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ABSTRACT

Groups are a fundamental and essential part of organizational decision making. A group decision support system (GDSS) attempts to use computer and communications technology to help a group make better decisions. In this paper, previous GDSS research is extended to develop a better framework for future GDSS research and design. Six situational factors are identified; group size, member proximity, task type, group environment, and group development stage; so that a given group decision making situation can be accurately described. To standardize the features across different GDSS, six different levels of GDSS features are also identified. The paper then presents a multidimensional framework for conducting future GDSS research, and argues that future GDSS research needs to identify the appropriate GDSS features for the appropriate group decision situation. *It is also suggested that researchers take a long-term, holistic approach while analyzing the results of using a GDSS.*

INTRODUCTION

Organizational decisions are made in a group setting for many reasons. A group of people, at least in most circumstances, tends to consider a larger number of decision factors than do individuals. Therefore, there is an "expectation that a decision arrived at by a group is more reliable than one arrived at by an individual" (Smoke & Zajonc, 1961). Group decisions are, in general, perceived as superior to individual decisions because they are more thoroughly analyzed and therefore have less uncertainty. All of Simon's (1960) three decision phases, intelligence, design, and choice are considered in more detail by the group. Groups, therefore, can be expected to be better in introducing some extent of structure to an otherwise ill-structured problem (Turoff & Hiltz, 1982).

A group has been defined by DeSanctis and Gallupe (1986) as "two or more people who are jointly responsible for detecting a problem, elaborating on the nature of the problem, generating possible solutions, or formulating strategies for implementing solutions." The term Group Decision Support Systems (GDSS) is often used to describe computer-based systems that assist in group decision making. Many group process techniques such as brainstorming, Delphi technique, the Nominal Group Technique, the consensus approach, dialectical inquiry, and strategic assumptions surfacing and testing have been devised to make group decision making more effective. There is also much research regarding the use of technology to implement the above processes and to evaluate the merits and demerits of using technology. A fairly comprehensive study of group decision making and technological group support is present in Johnson, Trumbley, Dejoie and Walther (1993).

Research on the effect of different electronic tools on group outcomes is, however, scarce in the literature (Aljumaih, Aiken, & Vanjani, 1995). Javenpa, et al. (1988) did a preliminary study on the effect of three electronic group tools on group situations, and found that the choice of tools has an effect on the group outcome. Easton, et al. (1990) found significant differences in decision outcomes by using two different tools. The intent of this paper is to develop a GDSS framework that helps analyze the effect of different tools on different group situations.

The remainder of the paper is organized as follows. Section 2 motivates the need for a GDSS analysis framework. In Section 3, we extend the three-dimensional model postulated in DeSanctis and Gallupe (1986), and describe the six contingency factors of group decision making. The framework to conduct future GDSS research is then developed in Section 4. The paper is summarized and concluded in Section 5.

NEED FOR A GDSS ANALYSIS FRAMEWORK

The analysis of GDSS literature reveals some rather unsettling findings. A recent survey (Johnson et al., 1993) concluded that there was no appreciable difference in decision quality or decision satisfaction between decisions made with and without technological support. It was also concluded that it was *less likely* for a group with a GDSS to attain consensus than one without. Another finding was that groups utilizing a GDSS *took longer* to arrive at a decision than groups without a GDSS. Several other GDSS studies have also been conducted (Beauclair, 1989; Gallupe & DeSanctis, 1986; Jarvenpa, Rao, & Huber, 1988; Nunamaker & Vogel, et al., 1992) and the results are still mixed, varying from strongly positive results to neutral or negative results. Clearly, the application of computer and communications technology alone does not result in better group decision making.

The above findings do not lead to the conclusion that GDSS are ineffective. Taking decision quality for example, it was reported that six studies reported higher decision quality while four showed no differences between groups with and without GDSS. One should not combine these two different results and conclude that GDSS use results in marginal or no improvement in decision quality. A more useful research question would be "*under what situations do GDSS*

lead to better decision quality, and what are the relevant GDSS features for those situations?" The answer to this question would be more beneficial to future GDSS researchers and designers than to "whether GDSS is useful for group decision making?"

