Computer-Aided Decision-Making in Large Groups

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ABSTRACT

Computer-aided decision making by individuals and groups is a reality in many organizations. Recently, the use of GDSS has received much attention. The effects of group dynamics and computer mediation in group decision making is an important issue. These factors become more important in larger groups. In this paper we report the results of a study of computer-aided decision-making in large groups (nine members). Several new results were obtained in this study on measures such as decision time, number of alternatives generated, overall decision satisfaction and decision quality. We present these results and discuss their implications for both large group decision-making and the use of computer-aided group decision making.

INTRODUCTION

Both group decision-making and individual decision-making have been important topics of research in MIS. Group decision-making is a common occurrence in most organizations. It can make a significant impact in organizations in the area of decision-making. As decision tasks become more complex and the number of people involved in the decision increases, the use of computer support for decision-making can impact both the process and the result.

The use of Decision Support Systems (DSS) to assist decision makers has been well studied. Systems that facilitate group decision-making by managing information pools generated by the group members have been called Group Decision Support System (GDSS). DeSanctis and Gallupe [4] developed a framework for classifying various types of GDSS according to their capability. Other researchers have also studied the use of DSS in group decision-making.

Group size has been a variable of much interest in GDSS research. Early GDSS research concentrated on comparing the performance of groups using GDSS against those not using GDSS. Due to the limitations of the GDSS software and the difficulty of obtaining large groups to replicate the experiments, these studies kept groups sizes small, generally no more than five (5) members [5,6,8,9]. Pinsonneault and Kraemer [7] provide an excellent summary of empirical research in GDSS to date.

There have been several studies in GDSS using groups size as a variable. These studies generally fall into two categories: a) GDSS studies with groups of small groups (size 5 or fewer) and b) large groups studies using GDSS or EMS to study idea generation, group interaction or proximity effects. Most large group studies have been done at the University of Arizona in the EMS environment. For instance, Dennis, Heminger, Nunamaker, and Vogel [2] describe an experiment in using computer support for large groups. Dennis, Valacich, and Nunamaker [3] report results on the use of Electronic Meeting Systems by large groups.

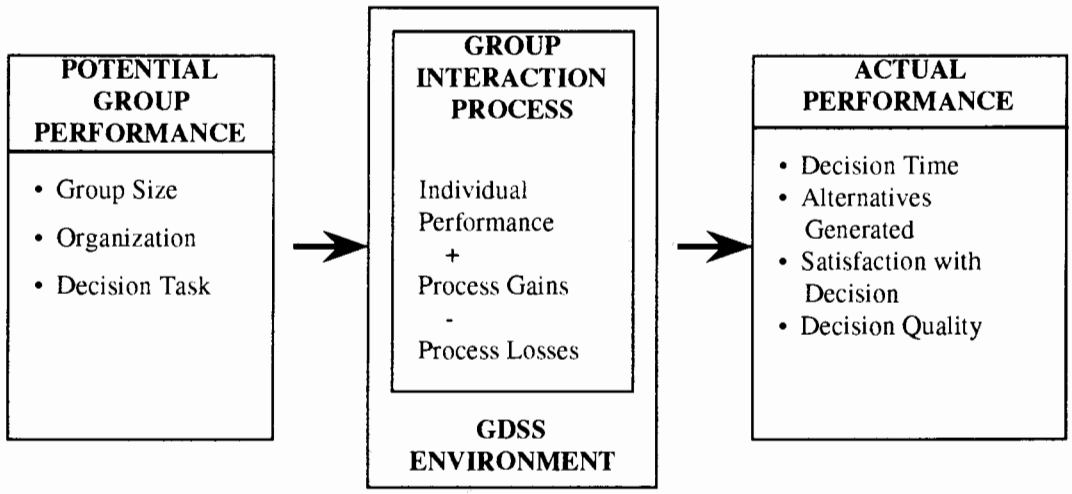
The study reported here differs from other large group studies in two respects. We studied large groups of nine members in a level-1 GDSS environment, and we measured several variables related to the decision outcomes. Researchers who have studied groups using GDSS only studied groups of five members or fewer. Those researchers who have studied groups of size more than five used an EMS environment and studied only the idea generation aspects of the decision-making process. This paper, on the use of GDSS by large groups, presents some interesting and useful results that have not been reported by any past researchers.

