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Use of Mobile Devices in the Performance of Group Decision-Making under Contextual Pressure

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Abstract: Mobile technology appears promising as a method to promote group performance in circumstances dependent on time, but not member proximity. However, the success of mobile technology in group decision-making situations has not yet been proven. This paper aims to see how mobile technology affects the performance of group decision-making tasks that should be resolved urgently and/or sources of idea are disconnected with on-line network. Laboratory experiment was used to investigate the effects of mobile factors on group decision-making. The results from the experiment supported the proposition that pressures of time and location play a significant role in the assessment of group decision performance measures. We found that the adoption of mobile technology to group decision-making procedures might be competitive when group decision-making tasks are urgent and sources of idea are disconnected with on-line network, even though mobile technology is not a panacea on which to depend when designing group decision-making.

Keywords: *Group Decision Making, Mobile Technology, Mobile Devices, Group Decision Support*

1. Introduction

Mobile technology has made communication possible anytime, anywhere. The number of users of mobile terminals (phones, PDAs, and communicators) is continuously increasing. The miniature size of mobile terminals and the fact that they can easily fit in a pocket and carried everywhere makes them an ideal channel for offering personalized and localized services to the continuously increasing number of mobile users. SMS (Short Message Service), USSD(Unstructured Supplementary Services Data), CB (Cell Broadcast), SAT (SIM Application Toolkit), WAP (Wireless Application Protocol), Web Clipping, MexE (Mobile Station Application Execution Environment), and GPS(Global Positioning System) are representing enabling technologies for mobile communication and commerce. These advanced technologies are now extensively applied in the business world in the form of e-mail, corporate network information transfer, information services, location-specific information sharing, financial applications, and stock trading services. In general, decision-making has greatly benefited because of the ease associated with high-speed mobile communication (Aiken *et al.* 1994, Kurland and Bailey 1999). Information can be acquired instantaneously, in or out of the office. The network between information users and information providers is becoming closer as well, allowing for the enhanced dispersal of information and increased facility of troubleshooting (Yen and Chou 2000). Moreover, as the time to make certain decisions becomes shorter, the travel expenses escalate, and as globalization spreads, it may be impossible, expensive, or impractical to meet face-to-face (VanGundi 1992).

If mobile technologies are embedded in the current Group Decision Support System (GDSS), interactivity, information sharing, user access, and group support technology is expected to be enhanced (Nosek and Mandviwilla 1996). The group members who have mobile terminals can keep on moving while making decisions to access some useful sources that are sometimes widely spread and disconnected with on-line network. If this kind of group decision-making is more frequently happened in the near future, then GDSSs need to be ready for adopting mobile technology.

Unfortunately, however, current GDSSs do not fully support the requirements of mobile decision-making under time and/or location restraints. A typical GDSS supports group communication for people located in one room or for people in remote sites where each person has access to a computer, wired connection, and electronic assistance. They have conventionally classified as distributed meetings and face-to-face meetings (VanGundi 1992). Mobile technology may help to increase performance in this type of group. However, findings showing if mobile technology outperforms conventional on-line technology are very few. Moreover, we could not find a research that addressed if contextual pressures, such as strict deadlines, cause some of the differences in the findings of experimental

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researches in GDSS area (Chun and Park, 1998). Moreover, with the growing need for mobile business, researchers must address if decision-making performance can be improved by mobile technology.

Hence, this paper presents empirical research on the effects of using mobile devices in group decision-making processes, particularly under some tasks that should be resolved urgently and/or sources of idea are disconnected with on-line network. In this paper, we use the term "time constraint" and "location constraint" when problem solving is urgent and sources of idea are not connected with on-line, respectively. Section 2 reviews group decision-making. Research models are addressed in section 3 and 4. Section 5 and 6 provide results and conclusions, along with possibilities for future research.