In order to answer the above question, we have to clearly distinguish and categorize the dimensions, *group situations* and *GDSS features*. This is the raison d'etat of the framework provided in this paper. While it is relatively easy to enumerate the various features of a GDSS, it is more difficult to identify a group situation. The bulk of this paper is devoted to defining various group situations.

DeSanctis and Gallupe (1986) have combined two important taxonomies, a taxonomy of GDSS settings based on Group Size and Proximity and the McGrath's circumplex model (McGrath, 1984) of tasks, to create a three-dimensional framework for GDSS research. The purpose of this paper is to extend the work in DeSanctis and Galluppe (1986) and construct a multidimensional framework for GDSS design and research. As DeSanctis and Gallupe point out, their effort was an important preliminary step, but there is need for "further development and refinement" to "yield specific guidelines for GDSS design." This paper is an effort in that direction.

CONTINGENCY FACTORS IN GROUP DECISION MAKING

Group decision making is a relatively dynamic process that depends on myriad factors. The type and level of support provided by a GDSS should also vary to reflect the type of group decision-making situation. In this section we discuss six important contingency factors affecting group decision making. Group size, member proximity, and task type were recognized by DeSanctis and Gallupe (1986), and the other three factors (group type, group environment and group development stage) are introduced in this paper.

While DeSanctis and Gallupe have indeed identified three contingency factors of group decision making, there exists other important factors which they fail to consider. Consider the following pertinent questions in the context of supporting group decision making:

1. What is the required degree of group satisfaction for a group?
2. What are the requirements for group control mechanisms?
3. How do the requirements, functions, and behavior of a group vary with time?

These questions cannot be answered on the basis of the three factors identified in DeSanctis and Gallupe, and to effectively support a group the answers are critical. Clearly the problem of group decision making encompa ses more dimensions. The answer to the first question is that it depends on the type of group. The degree of satisfaction should be more for "social" and "long-term" groups, whereas a temporary group can afford to trade off satisfaction for perhaps higher performance as suggested in the literature (Turoff & Hiltz, 1982). Question 2 can be answered if we know whether the group environment is *cooperative* or *uncooperative*. Presumably, more extensive control mechanisms are needed for uncooperative environments. The last question can be answered if we know the group's *developmental stage.* A group could need different types and levels of support depending on how long it has functioned together. This is a temporal dimension.

The six contingency factors affecting group decision making and the various levels within each factor are presented in Table 1. The levels within each factor should be viewed as extreme points in a continuum. Different group meeting situations call for different level settings within each factor. A GDSS, therefore, should ideally support all the six factors, and let the users choose specific levels within each factor. We next describe the six factors.

Table 1. Six Contingency Factors Affecting Group Decision Making

GROUP SIZE	MEMBER PROXIMITY	TASK TYPE
1. Small	1. Face-to-Face	1. Generating Ideas
2. Large	2. Dispersed	2. Choosing Alternatives
		3. Negotiation
ENVIRONMENT	**GROUP TYPE**	**DEVELOPMENT STAGE**
1. Cooperative	1. Functional	1. Orientation & Internal Problem Solving
2. Noncooperative	2. Task (Project)	2. Growth & Productivity
	3. Interest or Friendship	3. Evaluation & Control

Group Size. Classification by group size is rather arbitrary because the concept "large" and "small" is relative. GDSS research, however, has been largely restricted to "small" groups (Johnson, Trumbley, Dejoie, & Walther, 1993). As a group gets larger, the number of potential interactions gets larger geometrically, but the "frequency, duration, and intimacy of information exchange" (DeSanctis & Gallupe, 1986) tend to decrease. In large groups, group satisfaction and affectional ties decline, and it gets increasingly difficult to attain consensus (Cartwright & Zander, 1968; DeSanctis & Gallupe, 1986; Hoffman, 1979). Even the logistics of scheduling, conducting, controlling, and tabulating the results of a large group is a complex task that needs extensive support. Although there are no definitive studies, we conjecture that controlling process losses is more critical in larger groups than in smaller groups. While members of a small group strive harder to resolve conflicts, larger groups tend to use humor to mitigate conflicts (DeSanctis & Gallupe, 1986). It would be better if a GDSS could help the larger group solve the conflict instead of just suppressing it. As stated before, "constructive" conflicts could lead to better decisions, so suppressing them is not desirable (Wall, Galanes, & Love, 1987).

