing set of MIS reports. Since the study is based on user perceptions, the reports are limited to those requested by managers for their own use. Further, the questionnaire was designed for computer-generated, periodic reports used for making nonprogrammed decisions.

Measures of Value

Two measures of perceived value were included in the questionnaire. The first measure was an estimated annual dollar value in response to the hypothetical question: "Assume that your company plans to eliminate all data processing and to obtain this report from another firm on an annual subscription basis. What is the maximum amount you would recommend paying for this report for your use?" This question appeared three times, referenced to: (a) the existing report, (b) a hypothetical report consisting of the existing report corrected for user perceived deficiencies, and (c) an ideal report as perceived by the user.

The second measure of value was a nondollar measure obtained through

application of the semantic differential technique (11). Each respondent was asked to indicate his opinion of the subject report by scoring fifteen bipolar adjective pairs on a seven-point scale. This was done for both the existing and the hypothetical reports.

Additional Data

In addition to the two value measures, data were gathered on the quantity, format, reliability, timeliness, and user cost of the report using another fifteen-pair semantic differential. These attribute data are intended to aid in the analysis of the strengths and weaknesses of the MIS. Background data obtained on the respondents included organization position, size of budget, and whether the respondent participated in the design of the report.

Field Test

To test the methodology, a medium-size firm was selected. The company employed approximately 1,800 people, of whom 375 were management personnel. The organization included eight scalar levels from the chairman of the board down to the foreman level.

The management information system evaluated in this study is known within the firm as the EAB System—an acronym for Expense and Budget System. Essentially a cost accounting system, it was developed in 1967/68 and implemented in 1969. At the time of this study it was not quite two years old and was considered fully operational although still evolving.

The system output consisted of monthly reports comprised of four sections. One section, called the *Detail Report,* listed individual transactions for the month. The *Summary Report* showed only the totals from the Detail Report. The *Variance Report* compared monthly transactions with budget figures and showed dollar and percentage variations from budgeted amounts. The last section, the *Exception Report,* listed those transactions having a variance in excess of predetermined limits.

At the time of the study, 103 managers were receiving EAB reports. They did not all receive the same sections, however; some might receive all four sections, while others might receive only one section. Among the questionnaire respondents, eight different combinations of EAB sections were reported.

The possibility of evaluating the EAB System by individual section was considered: one questionnaire could be distributed asking only about the Detail Report, a second questionnaire would cover the Summary Report, a third the Variance Report, and the fourth the Exception Report. This method was rejected, however, since company officials felt that individual managers perceived EAB as an entity, not as separate reports. Each manager received *one* monthly report whether that report consisted of one section or four sections. To inquire about only one section would, they felt, be confusing and misleading to the managers. A further consideration was the fact that all account numbers were changed upon the introduction of EAB. Thus, EAB connoted a numbering system as well as an informa-

tion system report. Unless EAB were evaluated as an entity, this connotation would be masked.

RESULTS

Value Measures

Of the 103 questionnaires mailed, 75 usable replies were received. Fifty-two of the respondents answered the hypothetical question on the dollar value of the EAB system. The results are shown in Table 1. The large difference between the mean and median is caused by the higher dollar value estimates, which influence the mean but not the median. This type of skewed distribution, typical of economic data, is clearly seen in Figure 2, a histogram of respondents' replies.

A question arises as to whether these individual responses can legitimately be aggregated. The key factor in considering this issue is the degree to which the EAB System report reviewed by one manager is independent of the reports to all other managers. The two major aspects of independence are: (a) the uniqueness of each manager's report, and (b) the degree to which each manager's report is related to other reports which he also received. The EAB System provided data only on those transactions within the zone of responsibility of each manager. While the same data may appear at several levels in the managerial hierarchy, they would be combined with other data at each step upward in the hierarchy. Thus, to the extent that each manager's job was unique, his EAB System report was also unique. Also, the EAB System report was not used in conjunction with any other report. Thus, aggregation was deemed valid. Based upon the sample mean and using 95 percent confidence limits, the interval estimate of total monetary value for the EAB System to all of its 103 recipients was between $176,000 and $404,000.

