Determining the Impact of Computer-Mediated Communication: An Experimental Investigation into the Use of an Asynchronous Discussion System to Improve the Effectiveness of Virtual Teams

Ying Chieh Liu*

Department of Information Management,

ChaoYang University of Technology,

Taiwan, ROC

allanliu@cyut.edu.tw

Abstract. Information technology has had a significant influence on individual, group and organizational work patterns and promoted virtual work environments. However, the performance and satisfaction of Virtual Teams (VTs) is generally perceived to be lower than that of traditional Face-To-Face teams. In order to identify the underpinning issues impacting on the effectiveness of virtual teams caused by Computer-Mediated Communication (CMC), a comparative study was undertaken. A preliminary framework was built through an extensive literature review and then, a one-year experiment was conducted to collect data to validate the models for both face-to-face and virtual teams. The results of this longitudinal study revealed a number of factors impacting on performance and satisfaction. The study made three major contributions: (a) this study confirmed that FTF (Face-to-Face) groups perceived higher levels of performance than VTs but not of satisfaction; (b) the factors that affected the performance and satisfaction of FTF and VTs were identified along with their relationships and impacts on performance and satisfaction; (c) solutions to improve the effectiveness of VTs were proposed.

References

[1] F.F. Anderson and H.M. Shane, "The Impact of Netcentricity on Virtual Teams: The New Performance Challenge," *Team Performance Management,* Vol. 8, No. 1/2, pp. 5-12, 2002.

[2] J.E. Driskell and P.H. Radtke, "Virtual Teams: Effects of Technological Mediation on Team Performance," *Group Dynamics: Theory, Research and Practice*, Vol. 7, No. 4, pp. 297-323, 2003.

[3] K.S. Lojeski, R. Reilly, P. Dominick, "Multitasking and Innovation in Virtual Teams," *Proceedings of the 40th Hawaii International Conference on System Sciences*, pp. 44, 2007.

[4] I. Geyskens, J-B.E.M. Steenkamp, L.K. Scheer, N. Kumar, "The Effects of Trust and Interdependence on Relationship Commitment: A Trans-Atlantic Study," *International Journal of Research in Marketing*, Vol. 13, No. 4, pp. 303-317, 1996.

[5] S. Sarker, J.S. Valacich, S. Sarker, "Virtual Team Trust: Instrument Development and Validation in an IS Educational Environment," *Information Resources Management Journal*, Vol. 16, No. 2, pp. 35-56, 2003.

[6] S.G. Straus, "Technology, Group Process, and Group Outcomes: Testing the Connections in Computer-mediated and Face-to-Face Groups," *Human-Computer Interaction*, Vol. 12, pp. 227-266, 1997.

[7] M.E. Warkentin, L. Sayeed, R. Hightower, "Virtual Teams Versus Face-to-Face Teams: An Exploratory Study of a Web-based Conference System," *Decision Science*, Vol. 28, No. 4, pp. 975-996, 1997.

[8] R. Benbunan-Fich, S.R. Hiltz, M. Turoff, "A Comparative Content Analysis of Face-to-Face vs. ALN-mediated Team-

---

*Correspondence author

work," *Proceedings of the 34th Hawaii International Conference on System Sciences*, Vol. 1, pp. 1009, 2001.

[9]   M. Scardamalia and C. Bereiter, C*omputer Support for Knowledge-building Communities. In T. Kotchman (Ed.)*, CSCL: Theory and Practice of an Emerging Paradigm, Mahwah, NJ: Lawrence Erlbaum Associates, pp. 14-37, 1996.

[10]   P. Kanawattanachai and Y. Yoo, "The Impact of Knowledge Coordination on Virtual Team Performance Over Time," *MIS Quarterly*, Vol. 31, No. 4, pp. 783-808, 2007.

[11]   R.J. Ocker, "The Mediating Effect of Group Development on Satisfaction in a Virtual and Mixed-mode Environment," *Proceedings of the 35th Hawaii International Conference on System Sciences*, pp.143-152, 2002.

