8-16-1996

The Impact of Communication Medium on Software Development Performance: A Comparison of Face-to-Face and Virtual Teams

Hayward P. Andres
Portland State University

The Impact of Communication Medium on Software Development Performance: A Comparison of Face-to-Face and Virtual Teams

Hayward P. Andres
School of Business Administration
Portland State University

1. Introduction

Virtual teams, within and across organizations, are a recent phenomenon (Geber, 1995). Virtual teams are groups of individuals collaborating in the execution of a specific project while located at multiple individual sites or multiple group sites. Virtual teams have been brought about by the need for organizations to get projects done as quickly as possible while utilizing the skills of project team members that are geographically dispersed. Communication technologies used to support dispersed groups include electronic mail, computerized conferencing, and videoconferencing (Chidambaram & Jones, 1993; O'Conaill et. al., 1993). Group process support provided by communication technologies include idea generation, problem solving information exchange, conflict resolution, negotiation, and decision making. These communication technologies allow organizations to form virtual teams by dissolving the boundaries that separate groups. In addition, these virtual teams can be instantly dissolved. Finally, communication technologies give rise to potential collaborations among workgroups and organizations that would otherwise not be considered.

Organizations involved in, accounting consultancy, product engineering, and hardware and software development have recognized the need for collaborative ventures. Communication technology has been suggested to have an influence on collaborative ventures in product development among engineering workgroups (Bruce et. al., 1995). Mitel Corporation announced a joint agreement with Digital Equipment Corporation to produce a single platform to run communication products (Shoesmith, J., 1995). These trade journal articles are evidence to the need to investigate the potential for communication technologies to create "virtual teams" and "virtual organizations."

The purpose of this study is to investigate the impact of videoconferencing technology on software development task and affective outcomes of dispersed software development teams. Software development has been described as a collaborative problem solving activity where success is dependent upon knowledge acquisition, sharing, and integration and minimizing communication breakdowns (Curtis et. al., 1988; Walz et. al., 1993). Social presence theory, media richness theory, and the software development literature are used to provide a framework for the comparison of the impact of face-to-face and videoconferencing collaboration on software project success.

2. Project Success and Group Process

Project success has been defined as a combination of two types of implementation outcomes: task outcomes and perceived team psychosocial outcomes (Pinto & Pinto, 1990). Software project task outcomes typically refer to adherence to the estimated schedule and budget and optimal productivity in terms of delivered source code instructions per man-hour (Henderson & Lee, 1992). Dimensions of software quality such as user-friendliness and adherence to end-user specifications are also associated with software development task outcomes (Yeh, 1993). Team psychosocial outcomes refer to the evaluation of the degree of experienced friendliness and support, positive feelings associated with interactions, acquired knowledge and skills, enjoyment of participation, and sense of pride and value resulting from participation in project implementation (Pinto & Pinto, 1990).

Empirical findings on technological support for group work have suggested that communication technology support facilitates group process through enhancing group problem solving capabilities, improving group

interaction, and reinforcing satisfaction with the task process and the evolving solution (Alavi et. al., 1995; Chidambaram & Jones, 1993; Daft & Lengel, 1986; Nunamaker et. al., 1991). It is suggested that software development, when perceived as a collaborative problem solving process, is certainly dependent upon the group process experienced by work groups engaged in that activity. Consequently, software project success, as defined above, should vary depending on the nature of the group process which is a function of the communication medium used in the execution of the software development task. The following section will present a theoretical framework using social presence theory, media richness theory, and the software development literature to support hypotheses regarding
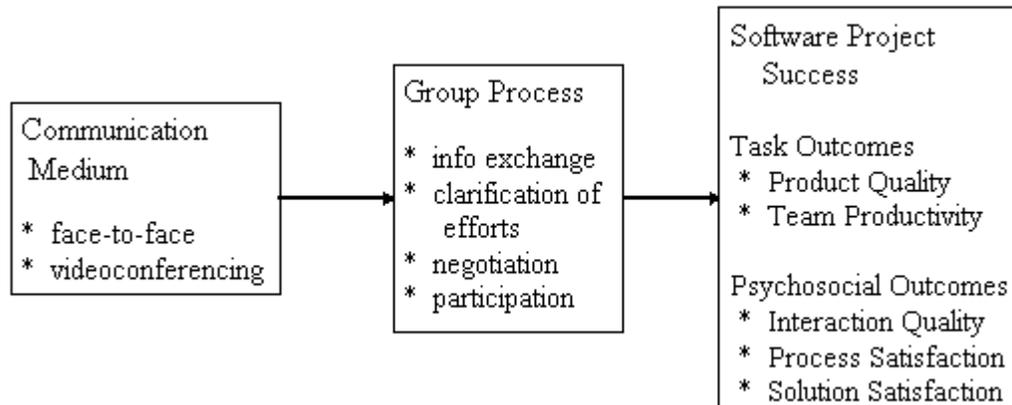

Figure 1. Communication Medium and Software Project Success

the impact of face-to-face and videoconferencing collaboration on software project success.

