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Knowledge Quality In Knowledge-Based Systems: An Investigation In A Group Decision Making Environment

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Abstract

Group decision making has been studied for almost five decades. In recent years research has focused on information technology like Group Support Systems (GSS) that help groups make decisions. In this paper we look at another kind of information technology, knowledge-based systems and its impact on groups. In addition, we investigate the impact of knowledge quality on group decision making processes and outcomes.

Introduction

Knowledge Based Systems are computer programs that use specialized knowledge about a particular problem area and perform at a level of competence that is better than non-expert humans. Laudon and Laudon (1991) defined a knowledge based system to be a knowledge-intensive program (software) that solves a problem that normally requires human expertise. Human knowledge about the solution of a problem is stored in the knowledge base. There are three ways of representing human knowledge and expertise: rules, semantic nets, and frames. A knowledge based system can assist decision making, both individual and group, by asking relevant questions and explaining the reasons for adopting certain actions.

While Knowledge Based Systems have been studied in some detail very few studies have investigated their effect on group decision making. Also, it is very important to check the effect of knowledge quality on decision makers. In this research we utilize two types of Knowledge Based Systems based on quality: one having good knowledge, we call it KBS-Best and the other having poor knowledge, we call it KBS-Poor. We provided KBS –Best to some groups and KBS – Poor to others to study the effects of knowledge quality on decision making.

Theoretical Framework

In this study we investigate the effect of knowledge quality in a group decision-making in a business gaming environment. There are two basic differences between studies conducted using business gaming and those using Group Support Systems (GSS). First, in a business gaming environment there is no control of the group environment in terms of communication and use of decision support. Second, many business games utilize repetitive decisions made by groups, compared to a single decision in most GSS studies.

Pinnsoneault and Kraemer in their review of group decision making research identified an integrative model which included contextual variables, group process variables and outcome variables. We use this framework in our study. We discuss the different variables separately in the following section.

Contextual Variables

Independent or contextual variables in this study include the personal characteristics of group members, and the technological support provided to the group. Personal characteristics of group members, which have an effect on group dynamics and group decisions, are work experience of the group members, and academic prowess (GPA).

Experience

There are few studies that have considered the effect of previous work experience of group members on group performance in the business gaming environment. One related study by Keys and Wolfe (1990) found a strong relationship between successful executive game play and previous career success of the executives. Research in this area has negated the effect of previous work experience of group members by random assignment of group members to groups at the start of the simulation. We use the same approach in this study.

GPA

Some of the earliest studies using business games investigated the relationship between student aptitudes and achievement levels, and game performance. While one study by Dill (1961) found no relationship, other studies by Gray (1972) found correlations ranging from 0.285 to 0.365 between business school grade-point averages and the group's performance index. In this research, subjects were randomly assigned to groups.

This random assignment made the effect of student aptitude/achievement on group performance negligible.

Technological Support

Four types of technological support was provided in this study. Three different information technologies: Decision Support System (DSS), a Knowledge Based System having the best strategies (KBS-Best), and another Knowledge Based System having the worst strategies (KBS-Poor) for the business game, were used to provide technological support. Some groups received no technological support. These groups were the Control groups of this experiment.

Group processes

Group processes have been studied in some detail using groups making decisions in a business gaming environment. The intervening variables that are considered here will shed some light on the changes in group processes due to the presence of information technology. The variables considered are: conflict, group cohesiveness, and information usage.

Conflict

Conflict is defined as the interaction of interdependent people who perceive incompatible goals and interfere with each other in achieving those goals (Fogler and Poole, 1984). Different methods of dealing with conflict are observed when conflict is generated as a part of a decision making process. Blake and Morton (1964) first presented a conceptual scheme for handling interpersonal conflict by classifying modes of conflict into five types. Their scheme was further developed by Kilmann and Thomas (1977), and later refined by Rahim (1983). Rahim provided five specific styles of handling interpersonal conflict: Integrating (High concern for self and high concern for others), Obliging (Low concern for self and high concern for others), Dominating (High concern for self and low concern for others), Avoiding: (Low concern for self and low concern for others), Compromising (Moderate concern for self and moderate concern for others).