[12]   J.S. Valacich and S. Sarker, "Computer-mediated and Face-to-Face Groups: Who Makes Riskier Decisions?" *Proceedings of the 35th Hawaii International Conference on System Sciences*, pp. 133-142, 2002.

[13]   L. Branson, T.S. Clausen, C.H. Sung, "Group Style Differences Between Virtual and F2F Teams," *American Journal of Business,* Vol. 23, No. 1, pp. 65-70, 2008.

[14]   J. Shen, S.R. Hiltz, K.-E. Cheng, Y. Cho, M. Bieber, "Collaborative Examinations for Asynchronous Learning Networks: Evaluation Results," *Proceedings of the 34th Hawaii International Conference on System Sciences*, pp. 10, 2001.

[15]   L.C. Tidwell and J.B. Walther, "Computer-mediated Communication Effects on Disclosure, Impression and Interpersonal Evaluations: Getting to Know One Another a Bit at a Time," *Human Communication Research*, Vol. 28, No. 3, pp. 317-348, 2002.

[16]   K. Burke and L. Chidambaram, "Do Mediated Contexts Differ in Information Richness? A Comparison of Collocated and Dispersed Meetings," *Proceedings of the Twenty-Ninth Hawaii International Conference*, Vol. 3, pp. 92-101, 1996.

[17]   J. Galegher and R.E. Kraut, "Computer-mediated Communication for Intellectual Teamwork: An Experiment in Group Writing," *Information System Research*, Vol. 5, No. 2, pp. 110-138, 1994.

[18]   D.A. Sapp and J. Simon, "Comparing Grades in Online and Face-to-Face Writing Courses: Interpersonal Accountability and Institutional Commitment," *Computers and Composition*, Vol. 22, No. 3, pp. 471-489, 2005.

[19]   R. Sharda, S.H. Barr, J.C. McDonnel, "Decision Support System Effectiveness: A Review and an Empirical Test," *Management Science*, Vol. 34, No. 2, pp. 139-159, 1988.

[20]   J.I. Tutty and J.D. Klein, "Computer-mediated Instruction: A Comparison of Online and Face-to-Face Collaboration," *Education Technology Research and Development*, Vol. 56, pp. 101-124, 2008.

[21]   D.G. Ancona and D.F. Caldwell, "Demography and Design: Predictors of New Product Team Performance," *Organization Science,* Vol. 3, No. 3, pp. 321-341, 1992.

[22]   P. Balthazard, R.E. Potter, J. Warren, "Expertise, Extraversion and Group Interaction Styles as Performance Indicators in Virtual Teams," *Database for Advances in Information Systems*, Vol. 35, No. 1, pp. 41-64, 2004.

[23]   A. Pinsonneault and O. Caya, "Virtual Teams: What We Know, What We Don't Know," *International Journal of e-Collaboration*, Vol. 1, No. 3, pp. 1-16, 2005.

[24]   J. Bradley, B.J. White, B.E. Mennecke, "Teams and Tasks: A Temporal Framework for the Effects of Interpersonal Interventions on Team Performance," *Small Group Research,* Vol. 34, No. 3, pp. 353-387, 2003.

[25]   B.L. Kirkman, B. Rosen, P.E. Tesluk, C.B. Gibson, "The Impact of Team Empowerment on Virtual Team Performance: The Moderating Role of Face-to-Face Interaction," *Academy of Management Journal*, Vol. 47, No. 2, pp. 175-192, 2004.

[26]   B.D. Janz, J.C. Wetherbe, G.B. Davis, R.A. Noe, "Reengineering the Systems Development Process: The Link Be-

tween Autonomous Team and Business Process Outcomes," *Journal of Management Information Systems*, Vol. 14, No. 1, pp. 41-68, 1997.

[27] P.S. Greenberga, R.H. Greenbergb, Y.L. Antonucci, "Creating and Sustaining Trust in Virtual Teams," *Business Horizons*, Vol. 50, No. 4, pp. 325-333, 2007.