2. Review of Group Decision-Making

The practice and productivity of electronic group work depends on the interaction of four variables: group characteristics, type of tasks, organizational structure, and technology (Dennis *et al*. 1988, Pinsonncault and Kraemer, 1990). These factors are considered on an individual level in a GDSS environment, where the conventional variables for evaluating GDSS are performance, user attitudes, participation, and conflict [table 1]. The category of performance consists of decision-making time and quality, whereas attitudes are a combination of confidence and participation. Since an excellent review of group decision support systems has already been developed (Chun and Park 1998, DeSantis and Galuupe 1987, Kraemer and King 1988), this paper will focus only on the latest issues of conflict: the effects of contextual pressures and the laboratory situation.

Contextual pressure often occurs within a multi-cultural setting (Aiken *et al.* 1994, Davison and Jordan 1998, Griffith 1998). The self-competence rating of ethnic minority members was significantly lower than the rating these same minority members gave to others in the non-GDSS environment. However, in Daily and Teich's study, no significant differences in self-ranking were found between employees in the GDSS environment (Daily and Teich 2001, Daily *et al*. 1997). Thus, the factor of multiculturalism will not be considered in this paper.

Table 1. Conventional factors for GDSS performance evaluation

Performance Indicator	Description
Decision Time	Time required to make a decision
Decision Quality	Number of correct idea
User Satisfaction	User satisfaction with the decision process
Decision Confidence	and outcome users' Confidence about their decisions
Equal Participation	Increased number of interpersonal exchanges and reduction of the probability of any one member dominating the meeting
Conflict	Increased conflicts among participants from the use of GDSS

Furthermore, decision-makers in work settings may be subject to a variety of pressures and constraints not easily investigated in the laboratory. O'Reilly has discovered that a willingness to search for business alternatives is affected by contextual pressures (O'Reilly *et al*. 1987). One of the most easily observed pressures is time. In general, the time needed to reach a decision has been regarded as a dependent variable. Sharda *et al*. (1988) found that GDSS groups, compared to no-support groups, took more time to make a decision during the first three-week period, but showed no difference in the decision time during the last five-week period. However, some other studies argue that a group using GDSS takes more time than a manually processing group because of logistics (Gallupe, 1986, Lewis 1982). Nevertheless, in a real business setting, time limits may be more critical than the time taken to reach a decision. As the time limit for making decisions will be subject to the task structure and GDSS configuration, it is surprising that experiments have not yet been conceived to compare decision-making performances by varying time limits. Time management during experimentation is crucial in GDSS (Chen *et al*. 1998).

As the performance of GDSS may differ according to the laboratory situation (Beach 1975), one expects that the decisions made by workers gathered in a laboratory and by employees scattered in relation to one another will be different. For instance, we have observed that group meetings tend to experience an increase in interpersonal conflict when members are scattered and a GDSS with computer-mediated communication is utilized (Siegel *et al*. 1986). This paper is interested in evaluating how mobile devices affect group effectiveness under time and/or place pressured situations.

3. Research models and hypotheses

Mobile technologies are expected to affect the following factors:

- Ease of acquiring information
- Timeliness of information acquisition
- Organization
- Access to information sources

Research on the effects of electronic meeting systems on employee interaction suggests that personal factors, situational factors, group structure, technological support, and task features affect the characteristics of the decision su as quality and breadth, implementation of the decision such as cost, ease, and commitment of participants, and attitude of participants toward the decision: e.g. acceptance, comprehension, satisfaction, and conflicts (Pinsonncault and Kraemer 1990). Among these components, if we assume that no differences exist between personal factors, situational factors, and group structure among the legacy GDSSs, we can isolate for the effect that technological support and task features have on group performance.

To understand the impact of mobile factors, we must specify for varied technological environments, such as the

wired meeting, the GDSS-wired meeting, and the meeting that uses mobile technology. Factors that are taken into account are listed in table 2. Technological support is evaluated in terms of the wired model, the Client/Server model, the Internet-centric model, and the pervasive computing model. Only the wired and the pervasive computing model will be considered in this paper.

