The Effect of GDSS and Elected Leadership on Small Group Meetings

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ABSTRACT: This research investigated the effect of a group decision support system (GDSS) and elected leadership on meetings of five-person groups. A controlled experiment that varied the form of decision support (no support, manual structure support equivalent to the GDSS structure, and GDSS support) and elected leadership (yes and no) was used to compare group decisions. Forty-eight undergraduate student groups were randomly assigned to one of the six treatment conditions of this 3×2 factorial design. The groups solved a preference task that required resolution of competing preference structures to arrive at group decisions. The level of premeeting consensus was used as a covariate. The dependent measures included postmeeting consensus, equality of influence, and influence of the leader. The major findings of this research are:

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• Manual groups displayed a significantly higher postmeeting consensus than GDSS groups. Elected leadership did not increase postmeeting consensus.

• There was a significant correlation between equality of influence and premeeting consensus in GDSS groups. Groups that had high premeeting consensus seemed willing to let one member dominate the final solution.

• Group support in the form of structure has potential to undermine leadership in small group meetings because leaders in manual and GDSS groups appeared to be less influential than their counterparts in baseline groups.

KEY WORDS AND PHRASES: electronic meeting systems, group decision support systems.

1. Introduction

> A major task ahead for science and technology is to design effective information processing systems for making decisions in business and in government.
>
> —Herbert Simon [44, p. 286].

GROUPS ARE PERVASIVE AND NEARLY UNIVERSAL in organizations. Although previous research findings suggest that judgments produced by groups are superior to judgments produced by individuals [for review, see 18, 37], groups are often perceived to be ineffective [25, 39]. Frequently, groups fail to utilize the full resources of their members due to process losses. The sources of process losses are [22]:

• Dominant group members tend to participate in the group discussion more than their contribution to the group's goal attainment merits and suppress the potential contribution of other members.

• Miscommunications, which occur in group discussion, reduce the actual contribution of individual group members.

• Groups may fail to pay sufficient attention to the problem-exploration and alternative-generation steps. This often leads to a low-quality solution.

• Low-status members have a tendency to yield automatically to the opinions expressed by high-status members, thus depriving the group of the potential contribution that originally justifies the presence of low-status members.

• Group members have a tendency to conform because of group pressures, resulting in groupthink [25]. This phenomenon can suppress information that is not in keeping with the direction in which the group is headed.

Despite these shortcomings, groups remain the major decision makers in organizations. The necessity for group work in addition to individual work has been assured by the modern industrial state, which cannot survive on individual effort alone [27]. It has been suggested that the formation of functional task groups in organizations stems from division of labor [39]. Groups are also believed to possess the potential to increase performance because of the combining of abilities and insights, the error checking and quality control, and the eliciting and provoking of new thought [18, 36]. Hence, the study of groups has both scientific and practical relevance.

One important area in the study of groups has been how to improve group meetings. The practical relevance of the area stems from the sheer number of meetings held and the amount of time managers and other professionals spend in group meetings. In corporate America, a meeting is held every minute and the average attendance is five persons [8]. The *Wall Street Journal* [24] reports that managers spend from 25 to 50 percent of their work time in group meetings. Furthermore, the current and increasing complexity and turbulence of postindustrial organizational environments can only heighten demands for information exchange and use between group members. Hence, the amount of time spent in group meetings will become even larger in postindustrial societies [22, 23], which would mean less time for other managerial and professional activities. This perceived imbalance in the allocation of managerial time creates a need for developing and implementing new approaches for making meetings more effective and efficient.

This need has been assured by a growth of studies of structured group management techniques such as the Nominal Group Technique [9], the Delphi Technique [29], and the Social Judgment Analysis Technique [36, 37] in the 1970s and Group Decision Support Systems (GDSSs) [11, 13, 27, 31, 35, 43, 46, 48, 51, 53] in the 1980s. Structured group management techniques have been shown to be superior to less structured processes for helping groups make decisions, at least in some situations [36]. Nevertheless, each technique contains cumbersome information aggregation, collation, analysis, and display processes [21]. GDSSs, which combine computer, communication, and decision support technologies, have been suggested as an alternative means for improving group meetings because of their information-processing capability [21].

The goal of a GDSS is to increase the effectiveness and efficiency of group meetings by adding process gains and reducing process losses associated with group discussion [23]. GDSS technology aims to achieve this goal by augmenting the information-processing capability of the groups, increasing participation from group members, and improving communication between group members. Augmenting information-processing capability may be realized by providing decision aids and techniques for structuring decision analysis; increasing participation and improving communication may be achieved by providing an additional communication channel and software features such as anonymity and flexible meeting agendas.

Leadership is one of the most observed and least understood phenomena [5]. It is a rather sophisticated concept with many definitions that depend on the leader and the context. In this research, we study leadership in the context and as a focus of group process. At the group level, the leader, by virtue of his or her special position, serves as the primary agent for the determination of the group goals, structure, process, outcome, morale, and satisfaction [3, 46]. Despite the importance of leadership to the performance of groups, a review of GDSS literature shows that the effects of GDSS on leadership behavior have largely remained unexplored. Turoff and Hiltz [51] studied the effects of elected leadership in a computerized conferencing environment. Their study showed that group leadership and structured computer support interacted strongly and canceled each other. The applicability of this result to a face-to-face meeting with GDSS support is unknown.

This research is an experimental investigation of the effects of a GDSS and elected leadership on the performance of small groups in a face-to-face meeting environment. It replicates Watson's [52] work in adopting his experimental design and research task; it extends his work by introducing leadership as a new independent variable.

2. Literature Review

2.1. Group versus Individual Performance

THERE IS A VAST LITERATURE ON GROUP versus individual performance. A comprehensive review of this literature in the period 1920–80 can be found in Hill [18]. The findings of the research reviewed show that performance is influenced by group conditions and task type. Hill identifies three group conditions and five task types. The three group conditions are individual, statistical aggregate, and group. The five task types are learning, creativity, abstract problem solving, brainstorming, and complex problem solving.