Studies examining the impact of information technology on conflict in groups have yielded mixed results. Affisco and Chanin (1990) reported that there were no significant differences in conflict handling within groups, between DSS and non-DSS groups in a business gaming environment. Using GSS supported groups, Miranda and Bostrom (1994) found that information technology supported groups perceived lower amounts of issue-based and interpersonal conflict than control groups. A study by Tung and Heminger (1993) did not find significant differences between dialectical inquiry, devil's

advocacy and consensus inquiry methods when used in a GSS environment.

Therefore, we state the null hypothesis for each of the five interpersonal conflict modes as follows:

Hypothesis 1
There is no significant relationship between the type of information technology used and the integrating conflict mode in groups.

Hypothesis 1A
There is no significant difference in the integrating conflict mode among KBS-Best, KBS-Poor, DSS, and Control groups.

Hypothesis 2
There is no significant relationship between the type of information technology used and the obliging conflict mode in groups.

Hypothesis 2A
There is no significant difference in the obliging conflict mode among KBS-Best, KBS-Poor, DSS, and Control groups.

Hypothesis 3
There is no significant relationship between the type of information technology used and the dominating conflict mode in groups.

Hypothesis 3A
There is no significant difference in the dominating conflict mode among KBS-Best, KBS-Poor, DSS, and Control groups.

Hypothesis 4
There is no significant relationship between the type of information technology used and the avoiding conflict mode in groups.

Hypothesis 4A
There is no significant difference in the avoiding conflict mode among KBS-Best, KBS-Poor, DSS, and Control groups.

Hypothesis 5
There is no significant relationship between the type of information technology used and the compromising conflict mode in groups.

Hypothesis 5A
There is no significant difference in the compromising conflict mode among KBS-Best, KBS-Poor, DSS, and Control groups.

While Hypotheses 1,2,3,4,5 state that there is no significant relationship between the type of information technology used and the five conflict handling modes, Hypotheses 1A, 2A,3A,4A,5A state that for each of the conflict handling modes there is no significant difference among the four treatment groups: KBS-Best, KBS-Poor, DSS, and Control.

Cohesion

A group's cohesion can be defined as the degree to which the group holds an attraction for its individual members, and the resulting desire of the group's members to remain in the aggregation (Eddy, 1985). The cohesion of a group is dependent on such factors as personal liking for each other or mutual admiration, personality of group members, the acceptance of the group's goals and activities, satisfaction with the leadership style exercised, the decision making process employed by the group, as well as the group's structure.

In a study using business gaming, Wolfe and Box (1988) found a significant relationship between cumulative grade point average of group members and group cohesion. It should be noted that in this study grade point average of group members was controlled by the random assignment of subjects to groups. There were no studies using business gaming or GSS that considered the effect of information technology on cohesion. Most GSS studies did consider this to be an important process variable and controlled cohesion by random assignment of subjects to groups. Such assignment is more appropriate for GSS studies since this research involved groups making one non-repetitive decision. The null hypothesis for cohesion is stated as follows:

Hypothesis 6
There is no significant relationship between the type of information technology used and cohesiveness in groups.

Hypothesis 6A
There is no significant difference in the cohesiveness among KBS-Best, KBS-Poor, DSS, and Control groups.

Information Usage

Group members analyzed the information available to them before making a decision. Information usage determined the extent to which the group used and analyzed the available information. Studies on information usage in groups have found that frequency of use of information sources increases with the quality and accessibility of the sources, as well as with increase in environmental uncertainty (O'Reilly, 1982; Schroeder and Benbassat, 1975). These findings are important since the quality of the two KBSs is different in terms of the strategies (best and worst) incorporated in their knowledge bases. Therefore we state the null hypotheses as follows:

Hypothesis 7
There is no significant relationship between the type of information technology used and information usage.