Table 2. Factors that are taken into account

Factors	Values
Technological Support	
Type (network computing model)	Wired Pervasive computing model
Task characteristics Type	 Idea generation
Nature (1) Time-critical (2) Location-critical	 Critical, Non-critical Critical, Non-critical
Personal characteristics Frequency of use	 Skilled commuters, Less skilled commuters

Task features can be divided into two sub-factors: type and nature. As for types of task, employees struggle to identify the problem, generate ideas, and reach a consensus. We will primarily consider idea generation in this paper. We will adopt frequency of use and degrees of commuting as our only defining personal characteristics. The dependent variables are listed in table 3.

Table 3. Dependent Variables

Dependent Variables	Values
Quality of decision	Number of ideas
Consensus	Order (1~7)
Satisfaction Equal participation Confidence	Order (1~7) Order (1~7) Order (1~7)

3.1 A Recent History of Technological Support in Group Decision-Making

In the early 1990s, a simple Client/Server model defined network computing. The architecture of the model was versatile, message-based, and possessed a modular infrastructure. It was intended to improve performance, usability, flexibility, interoperability, and scalability, as compared to centralized mainframe, time-sharing computing. Since user interfaces differed greatly, users of the Client/Server model often needed training to learn how to interact with various systems.

The Internet-centric model, in contrast, seeks to ease communication between machines and humans. Client software has been standardized in the form of Internet browsers. This user interface revolution enables the same information on back-end servers to be accessed from essentially any desktop computer connected to the network.

The pervasive computing model is also Internet-centric. The key difference between the Internet-centric model and pervasive computing model is the mobile factor. Mobile computing technology expands the information network that was previously limited to devices such as mobile phones or PDAs. Advances in mobile and Internet technologies are redefining the legacy Internet model and its services. Pervasive computing enables people to accomplish day-to-day personal and professional tasks via a new breed of intelligent, portable devices (Chetan, 2001).

3.2 Effects of Task Characteristics on Group Decision-Making

McGrath has developed a list, entitled "Task Circumplex," that identifies eight types of basic group task processes (McGrath 1984, McGrath 1993). The types of group tasks vary in terms of their need for "richness" in the chosen communication medium. Information richness refers to the degree to which a message conveys additional information, such as emotion, attitude, values, or expectations, beyond the literal meaning of the message. The eight group task processes in McGrath's "Task Circumplex," ordered in terms of increasing need for richness, are:

1. planning tasks (generating plans)
2. creativity tasks (generating ideas)
3. intellectual tasks (solving problems)
4. decision-making tasks (making decisions on issues without solutions)
5. cognitive conflict tasks (resolving conflicts of viewpoint)
6. mixed-motive tasks (resolving conflicts of interest)
7. contests/ competitive tasks (resolving conflicts of power)
8. performances/ psychomotor tasks (executing performance tasks).

Among those, this paper will stress on creativity tasks, such as generating ideas, under constraints of contextual pressure. How the using mobile devices when making a group decision in terms of the performance measures usually adopted in GDSS researches was focused. To do so, the groups are divided into "wired" and "mobile" group. Here the term "wired" group indicates that the members of the group have to use wired terminals such as public telephone or desktop computers that are connected with servers using any kind of wired networks. Comparing with mobile communication group, members in a wired communication group may not communicate with their peers by moving themselves. However, they can be distributed and communicate using any wired network devices. The "mobile" group uses mobile devices under any situations to gather information, submit options, and even arrive at a consensus for final decision.

Thus the following hypotheses have been constructed:

Hypothesis A: The outcomes of mobile group decision-

making will be equivalent or superior to that of competitive wired group decision-making under the pressure of time constraints.

A.1 The number of ideas generated in a mobile group's decision-making process will be equivalent or superior to that of competitive wired groups under the pressure of time constraints.