The findings of the research over the sixty-one-year period reviewed by Hill show that group performance is generally superior to individual performance. In learning tasks, group performance was consistently superior to individual performance. In creativity tasks, the relative abilities of group members influenced group performance. Homogeneous groups with high-ability members performed better than high-ability individuals, but a high-ability individual performed better than medium-ability groups. In heterogeneous groups, performance was proportional to the sum of the ability levels of the members and performance of high-ability members was detrimentally affected by lower-ability members. In abstract problem-solving tasks, groups produced more correct solutions than individuals, but about the same number as the best member of statistical aggregates. Groups performed better than individuals in brainstorming tasks over a variety of problems. However, across all problems, scores from statistical pooling were equal to or greater than those of groups. In complex problem-solving tasks, group performance was usually superior to individual performance, but inferior to statistical pooling of responses.

The superior performance of groups in certain task types is attributable to the ability of groups to pool their resources, correct errors, and use qualitatively different problem-solving strategies. In brainstorming and complex problem solving, statistical pooling has the advantage of simultaneous generation of solutions by writing, whereas groups had to verbalize serially.

Some researchers have argued that the results of research on group versus individual performance are merely an artifact of the algorithm used to compute the scores [49] and proposed alternative scoring strategies. Cooke and Kernagan [7] used five alternate strategies to compare scores in a study of sixty-one groups (347 individuals) performing a complex problem-solving task. Although the alternative strategies produced different estimates of the amount of gain attributable to group interaction, they supported the conclusion that groups perform better than their individual members in problem-solving tasks.

2.2. Group Decision Support Systems

Extensive reviews of empirical research in GDSS can be found in Dennis et al. [10] and Pinsonneault and Kraemer [33]. Nearly all empirical research in GDSS (for an exception, see the process analysis of Zigurs et al. [54]) adopts an input–output perspective and compares the decision outcomes of GDSS groups with those of traditional, face-to-face groups. The dependent variables commonly used are decision quality, consensus, equality of participation, and satisfaction with the process. Some research has included an additional treatment in which groups are manually supported by a structure that is equivalent to the GDSS support [28, 53]. Manual support is used to isolate the effect of structure on group decision making so that the impact of GDSS technology, over and above the effect of structure, can be determined.

The number of reported empirical studies, although small, deal with a large number of issues. The DeSanctis–Gallupe taxonomy for GDSS research [11] is used to organize the findings of these studies. This taxonomy adopts an information exchange perspective and identifies group size, member proximity, and task type as the key variables for the study of GDSS. It consists of twenty-four cells. Since our study uses five-person groups, we concentrate on the twelve cells that correspond to small group size. (See Nunamaker et al. [31] for an example of the large-group studies.) Table 1 shows eight empirical studies positioned in their appropriate cells in the taxonomy. The classification of tasks in Table 1 is based on McGrath's task circumplex [30].

The use of a GDSS appears to lead to better-quality decisions for planning, creativity, and intellective tasks. Four studies [13, 26, 47, 51] reported that GDSS groups made better-quality decisions than baseline groups.[1] Lewis [28] reported that GDSS groups made better decisions than manual groups.[2] On the other hand, the use of a GDSS does not appear to increase decision quality for preference and cognitive conflict tasks [4, 52].

The use of a GDSS also tends to lead to a more equal participation of the group members. Siegel et al. [43], Lewis [28], and Turoff and Hiltz [51] reported more equal participation from GDSS groups. Four studies [4, 13, 26, 52], however, reported no significant difference between GDSS groups and baseline groups. The findings seem to suggest that the anonymity feature of GDSS encourages participation from group members.

On the other hand, the use of a GDSS appears to reduce group consensus in a face-to-face decision-making environment. Gallupe [13] reported that the use of GDSS leads to a lower level of consensus. Watson [52] reported no significant difference in group consensus between the GDSS and the baseline groups. The use of a GDSS appears to help dispersed groups to reach consensus for an intellective task but to prevent them from reaching consensus for a preference task [43, 51]. These research findings appear inconsistent about the effect of GDSS on equality of participation. As a result of a more open and even participation, we would expect group

Table 1 Eight Empirical Studies Organized in the DeSanctis and Gallupe Taxonomy

	Face-to-face	Dispersed
Planning	Steeb and Johnston [47]	
Creativity	Lewis [28]	
Intellective	Gallupe [13] Jarvenpaa et al. [26]	Turoff and Hiltz [51]
Preference	Beauclair [4]	Siegel et al. [43]
Cognitive Conflict	Watson [52]	
Mixed Motive		

members to feel a greater personal commitment toward the group's decision. Pinsonneault and Kraemer [33] suggest that when a GDSS is applied to groups that are in early stages of development and the efforts of members are oriented toward establishing position and power over the decision process, a GDSS decreases consensus. If this suggestion is valid, a GDSS may not affect the consensus of groups that have established their power relations and structures.

In addition, a GDSS appears to increase the group's satisfaction with the decision-making process when it is used for planning tasks [47]. However, it decreases the group's satisfaction with the decision-making process when it is used for intellective and cognitive conflict tasks [13, 52].

Of the empirical studies discussed above, only the study by Turoff and Hiltz [51] investigated the leadership variable. They studied the behavior of elected leaders in a computerized conferencing environment and concluded that there was a strong interaction effect between leadership and computer support: they canceled one another in helping groups to reach consensus.

DeSanctis and Gallupe [11] suggest that the usual political dynamics of the group will change when GDSS technology is introduced to the decision-making process. They imply that perceived member power and influence would become more distributed in a GDSS-supported environment because the technology encourages equality of participation. Consequently, GDSS technology will prevent members with high perceived power from exercising influence, and prohibit the emergence of new power from those seeking it. This is an interesting observation and it deserves careful investigation. One of the aims of this research is to investigate how GDSS may affect the influence of elected leaders in small group meetings.