Hypothesis 7A
There is no significant difference in the information used by the KBS-Best, KBS-Poor, DSS, and Control groups.

Process variables

Since we have considered hypotheses for the effect of information technology on conflict handling modes, cohesiveness in groups, and information usage separately, we now state the null hypothesis that there is no significant relationship between information technology and all the process variables considered together.

Hypothesis 8
There is no significant relationship between information technology used and the process variables.

Outcomes

Among the outcome variables, performance of groups has been the most widely studied variable. A few studies have examined the effect of computer-based decision making in a business gaming environment and the results have been mixed.

Performance

Wolfe and Box (1988) reported a significant positive relationship between group cohesion and group performance in a business game. Use of computer-based work sheets improved group performance (Keys et al., 1988; Wolfe and Gregg, 1989), whereas use of DSS had no effect on performance (Affisco and Chanin, 1990). Most GSS studies have shown that GSS improves group performance (George et al., 1990; Bui, et al. , 1987; Steeb and Johnson, 1981). We state the null hypothesis as the following:

Hypothesis 9
There is no significant relationship between the type of information technology used, conflict, cohesiveness, information usage, and performance of groups.

Hypothesis 9A
There is no significant difference in the performance of the KBS-Best, KBS-Poor, DSS, and Control groups.

Satisfaction

In business gaming studies, group members of more cohesive groups were found to have greater satisfaction with their group decisions (Wolfe et al., 1989). GSS also increase satisfaction of members (Nunamaker et al., 1988; Steeb and Johnson, 1981; Vogel and Nunamaker, 1988). Therefore, we state the hypothesis below.

Hypothesis 10
There is no significant relationship between the type of information technology used, conflict, cohesiveness, information usage, and group members' satisfaction with group decisions.

Hypothesis 10A
There is no significant difference in the satisfaction of individual group members with the group decision for the KBS-Best, KBS-Poor, DSS, and Control groups.

Confidence

Group members' confidence in their group decision has not been examined in business gaming studies. In GSS research , Nunamaker et al. (1988), Steeb and Johnson (1981), and Vogel and Nunamaker (1988) found that GSS increase the confidence of members with their group decisions. Based on these findings, we state the null hypothesis as follows.

Hypothesis 11
There is no significant relationship between the type of information technology used, conflict, cohesiveness, information usage, and group members' confidence in their decisions.

Hypothesis 11A
There is no significant difference in the confidence of individual group members with the group decision for the KBS-Best, KBS-Poor, DSS, and Control groups.

Outcome variables

Some GSS studies have reported a significant relationship between process variables like conflict handling modes, cohesiveness in groups and information usage, and the outcome variables like performance, satisfaction and confidence of group members in their decisions (Bui et al., 1987; Nunamaker et al., 1988; Steeb and Johnson, 1981; Vogel and Nunamaker, 1988). There were no studies using business gaming that investigated the relationship between process variables and all the outcome variables considered here, although research on individual outcome variables has been performed. After considering the outcome variables separately in Hypotheses 9, 10, 11, we consider them together in this hypothesis.

Hypothesis 12
There is no significant relationship between process variables like conflict mode, cohesiveness and information usage, and the outcome variables like performance, satisfaction, and confidence of group members.

Research Methodology

The Business Management Laboratory

The business game used in this study was The Business Management Laboratory, version 4.0, a business simulation of moderate complexity (Jensen, 1992). The Business Management Laboratory is a game based on decisions made by groups. Each group acts like a firm and competes with 7 other groups or firms in the food processor industry. All firms manufacture 2 products: a deluxe food processor and a mini-processor and sell to one common market. The groups make 32 decisions regarding their firms in the functional areas of marketing, production, and finance. Marketing decisions include price, advertising, commission for the two products, and the number of sales representatives and their salaries.

The DSS used in this study is called "The BML Assistant", developed by Joseph Rappa and Abdul Ishahak (1993). This DSS provided support in making decisions for the "Business Management Laboratory", the business gaming environment used for this study. The DSS consisted of different modules for forecasting, marketing decisions, production scheduling, and financial decisions.