A.2 The perceived difficulty of reaching a consensus in a mobile group will be equivalent or superior to that of competitive wired groups under the pressure of time constraints.

A.3 The perceived confidence regarding the correctness of the ideas generated during mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of time constraints.

A.4 The perceived confidence regarding the comprehensiveness of the ideas generated during mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of time constraints.

A.5 The satisfaction experienced due to the decision-making procedure of mobile groups will be equivalent or superior to that of competitive wired groups under the pressure of time constraints.

A.6 The perceived equal participation due to the decision-making procedure of mobile groups will be equivalent or superior to that of competitive wired groups under the pressure of time constraints.

Hypothesis B: The outcomes of mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

B.1 The number of ideas generated in a mobile group's decision-making process will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

B.2 The perceived difficulty of reaching a consensus in a mobile group will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

B.3 The perceived confidence regarding the correctness of the ideas generated during mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

B.4 The perceived confidence regarding the comprehensiveness of the ideas generated during mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

B.5 The satisfaction experienced due to the decision-making procedure of mobile groups will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

B.6 The perceived equal participation due to the decision-making procedure of mobile groups will be equivalent or superior to that of competitive wired groups under the pressure of location constraints.

Hypothesis C: The outcomes of mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

C.1 The number of ideas generated in a mobile group's decision-making process will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

C.2 The perceived difficulty of reaching a consensus in a mobile group will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

C.3 The perceived confidence regarding the correctness of the ideas generated during mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

C.4 The perceived confidence regarding the comprehensiveness of the ideas generated during mobile group decision-making will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

C.5 The satisfaction experienced due to the decision-making procedure of mobile groups will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

C.6 The perceived equal participation due to the decision-making procedure of mobile groups will be equivalent or superior to that of competitive wired groups under the pressure of time and location constraints.

4. Method

4.1 Subjects

The study consisted of forty-eight participants (twenty-one men and twenty-seven women), who were undergraduate students at a university. Participants' ages ranged from eighteen to twenty-two, with a mean of 20.4. Selected demographic characteristics of the subjects are presented in table 4.

Table 4. Subjects demographics

	Skilled commuters	Less skilled commuters	All
Gender			
#Female	14	13	27
%Female	58.3%	54.2%	56.2%
#Male	10	11	21
%Male	41.7%	45.8%	43.8%
	N = 24	N = 24	N = 48
Age			
Mean (Stand. Deviation)	20.4 (1.10)	20.5 (1.23)	20.4 (1.17)
Years experience with mobile phones			
Mean (Stand. Deviation)	2.5 (2.1)	0.3 (0.5)	1.4 (1.9)
Frequencies of phone use per day			
Mean (Stand. Deviation)	30 (10.95)	8 (9.87)	21 (29.34)

4.2 Experimental Procedures

To control for the variable of personal experience, the participants were classified into two categories: more-skilled and less-skilled commuters. They were then equally distributed into mobile and wired communication groups. We identified the skilled commuter as a person who has more years experience with mobile phones and more frequencies of phone use per day than less skilled commuter. These statistics are shown in table 4. The assumption was made that the participants in the same commuting category would similarly favor mobile devices (Dennis *et al*. 1989, Tung and Turban 1998). The term "wired" indicates that the members of the group have to use wired terminals such as public telephone or desktop computers that are connected with servers using any kind of wired networks. Comparing with mobile communication group, a member in a wired communication group may not communicate with his/her peers by moving himself. They can be distributed, as conventional GDSSs support using wired network. However, the mobile group can keep on moving during the experiment to find some sources of idea such as bookstore, office, and even computer lab. Furthermore, ad-hoc groups were considered more hesitant to participate than the others (Dennis *et al*. 1990). All members in a group were asked to supervise the behavior of their peers as a result.