THE STUDY

Research Model

The research presented is based on the model proposed by Connolly et.al. [1] shown in Figure 1. In our study we

Figure 1. GDSS Research Model

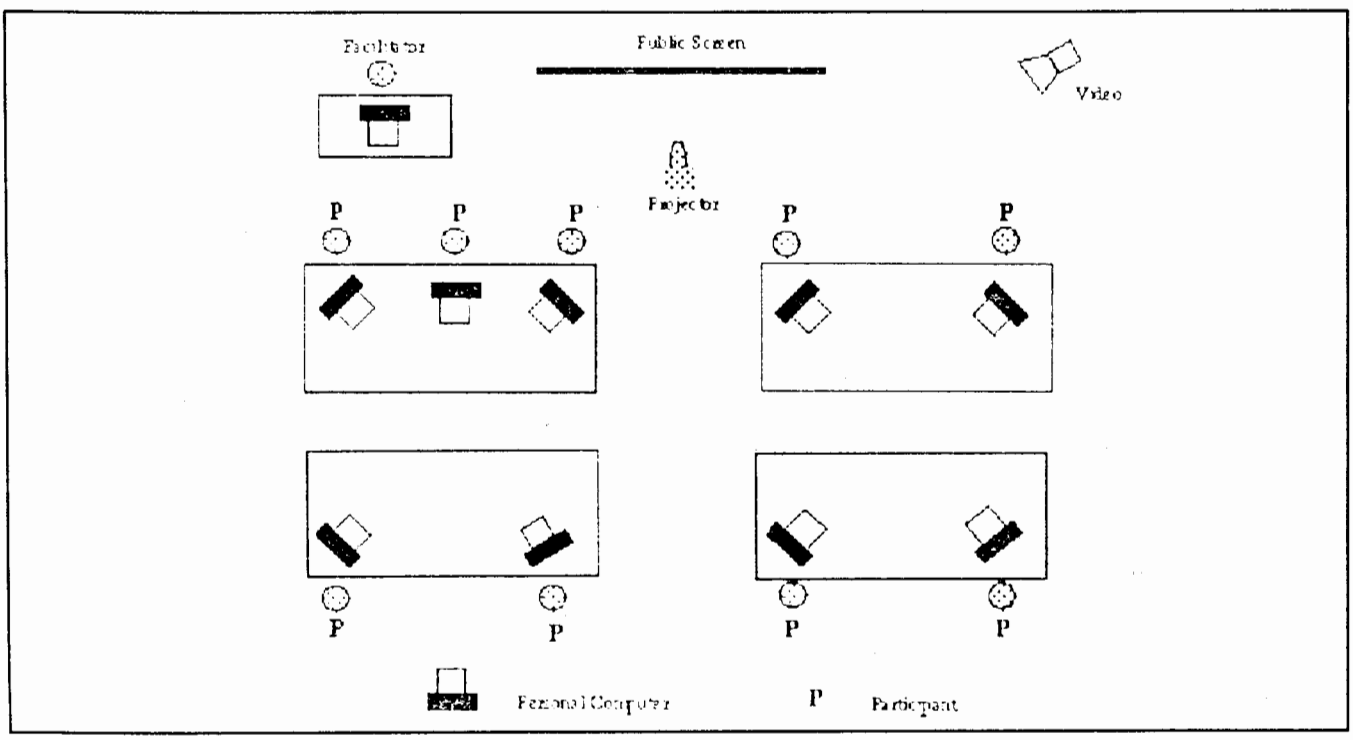


fixed the group size, decision task and organization variables. We then tested the groups in two different environments, one with GDSS and one without GDSS. The output variables measured were: a) decision time, b) number of alternatives generated, c) satisfaction with decision, and d) decision quality. GDSS researchers have consistently used these measures as valid indicators of the usefulness and effectiveness of GDSS in small group studies. It is important to study these variables in large group GDSS research.

Experimental Setting

The groups using GDSS performed their task in a "decision room" designed to accommodate face-to-face group interaction [4]. Figure 2 shows the arrangement of the deci-

Figure 2. GDSS Configuration



sion room. The layout includes a facilitator station in front of the group. The group members were seated around four desks equipped with IBM PCs linked by a Novell network. The terminals were positioned to allow anonymity for each member during interaction with the GDSS. The facilitator instructed the group members on the procedures to follow in the decision-making process, but did not participate in the proceedings or answer questions related to the decision problem. The public screen was used by the facilitator to display information the group used, such as the agenda and the consolidated and randomized alternatives generated by the members. This information was also displayed on the members' terminal. The public screen was used to facilitate group interaction.