[28] A.V. Matveev and P.E. Nelson, "Cross Cultural Communication Competence and Multicultural Team Performance-perceptions of American and Russian Managers," *International Journal of Cross Cultural Management*, Vol. 4, No. 2, pp. 253-270, 2004.

[29] C. Johansson, Y. Dittrich, A. Juustila, "Software Engineering across Boundaries: Student Project in Distributed Collaboration," *IEEE Transactions on Professional Communication*, Vol. 42, No. 4, pp. 286-296, 1999.

[30] B. O'Connail, S. Whittaker, S. Wilbur, "Conversations over Video Conferences: An Evaluation of the Spoken Aspects of Video-mediated Communication," *Human-Computer Interaction*, Vol. 8, No. 4, pp. 389-429, 1993.

[31] M. Sarbaugh-Thompson, M.S. Feldman, "Electronic Mail and Organizational Communication: Does Saying "Hi" Really Matter?" *Organization Science*, Vol. 9, No. 6, pp. 685-698, 1998.

[32] S.G. Straus, "Getting a Clue: The Effects of Communication Media and Information Distribution on Participation and Performance in Computer-mediated and Face-to-Face Groups," *Small Group Research*, Vol. 27, No. 1, pp. 115-142, 1996.

[33] R.B. Gallupe and J.D. McKeen, "Enhancing Computer-mediated Communication: An Experimental Investigation into the Use of a Group Decision Support System for Face-to-Face Versus Remote Meetings," *Information and Management*, Vol. 18, No. 1, pp. 1-13, 1990.

[34] A.B. Hollingshead, "Communication, Learning, and Retrieval in Transactive Memory Systems," *Journal of Experimental Social Psychology*, Vol. 34, No. 5, pp. 423-442, 1998.

[35] C.R. Marshall and D.G. Novick, "Conversational Effectiveness in Multimedia Communications," *Information Technology and People*, Vol. 8, No. 1, pp. 54-79, 1995.

[36] S.G. Straus, J.A. Miles, L.L. Levesque, "The Effects of Videoconference, Telephone, and Face-to-face Media on Interviewer and Applicant Judgments in Employment Interviews," *Journal of management*, Vol. 27, No. 3, pp. 363-381, 2001.

[37] G. DeSanctis and P. Monge, "Introduction to the Special Issue: Communication Processes for Virtual Organizations," *Organization Science*, Vol. 10, No. 6, pp. 693-703, 1999.

[38] D.K. Dufner, O. Kwon, Y.T. Park, Q. Peng, "Asynchronous Team Support: Perceptions of the Group Problem Solving Process When Using a Cybercollaboratory," *Proceeding of the 35th Hawaii International Conference on System Sciences*, pp.12-20, 2002.

[39] J.D. Thompson, *Organizations in Action*, New York: McGraw Hill, 1967.

[40] M. Turoff and A. Rana, *A Task Morphology for Group Decision Support Systems. In S. R. Hiltz & M. Turoff (Eds.)*, The Network Nation: Human Communication via Computer, Cambridge: M.I.T. Press, 1993.

[41] A. Simha and R. Kishore, "Enhancing E-Collaboration Effectiveness Through the Use of Wikis: A Theoretical Examination in the Context of Requirements Elicitation," *International Journal of e-Collaboration*, Vol. 5, No. 3, pp. 58-78, 2009.

[42] A.P. Massey, M. Montoya-Weiss, Y.-T.C. Hung, "Synchronizing Pace in Asynchronous Global Virtual Project Teams," in *Proceedings of the 35th Hawaii International Conference on System Sciences*, Vol. 1, pp. 14, 2002.

[43] J.E. McGrath, "Time, Interaction, and Performance (TIP): A Theory of Groups," *Small Group Research*, Vol. 22, No. 2, pp. 147-174, 1991.

[44] M.M. Montoya-Weiss, A.P. Massey, M. Song, "Getting It Together: Temporal Coordination and Conflict Management in Global Virtual Teams," *Academy of Management Journal*, Vol. 44, No. 6, pp. 1251-1262, 2001.

[45] D. Kitchen and D. McDougall, "Collaborative Learning on the Internet," *Journal of Educational Technology Systems*, Vol. 27, No. 3, pp. 245-258, 1999.