The two Knowledge Based Systems, KBS-Best and KBS-Poor, were developed using a popular expert system shell. The knowledge base of KBS-Best had the knowledge of the best strategies for the business game, and the KBS-Poor had knowledge consisting of poor strategies for the business game.

The KBS-Best and KBS-Poor consisted of three modules: a marketing module which considered marketing decisions, a production module which handled groups' manufacturing decisions, and a financial module which considered monetary/financial decisions. The Knowledge Based Systems provided recommendations for each of the 32 decisions made by the group, as well as, recommendations regarding the overall quality of marketing, production and financial decisions. The KBS-Best and the KBS-Poor each had 156 rules and provided a cash flow statement to the group, on request, at the end of the decision.

Most research on group behavior has used students as subjects (Keys and Wolfe, 1990), although in recent years studies on executive game play and executive use of GSS are increasing. The subjects in this study were undergraduate students of a capstone Business Policy course at a large public university. Students in this course participated in the business game called The Business Management Laboratory. The sample consisted of approximately 256 students registered in eight sections of the course. Performance in business simulation accounted for 30% of the students' course grade. Students were randomly assigned to groups and group size was restricted to 4 or 5 members.

Experiment

This research was conducted using a controlled experiment. As mentioned earlier, there were 8 Business Policy sections taken into consideration in this study, with each section having 8 groups or firms. Each section was randomly allocated one of four treatments: KBS-Best, KBS-Poor, DSS, or Control. There were 8 groups in each section, and each group was then assigned to one of 8 different industries of the business simulation. Therefore, after allocating industries to all groups, each industry had 2 groups with KBS-Best, 2 groups with KBS-Poor, 2 groups using a DSS and 2 control groups.

All groups using information technology were provided hands-on training in their respective technologies for two class periods. They also used information technology for their trial decision. During decision times, all treatment groups met in a computer laboratory where they had access to appropriate information technology. The time available to a group for one quarterly decision was an hour and fifteen minutes, i.e., one class period. At the end of this period, treatment groups were required to submit a cash flow statement printed from the KBS-Best, KBS-Poor or DSS used, as proof usage of the technology. Control groups were allowed the same amount of time (an hour and 15 minutes) to reach their quarterly decisions. They met in their classrooms with no access to any information technology. Groups made 9 quarterly decisions including a trial decision.

Instruments and Data Collection

Two instruments were used for data collection. The first, a pre-decision questionnaire, was administered at the beginning of the experiment, before students made their first decision. This was the Rahim Organizational Conflict Inventory II (ROCI-II) questionnaire (Rahim, 1983). It provided data about the group members' predisposition toward conflict. The second instrument was a post-decision questionnaire which was administered after all 9 quarterly decisions had been completed. The post-decision questionnaire consisted of three parts. Part I was the Rahim Organizational Conflict Inventory II (ROCI-II) which

provided data regarding the students' perception of conflict within their groups. This data, when compared with the data collected from the pre-decision questionnaire, gave an indication of the changes in conflict due to the presence or absence of an information technology for group decision making. Part II of the post-decision questionnaire provided data regarding the subjects' satisfaction with the group decisions, confidence with group decisions, information usage and group cohesiveness. This part of the questionnaire was a modified version of an instrument used by Dennis (1993) in his study which compared information exchange within face-to-face groups with anonymous groups using a GSS. Part III of the post-decision questionnaire provided data about the group members, including their majors, work experience and cumulative grade point average (GPA). The conflict variables were calculated as the difference between values reported from the pre- and post- decision questionnaires. All other variables, except performance, were calculated from the post-decision questionnaire. From the sample of 256 subjects in 64 groups, 240 usable responses were collected.

