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Grouping EIS Benefits: An Optimal Clustering Approach

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Introduction

Executive Information Systems (EISs) emerged in the late 1970s to meet the information needs of senior executives. Leading EIS research indicates three major groupings of EIS benefits: (1) Information delivery, i.e., providing more timely, accurate, relevant, and concise information; (2) Task improvement, i.e., improving the efficiency and effectiveness of executives; and (3) Supporting the accomplishment of strategic business objectives (Wallis 1989; Volonio and Watson 1990; Houdeshel and Watson 1987).

Mintzberg (1975, 1980) classifies managerial activities into three broad groups - interpersonal roles, informational roles, and decisional roles. McLeod and Jones (1986) suggest that an EIS can be a valued tool if: it can provide and integrate external and internal information; it can offer information with richness (e.g. soft, human, contextual information to enhance hard information); and it can overcome problems typical of traditional MIS hard copy reports by providing accurate, timely, concise and relevant information (Watson, Rainer and Houdeshel 1992). According to Mintzberg (1975), managers use information in four decision roles: resource allocation (e.g. budgetary allocation), disturbance handler, entrepreneur and negotiator. An effective EIS primarily supports disturbance handling and entrepreneurial activity, and to a lesser extent resource allocation (McLeod and Jones 1986).

Though prior research alludes to major managerial roles and/or activities, very little research explores grouping of EIS benefits and the implications of such groupings. The purpose of this study is to explore whether there are more than the three broad categories of EIS benefits found in the literature. Secondly, we identify the specific benefits within each category. We also tentatively confirm that these broad categories of benefits support the major roles of managers as specified by Mintzberg (1975, 1980). The findings of this study should be significant considering the fact that the success of an EIS is vital to the organization that has or plans to develop one.

To gain insights to these questions, data were obtained from questionnaires sent to organizations that use EIS. The details of the study method and findings are discussed next.

The Study

The study data were obtained from mail surveys. The survey instrument was designed to collect data on the participating firms, the respondents, their EISs, and benefit/cost related issues. After pilot studies, the instrument was mailed to 215 firms from The

University of Georgia's EIS database, which contains over 300 organizations believed to have an EIS. The database was created from a variety of sources, including magazines (e.g., Computerworld, Information Week), conference registrations lists (e.g., The EIS Institute, DSS-XX), journals (e.g., Harvard Business Review), and personal contacts. The database is thought to be representative of firms with EISs and has been used in other studies (e.g., Watson, Rainer and Koh 1991; Watson, Rainer and Frolick 1992). A follow-up mailing was sent to non-respondents.

We listed 23 EIS benefits (see Table 1) and asked the respondents to group them and also identify a name for their groups. A total of 54 responses were received from the two mailings. Of these, we deleted the ones that had either more than 4 missing values or if the response indicated that the subject did not understand the question. For example, one respondent grouped all the benefits into one group while another put most of the items into separate groups. We obtained 49 usable responses.

Findings and Discussions

Demographics

The organizations came from a variety of industries with financial, insurance, and real estate (29.6 percent) and manufacturing (24.1 percent) the most heavily represented (see Table 2). The respondents were seasoned managers and professionals, who had an average 3 years of EIS, 13 years of IS, and 18 years of total work experience. Their job categories include EIS manager (35.2 percent), IS staff (18.5 percent) and EIS support staff (14.8 percent) (see Table 3).

Grouping EIS Benefits

The number of groups identified by the respondents ranged from 2 to 12 with an average of 5.14 and a standard deviation of 1.82. The median group size was 5. The average group size (number of benefits in each group) was 4.88 with a standard deviation of 1.51. There exist both statistical and non-statistical (mathematical programming) methods for solving cluster analysis problems (Aronson and Sundaram 1994). While statistical methods (e.g., agglomerative or divisive clustering, factor analysis, etc.) use certain transformation measures such as correlations to clump items together, the optimal clustering method uses the actual data (similarity or dissimilarity matrix) with no any statistical transformations. In addition, there is a lot of subjectivity involved in analyzing the results of statistical methods. Factor analysis, for example, yields as its final results the number of factors and the factor loadings (a number that indicates the significance of each item towards a factor). Factor loadings greater than an absolute value of 0.30 are considered significant. In practice, many items have several significant loadings and the researcher must further analyze the results to obtain meaningful clusters (Hair et al. 1987). In contrast, the optimization method yields the best solution for the specified number of groups.