2.3. Leadership

A review of literature on leadership shows that different researchers view leadership differently [2, 14]. Here, we view leadership as the exercise of influence, and the leader as an individual "who exercises positive influence acts upon others" or "who exercises more important influence acts than any other member of the group" [40, 41].

There is some evidence to suggest that a leader, through the exercise of appropriate influence acts, can improve group performance. A review by Schriesheim, Mowday, and Stogdill [40] indicates that leadership can affect group drive and cohesion. Both task-oriented and social-oriented leader behavior are found causally antecedent to group drive [16]. The same study also suggests that both types of leader behavior are important to group cohesiveness. According to Farrow, Valenzi, and Bass [12], consultative leadership would yield more subordinate satisfaction if the leader felt that members were highly committed to the group and its goals. O'Reilly and Roberts's study [32] suggests that low leader influence could reduce the impact of leader behavior on satisfaction and performance.

Hopkins [20] studied the exercise of influence in small groups. He took a functional perspective and developed a theory for exercise of influence in small groups based on properties of the status of the member. Influence is defined as the effects of action on the group's consensus. A member's influence, over a given period of time, consists of the impact of his or her actions on consensus during the period. His or her relative influence is the impact of his or her actions relative to the impact of the other members' actions. This theory is relevant here because the elected leader of a group has different status properties from the other members.

Hopkins proposes fifteen interrelated assertions on exercise of influence in small groups. These are based on four properties of the status of the member: rank, centrality, observability, and conformity. These propositions assert that the four properties and influence are positively related to one another, and for any member of a small group relative to other members, the more of any one of them he has, the more he has of the others. In particular, Hopkins suggests that:

> Briefly, rank is seen to lead to centrality, centrality to observability and conformity, these to influence, then influence back to rank, and so on. It is this set of sequential relations that presumably describes a basic process of groups the main tendency of which is to bring into balance over a group's membership the distribution of rank and of influence. [20, p. 8].

Because an appointed or elected leader normally has a higher rank in the group, it follows from the above arguments that he or she has a greater centrality, which leads to a greater observability and conformity, and these lead to a greater influence. Hopkins's theory will be used to formulate a hypothesis on leadership in section 3.

3. Model and Hypotheses

3.1. The Causal Model

McGRATH'S [30] FRAMEWORK HAS BEEN SUGGESTED as a suitable theoretical basis for investigating the effects of GDSS [52, 54]. According to this framework, the central feature of a group lies in the interaction of its members—the behavior together of two or more persons. The framework identifies two states of the group and four major classes of group properties that set the conditions under which group interaction takes place.

The two states of the groups are:

- the standing group: this denotes the group structure and patterned relations among group members prior to a meeting;
- the acting group: this denotes the group interaction process and patterned relationships among group members in relation to task/situation and environment.

The four major classes of group properties are:

- the biological, social, and psychological properties of individuals;
- the physical, sociocultural, and technological properties of environment(s);
- the properties of the standing group;
- the characteristics of group task.

The effects of these four sets of properties, singly and in combination, are the forces that shape the group interaction process. The group interaction process itself is both the result of these shaping forces and the source of some additional forces. The interaction process and its results represent forces that potentially lead to changes in the input variables. For example, the level of consensus of a group prior to a meeting, a property of a standing group, will influence the group interaction process, and the interaction process will, in turn, lead to changes in the level of consensus after the meeting. In other words, the input classes of variables and the group interaction process interact with each other.

The causal model for this study, which is derived from McGrath's framework

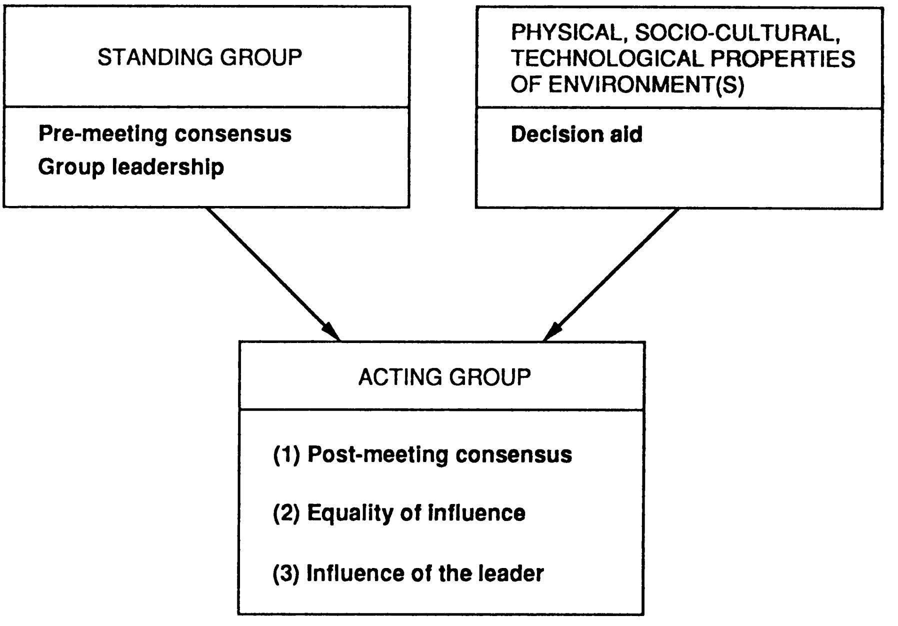

Figure 1. Causal Model of the Group's Behavior

[30], is shown in Figure 1. The model asserts that the behavior of the acting group is influenced by the type of decision support, the premeeting consensus of the standing group, and the existence of group leadership in the standing group.

Three properties of the acting group are of interest: level of postmeeting consensus, equality of influence, and influence of the leader. The level of consensus of a group that solves a preference allocation task is a key measure of the degree of success in a group discussion because it is related to the level of commitment of each member to the group's decision after the meeting, and it affects the group's stability in the long term. Equality of influence, which is related to degree of member domination, is an important measure because it tells us the influence patterns of group members and suggests how group members arrive at the group's decision. Influence of the leader measures the degree of leader's influence in a group's decision and tells us the pattern of power relation in a group discussion.