[46] P. Bordia, "Face-to-Face Versus Computer-mediated Communication: A Synthesis of the Experimental Literature," *The Journal of Business Communication*, Vol. 34, No. 1, pp. 99-120, 1997.

[47] M.L. Maznevski and K.M. Chudoba, "Bridging Space over Time: Global Virtual Team Dynamics and Effectiveness," *Organization Science*, Vol. 11, No. 5, pp. 473-492, 2000.

[48] D. Robey, H.M. Khoo, C. Powers, "Situated Learning in Cross-functional Virtual Teams," *IEEE Transactions on Professional Communications*, Vol. 43, No. 1, pp. 51-66, 2000.

[49] A.V. Carron, L.R. Brawley, N.W. Widmeyer, "The Group Environment Questionnaire Test Manual," *USA: Fitness Information Technology*, 2002.

[50] J.S. Lurey and M.S. Raisinghani, "An Empirical Study of Best Practices in Virtual Teams," *Information and Management*, Vol. 38, No. 8, pp. 523-544, 2001.

[51] A. Powell, G. Piccoli, B. Ives, "Virtual Teams: A Review of Current Literature and Directions for Future Research," *Database for Advances in Information Systems*, Vol. 35, No. 1, pp. 6-36, 2004.

[52] B. Collins and H. Guetzkow, *A social psychology of group processes for decision-making*, New York: Wiley, 1964.

[53] F. Lau, S. Sarker, S. Sahay, "On Managing Virtual Teams," *Healthcare Information Management Communications Canada*, Vol. 14, No. 2, pp. 46-53, 2000.

[54] D.J. Pauleen, "An Inductively Derived Model of Leader-initiated Relationship Building with Virtual Teams Members," *Journal of Management Information Systems*, Vol. 20, No. 3, pp. 227-256, 2003.

[55] C.D. Cramton, "The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration," *Organization Science*, Vol. 12, No. 3, pp. 346-371, 2001.

[56] R. Kraut, C. Steinfield, A.P. Chan, B. Butler, A. Hoag, "Coordination and Virtualization: The Role of Electronic Networks and Personal Relationships," *Organization Science*, Vol. 10, No. 6, pp. 722-740, 1999.

[57] G.S. Mesch, "Social Context and Communication Channels Choice among Adolescents," *Computers in Human Behavior*, Vol. 25, No. 1, pp. 244-251, 2009.

[58] S. Sawyer and P.J. Guinan, "Software Development: Processes and Performance," *IBM Systems Journal*, Vol. 37, No. 4, pp. 552-568, 1998.

[59] A.J. Lott and B.D. Lott, "Group Cohesiveness as Interpersonal Attraction: A Review of Relationships with Antecedent and Consequent Variables," *Psychological Bulletin*, Vol. 64, No. 4, pp. 259-309, 1965.

[60] K.A. Bollen and R.H. Hoyle, "Perceived Cohesion: A Conceptual and Empirical Examination," *Social Force,* Vol. 69, No. 2, pp. 479-504, 1990.

[61] A.A. Cota, C.R. Evans, K.L. Dion, L. Kilik, R.S. Longman, "The Structure of Group Cohesion," *Personality and Social Psychology Bulletin*, Vol. 21, No. 6, pp. 572-580, 1995.

[62] A.V. Carron, W.N. Widmeyer, L.R. Brawley, "The Development of an Instrument to Assess Cohesion in Sport Teams: The Group Environment Questionnaire," *Journal of Sport Psychology,* Vol. 7, No. 3, pp. 244-266, 1985.

[63] A. Chang and P. Bordia, "A Multidimensional Approach to the Group Cohesion-group Performance Relationship," *Small Group Research*, Vol. 32, No. 4, pp. 379-405, 2001.

[64] L. Chidambaram, "Relational Development in Computer-supported Groups," *MIS Quarterly*, Vol. 20, No. 2, pp. 143-165, 1996.