Group Proximity. While "traditional" meetings are conducted in a face-to-face mode, the rapid development of communication technology is making "remote" or "dispersed" meetings more attractive. Several studies have concluded that decreased physical proximity results in less group cohesiveness and norm development (DeSanctis & Gallupe, 1986). Remote meetings may be especially desirable for members who are geographically dispersed. Advantages of remote

meetings include reduced cost of conducting a meeting (no plane tickets, hotel reservations, etc.), less wasted time in traveling, and more flexibility. Sometimes a group may prefer to have a remote meeting (even if it is physically possible to meet face-to-face) because this may be perceived as a more productive method.

Interestingly, it appears that *perceived* physical proximity is more critical than *actual* physical proximity (Monge et al., 1985). With the promise of multimedia networks that support electronic text, audio, video and graphic messages, the "perceived" distance among dispersed group members could be reduced even further making remote meetings more effective. Of course, computer and telecommunications technology would play a critical role in scheduling, controlling, conducting, analyzing, and dispersing the results of remote meetings.

Currently, the traditional face-to-face meetings are common in most organizations. Many decisions are made in such an environment because it allows for good verbal and non-verbal communication of ideas and enhances group satisfaction (DeSanctis & Gallupe, 1986). Moreover, it may be the only way many firms can currently conduct their meetings.

Task Type. DeSanctis and Gallupe have used the "circumplex model" of group task types proposed by McGrath (1984) to classify group tasks. The circumplex model categorizes group tasks according to the objectives of a meeting. Table 2 summarizes the three task types: Generating Ideas, Choosing Alternatives, and Negotiating Solutions. An effective GDSS must support all three task types. For "Generating Ideas," the GDSS must provide an effective way in which each group member could voice his/her opinion (perhaps by preserving anonymity of ideas), and facilitate fast evaluation of these ideas. The GDSS should also provide means by which various group structuring techniques like Nominal Group Technique, Brainstorming, and Delphi technique could be enforced.

Table 2. Group Task Types

1. **Generating Ideas**
   a. Action-oriented plans are required for
      Planning Tasks
   b. Novel ideas are required for
      Creative Tasks

2. **Choosing Alternatives**
   a. The selection of the correct alternative is an
      Intellect Task
   b. The selection of an alternative for which there exists no "correct alternative" is a
      Preference Task

3. **Negotiating Solutions**
   a. Resolution of conflicting viewpoints is a
      Cognitive Conflict Task
   b. Resolution of conflicting motives or interests is a
      Mixed-Motive Task

For "Choosing Alternatives," the GDSS must aid the group to arrive at a "high-quality" decision. Intellect tasks can be supported by providing mathematical models and tools, whereas preference tasks can be supported by providing "voting" schemes and idea-ranking mechanisms. Additional support can be given to preference tasks by providing mechanisms that allow all members to participate actively.

In order to support "Negotiating Solutions," a GDSS must support both cognitive-conflict tasks and mixed-motive tasks. The primary tasks of the GDSS must be to ensure that no members dominate the group, and to ensure that the meeting does not get distracted by unproductive conflicts among the members. It might be useful to have some conflict resolution techniques built into the GDSS. The GDSS must also provide some voting schemes, and mechanisms to display the various members' ideas.