3.2. Variables and Hypotheses

The independent variables used for this study were the type of decision aid provided to groups and elected leadership in groups. Premeeting consensus could not be manipulated; it was measured and used as a covariate. Three levels of decision support were used. GDSS groups received a level one GDSS support.[3] Manual groups were provided with flip-chart support and meeting agenda similar to the GDSS support. Baseline groups were freely interacting and received no support. Elected leadership had two levels: half the groups had an elected leader and the other half had no elected leader.

The dependent variables were postmeeting consensus, equality of influence, and influence of the leader. Using these variables, four major hypotheses were developed. Three hypotheses were derived from the conceptual foundations of GDSS proposed by DeSanctis and Gallupe [11]. The hypothesis on elected leadership was derived from Hopkins's theory of exercise of influence in small groups discussed in section 2.

3.2.1. Postmeeting Consensus

Prior to the meeting, the members of each group have a set of preferences with regard to the issue at hand (i.e., premeeting consensus). Following a discussion, group members may alter their preferences to align more closely with the group's decision (i.e., postmeeting consensus). Premeeting consensus is a function of the positions members express individually about an issue before the meeting occurs. Postmeeting consensus is a function of the positions members express again individually about the same issue after the conclusion of the meeting.

The type of decision support provided to a group can influence this shift in an individual's preferences because it changes the communication patterns of the group. A GDSS is expected to lead to a more even member participation because it provides a meeting structure and an additional anonymous communication channel for the group. By imposing an agenda of items such as problem definition, selection criteria definition, rating, ranking, and voting, the system suggests the procedures that groups may use in reaching their decisions. The provision of an additional anonymous communication channel encourages group members who may be reticent about verbally communicating their views to use the computer as a medium to express their ideas. Because of a more balanced involvement, GDSS group members should have a higher commitment to the group's decisions, and hence display a higher degree of postmeeting consensus. Using a similar argument, we can also conclude that manual groups who are provided with a structured approach to group decision making, compared to freely interacting groups, should attain a higher level of postmeeting consensus.

> *H1a: Level of postmeeting consensus will be higher in the GDSS groups than in the manual groups or the baseline groups, controlling for premeeting consensus.*
> *H1b: Level of postmeeting consensus will be higher in the manual groups than in the baseline groups, controlling for premeeting consensus.*

3.2.2. Equality of Influence

It is usually considered desirable to have higher equality of influence in a group discussion where no group member's opinion is considered more worthy than another. The presence of an anonymous communication channel and the imposition of a structure encourage those group members who are unwilling to communicate to participate and potentially influence the group discussion. As a result, groups that are supported by GDSS should display a higher equality of influence than manual groups or baseline groups. Using a similar argument, manual groups that are provided with a structured approach to group decision making should display a higher equality of influence than baseline groups.

H2a: Equality of influence will be higher in the GDSS groups than in the manual groups or the baseline groups, controlling for premeeting consensus.
H2b: Equality of influence will be higher in the manual groups than in the baseline groups, controlling for premeeting consensus.

3.2.3. Elected Leadership

Elected leaders in the experiments were told specifically that their main responsibilities were: (1) to promote consensus; (2) to summarize the meeting's progress; (3) to focus discussion; and (4) to suggest specific ranking changes [51]. As elected leaders were told specifically to promote consensus, we hypothesized that the level of postmeeting consensus would be higher in groups with elected leaders than in groups without elected leaders. This hypothesis was derived from three propositions of Hopkins [20] on exercise of influence. They are: for any member in a small group, (1) the higher his rank, the greater his centrality; (2) the greater his centrality, the greater his observability; (3) the greater his observability, the greater his influence. Consequently, we would expect equality of influence to be lower in elected-leader groups.

H3a: Postmeeting consensus will be higher in groups with elected leaders than in groups without elected leaders, controlling for premeeting consensus.
H3b: Equality of influence will be lower in groups with elected leaders than in groups without elected leaders, controlling for premeeting consensus.

3.2.4. Influence of the Leader

Unlike equality of influence, which is a group measure, influence of the leader is an individual measure. This measure focuses on the influence of the leader alone. As discussed above, GDSS technology is expected to discourage dominance by an individual member. Consequently, the perceived power and influence of leaders in groups supported by GDSS technology may be reduced. Therefore, we would expect the influence of a leader to be a function of the type of support given to the group. Since imposing a structure and providing an anonymous electronic communication channel discourage dominance by an individual member, we would expect the leader's influence to be lower in GDSS groups than in manual and baseline groups. Similarly, we would expect the leader's influence to be lower in manual groups than in baseline groups.

H4a: Influence of the elected leader will be higher in the baseline groups than in the GDSS groups or the manual groups, controlling for premeeting consensus.
H4b: Influence of the elected leader will be higher in the manual groups than in the GDSS groups, controlling for premeeting consensus.

In summary, we suggest that the imposition of structure raises the quality of group discussion. We emphasize the theory that the additional anonymous communication channel of the GDSS promotes a democratic decision-making process. As a result, GDSS improves the decision outcomes. We also suggest that elected leaders increase postmeeting consensus and decrease equality of influence in group discussions, and hypothesize that a GDSS reduces the influence of a leader in a group discussion.

4. Research Methodology

4.1. The Research Task

THE RESEARCH TASK WAS A PREFERENCE TASK. It was developed and validated by Watson [52]. The task involved an allocation of money to six projects based on personal preference structures and called for group members to resolve their conflict to arrive at a solution. Each of the six projects represents one of the dominant personal values discussed by Allport et al. [1]. These personal values are theoretical, economic, aesthetic, social, political, and religious. It is a convergent task that requires achievement of group consensus. It has no correct solution and is typical of many decisions made by real organizational groups, who frequently must decide how to allocate scarce resources among competing demands. This task is more suitable than a real-life organizational task because it does not require explicit knowledge of a functional area in organizations. A real-life organizational task would be inappropriate for the student subjects because they have limited organizational experience.