In the similarity matrix (see Table 4), for each pair of benefits i,j, Sij = the number of times the respondents grouped i and j together. The optimal clustering procedure (that minimizes the sum of pairwise interactions within all groups) of Aronson and Klein (1989) and Klein and Aronson (1991) was used. Since this method uses a distance matrix, the similarity matrix was converted to a dissimilarity matrix (see Table 5) by subtracting the off-diagonal elements by the maximum value in the similarity matrix (so that we now minimize the sum of dissimilar interactions within all groups). The problems were solved on a dedicated IBM RS/6000 Model 340 POWERStation at The University of Georgia.

The Results

The optimal clusterings of the benefits were obtained for a range of three to seven groups, as were indicated more frequently by the respondents. The optimal group assignments and total cost1 (sum of pairwise interactions within each group) for each case are shown in Table 6. As expected, the cost for the solution provided by the respondents was always worse than that of the respective optimal solution. For five clusters, the optimal cost was 725. The average deviation of the total cost was 505.78. The run times ranged from about 60 CPU seconds to approximately 10 CPU hours. For all cases, an optimum was obtained within several minutes, but for the more difficult problems, several hours were necessary to guarantee its optimal status.

There are five crisp categories for EIS benefits in contrast to the three broad categories found in the literature. The five categories pertain to: (1) information; (2) environmental scanning; (3) improving executives' effectiveness; (4) meeting strategic objectives; and (5) economy. The benefits within each category are (see Table 7):

1. Information: more timely information, faster access to information, more accurate information, more relevant information, and more concise information.

2. Environmental scanning: better access to soft information, improved access to external data, better environmental scanning, and more competitive information.

3. Improving executives' effectiveness: improved communications, improved executive, performance, save executive time, and improved presentation of data.

4. Meeting strategic objectives: increased span of control, improved planning, improved decision making, better problem understanding, and better development of alternatives.

5. Economy: cost savings, less paper, support TQM program, more responsive to changing customer needs, support downsizing the organization.

Limitations of the Study

This study is subject to a number of limitations. An issue is the time required to guarantee that an optimum is obtained for the more difficult problems. Strong bounds on its value may be obtained and early termination may be performed when computer time is a

limited resource. There are 23 benefits of an EIS listed, based on prior research. Being the first study of its kind, some benefits may have been omitted even though no respondent volunteered additional ones on the survey when directly asked. The benefits were not randomized which may have introduced some bias. The respondents were mainly IS managers. As part of further research, one could attempt to obtain the executives' impressions directly. Though the scope of this study is limited to EISs, the results may or may not be generalizable to all IS.

Conclusions

This study is the first to examine clustering EIS benefits (optimal or otherwise). Prior research identifies a large number of potential benefits from an EIS (Rockart and Delong 1988). Many of these benefits are related to improved access, preparation, delivery and presentation of executive information. EISs are said to improve the effectiveness of the executives. Not only do they save executives' time and improve their performance, but they also support the accomplishment of strategic business objectives.

The results of this study indicate two additional, relatively broad categories of EIS benefits: Environmental Scanning and Economy or Cost Savings. We confirm that these five groups of benefits do support the major roles of a manager as described by Mintzberg (1975, 1980). Obtaining information is key for the interpersonal role, and the benefits related to environmental scanning and improving executives' effectiveness serve this purpose very well. Benefits related to information serve the informational role of the manager. The benefits under the categories of meeting strategic objectives and economy serve the decisional role of the manager. Thus, for developing a successful EIS, one may use our results as a guide or to augment new research findings2.

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1 The cost defined here is not a dollar figure. The unit costs are obtained from the distance matrix entries.

2 A longer (unabridged) version of this paper, including all Tables, is available from either author.