Each of the groups participated in three experimental sessions, with each session held a week apart. Half of the sessions utilized wired or wired interaction and half of the sessions used mobile devices. The sessions are listed in table 5. As for mobile devices, we should choose only one kind of device to get rid of the noise from using different devices. Phones, PDAs and communicators were candidates since they are widely used mobile devices in Korea. Among those, cellular phones were selected because they are used by a large majority of undergraduate students and are configured similarly. Moreover, we assumed that there would be no different effects in using phone, PDA and communicators. Each group received a case problem to solve during the session. The case problems were placed in the context of varying situations and were the same for each group (MacGrath 1984). "Enumerate as many books for TOEFL as possible within an hour", "Enumerate as many candidate places suitable for membership training as possible within an hour", and "Enumerate as many Japanese restaurants as possible within a day" are given to all groups in situation I, II, and III, respectively.

Table 5. Situations presented to the participants

	Location constraint	No location constraint
Time constraint	Situation I	Situation III
No time constraint	Situation II	Situation IV (excepted)

The experimental design was a 2 * 3 repeated measure with mobile and wired communication, and three situations. Group members were randomly divided into eight groups of six. We used a random number generation function in MS Excel. Each group participated in both a mobile communication and wired communication for one task type. The overall experimental design is listed in table 6.

Table 6. Design of experiment

Section	Group	Week 1		Week 2		Week 3	
		Situation	Mobile	Situation	Mobile	Situation	Mobile
1	A	I	Yes	II	No	III	Yes
	B	I	No	II	Yes	III	No
2	C	II	Yes	III	No	I	Yes
	D	II	No	III	Yes	I	No
3	E	III	Yes	I	No	II	Yes
	F	III	No	I	Yes	II	No

To create a time constraint, deadlines of one hour were given to a portion of the groups. The remaining groups received a full day to settle the problem. Constraints of location were also assigned. To create a location constraint, situations were created where the information required to resolve a problem was located over a large area and the information was hard to be acquired using Internet. Face-to-face and distributed communications were freely allowed at any situations.

Among several usual types of tasks, idea generation, selection, *etc*., idea generation type was suggested to the participants. For the idea generation task, we proposed brainstorming (Watson *et al*. 1988). A group uses brainstorming to indicate the verbal generation of ideas. Ideas were recorded and anonymity was preserved (Aiken *et al*. 1996). Brainstorming was primarily adopted for the experiment since verbal communication is effective in

mobile communication. When using the brainstorming technique, participants were discouraged from criticizing the ideas of others. At the end of the experiment, the group members were asked to answer five questions. To preserve reliability, they should be well acquainted with the questionnaire before the experiment. To do so, the instructor has carefully explained what the questions mean.

5. Results

Tables 7 through 12 summarize the results of a t-test, a normality-test, and a power analysis where the number of ideas, the perceived difficulty of reaching a consensus, the perceived confidence in brainstorming correct ideas, the perceived confidence in completing the project, and the satisfaction concerning the decision-making procedure and levels of member participation were evaluated. The original data of number of ideas are shown high skewness and kurtosis. So the original data of that variable is log-transformed. In general, most of the values of skewness and kurtosis are less than one except some of number of ideas and perceived difficulty in reaching consensus. These results show that the distributions of our variables are very similar to the normal distribution. In addition, we had checked the graphic distributions such as Box and Whisker plot and normal probability plots. Those distributions also showed that the data are normally distributed and linear to the expected line. table 7 shows the log transformed values and the results of t-tests. In general, the group members who had mobile devices generated many more original ideas than did those using wired communication, but their differences did not statically significant. The results tend to show that mobile devices may have equal or relax the pressures associated with time and location.

Table 7. Number of ideas

	Situation I		Situation II		Situation III	
Statistics	Manual	Mobile	Manual	Mobile	Manual	Mobile
Mean	3.89*	4.07	3.27	3.59	3.37	3.76
Std. Dev.	0.60	1.66	1.17	1.30	1.19	0.89
Skewness	-0.39	0.57	-0.18	0.93	1.12	1.28
Kurtosis	-1.11	-0.87	0.03	0.37	0.91	1.57
t-Value	0.52(p<0.3046)		0.89(p<0.1886)		1.28(p<0.1030)	
Power	0.128		0.222		0.352	

* The value is log-transformed.