Group Environment. The decision making environment itself can be classified broadly as *cooperative* and *non-cooperative* categories. In a cooperative environment, the decision makers try to reach a decision in an amicable fashion, and then share the responsibility of the decision collectively. There is mutual trust, and the participants try to reach a decision by consensus, negotiation, or by voting. Also, in a purely cooperative environment, there is no attempt to cheat, or seek coalition within a subgroup, and there is no third party intervention (Bui & Jarke, 1984). The cooperative environment tends to increase group satisfaction (Schweiger et al., 1986), but it may be at the expense of decision quality. In a cooperative environment, there is immense pressure for group conformity, and this may result in "groupthink" (Janis, 1971). We could also have a situation in which the decision is biased by the dominant group members. Many times, the minority views tend to be suppressed or deferred to majority views.

A study by Thomas (1976), on the other hand, points out that in the cooperative approach, all the parties are highly motivated to ensure that their own concerns, and as well as the concerns of the other parties, are met in the final decision. So, there will be a genuine attempt to incorporate suggestions of all parties, which in turn leads to a better acceptance of a group decision.

When the decision environment is non-cooperative, the decision makers play the role of antagonists. Much of their decision making is centered around conflict and competition (Bui & Jarke, 1984). Competition is said to occur when each participant tries to outperform the others. Conflict includes anything from intellectual disagreements to physical violence, and can lead to higher productiveness or destructiveness. If conflicts tend to tear a group apart, then it is clearly destructive. On the other hand, conflict is said to be productive when it adds to the pool of ideas, opens up an issue, helps to clarify it, alerts the organization that corrective actions need to be taken, prevents the arrival of a premature consensus, or increases constructive involvement of individuals in the decision making process (Wall, Galanes, & Love, 1987). Conflicts are also liable to have a double-edged effect (Guetzkow & Gyr, 1954). A particular conflict could affect group productivity and adaptability positively, but affect group stability negatively. In any case, conflict tends to inhibit the attainment of consensus.

Results from previous research (Schweiger et al., 1986) have shown that both "dialectical inquiry" and "devil's advocacy" can lead to higher quality decisions than can consensus.

Dialectical inquiry uses debates between diametric sets of recommendations and assumptions, whereas devil's advocacy relies on critiques of single sets of recommendations and assumptions.

Group Type. The group is a key element in the social order of our culture. Besides providing a focal point of social life, groups also provide an important source of direction to individuals for understanding social values and norms. Also, via participation in groups, individuals may satisfy their economic, status, safety, security, and friendship needs. Finally, the behavior and performance of groups provide a major mechanism for the achievement of organizational goals. Lack of group direction, a tense and stressful atmosphere, continuous occurrence of conflicts, and a lack of employee need-satisfaction can all affect the quality of the group's performance.

In order to support groups, it is necessary to categorize groups according to their needs and functions. This is important because each type of group may have its own special requirements which have to be supported for effective functioning of the group. The approach we have chosen is based on the work described by Cartwright and Zander (1968) which classifies groups according to their purpose. This results in three types of groups: Functional Groups, Task Groups, and Interest and Friendship Groups. The characteristics of these groups are detailed by Szilagyi (1984), and are described briefly below.

Functional Groups are considered formal groups, and typically accomplish ongoing tasks. They are formal because member relationships are specified by the organizational structure which frequently involve superior-subordinate relationship. ***Task Groups*** are also formal groups; however, member relationships are established for the accomplishment of a specific task. Superior-subordinate relationships are not uncommon, and relationships are often of a short-term nature as the task group may be disbanded after accomplishing their task. Finally, there are the ***Interest and Friendship Groups*** in which member relationships are formed because of some common characteristic such as age, political beliefs, or interests. These groups are considered either a formal or an informal group, and they may have goals which are congruent or incongruent to the organizational goals.

The characteristics of the various group types should determine the nature of group decision support. Studies by Turoff and Hiltz (1982) have shown that high satisfaction and high decision quality cannot be simultaneously attained. Relatively more support is needed to achieve group satisfaction in functional groups than in task groups because the former are permanent groups and the latter are temporary. A functional group must be able to work effectively as a team for a relatively long time horizon; therefore, it is presumable that the group members be sufficiently satisfied. On the other hand, group satisfaction could be compromised for achieving higher quality decisions for task groups because these groups are temporary. Knowing the type of group can therefore allow us to exploit this quality/satisfaction trade-off.