4.2. The GDSS: Software Aided Meeting Management (SAMM)

The GDSS used in this research is the SAMM system (version 1.3) developed at the University of Minnesota. SAMM provides each group member with a computer terminal through which group members can communicate, and a large public screen, easily viewed by all group members, that displays the inputs of the group members. SAMM has a modular structure and is written in the C programming language. The main menu of SAMM is illustrated in Figure 2.

The left-hand side of the screen shows a standard procedure that a group may follow when conducting a meeting. The right-hand side provides decision aids that can be accessed at any stage during the meeting. In this experiment, the decision aids option was not used. The software has seven features: problem definition, input of selection criteria, input of alternatives, rating, ranking, voting, and solution definition. These features are aimed at reducing process losses in group meetings and supporting primarily the communication needs of groups.

4.3. The Subjects

Two hundred forty undergraduate students of the National University of Singapore served as subjects for the experiment. They were formed into forty-eight five-person

Agenda

1. Define/View Problem
2. Define/View Selection Criteria
3. Define/View Alternatives
4. Rate Alternatives
5. Rank Alternatives
6. Vote or Straw Poll on Alternatives
7. Define/View Decision
8. Conclude Meeting

a. Define/View Comments
b. Multiplan

Figure 2. Main Menu Screen of SAMM 1.3

groups. All participants had used computers before. On the average, the subjects were twenty years old. Approximately 65 percent of the subjects were males who had completed two and a half years of national service and had worked in teams before. Most subjects knew each other beforehand. The subjects were given course credit for their participation.

4.4. The Experimental Procedure

Leaders of groups were elected by group members after the groups had been engaged in a preexperimental task. While this is a normal practice in experimental social science and study of small group behavior [3, 51], it may be argued that groups in real-life organizations seldom elect their leaders. The groups in this study are similar to task forces, quality circles, self-managed groups, and standing committees found in organizations. Chairpersons of such groups may be appointed or elected [38]. The groups also simulate small public bodies such as town councils, which elect their leaders.

Each experimental session had three phases. In the first phase, each group member allocated funds in five different scenarios. In the second phase, computer-supported groups received training on how to use the GDSS software. During the training session, computer-supported groups followed the agenda provided by the software and entered their inputs at each phase of the agenda. The training session lasted for forty-five minutes. Manual groups were provided with a handout outlining the same agenda that was used on the GDSS. Baseline groups received no training whatsoever. The third phase was the meeting session in which the groups solved a fund allocation task in each of the controlled experimental conditions described above. The task solved was the same as that solved in the first phase in one of the five scenarios. After the meeting concluded, group members again individually solved the same task and postmeeting allocation of funds by individuals was used to calculate postmeeting consensus. The meeting sessions were video-recorded. Pre- and postmeeting consensus was measured by the method developed by Spillman et al. [45]. Following the meeting session, two questionnaires were administered to measure other dependent variables that are not reported in this paper.

5. Analysis of Experimental Results

THE ANALYSIS OF COVARIANCE (ANCOVA) was used to test for significant overall effects for the two factors. The covariate was the level of consensus prior to the meeting. When a significant effect was found for a factor, a Ryan–Einot–Gabrial–Welsch (REGW) multiple F test was performed on all main effects means. The REGW procedure, which is called the method of adjusted significance levels, controls the experimentwise error rate at a given significance level.

5.1. Postmeeting Consensus

As indicated earlier, postmeeting consensus was measured by a method developed by Spillman et al. [45]. The measure gives a postmeeting consensus score ranging from 0 to 1, where 1 means complete agreement in the group. Table 2 summarizes the measurement of postmeeting consensus for each treatment.

The ANCOVA model was used to analyze the results. The results of the ANCOVA analysis are presented in Table 3.

The overall ANCOVA revealed a significant main effect for decision aid ($F = 4.44$, $p = 0.0188$). The REGW test indicated that manual groups displayed a higher level of postmeeting consensus than the GDSS groups. This is opposite to what was hypothesized. There were no significant main effects for the elected leadership. Hence, there is no support for hypotheses 1a, 1b, and 3a.

There was a significant interaction effect between decision aid and the covariate ($F = 3.50, p = 0.0407$). To further explore the interaction effect of decision aid and premeeting consensus (covariate), the correlation between postmeeting consensus and premeeting consensus was examined. Table 4 shows that there is a significant correlation between postmeeting consensus and premeeting consensus in baseline groups, but the relationship is not significant in manual and GDSS groups. Note, however, the negative correlation for manual groups. Figure 3 suggests that, in baseline groups, postmeeting consensus is positively related to premeeting consensus.

5.2. Equality of Influence

Equality of influence was measured using a method developed by Watson [52]. This measure produces a positive number where a score of zero means even influence in

Table 2 Postmeeting Consensus, Mean Score (Standard Deviation, Cell Size), Elected Leadership by Decision Aid

		Decision Aid			Totals
		Baseline	Manual	GDSS	
Elected Leadership	Yes	0.505 (0.18, 7)	0.556 (0.11, 8)	0.523 (0.13, 7)	0.529 (0.14, 22)
	No	0.597 (0.18, 7)	0.715 (0.25, 8)	0.448 (0.10, 8)	0.587 (0.21, 23)
Totals		0.556 (0.18, 14)	0.636 (0.21, 16)	0.483 (0.12, 15)	0.558 (0.18, 45)

Table 3 Postmeeting Consensus Analysis of Covariance

Source of variation	df	SS	F	Pr > F
Decision aid	2	0.216	4.44	0.0188*
Group leadership	1	0.003	0.12	0.7299
Decision aid x Group leadership	2	0.084	1.73	0.1923
Pre-meeting consensus	1	0.063	2.59	0.1165
Pre-meeting consensus x Decision aid	2	0.170	3.50	0.0407*
Error	36	0.874		
Total	44	1.421		

the group; the higher the score, the less even the influence. Table 5 summarizes the measurement of equality of influence for each treatment.