[65] D.R. Ilgen, J.R. Hollenbeck, M. Johnson, D. Jundt, "Teams in Organizations: From Input-Process-Output Models to IMOI Models," *Annual Review of Psychology*, Vol. 56, No. 1, pp. 517-543, 2005.

[66] J. Short, E. Williams, B. Christie, *The social psychology of telecommunications*, London: Wiley, 1976.

[67] R.L. Daft, R.H. Lengel, L.K. Trevino, "Message Equivocality, Media Selection, and Manager Performance: Implications for Information Systems," *MIS Quarterly*, Vol. 11, No. 3, pp. 355-366, 1987.

[68] J.B. Walther, "Computer-mediated Communication: Impersonal, Interpersonal, and Hyperpersonal Interaction," *Human Communication Research*, Vol. 23, No. 1, pp. 3-43, 1996.

[69] B.C.Y. Tan, K.-K. Wei, W.W. Huang, G.-N. Ng, "A Dialogue Technique to Enhance Electronic Communication in Virtual Teams," *IEEE Transactions on Professional Communication*, Vol. 43, No. 2, pp. 153-165, 2000.

[70] H.B. Hian, S.L. Chuan, T.M.K. Trevor, B.H. Detenber, "Getting to Know You: Exploring the Development of Relational Intimacy in Computer-mediated Communication," *Journal of Computer Mediated Communication*, Vol. 9, No. 3, 2004.

[71] J.B. Walther, C.L. Slovacek, L.C. Tidwell, "Is a Picture Worth a Thousand Words? Photographic Images in Long-term and Short-term Computer-mediated Communication," *Communication Research*, Vol. 28, No. 1, pp. 105-134, 2001.

[72] R. Grohowski, C. McGoff, D. Vogel, B. Martz, J. Nunamaker, "Implementing Electronic Meeting Systems at IBM: Lessons Learned and Success Factors," *MIS Quarterly*, Vol. 14, No. 4, pp. 368-383, 1990.

[73] J. Lipnack and J. Stamps, *Virtual teams (Second ed.)*, United States: John Wiley & Sons, 2000.

[74] R.P. Bagozzi and Y. Youjae, "On the Evaluation of Structural Equation Models," *Journal of the Academy of Marketing Science,* Vol. 16, No. 1, pp. 74-94, 1988.

[75] K.G. Jöreskog and D. Sörbom, *PRELIS 2: User's reference guide*, Chicago: Scientific Software International, 1996.

[76] J. Jaccard and C.K. Wan, *LISREL Approaches to Interaction Effects in Multiple Regression*, Thousand Oaks, California: Sage Publications, 1996.

[77] W.W. Chin and P.A. Todd, "On the Use, Usefulness, and Ease of Use of Structural Equation Modeling in MIS Research: A Note of Caution," *MIS Quarterly*, Vol. 19, No. 2, pp. 237-246, 1995.

[78] R.P. McDonald and M.-H.R. Ho, "Principles and Practice in Reporting Structural Equation Analyses," *Psychological Methods*, Vol. 7, No. 1, pp. 64-82, 2002.

[79] L. Hu and P.M. Bentler, "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives," *Structural Equation Modeling*, Vol. 6, No. 1, pp. 1-55, 1999.

[80] A.L. Casper-Curtis, *Virtual Team Development in a College Course Setting*, Unpublished Master of Science, University of Wisconsin-Stout, 2002.

[81] K. Swan, "Virtual Interaction: Design Factors Affecting Student Satisfaction and Perceived Learning in Asynchronous Online Courses," *Distance Education*, Vol. 22, No. 2, pp. 306-331, 2001.

[82] B.W. Tuckman, "Development Sequence in Small Groups," *Psychological Bulletin*, Vol. 63, pp. 348-399, 1965.

[83] C.M. Solomon, "Managing Virtual Teams," *Workforce*, Vol. 80, No. 6, pp. 60-64, 2001.

[84] S. Qureshi and D. Vogel, "Adaptiveness in Virtual Teams: Organisational Challenges and Research Directions," *Group*

Decision and Negotiation, Vol. 10, pp. 27-46, 2001.