The Subjects and the Decision Task

The subjects in this study were students from graduate and undergraduate classes in the College of Business Administration of a major U.S. university, who had completed a course in either Decision Support Systems or Introduction to Information Systems. The Whirlwind Aircraft Corporation case was chosen as the decision-making task. It was chosen because it had been used by other researchers to study group decision-making. The case involved a judgmental decision task requiring interaction and participation of all group members. The members were required to read the case and develop alternative solutions.

The Experimental Procedures

The experimental groups used the GDSS software to enter their alternative solutions. The GDSS collected, randomized and presented the alternatives to the group for further discussion. The results were displayed on both the public screen and individual terminals. During group interaction and discussion, alternatives were changed, deleted and refined. At the end of this process, a list of alternatives was displayed to be ranked by the group. After ranking, the GDSS collected, organized and disseminated the rankings by presenting the total score for each alternative. Each member reviewed these alternatives and voted on one as the best choice. If a majority of the group chose the same alternative, that alternative was recorded as the final solution. If there was no majority vote for a single alternative, the alternatives that received votes were displayed along with the number of votes that each received. Alternatives not receiving any votes were deleted. The members ranked the alternatives again, and the voting process was repeated.

The non-GDSS groups performed the same set of steps as above, except that they did not receive any computer-based assistance. Instead, they used paper and pencil to record alternatives and votes. The facilitator performed the organizing, collating, sorting and disseminating work. A blackboard and/or flip chart was used to enable group interaction and communication of the results of alternative generation, ranking and voting.

The Hypotheses

1. The time taken to arrive at the final decision by the groups using GDSS will be less than that of the groups not using GDSS.

We expect that the use of GDSS will speed up the various steps involved in the decision-making process. Computer assistance will reduce the time taken to collect, organize and disseminate the information generated in the group interaction.

2. The number of alternatives generated by the groups using GDSS will be larger than those not using GDSS. Small groups using GDSS tend to generate more alternatives than the ones not using GDSS. We anticipate that in large groups this effect will be more pronounced, resulting in the generation of more alternatives by GDSS groups than by non-GDSS groups.

3. The overall decision satisfaction will be higher for the groups using GDSS than those not using GDSS. We expect this hypothesis to result from better facilitation of inter-group communication and better assistance in the group process provided by the GDSS.

4. The decision quality will be higher for the groups using GDSS than those not using GDSS.

Steeb and Johnson [8], Lewis [6], and Gallupe et. al. [5] reported that GDSS improved the decision quality in small groups. The use of GDSS by large groups should accentuate this effect and produce further increase in decision quality.

The Measurements

The time taken to arrive at a decision was measured from the time the group started reading the case to the time they arrived at the final decision. The number of alternatives generated by the groups were measured by the output of the GDSS (for the GDSS group) and by the paper work collected by the facilitator (for the non-GDSS group). Two independent examiners were assigned to count the alternatives in each case. In the case of conflicting count, an arbitrator resolved the problem by discussing it with the examiners. Decision satisfaction was measured by a post-test question. Each member was asked to rank his or her level of satisfaction with the final decision on a Likert scale. The individual rankings were summed and divided by the number of members in the group to obtain an aggregate group score. The decision quality in this study was evaluated by two independent "experts" who were familiar with the case used and were disinterested parties to this study. They were unaware of the hypothesis and of the manner in which the groups arrived at the decision. They rated each group's decision

quality on a three point scale. The sum of the experts' two scores was used as a measure of the quality of the decision for each group.

DISCUSSION OF RESULTS

A total of sixteen groups participated in the experiment. Eight groups were randomly assigned to use GDSS and eight others did not use GDSS. The only independent variable was the presence or absence of GDSS. We used an adjusted t-test to determine the statistical significance of the results.

The decision times for the GDSS and non-GDSS groups were 103.25 min. and 110.50 min., respectively. This difference was not statistically significant at a 5% level. This result indicated that the use of GDSS for large groups did not affect their decision time. This result may imply that the complexities of the GDSS software may have neutralized any effects it had in reducing decision time. Previous small group studies with GDSS reported that the use of a GDSS either increased the decision time or had no significant effect. Our results for large groups are consistent with these studies.

The mean number of alternatives generated by the GDSS groups was about the same as that of non-GDSS groups as shown in Table 1. The result is not a statistically significant difference at a 5% level. In small group GDSS research, it was reported that GDSS groups generated more alternatives than non-GDSS groups [5,6,8]. The current study found that as the group size increased, the positive effect of GDSS in increasing the number of alternatives was not realized. It is likely that the trend may change with large groups. Further study with larger group sizes is needed to establish the pattern of change here.