Table 8. Perceived difficulty in reaching consensus

	Situation I		Situation II		Situation III	
Statistics	Manual	Mobile	Manual	Mobile	Manual	Mobile
Mean	2.92	2.13	2.08	2.96	3.00	2.52
Std. Dev.	1.76	1.25	1.31	1.88	2.08	1.64
Skewness	1.12	1.55	1.42	0.93	1.00	0.59
Kurtosis	0.76	2.90	2.16	-0.02	-0.34	-1.03
t-Value	-1.75(p<0.0433)**		1.86(p<0.9637)		-0.87(p<0.1945)	
Power	0.532		0.000		0.215	

Table 9. Perceived confidence on the correctness of the generated ideas

	Situation I		Situation II		Situation III	
Statistics	Manual	Mobile	Manual	Mobile	Manual	Mobile
Mean	4.92	5.78	5.30	5.17	4.42	4.70
Std. Dev.	1.34	1.04	1.18	1.63	1.88	1.49
Skewness	-0.18	-0.84	-1.01	0.93	0.18	-0.15
Kurtosis	0.55	0.87	1.91	-0.02	-1.59	-0.70
t-Value	2.46(p<0.0090)***		-0.33(p<0.6284)		0.56(p<0.2888)	
Power	0.780		0.000		0.137	

Table 10. Perceived confidence on the completeness

	Situation I		Situation II		Situation III	
Statistics	Manual	Mobile	Manual	Mobile	Manual	Mobile
Mean	5.00	5.65	4.56	5.08	3.96	4.56
Std. Dev.	1.38	0.98	1.44	1.56	1.71	1.44
Skewness	-0.86	-0.15	0.16	-0.55	0.36	0.06
Kurtosis	0.21	-0.87	-1.10	-0.85	-1.11	-1.08
t-Value	1.86(p<0.0350)**		1.18(p<0.1216)		1.32(p<0.0976)*	
Power	0.573		0.316		0.363	

Table 11. Satisfaction on decision-making procedure

	Situation I		Situation II		Situation III	
Statistics	Manual	Mobile	Manual	Mobile	Manual	Mobile
Mean	5.42	5.83	5.43	5.79	4.92	5.17
Std. Dev.	1.50	1.03	1.12	1.22	1.91	1.15
Skewness	-0.62	-0.99	-0.78	-1.47	-0.65	-0.95
Kurtosis	-0.46	1.26	0.25	2.88	-1.14	1.70
t-Value	1.09(p<0.14)		1.05(p<0.1507)		0.56(p<0.2905)	
Power	0.283		0.269		0.136	

Table 12. Perceived Equal participation

	Situation I		Situation II		Situation III	
Statistics	Manual	Mobile	Manual	Mobile	Manual	Mobile
Mean	5.54	5.13	5.26	5.41	4.83	4.83
Std. Dev.	1.31	1.81	2.05	1.53	1.49	1.94
Skewness	-0.28	-0.71	-0.87	-0.62	-0.46	-0.62
Kurtosis	-1.33	-0.48	-0.54	-0.64	-0.87	-0.74
t-Value	-0.89(p<0.8000)		0.30(p<0.3842)		-0.01(p<0.5057)	
Power	0.000		0.088		0.000	

In the case of the perceived difficulty in reaching a consensus, the results were inconsistent. In situation I, the groups who used mobile devices significantly outperformed wired groups ($T = -1.75$, $p < 0.05$). In situation II, however, reaching a consensus was significantly easier for the groups who did not use mobile devices at the 5% significance levels, contrary to our expectation. The results may imply that manual communication outperforms mobile communication when deadlines are not critical. However, when urgent decision-making is needed, the mobile groups experienced the same degree of difficulty in reaching a consensus, as did manual communication groups. Therefore, mobile devices have a

lesser effect on decision-making outcomes in urgent situations.