The ANCOVA model was used to analyze the results. The results of the ANCOVA analysis are presented in Table 6.

The ANCOVA model revealed no significant effects for both factors. Hence, there is

Table 4 Correlation between Premeeting Consensus and Postmeeting Consensus by Decision Aid

	Decision Aid		
	Baseline	Manual	GDSS
Correlation coefficient	0.583	-0.393	0.463
Significance	0.0287	0.1319	0.0820

Table 5 Equality of Influence, Mean Score (Standard Deviation, Cell Size), Elected Leadership by Decision Aid

		Decision Aid			Totals
		Baseline	Manual	GDSS	
Elected Leadership	Yes	0.52 (0.25, 7)	0.84 (0.91, 8)	1.26 (1.28, 7)	0.87 (0.92, 22)
	No	0.46 (0.29, 7)	0.40 (0.25, 8)	0.83 (0.38, 8)	0.57 (0.36, 23)
Totals		0.49 (0.26, 14)	0.62 (0.69, 16)	1.03 (0.91, 15)	0.72 (0.70, 45)

no support for hypotheses 2a, 2b, and 3b. The power value for this test is 0.28 [6]. This suggests that the sample size may have been too small to detect the effects of decision aid and elected leadership on equality of influence. There was a significant effect for the covariate. A correlation analysis between the equality of influence and premeeting consensus was conducted. Table 7 shows that there is a significant correlation between equality of influence and premeeting consensus in GDSS groups, but there is no relationship in the manual and baseline groups. Figure 4 suggests that, in GDSS groups, equality of influence is negatively correlated with premeeting consensus. In other words, high premeeting consensus leads to low equality of influence.

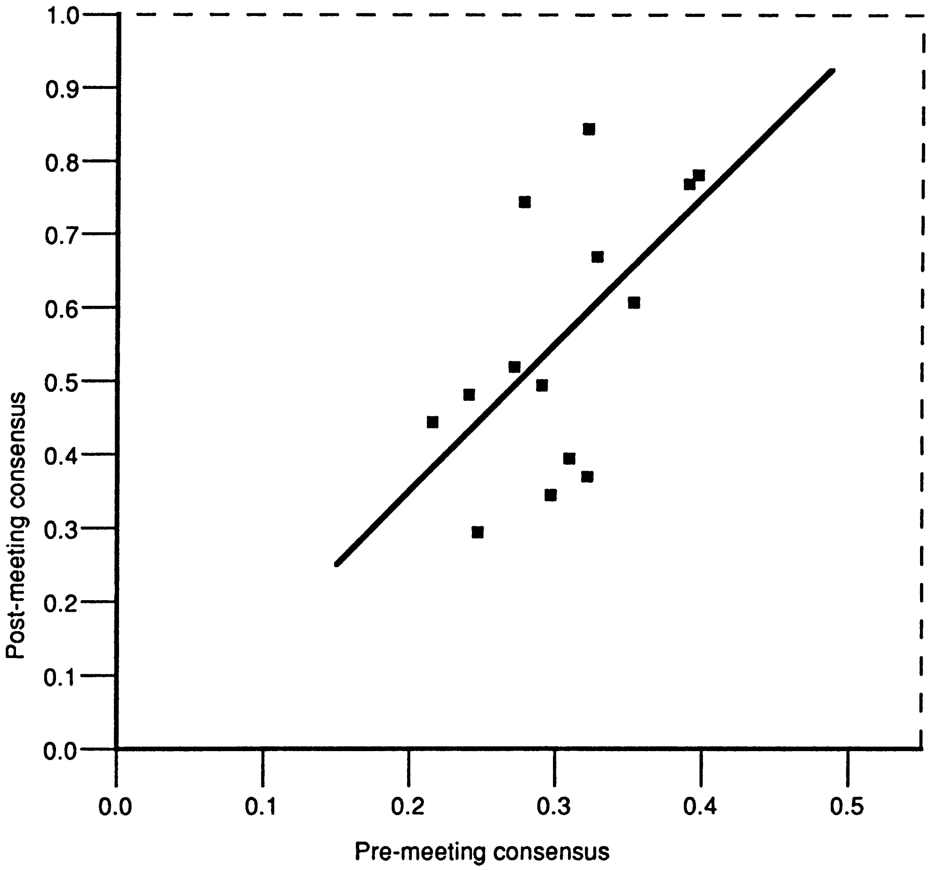

Figure 3. Postmeeting Consensus as a Function of Premeeting Consensus in Baseline Groups

Table 6 Log (Equality of Influence) Analysis of Covariance

Source of variation	df	SS	F	Pr > F
Decision aid	2	2.01	2.20	0.1247
Group leadership	1	0.93	2.04	0.1618
Decision aid x Group leadership	2	0.09	0.10	0.9060
Pre-meeting consensus	1	3.11	6.80	0.0130*
Error	38	17.36		
Total	44	25.13		

Table 7 Correlation between Premeeting Consensus and Equality of Influence by Decision Aid

	Decision Aid		
	Baseline	Manual	GDSS
Correlation coefficient	0.306	0.199	0.505
Significance	0.287	0.461	0.054*