Interest and Friendship groups are important to our social culture, and such groups will affect corporate decision making in some manner. For instance, the members of a particular club in an organizational group might share certain views on specific issues. In a corporate meeting the club members could "stick together" and bias certain decisions. Whether such a bias is desirable is altogether a different issue; however, one should be aware of such group dynamics.

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Group Development Stage. The capacity of a group to perform in unison does not emerge from the very instant that the group forms, but evolves over time (Bennis & Shephard, 1963). Three stages in this evolutionary process have been identified (Szilagyi, 1984), and are briefly discussed below. An important point to keep in mind is that a group can revert to an earlier stage at any time.

The first stage, *orientation and internal problem solving* stage, is concerned with the various activities that occur when a group gets together for the first few times. This stage is usually filled with apprehension, wary group interaction, and a concern for integration (Szilagyi, 1984). After the initial adjustments, problems such as personality conflicts and role acceptances are resolved. At this stage, it might be better to foster an informal, less-controlled atmosphere. It might also be better to have support for resolving any conflicts instead of avoiding or suppressing it.

In the second stage, *growth and productivity,* the group is more task-oriented, and tries to meet its objective effectively. The group's internal problems are largely solved, and the members can devote their effort and time to accomplish the task at hand. Activities in this stage include sharing of ideas and approaches, providing and receiving feedback, and finding better ways to do the job. At this stage, because the members have a well-established relationship, a GDSS could provide support for higher quality decisions at the expense of group satisfaction.

The final stage, *evaluation and control stage,* is concerned with activities as the group approaches the conclusion of its tasks, or after the group has been together for a relatively long time. Activities include reviewing of procedures, revising group norms, and public communication programs. During this stage, a GDSS might help in summarizing and distributing the decisions to relevant people.

A FRAMEWORK FOR GDSS RESEARCH AND DESIGN

In this section, we complete the proposed multidimensional GDSS framework to conduct meaningful research in GDSS so that effective group decision support systems can be designed. As we have stated earlier, it is important to match the appropriate GDSS features with a given situation. As with all tools, it is important to recognize the right tool for a particular job. It is illogical to conduct GDSS research and then make conclusions as we have done in the past (for example, "GDSS does not help make better decisions" or "GDSS users are more satisfied than non-GDSS users"). A more meaningful conclusion to make would be "GDSS features X, Y, and Z help in group situations A and B, but not in situation C."

The six situational variables (contingency factors) suggested in this paper can be used as control variables in GDSS field experiments to describe particular group situations, and the utility of different GDSS features can then be studied in a meaningful way. Since it would be difficult to standardize the specific features across different group decision support systems in experiments, we next define six generic levels of GDSS support. In defining these GDSS levels, we follow the lead in DeSanctis and Gallupe (1986), where a useful list of GDSS features was

categorized into three levels. In this paper we categorize GDSS features into *six* levels so that there is better control over the type of features in an experiment. Table 3 lists these six levels and examples of features (not an exhaustive list) at each level.

Table 3. Six Levels of GDSS

Level 1:	**Facilitate Interpersonal Communication**	
	Features:	Electronic-Mail, Individual and Public Display Screens
Level 2:	**Utilities**	
	Features:	Electronic Record of Meeting, Electronic Voting & Ranking, Access to Corporate & Private Databases
Level 3:	**Basic Communication Control**	
	Features:	Anonymity, "Tagged" Anonymity, Agenda Creation & Enforcement
Level 4:	**Facilitate "Between-Meeting" Activities**	
	Features:	Meeting Scheduling, Document Sharing Outside of the Meeting Environment
Level 5:	**Extended Communication Control**	
	Features:	Automated Decision-Making Structure (ex: Brainstorming, Delphi, NGT, Arbitrary Rules)
Level 6:	**Model Base Management**	
	Features: Suggest & Facilitate the Use of Appropriate Decision Models	