3. Theoretical Framework and Hypotheses

Social presence refers to the ability of a communication medium (e.g., face-to-face meeting, e-mail, or videoconferencing) to allow the group members to feel the presence of a communicator (Short et. al., 1976). Media richness refers to the extent to which communication medium can provide immediate feedback, the number of cues and channels utilized, backchanneling cues, and socio-emotional content in a communication session (Daft & Lengel, 1986). Communication mediums can be differentiated in terms of the extent with which they facilitate social presence. For example, videoconferencing permits the transmission of multiple channels of communication for exchanging verbal, nonverbal, and visual cues, and socio-emotional content during a communication session. However, O'Conaill et. al. (1993) noted that during conversations over videoconferencing: 1) listeners produced fewer backchannels and interrupted less often; 2) turn endings were not adequately anticipated; and 3) the hand over of turns were formal. In Short et. al.'s (1976) study, face-to-face meetings were found to have a broader range of verbal and nonverbal cues. This suggests that face-to-face meetings afford a higher degree of social presence and media richness than videoconferencing. Media richness has been found to be positively associated with equivocality resolution (Daft & Lengel, 1986). Alternatively, social presence and participation were found to be negatively related (Nunamaker et. al., 1991; Chidambaram & Jones 1993). Reduced social presence was more conducive to equalized participation and a lower tendency for domination during the group process. A model of this framework is depicted in Figure 1 above.

Walz et. al. (1993) noted that an effective software development group process involves knowledge acquisition and the sharing and integration of that knowledge. Software design teams must acquire knowledge regarding the problem domain, user requirements, and design approaches. Consequently, the communication medium used during systems analysis and design can impact software project outcome (i.e., task and psychosocial outcomes) depending on the extent of social presence and media richness associated with the communication medium. Media richness is essential to the support of information exchange of user requirements, negotiation of the final design, and satisfaction with design solution. As a result, media richness should be positively associated with software development task outcomes. In

addition, media richness is associated with higher social presence which suggests that psychosocial task outcomes may be reduced. Social presence theory suggests that through the lower social presence-increased participation relationship, project team members should experience a greater sense satisfaction with the socio-emotional aspects (e.g., negotiation and equality of participation) of the group process. However, lower social presence is associated with lower media richness suggesting that task outcome may be reduced. Consequently it is hypothesized that:

H1: The face-to-face environment will experience a greater degree of software project success in task outcomes than in the videoconferencing environment.

H2: The videoconferencing environment will experience a greater degree of software project success in psychosocial outcomes than in the face-to-face environment.

4. Research Design

In this study, subjects will be drawn from a population of management information systems undergraduate students familiar with the Systems Development Life Cycle approach to software design. The students will be formed into design teams consisting of two dyads. Experimental task execution will entail a requirements assessment and detailed design of a small application program. The experimental design is a single factor ANOVA with face-to-face meetings and videoconferencing meetings as levels of the communication medium factor. Experimental sessions will take place across three one hour and fifteen minutes sessions. The dependent variable is a multiple measure of project success which is comprised of task outcomes (i.e., productivity and product quality) and team psychosocial outcomes (i.e., interaction quality, solution satisfaction, and process satisfaction).

5. Conclusion

Future research should address the potential of various communication technologies (e.g., desktop videoconferencing, videoconferencing, etc.) in the construction of "virtual teams" and "virtual organizations." The impact of these technologies on the group process variables associated with specific contexts are essential for successful application of these technologies. Such successful applications could afford invaluable collaborations and reduce the time to complete joint ventures and the associated costs in engaging in joint ventures.

6. References

Alavi, M., Wheeler, B.C. and Valacich, J.S. (1995). "Using IT to Reengineer Business Education: An Exploratory Investigation of Collaborative Telelearning," *MIS Quarterly,* 19(3), pp. 293-312.

Bruce, M., Leverick, F. and Littler, D. (1995). "Complexities of Collaborative Product Development," *Technovation,* 15(9), pp. 535-552.

Chidambaram, L. and Jones, B. (1993). "Impact of Communication Medium and Computer Support on Group Perceptions and Performance: A Comparison of Face-to-Face and Dispersed Meetings," *MIS Quarterly*, 17(4), pp. 465-491.

Curtis, B. Krasner, H. and Iscoe, N. (1988). "A Field study of the Software Design Process for Large Systems," *Communications of the ACM,* 31(11), pp.1268-1287.

Daft, R.L. and Lengel, R.H. (1986). "Organizational Information Requirements, Media Richness, and Structural Design," *Management Science,* 32(5), pp. 554-571.

Henderson, J.C. and Lee, S. (1992). "Managing I/S Design Teams: A Control Theories Perspective," *Management Science*, 18(6), pp. 757-777.

Geber, B. (1995). "Virtual Teams," *Training*, April 1995, pp. 36-40.

Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D.R. and George, J.F. (1991). "Electronic Meeting Systems to Support Group Work," *Communications of the ACM,* 34(7), pp. 40-61.

O'Conaill, B., Whittaker, S. and Wilbur, S. (1993). "Conversations Over Video Conferences: An Evaluation of the Spoken Aspects of Video-Mediated Communication," *Human-Computer Interaction,* 8, pp. 389-428.

Pinto, J.K. and Pinto M.B. (1990). "Project Team Communication and Cross-Functional Cooperation in New Program Development," *Journal of Product Innovation and Management,* vol. 7, pp.200-212.

Shoesmith, J. (1995). "Mitel Hooks Up with Digital for CTI," *Computing Canada,* 21(7), pp. 21,28.

Short, J., Williams, E. and Christie, B. (1976). *The Social Psychology of Telecommunications.* John Wiley: New York.

Walz, D.B., Elam, J.J. and Curtis, B. (1993). "Inside A Software Design Team: Knowledge Acquisition, Sharing, and Integration," *Communications of the ACM,* 36(10), pp. 62-77.

Yeh, H. (1993). *Software Process Quality*. R.R. Donnelley & Sons.