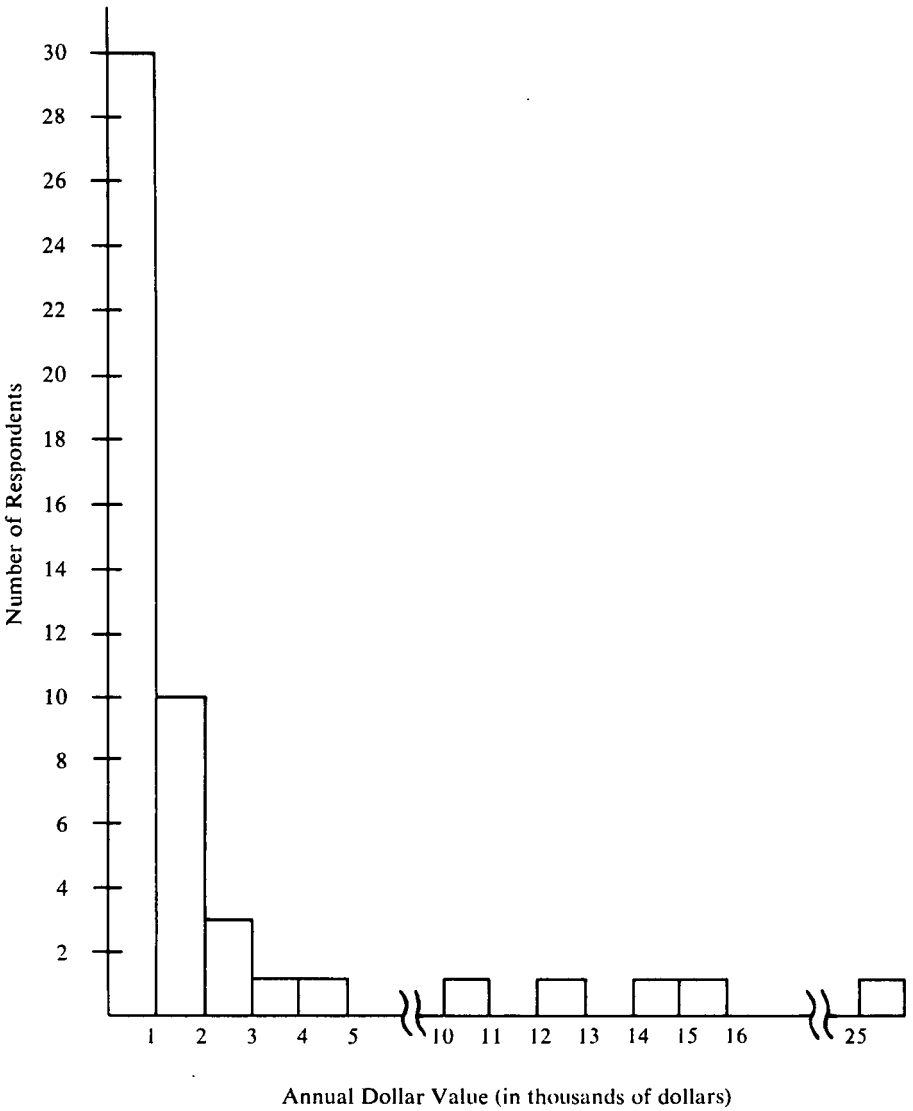
The seven highest respondent estimates exerted considerable influence on both the level and range of the estimates of total EAB System monetary value. These seven managers accounted for 77 percent of the $146,565 total estimated by the 52 respondents and approximately 90 percent of the mean error. Careful analysis of their replies plus subsequent interviews failed to provide any basis for disqualifying their estimates. On the contrary, all

TABLE 1

Summary of Dollar Value Estimates

Statistic	*EAB System*		*Ideal System*
	Actual	*Hypothetical*	
Mean dollar value	$ 2,819	$ 3,960	$ 4,925
Median dollar value	$ 550	$ 1,000	$ 1,000
Standard deviation	$ 4,090	$ 8,520	$10,800
Standard error	$ 565	$ 848	$ 992
Minimum	$ 0	$ 0	$ 0
Maximum	$25,000	$50,000	$60,000

FIGURE 2
Histogram of EAB System Dollar Value Estimates



occupied functionally similar positions. Their positions can be characterized as upper middle-management, line, operating positions. The survey included eight other managers with similar positions; the estimates of these managers were $100, $100, $500, $1,000, $1,200, $1,200, $3,600, and $12,000. It appears that the EAB System had a high value to managers in these upper middle-management line positions.

All of the 52 respondents providing an estimate of the EAB System annual dollar value also provided dollar value estimates for the hypothetical EAB System. Thirty-six respondents assigned equal value to both systems, while sixteen respondents valued the hypothetical system more highly. The results are summarized in Table 1. The difference between the two mean dollar value estimates is statistically significant at the .05 level. Since 30 percent of those responding were willing to pay more for the hypothetical EAB System, a search for improvements in the system would appear to be worthwhile.

A total of 49 respondents provided dollar value estimates for an ideal report. Their replies are summarized in Table 1. Again, the mean dollar value for the ideal system was significantly higher than that for the EAB System (at the .05 level). Mean dollar values for the ideal and the hypothetical EAB System do not differ significantly, however. This suggests that the value of an improved EAB System would approach the upper limit of what users were willing to pay for information.

Semantic Differential Results

A total of 74 usable replies was received for the semantic differential. To quantify each seven-point scale, linear weighting was used ranging from −3 (extremely unfavorable) to +3 (extremely favorable), with zero considered neutral. The results for the EAB System are shown in Table 2. The combined mean was +1.75 with a standard deviation of 1.11. With the mean falling between the descriptors "slightly favorable" and "quite favorable," it seems fair to conclude that the EAB System was well thought of by the respondents as a whole.