Results

A summary of the results of this study is provided in table 1 and Table 2. Table 1 gives the results obtained after testing the eight process hypotheses. Hypotheses 1, 2, 3, 4, 5 considered the five conflict modes as the dependent variables with treatment as the independent variable. The objective here was to determine whether there was a relationship between information technology used and each of the five conflict modes of group members.

Table 1: Process Hypotheses

Hypothesis	Result (Null Hypothesis)	Difference between treatments*
1	Not Rejected	Not Significant**
2	Rejected	Not Significant
3	Not Rejected	Not Significant **
4	Not Rejected	Not Significant **
5	Rejected	Not Significant
6	Not Rejected	Not Significant**
7	Not Rejected	Not Significant**
8	Not Rejected	Not Applicable

* Separate hypotheses considered difference between treatments. They can be identified as the hypotheses which have numbers with a subscript "A", e.g., Hypothesis 7A.
** Differences between means for these hypotheses were not significant since the original model was not significant.

As given in Table 1, null hypotheses for integrating, dominating, and avoiding conflict handling modes could not be rejected. Therefore, we conclude that there is no relationship between information technology used and the integrating, dominating, and avoiding conflict modes in groups. Since these hypotheses could not be rejected, the corresponding hypotheses 1A, 3A, and 4A which compared integrating, dominating and avoiding conflict mode between treatment groups could not be rejected. Therefore, we can say that there is no difference in the integrating, dominating, and avoiding conflict modes between DSS, KBS-Best, KBS-Poor, and Control groups.

Hypotheses 2 and 5 that investigated the relationship between information technology used and the obliging and compromising modes were rejected. Therefore, we can say that there is a relationship between information technology used and the obliging conflict mode, as well as, between information technology and the compromising conflict handling modes in groups. On checking hypothesis 2A, which considered the differences between obliging mode means for the four treatment groups, it was found that the obliging mode was highest in groups using KBS-Poor and among the lowest in groups using KBS-Best and the DSS, but the ranks of the group were not significant. Therefore, the difference between the means was not found to be significant. Similarly, by checking hypothesis 5A which investigated the differences in the compromising conflict mode between the four treatment groups, it was found that the Control groups were among the highest and DSS groups among the lowest, but the differences between the means were not significant. No relationship was found between information technology used by groups and group cohesiveness (Hypothesis 6), and between information technology and information usage (Hypothesis 7). There was no difference in cohesiveness and information usage between treatment groups (Hypothesis 6A & 7A), since hypotheses 6 and 7 could not be rejected.

We also could not conclude that there was a relationship between information technology used by groups and all the process variables considered together. As given in Table 2, all outcome hypotheses (Hypotheses 9, 10, 11, 12) were rejected. In hypothesis 9, all the process variables which include integrating, obliging, dominating, avoiding, and compromising conflict modes, cohesiveness, and information usage, as well as treatment, were considered to be independent. The dependent variable was group performance. We could conclude that the process variables and treatment have an impact, or are related to, group performance. Hypothesis 9A which investigated the differences in performance between DSS, KBS-Best, KBS-Poor and Control groups was also rejected. Significant differences were found between the treatment groups based on performance. DSS groups outperformed all other groups, and Control groups fared the worst.

Table 2: Outcome Hypotheses

Hypothesis	Result (Null Hypothesis)	Difference between treatments*
9	Rejected	DSS > KBS-Best > KBS-Poor > Control
10	Rejected	DSS > Control > KBS-Poor > KBS-Best
11	Rejected	Not Significant
12	Rejected	Not Applicable

The process variables and treatment were found to influence satisfaction of group members with the group decision (Hypothesis 10). Significant differences in satisfaction were found between groups using different information technologies. DSS group members had the greatest satisfaction with their group decision followed by Control, KBS-Poor and KBS-Best groups, in that order. The process variables were also found to influence the confidence group members had with their group decision (Hypothesis 11), but the differences between treatments were not significant. All outcome variables considered together were influenced by the process variables and the treatment provided.