The measure of decision satisfaction for the GDSS groups was not significantly different (at 5% level) from the non-GDSS groups as shown in Table 1. Results of past research on small group GDSS use have been inconclusive regarding satisfaction with the final decision. The results in this study show no significant difference in satisfaction between GDSS users and non-users. Studies with group sizes larger than nine must be done to establish any significant trend in this variable.

Table 1 shows that the mean measure of decision quality for GDSS was 2.63 and it was 3.38 for non-GDSS. This difference, statistically significant at the 5% level, indicates that the GDSS groups generated on the average, higher quality decisions than the non-GDSS groups. Results from small group GDSS research indicate that GDSS users produce better quality results than non-GDSS users.

Table 1.

	GDSS		NON-GDSS		
MEASUREMENTS	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**p-Value**
Decision Time	103.25	25.98	110.50	15.82	0.2565
No. of Alternatives Generated	41.50	8.96	41.38	12.14	0.4908
Satisfaction with Final Decision	2.49	0.92	2.25	0.57	0.7263
Decision Quality	1.63	0.74	3.38	0.92	0.0443

CONCLUSIONS AND IMPLICATIONS

The use of computer-aided decision tools such as GDSS for large groups does not necessarily decrease the time taken for decision-making. This conclusion has practical implications for the use of GDSS. Many organizations may want to use computer aided tools for group decision-making to reduce the amount of time spent in group meetings. This study shows that this time reduction may not occur. Some GDSS researchers have reported an increase in time required while others have reported a decrease in time required. Our result shows that there will be no significant difference in the time taken to make the decision with or without the GDSS. Therefore, time saving should not be a major justification for

introducing GDSS for large group decision-making.

It is generally believed that the use of computer-based decision aids will increase the number of alternatives generated in the decision-making process, thereby increasing the chances of arriving at a better decision. Our study shows that this increase did not occur for large groups using GDSS. The groups not using GDSS generated as many alternatives as those using the GDSS. Therefore, the generation of alternatives in the decision-making process is not a function of technology support. It appears that in large groups the number of alternatives generated is purely an intellectual and/or analytical process and that use of a GDSS does not provide significant support for this task. The use of GDSS by large groups should not be expected to increase the number of alternative solutions generated in the problem solving process.

Decision satisfaction is an important aspect of the ultimate implementation of the decision. The results presented here show that the use of GDSS in large groups does not help in this area. In other words, large groups using GDSS are no more satisfied with their final decision than those not using GDSS. Since a lower value indicates more satisfaction, there may be reasons to believe that the groups not using GDSS may be more satisfied with their final decision than those using GDSS. Though this conclusion is not statistically confirmed, it indicates one negative aspect of computer-aided decision-making. It is likely that the face-to-face human interaction without the presence of a computer may increase satisfaction with the final decision due to the human and social aspects associated with such interaction. The use of GDSS, even when human interaction is not restricted, seems to diminish the effects of such interaction.

The quality of decisions produced by the group is an essential feature of group decision-making. Since the participant's reputation, stature or job is not at stake in a group decision process, it is generally thought that the quality of group decisions is not as high as the quality of individual decisions. The results regarding the decision quality shows that there is a significant difference between the decision quality of groups using GDSS as compared to those not using GDSS. The quality of decisions made by groups using GDSS was better than the quality of decisions made by groups not using GDSS. This conclusion indicates that, as a practical matter, decision quality is the only area where GDSS use for large groups can be justified. If better quality decisions can save an organization's resources and put the organization at a competitive advantage, the expenditure in creating and maintaining a GDSS can be supported. Because the measure for decision quality is not always straightforward, there is some bias in this measure determined by the experts. Since two experts were used and they were given consistent, randomized final alternatives for both the GDSS and the non-GDSS, the bias is minimized.

The current research was an exploratory study which contributes to an understanding of the use of GDSS in large groups. Further research is needed to understand this area better. The following suggestions for future research are proposed: 1) use of higher levels of GDSS than level-1 GDSS, 2) simultaneous evaluation of types of task, group size, and GDSS usage, and 3) performance of field studies. These types of research will help both researchers and users understand the impact of GDSS technology on users and organizations.

Any experimental study has its limitations. The study reported here used a level-1 GDSS [7], and the results cannot be extended to any other levels of GDSS. In this study the groups made decisions in face-to-face meeting. Group decisions can also be made without the groups meeting face-to-face. This type of decision-making was not studied. Using students as the subject limits the external validity of the experiment. Nevertheless, the results obtained provide knowledge and insight into both large group decision-making and the use of GDSS.

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