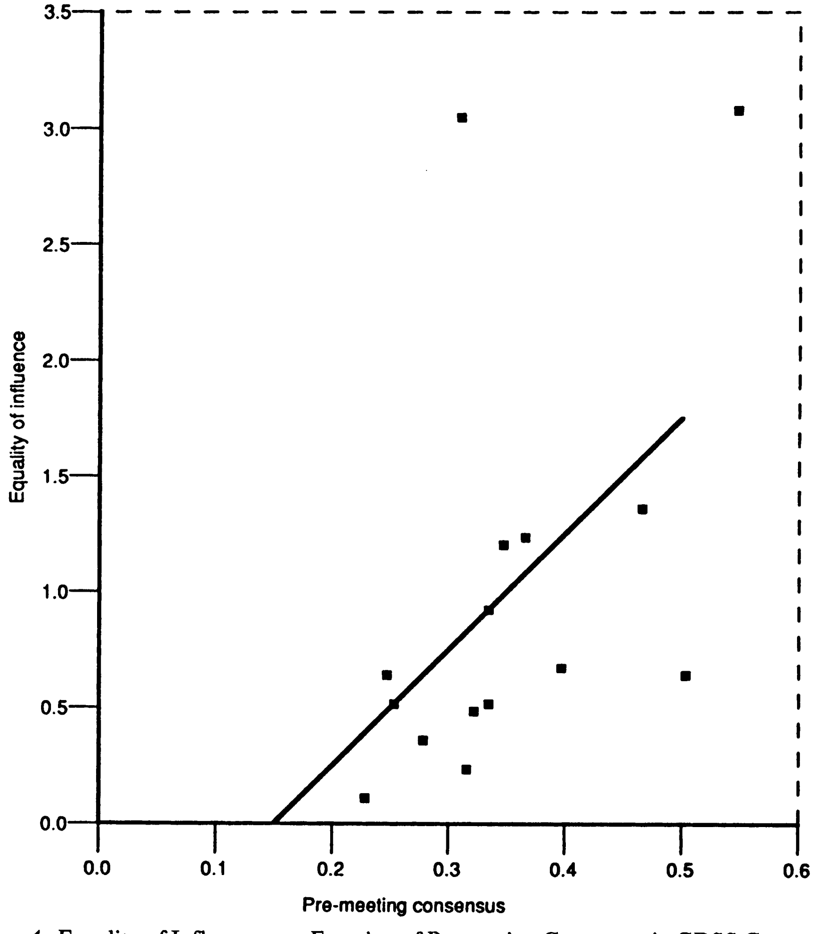

Figure 4. Equality of Influence as a Function of Premeeting Consensus in GDSS Groups

5.3. Influence of the Elected Leader

Influence of the elected leader was measured using a method developed by Watson [52]. This measure produces a positive number where a score of zero means the leader

Table 8 Influence of the Elected Leader, Mean Score (Standard Deviation, Cell Size), by Decision Aid

Decision Aid			Totals
Baseline	Manual	GDSS	
0.239 (0.11, 7)	0.163 (0.09, 8)	0.199 (0.16, 7)	0.199 (0.12, 22)

Table 9 Influence of the Elected Leader Analysis of Covariance

Source of variation	df	SS	F	Pr > F
Decision aid	2	0.00276	0.09	0.9107
Pre-meeting consensus	1	0.03221	2.19	0.1559
Error	18	0.26442		
Total	21	0.31827		

has no influence and a score of one means the leader has complete influence. The measurement of the influence of the elected leader is summarized in Table 8. The ANCOVA model was used to analyze the results. The results of the ANCOVA analysis are presented in Table 9.

The ANCOVA model revealed no significant effect for the factor decision aid. Hence, there is no support for hypotheses 4a and 4b.

6. Discussion and Implications

6.1. Postmeeting Consensus

THE STATISTICAL TEST INDICATED THAT MANUAL GROUPS displayed a significantly higher postmeeting consensus than the GDSS groups. The average level of postmeeting consensus appears to be a function of the decision aid. Structure appears to help groups to reach consensus. The provision of an additional anonymous communication channel to the GDSS groups appears to reduce the level of consensus of the groups. This negative effect of the anonymity feature cancels the positive effect of the structure feature. Consequently, GDSS did not help groups in reaching consensus for a conflict resolution task. This finding does not support the theory of GDSS suggested by DeSanctis and Gallupe [11].

The theory suggests that GDSS technology encourages more balanced participation by all group members and reduces dominant influence by one group member. Because of a more balanced involvement, GDSS group members should have a higher commitment to the group decisions and hence reach a higher degree of consensus. An examination of video recordings of the meeting sessions suggests that the GDSS groups did participate more evenly, but there was no obvious increase in information exchange.

The GDSS group members tend to communicate less verbally. This might have an implication, as verbal communication might have a higher "influence content" than electronic communication because the former has higher social and emotional cues. If this is the case, GDSS will not necessarily increase postmeeting consensus even if it leads to more even participation.

The fact that GDSS groups achieved a lower postmeeting consensus has both short- and long-run implications. In the short run, this finding means that GDSS group members are less committed to the decision, which, in turn, may slow down the implementation of the decision and decrease the group's immediate output. In the long run, this may affect group cohesiveness, which, in turn, may affect the morale, long-term cooperation, and conformity to group norms.

An interesting issue is whether or not the lowering of postmeeting consensus by the GDSS is acceptable in an Asiatic culture. In a consensus-building type of decision-making environment, which prevails in Asiatic countries, decision makers look for a solution that minimizes internal conflict and maximizes internal group harmony [19]. Thus, consensus forging is often considered as a key objective of group decision making. If GDSS support does not help groups to reach consensus as well as manual support, the technology not only falls short of achieving a key objective of group decision making, but also disturbs the cultural norms of the group. This negative effect will seriously limit the acceptance and implementation of the technology in such a decision-making environment. Longitudinal investigation using established groups is under way to examine the robustness of this finding and to determine the acceptability of GDSS technology in an Asiatic culture.

6.2. Equality of Influence

There were no significant effects for the dependent variable equality of influence. The large variance in each treatment cell is of concern because it indicates that within-cell variance might mask any difference between cells. A casual observation of Table 7 would suggest that computer support reduces equality of influence. This observation appears consistent with the finding that GDSS groups achieved a lower level of postmeeting consensus.