Perceived confidence regarding the correctness of the generated ideas was greater in mobile groups than in manual groups in situation I ($T= 2.46$, $p < 0.01$). In situations dependent on strict deadlines or close member proximity, members perceived correct decision-making as difficult. Hence, group members likely think of ideas that accurately address the given problem best in their individual locations.

When considering the perceived confidence in completing the project, the t-tests showed that mobile groups had more confidence than wired groups in situation I and III at the 5% and 10% significance levels, respectively. Thus, both time and location may affect the perceived confidence when completing a given project.

A t-test evaluating the satisfaction of the decision-making procedure showed that the satisfaction level tend to be higher among mobile groups than manual groups when members were not within close proximity to one another. However, when time was a critical factor, there were no significant differences between the two groups. One possible explanation is that the number of ideas developed was more important than reaching a consensus during the experiment. As for satisfaction concerning the level of peer participation, no other significant differences were found in the experiment.

The results are unexpected considering that mobile devises are useful in supporting communication and were predicted to be beneficial for performance as well. However, as a 10% significance level is likely more significant than a 5% or 1% level, the results may have been influenced by untested factors, such as a multicultural environment or other personal characteristics. Moreover, in situation I, researchers analyzed how the experience of using mobile devices may affect participation and no statistical differences were found. Therefore, we conclude that the use of mobile devices does not influence the degree of participation in a group decision-making situation.

6. Concluding Remarks

The effect of personal characteristics on group decision-making practices and efficacy, other than the length of individual commute and frequency of technology usage, was not considered in this paper. Experimenting with only a mobile phone, we were incapable of testing other effects that result from mobile technology. The focus group of undergraduate students also limited the scope of this research. Students may lack the concentration or dedication needed to accurately mirror business people in a serious organizational setting. Even though some previous GDSS studies have used only a small number of observations, the small size of the study was a further limitation. Hence, implications produced in this study should be carefully viewed within the context of its restrictions. Future research using a larger sample size, different types of mobile technology, and professional subjects will be necessary to ascertain results that are more precise.

Considering the factors that were applied, the experimental results supported four of the fifteen hypotheses. Under both time and location constraints, the mobile groups outperformed the traditional groups (C.2, C.3, C.4). The results from the experiment support the proposition that pressures of time and location play a significant role in the assessment of general GDSS performance measures.

No differences arose concerning the satisfaction of decision-making procedures. Furthermore, no significant differences were found between the groups placed solely under a time constraint or solely under a location constraint (B1, C1). Significant differences were uncovered regarding the perceived difficulty of reaching a consensus. The mobile groups did handle the pressures of time and location with a greater perception of confidence and correctness than did the manual groups (C3, C4). This finding, possibly attributed to the ease and comfort promoted by mobile communication, did support the experimental hypotheses.

Our overall findings imply that the adoption of mobile technology to group decision-making procedures may be competitive when group decision-making tasks are urgent and sources of idea are disconnected with on-line network, even though mobile technology is not a panacea on which to depend when designing GDSS. These findings give insight that current research framework on group support system need to be refined from “distributed” and “face-to-face” to “distributed with wired connection”, “distributed with wireless connection”, and “face-to-face” (Tung and Turban 1998). Careful consideration regarding which mobile technology should be applied to which situation is crucial. If used and monitored correctly, the incorporation of mobile systems will significantly increase the capabilities of GDSS on a technical level. Mobile application building blocks, such as microbrowsers, location-based services, smartcards, short message services, voice services, telematics, Radio Frequency Identification Devices, and device-to-device communication, like bluetooth, should be considered the mobile systems on which to concentrate in the future. Taking advantage of an increased capacity in mobile applications, devices, filtering capabilities, and corresponding databases, mobile technology will shape the new patterns of group decision-making (Zigurs *et al*. 1988).

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