References

Affisco, J.F. and Chanin, M.N. (1989). The Impact of decision support systems on the effectiveness of small group decisions: An exploratory study. In T. Pray and J. Wingender (Eds.) *Developments in business simulation and experiential exercises*, 132-135. Stillwater, OK: Oklahoma University Press.

Affisco, J.F. and Chanin, M.N. (1990). An empirical investigation of multiciteria group decision models in a simulation/gaming context. *Simulation and Gaming*, 21(1), 27-47.

Blake, R. R., and Morton, F. S. (1964). *The Managerial Grid*. Houston, TX: Gulf Publishing.

Bui, T., Sivasankaran, T. R., Fijol, Y., and Woodbury, M. A. (1987). Identifying organizational opportunities for GDSS use: Some experimental evidence. *Decision Support Systems, 3*, 68-75.

Dennis, A. R. (1993). Information processing in group decision making: You canlead a group to information, but you can't make it think. *Proceedings of 53rd Annual Meeting of the Academy of Management*, 283-287.

Dill, W. R. (1961). What management games do best. *Business Horizons*, 4(3), 55-64.

Folger, J. P., and Poole, M. S. (1984). *Working through conflict: A communication perspective*. Glenview, IL: Scott, Foresman.

George, J. F., Easton, G. K., Nunamaker, J. F., Jr., and Northcraft, G. B. (1990). A Study of Collaborative Group Work With and Without Computer-Based Support. *Information Systems Research*, 1, 394-415.

Gray, C. F. (1972). Performance as a criterion variable in measuring business gaming success: An experiment with a multiple objective performance model. *Performance of the Southeastern AIDS Conference*, 193-198.

Keys, B., and Wolfe, J. (1990). The role of management games and simulations in education and research. *Journal of Management*, 16(2), 307-336.

Keys, B., Burns, O.M., Case, T., and Wells, R.A. (1988). Decision support package in a business game: Performance and attitudinal effects. *Simulation & Games*, 19 (4), 440-452.

Kilmann, R. H., and Thomas, K. W. (1977). Developing a forced- choice measure of conflict-handling behavior: The "MODE" instrument. *Educational and Psychological Measurement*, 37, 309-325.

Laudon, K. C., and Laudon, J. P. (1991). *Management Information Systems: A contemporary perspective*. 2nd. ed. New York: Macmillan.

Miranda, S.M., and Borstrom, R.P. (1994). The impact of group support systems on group conflict and conflict management. *Journal of Management Information Systems*, 10(3), 63-95.

Nunamaker, J. F., Jr., Applegate, L. M., and Konsynski, B. R. (1988). Computer-aided deliberation: Model management and group decision support. *Journal of Operations Research,* 6, 826-848.

Rahim, A. (1983). *Rahim Organizational Conflict Inventory-II: Forms A, B and C*. Palo Alto, CA: Consulting Psychologists Press.

Rappa, , and Isahak, A. (1993). *The BPL Assistant - Manual (draft)*, unpublished manuscript.

Schroeder, R.G., and Benbassat, I. (1975). An experimental evaluation of the relationship of uncertainty in the environment to information used by decision makers. *Decision Sciences*, 6, 556-567.

Steeb, R., and Johnson, S. C. (1981). A computer-based interactive system for group decision making, *IEEE Transactions*, 11, 544-552.

Tung, L.L., and Heminger, A.R. (1993). The effects of dialectical inquiry, devil's advocacy and consensus inquiry methods in a GSS environment. *Information & Management*, 25(1), 33-41.

Vogel, D., and Nunamaker, J. F., Jr. (1988). Group decision support impact: Multi-methodological exploration, in J. Galeghar, R.E. Kraut, and C. Egido (ed.), *Conference on Technology and Cooperative Work*, Feb 25-28, Tucson, AZ.

Wolfe, J., and Box, T.M. (1988). Team cohesion effects on business game performance. *Simulation & Games*, 19: 82-98.

Wolfe, J., Bowen, D.D., and Roberts, C.R. (1989). Team building study. *Simulation & Games*, 20(4): 388-408.