Many of the features in Table 3 are similar to that of DeSanctis and Gallupe (1986), except for the new features classified as Level 4 which specifies GDSS support for activities "between" meetings. A recent study by Satzinger and Olfman (1992) which assesses user perceptions of group support systems suggests that "support for between meetings group work was perceived to be *more* useful than support foı either face-to-face or electronic meetings." Satzinger's study drives home the point that future GDSS must also support "between meeting" activities. Many meeting-related activities are often done individually by members of the group or in smaller subgroups outside the meeting environment. Activities such as scheduling of meetings, conducting background information research for the meeting, and promoting discussions among a subset of the group's members (or even with people who may not even be part of the original group) occur prior to or between meetings.

We believe decision *quality* is the most important criterion while making group decisions, and would like to emphasize a *long-term* outlook for decisions when conducting field studies in GDSS. Although, optimizing a GDSS to enhance decision quality might lead to group dissatisfaction (as suggested by Turoff & Hiltz, 1982), we conjecture that the eventual positive outcomes of a good decision would far outweigh any "side-effects" of maximizing the quality. For example, if 40% of the group members feel bitter about the final decision of the group, we should not immediately conclude that the meeting led to dissatisfaction - it probably only led to *short-term* dissatisfaction. If after implementing the high-quality solution, the company makes enormous profits and subsequently rewards all the group members for a great decision, the initially "bitter" members might become less bitter or might even feel satisfied with the group. The author is not aware of any GDSS studies that have taken this "long-term," holistic view of high quality decision making. GDSS researchers should go beyond the meeting situation to study the effects of a decision-making process on the perceptions of group members.

SUMMARY AND CONCLUSIONS

Much of the past research in GDSS have focused on (i) automating techniques and ideas (such as the Delphi technique, brainstorming, brainwriting, anonymity, etc.) and (ii) studying the effect of group size, anonymity, physical proximity and so forth on group decision making (Aljumaih et al., 1995). The findings of these studies, however, provided very mixed results - ranging from positive to negative or no effect on group decision making. In this paper, we develop a multidimensional framework for future GDSS research and design in order to obtain more consistent results. The only meaningful way to assess the effect of a GDSS on group decision making is to study the effects of specific GDSS features on specific group situations.

DeSanctis and Gallupe (1986) had provided an important starting point for constructing our framework, and we have extended their approach in this paper. We have identified and described six situational factors - group size, member proximity, task type, group environment, and group development stage - that can be used to describe a given group decision making situation. We have suggested that these factors be used as control variables in future GDSS research.

We argue that it is essential for GDSS designers to know the efficacy of specific GDSS features for different group situations so that the GDSS can be used in an effective manner. A GDSS's full potential can only be realized when it is used in "appropriate" situations. An important research issue is to *identify the appropriate GDSS features for the appropriate situation.* To standardize the GDSS features in experiments, we have defined six levels of GDSS features. For a given group situation, say members of a small, face-to-face, functional group engaged in a cooperative, idea-generation activity (in the growth and productivity stage), a study using our framework might conclude that Levels 1 and 4 are helpful for generating high quality decisions - and that Levels 3 and 5 were disruptive. We feel that the ability to make such conclusions will add considerably to our knowledge of group decision making, and help in effective GDSS design and use. It is also suggested that researchers take a long-term, holistic approach while analyzing the results of using a GDSS.

An ideal GDSS (Kraemer & King, 1986) satisfies the need of the situation (i.e., helps solve the problem in an acceptable manner), solves problems in a manner which leaves the group more satisfied than dissatisfied, and encourages the group to want to work together in the future. Satisfying all these goals simultaneously, however, is an elusive objective (Turoff & Hiltz, 1982), thus any GDSS can only attempt to help reach a good compromise. A clear grasp of the group decision making situation helps the GDSS designer compromise in the best possible way - i.e., make the right tradeoffs.

It would indeed be a great challenge to conduct GDSS field experiments (not using hypothetical subjects using hypothetical scenarios) as described in this paper, but we feel that they are essential for making any meaningful conclusions. We hope that this paper has paved a way for future research in this challenging and important domain.

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