When this same semantic differential was repeated for the hypothetical EAB System, the overall mean rose to +2.09 with a standard deviation of 0.96. This mean is significantly higher than that for the existing system

TABLE 2

Semantic Differential Value Scale Results

Scale	*Mean*	*S.D.*
informative-uninformative	2.08	0.86
helpful-harmful	2.05	0.96
useful-useless	1.95	1.10
desirable-undesirable	1.89	1.13
meaningful-meaningless	1.86	1.15
good-bad	1.85	1.13
relevant-irrelevant	1.82	1.19
important-unimportant	1.82	1.08
valuable-worthless	1.72	1.09
applicable-inapplicable	1.68	1.05
necessary-unnecessary	1.64	1.30
material-immaterial	1.54	1.15
responsive-unresponsive	1.47	0.97
effective-ineffective	1.43	1.30
successful-unsuccessful	1.41	1.11

(at the .01 level), further supporting the earlier conclusion that improvements could be made in the EAB System.

Correlation between Value Measures

The correlation between the estimated dollar value of the EAB System and the mean score on the semantic differential was +0.29. While this is statistically significant at the .05 level, it must be considered too low to use semantic differential mean score as a surrogate for dollar value.

The lack of a substantial correlation between the two value measures may be due to variation in the utility for money among respondents. There may have been differences in their knowledge of information costs. Risk preference may also be a confounding factor. Managerial styles may have exerted an influence. None of these factors was measured in this study.

Other Results

The results of the fifteen scale attribute semantic differential are shown in Table 3. One scale, simple-complex, proved to be invalid. Its intent was that a good report should be simple in its presentation. Respondents, however, perceived the scale in relation to the total system, which they viewed as complex.

The scale groupings are self-explanatory with the possible exception of the cost category. These scales were intended to measure the cost to the user in terms of the difficulty involved in making use of the report. The results in this category seem to be in conflict with those in other categories, thus casting doubt on their usefulness. The other four categories, however, provide meaningful insight into EAB System deficiencies.

TABLE 3

Analysis of Semantic Differential Attribute Scale Scores

Scale	*Mean*	*S.D.*
Quantity		
complete-incomplete	1.36	1.45
enough-insufficient	1.27	1.44
Quality-Format		
readable-unreadable	1.95	1.18
orderly-disordered	1.86	1.01
logical-illogical	1.70	1.26
clear-unclear	1.58	1.26
simple-complex	0.19	1.71
Quality-Reliability		
true-false	1.68	1.11
reliable-unreliable	1.59	1.13
valid-invalid	1.59	1.24
accurate-inaccurate	1.49	1.42
Timeliness		
current-outdated	1.76	1.24
timely-untimely	1.42	1.13
Cost		
concise-rambling	1.49	1.21
efficient-inefficient	1.41	1.11

Correlation analyses involving the two value measures and participation in system design showed that those who did participate in design (36 of the 74 respondents) valued the EAB System more highly than those who did not participate in design. This finding provides a clear demonstration of the importance of behavioral considerations in the design of information systems.

No significant correlation was found between budget or hierarchical level and the two value measures.

DISCUSSION

This study included one test of a new methodology. The results of a single test cannot establish the validity of a methodology, although they can discredit all or part of the methodology. In this test the two value measures, estimated annual dollar value and semantic differential, performed well enough to suggest their potential for wide application.

With 70 percent of all respondents answering the dollar value question, the feasibility of the question was amply demonstrated. Of the 22 respondents who did not answer the question, 16 indicated that they felt too unfamiliar with management information system costs to give an estimate of value. One respondent claimed newness to the EAB System and five simply left blanks.

A question may be raised regarding the use of hypothetical questions. Do the answers to a hypothetical question bear any relationship to those that would be obtained in an actual situation? Surely the answers would not be identical. It is believed, however, that by using a large sample and verifying high estimates, a reliable estimate may be obtained for the maximum that users collectively would be willing to expend for a report.

The semantic differentials performed well in the aggregate but showed some weaknesses. The value scales lacked substantial correlation with estimated annual dollar value. The analytic scales were found weak in certain areas. The study results suggest that the technique is basically useful in this application, but better scales need to be found.

The finding of this study that managers in certain upper-level managerial positions valued EAB reports more highly than other managers suggest the possibility of a general relationship between managerial position and the value of information. Such a general relationship, if it exists, should vary with the type of information and the type of organization structure. Research in this area may uncover the significant factors influencing this phenomenon and, ultimately, lead to predictions as to which managerial positions would value a given type of information most highly. Predictions regarding these key managerial positions would allow system designers to better satisfy these key users in the design of the system.

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