The finding, however, is inconsistent with the findings of the existing GDSS literature. Watson [52] found the opposite results. DeSanctis and Gallupe [11] suggest that GDSS technology encourages democratic decision-making process and hence increases equality of influence. This finding cannot be adequately explained by the existing GDSS theory. There are two possible sources of this inconsistency: effect of culture and effect of premeeting consensus. A cross-cultural analysis by Ho, Raman, and Watson [19] suggests that this inconsistency in findings may be due to the different cultural backgrounds of the subjects (American and Singaporean) used in the two studies.

There was a significant effect for the covariate ($p = 0.013$). Separate regression analyses for each decision aid treatment revealed that there was a significant correlation between equality of influence and premeeting consensus in GDSS groups. Some 20 percent of the variation in equality of influence is explained by the premeeting consensus. Groups that had high premeeting consensus on the solution to the task seem willing to let one person dominate the final solution. A possible explanation is that in situations of high premeeting consensus, most group members are satisfied as long as the group view is not very different from their opinion, and hence are willing to let one person dominate the group decision. Because the influence measure is a relative measure based on the premeeting positions of each group member, in a situation with high premeeting consensus, the group members' positions are relatively close and a slight shift in one direction can lead to high relative, but low absolute, influence.

The question now is why this happens only in GDSS groups. A possible reason is that the GDSS used in this study supports the anonymous assessment of group opinion and has voting tools that help the groups to identify their collective opinion quickly. Baseline groups did not use a formal method to establish group opinion and group members never had a clear picture of the group opinion. Manual groups were supplied with a method of establishing their opinion. But the method requires the members to state their opinion publicly and this might have induced a greater commitment to that opinion than a view stated anonymously via the electronic communication channel.

The above discussion indicates a need for a more refined instrument that includes both process (e.g., group's pattern of information exchange) and outcome (e.g., group's decision) variables to measure the influence behavior of groups. In addition, it raises two fundamental questions that deserve future research:

- Are GDSS group members, who contribute their ideas anonymously, less willing to defend their ideas? If the answer is yes, then GDSS with anonymity might lead to a decision that is less thoroughly justified and defended. This may create problems because, in real organizational settings, justification of the decision could be as important as, if not more important than, the decision itself. In addition, as a consequence of less defending of ideas, novel ideas might not get as good a chance to be pursued actively during the group meeting.
- Does GDSS really promote more democratic decision making? Our video-recording data suggest that GDSS does lead to more even participation, but the equality of influence data suggest the opposite. As indicated above, to answer this question adequately, we require a more sophisticated measure that combines both the process and outcome variables of group discussion.

6.3. Elected Leadership

Elected leadership was an independent variable in this research. It was hypothesized that elected leadership would increase the postmeeting consensus and decrease the equality of influence in group discussions. This hypothesis was not supported. However, Table 5 appeared to suggest that elected-leader groups had a lower equality of influence. In other words, elected leaders appeared to exhibit a potential to increase unevenness in influence.

There are two possible reasons for this finding. First, student leaders might not be as successful in influencing other group members as real-life leaders. Although the student leaders in this study were elected by group members possibly based on greater leadership abilities, they might not have enough experience in leading the group meetings. Second, the lack of adequate statistical power to detect a difference, if it did really exist, in equality of influence is of concern.

At this juncture, it is still too early to assess how GDSS would affect the performance of leaders in group meetings. We will be interested to know whether leaders will be able to "take over" groups via the GDSS system. This insufficient knowledge points to the importance of further study of a GDSS in the laboratory before moving into the field. In addition, we think that future research should try to involve established groups rather than ad-hoc groups in a longitudinal study. This is because the former provides a more realistic basis for behavior. In addition, Hall and Williams [17] show that established groups are more effective than ad-hoc groups in the solution of problems, the use of member resources, and the handling of intermember conflict.

6.4. Influence of the Leader

There were no significant results for the variable influence of the leader. However, the mean scores of manual and GDSS groups were lower than those of baseline groups. This means that a leader in either a manual group or a GDSS group had less influence than a leader in an unsupported group. This appears to suggest that leadership may be important where a group needs to establish a structure. It may be redundant in groups with a structured approach to decision making. This finding is consistent with the findings of Turoff and Hiltz [51], that computer feedback and leadership produced an interaction effect that cancels each other in helping groups to reach consensus in a computer conferencing environment.

One significant implication from this finding is the possibility that decision support in the form of structure may undermine human leadership. This could give rise to problems in a real-life organizational context. Leaders will not want to adopt a technology that undermines their influence. Turoff and Hiltz [51] observe that in the computerized conferencing environment, "facilitation" or "democratic" styles of leadership are more appropriate than "control" or "authoritarian" styles. It may be possible that this is also true in a decision room setting. This subject deserves careful consideration in the evolution of GDSS.

We believe that GDSS designers must take into account managerial decision styles when designing a system for an organization. The GDSS will have to be tailored to the nature of the organization and the decision styles of the leader. Although it may be possible to exploit the design of GDSS to facilitate certain desirable organizational behavior, such a change would have to be gradual and is best implemented as an evolutionary, long-term process.

6.5. Limitations of the Study

This study has several limitations. First, the use of student subjects may limit the generalizability of the findings. There is the usual concern with the appropriateness of using student subjects to perform the roles of elected leaders. Second, the results may be specific to a preference task. As suggested in the literature review, both group process and impact of GDSS technology tend to be heavily influenced by the nature of the task. Third, the results may be GDSS (SAMM) specific. There is always a question of whether a differently designed level one GDSS, or the same GDSS with additional software features, would change the nature of the findings. Fourth, a single session meeting with a new technology may not correctly detect the long-term effects of GDSS technology [34].

NOTES

1. Baseline groups were freely interacting and received no support.

2. Manual groups were provided with flip-chart support and meeting agenda similar to that provided by the GDSS to GDSS groups.

3. Level one GDSSs provide technical features such as a large screen for instantaneous display of ideas, voting solicitation and compilation, anonymous input of ideas and preferences, and electronic message exchange between members aimed at removing common communication barriers [11].

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